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[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 429 and 431

[EERE-2020-BT-STD-0007]

RIN 1904-AF55

Energy Conservation Program: Energy Conservation Standards for Expanded Scope Electric Motors

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

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act, as amended ("EPCA"), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including electric motors**.** In this final rule, DOE is adopting amended energy conservation standards for a subset of electric motors, expanded scope electric motors. It has determined that the energy conservation standards for this equipment would result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: The effective date of this rule is **[INSERT DATE 75 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER*]**. Compliance with the standards established for expanded scope electric motors in this final rule is required on and after

January 1, 2029. The incorporation by reference of certain publications listed in the rule is approved by the Director of the Federal Register on **INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***.

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

The docket webpage can be found at *www.regulations.gov/docket/EERE-2020-BT-STD-0007*. The docket webpage contains instructions on how to access all documents, including public comments, in the docket.

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

FOR FURTHER INFORMATION CONTACT:

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Ms. Matthew Schneider, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-4798. Email: *matthew.schneider@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

DOE incorporates by reference the following industry standard into part 431:

UL 674 ("UL 674-2022"), "Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations", Sixth Edition, July 29, 2022."

Copies of UL 674-2022 can be obtained from the Underwriters Laboratories ("UL") at 333 Pfingsten Road, Northbrook, IL 60062, (841) 272-8800, or by going to *www.ul.com*.

See section IV.N of this document for further discussion of this standard.

Table of Contents

I. Synopsis of the Final Rule

The Energy Policy and Conservation Act, Pub. L. 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, as codified) Title III, Part C[2] of the EPCA, established the Energy Conservation Program for Certain Industrial Equipment. (42 U.S.C. 6311–6317) Such equipment includes electric motors. This rulemaking concerns a subcategory of electric motors, referred to hereinafter as expanded scope electric motors ("ESEMs"). This rulemaking does not address small electric motors ("SEMs") that are covered under title 10 of the Code of Federal Regulations ("CFR") part 431, subpart X.

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 significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Pub. L. 116-260 (Dec. 27, 2020), which reflects 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 re-designated Part A-1.

ESEMs are a subcategory of electric motor with specific characteristics,[3] which include certain single phase and polyphase alternative current induction motors between 0.25 and 3 horsepower ("hp"). ESEMs may be sold and incorporated in a wide range of residential, commercial, and industrial applications such as power tools, pressure washers, air handling units, and industrial processing equipment. These applications can include end-use equipment and products that are regulated by DOE as well as end-use equipment and products that are not regulated by DOE.

In addition, ESEMs may be sold as standalone motors to original equipment manufacturers ("OEMs") for use in new equipment or may be sold to OEMs or other parts of a distribution chain as replacement products to go into existing equipment that is already installed in the field. At the point of manufacture, there are no physical or technological distinguishing factors in a ESEM that could be used to definitively identify a particular end-use application, or to identify if the ESEM will be sold for incorporation in a regulated or a non-regulated equipment or consumer product, or sold for the replacement market. See section III.C of this document for further description.

As discussed in detail in section II.B of this document, as a part of the process to determine if it was necessary to amend the existing standards for electric motors found in 10 CFR part 431, subpart B, DOE also assessed whether to include standards for ESEMs. ESEMs are already included in the scope of the DOE test procedure for electric motors (*see* section III.E of this document for further description) but were not subject to energy

[3] See section III.C.1.a of this document for a full description

conservation standards. DOE received separate recommendations for proposed energy conservation standards and as a result, split the process into two separate rulemakings, one for certain electric motors, which are hereinafter referred to as medium electric motors, which were covered in a separate rulemaking ("MEMs" - *see* section III.C.1 of this document for further description) and this final rule for ESEMs.

In accordance with these and other statutory provisions discussed in this document, DOE analyzed the benefits and burdens of four trial standard levels ("TSLs") for ESEMs. 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 of this document, DOE has determined that TSL 2 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified. The adopted standards, which are expressed in average full-load efficiency, are shown in Table I-1 through Table I-3 and are equivalent to those recommended in a joint recommendation for energy conservation standards for ESEMs[4] ("December 2022 Joint Recommendation") from the Motor Coalition, representing the motors industry, energy efficiency organizations, and utilities.[5] These standards apply to all ESEMs listed in Table I-1 through Table I-3 and manufactured in, or imported into, the United States starting on January 1, 2029. These standards apply whether those ESEMs are

[4] In the letter, this category is referred to as "SNEM." *See* discussion on the change in terminology in sections III.A and III.B of this document.
[5] The members of the Motor Coalition included American Council for an Energy-Efficient Economy, Appliance Standards Awareness Project, National Electrical Manufacturers Association, Natural Resources Defense Council, Northwest Energy Efficiency Alliance, Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison. The December 2022 Joint Recommendation is accessible at *www.regulations.gov/comment/EERE-2020-BT-STD-0007-0038*.

manufactured/imported alone or as a component of another piece of equipment or consumer product.

Table I-1 Energy Conservation Standards for High- and Medium-Torque ESEMs (Including Air-over ESEMs) (Compliance Starting on January 1, 2029) (Recommended TSL 2)

	Average Full-Load Efficiency							
	Open				Enclosed			
Hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	59.5	59.5	57.5	--	59.5	59.5	57.5	--
0.33	64.0	64.0	62.0	50.5	64.0	64.0	62.0	50.5
0.5	68.0	69.2	68.0	52.5	68.0	67.4	68.0	52.5
0.75	76.2	81.8	80.2	72.0	75.5	75.5	75.5	72.0
1	80.4	82.6	81.1	74.0	77.0	80.0	77.0	74.0
1.5	81.5	83.8	--	--	81.5	81.5	80.0	--
2	82.9	84.5	--	--	82.5	82.5	--	--
3	84.1	--	--	--	84.0	--	--	--

Table I-2 Energy Conservation Standards for Low-Torque ESEMs (Including Air-over ESEMs) (Compliance Starting on January 1, 2029) (Recommended TSL 2)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	63.9	66.1	60.2	52.5	60.9	64.1	59.2	52.5
0.33	66.9	69.7	65.0	56.6	63.9	67.7	64.0	56.6
0.5	68.8	70.1	66.8	57.1	65.8	68.1	65.8	57.1
0.75	70.5	74.8	73.1	62.8	67.5	72.8	72.1	62.8
1	74.3	77.1	77.3	65.7	71.3	75.1	76.3	65.7
1.5	79.9	82.1	80.5	72.2	76.9	80.1	79.5	72.2
2	81.0	82.9	81.4	73.3	78.0	80.9	80.4	73.3
3	82.4	84.0	82.5	74.9	79.4	82.0	81.5	74.9

Table I-3 Energy Conservation Standards for Polyphase ESEMs (Including Air-over ESEMs) (Compliance Starting on January 1, 2029) (Recommended TSL 2)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	65.6	69.5	67.5	62.0	66.0	68.0	66.0	62.0
0.33	69.5	73.4	71.4	64.0	70.0	72.0	70.0	64.0
0.5	73.4	78.2	75.3	66.0	72.0	75.5	72.0	66.0
0.75	76.8	81.1	81.7	70.0	75.5	77.0	74.0	70.0
1	77.0	83.5	82.5	75.5	75.5	77.0	74.0	75.5
1.5	84.0	86.5	83.8	77.0	84.0	82.5	87.5	78.5
2	85.5	86.5	--	86.5	85.5	85.5	88.5	84.0
3	85.5	86.9	--	87.5	86.5	86.5	89.5	85.5

A. Benefits and Costs to Consumers

Table I-4 summarizes DOE's evaluation of the economic impacts of the adopted standards on consumers of ESEMs, as measured by the average life-cycle cost ("LCC") savings and the simple payback period ("PBP").[6] The average LCC savings are positive for all equipment classes, and the PBP is less than the average lifetime of ESEMs, which is estimated to be 7.1 years (*see* section IV.F of this document).

Table I-4 Impacts of Energy Conservation Standards on Consumers of ESEMs

Representative Unit	Average LCC Savings *2023$*	Simple Payback Period *years*
ESEM High/Med Torque, 4 poles, enclosed, 0.25 hp	59.3	1.2
ESEM High/Med Torque, 4 poles, enclosed, 1 hp	159.9	0.9
ESEM Low-torque, 6 poles, enclosed, 0.25 hp	186.4	0.9
ESEM Low-torque, 6 poles, enclosed, 0.5 hp	124.4	1.7
ESEM Polyphase, 4 poles, enclosed, 0.25 hp	31.3	1.9
AO-ESEM High/Med Torque, 4 poles, enclosed, 0.25 hp	103.7	0.9
AO-ESEM High/Med Torque, 4 poles, enclosed, 1 hp	189.6	0.7
AO-ESEM Low-torque, 6 poles, enclosed, 0.25 hp	170.3	0.9
AO-ESEM Low-torque, 6 poles, enclosed, 0.5 hp	109.6	1.7
AO-ESEM Polyphase, 4 poles, enclosed, 0.25 hp	47.2	1.7

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

[6] 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 standards (*see* section IV.F.9 of this document). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (*see* section IV.C 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 (2024–2058). Using a real discount rate of 9.1 percent, DOE estimates that the INPV for manufacturers of ESEMs in the case without new standards is $2,007 million in 2023$. Under the adopted standards, DOE estimates the change in INPV to range from -13.7 percent to -8.0 percent, which is approximately -$274 million to -$160 million. In order to bring products into compliance with new standards, it is estimated that industry will incur total conversion costs of $360 million.

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

In addition, in response to comments received on the December 2023 NOPR and discussed in section III.D.2 of this document, DOE also considered the impacts on OEMs of equipment and products incorporating ESEMs. See section V.B.7 of this document for more details.

C. National Benefits and Costs[7]

DOE's analyses indicate that the adopted energy conservation standards for ESEMs would save a significant amount of energy. Relative to the case without standards, the lifetime energy savings for ESEMs purchased in the 30-year period that begins in the anticipated year of compliance with the standards (2029–2058) amount to

[7] All monetary values in this document are expressed in 2023 dollars. and, where appropriate, are discounted to 2024 unless explicitly stated otherwise.

8.8 quadrillion British thermal units ("Btu"), or quads.[8] This represents a savings of 8.2 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 standards for ESEMs ranges from $21.1 billion (at a 7-percent discount rate) to $47.5 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 ESEMs purchased during the period 2029–2058.

In addition, the adopted standards for ESEMs are projected to yield significant environmental benefits. DOE estimates that the standards will result in cumulative emission reductions (over the same period as for energy savings) of 156.0 million metric tons ("Mt")[9] of carbon dioxide ("CO_2"), 292.3 thousand tons of sulfur dioxide ("SO_2"), 41.6 thousand tons of nitrogen oxides ("NO_X"), 1,338.0 thousand tons of methane ("CH_4"), 1.4 thousand tons of nitrous oxide ("N_2O"), and 0.3 tons of mercury ("Hg").[10]

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[8] 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 of this document.

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

[10] DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2023* ("*AEO2023*"). *AEO2023* reflects, to the extent possible, laws and regulations adopted through mid-November 2022, including the Inflation Reduction Act. *See* section IV.K of this document for further discussion of *AEO2023* assumptions that affect air pollutant emissions.

DOE estimates the value of climate benefits from a reduction in greenhouse gases ("GHGs") using 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").[11] Together these represent the social cost of GHG ("SC-GHG"). DOE used an updated set of SC-GHG estimates (in terms of benefit-per-ton of GHG avoided) published in 2023 by the Environmental Protection Agency ("EPA") ("2023 SC-GHG"), as well as the interim SC-GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases ("IWG") in 2021 ("2021 Interim SC-GHG") , which DOE used in the NOPR for this rule before the updated values were available. [12] The values are discussed in section IV.L of this document. The climate benefits associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates are estimated to be $36.5 billion, and the climate benefits associated with the average 2021 Interim SC-GHG estimates at a 3-percent discount rate are estimated to be $9.1 billion. DOE notes, however, that the adopted standards would be economically justified even without inclusion of the estimated monetized benefits of reduced GHG emissions.

Estimated climate-related benefits are provided in compliance with Executive Order 12866.[12] *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. www.epa.gov/system/files/documents/2023-12/eo12866_oil-and-gas-nsps-eg-climate-review-2060-av16-final-rule-20231130.pdf; https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf* (last accessed July 3, 2024)

[12] *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. www.epa.gov/system/files/documents/2023-12/eo12866_oil-and-gas-nsps-eg-climate-review-2060-av16-final-rule-20231130.pdf; https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf* (last accessed July 3, 2024)

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions using benefit-per-ton estimates from EPA's Benefit Mapping and Analysis Program, [13] 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 $7.3 billion using a 7-percent discount rate, and $17.6 billion using a 3-percent discount rate. [14] DOE is currently only monetizing health benefits from changes in ambient fine particulate matter ($PM_{2.5}$) concentrations from two precursors (SO_2 and NO_X), and from changes in ambient ozone from one precursor (for NO_X), but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions.

Table I-5 summarizes the monetized benefits and costs expected to result from the new standards for ESEMs. 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.

[13] U.S. EPA. Estimating the Benefit per Ton of Reducing Directly Emitted PM2.5, PM2.5 Precursors and Ozone Precursors from 21 Sectors. Available at *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors.*

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

Table I-5 Summary of Monetized Benefits and Costs of Adopted Energy Conservation Standards for ESEMs (2029–2058)

	Billion $2023
3% Discount Rate	
Consumer Operating Cost Savings	55.8
Climate Benefits* (2023 SC-GHG estimates)	36.5
Climate Benefits*(2021 Interim SC-GHG estimates)	9.1
Health Benefits**	17.6
Total Benefits† (2023 SC-GHG estimates)	109.9
Total Benefits† (2021 Interim SC-GHG estimates)	82.5
Consumer Incremental Product Costs‡	8.3
Net Monetized Benefits (2023 SC-GHG estimates)	101.5
Net Monetized Benefits (2021 Interim SC-GHG estimates)	74.2
Change in Producer Cash Flow (INPV)‡‡	(0.3)–(0.2)
7% Discount Rate	
Consumer Operating Cost Savings	25.5
Climate Benefits* (2023 SC-GHG estimates)	36.5
Climate Benefits*(2021 Interim SC-GHG estimates)	9.1
Health Benefits**	7.3
Total Benefits† (2023 SC-GHG estimates)	69.3
Total Benefits† (2021 Interim SC-GHG estimates)	41.9
Consumer Incremental Product Costs‡	4.4
Net Monetized Benefits (2023 SC-GHG estimates)	64.8
Net Monetized Benefits (2021 Interim SC-GHG estimates)	37.5
Change in Producer Cash Flow (INPV)‡‡	(0.3)–(0.2)

Note: This table presents the costs and benefits associated with ESEMs shipped in 2029−2058. These results include consumer, climate, and health benefits that accrue after 2058 from the equipment shipped in 2029−2058.
* Climate benefits are calculated using different estimates of the social cost of carbon (SC-CO_2), methane (SC-CH_4), and nitrous oxide (SC-N_2O). Climate benefits are estimated using two separate sets of estimates of the social cost for each greenhouse gas, an updated set published in 2023 by the Environmental Protection Agency (EPA) ("2023 SC-GHG") and the interim set of estimates used in the NOPR which were published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim 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 2 percent near-term Ramsey discount rate are shown for the 2023 SC-GHG estimates, and the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown for the 2021 Interim SC-GHG estimates.
** 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. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 21 Sectors* TSD provides a summary of the health impact endpoints quantified in the analysis. *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 2 percent near-term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-GHG with 3-percent discount rate for the 2021 Interim SC-GHG estimates.
‡ Costs include incremental equipment costs as well as installation costs.
‡‡ Operating Cost Savings are calculated based on the LCC analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impact analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, manufacturer impact analysis ("MIA")). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cash flow, 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 9.1 percent that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For ESEMs, the change in INPV ranges from -$274 million to -$160 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 Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the 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 INPV in the above table, drawing on the MIA explained further in section IV.J of this document to provide additional context for assessing the estimated impacts of this final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation (2023 SC-GHG estimates) for this final rule, the net benefits would range from $101.2 billion to $101.3 billion at 3-percent discount rate and would range from $64.5 billion to $64.6 billion at 7-percent discount rate.

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are (1) the reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the value of climate and health benefits of emission reductions, all annualized.[15]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of ESEMs shipped during the period 2029–2058. The benefits associated with reduced emissions achieved as a result of the adopted standards are also calculated based on the lifetime of ESEMs shipped during the period 2029–2058. Total benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with a 2 percent near-term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-GHG with 3-percent discount rate for the 2021 Interim SC-GHG estimates.[16]

Table I-6 presents the total estimated monetized benefits and costs associated with the adopted standard, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from

[15] 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.*, 2020 or 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.

[16] DOE notes that using consumption-based discount rates (*e.g.*, 2 or 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.

reduced GHG emissions, the estimated cost of the standards adopted in this rule is $466 million per year in increased equipment installed costs, while the estimated annual benefits are $2,692 million from reduced equipment operating costs, $1,762 million in climate benefits (using the 2023 SC-GHG estimates) or $522 million in climate benefits (using the 2021 Interim SC-GHG estimates), and $773 million in health benefits. In this case, the net benefit amounts to $4,760 million per year (using the 2023 SC-GHG estimates) or $3,520 million per year (using the 2021 Interim SC-GHG estimates).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards is $477 million per year in increased equipment installed costs, while the estimated annual benefits are $3,202 million from reduced equipment operating costs, $1,762 million in climate benefits (using the 2023 SC-GHG estimates) or $522 million in climate benefits (using the 2021 Interim SC-GHG estimates), and $1,012 million in health benefits. In this case, the net benefit amounts to $5,499 million per year (using the 2023 SC-GHG estimates) or $4,260 million per year (using the 2021 Interim SC-GHG estimates).

Table I-6 Annualized Benefits and Costs of Adopted Standards for ESEMs (2029–2058)

	Million 2023$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
	3% Discount Rate		
Consumer Operating Cost Savings	3,202	3,021	3,400
Climate Benefits* (2023 SC-GHG estimates)	1,762	1,708	1,827
Climate Benefits* (2021 Interim SC-GHG estimates)	522	506	541
Health Benefits**	1,012	983	1,048
Total Benefits† (2023 SC-GHG estimates)	5,976	5,711	6,276
Total Benefits† (2021 Interim SC-GHG estimates)	4,737	4,510	4,989
Consumer Incremental Product Costs‡	477	494	468
Net Monetized Benefits (2023 SC-GHG estimates)	5,499	5,218	5,807
Net Monetized Benefits (2021 Interim SC-GHG estimates)	4,260	4,016	4,521
Change in Producer Cash Flow (INPV)‡‡	(26)–(15)	(26)–(15)	(26)–(15)
	7% Discount Rate		
Consumer Operating Cost Savings	2,692	2,552	2,848
Climate Benefits* (2023 SC-GHG estimates)	1,762	1,708	1,827
Climate Benefits* (2021 Interim SC-GHG estimates)	522	506	541
Health Benefits**	773	753	797
Total Benefits† (2023 SC-GHG estimates)	5,226	5,013	5,472
Total Benefits† (2021 Interim SC-GHG estimates)	3,987	3,811	4,186
Consumer Incremental Product Costs‡	466	478	461
Net Monetized Benefits (2023 SC-GHG estimates)	4,760	4,535	5,011
Net Monetized Benefits (2021 Interim SC-GHG estimates)	3,520	3,334	3,725
Change in Producer Cash Flow (INPV)‡‡	(26)–(15)	(26)–(15)	(26)–(15)

Note: This table presents the costs and benefits associated with ESEMs shipped in 2029−2058. These results include consumer, climate, and health benefits that accrue after 2058 from the products shipped in 2029−2058. 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 and IV.H. of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.
* Climate benefits are estimated using two separate sets of estimates of the social cost for each greenhouse gas, an updated set published in 2023 by the Environmental Protection Agency (EPA) ("2023 SC-GHG") and the set used in the NOPR which was published in 2021 as interim estimates by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim 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 2 percent near-term Ramsey discount rate are shown for the 2023 SC-GHG estimates, and the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown for the 2021 Interim SC-GHG estimates.
** 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. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 21 Sectors* TSD provides a summary of the health impact endpoints quantified in the analysis. *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 2 percent near-term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-GHG with 3-percent discount rate for the 2021 Interim SC-GHG estimates.
‡ Costs include incremental equipment costs as well as installation costs.
‡‡ Operating Cost Savings are calculated based on the LCC analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impact analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cash flow, 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 9.1 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 ESEMs, the annualized change in INPV ranges from -$26 million to -$15 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 Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the 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 final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this final rule, the annualized net benefits (2023 SC-GHG estimates) would range from $5,473 million to $5,484 million at 3-percent discount rate and would range from $4,734 million to $4,745 million at 7-percent discount rate.

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

D. Conclusion

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

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards for ESEMs is $466 million per year in increased equipment costs, while the estimated annual benefits are $2,692 million in reduced equipment operating costs, $1,762 million in climate benefits (using the 2023 SC-GHG estimates) or $522 million in climate benefits (using the 2021 Interim SC-GHG estimates), and $773 million in health benefits. In this case, the net benefit amounts to $4,760 million per year (using the 2023 SC-GHG estimates) or $3,520 million per year (using the 2021 Interim SC-GHG estimates). DOE notes that the net benefits are substantial even in the absence of the climate benefits,[17] and DOE would adopt the same standards in the absence of such benefits.

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

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.[18] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than that of products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the standards are projected to result in estimated national energy savings of 8.8 quads FFC, the equivalent of the primary annual energy use of 58.7 million homes. In addition, they are projected to reduce cumulative CO_2 emissions by 156.0 Mt. Based on these findings, DOE has determined the energy savings from the standard levels adopted in this final rule are "significant" within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these conclusions is contained in the remainder of this document and the accompanying TSD.

In accordance with these and other statutory provisions discussed in this document, DOE analyzed the benefits and burdens of four trial standard levels ("TSLs") for ESEMs. 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 of this document, DOE has determined that TSL 2 (the Recommended TSL) represents the

[18] 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).

maximum improvement in energy efficiency that is technologically feasible and economically justified

II. Introduction

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

A. Authority

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317, as codified) Title III, Part C of EPCA,[19] added by Pub. L. 95-619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. (42 U.S.C. 6311–6317) This equipment includes electric motors. (42 U.S.C. 6311(1)(A)) ESEMs, the subject of this document, are a category of electric motors.

EPCA further provides that, not later than 6 years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the equipment do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as

[19] As noted previously, for editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A-1.

appropriate). (42 U.S.C. 6295(m)(1); 42 U.S.C. 6316(a)) As part of the Department's review process under the 6-year lookback, it has been DOE's long-standing practice to not only consider whether more-stringent standards are warranted for existing equipment classes, but also whether existing equipment classes should be revised or new equipment classes should be added. For example, in a final rule adopted in January 2015, DOE revised the existing equipment classes for automatic commercial ice makers by including additional harvest capacities. 80 FR 4646, 4647 (Jan. 28, 2015). DOE also amends standards by adding additional equipment classes to an existing covered equipment category as new equipment is introduced in the market or more information and data becomes available that allows DOE to establish standards. For example, manufacturers have made several design innovations to refrigerator-freezers over the years, including the introduction of bottom-mount freezers with the refrigerator sitting on top, which DOE established as a new product class and set new energy standards for in 2011. 76 FR 57516 (September 15, 2011). As another example, DOE established initial energy conservation standards for refrigerated beverage vending machines ("BVMs") in a final rule published on August 31, 2009. 74 FR 44914. In that rule, DOE determined that combination vending machines were covered equipment as they met the definition of a BVM. But as DOE did not have sufficient information and data to determine whether standards for combination vending machines would satisfy the applicable statutory criteria, DOE did not establish standards for combination vending machines as part of the initial standards for BVMs. *Id.* at 44920. Subsequently, in a rulemaking conducted under the 6-year lookback provision in 42 U.S.C. 6295(m), DOE amended the standards for BVMs to, among other things, include equipment classes and standards for combination vending machines. 81 FR 1028 (Jan. 8, 2016).

It is also a long-standing practice for Congress to establish initial standards for a covered product or equipment and only apply them to a portion of that covered product or equipment category, leaving it to the Department to further amend the standards consistent with EPCA. For instance, Congress established an initial design standard for residential clothes dryers that applied to gas clothes dryers, but not electric clothes dryers. (42 U.S.C. 6295(g)(3)). DOE subsequently amended the standard for clothes dryers to include performance standards for both gas and electric clothes dryers. *See* 56 FR 22250 (May 14, 1991). DOE has since further amended these standards several times, again addressing both gas and electric dryers. *See* 76 FR 22454 (April 21, 2011) and 89 FR 18164 (March 12, 2024). Similarly, in the Energy Policy Act of 2005, Congress established initial standards for distribution transformers that only applied to low-voltage, dry-type distribution transformers. (42 U.S.C. 6295(y)) DOE subsequently amended the standards for distribution transformers by adding equipment classes and standards for liquid-immersed and medium-voltage, dry-type distribution transformers. *See* 72 FR 58190 (Oct. 12, 2007).

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(a), (b), and (d)).

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); 42 U.S.C. 6297(a)–(c)) DOE may, however, grant waivers of Federal preemption in limited circumstances for particular State laws or regulations, in accordance with the procedures and other provisions set forth under EPCA. (42 U.S.C. 6316(a); 42 U.S.C. 6297(d))

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 covered equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(3)(A) and 6295(r)) Manufacturers of covered equipment must use the Federal test procedures as the basis for certifying to DOE that their equipment complies with the applicable energy conservation standards and as the basis for any representations regarding the energy use or energy efficiency of the equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(s); 42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to evaluate whether a basic model complies with the applicable energy conservation standard(s). (42 U.S.C. 6316(a); 42 U.S.C. 6295(s)) The DOE test procedures for ESEMs appear at title 10 of the Code of Federal Regulations ("CFR") part 431, subpart B, appendix B ("appendix B").

DOE must follow specific statutory criteria for prescribing new or amended standards for covered equipment, including ESEMs. Any new or amended standard for covered equipment must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy ("Secretary") determines is technologically feasible and economically justified. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(A)) 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)(B))

Moreover, DOE may not prescribe a standard if: (1) for certain equipment, including ESEMs, no test procedure has been established for the equipment; or (2) DOE determines by rule that the establishment of such standard will not result in significant conservation of energy (or, for certain products, water), or 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 products subject to the standard;

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

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

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

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

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

7) Other factors the Secretary considers relevant.

(42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

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

EPCA, as codified, also contains what is known as an "anti-backsliding" provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 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 of any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(4))

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

EPCA also addresses the regulation of components for some types of industrial equipment. Several types of industrial equipment, including electric motors, are common components of other industrial equipment and consumer products, e.g., heating, ventilation, and cooling equipment. In certain specific instances, however, EPCA exempted certain motors from regulation. As explained below, those exemptions do not apply to this rulemaking.

EPCA directly addresses component regulation with respect to two subcategories of electric motors. While not directly applicable to this final rule, those exemptions nevertheless illuminate the contours of DOE's authority here. With respect to the initial standards for small electric motors, Congress specified that the standards did not apply to small electric motors used as component parts of covered products or equipment. (42 U.S.C. 6317(b)(3)) In other words, those standards excluded components of covered products and equipment, but did apply to components of non-covered equipment. With respect to the initial standards for general purpose motors, Congress specified that the standards apply to "electric motors manufactured (alone or as a component of another piece of equipment)." (42 U.S.C. 6313(b)). So, those initial Congressionally-set standards applied to motors sold alone or as components in industrial equipment—whether that equipment was itself covered or not under EPCA. But those initial standards did not apply to electric motors sold as components of consumer products— covered or not.

Those specific limits on regulation of component motors do not apply to this rulemaking and therefore do not limit DOE's exercise of its authority here. First, the exemption under section 6317(b)(3)—exempting small electric motors from regulation if they are components of covered products or equipment—does not apply because the motors subject to this rule are not "small electric motors." Second, the limits in section 6313(b) do not apply because those limits applied only to the standards Congress itself prescribed in that subsection. Section 6313(b) is not the source of DOE's authority here. Furthermore, the inapplicable limits in 6313(b) do not supersede the DOE's authority to amend standards under section 6295(m). Nor did section 6313(b) eliminate DOE's authority to regulate covered equipment generally.

DOE is adopting the standards in this rule under the 6-year lookback provision of its authority to regulate "electric motors" as a "type of industrial equipment." 42 U.S.C. 6295(m); 42 U.S.C. 6311(1)(A); *see also* 42 U.S.C. 6298. DOE has long-established discretion to establish the specific scope of the energy conservation standards applicable to a set of covered products or equipment. In this rulemaking, DOE has determined that additional equipment falling within the definition of electric motors, beyond those previously subject to energy conservation standards, ought to be subject to such standards. Determining, revisiting, and revising the scope of its energy conservation standards is routine practice for DOE. *See, e.g.*, Energy Conservation Standards for Dedicated Purpose Electric Motors (88 FR 66966, 66978) (Sept. 28, 2023) (establishing standards for a subset of dedicate purpose electric motors). Absent an express limitation, DOE may include covered equipment that is a component of other regulated products or equipment within the scope of a standard. DOE's authority to regulate ESEMs does not exclude components of equipment or consumer products.

B. Background

1. Current Standards

DOE does not currently have energy conservation standards for ESEMs. DOE has adopted energy conservation standards for MEMs at 10 CFR 431.25 (*see* section III.C.1 of this document for further description), as well as SEMs at 10 CFR 431.446. As discussed in detail below, as a part of the process to determine if it was necessary to amend the existing standards for MEMs, DOE also assessed whether to include standards for ESEMs. ESEMs are already included in the scope of the DOE test procedure for electric motors (*see* section III.E of this document for further description) and are currently not subject to energy conservation standards. DOE received separate recommendations for proposed energy conservation standards and as a result, split the process into two separate rulemakings, one for MEMs and this final rule for ESEMs.

2. History of Standards Rulemaking for ESEMs

On May 21, 2020, DOE issued an early assessment request for information ("RFI") ("May 2020 Early Assessment Review RFI") in which DOE stated that it was initiating an early assessment review to determine whether a new or amended energy conservation standard for electric motors was necessary and sought information related to that effort. Specifically, DOE sought data and information that could enable the agency to determine whether DOE should propose a "no new standard" determination because a more stringent standard: (1) would not result in a significant savings of energy, (2) is not technologically feasible, (3) is not economically justified, or (4) any combination of the foregoing. 85 FR 30878, 30879.

On March 2, 2022, DOE published a preliminary analysis for electric motors ("March 2022 Preliminary Analysis"). 87 FR 11650. In conjunction with the March 2022 Preliminary Analysis, DOE published the March 2022 Preliminary TSD, which presented the results of the in-depth technical analyses in the following areas: (1) engineering, (2) markups to determine equipment price, (3) energy use, (4) LCC and PBP, and (5) national impacts. The results presented included the current scope of electric motors regulated at 10 CFR 431.25, in addition to an expanded scope of motors, including electric motors above 500 hp, air-over electric motors, and ESEMs[20] (*see* chapter 2 of the March 2022 Preliminary TSD).

On April 5, 2022, DOE held a public webinar in which it presented the methods and analysis in the March 2022 Preliminary Analysis and solicited public comment ("April 5, 2022 Public Meeting").

On November 15, 2022, DOE received a joint recommendation (the "November 2022 Joint Recommendation") addressing certain electric motors considered in the March 2022 Preliminary Analysis, but not including ESEMs.[21] By letter dated December 22, 2022, DOE also received the December 2022 Joint Recommendation from the Motor Coalition. The December 2022 Joint Recommendation addressed energy conservation

[20] In the March 2022 Preliminary Analysis, DOE used the term "small, non-small electric motor, electric motors" ("SNEMs") to designate ESEMs.

[21] By letter dated on November 15, 2022, DOE received a joint recommendation for energy conservation standards for electric motors ("November 2022 Joint Recommendation") followed by a supplemental letter on December 9, 2022. The November 2022 Joint Recommendation addressed energy conservation standards for MEMs. After carefully considering the November 2022 Joint Recommendation and supplement for amending the energy conservation standards for electric motors, DOE determined that these recommendations were in accordance with the statutory requirements of 42 U.S.C. 6295(p)(4) for the issuance of a direct final rule.

standards for high-torque, medium-torque, low-torque, and polyphase ESEMs that are 0.25–3 hp, as well as AO-ESEMs. The December 2022 Joint Recommendation recommended a compliance date for updated energy conservation standards for AO-ESEMs as well. (Motor Coalition, No. 38 at p. 5) These recommendations are detailed in section II.B.3 of this document.

While DOE initiated the rulemaking process under 42 U.S.C. 6295(m) by looking at both the current scope of electric motors regulated at 10 CFR 431.25, as well as an expanded scope of motors, in light of the separate recommendations, DOE determined it was appropriate to proceed with two separate rulemakings. On June 1, 2023, DOE published the Electric Motors Direct Final Rule ("June 2023 DFR") that amended energy conservation standards for MEMs and their air-over equivalents. 88 FR 36066.

On December 15, 2023, DOE published a NOPR ("December 2023 NOPR") for ESEMs, in which DOE proposed new energy conservation standards for those electric motors not covered by the June 2023 DFR — *i.e.*, ESEMs — equivalent to those recommended by the Motor Coalition and expressed in terms of average full-load efficiency. 88 FR 87062. DOE decided to proceed with additional public comment on the proposed, recommended standard levels to better understand the impacts of those standards. 88 FR 87064. On January 17, 2024, DOE held a public meeting in which it presented the methods and analysis in the December 2023 NOPR and solicited public comment ("January 17, 2024 Public Meeting").

DOE received comments in response to the December 2023 NOPR from the interested parties listed in Table II-1.

Table II-1 List of Commenters with Written Submissions in Response to the December 2023 NOPR

Commenter(s)	Abbreviation	Comment No. in the Docket	Commenter Type
ABB Ltd.	ABB	65	Manufacturer
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, National Consumer Law Center, Natural Resources Defense Council	Advocates	72	Efficiency Organizations
Association of Home Appliance Manufacturers	AHAM	75	Trade Association
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	70	Trade Association
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison	CA IOUs	73	Utilities
Carrier Global Corporation	Carrier	71	Manufacturer
GE Appliances	GE	76	Manufacturer
Grundfos	Grundfos	67	Manufacturer
Lennox International	Lennox	69	Manufacturer
American Council for an Energy-Efficient Economy Appliance Standards, Awareness Project Electrical Apparatus Service Association Inc., National Electrical Manufacturers Association, Natural Resources Defense Council, Northwest Energy Efficiency Alliance, Pacific Gas & Electric Company, San Diego Gas & Electric, Southern California Edison, WEG Electric Corporation	Motor Coalition	77	Joint Coalition of Advocates, Utilities, and Motor Manufacturers
National Electrical Manufacturer Association	NEMA	68	Trade Association
Michael Ravnitzky	Ravnitzky	62	Individual
Rheem Manufacturing Company	Rheem	74	Manufacturer

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[22] To the extent that interested

[22] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for electric motors, including ESEMs. (Docket No. EERE-2020-BT-STD-0007, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

parties have provided written comments that are substantively consistent with any oral comments provided during the January 17, 2024 Public Meeting, DOE cites the written comments throughout this final rule. DOE did not identify any oral comments provided during the January 17, 2024 Public Meeting that are not substantively addressed by written comments.

3. December 2022 Joint Recommendation

This section summarizes the standard levels recommended in the December 2022 Joint Recommendation and the subsequent procedural steps taken by DOE. Further discussion on scope is provided in section III.C of this document. The Motor Coalition stated that the recommended levels would minimize potential market disruptions by allowing smaller topologies and frame sizes to remain on the market and by generally aligning with standardized efficiency levels published in current industry standards (*i.e.*, Table 12-19, Table 12-20, and Table 12-21 of NEMA MG1-2021) or current regulations for SEMs found at 10 CFR 431.446. Specifically, the Motor Coalition stated that the recommended levels for high- and medium-torque ESEMs would allow smaller frame sizes to remain on the market at a given horsepower and would allow capacitor start induction run ("CSIR") and split-phase topologies, which are common in certain space-constrained products, to remain on the market (0.25–0.5 hp). For low-torque ESEMs, the Motor Coalition stated that efficiency levels above the recommended levels could result in significant increases in the physical size and unavailability of product and may be extremely difficult to achieve with current permanent split capacitor ("PSC") technology and that the recommended levels are achievable without creating market disruptions; for polyphase ESEMs, the Motor Coalition recommended levels that also represent the highest levels of efficiency while minimizing potential market disruptions and would allow smaller frame designs to remain on the market; finally, for AO-ESEMs, the Motor Coalition stated that the recommended levels represented the highest feasible efficiencies given the potential design constraints associated with their use in covered equipment. (Motor Coalition, No. 38 at pp. 3–5)

Recommendation A: For high-torque and medium-torque ESEMs (*i.e.*, CSIR, capacitor-start/capacitor-run ("CSCR"), and split-phase motors), the Motor Coalition recommended the following standard levels, expressed in average full-load efficiency:

1) Values for open and enclosed motors rated at 0.25, 0.33, and 0.5 hp (all pole configurations) that are largely based on the levels in NEMA MG 1, Table 12-19, "Premium Efficiency Levels for Capacitor-Start/Induction-Run Single-Phase Small Motors." The exceptions are the open and enclosed 0.5 hp 4-pole values, which have lower efficiency standards described in Table II-2. For cases where Table 12-19 lists two frame sizes (e.g., 48 and 56 frame) for a given hp rating, the recommended efficiency level reflects the smaller frame size (i.e., lower efficiency).[23]

2) Values for open motors (2-, 4-, 6-pole) above 0.5 hp that are consistent with the current SEM standards for CSCR and CSIR motors found in 10 CFR part 431, subpart X (§ 431.446).

[23] The recommendation did not specify what version of NEMA MG1 to use. DOE referred to NEMA MG1-2021 which was the most recent version available when the recommendation was submitted.

3) Values for 8-pole open motors above 0.5 hp and all-enclosed motors above 0.5 hp that are based on the levels in NEMA MG 1, Table 12-20, "Premium Efficiency Levels for Capacitor-Start/Capacitor-Run Single-Phase Small Motors." For cases where Table 12-20 lists two frame sizes (e.g., 48 and 56 frame) for a given hp rating, the recommended efficiency level reflects the smaller frame size (i.e., lower efficiency).

Table II-2 Recommended Energy Conservation Standards for High-Torque and Medium-Torque ESEMs (*i.e.*, CSIR, CSCR, and split-phase motors)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	59.5	59.5	57.5	--	59.5	59.5	57.5	--
0.33	64.0	64.0	62.0	50.5	64.0	64.0	62.0	50.5
0.5	68.0	69.2	68.0	52.5	68.0	67.4	68.0	52.5
0.75	76.2	81.8	80.2	72.0	75.5	75.5	75.5	72.0
1	80.4	82.6	81.1	74.0	77.0	80.0	77.0	74.0
1.5	81.5	83.8	--	--	81.5	81.5	80.0	--
2	82.9	84.5	--	--	82.5	82.5	--	--
3	84.1	--	--	--	84.0	--	--	--

(*Id*. at pp. 3, 6).

<u>Recommendation B:</u> For low-torque ESEMs (*i.e.*, shaded pole and PSC motors), the Motor Coalition recommended the following standard levels, expressed in terms of average full-load efficiency:

1) Values for open motors rated at 0.25 hp, 0.33 hp, and 1.5 hp and above that are based on DOE's new efficiency level (EL 3).[24]

2) Values for open motors rated at 0.5, 0.75, and 1.0 hp that are based on DOE's new EL 2, with two exceptions:[25]

a) The 6-pole, 1.0 hp value is the midpoint between EL 2 (75.3 percent) and EL 3 (79.2 percent)

b) The 2-pole, 0.5 hp value is the midpoint between EL 2 (66.4 percent) and EL 3 (71.1 percent)

3) Values for enclosed motors that are based on the equivalent open motor efficiency but are adjusted to account for the lack of additional cooling, which is a function of motor rpm (i.e., number of poles). The adjustment is 3 percent for 2-pole motors, 2 percent for 4-pole motors, 1 percent for 6-pole motors, and 0 percent for 8-pole motors.

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[24] "DOE's new efficiency level" refers to preliminary efficiency levels that were developed during the private negotiations of the Motor Coalition. See Table II-3 for the final values chosen from those preliminary efficiency levels.

[25] See footnote 21.

Table II-3 Recommended Energy Conservation Standards for Low-Torque ESEMs (*i.e.*, shaded pole and PSC motors)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	63.9	66.1	60.2	52.5	60.9	64.1	59.2	52.5
0.33	66.9	69.7	65.0	56.6	63.9	67.7	64.0	56.6
0.5	68.8	70.1	66.8	57.1	65.8	68.1	65.8	57.1
0.75	70.5	74.8	73.1	62.8	67.5	72.8	72.1	62.8
1	74.3	77.1	77.3	65.7	71.3	75.1	76.3	65.7
1.5	79.9	82.1	80.5	72.2	76.9	80.1	79.5	72.2
2	81.0	82.9	81.4	73.3	78.0	80.9	80.4	73.3
3	82.4	84.0	82.5	74.9	79.4	82.0	81.5	74.9

(*Id*. at pp. 4, 6)

Recommendation C: For polyphase ESEMs (*i.e.*, three-phase ESEMs), the Motor Coalition recommended the following standard levels, expressed in terms of average full-load efficiency:

1) Values for 2-pole, 4-pole, and 6-pole open motors that are consistent with the current SEM standards for polyphase motors found in 10 CFR part 431, subpart X (section 431.446).

2) Values for 8-pole open and all-enclosed motors from NEMA MG 1, Table 12-21, "Premium Efficiency Levels for Three-Phase Induction Small Motors." For cases where Table 12-21 lists two frame sizes (e.g., 48 and 56 frame) for a given hp rating, the recommended efficiency level reflects the smaller frame size (i.e., lower efficiency).

Table II-4 Recommended Energy Conservation Standards for Polyphase ESEMs (*i.e.*, Three-Phase ESEMs)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	65.6	69.5	67.5	62.0	66.0	68.0	66.0	62.0
0.33	69.5	73.4	71.4	64.0	70.0	72.0	70.0	64.0
0.5	73.4	78.2	75.3	66.0	72.0	75.5	72.0	66.0
0.75	76.8	81.1	81.7	70.0	75.5	77.0	74.0	70.0
1	77.0	83.5	82.5	75.5	75.5	77.0	74.0	75.5
1.5	84.0	86.5	83.8	77.0	84.0	82.5	87.5	78.5
2	85.5	86.5	--	86.5	85.5	85.5	88.5	84.0
3	85.5	86.9	--	87.5	86.5	86.5	89.5	85.5

(*Id.*)

Recommendation D: The Motor Coalition recommended that, if standards are warranted for AO-ESEMs, DOE set the standards at the same levels as those for comparable ESEMs used in non-air-over applications. (*Id.* at p. 5)

Recommendation E: The Motor Coalition recommended that DOE align the compliance date for AO-ESEMs with the compliance date for updated energy conservation standards for commercial unitary air conditioners/heat pumps ("CUAC/HPs") currently under negotiation in DOE's Appliance Standards and Rulemaking Federal Advisory Committee ("ASRAC") Working Group on CUAC/HPs. The Motor Coalition stated this recommended compliance date would appropriately balance energy savings and the time needed for manufacturers of equipment with AO-ESEMs to redesign products. (*Id.*)

In response to the December 2023 NOPR, Lennox stated that the Motor Coalition did not recommend that air-over motors be regulated. Lennox further stated that the Motor Coalition is non-representative because no manufacturers of HVACR products were part of the group. (Lennox, No. 69 at p. 3)

Carrier commented that the Working Group's recommendation was not to have AO motors in scope of this rule, but to identify the specific issues that occur when regulating this type of motor and advise DOE to take the measures required to limit possible disruption in the market. Carrier commented that HVAC manufacturers were not included in the Electric Motor Working Group and that HVAC manufacturers' concerns have not been fully considered. (Carrier, No. 71 at p. 2)

The scope and standards adopted in this document are equivalent to those recommended by the Motor Coalition. Although the Motor Coalition did not specifically recommend standards for AO-ESEMs, the Motor Coalition did recommend that if standards are warranted for AO-ESEMs, DOE set the standards at the same levels as those for comparable ESEMs used in non-air-over applications. (Motor Coalition, No. 38 at p. 5) DOE's newly adopted standards for AO-ESEMs follow this recommendation. In terms of stakeholder representation, the Motor Coalition represents the motors industry, energy efficiency organizations, and utilities. As discussed in the December 2023 NOPR, DOE decided to proceed with additional public comment on the proposed, recommended standard levels to better understand the impacts of those standards, including additional comments from HVACR manufacturers.[26] 88 FR 87064. In addition, as part of the final rule DOE further analyzed the impacts on OEMs as discussed in sections III.D and V.B.7 of this document.

Regarding the compliance year for energy conservation standards for ESEMs, the Motor Coalition recommended that DOE align the compliance date for AO-ESEMs with the compliance date for updated energy conservation standards for CUAC/HPs, which were under negotiation in DOE's ASRAC Working Group on CUAC/HPs at the time. Since then, the CUAC/HP negotiations have concluded and include a recommended compliance year of 2029 (*i.e.*, January 1, 2029).[27] DOE has adopted these amended standards with the recommended compliance date in a direct final rule published May 20, 2024 (89 FR 44052). For this rule, DOE adopts a January 1, 2029 compliance date in accordance with the recommendation from the Motor Coalition on AO-ESEMs. DOE notes that this compliance date is consistent with the requirements in 42 U.S.C. 6295(m)(4)(B). DOE also notes that it adopts this compliance year for all ESEMs.[28,]

Ravnitzky stated support for the compliance timeframes and how DOE considered the impacts and challenges of regulating ESEMs, particularly the low-torque ESEMs. (Ravnitzky, No. 62 at p. 1)

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[26] Table II-1 provides the list of stakeholders who commented in response to the December 2023 NOPR. The comments are summarized and addressed in section II and III of this document.
[27] *See* CUAC/HP ASRAC Working group term sheet at *www.regulations.gov/document/EERE-2022-BT-STD-0015-0087*.
[28] EPCA provides a compliance timeframe afforded to electric motor manufacturers when DOE amends an existing electric motor standard (*see* 42 U.S.C. 6313(b)(4)(B)). However, EPCA does not specify an applicable compliance timeframe when establishing initial standards for classes of electric motors that are not currently subject to DOE standards.

NEMA commented that for EL 2, compliant low-torque ESEMs can be built by the compliance date. The timeframe allows manufacturers to explore technology options while addressing end-users' form, fit, and function needs. (NEMA, No. 68 at p. 4)

The Motor Coalition commented in support of (1) the proposed January 1, 2029, compliance date, which allows sufficient lead time for ESEM manufacturers to redesign products to meet the proposed standards, and (2) the alignment of compliance dates with CUAC/HPs, which will allow CUAC/HP manufacturers to minimize costs, as they can incorporate compliant motors into their design processes to meet the new CUAC/HP standards. (Motor Coalition, No. 77 at p. 2)

As previously noted, DOE adopts a January 1, 2029 compliance date, as proposed in accordance with the recommendation from the Motor Coalition.

III. General Discussion

DOE developed this final rule after a review of the market for the subject ESEMs. DOE also considered comments, data, and information from interested parties that represent a variety of interests. This notice addresses issues raised by these commenters.

A. General Comments

This section summarizes comments received from interested parties regarding the rulemaking overall.

The Advocates and Ravnitzky expressed support of the proposed rule. (Advocates, No. 72 at p. 1; Ravnitzky, No. 62 at p. 1)

Ravnitzky recommended that DOE harmonize the proposed standards across equipment types using similar efficiency levels, test methods, and definitions to avoid duplication and confusion of the standards. (Ravnitzky, No. 62 at p. 2)

As discussed in sections III.E and IV.C of this document, DOE relied on existing industry test methods to develops its test procedure. In addition, DOE relied on existing efficiency requirements to establish efficiency levels.

Ravnitzky recommended that DOE create a simple and fair process allowing for exemptions or waivers to the proposed standards and explain how the waiver process works (*i.e.*, what is required to be granted an exemption), how long the overall process is expected to take, and the pros and cons of exemptions and waivers. (Ravnitzky, No. 62 at p. 2)

Regulations applicable to test procedure waivers for appliances can be found at 10 CFR 430.27 and those applicable to test procedure waivers for commercial equipment are at 10 CFR 431.401. In general, any interested party—typically a manufacturer—may submit a petition for a test procedure waiver for a basic model of a covered product or equipment if the basic model's design prevents it from being tested according to the test procedures, or if the test procedure yields materially inaccurate or unrepresentative energy or water use data. DOE is not changing any provisions related to the test procedure waiver process in this final rule. DOE does not have a waiver process for energy conservation standards.

AHAM commented that DOE did not include impacts on commercial laundry products, customers, or manufacturers in its analysis. (AHAM, No. 75 at p. 1)

While DOE did not explicitly disaggregate ESEMs shipments or the impacts on the ESEM standard by end-use applications, the distributions used to characterize the inputs to the energy use and LCC analysis are designed to cover the wide range of potential ESEM applications, including commercial laundry products. In addition, DOE considered the impacts on OEMs as discussed in sections III.D.2 and V.B.7 and of this document.

B. Comments Related to DOE's Authority

In the December 2023 NOPR, DOE proposed energy conservation standards for ESEMs manufactured alone or as a component of another piece of equipment, including ESEMs that are components of product and equipment subject to energy conservation standards. 88 FR 87062, 87074-87075, 87080 This section summarizes comments received from interested parties regarding DOE's authority to regulate the electric motors within the scope of this rulemaking.

Lennox cited 42 U.S.C 6312(c), noting that DOE can only separately regulate components of consumer products if those components are distributed in commerce, to a significant extent, for purposes other than as component parts of consumer products.

Lennox asserted that air-over ESEMs are not significantly distributed in commerce outside of component parts of consumer products. (Lennox, No. 69 at pp. 4–5)

Contrary to Lennox's assertion, air-over ESEMs are distributed in commerce other than as component parts of consumer products. DOE reviewed motor nameplate information for several categories of commercial HVAC equipment—commercial unitary air conditioners (CUAC), dedicated outdoor air systems (DOAS), and single package vertical air conditioners (SPVU)—from previous rulemaking engineering teardown analyses of commercially available models. DOE found that a substantial number of condenser fan motors used in these commercial equipment were single-phase, air-over ESEMs, with 2-digit frame size and horsepower less than 1hp, which are the same motors used in residential central air conditioners and heat pumps. As a result, air-over ESEMs are, to a significant extent, distributed in commerce other than as component parts of consumer products, *i.e.*, as component parts of several types of commercial equipment.

GE stated that component-level regulation is out of DOE's statutory authority, as it would never be supported by a proper economic analysis. (GE Appliances, No. 76 at p. 2)

The CA IOUs commented that DOE has clear authority to regulate electric motors, including ESEMs, that are components of covered products or equipment. The CA IOUs commented that section 6312 of EPCA authorizes DOE to regulate electric motors that are components of consumer products, provided these motors are "to a significant extent, distributed in commerce other than as component parts for consumer products" and "meet the requirements of section 6311(2)(A)." The CA IOUs commented that ESEMs covered by the proposal are found mainly in non-covered products; thus, they are distributed in commerce as other than component parts for consumer products. In addition, the CA IOUs commented that both "electric motors" and "other motors" are explicitly covered as the type of equipment referred to in section 6311(2)(A). The CA IOUs added that in section 6313(b), Congress made clear that DOE may regulate electric motors "alone or as a component of another piece of equipment. Only certain motor types (*i.e.*, definite-purpose motors, special-purpose motors, and DOE-exempted motors) are exempt from this requirement." The CA IOUs stated that ESEMs are not covered by this exemption—Congress exempted SEMs that are components of a covered product or equipment from standards prescribed by DOE pursuant to 42 U.S.C. 6317(b); however, "small electric motors" are defined by statute and do not include ESEMs. (CA IOUs, No. 74 at p. 2)

AHRI[29] stated that DOE should not move forward with its proposals on ESEMs and AO-ESEMs. AHRI stated that DOE lacks authority under EPCA to regulate definite-purpose and special-purpose motors and lacks the authority to regulate ESEMs as components of other covered equipment or products. AHRI commented that DOE's lack of authority is particularly clear with respect to definite-purpose and special-purpose motors, which include many ESEMs and AO-ESEMs. AHRI commented that Congress did not grant DOE general authority over electric motors, only particular motors described in 42 U.S.C. 6313(b) with timelines for compliance and for DOE to update

[29] AHRI's comments are supported by AHAM, Carrier, GE, and Rheem. (AHAM, No. 75 at p. 1; Carrier, No. 71 at p. 1; GE, No. 76 at p. 2; Rheem, No. 74 at p. 1)

some of those standards. AHRI further commented that DOE admits in the NOPR that ESEMs and AO-ESEMs are not among those listed in the statute.[30] AHRI argues that DOE's quotations in the NOPR from section 6313(b) omit critical context. AHRI further commented that it would be irrational for DOE to admit that Congress did not include ESEMs within the scope of section 6313(b)'s text while also asserting that Congress did specifically authorize DOE to regulate ESEMs (particularly as components of other equipment) in the same text.

In addition, AHRI noted that, DOE in 2014 "determined that the regulation of special and definite purpose motors is necessary to carry out the purposes of Part A-1 of EPCA because regulating these motors will promote the conservation of energy supplies" under 42 U.S.C. 6312(a)–(b). AHRI commented that sections 6312(a) and (b) do not contain the language DOE has relied upon in the NOPR to regulate ESEMs and AO-ESEMs as components of other pieces of equipment. AHRI also commented that DOE's analysis of section 6313 itself in the NOPR does not account for the statute's actual text and that DOE must be very specific as to where its authority to regulate ESEMs (and AO-ESEMs in particular) arises from. Moreover, AHRI commented that DOE's previous reliance on section 6312 for authority over definite-purpose and special-purpose motors reinforces the weaknesses of the NOPR's reliance on section 6313(b). According to AHRI, section 6312(b) permits DOE to, "by rule, include a type of industrial equipment as covered equipment" that is not already within the scope of the statute. AHRI commented that reliance on section 6312(b) is inconsistent with reliance on the "alone or

[30] AHRI cited 88 FR 87062, 87072.

as a component of another piece of equipment" language from section 6313(b) in support of its regulation of ESEMs and AO-ESEMs as components of finished products. AHRI also commented that section 6295(o) does not add any authority for DOE to regulate motors as components of finished products and instead describes the criteria for new or amended standards over which DOE has regulatory authority as covered equipment or products. *See Id*. section 6295(a). (AHRI, No. 70 at pp. 2–6)

As discussed in the October 2022 Final Rule for the electric motors test procedure, EPCA, as amended through EISA 2007, provides DOE with the authority to regulate electric motors including the ESEMs addressed in this rule. 87 FR 63588, 63596. In response to AHRI's comments and as noted above, electric motors are covered equipment as defined under 42 U.S.C. 6311(a). In this final rule, DOE clarifies that it is expanding the scope of the electric motors efficiency standards to include ESEMs, and is doing so under its authority in 42 U.S.C. 6295(m)(1), applied to covered equipment under 42 U.S.C. 6316(a)(1). Under section 6295(m)(1), not later than six years after issuance of any final rule establishing or amending a standard, DOE may issue a notice of proposed rulemaking including new proposed standards based on the criteria established under subsection (o). DOE is not required to wait six years, however, and in circumstances where it is merited may proceed to amend a standard to add new proposed standards for additional products or equipment within the scope of an existing covered category. Moreover, DOE did not rely on 6312(b) to establish its authority to regulate ESEMs.

The limited scope of the statutory standard set by Congress in section 6313(b) does not limit DOE's authority with respect to this rulemaking. More importantly, it does not withdraw DOE's authority to regulate the full scope of electric motors under EPCA. Congress has set initial energy conservation standards for many, but not all, products included on the list of "covered equipment." *See* 42 U.S.C. 6313. Congress, in setting the initial energy conservation standards for general-purpose electric motors, specified that those standards would apply to the specific general-purpose motors identified and would not apply to "special purpose" or "definite purpose" motors. 42 U.S.C. 6313(b)(1).[31] These exemptions simply reflect that the scope of "electric motors" is broad, such that Congress's initial standards might not be appropriate for certain subsets of electric motors made for other applications. DOE's position is that there is no textual basis for inferring that Congress intended for there to be *no* energy efficiency regulation with respect to any electric motors except for the general-purpose motors subject to the initial statutory efficiency standards.

The history of EPCA's electric motor provisions reinforces DOE's understanding that it has the relevant authority to issue the final rule adopted here today. Before the enactment of EISA 2007, EPCA defined the term "electric motor" as any motor that is a general-purpose T-frame, single-speed, foot-mounting, polyphase, squirrel-cage induction motor of the NEMA, Design A and B, continuous rated, operating on 230/460 volts and constant 60 Hertz line power, as defined in NEMA Standards Publication MG1-1987. (*See* 42 U.S.C. 6311(13)(A) (2006)) Section 313(a)(2) of EISA 2007 removed that definition, however, and in doing so, removed prior limits that narrowly defined what

[31] There is no dispute that ESEMs are not regulated by the standards set forth in section 6313(b). DOE's agreement that these motors are not subject to regulation under section 6313(b) does not undermine its authority to regulate the motors as covered equipment under other provisions of EPCA, *see, e.g.*, sections 6311(1)(A)(1), 6316(a), 6295.

types of motors would be considered as "electric motors." In its place, EISA 2007 inserted a new "Electric motors" heading and defined two new subtypes of electric motors: general-purpose electric motor (subtype I) and general-purpose electric motor (subtype II). (42 U.S.C. 6311(13)(A)–(B) (2011)) In addition, section 313(b)(2) of EISA 2007 established energy conservation standards for four types of electric motors: general-purpose electric motors (subtype I) (*i.e.*, subtype I motors) with a power rating of 1 to 200 horsepower; fire pump motors; general-purpose electric motors (subtype II) (*i.e.*, subtype II motors) with a power rating of 1 to 200 horsepower; and NEMA Design B, general-purpose electric motors with a power rating of more than 200 horsepower, but less than or equal to 500 horsepower. (42 U.S.C. 6313(b)(2)) The broader term "electric motor" was left undefined. In a May 4, 2012 final rule amending the electric motors test procedure ("May 2012 TP Final Rule"), DOE adopted the current definition of "electric motor," found in 10 CFR 431.12 to mean a "a machine that converts electrical power into rotational mechanical power." At the time, DOE noted that the absence of a definition may cause confusion about which electric motors are required to comply with mandatory test procedures and energy conservation standards, and the broader definition provided DOE with the flexibility to set energy conservation standards for other types of electric motors without having to continually update the definition of "electric motors." 77 FR 26608, 26613. ESEMs fall within the definition of electric motors established in 10 CFR 431.12.

AHRI also commented that DOE's authority over SEMs and EPCA's statutory history reinforce DOE's lack of authority. Specifically, AHRI commented that in the NOPR, DOE contrasts its authority over electric motors under section 6313(b) with its authority over SEMs under section 6317(b). (NOPR at 87080.) AHRI stated that section 6313(b) does not support the NOPR approach to ESEMs and AO-ESEMs but section 6317(b)(3), which specifies that standards adopted for SEMs "shall not apply to any small electric motor which is a component of a covered product … or a covered equipment," reinforces DOE's lack of authority. 42 U.S.C. 6317(b)(3). AHRI stated that even to the extent that ESEMs and AO-ESEMs do not meet the statutory definition of "small electric motors," Congress's adoption of that part of EPCA still points against DOE's approach in the NOPR. AHRI commented that Congress added section 6317(b) regarding SEMs (including the carveout of authority to regulate small electric motors as a component of other products or equipment) in the Energy Policy Act of 1992. (Pub. L. No. 102-486, 106 Stat. 2776, section 124 (1992).) AHRI added that in the same legislation, Congress exempted "definite purpose motors" and "special purpose motors" from authority under section 6313(b) for regulation "alone or as a component of another piece of equipment." (*See Id*. section 122.) AHRI commented that for SEMs, in a separate section of EPCA, it was reasonable to specify that energy conservation standards would not apply to motors that were components of covered products or equipment. But, AHRI added, in section 6313(b), Congress achieved the same thing by explicitly exempting definite-purpose motors and special-purpose motors. AHRI added that Congress's revisions to EPCA in the Energy Independence and Security Act of 2007 are consistent with this plain-text interpretation of the statute. AHRI commented that in that legislation, Congress revised the definition of "electric motor" to include more specific definitions of "General purpose electric motors" of "subtype I" and "subtype II," and it added the parts of section 6313(b)(2), each of which specifically noted that standards for those kinds of motors (but not definite-purpose motors or special-purpose motors) could apply “alone or as a component of another piece of equipment.” (Pub. L. No. 110-140, 121 Stat. 1492, section 313 (2007).) AHRI argued that if all electric motors except for SEMs could be regulated alone or as components, Congress would not have needed to include that language. AHRI commented that Congress going out of its way to apply the standards under section 6313(b)(2) to those kinds of motors “alone or as a component of another piece of equipment” further undermines DOE’s assertion of authority in the NOPR. (AHRI, No. 70 at pp. 6–7)

AHRI further commented that ESEMs and AO-ESEMs are more similar to SEMs, which DOE cannot regulate as components, than to the motors specified in section 6313(b) that DOE can regulate as components. AHRI commented that those similarities also counsel against DOE’s adoption of the NOPR proposals. AHRI added that ESEMs and AO-ESEMs present at least the same, if not greater, risk of double regulation that Congress recognized in section 6317(b)(3) with respect to SEMs. AHRI commented that the NOPR does not appropriately consider those similarities, instead appearing to conclude that simply because DOE can regulate ESEMs and AO-ESEMs (contrary to the statute, as discussed above), it will. (*See, e.g*., 88 FR 87062, 87082.) AHRI stated that this approach is an end run around Congress’s intent regarding which electric motors are and are not subject to component regulation. (AHRI, No. 70 at p. 7)

Lennox cited 42 U.S.C 6317(b)(3), noting that DOE is going against the intent of EPCA by treating ESEMs differently than statutory "small electric motors" since they are both built in two-digit frame sizes. Lennox added that SEMs as a component of covered equipment cannot be regulated separately according to 42 U.S.C 6317(b)(3). (Lennox, No. 69 at p. 5)

EPCA does not limit DOE's authority to regulate an electric motor with respect to whether “electric motors” are stand-alone equipment items or components of covered or non-covered products and equipment. As DOE noted in the NOPR, Congress exempted SEMs that are a component of a covered product or a covered equipment from the standards that DOE was required to establish under 42 U.S.C. 6317(b). 88 FR 87081. Congress did not, however, similarly restrict other electric motors, including the ESEMs at issue here. Indeed, for its initial standard for MEMs, Congress specifically provided that DOE could regulate general purpose electric motors that are components of other covered equipment in the standards established by DOE. (*See* 42 U.S.C. 6313(b)(1) (providing that standards for electric motors be applied to electric motors manufactured “alone or as a component of another piece of equipment”)). While the provisions of section 6313(b) do not apply to ESEMs, DOE finds this section supportive of the position that the SEM component exemption should not apply to ESEMs and, therefore, ESEMs installed as components in other DOE-regulated products and equipment are included in these energy conservation standards.

AHRI commented that DOE has a legal duty to consider the effect of any proposed rule on manufacturers of finished products, not only on manufacturers of ESEMs. AHRI stated that other results would be both inconsistent with the statute and irrational. AHRI commented that DOE has previously stated: “With respect to overlapping efficiency standards on a product and components of the product, the

Department will pay special attention to the cumulative regulatory burden being borne by the manufacturer of finished products containing that component. In such cases, the Department will specifically address the cost of potential component standards plus the overlapping costs of existing parallel standards on both the component and the system in which the component is installed."[32] AHRI added that DOE reiterated in 2021 that "[i]f the Department is directed to establish or revise standards for products/equipment that are components of other products/equipment subject to standards, the Department will consider the interaction between such standards in setting rulemaking priorities and assessing manufacturer impacts of a particular standard."[33] AHRI stated that this understanding is consistent with EPCA's text. Section 6295(o)(2) requires DOE, in considering whether a proposed standard is "economically justified," to determine whether "the benefits of the standard exceed its burdens." (42 U.S.C. 6295(o)(2)(B)) AHRI stated that Congress directed that the very first factor DOE must "consider []," "to the greatest extent practicable," is the "economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard. *Id* Section 6295(o)(2)(B)(i)(I). AHRI commented that makers of products that use ESEMs must be considered either "manufacturers"—defined broadly by Congress as "any person who manufactures a consumer product"—(42 USC 6291(12)) or as "consumers" of that product. AHRI commented that its members that produce the equipment discussed in these comments plainly "manufacture[] a consumer product," which means they are

[32] AHRI cited the following: Energy Conservation Program for Consumer Products: Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products, 61 FR 36974, 36978 (July 15, 1996).
[33] AHRI cited the following: Energy Conservation Program for Appliance Standards: 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, 70930 (December 13, 2021).

manufacturers under the statute. Further, AHRI added that if AHRI members are not manufacturers in the relevant sense, they are certainly consumers of ESEMs and AO-ESEMs. AHRI commented that Congress did not define "consumer," yet it is those entities that buy ESEMs and use them as a component of a different product sold to end-users. AHRI stated that in ordinary language, end-user purchasers of an HVAC product that contains an ESEM are no more "consumers" of that ESEM than a buyer of a car would ordinarily be said to be a consumer of a brake assembly. AHRI commented that Congress knows how to refer to "users" or "end users"—as opposed to "consumers"—and did so elsewhere in EPCA, and its choice to use a different term here must be respected.[34] However, AHRI stated that DOE did not consider the costs for OEMs regarding finished products.[35] Finally, AHRI added that Congress further required that, as part of its analysis of benefits and burdens, DOE consider "any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard." (*Id*. section 6295(o)(2)(B)(i)(IV).) AHRI added that the proposed rule would negatively affect the utility and performance of multiple covered products manufactured

[34] AHRI provided the following citations: 42 USC § 6291(41), defining "standby mode" as "the lowest power consumption mode, as established on an individual product basis by the Secretary, that … cannot be switched off or influenced by the user"; *id*. section 6295(e)(6)(A)(ii)(V)(cc), defining a "grid-enabled water heater" as a heater that, among other things, "bears a permanent label applied by the manufacturer that … advises purchasers and end-users of the intended and appropriate use of the product"; *id*. section 6276(c)(2)(D)(i), establishing an information program regarding "technical information about the domestic renewable energy industry and related service industries … [for] appropriate public and private officials engaged in commerce, and [for] potential end users"; *id*. section 6345(b)(2)(B)(ii), directing DOE to "produce and conduct workshops, reports, seminars, internet programs, CHP resiliency resources, and other activities to provide education to end users, regulators, and stakeholders in a manner that leads to the deployment of CHP technologies."

[35] AHRI cited the December 2023 NOPR: "DOE typically does not include the impacts to other manufacturers." 88 FR 87062, 87089

by AHRI members by, among other things, shortening their lifespan by making replacement parts more difficult or impossible to obtain. (AHRI, No. 70 at pp. 17–19)

In the December 2023 NOPR, DOE conducted the MIA analysis on ESEM manufacturers (including OEMs that also manufacture ESEMs). 88 FR 87062, 87101 In addition, consistent with what DOE said it would do in the December 13, 2021, rulemaking when analyzing component regulation, DOE also conducted the energy use and LCC analysis from the perspective of the end-users. 88 FR 87062, 87091-87093 In the December 2023 NOPR, DOE did not include the potential additional testing and certification costs that OEM may be subject to as a result of new ESEM energy conservation standards and noted that the proposed levels would preserve the frame sizes of ESEMs on the market today and estimated that these costs would not be significant. 88 FR 87062, 87089-87090. In this final rule, in response to comments, DOE conducted additional analysis to consider the impacts on OEMs incorporating ESEMs. DOE considered the impacts on OEMs in terms of increased testing and certification costs and potential redesign costs as another factor to help determine whether a standard is economically justified. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(VII)) See section V.B.7 of this document.

In this final rule, DOE continues to conduct the MIA on ESEM manufacturers. In deciding whether a proposed standard is economically justified, EPCA requires DOE to determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(3)(A)–(B)) DOE must make this determination after receiving comments on the proposed standard and by considering, to the greatest extent practicable, the seven statutory factors discussed in section II.A of this document. The first factor that DOE must consider is the economic impact of the standard on manufacturers and consumers of the products subject to the standard. The products subject to standards in this case are ESEMs. As discussed in section IV.J of this document, DOE performed a manufacturer impact analysis ("MIA") to estimate the financial impacts of new energy conservation standards on manufacturers of ESEMs and to estimate the potential impacts of such standards on employment and manufacturing capacity. However, as noted in the December 2023 NOPR, and in accordance with the statute, this analysis is limited to the impacts on the manufacturers of the products subject to the standard (*i.e.*, ESEMs) and does not extend to manufacturers of HVACR equipment (unless these manufacturers also manufacture ESEMs). Further, in this final rule, DOE continues to consider the consumers of ESEMs to be equivalent to the end-users of ESEMs[36] and not to the OEMs. This is consistent with how DOE has analyzed other commercial and industrial equipment (*See* 84 FR 4368, 4392 and 85 FR 1505, 1555 for more examples of energy conservation standards with commercial and industrial end-users). As such, as required by the statute, DOE conducted the LCC and national impact analyses to estimate the economic impacts of potential standards on end-users of products or equipment containing ESEMs. *See* sections IV.F and IV.H of this document.

AHRI commented that DOE should not adopt energy conservation standards for ESEMs and AO-ESEMs because it would be contrary to a DOE precedent that exempts embedded products. AHRI stated that as the D.C. Circuit has noted, "[a] fundamental

[36] Including end-users of equipment incorporating ESEMs

norm of administrative procedure requires an agency to treat like cases alike."[37] AHRI added that an agency's action is arbitrary and capricious if the agency offers insufficient reasons for treating similar situations differently.[38] AHRI further commented that if an agency makes an exception in one case, then it must either make an exception in a similar case or point to a relevant distinction between the two cases.[39] AHRI noted in response to the NOPR, that DOE proposed to regulate ESEMs and AO-ESEMs regardless of whether these are sold alone or embedded into a covered product or equipment. AHRI noted that in the fans and blowers rulemaking, DOE proposed to exclude certain embedded fans from its test procedure because embedded fan energy use is already captured in the equipment-specific test procedures. AHRI added that DOE also proposed to exclude them from its energy conservation standard in order to avoid duplicative regulations. AHRI commented that the attempt to resolve the double-regulation conflict is most evident with condenser fans for air conditioners and heat pumps, where a complicated series of exclusions were set up to scope out condenser fans.[40] AHRI stated that the same concern regarding duplicative regulation applies to ESEMs and AO-ESEMs and that if DOE proceeds to include ESEMs and AO-ESEMs, its action would be arbitrary and capricious, because DOE would not be "treat[ing] like cases alike." (AHRI, No. 70 at pp. 2–3, 16–17)

[37] AHRI cited: Westar Energy, Inc. v. Fed. Energy Regul. Comm'n, 473 F.3d 1239, 1241 (D.C. Cir. 2007).
[38] AHRI cited: Muwekma Ohlone Tribe v. Salazar, 708 F.3d 209, 216 (D.C. Cir. 2013) (quoting County of Los Angeles v. Shalala, 192 F.3d 1005, 1022 (D.C. Cir. 1999)).
[39] AHRI cited Westar Energy, 473 F.3d at 1241.
[40] AHRI cited the energy conservation standards for fans and blowers published on January 19, 2024. 89 FR 3714, 3742.

DOE responds that ESEMs are a subcategory of electric motors. As discussed in section II.B of this document, DOE's authority to regulate electric motors includes those manufactured alone or as a component of another piece of equipment, including covered equipment. DOE's approach is consistent with its regulation of other electric motors, namely the general purpose motors initially regulated under 42 U.S.C. 6313(b) and MEMs. DOE takes the same approach in this rule and adopts standards for ESEMs manufactured alone or as a component of another piece of equipment. As explained below, electric motors, unlike fans, cannot be distinguished at the point of manufacture on the basis of their end use applications. While most embedded fans are manufactured by the OEM, most electric motors are not. Accordingly, electric motors cannot be practicably exempted from regulation on the basis that they will become components of otherwise-regulated products or equipment.

AHRI commented that the NOPR did not address the impact of the proposals on residential and commercial covered products. AHRI stated that DOE's approach to AO-ESEMs in the NOPR is irrational, as AO-ESEMs are likely to be used almost exclusively in heating and air-conditioning equipment already subject to DOE regulation. AHRI commented that adopting the NOPR proposals will increase manufacturing costs, make repairing existing equipment more difficult and costly, and have other negative downstream impacts, without significant corresponding benefits. AHRI stated that DOE should not move forward with its proposals on ESEMs and AO-ESEMs because it would be unreasonable, arbitrary, and contrary to the governing statute to subject ESEMs and AO-ESEMs to regulation where they are used in finished products also subject to energy conservation standards. AHRI stated that the burdens of that double regulation far exceed the benefit, if any, from such action. (AHRI, No. 70 at pp. 2–3) AHRI Commented that if DOE moves forward with energy conservation standards for ESEMs, it should adopt a standard no higher than EL 1. AHRI commented that under no circumstances should DOE establish minimum efficiency standards for AO-ESEMs. (AHRI, No. 70 at p. 3)

As discussed in section V.C of this document, DOE has found that adopting TSL 2 (corresponding to EL 2 for all equipment classes) would offer the maximum improvement in efficiency that is technologically feasible and economically justified and would result in the significant conservation of energy. In addition, DOE's analysis includes ESEMs incorporated in certain covered commercial and residential equipment/products, and DOE has further considered the impacts on OEMs as discussed in section V.B.7.a.

C. Scope of Coverage

1. General Scope of Coverage

This final rule covers ESEMs, a category of electric motors. The term "electric motor" is defined to mean "a machine that converts electrical power into rotational mechanical power." 10 CFR 431.12. This final rule does not address SEMs, which are covered under 10 CFR part 431 subpart X.[41]

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[41] DOE uses the term "expanded scope electric motor," or "ESEM" (formally known as small, non-small electric motor, electric motors or "SNEMs"), to describe those SEMs that are not included in the definition "small electric motor" under EPCA but otherwise fall within the definition of "electric motor" under EPCA. The term "small electric motor" means a NEMA general-purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1-1987. (42 U.S.C. 6311(13)(G)).

As discussed in detail in section II.B of this document, as a part of the process under section 6295(m) to determine if it was necessary to amend the existing standards for electric motors, DOE also assessed whether to include standards for ESEMs. ESEMs are already included in the scope of the DOE test procedure for electric motors (*see* section III.E of this document for further description) and are currently not subject to energy conservation standards. DOE received separate recommendations for proposed energy conservation standards and as a result, split the process into two separate rulemakings, one for certain electric motors, which are hereinafter referred to as medium electric motors, which were covered in a separate rulemaking ("MEMs" - *see* section III.C.1 of this document for further description) and this final rule for ESEMs.

Specifically, in this final rule, DOE is adopting standards for ESEMs, including AO-ESEMs and is not adopting standards for inverter-only ESEMs as well as ESEMs for which DOE did not establish test procedures (*i.e.*, components sets, liquid-cooled ESEMs, and submersible ESEMs). ESEMs include both single phase and polyphase alternative current induction motors between 0.25 and 3 hp, built in 2, 4, 6, and 8 pole configurations, and with both open and enclosed constructions that meet the criteria further described in section III.C.1.a of this document.

In addition, as discussed in section III.C.1.b of this document, DOE is not adopting standards for explosion-proof high- and medium-torque ESEMs certified to UL 674-2022 with a horsepower greater than or equal to 0.5 hp in order to ensure high- and medium-torque explosion-proof ESEMs remain available above 0.5 hp. DOE is also clarifying the distinction between AO-MEMs and AO-ESEMs, as discussed in section III.C.1.b of this document.

ESEMs are sold incorporated in a wide range of commercial and industrial applications such as power tools, pressure washers, air handling units, and industrial processing equipment. These applications can include end-use equipment and products that are regulated by DOE as well as equipment and products that are not regulated by DOE.[42] In some cases, such as for residential central air conditioning and heat pumps and single packaged vertical units, DOE's energy conservation standards applicable to the end product account for the energy consumption of the motor and increasing the motor efficiency is a potential pathway to improve the overall efficiency of the equipment.[43] Accordingly, manufacturers of such products already include more-efficient motors in their equipment designs in order to comply. In other cases like power tools or air handling units, the end product is either not subject to energy conservation standards or subject to standards that do not impose any limits on the embedded motors. In those cases, such motors would be impacted by the standards set for ESEMs in this rule. In addition, ESEMs may be sold to OEMs for use in new equipment or may be sold as standalone motors to OEMs or other parts of a distribution chain as replacement products to go into existing equipment that is already installed in the field. DOE accounts for this varying landscape by estimating that 53 percent of motor shipments will be impacted by this rulemaking, while 47 percent of motor shipments are already more efficient than the

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[42] ESEMs are built in standard NEMA frame sizes and are not common in regulated consumer products including ceiling fans, clothes washers (top and front load) clothes dryers, refrigerators, and room air conditioners.

[43] These equipment-level regulations do not include a design-requirement to use a specific motor.

adopted standards and would not be impacted based on DOE's analysis of the efficiency of 4,000 commercially available ESEMs. [44] The shipments and efficiency level distribution analyses, based on actual efficiency data of ESEMs, encompass both ESEMs that serve embedded motor applications in newly shipped end-use equipment and replacement motors. Thus, DOE knows based on shipments data today what the breakdown of impacted and non-impacted motor shipments look like. For AO-ESEMs which are primarily used in regulated HVACR equipment, the percentage of impacted ESEMs shipments is lower (32 percent) while the percentage of non-impacted shipments is even higher (68 percent). In analyzing this rulemaking DOE did not include the cost or the benefits of such ESEMs that are already more efficient than the levels adopted in this rulemaking.

ESEMs are distributed in commerce broadly and in high volume for a variety of end-use applications and are generally not manufactured in-house by OEMs. At the point of manufacture, there are no physical or technological distinguishing factors in a given ESEM that could be used to identify a particular end-use application, or to identify if the ESEM will be sold for the replacement market or for a new installation. As such, it is not possible to differentiate a motor sold for incorporation in a covered product or equipment and DOE is not excluding ESEMs in covered products or equipment, nor analyzing application-based equipment classes. This contrasts with the fan market where HVAC

[44] The 53 percent market share represents the fraction of ESEM shipments with efficiencies below the efficiency level corresponding to the selected TSL (i.e., TSL 2, EL2) and was calculated by adding the fraction of shipments at EL0 and EL1 in each equipment class and horsepower range (see section IV.F.8 of this document for a description of the market shared by efficiency level) and multiplying the resulting fraction by the number of shipments in that equipment class and horsepower range. (see section IV.G of this document for a description of the shipments analysis). The 47 percent value was then calculated by subtracting 53 percent from 100 %.

fans are primarily manufactured in-house by OEMs[45] and are distributed in commerce already incorporated in the end-use equipment, making it much easier to distinguish if the fan is incorporated in a covered products or equipment.

DOE has conducted its analysis to ensure that it is representative of the various end-use applications and to ensure that it does not double count costs and benefits across this rulemaking and rulemakings related to relevant covered products and equipment. Regarding representative analysis, DOE considered, for example, the operating hours of CAC-HP when conducting the energy use analysis as discussed in section IV.E.3 of this document. In terms of quantifying energy savings, as previously mentioned, DOE accounts for ESEMs already on the market at efficiency levels higher than adopted in this standard due to existing equipment-level energy conservation standards, as further discussed in sections III.D.1.b, IV.F, and IV.H of this document. DOE also considered the impacts on OEMs and on the replacement market as discussed in sections III.D.2, III.D.2.d, and V.B.7 of this document.

In addition, as discussed in section III.D.2.b, DOE considered the timing of upcoming equipment-level regulations (*i.e.*, WICFs, circulator pumps, CUAC/HPs, and air circulating fans) to ensure the regulatory cycles of these rules would not conflict. Specifically, for WICFs and circulator pumps, which both have a compliance year that is before the ESEM compliance date (January 1, 2029) the upcoming equipment level

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[45] DOE estimates that 95 percent of HVACR fans are manufactured by the OEMs based on input from AHRI (See Fans and Blowers NOPR TSD, chapter 9, available at: *www.regulations.gov/document/EERE-2022-BT-STD-0002-0133*)

energy conservation standards would likely require shifting from ESEMs to ECMs. As such, these categories of equipment would likely no longer incorporate ESEMs, and would not be impacted by the ESEM rule. Further, as discussed in section II.B.3 of this document, DOE aligned the ESEM compliance date with the compliance date for CUAC/HPs, such that OEMs would not have to perform two separate redesigns. Finally, for ACFs, the proposed levels would require a motor above the adopted ESEM levels and compliance in 2030 and therefore, if the ACF rule is finalized as proposed, the ESEM rule would not trigger an additional redesign after that date. For other covered equipment with no upcoming rulemaking, DOE recognizes that OEMs could be affected by this rulemaking as a result of the conversion costs needed to incorporate compliant ESEMs. DOE has considered the costs to such OEMs in this final rule. As previously mentioned, DOE examined OEM retesting and recertification cost impacts for OEMs of covered equipment and products incorporating ESEMs in general, as described in section V.B.7.a of this document.

a. Detailed Scope Discussion

Prior to this final rule DOE regulates certain electric motors, MEMs, falling into the NEMA Design A, NEMA Design B, NEMA Design C, and fire pump motor categories and those electric motors that meet the criteria specified at 10 CFR 431.25(g). 10 CFR 431.25(h)–(j). Section 431.25(g) specifies that the standards apply only to certain electric motors, including partial electric motors, that satisfy the following criteria:

1) Are single-speed, induction motors;

2) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

3) Contain a squirrel-cage (MG 1) or cage (IEC) rotor;

4) Operate on polyphase alternating current 60-hertz sinusoidal line power;

5) Are rated 600 volts or less;

6) Have a 2-, 4-, 6-, or 8-pole configuration;

7) Are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent);

8) Produce at least one horsepower (0.746 kW) but not greater than 500 horsepower (373 kW); and

9) Meet all of the performance requirements of one of the following motor types: a NEMA Design A, B, or C motor or an IEC Design N, NE, NEY, NY or H, HE, HEY, HY motor. [46]

10 CFR 431.25(g).

[46] DOE added the "E" and "Y" designations for IEC Design motors into §431.25(g) in the electric motors test procedure final rule. 87 FR 63588, 63596-636597, 63606 (Oct. 19, 2022).

The definitions for "NEMA Design A motors," "NEMA Design B motors," "NEMA Design C motors," "fire pump electric motors," "IEC Design N motor," and "IEC Design H motor," as well as "E" and "Y" designated IEC Design motors, are codified in 10 CFR 431.12. DOE exempted certain categories of motors from the standards. The exemptions are as follows:

1) Air-over electric motors;

2) Component sets of an electric motor;

3) Liquid-cooled electric motors;

4) Submersible electric motors; and

5) Inverter-only electric motors.

10 CFR 431.25(l).

On October 19, 2022, DOE published the electric motors test procedure final rule ("October 2022 Final Rule"). 87 FR 63588. As part of the October 2022 Final Rule, DOE expanded the test procedure scope to additional categories of electric motors that currently do not have energy conservation standards. 87 FR 63588, 63593-63606. The expanded test procedure scope included the following:

1) Electric motors having a rated horsepower above 500 hp and up to 750 hp that meet the criteria listed at §431.25(g), with the exception of criteria §431.25(g)(8) MEMs, air-over electric motors ("AO-MEMs") and inverter-only MEMs;

2) ESEMs (formally known as small, non-small electric motor, electric motors or "SNEMs"), that are not air-over electric motors, which:

a) Are not a small electric motor, as defined at §431.442 and is not a dedicated pool pump motors as defined at §431.483;

b) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

c) Operate on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or is used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power;

d) Are rated for 600 volts or less;

e) Are a single-speed induction motor capable of operating without an inverter or is an inverter-only electric motor;

f) Produce a rated motor horsepower greater than or equal to 0.25 horsepower (0.18 kW); and

g) Are built in the following frame sizes: any two-, or three-digit NEMA frame size (or IEC equivalent) if the motor operates on single-phase power; any two- or three-digit NEMA frame size (or IEC equivalent) if the motor operates on polyphase power, and has a rated motor horsepower less than 1 horsepower (0.75 kW); or a two-digit NEMA frame size (or IEC metric equivalent), if the motor operates on polyphase power, has a rated motor horsepower equal to or greater than 1 horsepower (0.75 kW), and is not an enclosed 56 NEMA frame size (or IEC metric equivalent).

3) ESEMs that are air-over electric motors ("AO-ESEMs") and inverter-only ESEMs;

4) Synchronous electric motors, which:

a) Are not a dedicated pool pump motor as defined at §431.483 or are not an air-over electric motor;

b) Are a synchronous electric motor;

c) Operate on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or are used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power;

d) Are rated 600 volts or less; and

e) Produce at least 0.25 hp (0.18 kW) but not greater than 750 hp (559 kW).

5) Synchronous electric motors that are inverter-only electric motors.

See section 1.2, appendix B.

In the October 2022 Final Rule, DOE noted that, for these motors newly included within the scope of the test procedure for which there was no established energy conservation standards, such as ESEMs and AO-ESEMs, manufacturers would not be required to use the test procedure to certify these motors to DOE until such time as a standard is established. 87 FR 63588, 63591.[47] Further, the October 2022 Final Rule continued to exclude the following categories of electric motors:

1) Inverter-only electric motors that are air-over electric motors,

2) Component sets of an electric motor,

3) Liquid-cooled electric motors, and

4) Submersible electric motors.

In the March 2022 Preliminary Analysis, DOE analyzed the additional motors now included within the scope of the test procedure after the October 2022 Final Rule.[48] *See* sections 2.2.1 and 2.2.3.2 of the March 2022 Preliminary TSD. This analysis included MEMs from 1 to 500 hp, AO-MEMs, and ESEMs (including AO-ESEMs). However, consistent with the December 2022 Joint Recommendation and the December 2023 NOPR, this final rule establishes new standards for only a portion of the scope analyzed in the March 2022 Preliminary Analysis and included within the scope of the test procedure after the October 2022 Final Rule. As stated previously, in this final rule, DOE is only adopting standards for ESEMs, including AO-ESEMs and excluding inverter-only ESEMs as well as ESEMs for which DOE did not establish test procedures (*i.e.*, components sets, liquid-cooled ESEMs, and submersible ESEMs). In addition, as

[47] However, manufacturers making voluntary representations respecting the energy consumption or cost of energy consumed by such motors are required to use the DOE test procedure for making such representations beginning 180 days following publication of the October 2022 Final Rule. *Id.* at 87 FR 63591.

[48] At the time, most of these motors had been proposed for inclusion in the scope of the test procedure in the December 2021 Test Procedure NOPR. 86 FR 71710 (Dec. 17, 2021).

discussed in section III.C.1.b of this document, DOE is also excluding explosion-proof high- and medium-torque ESEMs certified to UL 674-2022 with a horsepower greater than or equal to 0.5 hp.

In summary, the energy conservations standards adopted in this rule apply to ESEMs which are electric motors, including partial electric motors, that satisfy the following criteria:

> (1) Are not small electric motors, as defined at §431.442 and are not a dedicated pool pump motors as defined at §431.483; and do not have an air-over enclosure and a specialized frame size if the motor operates on polyphase power;
> (2) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);
> (3) Operate on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or are used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power;
> (4) Are rated for 600 volts or less;
> (5) Are single-speed induction motors capable of operating without an inverter or are inverter-only electric motors;
> (6) Produce a rated motor horsepower greater than or equal to 0.25 horsepower (0.18 kW); and
> (7) Are built in the following frame sizes: any two-, or three-digit NEMA frame size (or IEC equivalent) if the motor operates on single-phase power; any two-, or three-digit NEMA frame size (or IEC equivalent) if the motor

operates on polyphase power, and has a rated motor horsepower less than 1 horsepower (0.75 kW); or a two-digit NEMA frame size (or IEC metric equivalent), if the motor operates on polyphase power, has a rated motor horsepower equal to or greater than 1 horsepower (0.75 kW), and is not an enclosed 56 NEMA frame size (or IEC metric equivalent).

And with the following exemptions:

1) Component sets of an electric motor;

2) Liquid-cooled electric motors;

3) Submersible electric motors;

4) Inverter-only electric motors; and

5) High-torque and medium-torque electric motor with explosion proof certification in accordance with UL 674-2022 and a rated motor horsepower of greater than or equal to 0.5 horsepower.

As further described in section IV.A.1 of this document, this final rule includes high- and medium-torque single-phase ESEMs (i.e., CSIR/CSCR and split phase), low-torque single-phase ESEMs (i.e., shaded pole, PSC) and certain polyphase ESEMs that meet the criteria (1) through (7) as listed previously. These ESEMs comprise 0.25 to 3 hp; 2, 4, 6, and 8 pole configurations, and both open and enclosed motors, and are not limited to general-purpose electric motors. Table III-1 summarizes the equipment class groups ("ECGs") DOE analyzed in this final rule. Further discussion on equipment classes is provided in section IV.A.1 of this document.

Table III-1 Equipment Class Groups Considered

ECG	Motor Topology	Horsepower Rating	Pole Configuration	Enclosure	Cooling Requirements
1	CSCR, CSIR, Split Phase	0.25–3	2, 4, 6, 8	Open	Non-Air-Over
				Enclosed	
2	PSC, Shaded Pole	0.25–3	2, 4, 6, 8	Open	Non-Air-Over
				Enclosed	
3	Polyphase	0.25–3	2, 4, 6, 8	Open	Non-Air-Over
				Enclosed	
4	CSCR, CSIR, Split Phase	0.25–3	2, 4, 6, 8	Open	Air-Over
				Enclosed	
5	PSC, Shaded Pole	0.25–3	2, 4, 6, 8	Open	Air-Over
				Enclosed	
6	Polyphase	0.25–3	2, 4, 6, 8	Open	Air-Over
				Enclosed	

b. Stakeholder Comments

NEMA commented that it sought to highlight complexities of 56-frame enclosed polyphase motors between 1 and 3 hp. NEMA commented that the EM and ESEM rules both include 56-frame enclosed motors that have similar defining characteristics, but different minimum efficiency levels and requirements (average vs. nominal efficiency). NEMA commented that to avoid market confusion, DOE should issue additional guidance to ensure manufacturers can consistently apply appropriate efficiency levels. (NEMA, No. 68 at p. 3)

As described in the scope criteria above, DOE currently regulates polyphase 56-frame enclosed electric motors with horsepower above 1 hp. To avoid any overlaps, in the December 2023 NOPR, DOE proposed to exclude enclosed polyphase ESEMs with a rated motor horsepower equal to or greater than 1 horsepower (0.75 kW) with 56 NEMA frame size (or IEC metric equivalent) consistent with the scope of the October 2022 Final rule. 88 FR 87062, 87073 In this final rule, DOE continues to exclude these motors. *See* 10 CFR 431.25.(d)(2)(i)(A)(7) of the newly adopted regulatory text.

Lennox agreed that inverter-only motors should remain out of scope. (Lennox, No. 69 at p. 10) In this final rule, DOE confirmed it was appropriate to exclude inverter-only ESEMs from the scope of these energy conservation standards.

Ravnitzky commented that DOE should clarify the scope of motors covered by the proposed standards. Specifically, they commented that DOE should state whether the standards apply to motors that are part of other systems, such as pumps, fans, compressors, or appliances. Ravnitzky also stated that DOE should explain why each application was kept in or out of scope. (Ravnitzky, No. 62 at pp. 1–2)

DOE received additional comments related to ESEMs that are components of other equipment. As discussed in section III.D of this document, DOE is adopting energy conservation standards for ESEMs regardless of their end-use application.

NEMA commented that applying proposed levels to explosion-proof motors would result in disruption or non-availability of product. NEMA commented that these motors represent a niche but important market and that if the proposed levels were applied to this class of product, many designs would need to change to a CSCR design. NEMA stated that explosion-proof designs have physical limitations and additional capacitors are not an option for most designs. NEMA commented that there should be an exemption for medium- and high-torque ESEMs with explosion-proof certifications since no widespread alternatives exist. NEMA commented that these motors are evaluated to more stringent safety and industry standards, so it will not create an incentive for users to substitute ordinary motors with exempted explosion-proof motors to bypass efficiency standards. (NEMA, No. 68 at p. 7)

ABB commented that DOE stated that an explosion-proof motor would not need to be converted from CSIR to CSCR. 88 FR 87062, 87081 However, ABB stated that the NOPR requires efficiencies not achievable by CSIR motors. ABB commented that single-phase explosion-proof (Division 1) motors should be excluded from the rule because CSCR designs are not feasible. (ABB, No. 65 at p. 5)

In the NOPR, DOE stated that moving to CSCR is not needed at the proposed TSL (TSL 2). 88 FR 87062, 87081 However, after additional consideration, DOE understands this statement is only true in the 0.25–0.5 hp range. Above 0.5 hp, CSCR is expected to be required. In addition, *UL 674 Electric Motors and Generators for Use in Hazardous (Classified) Locations*, *Edition 6*, published on July 29, 2022, (“UL 674-2022”) is the industry standard used to certify explosion-proof motors. Therefore, to ensure high- and medium-torque explosion-proof ESEMs remain available above 0.5 hp, DOE is excluding high- and medium-torque explosion-proof ESEMs certified to UL 674-2022 with horsepower at or above 0.5 hp from the adopted standard.

Lennox stated that residential CAC-HP systems do not consume a lot of energy because they use motors under 1 hp, and recommended that DOE exempt AO-ESEMs under 1 hp if it decides to regulate air-over motors. Lennox commented that DOE is selectively choosing to benefit motor manufacturers by mandating the use of more expensive air-over ESEMs for these HVACR products and that HVACR manufacturers would adjust the design to reduce the costs (and also efficiency) of the condenser fan, condenser coil, and/or compressor. (Lennox, No. 69 at p. 4)

In this final rule, DOE is not exempting ESEMs used in residential CAC-HPs and is not excluding AO-ESEMs below 1hp. In addition, as discussed in section V.C of this document, in determining whether a standard is economically justified, DOE determined whether the benefits of the standard exceed its burdens, considering seven statutory factors discussed previously and did not choose to benefit motor manufacturers. As previously stated, DOE's economic analysis includes the impact of various market actors along the distribution channel, starting from ESEM manufacturers through OEM, wholesalers, contractors, and retailers, to finally reach consumers. DOE additionally considered the impacts on OEMs as another factor to help determine whether a standard is economically justified. See section V.B.7 III.I.1.g of this document. DOE received additional comments related to OEM adjusting their equipment design and these are further addressed in section III.D.1 of this document.

2. Air-over Medium Electric Motors and Air-over ESEMs

In the December 2023 NOPR, DOE proposed to further clarify the distinction between the AO electric motors for which DOE proposed standards and the AO electric motors for which DOE established energy conservation standards as part of the June 2023 DFR. In the December 2023 NOPR, DOE proposed to clarify this distinction as part of the scope of this rulemaking as further described in this section and by clarifying the regulatory text adopted in the June 2023 DFR. 88 FR 87063, 87075-87076

The June 2023 DFR amended the existing energy conservation standards for electric motors by establishing higher standards for certain horsepower electric motors and expanding the scope of the energy conservation standards to include certain air-over electric motors and electric motors with horsepower greater than 500. Under its authority in EPCA at 42 U.S.C. 6295(p)(4), DOE promulgated a direct final rule adopting standards that were consistent with the "November 2022 Joint Recommendation, after determining that the recommendation was submitted jointly by interested persons that were of fairly representative of relevant points of view, and the new and amended energy conservation standards for these products would result in significant conservation of energy and are technologically feasible and economically justified. *See* June 2023 DFR, 88 FR 36066, 36067–36069.

In the June 2023 DFR, DOE described that it currently regulates MEMs falling into the NEMA Design A, NEMA Design B, NEMA Design C, and fire pump motor categories and those electric motors that meet the criteria specified at 10 CFR 431.25(g). *See Id*. at 88 FR 36079-36080; 10 CFR 431.25(h)–(j). Specifically, DOE noted the nine criteria used to describe currently regulated MEMs, including the criteria at 10 CFR 431.25(g)(7), which specifies MEMs "are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent)." 88 FR 36066, 36080.

In the June 2023 DFR, to support the new energy conservations standards for air-over electric motors, DOE created new equipment classes: one for standard frame size air-over motors ("AO-MEM (standard frame size)") and one for specialized frame size air-over electric motors ("AO-Polyphase (specialized frame size)"). *Id*. at 88 FR 36088. DOE also established a definition for "specialized frame size" based on a table that specified the maximum NEMA frame diameter (or size) for a given motor horsepower, pole configuration, and enclosure combination. *Id*. This table was part of the November 2022 Joint Recommendation. *Id*. In this table, the maximum frame diameter specified ranges from a 48 NEMA frame motor diameter up to a 210 NEMA frame diameter, therefore including intermediate sizes such as 56 NEMA frame size in enclosed and open enclosure configurations. *Id*.

In the December 2023 NOPR for ESEMs, to clarify that AO-polyphase (specialized frame size) electric motors are not included in the scope of electric motors included as ESEMs, DOE proposed to add "and do not have an air-over enclosure and a specialized frame size if the motor operates on polyphase power" to the ESEM scope criteria in the proposed paragraph (d)(2)(i)(1) of 10 CFR 431.25 in the December 2023 NOPR. DOE noted that AO-MEMs (standard frame size) do not meet the frame criteria for ESEMs and are not included in the scope of ESEMs. 88 FR 87062, 87076

ABB commented that there are differences in AO-ESEM and specialized frames and that specialized frames require Designs A and B. (ABB, No. 65 at p. 1) DOE agrees with ABB that additionally, AO-polyphase (specialized frame size) electric motors are required to be either NEMA Design A or NEMA Design B, or have an equivalent IEC design (*i.e.*, IEC Design N, NE, NEY, or NY). However, DOE notes that although ESEMs are not required to be NEMA Design A or NEMA Design B, or have an equivalent IEC design, this is not a criteria that would exclude a motor from the ESEM scope. Therefore, as proposed in the December 2023 NOPR, to clarify the distinction between AO-polyphase (specialized frame size) electric motors and polyphase AO-ESEMs, DOE has added "and do not have an air-over enclosure and a specialized frame size if the motor operates on polyphase power" to the ESEM scope criteria in the new paragraph (d)(2)(i)(1) of 10 CFR 431.25 adopted in this final rule.

In the June 2023 DFR, DOE further noted that the specialized frame size air-over electric motors equipment class included frame sizes beyond those described at 10 CFR 431.25(g)(7). *Id*. To better characterize this distinction in frame sizes, DOE stated that it was renaming "Specialized Frame Size AO–MEMs" (from the November 2022 Joint Recommendation) to "AO–Polyphase (Specialized frame size)." *Id*. DOE added that only the naming convention was changed compared to the November 2022 Joint Recommendation, and the scope of motors being represented in that equipment class continued to stay the same as in the November 2022 Joint Recommendation. *Id*.

The general scope description in section 10 CFR 431.25(m) of the regulatory text published in the June 2023 DFR presents the nine criteria that determine what electric motors the standards in 10 CFR 431.25 apply to. Specifically, the criteria at 10 CFR 431.25(m)(7) specifies that the standards apply to electric motors that "are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent)."

When describing the energy conservation standards adopted for specialized frame size air-over electric motors, DOE specified that the standards are applicable to an "air-over electric motor meeting the criteria in paragraph (m) of this section and […] built in a specialized frame size" in section 10 CFR 431.25(p) of the regulatory text published in the June 2023 DFR. 88 FR 36066, 36150.

As published, the general scope description in section 10 CFR 431.25(m)(7) of the regulatory text in the June 2023 DFR and the scope description in section 10 CFR 431.25(p) may be interpreted as inconsistent with the scope of electric motors included in the AO-polyphase (specialized frame size) equipment class analyzed in the June 2023 DFR, and for which DOE intended to establish new standards in section 10 CFR 431.25(p). Specifically, DOE identified that the criteria at 10 CFR 431.25 (m)(7), which are identical to the criteria currently at 10 CFR 431.25(g)(7), exclude specialized frame air-over motors built in two-digit NEMA frame sizes (other than enclosed 56-frame motors). Therefore, while in the preamble DOE explicitly stated that the specialized-frame-size air-over electric motors equipment class included frame sizes beyond those described at 10 CFR 431.25(g)(7), the regulatory text as written may be interpreted as limiting the covered frame sizes to those specifically described at 10 CFR 431.25(g)(7).

Therefore, in the December 2023 NOPR, to clarify the intent of the preamble of the June 2023 DFR when establishing standards for the AO-polyphase (specialized frame size) equipment class, which was to include frame sizes beyond those described at 10 CFR 431.25(g)(7), DOE proposed to clarify by adding "or have an air-over enclosure and a specialized frame size" to the criteria originally included under 10 CFR 431.25 (m)(7) in the June 2023 DFR, to read as follows: "Are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent), or have an air-over enclosure and a specialized frame size." As discussed in section III.C.3 of this document, in the December 2023 NOPR, DOE proposed to reorganize the regulatory text at 10 CFR 431.25 and, therefore, proposed to add this clarification in the newly proposed paragraphs (c)(1)(i)(7) and (d)(1)(i)(7). 88 FR 87062, 87076

DOE did not receive any comments on this proposal and adopts to add the clarification "or have an air-over enclosure and a specialized frame size" in the newly adopted paragraphs (c)(1)(i)(7) and (d)(1)(i)(7) in this final rule.

3. Structure of the Regulatory Text

In the December 2023 NOPR, in addition to proposing new requirements for ESEMs, DOE proposed to move portions of the existing electric motor regulations that pertain to the energy conservation standards and their compliance dates (at 10 CFR 431.25) to improve clarity. In the December 2023 NOPR, DOE proposed to revise 10 CFR 431.25 by retaining the existing electric motor energy conservation standards and their compliance dates, adding provisions pertaining to ESEMs and reorganizing all provisions currently in 10 CFR 431.25 by compliance date (*i.e.*, each section has a different compliance date) to improve clarity. 88 FR 87062, 87074-87075. *See* Table III-2 for details.

DOE did not receive comments on these proposals and adopts to revise the structure of the regulatory text as proposed in the December 2023 NOPR.

Table III-2: Revisions to 10 CFR 431.25

Current Location	Content High-Level Description	Revised Location	Impact
§431.25(a)–(f)	Describes standards for certain electric motors manufactured on or after December 19, 2010, but before June 1, 2016.	None	None—removed as these requirements are no longer current.
§431.25(k) §431.25(q)	Describes how to establish the horsepower for purposes of determining the required minimum nominal full-load efficiency of an electric motor.	§431.25(a)	Avoids repeating identical provisions in each subsection.
§431.25(g)	Describes the criteria for inclusion for certain electric motors manufactured on or after June 1, 2016, but before June 1, 2027 subject to energy conservation standards.	§431.25(b)(1)(i)	Moves the "inclusion" criteria, so that the proper scope is presented fully up front in each section.
§431.25(h)	Describes standards for certain NEMA Design A and B electric motors (and IEC equivalent) manufactured on or after June 1, 2016, but before June 1, 2027.	§431.25(b)(2)(i)	Makes each section "comprehensive" by carrying over the existing standards for all electric motors categories in each section.

§431.25(i)	Describes standards for certain NEMA Design C electric motors (and IEC equivalent) manufactured on or after June 1, 2016.	§431.25(b)(2)(ii) §431.25(c)(2)(iv) §431.25(d)(1)(ii)(D)	Makes each section "comprehensive" by carrying over the existing standards for all electric motors categories in each section.
§431.25(j)	Describes standards for certain fire pump electric motors (and IEC equivalent) manufactured on or after June 1, 2016.	§431.25(b)(2)(iii) §431.25(c)(2)(v) §431.25(d)(1)(ii)(E)	Makes each section "comprehensive" by carrying over the existing standards for all electric motors categories in each section.
§431.25(l)	Describes the criteria for exclusion for certain electric motors manufactured on or after June 1, 2016, but before June 1, 2027, subject to energy conservation standards.	§431.25(b)(1)(ii)	Moves the "exemptions" to directly after the "inclusion" criteria, so that the proper scope is presented fully up front in each section, prior to presenting the subgroup criteria and standards.
§431.25(m)	Describes the criteria for inclusion for certain electric motors manufactured on or after June 1, 2027, subject to energy conservation standards.	§431.25(c)(1)(i)	Moves the "inclusion" criteria, so that the proper scope is presented fully up front in each section.
§431.25(n)	Describes standards for certain NEMA Design A and B electric motors (and IEC equivalent), but excluding fire pump electric motors and air-over electric motors manufactured on or after June 1, 2027.	§431.25(c)(2)(i) §431.25(d)(1)(ii)(A)	Makes each section "comprehensive" by carrying over the existing standards for all electric motors categories in each section.
§431.25(o)	Describes standards for certain air-over	§431.25(c)(2)(ii) §431.25(d)(1)(ii)(B)	Makes each section "comprehensive" by

	NEMA Design A and B electric motors (and IEC equivalent), built in standard frame size manufactured on or after June 1, 2027.		carrying over the existing standards for all electric motors categories in each section.
§431.25(p)	Describes standards for certain air-over NEMA Design A and B electric motors (and IEC equivalent), built in specialized frame size manufactured on or after June 1, 2027.	§431.25(c)(2)(iii) §431.25(d)(1)(ii)(C)	Makes each section "comprehensive" by carrying over the existing standards for all electric motors categories in each section.
§431.25(r)	Describes the criteria for exclusion for certain electric motors manufactured on or after June 1, 2027, subject to energy conservation standards.	§431.25(c)(1)(ii)	Moves the "exemptions" to directly after the "inclusion" criteria, so that the proper scope is presented fully up front in each section, prior to presenting the subgroup criteria and standards.
New section	Describes the criteria for inclusion as ESEMs.	§431.25(d)(2)(i)(A)	New section—adds the ESEM provisions adopted in this final rule.
New section	Describes the criteria for exclusion for certain ESEMs manufactured on or after January 1, 2029.	§431.25(d)(2)(i)(B)	New section—adds the ESEM provisions adopted in this final rule.
New section	Describes standards for certain high- and medium-torque ESEMs manufactured on or after January 1, 2029.	§431.25(d)(2)(ii)(A)	New section—adds the ESEM provisions adopted in this final rule.
New section	Describes standards for certain low-torque ESEMs manufactured on or after January 1, 2029.	§431.25(d)(2)(ii)(B)	New section —adds the ESEM provisions adopted in this final rule.

New section	Describes standards for certain polyphase ESEMs manufactured on or after January 1, 2029.	§431.25(d)(2)(ii)(C)	New section—adds the ESEM provisions adopted in this final rule.

D. ESEMs Used as a Component of Covered Products or Equipment

1. Energy Savings from ESEMs Used as a Component of Covered Products or Equipment

a. Absence of Energy Savings

Several stakeholders commented that regulating ESEM that are components of covered product/equipment would not result in any energy savings as summarized in this section.

Lennox stated that DOE should not regulate AO-ESEMs used in regulated HVACR products such as residential central air conditioners and heat pumps ("CAC-HPs"), commercial air-conditioning equipment ("CUACs") and walk-in coolers and freezers ("WICFs"). (Lennox, No. 69 at p. 11) Lennox stated that this would add cost to the product without saving energy, and thus fails to meet the statutory criteria of EPCA. Lennox stated that DOE's standards for HVACR products already include the energy used by the electric motors and that OEMs operate in a highly competitive market that is cost competitive, resulting in product affordability for end-users. Lennox stated that HVACR manufacturers will offset increased motor costs by reducing the costs (and efficiencies) of other components while continuing to meet minimum efficiency standards at the system level. Lennox commented that any new motor requirements would impose additional testing and certification requirements that impose additional costs without corresponding benefits, since testing and certification that governs the overall product is already done at the systems level and end-users have no interest in component-level metrics. (Lennox, No. 69 at pp. 1–2, 4) Lennox added that HVAC OEMs will need to optimize equipment to offset more expensive motors with lower-priced alternative components that have reduced efficiency but still allow the larger system to meet system-level minimum efficiency standards. (Lennox, No. 69 at pp. 6–7)

AHRI stated that DOE's economic justification analysis in the NOPR fails to account for many of the issues raised by double regulation of ESEMs/AO-ESEMs and the covered equipment in which they are included. AHRI commented that expanding the scope of coverage to include special- and definite-purpose motors would increase the costs of the motors, appliances, and equipment without necessarily improving the energy performance of the finished product. AHRI noted that EPCA requires that any proposed new or amended energy conservation standard must result in significant energy savings and be technologically feasible and economically justified. 42 U.S.C. 6295(o). (AHRI, No. 70 at pp. 3, 8–9) AHRI added that ESEMs and AO-ESEMs are embedded in many consumer and commercial OEM products that are already regulated by DOE, including small, large, and very large commercial package air-conditioning and heating equipment, residential air conditioners and heat pumps, single-package vertical air conditioners and heat pumps, commercial and residential furnaces, commercial and residential boilers, commercial and residential water heaters, air-cooled condensing units, central station air-handling units, geothermal heat pumps, unit coolers and ventilators, and water source heat pumps. AHRI stated that regulation would not result in additional conservation of energy because manufacturers of finished goods design products based on their products' pre-existing efficiency standards. Further, AHRI stated that the efficiency of electric motors already is a significant consideration for OEMs assessing what design options to apply to meet new finished product standards in an economically competitive manner and that regulating ESEMs and AO-ESEMs would distort those considerations. AHRI added that even if motors that complied with the NOPR proposal would themselves increase the efficiency of a product compared to existing motors, marketplace competition would drive OEMs generally to find cost savings in other parts of the equipment, meeting the applicable energy conservation standard for the finished product based on a combination of the various components. AHRI commented that DOE’s suggestion that increasing the efficiency of the motor component will increase the efficiency of the overall equipment if all other characteristics of the equipment and motor are held constant ignores the reality of the marketplace and comments from multiple parties.[49] For example, AHRI commented that the NOPR’s proposal would include low-torque AO-ESEMs between 0.25 and 0.75 hp, which are common in residential air conditioner and heat pump condenser fans, and AHRI described the different ways that an OEM could redesign its equipment to meet the standard for residential central heat pumps: by increasing the motor efficiency of the outdoor fan for high part-load performance products, increasing the diameter of the outdoor fan, improving the fan blade design, making modifications to the fan housing, and/or changing the number of rows in the outdoor coil. (AHRI, No. 70 at pp. 8–10)

[49] AHRI cited 88 FR 87062, 87094.

GE commented in support of AHRI's comments and against regulating components of regulated products. GE stated that this would increase costs with no benefit. (GE, No. 76 at pp. 1–2)

Rheem commented in support of AHRI's comments on the rulemaking and against regulating components of regulated products. Rheem commented that motors contribute to the overall system performance of HVACR products, as measured by newer metrics such as SEER2 and IVEC.[50] Rheem commented that it did not support redundant regulation of finished goods and applying the burden of component regulation to manufacturers who import such components in assembled complex products. Rheem commented that adopting the NOPR proposals would increase manufacturing costs, make repairing existing equipment more difficult and costly, and have other negative downstream impacts without significant corresponding benefits. Rheem added that DOE did not account for many of the issues raised by double regulation of ESEMs/AO-ESEMs and the covered equipment in which they are included. (Rheem, No. 74 at p. 1)

Carrier recommended not regulating components of regulated products where the efficiency of the component is already captured at the finished product level. Carrier commented that regulating special- or definite-purpose motors, specifically air-over motors, does not necessarily result in energy savings, introduces double regulation, impacts utility for consumers, and creates unnecessary burden for end-product manufacturers. Carrier stated that definite-purpose air-over motors should be excluded

[50] Seasonal Energy Efficiency Rating 2 and Integrated Ventilation, Economizer, and Cooling.

from the scope. Carrier commented that manufacturers typically design their products to that product's minimum efficiency requirement. Carrier stated that if DOE requires specific component efficiencies to be used within these covered products, manufacturers will typically trade off the increased cost of that component with other systems or components that have impact on the overall product performance, likely resulting in net-zero energy savings. Carrier added that these tradeoffs are usually necessary to avoid increased cost to the consumer and that including air-over motors in regulated end products is unlikely to result in energy savings. (Carrier, No. 71 at pp. 1–2, 6) Carrier noted that single-speed induction motors in the size range of 0.25 to 1 hp are widely used as condenser fan motors across both residential and commercial products. Carrier commented that for residential and light commercial application, the finished product typically includes one condenser fan motor, and as the size of the product increases to large and very large commercial models, four or six condenser fan motors may be used per unit. Carrier stated that condenser fans operate in conjunction with compressors in vapor compression systems and the performance metric of the end product includes the energy from the condenser fan motor. Carrier noted that manufacturers must comply with end-product minimum efficiency levels regardless of motor efficiency. Carrier added that the same situation exists for supply fans that incorporate single-speed induction motors that are operated with a VFD speed control primarily used in commercial unitary products where the energy used by that motor is included in the end-product performance metric that is regulated by DOE. Carrier commented that DOE's commercial fans and blowers rule is analogous to this rule in that DOE is regulating a component of larger DOE-regulated products, but in the fans and blower rule DOE exempts units that go into a regulated end product, while that is not the case in this rule. Carrier stated that not having this exemption creates double regulation without any energy savings. (Carrier, No. 71 at p. 4)

AHAM stated its support for energy conservation standards for motors that are not already subject to an existing energy conservation standard. Specifically, AHAM stated that higher efficiency is already considered in DOE's analysis when establishing and amending energy conservation standards for commercial clothes washers. (AHAM, No. 75 at p. 1)

On the other hand, some stakeholders indicated that energy savings are still possible even where ESEMs are used in regulated equipment.

NEMA commented that low-torque AO-ESEMs are primarily used in regulated equipment. NEMA stated that energy savings would come from the replacement/retrofit market and that energy savings from motors going in new equipment would be captured in the equipment-level test procedures and standards. (NEMA, No. 68 at p. 3)

The Advocates stated support for covering motors that go into DOE-regulated products and commented that energy savings are still possible in regulated applications. The Advocates highlighted replacement motors for regulated products as an opportunity for energy savings. (Advocates, No. 72 at p. 2)

As discussed in section II.A of this document, DOE's authority to regulate electric motors includes those manufactured alone or as a component of another piece of equipment, including covered equipment. DOE notes that ESEMs are used in a variety of equipment, including equipment and consumer products subject to energy conservation standards such as CAC-HPs, WICFs, and CUAC/HPs. For new ESEM shipments, DOE understands there will be two distinct scenarios: OEM equipment that already includes an ESEM with an efficiency that meets or exceeds the standards adopted in this final rule and OEM equipment that includes an ESEM that is less efficient than the standards being adopted in this final rule.

For OEM equipment that has a compliant motor (i.e., an efficiency that meets or exceeds the adopted standards), DOE estimates there will be no benefits or costs from the standard and DOE does not include this part of the population in estimating the cost and benefits of the rule. For OEM equipment that has a non-compliant motor (i.e., an efficiency less than that the adopted standards), DOE estimates the incorporation of the more efficient ESEM would result in energy savings because this OEM would be replacing the less efficient motor with a more efficient, compliant ESEM. DOE also estimates that such a manufacturer would result in increased costs. OEMs required to incorporate a new, compliant ESEM into their products could make any number of design changes to allow for the new motor. However, DOE assesses the market for embedded ESEMs as if the more-efficient ESEM can be a drop-in replacement for the less-efficient ESEM. As previously noted, this is consistent with DOE's engineering analysis. In that analysis, DOE, relied only on design options that maintain the form, size, fit, and function of the embedded ESEM. DOE imposed that constraint on its analysis as a result of comments and input from manufacturers. Accordingly, DOE's analysis assumes that a standard-compliant ESEM can , and will, replace a non-compliant ESEM without substantial changes to the end use product.

DOE recognizes that OEMs that include ESEMs in their product designs can achieve higher efficiency using different technologies, including improving motor performance (efficiency and speed control), compressor staging, better heat exchanger designs, and more-efficient indoor fans. In many cases, modifications to one of these technologies can have ripple effects throughout the system requiring optimization and greater costs. DOE has concluded, however, that the more-efficient ESEMs required by this rule will not compel OEMs to significantly redesign any of these interrelated aspects of their final products. If an OEM is required to purchase a more efficient ESEM as a result of this rule, that ESEM would be a drop-in replacement ESEM. As such, the replacement of the less efficient ESEM by a more efficient compliant ESEM would not trigger the OEM to redesign the OEM equipment and would not result in any OEM conversion costs (even though HVACR equipment testing and certification costs would be incurred due to the inclusion of the more-efficient ESEM, which DOE accounts for in its analysis). *See* section V.B.7.a of this document.

To be sure, if OEMs choose to offset the increase in costs and energy savings resulting from a more efficient ESEM by downgrading the efficiency of other components within the OEM equipment such as the heat exchanger, compressor and fans, the OEM would likely be required to re-optimize the whole system to ensure the performance is maintained to the interconnections and interdependencies of the refrigeration system performance. This overall system optimization, as mentioned in Lennox in their comments, would actually result in higher OEM conversion costs than replacing the motor only and maintaining the higher system performance.

While technologically feasible, DOE has concluded that it is not realistic to expect that OEMs would go through this extensive and more costly redesign (more expensive than swapping the ESEM motor only), outside of a normal redesign cycle to offset the price increase of the compliant ESEM, specifically in a situation where all OEMs would be experiencing similar increases in costs and improvements in motor efficiency.

DOE considered the possibility that *all* OEMs would choose to offset the energy savings (and costs) associated with incorporating compliant ESEMs by redesigning their end-use equipment such that the resulting efficiency of the equipment was unchanged. DOE has concluded that such a scenario is unrealistic because the costs of redesigning equipment to maintain status quo efficiency levels are far greater than the costs of simply incorporating a drop-in replacement, standards-compliant ESEM. Nevertheless, such a scenario can serve as a lower bound for the possible energy savings from this rule because in such a scenario there would be no energy savings attributable to the ESEM standards for ESEMs incorporated into new equipment. However, even in such a scenario, energy savings would be achieved from ESEMs sold alone to replace a failed ESEM in an installed equipment/product (i.e., replacement market). DOE examined the expected energy savings from ESEMs sold only into this replacement by isolating the ESEM shipments that go into replacement only applications. Such shipments represent 30 percent of ESEM total shipments (see chapter 8 of the June 2023 DFR Technical Support Document, pp. 8–10).[51] Based on this estimate, energy savings from replacement motors meeting the adopted standards would still represent 2.64 quads. In addition, DOE expects that regulating replacement ESEM only would also be economically justified at the adopted levels (See section V.C of this document) given that replacement ESEMs have identical usage and engineering characteristics as non-replacement ESEMs.

As stated previously in section III.C of this document, there are no physical or technological distinguishing factors in a ESEM that could be used to identify a particular end-use application, or to identify if the ESEM will be sold for incorporation in a regulated or a non-regulated equipment or consumer product, or sold for the replacement market.

b. Double Counting of Energy Savings

Stakeholders disagreed as to whether DOE was double counting energy savings from more efficient ESEMs which are already captured in product/equipment-level regulations as summarized in this section.

Lennox commented that CAC-HP OEMs already use higher-efficiency motors when cost-effective, and the energy use associated with these motors is already captured in the product efficiency metrics as highlighted in the DOE report cited in the December

[51] DOE estimated the market share of replacement ESEMs based on input from NEMA.

2023 NOPR.[52] Lennox added that this report does not address issues related to double counting of benefits between component- and system-level regulations. (Lennox, No. 69 at pp. 6–7) Lennox stated that DOE did not properly avoid double counting energy savings in this rule and should develop a new proposal for comment and either: (1) excludes motors (particularly air-over motors) used in regulated HVACR equipment, or (2) excludes more efficient motors from its analysis. Lennox stated that DOE should follow the same approach as with the CAC-HP rule, which excluded furnace fan electricity savings. Lennox added that DOE's failure to assess double counting of energy savings invalidates the results of the LCC analysis and whether energy savings were in fact significant. (Lennox, No. 69 at pp. 7–8,10)

On the other hand, the CA IOUs commented that they support DOE's approach of incorporating final rules into the no-new-standards case to assess consumer cost savings, and they recommended that DOE continue this approach when evaluating savings for the final rule. The CA IOUs commented that in the NOPR, DOE acknowledges that some ESEMs covered by the proposed rule may be embedded in covered products and equipment, which are also subject to current and proposed efficiency standards. The CA IOUs added that as a result, DOE's LCC and national savings analyses should avoid double counting the savings from this rule where the savings are already accounted for in the efficiency improvements made to comply with other energy efficiency standards. The CA IOUs supported the following approach to avoiding double counting: incorporate

[52] Goetzler, William, Timothy Sutherland, and Callie Reis. 2013. *Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment*. doi:10.2172/1220812. Available at *osti.gov/biblio/1220812* (last accessed April 18, 2023).

each finalized rule into the baseline in subsequent savings analyses where a proposed rule for a product may also affect the efficiency of the product subject to a final rule. The CA IOUs commented that taking a "first-in-time" approach to the savings analysis is a reasonable approach to addressing the uncertainty posed by interactive proposed rules. (CA IOUs, No. 76 at p. 4)

First, in response to Lennox's claims that OEMs already use higher-efficiency motors when cost-effective, DOE examined one of the commenters' cited common end-use examples, that of CAC condensing unit fan motor. This example should provide a relevant illustration of potential economics, because shipments of CAC condensing units are greater than shipments of any of the other cited common air-over ESEM examples, thus making it more likely for this application than others that an OEM would incur the cost of redesign to compensate for the cost of a higher-efficiency more-expensive ESEM by reducing costs in other components to attain the same previous efficiency level. Based on review of key OEM product literature, DOE concluded that ¼-horsepower is representative for the condenser fan motor of a 5-ton (nominally 60,000 Btu/h) air conditioning condensing unit with 14.3 SEER2 efficiency level (baseline for Southwest and Southeast regions). For such a motor, DOE estimates that upgrade from baseline to the finalized efficiency level (EL2) would cost an OEM approximately $37 on average and save 200 W. This would result in a SEER improvement of 0.77 Btu/h-W, a cost per SEER of approximately $49 In comparison, the cost per SEER determined for the 2017

Direct Final Rule analysis near a 15 SEER efficiency was in the range $106 to $147.[53] Thus, the motor improvement to EL2 is 2 to 3 times more cost-effective than the design changes determined in the 2017 analysis to be justified in selecting a 15 SEER (14.3 SEER2) standard level. However, not all CAC condenser fan motors are currently at EL2, which indicates that not all OEMs have selected the most cost-effective design path to achieve the 14.3 SEER2 level. DOE is aware that can be numerous reasons for specific design decisions that don't always align with the most cost-effective approach. These decisions can be based on supplier relationships, selecting design paths having multiple sourcing options, maximizing purchase volumes of specific components to gain purchasing leverage, building design strategy on concepts other than motor efficiency, etc. To the extent that an OEM has not chosen a design strategy based on maximizing the cost effectiveness of a given efficiency improvement, it is not clear that the OEM would necessarily backtrack on these decisions as a result of motor efficiency increase. This suggests that, to the extent that OEMs are not yet using ESEMs at EL2 or above, it would appear that, contrary to the Lennox claims, they have not already decided to switch to the more cost-effective motor option even when there is strong economic evidence supporting such design decisions. This casts doubt on the claim that the ESEM rule will result in no savings for embedded ESEMs installed in regulated products.

DOE's approach to avoid any double counting of energy savings in analyzing energy conservation standards is as follows. First, as explained in more detail in section

[53] Based on MPCs for 5-ton Coil-Only CACs of $1,087 at 14 SEER, $1,234 at 15 SEER, and $1,287 at 15.5 SEER, see page 5-22 of the Direct Final Rule TSD. This does not consider the potential cost increase since 2017. However, DOE notes that including this would further support DOE's conclusion.

IV.F.8, DOE calculates LCC savings and national energy savings ("NES") relative to the no-new-standards case efficiency distribution, which represents the projected distribution (market shares) of equipment efficiencies under the no-new-standards case (*i.e.*, the case without new energy conservation standards) in the compliance year. This approach reflects the fact that some ESEMs are already sold at efficiencies greater than the baseline levels in the absence of new ESEM standards and accounts for any existing ESEM efficiency improvements on the market, including motor efficiency improvements expected to result from existing equipment-level regulations.[54] With this approach, when estimating the energy savings in each standards case, DOE considers that adopting new ESEM standards would not impact the fraction of consumers that are already purchasing more efficient ESEMs (*i.e*., ESEMs with efficiencies that are at or above the considered standards) and would not result in any energy savings in this case. As such, DOE is not double-counting energy savings that are already being captured in existing product/equipment level regulations. DOE notes that this approach aligns with Lennox's comment that DOE should exclude more efficient motors from its analysis to avoid double counting of energy savings. In addition, DOE acknowledges that upcoming equipment-level energy conservations standard could have an impact on future ESEM efficiencies on the market. To reflect this, as part of the national impact analysis ("NIA"), DOE included a sensitivity analysis which accounts for an increase in efficiency over time in the no-new standards case. See Section IV.H.1 for more details. DOE further acknowledges that upcoming equipment-level energy conservations standard could

[54] DOE did not separately assess the impacts of each equipment-/product-level energy conservation standard on the no-new-standards case ESEM efficiency distribution. Instead, as discussed in section IV.F.8 of this document, DOE relies on motor performance data and model counts from major motor manufacturers catalogs representative of ESEMs sold on the market.

reduce ESEM shipments as some OEM may decide to switch to ECM motors and accounted for this by conducting a sensitivity analysis based on lower ESEM shipments. See section IV.G of this document.

Further, the use of no-new-standards case efficiency distributions is common to all DOE energy conservation standards rulemaking analyses. Any future product-/equipment-level rulemaking would also rely on a no-new-standards case that would assume component ESEMs are compliant and already have efficiencies at or above the levels adopted in this final rule. This would ensure that any future product-/equipment-level rulemaking would not double count energy savings already accounted for in this final rule. Finally, any energy savings from product-/equipment-level rulemakings where the standard would implicitly require a shift from an ESEM to a non-ESEM motor are not double counted in this rule because the analysis only accounts for savings from ESEMs in scope. As such, the projected shipments do not capture non-ESEM motors, and the resulting energy savings calculation does not consider energy savings from non-ESEM motors. See section IV.G of this document.

In addition, DOE included the impacts of upcoming equipment-level rules on the projected ESEM market (i.e. WICFs, circulating pumps, CUAC/HP and air circulating fans), and addressed the potential double counting of savings,

First, in the NIA, DOE analyzed a scenario with reduced ESEM shipments to reflect a situation where OEMs of WICFs and circulator pumps could switch from using ESEMs to motors that are outside of the scope of this regulation such as ECMs. See section IV.G and IV.H of this document. This addresses the issue of double counting by removing from this rule, any savings already accounted for in the WICFs and circulating pump rulemaking.[55] DOE notes that a reduction in shipments due to a switch to ECMs or other out of scope motors would not change the relative comparison of the TSLs and would not change DOE's conclusion of economic justification of the adopted standards.

DOE identified that ESEMs are used as indoor and/or outdoor fan motors in certain CUAC/HP models. However, DOE did not analyze more efficient ESEMs as design options in the CUAC/HP direct final rule.[56] Instead, DOE expects OEMs to achieve higher efficiency using other design options including improving compressor staging, and heat exchangers, and indoor fan design.[57] As a result, DOE did not account for energy savings from more efficient ESEMs in the CUAC/HP rule. Therefore, the energy savings from more efficient ESEMs used in CUAC/HPs are captured in this final rule.

Finally, the energy savings calculated in this final rule include the savings from ESEM incorporated in air circulating fans ("ACFs"). To avoid double counting, the air circulating fan analysis in support of a proposed rule incorporated a sensitivity analysis[58] which represents a situation where, in the no-new standards case, all ACFs would

[55] DOE estimates that ESEMs in WICFs and circulator pumps to represent a small share of ESEM shipments (about 1.5 percent of ESEM shipments).

[56] To the extent that CUAC/HP manufacturers improve efficiency of indoor and/or fan motor/drives in CUAC/HPs, DOE understands that the improvement is more commonly achieved by changing motor topologies (e.g., changing from PSC to ECM) or adding a VFD to a polyphase motor, rather than by improving the efficiency of an ESEM.

[57] This option refers to the design of the fan itself, without the motor.

[58] At the time, the ESEM final rule was not finalized and DOE incorporated this as a sensitivity analysis in the fans and blowers NOPR. 89 FR 3714, 3777 (January 19, 2024).

incorporate a ESEM compliant with the standards adopted in this final rule. 89 FR 3714, 3777 (January 19, 2024). In the sensitivity case, DOE relied on a modified characterization of market efficiency distributions representing a scenario where all ACFs already incorporated a more efficient compliant ESEM, even in the absence of new ACF standards. As such, in the ACF sensitivity case, DOE did not account for any energy savings from ACFs shifting from lower efficiency ESEMs to compliant ESEMs.

2. Original Equipment Manufacturer Burden

a. OEM Testing and Certification Costs

In the December 2023 NOPR, DOE did not include the potential additional testing and certification costs that OEM may be subject to as a result of new ESEM energy conservation standards and noted that the proposed levels would preserve the frame sizes of ESEMs on the market today and estimated that these costs would not be significant. 88 FR 87062, 87089-87090. Several stakeholders commented that DOE needs to consider OEM testing and certification costs in its analysis.

Lennox commented that constraining the frame size alone does not eliminate the impact on the OEM due to other changes in the motor. Lennox commented that with any changes in stack length and weight, OEMs will need to reevaluate fit, mounting, structure, fan design, sound, vibration, reliability, and performance. Lennox added that a change in motor efficiency may change (*e.g.*, increase) the motor speed, which requires a full performance and reliability evaluation, and any change in the motor design will need full evaluation and approval from product safety agencies. (Lennox, No. 69 at p. 11)

Specifically, Lennox commented that DOE did not account for the complexity regarding how motors are integrated into HVACR equipment, particularly for air-over motors. Lennox stated that system-level regulations consider key measures related to air-over motors, which impact the finished product efficiency, such as: product air-moving system characteristics, how the motor is mounted and applied in the system-level application, and the air-moving system's relationship to heat exchanger design and compressor selection. Lennox added that while these air-over motors are constructed on standard frame sizes, they are designed specifically to the application, according to HVACR OEM manufacturer specifications. Due to this complexity, Lennox stated that DOE must not regulate motors (particularly air-over motors) used in HVACR equipment at the component level, and instead should rely on system-level standards. Lennox added that almost all these motors are made-to-order for—and/or interact in complex ways with—broader system dynamics, so that component-level regulation is unnecessary and incurs costs (including for consumers) without a corresponding benefit. Lennox provided additional information regarding the complex development and manufacturing process associated with HVACR OEMs incorporating new motor designs in an appendix. (Lennox, No. 69 at pp. 3, 15) Lennox added that air-over motors used in commercial air-conditioning and WICF refrigeration systems are highly customized and made-to-order for commercial air-conditioning and refrigeration OEMs, even if they are built in standard frame sizes. Lennox stated that the burden and cost associated with regulating air motors in commercial air-conditioning and WICF applications are compounded by the fact that as these products increase in capacity, multiple motors are used. Lennox stated that, for example, it is common for products in the 7.5- to 10-ton range to have two condenser fans, and for products over 15 tons, four or more condenser fan motors may be used. Lennox stated that DOE should include OEM testing and certification costs in the MIA of this rule. Lennox cited the $1.83 billion in costs estimated by AHAM and AHRI. (Lennox, No. 69 at p. 6) Lennox stated that DOE did not account for the costs that would be incurred by HVACR OEMs as a result of this rule. (Lennox, No. 69 at pp. 9, 13)

AHRI commented that certification, testing, and reporting requirements will also add cost to the motor, particularly with the proposed third-party nationally recognized certification program requirements. (AHRI, No. 70 at pp. 8–9) AHRI commented that any increase to motor stack length increases the motor's weight. AHRI added that if the motor casing size does not change, the weight increase will trigger a full evaluation by OEMs for physical fit, motor-mounting means, physical structure supporting the motor, fan design, sound, operational and shipping vibration, and other factors. AHRI further specified that any change in the physical and performance characteristics needs to be fully evaluated and that a change in motor efficiency may change (*e.g.*, increase) the motor speed, which requires a full performance and reliability evaluation. AHRI also commented that any change in the motor design would need full evaluation and approval from product safety agencies. (AHRI, No. 70 at pp. 14–15)

AHRI commented that DOE has failed to account for the burdens of certification, testing, and other aspects of compliance with the NOPR proposal. AHRI stated that some finished-good manufacturers buy, then embed, a completed AO-ESEM and that others buy motor components to directly install into equipment. In the latter case, AHRI stated that the OEM manufacturer "completes" the motor's construction and would be required to certify the motor. AHRI commented that these same concerns apply to finished goods manufactured overseas, where OEMs would be considered as electric motor manufacturers.[59] For imported equipment, AHRI commented that the increased motors scope would impact OEMs who purchase both air-over ("AO") motor components and AO motors that are not already sold in the U.S. market. AHRI stated that DOE did not address industry's scope-expansion concerns raised during the test procedure rulemaking and submitted in response to the standards RFI.[60] AHRI commented that DOE's shipments analysis did not include residential CAC-HPs and likely did not include AO motors that are purchased as component sets and manufactured into a testable configuration by the OEM. AHRI added that OEMs now considered motor manufacturers by the scope expansion would be subject to new requirements for establishing or verifying performance in an independent laboratory. AHRI stated that none of the low-torque AO motor-specific manufacturer or customer impacts were accounted for in DOE's analysis, since DOE did not consider residential CAC-HPs in its analysis. (AHRI, No. 70 at pp. 19–20) AHRI commented that DOE did not adequately account for the impacts of increasing the stack length and weight of AO-ESEMs. Specifically, AHRI argues that DOE incorrectly assumes that the market disruption would start at EL 3 and AHRI noted the stack length increases of 9 and 22 percent at EL 1 and EL 3. AHRI commented that while the OEM impacts are difficult to quantify due to the large range of applications, DOE could still interview OEMs or use information from tear down analysis from finished goods to try to evaluate this impact. AHRI added that no basis was

[59] AHRI noted that 42 U.S.C. 6291(1)(10) defines "manufacture" to include manufacture, produce, assemble, or import.
[60] AHRI cited AHAM and AHRI, Docket: EERE-2020-BT-TP-0011, No. 0036 at p. 11.

provided to correlate the degree of impact to OEMs to the stack length limitation DOE established. (AHRI, No. 70 at p. 14)

Rheem commented that regulating ESEMs would increase testing and overall regulatory burden without savings to consumers. (Rheem, No. 74 at p. 1)

In this final rule, as discussed further in section V.B.7.a of this document, DOE evaluated the additional retesting and recertification costs to OEMs who would be required to incorporate more efficient ESEMs in their equipment. These costs include any costs related to selecting higher-performance motors; designing, building, and testing prototypes; designing wirings, markings, and labels; obtaining safety agency approvals; designing and developing packaging; manufacturing fixturing, routing, and costing activities; developing and publishing technical literature; and any product aftermarket and launch activities. In addition, DOE considered these impacts when selecting the TSL adopted in this final rule. *See* section V.C.

Regarding the costs of testing and certifying the ESEMs, these costs are already included as part of the MIA, which evaluates the impacts on ESEM manufacturers, including OEMs of HVACR equipment, that also manufacture or import ESEMs.

Finally, DOE did not exclude any ESEMs from its NOPR analysis based on the type of end-use equipment (*e.g.*, CAC-HPs), and although DOE did not disaggregate shipments of ESEMs by end-use application, the shipments include ESEMs incorporated into CAC-HPs. *See* section IV.G of this document. In addition, in this final rule, DOE revised residential fan operating hours and equipment lifetimes with the expected fan operating hours and lifetimes of CAC-HPs, as further discussed in sections IV.E.3 and IV.F.6 of this document.

Carrier stated that with this regulation, OEMs that import foreign-made motors will have two options to comply: (1) switch their motor supplier to a manufacturer that certifies with DOE, or (2) certify their motors and become the ones responsible for the motors' performance. Carrier stated there was a high impact on the manufacturer for either option. Carrier noted the extensive specifying and reviewing done with the new supplier, as well as testing and redesigning of the application, to change motor supplier. Carrier commented that to certify according to DOE requirements, the manufacturer would have to invest more in testing, labeling, and certifying. (Carrier, No. 71 at pp. 5–6)

DOE acknowledges that OEMs will incur additional costs due to ESEM energy conservation standards, but as required under EPCA, DOE has determined that the rule is economically justified as well as technologically feasible. DOE examines and estimates these additional costs in section V.B.7.a of this document as well as in the MIA, when the OEM is also the motor manufacturer.

b. Timing of Compliance Years and Impacts on Consumer Products

In the December 2023 NOPR, DOE identified the following covered equipment as potentially incorporating ESEMs: WICFs,[61] circulator pumps,[62] air-circulating fans,[63] and CUAC/HPs.[64] Based on the proposed energy conservation standards for these rules,[65] DOE identified that these rules would all either (1) have a compliance year that is at or before the ESEM standard compliance date (January 1, 2029) and/or (2) require a motor that is either outside the scope of this rule (*e.g.*, an electronically commutated motor or "ECM") or an ESEM with an efficiency above the proposed ESEM standards, and therefore, would not be impacted by the proposed ESEM rule (*i.e.*, the ESEM rule would not trigger a redesign of these equipment). 88 FR 87062, 87081.[66] DOE also stated that ESEMs are built in standard NEMA frame sizes and are not common in regulated consumer products including clothes washers (top and front load), clothes dryers, food waste disposers, refrigerators, room air conditioners, and stick vacuums. *Id.,* 87080-87081.

Lennox commented that the NOPR inaccurately states that ESEMs are "built in standard NEMA frame sizes and are not common in currently regulated consumer

[61] The WICF standards rulemaking docket number is: EERE-2015-BT-STD-0016.
62 The circulator pumps energy conservation standard rulemaking docket number is: EERE-2016-BT-STD-0004.
[63] The commercial and industrial fans and blowers energy conservation standard rulemaking docket number is: EERE-2013-BT-STD-0006. Air-circulating fans are a subcategory of fans.
[64] The small, large, and very large air-cooled commercial package air conditioners and heat pumps energy conservation standard rulemaking docket number is: EERE-2013-BT-STD-0007.
[65] DOE notes that the final rule for circulator pumps has since published. 89 FR 44464 (May 20, 2024) as well as the direct final rule for CUAC/HPs. 89FR44052 (May 20, 2024).
[66]More specifically, WICFs and circulator pumps are expected to have a compliance year that is before the ESEM standard compliance date and will likely require a motor that is either outside the scope of this rule (ECM); Air circulating fans are expected to have a compliance year that is after the ESEM standard compliance date (January 1, 2029) and require an ESEM with an efficiency above the proposed ESEM standards; and CUAC have a compliance year at the ESEM standard compliance year (January 1, 2029).

products," including those products listed by AHRI. Lennox added that it was incorrect to state that the proposed ESEM standards would not impact manufacturers of consumer products.[67] Lennox commented that DOE's expanded motors regulation would adversely impact consumer products, in particular residential CAC-HPs, which are not mentioned in the December 2023 NOPR. (Lennox, No. 69 at p. 4)

Lennox commented that DOE is incorrect to state that commercial equipment incorporating ESEMs would not be impacted by the proposed rule because such equipment is separately regulated under DOE efficiency standards that: (1) have a compliance year that is at or before the ESEM standard compliance year (2029), and/or (2) require a motor that is outside of the scope of this rule. First, Lennox commented that OEMs may not have enough time to redesign their systems to accommodate new motors, even if the ESEM compliance date is after the compliance date of DOE energy conservation standards for WICFs and residential CAC-HPs. Lennox stated that changes in motor design must generally be made at least 18 months before the system-level regulations go into effect. Lennox commented that integrating new motor designs requires costly performance analysis at the system level, expensive testing, and reliability evaluations. Lennox added that the different regulatory cycles for commercial air-conditioning, WICFs, residential CAC-HPs, and ESEMs would be a continuing conflict for OEMs incorporating ESEMs with increased costs and no benefit. Second, Lennox commented that DOE should not regulate already-regulated systems, because these system-level regulations already incentivize motor efficiency above the proposed ESEM

[67] Lennox cited 88 FR 87062, 87080, and 87089 and 88 FR 87062, 87138, and 87081.

standard when appropriate. Lennox added that OEMs optimize equipment in ongoing design cycles rather than in reaction to unneeded and duplicative component regulation. (Lennox, No. 69 at pp. 5–6)

AHRI commented that DOE is incorrect in its assessment that regulating ESEMs would not impact consumer products, and it stated that regulating ESEMs could impact the following products: small, large, and very large commercial package air-conditioning and heating equipment; residential air conditioners and heat pumps; single-package vertical air conditioners and heat pumps; commercial and residential furnaces; commercial and residential boilers; commercial and residential water heaters; air-cooled condensing units; central station air-handling units; geothermal heat pumps; unit coolers and ventilators; and water source heat pumps. AHRI commented that motors used in these products are definite-purpose and special-purpose motors; have special operating characteristics or special mechanical construction, or both; and are designed for a particular application. AHRI noted that these motors differ from SEMs because they cannot be used in most general-purpose applications. AHRI stated that AO-ESEMs are primarily used in fan or blower applications and specifically built for OEMs. (AHRI, No. 70 at pp. 1–2)

AHRI disagreed that in cases where a product must meet an efficiency standard before the proposed ESEM standards would be effective, the new standards would not be a concern (*see* NOPR at 87089). AHRI stated that if this rule is adopted, manufacturers may have to change the design choices they have made to meet the standards for the finished covered product in order to accommodate the use of a compliant ESEM, which would impose significant costs and delays. (AHRI, No. 70 at p. 10)

Carrier disagreed with DOE ’s finding that other products with proposed rules finalizing before the ESEM rule or/and with a standard level that would require an ECM or an ESEM with an efficiency level above the proposed ESEM standards would not be impacted by the proposed ESEM rule. Carrier stated that manufacturers do not have the time or resources to redesign their equipment based on additional component constraints. Carrier commented that for CUACs specifically, there are many ways to enhance a product’s efficiency to meet the new energy conservation standard for January 1, 2029, and prescribing a specific component efficiency can add cost and require additional resources with no additional benefit. Carrier stated that product regulation is the way to drive and incentivize higher-efficiency motors to achieve DOE's goals. (Carrier, No. 71 at p. 3)

On the other hand, the Advocates and the Motor Coalition stated that this rule would have minimal impact on covered products and equipment.

The Advocates stated that this rule is expected to have minimal impact on covered product redesigns, noting that the compliance date for amended standards would require a motor that is out of scope of this rule before this rule comes into effect. The Advocates also stated that exempting ESEMs in covered equipment would create enforcement challenges, because DOE would have difficulty in identifying the end-use application of a given motor for sale. (Advocates, No. 72 at p. 2)

The Motor Coalition stated that the ESEM proposal would have minimal impact on DOE-covered equipment. The Motor Coalition noted that WICFs, circulator pumps, air-circulating fans, and CUAC/HPs all have a compliance date at or before the ESEM compliance date and would require a motor that is outside of the scope of the ESEM rule.(e.g. ECMs) (Motor Coalition, No. 77 at p. 3)

In response to AHRI's comment stating DOE is incorrect in its assessment that regulating ESEMs would not impact consumer products, in the December 2023 NOPR, the statement regarding the impact on consumer products was specific to the list of products identified as clothes washers (top and front load), clothes dryers, food waste disposers, refrigerators, room air conditioners, and stick vacuums specified in that paragraph and was not intended to be general to all consumer products. 88 FR 87062, 87080–87081 In addition, when DOE stated that certain commercial equipment incorporating ESEMs (*i.e.*, WICFs, circulator pumps, air-circulating fans, and commercial unitary air-conditioning equipment) would not be impacted by the proposed ESEM rule, DOE focused on covered equipment with upcoming rulemaking updates in order to ensure the regulatory cycles of these rules would not conflict. In that context, DOE specified the meaning of "not impacted" as "the ESEM rule would not trigger a redesign of these equipment" Specifically, for WICFs and circulator pumps, which both have a compliance year that is before the ESEM compliance date (January 1, 2029) the upcoming equipment-level energy conservation standards would likely require shifting from ESEMs to ECMs. As such, these two categories of equipment would no longer be impacted by the ESEM rule. Further, as discussed in section II.B.3 of this document, DOE aligned the ESEM compliance date with the compliance date for CUAC/HPs, such that OEMs would not have to perform two separate redesigns. Finally, for ACFs, the proposed levels would require a motor above the adopted ESEM levels and compliance in 2030 and therefore, if that rule is finalized, the ESEM rule would not trigger an additional redesign after that date.

For other covered equipment with no upcoming rulemaking, the impacts on OEMs would be in terms of the conversion costs needed to incorporate compliant ESEMs which DOE is considering in this final rule. DOE examined OEM retesting and recertification cost impacts for OEMs of covered equipment and products incorporating ESEMs in general, as described in section V.B.7.a of this document.

c. Additional Design Constraints

Several stakeholders commented that regulating ESEM would impose design constraints at the component level and limit innovation.

Lennox commented that HVACR component-level regulation imposes design constraints and impedes innovation in developing more effective systems. Lennox stated that component-level regulation inhibits the flexibility required by HVACR OEMs to create better products at marketable prices and adds significant burdens throughout the supply chain of products, ultimately resulting in increased consumer cost. (Lennox, No. 69 at p. 2)

AHRI stated that component regulation also imposes design constraints and limits innovation. AHRI added that OEMs make individual determinations regarding how to use all options available to best design a cost-effective, cohesive product that meets the relevant energy conservation requirements for the finished product. AHRI commented that a single component choice limits available options for manufacturers and, ultimately, consumers. (AHRI, No. 70 at pp. 8–10)

On the other hand, the Motor Coalition supported the energy conservation standards proposal, which reflects the Motor Coalition December 2022 Joint Recommendations. The Motor Coalition stated that the proposed levels minimize negative impacts on the market by ensuring a variety of technical options remain available for motor manufacturers to design motors that meet existing OEM designs. (Motor Coalition, No. 77 at p. 1)

DOE disagrees with AHRI and Lennox that the adopted standards will impose design constraints and limit innovation for OEMs. The adopted standards do not eliminate any equipment class of ESEMs from the market and would not limit OEMs' access to suitable ESEMs (*see also* discussion in section III.D.2.d of this document). Specifically, low-torque AO-ESEMs (PSC topologies) that are primarily used by HVACR OEMs would remain on the market. In addition, DOE notes that 67 percent of shipments of low-torque AO-ESEMs are already at efficiencies equal to or higher than the adopted TSL and would remain on the market. In addition, regulating ESEMs would not limit the flexibility that OEM currently have in terms of selecting and combining other components in their equipment as OEMs described in section III.D.1.a of this document.

d. Replacement Market and Potential Market Disruption

In the December 2023 NOPR, DOE did not exclude replacement ESEMs from the scope of the rulemaking and stated that it did not expect any losses in repairability for previously purchased appliances because the form, fit, and function of ESEMs would be preserved at the proposed TSL. DOE added that at the proposed TSL, drop-in replacement motors would remain available and there would be no major market disruption 88 FR 87062, 87089.

Lennox stated that higher ELs would result in significant market disruption for HVACR equipment. (Lennox, No. 69 at p. 11) Lennox stated that regulating AO-ESEMs will disrupt the HVACR replacement parts supply chain. Lennox commented that if the motor cost increases, the cost to replace a failed motor will increase as well. Lennox commented that motor manufacturers are expected to provide HVACR OEMs and their HVACR customers with approved replacement motors that meet performance and safety requirements. Lennox stated that these replacement motors must generally meet the same operational and size characteristics as the original motor, and as noted above, motors are typically specifically designed for particular HVACR equipment, and using non-approved motors for replacements may void product warranties. (Lennox, No. 69 at p. 12)

AHRI commented that the NOPR proposal would result in unavailability of replacement motors for existing equipment, increasing costs, and undermining of efficiency. AHRI stated that to the extent DOE is relying on increased stack length as a technology for improving ESEM efficiency, the increased size will mean that compliant

ESEMs cannot fit in many finished products. AHRI stated that this is particularly important in regulated applications. AHRI commented that the structural elements and fit by length in condenser fan applications is critical and that by extending the analysis from SEMs, DOE has overlooked the extensive impact on replacement motors. Further, AHRI commented that the added size and weight of compliant ESEMs may create additional issues when used as replacements, and it noted that product designs, brackets, vibration testing, installation in buildings, etc. are based on the motor that originally is used in the product. AHRI commented that for finished goods already installed in homes and businesses, the impact could be devastating, because motors could be no longer available as replacement parts, thereby forcing consumers to prematurely discard products that could have otherwise been repaired, with significant additional costs on consumers and environmental impacts that would likely entirely offset any marginal gains from the increased scope. AHRI stated that it had repeatedly commented that setting energy conservation standards on motors that are components of finished goods would result in unavailability of replacement motors and consumers would be forced to purchase a new appliance they could not afford because the existing equipment could no longer be serviced.[68] AHRI stated that, according to DOE, drop-in replacement motors would remain available and there would be no major market disruption; AHRI commented that this conclusion is insufficient to meet regulatory requirements.. 88 FR 87062, 87089. (AHRI, No. 70 at pp. 15–16)

[68] AHRI cited AHAM and AHRI, Docket: EERE-2020-BT-TP-0011, No. 36 at p. 10.

AHRI commented that DOE fails to account for the potential unavailability of the motors in use in today's HVACR equipment, particularly residential CAC-HP condensers fans, and that the cost to OEMs and, ultimately, the consumer, of retroactively designing equipment in use today for motors that become unavailable upon new standards is not included in DOE's analysis. AHRI commented that HVACR and water-heating equipment are built, tested, and certified as a completed design, which is reliant upon a specific set of components, and that slight changes to the motors can have significant, and sometimes unexpected, impacts on performance and efficiency. AHRI commented that there are a variety of safety standards affected by airflow in addition to the performance standards. AHRI commented that if a replacement motor is not compliant, then in most cases an engineered-to-fit substitution would be required, which would bring increased costs based on impacts to reliability, robustness assurance actions, and safety standard compliance. AHRI stated that costs, risks, and time required to retest HVACR and water-heating equipment would be prohibitive and testing could be impractical if the HVACR or water-heating equipment was out of production. AHRI commented that manufacturers would be forced to rebuild an out-of-production unit solely for the purpose of testing the new motor or risk abandoning a reasonable repair path for consumers. AHRI commented that while there may be instances where such part substitution makes sense, this is not a reasonable basis for a broad scope change to a component's energy standard. AHRI added that DOE fails to discuss or account for any of these costs in its economic justification analysis. Finally, AHRI added that some equipment may not be able to be retroactively designed with new motors due to new energy conservation standards or refrigerant changes, which would result in incredibly high costs for new designs. (AHRI, No. 70 at pp. 20–21)

Carrier stated that DOE considered larger and heavier electric motors for higher efficiency levels. Carrier stated that these motors could create problems for the replacement motor market, highlighting how some commercial equipment have eight condensing fan motors that would multiply the impact of a heavier motor. Carrier commented that this equipment is often on a commercial building rooftop where the loading of the roof is closely monitored, potentially causing a situation requiring more roof infrastructure to support the added weight. Carrier noted that ECMs could be used as a suitable replacement in residential applications. Carrier commented that in commercial applications, while an ECM is an option to replace an ESEM in condensing fan motor applications, this could result in significantly higher cost in applications where multiple condenser fan motors are used. Carrier added that the ECMs could cause reliability and/or performance issues and highlighted ramp rates, control schemes, and the noise produced from the electronics as potential issues. (Carrier, No. 71 at pp. 4–5)

ABB commented that replacement motors in HVAC systems have lower costs to end-users and result in lower emissions impact than installing a new system or making significant system changes. ABB commented that 80–90 percent of the market is embedded base, and by offering high-efficiency and drop-in replacement motors, DOE can maximize energy savings with minimal disruption. (ABB, No. 65 at p. 2)

The Motor Coalition noted that DOE's analysis estimates that the stack length of ESEM designs at EL 2 will increase by less than 0.5 in—which is similar in magnitude to the variation in stack lengths in the market today—and that weights will only increase by a maximum of 2.5 lb. The Motor Coalition commented that it believes that these negligible increases in size and weight will not impact the vast majority of installations. (Motor Coalition, No. 77 at p. 3) The Motor Coalition noted that if an application cannot tolerate even a small change in these dimensions, technology options such as using a different capacitor or thinner steel laminations are possible ways to not increase the motor size or weight. In addition, the Motor Coalition commented that ECMs are readily available today as efficient drop-in ESEM replacements and are ideally suited for size-constrained installations (Motor Coalition, No. 77 at p. 3)

NEMA commented that adopting efficiency standards that support drop-in replacement motors is essential to serve the entire market, and it added that low-income households benefit from economical ways to maintain equipment instead of replacing an entire system. NEMA commented that EL 2 levels would allow manufacturers to offer compliant motors compatible with existing installations. NEMA commented that in most cases, the increase in installation costs to accommodate ESEMs at EL 2 would be minimal. NEMA added that initial estimates by industry suggest the added weight and length for motors to meet EL 2 levels for low-torque ESEMs would be minor (*e.g.*, average increase of 1–2 pounds of active material and projected increase of core length of ~ 0.5 in). NEMA stated that similar differences exist across stack length and weight between motors produced by different motor manufacturers for use in the same OEM application today. Additionally, NEMA commented that the majority of applications where single-speed low-torque ESEMs are used are not typically classified as “space constrained,” meaning changes in this range are unlikely to necessitate a redesign for OEMs. NEMA commented that at EL 3 and EL 4, compatibility issues would arise, especially for equipment in the field, many of which are expected to operate for 30 years. (NEMA, No. 68 at p. 6)

ABB commented that they are aligned with NEMA recommendations, noting that PSCs are used in non-regulated industries and the levels recommended represent the highest efficiency levels the motor industry believes are possible with available technology options and minimized downstream market impacts while achieving energy savings. (ABB, No. 65 at p. 1)

DOE’s analysis shows that higher efficiency levels can be achieved with a fixed frame size, which remains the same across efficiency levels, and a constrained stack length increase. *See* section IV.C.1.d of this document. The added stack length and resulting weight for motors to meet higher efficiency levels for low-torque ESEMs were constrained. In particular, DOE notes that at EL 2, the stack length is an additional 0 (*i.e.*, no increase) to 0.46 in compared to the baseline, and the weight is an additional -1.55 (*i.e.*, weight reduction) to 2.67 lb compared to the baseline, depending on the representative unit considered. Specifically, the stack length increases 0 (*i.e.*, no increase) to 0.23 in, and the weight increases 1.40 to 2.04 lb for low-torque AO-ESEMs, which are primarily used in HVACR equipment. As stated by NEMA and the Motor Coalition, differences exist across stack length and weight between motors produced by different motor manufacturers for use in the same OEM applications today. In addition, the adopted levels would preserve key criteria that are used to identify suitable replacement motors,[69] such as frame sizes, voltages, horsepower, pole configurations, enclosure constructions, and mounting. DOE further notes that OEM equipment can usually accommodate different models of motors;[70] online cross-referencing tools exist to help consumers identify motors that can be used as drop-in replacements. Therefore, at TSL 2, DOE does not expect any disruption in the replacement market, as OEMs and motor manufacturers would be able to manufacture suitable replacement options.

Finally, as discussed in sections V.B.7.a and V.C of this document, in establishing this final rule, DOE evaluated and considered the OEM retesting and recertification costs impacts. Regarding replacement motors for out-of-production units, the same situation exists today in the absence of ESEM energy conservations standards, where industry needs replacement motors for legacy repairs, as ESEMs cycle through production and become obsolete and regulating ESEMs would not change the current situation.

AHAM commented that larger, more efficient motors would negatively impact the capacity of laundry appliances, which is a key feature, especially in commercial settings where many consumers are paying for each load of laundry, potentially resulting in a disproportionate impact on low-income consumers who more often use coin-operated and public-area laundry machines. AHAM stated that increasing the spin speed through a higher-power motor could have negative impacts on fabric care, such as tangling,

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[69] *See* "How to Cross Reference an OEM motor," available at *hvacknowitall.com/blog/how-to-cross-reference-an-oem-motor* (last accessed April 24, 2024); Rheem and Ruud PROTECH "Selecting a Motor," available at *assets.unilogcorp.com/267/ITEM/DOC/PROTECH_51_100998_33_Catalog.pdf* (last accessed April 24, 2024).
[70] *See www.emotorsdirect.ca/hvac*.

wrinkling, reduced detergent removal, biofilm accumulation, reduced particulate removal, and increased white residues on clothing. AHAM recommended that if DOE moves forward with standards for motors used in commercial laundry products despite its lack of data on the impact of doing so, DOE should conduct an analysis on such motors as used with commercial laundry products and provide an analysis as to the impact as well as an opportunity to comment before finalizing standards. (AHAM, No. 75 at p. 1)

On the issue of size, as noted previously, DOE's analysis shows that higher efficiency levels can be achieved with minimal increases in size and weight. In addition, the motor speed variations across ELs were kept minimal (*i.e.*, increase between -12 and 56 rpms, which corresponds to -1 percent and up to 3 percent across all efficiency levels and representative units). Therefore, DOE does not anticipate any negative impacts on the capacity of laundry appliances or fabric care as a result of this rule and expects that the impacts on commercial laundry products manufacturers will not be significant due to the preservation of ESEM form, fit and function. See discussion in section IV.C.1.d of this document.

E. Test Procedure

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 equipment must use these test procedures as the basis for certifying to DOE that their equipment complies with the applicable energy conservation standards and as the basis for any representations regarding the energy use or energy efficiency of the equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(s); and 42 U.S.C. 6314(d)) Similarly, DOE must use these test procedures to evaluate whether a basic model complies with the applicable energy conservation standard(s). 10 CFR 429.110(e). The current test procedure for ESEMs is codified in appendix B as “small, non-small-electric-motor electric motor” and measures the full-load efficiency of an electric motor.

To harmonize terminology, in the December 2023 NOPR, DOE proposed to replace any reference to small, non-small-electric-motor electric motor (“SNEM”) in appendix B with the term “expanded scope electric motor” (“ESEM”). 88 FR 87062, 87076. DOE did not receive comment on this proposal and adopts to replace the term SNEM with ESEM.

F. Represented Values

DOE’s energy conservation standards for electric motors are currently prescribed at 10 CFR 431.25. DOE’s current energy conservation standards for electric motors are expressed in terms of nominal full-load efficiency, and manufacturers must certify the represented value of nominal full-load efficiency of each basic model. 10 CFR 429.64. The provisions establishing how to determine the average full-load efficiency and the nominal full-load efficiency of a basic model are provided at 10 CFR 429.64.

As discussed in section II.B.3 of this document, the ESEM standard levels recommended by the Motor Coalition are expressed in average full-load efficiency and not in terms of nominal full-load efficiency. In the December 2023 NOPR, to align with the Motor Coalition recommendations, DOE proposed to revise the provisions related to the determination of the represented values for ESEMs at 10 CFR 429.64 such that manufacturers of ESEMs would certify a represented value of average full-load efficiency instead of a represented value of nominal full-load efficiency. DOE also proposed edits to 10 CFR 429.70(j) to reflect the use of a represented value of average full-load efficiency instead of a represented value of nominal full-load efficiency for ESEMs. *Id.*, 88 FR 87076–87077

ABB recommend that ESEMs be labeled with average efficiency for consistency with SEMs. (ABB, No. 65 at p. 1) Grundfos agreed with using average efficiency for ESEMs. (Grundfos, No. 67 at p. 1)

NEMA supported average full-load efficiency for single-phase ESEMs. However, NEMA commented that for polyphase ESEMs (AO and non-AO), nominal efficiency aligns better with other regulated electric motors in scope and matches industry standard (NEMA MG-1). NEMA recommended allowing the use of "nominal efficiency" or "nom. eff.," as it aligns with industry practices; if average full-load efficiency is used, changes to 10 CFR 431.31 will be needed. (NEMA, No. 68 at p. 3)

The CA IOUs commented that they support a full-load test metric that aligns with the metric used for SEMs. (CA IOUs, No. 77 at p. 4)

In this final rule, DOE adopts a represented value of average full-load efficiency for single-phase and polyphase ESEMs, for consistency across all ESEMs and to align with the metric used to determine the efficiency levels. DOE notes that this approach aligns with the ESEM standard levels recommended by the Motor Coalition (including

NEMA), which are expressed in average full-load efficiency and not in terms of nominal full-load efficiency.[71] DOE also adopts the revision of the provisions at 10 CFR 429.64 and 429.70(j) accordingly. DOE may consider addressing any additional changes related to labeling provisions described in 10 CFR 431.31 in a separate rulemaking.

G. Technological Feasibility

1. General

As discussed, 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))

To determine whether potential amended standards would be technologically feasible, DOE first develops a list of all known technologies and design options that could improve the efficiency of the products or equipment that are the subject of the rulemaking. DOE considers technologies incorporated in commercially available products or in working prototypes to be "technologically feasible." 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, sections 6(b)(3)(i) and 7(b)(1). Section IV.A.2 of this document discusses the technology options identified by DOE for this analysis. For further details on the technology assessment conducted for this final rule, *see* chapter 3 of the final rule technical support document ("TSD").

[71] Specifically, the Motor Coalition-recommended levels for open polyphase motors, which are consistent with the SEM standards at 10 CFR 431.446 and expressed in average full-load efficiency.

After DOE has determined which, if any, technologies and design options are technologically feasible, it further evaluates each technology and design 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; 10 CFR part 430, subpart C, appendix A, sections 6(b)(3)(ii)–(v) and 7(b)(2)–(5). Those technology options that are "screened out" based on these criteria are not considered further. Those technology and design options that are not screened out are considered as the basis for higher efficiency levels that DOE could consider for potential amended standards. Section IV.B of this document discusses the results of this screening analysis conducted for this final rule. For further details on the screening analysis conducted for this final rule, *see* chapter 4 of the final rule TSD.

2. Maximum Technologically Feasible Levels

EPCA requires that for any proposed rule that prescribes an amended or new energy conservation standard or prescribes no amendment or no new standard for a type (or class) of covered product, DOE must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for each type (or class) of covered products. (42 U.S.C. 6313(a); 42 U.S.C. 6295(p)(1)). Accordingly, in the engineering analysis, DOE identifies the maximum efficiency level currently available on the market. DOE also defines a "max-tech" efficiency level, representing the maximum theoretical efficiency that can be achieved through the application of all available technology options retained from the screening analysis.[72] In many cases, the max-tech efficiency level is not commercially available because it is not currently economically feasible.

The max-tech levels that DOE determined for this analysis are described in section IV.C.1.c of this document and in chapter 5 of the final rule TSD.

H. Energy Savings

1. Determination of Savings

For each trial standard level ("TSL"), DOE projected energy savings from application of the TSL to ESEMs purchased in the 30-year period that begins in the year of compliance with the standards (2029–2058).[73] The savings are measured over the entire lifetime of equipment purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of energy conservation standards.

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

[72] In applying these design options, DOE would only include those that are compatible with each other that when combined, would represent the theoretical maximum possible efficiency.
[73] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of full-fuel-cycle ("FFC") energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.*, coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[74] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, *see* section IV.H.2 of this document.

2. Significance of Savings

To adopt any new or amended standards for a covered product, DOE must determine that such action would result in significant energy savings. (42 U.S.C. 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.[75] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates

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[74] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).
[75] 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).

the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors.

As stated, the standard levels adopted in this final rule are projected to result in national energy savings of 8.8 quads, the equivalent of the primary annual energy use of 58.7 million homes. Based on the amount of FFC savings, the corresponding reduction in emissions, and the need to confront the global climate crisis, DOE has determined the energy savings from the standard levels adopted in this final rule are "significant" within the meaning of 42 U.S.C. 6316(a) and 42 U.S.C. 6295(o)(3)(B).

I. 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 potential new standards on manufacturers, DOE conducts an MIA, as discussed in section IV.J of this document. DOE first uses an annual cash flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—

and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include: (1) INPV, which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

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

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

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

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

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

d. Lessening of Utility or Performance of Products

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

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 adopted standards are likely to provide improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this document.

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

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 effect potential amended energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under (42 U.S.C. 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 IV.F of this final rule.

IV. Methodology and Discussion of Related Comments

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

DOE used several analytical tools to estimate the impact of the standards considered in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The NIA used 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 used the third spreadsheet tool, the Government Regulatory Impact Model ("GRIM"), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: *www.regulations.gov/docket/EERE-2020-BT-STD-0007*. Additionally, DOE used output from the latest version of the Energy Information Administration's ("EIA's") *Annual Energy Outlook* ("*AEO*") for the emissions and utility impact analyses.

A. Market and Technology Assessment

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

1. Equipment Classes

When evaluating and establishing or amending energy conservation standards, DOE may establish separate standards for a group of covered products (*i.e.*, establish a separate equipment class) if DOE determines that separate standards are justified based on the type of energy used, or if DOE determines that a product's capacity or other performance-related feature 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 considers such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (*Id.*)

In the December 2023 NOPR, DOE proposed equipment classes based on several capacity or performance-related features, including: motor horsepower rating, pole configuration (*i.e.,* 2, 4, 6, or 8 poles), enclosure type (*i.e.,* open or enclosed), locked-rotor torque level (*i.e.,* high, medium, or low), type of input power (*i.e.,* single phase or polyphase), and motor cooling requirements (*i.e.*, AO or non-AO). This resulted in 350 proposed equipment classes. To enable clear and succinct discussion of these 350 equipment classes, DOE introduced the nomenclature "equipment class group" to refer to all of the equipment classes with shared type of input power (*i.e.,* single phase or polyphase), locked-rotor torque level, and motor cooling requirement (*i.e.*, AO or non-AO). Within a proposed equipment class group, equipment classes varied only by motor horsepower rating, pole configuration (*i.e.,* 2, 4, 6, or 8 poles), and enclosure type (*i.e.,* open or enclosed). The result was 6 equipment class groups collectively containing 350 equipment classes. *See* chapter 3 of the December 2023 NOPR TSD.

In response to the NOPR, ABB commented that regulation of air-over PSC motors would cause problems with replacement motors if they are replaced by CSCR motors to meet the efficiency requirements. ABB notes that PSC motors have higher resistance rotors as compared to CSCR and operate with higher slip to generate sufficient starting torque and that using a CSCR fan as a replacement for a PSC motor will lead to higher energy usage. (ABB, No. 65 at p. 3)

NEMA commented that they agree with equipment classes presented in the NOPR. (NEMA, No. 68 at p. 3) CA IOUs commented that they support the scope of motors covered and definitions of equipment classes, particularly the distinction between medium/high and low-torque. (CA IOUs, No. 78 at p. 4)

DOE has constructed the equipment class groups in this analysis to segregate low-torque (*e.g.,* PSC) and high-torque motors (*e.g.,* CSCR) to prevent the standards from forcing an application to switch to a motor in another torque class. DOE determined that low-torque applications are a performance related feature that justify a different standard than that of a high-torque motor. As such, DOE has retained the equipment class structure that was proposed in the NOPR.

2. Technology Options

In the March 2022 Preliminary Analysis market and technology assessment, DOE identified several technology options initially determined to improve the efficiency of ESEMs, as measured by the DOE test procedure. Table IV-1 presents the technology options considered in the March 2022 Preliminary Analysis.

Table IV-1 March 2022 Preliminary Analysis Technology Options to Increase Motor Efficiency

Type of Loss to Reduce	Technology Option
Stator I^2R losses	Increase cross-sectional area of copper in stator slots
	Decrease the length of coil extensions
Rotor I^2R losses	Increase cross-sectional area of end rings
	Increase cross-sectional area of rotor conductor bars
	Use a die-cast copper rotor cage
Core losses	Use electrical steel laminations with lower losses (watts/lb)
	Use thinner steel laminations
	Increase stack length (*i.e.*, add electrical steel laminations)
Friction and windage losses	Optimize bearing and lubrication selection
	Improve cooling system design
Stray-load losses	Reduce skew on rotor cage
	Improve rotor bar insulation

DOE responded to comments on the technology options considered in the March 2022 Preliminary Analysis in the June 2023 DFR and proposed the same technology options for consideration in the December 2023 NOPR. *See* 88 FR 36066, 36089–36090. DOE maintained these technology options for this final rule.

While not considered a technology option for this rule, DOE acknowledges the likelihood of some OEMs opting to switch to an ECM in lieu of improving the efficiency of an existing induction motor design. *See* IV.C.1.d for more discussion on the design considerations involved in this switch and V.B.7.b for discussion regarding the prevalence of this switch at various ELs.

B. Screening Analysis

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

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

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

3) *Impacts on product utility*. If a technology is determined to have a significant adverse impact on the utility of the product to subgroups of consumers, or result in the unavailability of any covered product type with performance characteristics

(including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

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

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

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

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

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

1. Screened-Out Technologies

In the March 2022 Preliminary Analysis TSD, DOE screened out amorphous metal laminations and plastic bonded iron powder ("PBIP") from the analysis. *See* chapter 3 of the March 2022 Preliminary TSD. In response, DOE received comments concerning the exclusion of amorphous metal laminations from the engineering analysis which were discussed and responded to in the June 2023 DFR as these comments apply to the entire scope of motors. In the June 2023 DFR, DOE continued to exclude amorphous metal laminations and proposed excluding this technology on the same basis in the December 2023 NOPR. 88 FR 36066, 36091, 88 FR 87062, 87085.

In response to the December 2023 NOPR, ABB commented that premium steels required for high-efficiency motors may not be available from US suppliers in large enough quantities to meet the demand resulting from higher motor efficiency requirements. ABB goes on to state that offshoring and increased imports of high-grade electrical steel would be an unintended consequence of raising motor standards and that DOE should instead focus on implementing variable-speed technologies for more significant impacts on energy savings. (ABB, No. 65 at p. 1)

DOE notes that it expects some consumers will likely switch to variable-speed technologies as a result of this standard, for more discussion about the implications of this switch *see* section V.B.7.b of this document. DOE notes that domestic production is not a criterion considered in the screening analysis. DOE also notes that higher grade electrical steel is not the only technology option available to improve motor efficiency, and because this is the first energy conservation standard for ESEMs, manufacturers have not fully exploited other available technology options like in the SEM and MEM markets. As a result, higher grade electrical steel does not satisfy any of the five criteria required to be screened-out and is considered further in the engineering analysis.

ABB also commented that they disagree with DOE's comments regarding the viability of using thinner lamination (0.3 mm thick), citing the inability of manufacturers to process thinner lamination materials with existing capital equipment, noting that significant capital expenditures are required to handle specialized steels. DOE agrees that retooling and capital expenditure is necessary to handle these thinner laminations and in the cost analysis has included the estimated conversion costs in the efficiency levels that require these thinner electrical steels. *See* chapter 5 of the final rule TSD for more information.

2. Remaining Technologies

Through a review of each technology, DOE tentatively concludes that all of the other identified technologies listed in section IV.B.2 met all five screening criteria to be examined further as design options in DOE’s final rule analysis. In summary, DOE did not screen out the following technology options:

1) Increasing cross-sectional area of copper in stator slots

2) Decreasing the length of coil extensions

3) Increasing cross-sectional area of end rings

4) Increasing cross-sectional area of rotor conductor bars

5) Using a die-cast copper rotor cage

6) Using electrical steel laminations with lower core loss (i.e., higher grade electrical steel)

7) Using thinner steel laminations

8) Increasing stack length

9) Optimizing bearing and lubrication selection

10) Improving cooling system design

11) Reducing skew on rotor cage

12) Improving rotor bar insulation

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

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of the product. 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 product 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 product/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. Efficiency Analysis

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

For this final rule analysis, DOE used a combination of the efficiency-level approach and the design-option approach to establish efficiency levels to analyze, consistent with what was proposed in the December 2023 NOPR. The design-option approach was used to characterize efficiency levels that are not available on the market but appear to be market solutions for those higher efficiency levels if sufficient demand existed. For the efficiency levels available on the market, sufficient performance data was publicly available to characterize these levels.

In response to the NOPR, ABB commented that AO-ESEM efficiencies should be considered the same for equal ratings and frame size when compared to fan-cooled or open motors to ensure consistency with the structure of AO-MEM standards. (ABB, No. 65 at p. 1)

a. Representative Units Analyzed

In the December 2023 NOPR, DOE presented Table IV-2 and solicited comment on the representative units used as the basis of the analysis. DOE used representative units due to the infeasibility of directly analyzing the large number of individual equipment classes.

Table IV-2 Representative Units Analyzed

ECG	Representative Unit (RU)	Representative Unit Horsepower	Represented Horsepower range (all poles, all enclosures)
ESEM High-torque	1	0.25	0.25 ≤ hp ≤ 0.50
	2	1	0.5 < hp ≤ 3
ESEM Low-torque	3	0.25	0.25 hp
	4	0.5	0.25 < hp ≤ 3
ESEM Polyphase	5	0.25	0.25 ≤ hp ≤ 3
AO-ESEM High-torque	6	0.25	0.25 ≤ hp ≤ 0.50
	7	1	0.5 < hp ≤ 3
AO-ESEM Low-torque	8	0.25	0.25 hp
	9	0.5	0.25 < hp ≤ 3
AO-ESEM Polyphase	10	0.25	0.25 ≤ hp ≤ 3

In response to the NOPR, NEMA commented that while additional sampling is beneficial, the ratings selected are sufficient to support conclusions regarding EL 2. (NEMA, No. 68 at p. 4)

As such, DOE retained the representative units for this final rule.

b. Baseline Efficiency

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

In the December 2023 NOPR, DOE outlined its analytical approach to establish a baseline efficiency for ESEMs using a combination of similar motor efficiency standards, market data, and test data. *See* 88 FR 87062, 87086-87087 for more discussion.

In response to the baseline efficiencies presented in the NOPR TSD, NEMA commented that they agree with the baseline efficiencies used. NEMA notes there are challenges to select an accurate baseline for low-torque ESEMs since a majority of residential and commercial applications are OEM-specific or custom designs. (NEMA, No. 68 at p. 4)

AHRI commented that reliance on the January 2021 Final Determination Technical Support Document related to SEM to determine the baseline efficiency ratings for ESEMs and AO-ESEMs is inappropriate. (AHRI, No. 70 at pp. 10–11)

DOE notes that AHRI did not provide a justification as to why using the SEM baseline to inform the ESEM baseline was inappropriate beyond noting differences in the definitions of ESEMs and SEMs. While the SEM baseline was used as a starting point for the ESEM baseline, the motor horsepower vs. loss equations that determined the efficiency at different horsepowers was lowered to align with the least efficient ESEMs on the market.

Accordingly, DOE retained the baseline efficiencies from the NOPR in this final rule.

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.

In response to the NOPR, ABB noted that the efficiency levels considered in the NOPR were based on motor manufacturer recommendations. (ABB, No. 65 at p. 1)

NEMA stated the challenges of manufacturing max-tech motors using available technologies such as cast copper rotors, 0.35mm laminations, and low core loss steels. NEMA explained that such manufacturing process require additional changes to current processes and while technology options exist, they may not be mature or practical for all manufacturers to implement and achieve efficiency beyond EL 2. (NEMA, No. 68 at p. 4)

NEMA also commented that for ELs higher than EL 2, significant energy improvements were possible by implementing the technologies identified in Table 2.3.3 of the NOPR TSD; however, there would be differences in the time manufacturer's require to implement these improvements. NEMA stated that nearly half of the options presented in the DOE's TSD could require up to 5 years for certain manufacturers to implement. (NEMA, No. 68 at p. 4)

As such, DOE retained the higher efficiency levels from the NOPR in this final rule.

d. Form, Fit, and Function

To develop the higher efficiency levels, DOE purchased, tore-down, and modeled electric motors that had multiple design parameters constrained. DOE constrained the stack length to a 20% increase over the baseline unit for a representative unit and the NEMA frame size was consistent across all efficiency levels. DOE understands that there are electrical characteristics (*e.g.,* input voltage, inrush current) and output power characteristics (*e.g.,* the torque-speed curve of a motor, locked-rotor torque, full-load speed) that also can impact the performance of a motor in each application. As such, DOE modeled electric motors that attempted to keep these electrical and output power characteristics close to the baseline motor's values but notes these values do vary nonuniformly with efficiency. For more information on the exact stack length, weight, and other performance characteristics of each representative unit considered *see* chapter 5 of the final rule TSD.

The Motor Coalition commented in support of DOE's assumption limiting the frame size of all efficiency levels to that of the baseline EL and capping the increase in stack length. (Motor Coalition, No. 77 at p. 2) The Advocates commented in general support of the engineering analysis presented in the NOPR. (Advocates, No. 72 at p. 2) NEMA commented that they support including a frame size constraint for the efficiency analysis and that maintaining frame size helps ensure end-users can find replacement parts. NEMA stated that increasing the frame size even in applications without space constraints would require OEMs to redesign products or provide additional hardware and that preserving frame size allows for replacement of low efficiency motors, allowing older systems to operate at lower costs. (NEMA, No. 68 at p. 4) CA IOUs commented that they support maximizing efficiency while minimizing changes in frame sizes. CA IOUs also support constraining the frame size of all efficiency levels to that of the baseline unit and DOE's decision to cap the increase in stack length at 20%. (CA IOUs, No. 79 at p. 4)

CA IOUs commented that the motor coalition and the CA IOUs analyzed the manufacturer's available engineering design options to preserve the form, fit, and function. “Maintaining the form and fit is a foundational component of the coalition's analysis of the levels recommended to DOE. In the analysis, DOE analyzed various lamination thicknesses, steel grades, motor material choices, and slot fills that provide multiple design options with minimal impact on stack length and frame size if chosen as design option for proposed standard. This ensures OEMs can find replacement motors and new designs that comply with proposed standards and by leveraging tradeoffs in stack length, OEMs may have access to additional design options that could further reduce the overall product cost. It is anticipated manufacturers would develop designs based on demand. The proposed standards provide sufficient flexibility for motor manufacturers to meet OEM needs while driving significant efficiency improvements in these products. CA IOUs support DOE's approach of constraining representative motor units to the appropriate NEMA frame and enforcing limits on stack length increases (*i.e.,* capped at 20%) to mitigate consumer impacts while driving efficiency improvements in these products. CA IOUs support DOE's conclusion that the proposed rule will not adversely impact consumer or OEM access to suitable form and fit products." (CA IOUs, No. 73 at p. 2)

NEMA commented that based on market survey, they believe EL 2 represents the maximum level that can be implemented for low-torque ESEMs. (NEMA, No. 68 at p. 5) Grundfos commented that they do not believe efficiency can be increased beyond EL 2 without increasing frame size. (Grundfos, No. 67 at p. 1)

Further, NEMA commented the following regarding EL 3 for low-torque ESEMs without significant increases in frame size: 1) Manufacturers focused on heavy commercial and industrial markets believe if frame size is kept constant, 40% of ratings (*i.e.,* configurations of pole, horsepower, and topology) would be unfeasible. 2) Manufacturers focused on commercial and residential markets believe if frame size is kept constant, 70% ratings would not be available using current production methods 3) Even with a larger frame size, implementing all technology options outlined in the TSD did not ensure all product ratings would be achievable for EL 3. Based on NEMA's market survey, 25-30% ratings would become unavailable (NEMA, No. 68 at p. 5)

ABB also commented that different motor technologies such as permanent magnet or synchronous motors would be required to reach EL 3. ABB highlighted that this requiring VSDs and eliminates backward compatibility with existing motors and creates disruptions for OEM and customers. *Id.* ABB commented that they do not believe it is possible to meet similar product form, fit, and function with the same motor designs and meet TSL 4, asserting that TSL 4 requires technologies like permanent magnet or synchronous motors, and incorporation of VSDs, similarly highlighting concerns about backwards compatibility with current installations if variable-speed technologies are required. *Id.*

ABB commented that TSL 3 and TSL 4 will likely result in elimination of PSC motors, adding significant material costs compared to the energy savings achieved and eliminating cost-effective PSC motors from applications where switching to another motor topology would incur an undue cost burden on the end-user. (ABB, No. 65 at p. 5) ABB also commented that OEMs would exploit loopholes in the systems-level designs if pushed too hard (*i.e.,* EL 3 and EL 4). (ABB, No. 65 at p. 2)

NEMA argued that no design can meet EL 4 levels using current methods with constraint on frame size, and with an increase in frame size and all technology options >50% ratings would be unavailable. (NEMA, No. 68 at p. 5)

DOE notes that its representative units achieved ELs 3 and 4 while maintaining frame size and without exceeding the stack length constraints set. DOE acknowledges that scaling these results to non-representative unit equipment classes might be particularly difficult for ELs 3 and 4 because some of the technologies used are not widely adopted in the current market, and that standard frame sizes for certain horsepower and pole configuration result in certain designs having more room for changes to its geometry and electrical performance.

ABB commented that inrush currents increase when the same starting torque is required by an application. ABB notes that OEMs, retrofits, and installations bear significant burden with respect to redesign costs and equipment changes. (ABB, No. 65 at p. 2)

Carrier stated that while an ECM is an option to replace in ESEM in condensing fan motor applications, Carrier questioned if DOE considered the significantly higher cost and noted that in commercial applications where multiple condenser fan motors are used, the ECMs could cause reliability and/or performance issues. Carrier highlighted ramp rates, control schemes, and the noise produced from the electronics as potential issues. (Carrier, No. 71 at p. 5)

DOE notes that given the design constraints of specific applications, some OEMs will opt to use ECMs due to their versatility in controlling output power and speed and the greater power density compared to ESEMs. DOE considers the added costs of switching to ECMs in section V.B.7.b of this document.

2. Cost Analysis

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

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

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

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

In the December 2023 NOPR, DOE largely retained the cost modeling approach presented in the March 2022 Preliminary Analysis. This approach uses both physical teardowns and software models to generate a bill of materials ("BOM") for a given representative unit at a certain efficiency level. In that NOPR, DOE diverged from the March 2022 Preliminary Analysis by modifying critical inputs to BOM such as material prices, scrap costs, overhead costs, and conversion costs, using data provided by manufacturers under a nondisclosure agreement and the Electric Motors Working Group. *See* chapter 5 of the TSD for more detail on the material, scrap, overhead, and conversion costs used in the cost analysis.

The resulting bill of materials provides the basis for the manufacturer production cost ("MPC") estimates for products at various efficiency levels spanning the full range of efficiencies from the baseline to max-tech.

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 ESEM manufacturing and whose combined product range includes ESEMs. DOE used a non-production markup of 37 percent for all ESEMs in this final rule.

3. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency relationships (or "curves") in the form of MSP (in dollars) versus full-load efficiency (in %), which form the basis for subsequent analysis. DOE developed 10 curves representing the six ECGs. The methodology for developing the curves started with determining the full-load efficiency and MPCs for baseline motors. Above the baseline, DOE implemented various combinations of design options to achieve each efficiency level. Design options were implemented until all available technologies were employed at the max-tech level. To account for manufacturers' non-production costs and profit margin, DOE applies a manufacturer markup to the MPC, resulting in the MSP. *See* Table IV-3 and Table IV-4 for the results and chapter 5 of the TSD for additional detail on the engineering analysis.

Table IV-3 Cost-Efficiency Results (Non-Air-Over Representative Units)

RU	HP	Pole	ECG	Enclosure	Full-load Efficiency (%)					MSP (2023$)				
					EL0	EL1	EL2	EL3	EL4	EL0	EL1	EL2	EL3	EL4
6	.25	4	High/Medium-torque	Enclosed	46.78	53.14	59.50	66.41	73.31	66.61	69.55	79.24	126.22	201.70
7	1	4	High/Medium-torque	Enclosed	65.53	72.77	80.00	82.80	85.59	122.12	132.21	146.95	222.58	332.26
8	.25	6	Low-torque	Enclosed	36.23	47.72	59.20	65.49	71.77	54.61	66.18	87.54	121.65	172.04
9	.5	6	Low-torque	Enclosed	56.33	61.06	65.80	73.35	80.90	79.07	103.86	108.13	160.54	206.41
10	.25	4	Polyphase	Enclosed	57.86	62.93	68.00	74.61	81.21	70.58	74.34	82.54	112.63	183.02

Table IV-4 Cost-Efficiency Results (Air-Over Representative Units)

RU	HP	Pole	ECG	Enclosure	Full-load Efficiency (%)					MSP (2023$)				
					EL0	EL1	EL2	EL3	EL4	EL0	EL1	EL2	EL3	EL4
6	.25	4	AO - High/Medium-torque	Enclosed	46.78	53.14	59.50	66.41	73.31	62.06	65.30	75.57	121.14	195.82
7	1	4	AO - High/Medium-torque	Enclosed	65.53	72.77	80.00	82.80	85.59	117.60	127.88	142.72	218.00	326.32

8	.25	6	AO - Low-torque	Enclosed	36.23	47.72	59.20	65.49	71.77	50.16	61.98	83.06	116.30	166.07
9	.5	6	AO- Low-torque	Enclosed	56.33	61.06	65.80	73.35	80.90	74.88	99.12	103.67	154.32	200.11
10	.25	4	AO - Polyphase	Enclosed	57.86	62.93	68.00	74.61	81.21	66.75	70.77	79.07	108.88	178.58

D. Markups Analysis

The markups analysis develops appropriate markups (*e.g.*, distributor markups, retailer 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 MIA. At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin.

As part of the analysis, DOE identifies key market participants and distribution channels. In the December 2023 NOPR, DOE retained the approach used in the March 2022 Preliminary Analysis and identified distribution channels for ESEMs and their respective market shares (*i.e.*, percentage of sales going through each channel) based on information from the final determination for SEMs. 86 FR 86 4885, 4898–4899 (January 19, 2021). For ESEMs, the main parties in the distribution chain are OEMs, equipment or motor wholesalers, retailers, and contractors.

In response to the December 2023 NOPR, AHRI commented that reliance on the January 2021 Final Determination Technical Support Document related to SEMs to determine the distribution channels and proportion of shipments for ESEMs (including

AO-ESEMs) is inappropriate. (AHRI, No. 70 at p. 12). Lennox stated that the residential CAC-HP market is a key distribution channel for AO motors. (Lennox, No. 69 at p. 12)

DOE responds noting that ESEMs are used as components of equipment and pass through OEMs who design and assemble equipment that contain ESEMs. OEMs in turn obtain the ESEMs either directly from the motor manufacturers or from manufacturers via a motor wholesaler. ESEMs can also be purchased as stand-alone motors to be replacement or spare motors. As such, DOE has determined that the three key channels for ESEMs and their respective market shares identified in the December 2023 NOPR are appropriate, as they reflect ESEMs that are sold for incorporation in other equipment as well as ESEMs sold as stand-alone motors. The three distributions channels are as follows: (1) manufacturers to OEMs to equipment wholesalers to contractors to end-users (65 percent of shipments), (2) manufacturers to motor wholesalers to OEMs to equipment wholesalers to contractors to end-users (30 percent of shipments), and (3) manufacturers to motor wholesalers to retailers to contractors to end-users (5 percent of shipments). DOE further notes that it previously received input from industry[76] supporting the estimated fractions of shipments by distribution channels. Given the wide range of possible applications, when characterizing the distribution channels, DOE did not establish distribution channels for each specific category of equipment/product incorporating ESEMs and instead focused on the primary distribution channels.

[76] In response to the March 2022 Preliminary Analysis, NEMA agreed that 95 percent of ESEMs reach the market through the OEM equipment channel. (NEMA, No. 22 at p. 18)

DOE developed baseline and incremental markups for each actor in the distribution chain. Baseline markups are applied to the price of products 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.[77]

DOE primarily relied on economic data from the U.S. Census Bureau to estimate average baseline and incremental markups.

Chapter 6 of the final rule TSD provides details on DOE's development of markups for ESEMs.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of ESEMs at different efficiency levels for a representative sample of residential, commercial, and industrial consumers, and to assess the energy savings potential of increased ESEM efficiency. The energy use analysis estimates the range of energy use of ESEMs in the field (*i.e.*, as they are actually used by consumers) and is representative of the wide variety of end-use applications in which ESEMs are used (including ESEMs incorporated in equipment and product subject to energy conservation

[77] 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 markets that are reasonably competitive it is unlikely that standards would lead to a sustainable increase in profitability in the long run.

standards). For each consumer in the sample, the energy use is calculated by multiplying the annual average motor input power by the annual operating hours. The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of energy savings and the savings in consumer operating costs that could result from adoption of new standards.

1. Consumer Sample

DOE created a consumer sample to represent consumers of ESEMs in the commercial, industrial, and residential sectors. DOE used the sample to determine ESEM annual energy consumption as well as to conduct the LCC and PBP analyses (*see* section IV.F of this document). Each consumer in the sample was assigned a sector, an application, and a region. The sector and application determine the usage profile of the ESEM, and the economic characteristics of the ESEM owner vary by sector and region. In addition, residential consumers were assigned household income groups.

In line with the approach used in the December 2023 NOPR, DOE primarily relied on data from the 2018 Commercial Building Energy Consumption Survey ("CBECS"),[78] the 2018 Manufacturing Energy Consumption Survey ("MECS"),[79] the 2015 Residential Energy Consumption Survey ("RECS"), a previous DOE technical support document ("January 2021 Final Determination Technical Support Document")

[78] U.S. Department of Energy, Energy Information Administration. 2018. "2018 Commercial Buildings Energy Consumption Survey (CBECS)." 2018 CBECS Survey Data, available at *www.eia.gov/consumption/commercial/data/2018/index.php?view=methodology.*
[79] U.S. Department of Energy, Energy Information Administration. 2022. "2018 Manufacturing Energy Consumption Survey." Available at *www.eia.gov/consumption/manufacturing/data/2018/pdf/Table11_1.pdf.*

related to SEMs,[80] and a DOE-AMO report titled "U.S. Industrial and Commercial Motor System Market Assessment Report Volume 1: Characteristics of the Installed Base" ("MSMA report").[81]

In response to DOE's requests for feedback regarding the distributions by sector and application, ABB commented that DOE should utilize third-party research firms. ABB added that the 2022 Lawrence Berkeley National Laboratory ("LBNL") study on the installed base of industrial and commercial motors (*i.e.*, the MSMA report) is an appropriate source. (ABB, No. 65 at p. 3)

As previously described, DOE relied on information from the MSMA report to characterize distributions of ESEMs by sector and application. DOE did not receive any additional comments related to the consumer sample developed in the December 2023 NOPR, and in this final rule, DOE continued to rely on the same approach to the report to characterize the consumer samples in the commercial and industrial sectors.

DOE also received comments from AHRI related to reliance on the January 2021 Final Determination Technical Support Document related to SEMs to determine the motor applications and operating hours in the residential sector. These comments are summarized in section IV.E.3 of this document.

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[80] Navigant Consulting and LBNL. January 2021. "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Small Electric Motors Final Determination." Available at *www.regulations.gov/document/EERE-2019-BT-STD-0008-0035*.
[81] Rao, Prakash, *et al*. January 12, 2021. "U.S. Industrial and Commercial Motor System Market Assessment Report Volume 1: Characteristics of the Installed Base." LBNL, *doi.org/10.2172/1760267*.

2. Motor Input Power

In the December 2022 NOPR, DOE calculated the motor input power as the sum of: (1) the electric motor's rated horsepower multiplied by its operating load (*i.e.*, the motor output power), and (2) the losses at the operating load (*i.e.*, part-load losses). DOE estimated distributions of motor average annual operating load by application and sector based on information from the MSMA report. DOE determined the part-load losses using outputs from the engineering analysis (full-load efficiency at each efficiency level) and published part-load efficiency information from 2022 catalog data from several manufacturers to model motor part-load losses as a function of the motor's operating load.

In response to DOE's requests for feedback regarding distributions of average annual operating load by application and sector in the December 2022 NOPR, ABB commented that it recommended no changes to the current approach. ABB added that the operating loads are characterized within the bounds of the NEMA design characteristic for starting torque, pull-up torque, and breakdown torque for the specific type of motor. (ABB, No. 65 at p. 3)

DOE did not receive any additional comments related to the distributions of operating loads developed in the December 2022 NOPR analysis and retained the same approach for this final rule.

AHRI commented that DOE's test procedure for ESEMs and AO-ESEMs rates motor efficiency at full load, even though representative load conditions for finished products and equipment are largely optimized for, and regulated on, part-load performance; in other words, a motor that satisfies a new, higher standard for energy efficiency at full load may not actually be more efficient in real-world operating conditions. AHRI commented that a finished product, therefore, may not be more efficient as a result of incorporating a motor that complies with the proposed standards measured at full load rather than a motor currently available. (AHRI, No. 70 at p. 8)

As previously mentioned, DOE's energy use analysis used in developing this final rule accounts for motor part-load operation in the field. First, DOE relied on motor part-load information from the MSMA report to characterize the load of ESEMs as operated in the field. Second, DOE then determined the part-load losses at the given operating load, using outputs from the engineering analysis (full-load efficiency at each efficiency level), and published part-load efficiency information from 2022 manufacturer catalog data. The published part-load efficiency information shows that an ESEM with a higher full-load efficiency (*i.e.*, at a higher EL) typically has a part-load efficiency that is higher than the part-load efficiency of an ESEM with a lower full-load efficiency (*i.e.*, at a lower EL).[82] Therefore, although the operating part-load efficiency of a more efficient ESEM in the field may be lower than its full-load efficiency, it would still be higher than the operating part-load efficiency of a less efficient ESEM. Furthermore, DOE did not receive any comments on its approach to determine part-load losses and retained the same methodology for this final rule.

[82] DOE reviewed the part-load and full-load efficiency values from 1,974 models of ESEMs from the 2022 manufacturer catalog database.

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

3. Annual Operating Hours

In the December 2023 NOPR, DOE used information from the MSMA report to establish distributions of ESEM annual operating hours by application for the commercial and industrial sectors. The MSMA report provided average, mean, median, minimum, maximum, and quartile boundaries for annual operating hours by application and sector and showed no significant difference in average annual hours of operation between horsepower ranges. DOE used this information to develop application-specific statistical distributions of annual operating hours representative of end-use applications in the commercial and industrial sectors. In the December 2023 NOPR, for ESEMs used in the residential sector (which is a sector that was not studied in the MSMA report), DOE retained the approach used in the March 2022 Preliminary Analysis and relied on the distributions of operating hours by application, as presented in chapter 7 of the January 2021 Final Determination Technical Support Document pertaining to SEMs.

In response to DOE's request for comment on the distributions of operating hours for ESEMs, ABB commented that the 2022 LBNL study on the installed base of industrial and commercial motors (*i.e.*, the MSMA report) is an appropriate source. (ABB, No. 65 at p. 3)

The CA IOUs supported DOE's estimates of the distribution of ESEMs across sectors and applications and the distribution of loads. The CA IOUs commented that distribution of average annual operating hours characterized by application and sector of use accurately captures the variability in energy use for ESEMs based on the best available data. The CA IOUs stated that the MSMA report is a key resource for understanding end-use motor loads, and they recommended its continued use. The CA IOUs commented that the information in the MSMA report agrees closely with CA IOU data in the commercial and industrial California Public Utilities Commission load dataset, and they added that such data would represent California end-users well. (CA IOUs, No. 80 at p. 4)

Lennox stated that AO-ESEMs are used in CAC-HPs and in HVACR products that are already regulated at the system level. (Lennox, No. 69 at pp. 1, 12) In addition, Lennox stated that DOE failed to consider residential condensing unit applications, which is a large-scale market. (*Id*. at p. 11) Lennox commented that the operating hours for residential CAC-HPs, commercial air-conditioning, and WICFs should be consistent across DOE rulemakings. (*Id*. at p. 12)

AHRI commented that reliance on the January 2021 Final Determination Technical Support Document related to SEMs to determine the motor applications in the residential sector is inappropriate. AHRI commented that while—for the purposes of understanding DOE's legal authority—ESEMs and AO-ESEMs are more similar to SEMs than the kinds of motors under section 6313(b) for which component regulation might be permitted, the NOPR inappropriately extends DOE’s technical and economic analysis from SEMs to ESEMs. AHRI commented that DOE’s analysis is fatally flawed as a result, especially for low-torque AO-ESEMs. Specifically, AHRI noted that DOE used inputs from the January 2021 Final Determination Technical Support Document to inform residential sector operating hours, motor applications in the residential sector, mechanical lifetime estimates, baseline efficiency ratings, base-year shipments, distribution channels, and shipments projections.[83] (AHRI, No. 70 at pp. 10–12)

AHRI commented that low-torque AO-ESEMs between 0.25 and 0.75 hp, in particular, are commonly included in condenser fan residential air conditioners and heat pumps, yet in the Small Electric Motors January 2021 Final Determination Technical Support Document, DOE makes clear that "the analysis does not include small electric motors incorporated into residential and commercial products either covered or specifically excluded by statute." AHRI commented that the SEM analysis did not include special- or definite-purpose motors incorporated into residential and commercial products, and, therefore, it is not clear why DOE would rely on this analysis to characterize: (1) ESEM residential applications, (2) operating hours, (3) distributions of annual operating hours for ESEMs, (4) average mechanical lifetime estimates, and (5) distribution channels and the proportion of shipments. (AHRI, No. 70 at p. 12) AHRI noted that DOE has categorized the common use of AO-ESEMs as "HVAC applications to drive the blower that forces air through the HVAC system" and only captured one application: "fan." AHRI commented that low-torque 0.25 hp AO-ESEMs are also used

[83] DOE notes that this section addresses AHRI's comment on operating hours. The comments related to motor application, mechanical lifetimes, baseline efficiency ratings, base-year shipments, distribution channel, and shipments projections are addressed in section IV.E.1, IV.F.6, IV.C.1.a, IV.G, IV.D, and IV.G of this document, respectively.

in aftermarket furnace fans and widely used in condenser fans of residential CAC-HPs between three and five tons. (AHRI, No. 70 at pp. 12–13)

Regarding operating hours, AHRI commented that DOE's extension of distributions of annual operating hours from SEMs to residential ESEMs is inappropriate, as these 0.25 and 0.26–3 hp low-torque AO-ESEMs are used in high numbers in condensing unit fans. AHRI commented that DOE has better operating profiles and operating hours from the recent residential air conditioners and heat pumps rulemaking. AHRI commented that common commercial applications for 0.25 hp low-torque AO-ESEMs include circular fans, furnace supply fans, unit heater fans, furnace combustion fans, light commercial package air conditioners and heat pumps (up to 25 tons), and supply fans for air-handling units. AHRI noted that 0.26–3 hp low-torque AO-ESEMs are used in high quantities in commercial air conditioners and heat pumps and that additional commercial applications for these motors include commercial warm-air furnace and air-handling unit supply fans in both new and replacement equipment. (AHRI, No. 70 at p. 14)

Carrier commented that ESEMs are used throughout the HVAC industry as condenser fan motors in residential products. In addition, Carrier stated that ESEMs are found throughout the AHRI directory in many different product categories from many different manufacturers. (Carrier, No. 71 at p. 2)

DOE reviewed the residential applications for which AO-ESEMs are advertised in the 2022 manufacturer catalog database. DOE found that the majority of AO-ESEMs (*i.e.*, low-torque AO-ESEMs) are advertised for use as condenser fans and, more broadly, as HVACR fans.[84] DOE also found that these represent the primary residential applications for high- and medium-torque AO-ESEMs[85] as well as for low-torque ESEMs.[86]

DOE then reviewed available information specific to condenser fans and indoor fans in the residential sector and specifically in CAC-HP equipment. Based on this review, DOE found that fan operating hours were on average 2,460 hours, compared to 4,383 hours per year in the December 2023 NOPR. Because condenser fans and HVACR fans were identified as the primary applications for AO-ESEMs used in the residential sector and for low-torque ESEMs, DOE updated the fan operating hours in the residential sector to align with the fan operating hours from the CAC-HP rulemaking.

The scope of SEMs pertains only to equipment meeting the definition of "small electric motor," as codified in 10 CFR 431.442, which includes general-purpose single-speed induction motors. *See* 42 U.S.C. 6311(13)(G) and 10 CFR 431.442. Single-speed induction motors, as delineated and described in MG1-1987, fall into five categories:

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[84] DOE observed that 56 percent of low-torque AO-ESEMs were marketed for condenser fan applications, and 24 percent were marketed more broadly as HVAC/R fans (based on 402 models of low-torque AO-ESEMs with an advertised application in the 2022 manufacturer catalog database). The other applications advertised were not relevant to the residential sector.
[85] DOE observed that 19 percent of high- and medium-torque ESEMs were marketed for condenser fan applications, and 10 percent were marketed more broadly as HVAC/R fans (based on 83 models of high- and medium-torque ESEMs with an advertised application in the 2022 manufacturer catalog database). The other applications advertised, while representing a significant percentage, were not relevant to the residential sector.
[86] DOE observed that 55 percent of low-torque ESEMs were marketed for HVAC fan applications, and 18 percent were marketed more broadly as HVAC/R fans (based on 106 models of low-torque ESEMs with an advertised application in the 2022 manufacturer catalog database). The other applications advertised were not relevant to the residential sector.

split-phase, shaded-pole, capacitor-start (both CSIR and CSCR), PSC, and polyphase. Of these five motor categories, DOE determined in the final rule published on March 9, 2010 that only CSIR, CSCR, and polyphase motors were able to meet the relevant performance requirements in NEMA MG1-1987 (including breakdown torque, locked-rotor torque, and locked-rotor current; enclosure type; and service factor requirements) and fell within the general-purpose alternating current motor category, as indicated by the listings found in manufacturers' catalogs. 75 FR 10874, 10882–10885 ("March 2010 Final Rule"). While high-torque ESEMs (*i.e.*, CSCR and CSIR ESEMs) do not meet the statutory definition of SEMs, these motors can be very similar in performance. For example, an ESEM could meet all but one SEM scope criteria (*e.g.*, service factor or enclosure) and, therefore, would not meet the statutory definition of an SEM. As such, although they do not meet the definition of SEMs, a large fraction of high-torque ESEMs are advertised for "general-purpose applications" and are used in similar applications.[87] Therefore, for high-torque ESEMs, DOE has determined that using the operating hours developed in the Small Electric Motors January 2021 Final Determination Technical Support Document for residential sectors is appropriate, and DOE retained the approach of the December 2023 NOPR, except for residential fan applications, as discussed above. Furthermore, medium-torque motors are grouped in the same equipment class as high-torque motors, as discussed in section IV.A.1, and DOE used the same approach as for high-torque ESEMs to characterize the operating hours and distributions of medium-torque ESEMs.

[87] DOE observed that 62 percent of high-torque ESEMs were marketed for general-purpose applications (based on 1,672 models of high-torque ESEMs with an advertised application in the 2022 manufacturer catalog database). Other major applications advertised were primarily related to the commercial and industrial sectors and included farm-duty motors (14 percent), industrial and commercial pumps (12 percent), and fans and blowers (4 percent).

Regarding commercial applications and related operating hours, DOE did not rely on the January 2021 Final Determination Technical Support Document pertaining to SEMs to establish the distributions of operating hours by application. Instead, DOE relied on information published in the MSMA report, which provides a comprehensive inventory of the installed base of electric motor systems in the industrial and commercial building sectors and their operating characteristics. In the absence of data specific to ESEM operating hours, and given the wide range of applications, DOE used information related to electric motors used in the commercial sector in general. The MSMA report and DOE's analysis do not rely on a classification by end-use equipment (*e.g.*, WICFs); instead, the commercial electric motor application categories as described in the MSMA report include air compressors, fans, material handling, material processing, pumps, refrigeration compressors, and other applications and are not limited to fan applications. Where available, DOE collected operating-hour information for the equipment referenced by Lennox in the commercial sector. The equipment referenced by Lennox have fan motor operating hours that range from 4,623 hours for commercial air-conditioning (CUAC/HP)[88] to 5,073 hours per year for ESEMs used in WICFs[89] and are consistent and within the range of commercial fan operating hours used by DOE.[90] The MSMA

[88] Based on building simulation conducted in support of the CUAC/HP Direct Final Rule analysis. *See www.regulations.gov/document/EERE-2022-BT-STD-0015-0080*.

[89] Fan use in WICF equipment is a function of WICF temperature rating results and the number of hours per day the WICF is actively cooling. In its NOPR analysis, DOE maintained that the nominal hours of operation for medium-temperature WICFs was 16 hours per day and 18 hours per day for low-temperature WICFs. These nominal operating hours are adjusted to account for oversizing and other factors, resulting in 15.0 and 13.3 hours per day for low- and medium-temperature WICFs, respectively. (*See* WICF NOPR 88 FR 60746, 60789, September 5, 2023.) When these values are normalized by the number of sales for each temperature class, it results in a shipment weighted-average daily run time of 13.9 hours, or 5,073 per year.

[90] The MSMA report shows average commercial fan operating hours of 3,564 hours per year, with a median of 2,621 hours per year, and accounts for 50 percent of fans operating between 1,800 and 5,100 hours per year.

report constitutes a more recent source of information and captures a wide range of commercial applications. Therefore, DOE has determined that the MSMA report is an appropriate source of information in this final rule, and DOE continues to rely on the MSMA report to characterize the ESEM operation in the commercial sector. DOE further notes the MSMA report provides a more conservative estimate of the operating hours in the commercial sector for ESEMs (*i.e.*, leading to lower energy use estimates) compared to relying on limited equipment-specific operating hours from the previous DOE study.

4. Impact of ESEM speed

Any increase in operating speeds as the efficiency of the motor is increased could affect the energy saving benefits of more efficient motors in certain variable torque applications (*i.e.*, fans, pumps, and compressors) due to the cubic relation between speed and power requirements (*i.e.*, "affinity law"). In the December 2023 NOPR, DOE included the effect of increased speeds in the energy use calculation for all equipment classes. DOE reviewed information related to pump, fans, and compressor applications driven by electric motors and estimated that 20 percent of fans, pumps and compressors using ESEM would be negatively impacted by an increase in speed. 88 FR 88062, 87092-87093 DOE did not receive comments on this aspect of the analysis and retained the same approach in the final rule.

In addition, DOE incorporated a sensitivity analysis allowing the user to consider this effect for three additional scenarios described in appendix 7-A of the final rule TSD (*i.e.*, 0 percent, 50 percent and 100 percent) and corresponding LCC results are described in appendix 8D of the final rule TSD. The sensitivity results do not change DOE's conclusion of economic justification of the adopted standards.

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

F. Life-Cycle Cost and Payback Period Analysis

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

- The LCC is the total consumer expense of equipment over the life of that equipment, consisting of total installed cost (MSP, 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 ESEMs in the absence of new energy conservation standards. This approach avoids any double counting of energy savings already captured by existing equipment or product level regulations by accounting for any existing ESEM efficiency improvements on the market and reflecting the fact that some ESEMs are already sold at efficiencies greater than the baseline levels, even in the absence of new ESEM standards. With this approach, when estimating energy savings at each considered standard case, DOE considers that adopting new ESEM standards would not impact the fraction of consumers that are already purchasing more efficient ESEMs (*i.e.*, ESEMs with efficiencies that are at or above the considered standard level) and would not result in any energy savings in this case. In contrast, the PBP for a given efficiency level is measured relative to the baseline equipment.

For each considered efficiency level 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 various data sources (*see* section IV.E.1 of this document). For each sample consumer, DOE determined the energy consumption for the ESEM 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 ESEMs.

Inputs to the LCC calculation include the installed cost to the consumer, operating expenses, the lifetime of the equipment, and a discount rate. Inputs to the calculation of total installed cost include the cost of the equipment—which includes MPCs, manufacturer markups, distribution channel markups, and sales taxes—and any installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, any repair and maintenance costs, equipment lifetimes, and discount rates. Inputs to the payback period calculation include the installed cost to the consumer and first-year operating expenses. DOE created distributions of values for equipment lifetimes, 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 sample input values from the probability distributions and ESEM consumer samples. The model calculated the LCC for products at each efficiency level for 10,000 consumers per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, 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 are already projected to purchase more-efficient equipment in a given case, DOE avoids overstating the potential benefits from increasing equipment efficiency.

DOE calculated the LCC and PBP for consumers of ESEMs as if each were to purchase new equipment in the expected year of required compliance with new standards. DOE used 2029 as the first year of compliance with any new standards for ESEMs, as discussed in section II.B.3 of this document.

Table IV-5 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 final rule TSD and its appendices.

Table IV-5 Summary of Inputs and Methods for the LCC and PBP Analysis*

Input	Source/Method
Product Cost	Derived by multiplying MPCs by manufacturer and distribution channel markups and sales tax, as appropriate. Used a constant price trend to project equipment costs based on historical data.
Installation Costs	Assumed no change with efficiency level other than shipping costs.
Annual Energy Use	Motor input power multiplied by annual operating hours per year. Variability: Primarily based on the MSMA report, 2018 CBECS, 2018 MECS, and 2020 RECS.
Energy Prices	Electricity: Based on EEI Typical Bills and Average Rates Reports data for 2023. Variability: Regional energy prices determined for four census regions.
Energy Price Trends	Based on *AEO2023* price projections.
Repair and Maintenance Costs	ESEMs are not repaired. No change in maintenance costs with efficiency level.
Product Lifetime	Average: 9.3 years (7.6 to 10.6 years depending on the equipment class group and horsepower considered).
Discount Rates	For residential end-users, approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances. For commercial end-users, DOE calculates commercial discount rates as the weighted-average cost of capital, using various financial data.
Compliance Date	2029.

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the final rule TSD. Energy price trends, product lifetimes, and discount rates are not used for PBP calculation.

The CA IOUs commented that a recent review has found that "possibilistic approaches such as the Monte Carlo methodology were the most frequently used tool to cope with the uncertainties associated with life-cycle cost analysis and TEA [techno-economic analysis]." The CA IOUs supported the use of Monte Carlo methods in DOE's appliance standards analysis and stated that they have provided detailed comments in recent rulemakings affirming its use. The CA IOUs added that the Monte Carlo methodology is especially appropriate for assessing consumer impacts and benefits in this rule. The CA IOUs commented that ESEMs are used in a variety of applications with a range of motor loads and operating hours specific to the installation's aspects, especially regarding the sector and application type of the motor. The CA IOUs stated that the Monte Carlo analysis enables the use of distributions for key product elements to be varied in a manner appropriate to the underlying distribution in each case and allows the interpretation of meaningful impacts at the population level, taking more detail of the application into account. The CA IOUs commented that this detailed analysis is especially important with ESEMs, which are generally subcomponents of various equipment types. The CA IOUs added that the ESEM analysis accounts for different equipment classes, sectors, regions of the country (*e.g.*, electricity prices and sales tax), applications, and efficiencies. The CA IOUs noted that, in particular, the Monte Carlo LCC approach accounts for differences in lifetime operating costs due to different average and marginal electricity prices, operating hours, lifetimes, and discount rates. (CA IOUs, No. 73 at p. 3)

As previously noted, DOE relied on a Monte Carlo simulation to incorporate uncertainty and variability into the LCC analysis.

Lennox recommended that DOE conduct economic analyses on consumer products such as residential CAC-HP systems. (Lennox, No. 69 at p. 4) DOE's economic analysis includes consumers of ESEMs across all sectors and applications, including consumers of ESEMs incorporated in residential CAC-HP equipment.

1. Equipment Cost

To calculate consumer 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 products and higher-efficiency products, because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency products.

To project an equipment price trend for ESEMs, DOE obtained historical Producer Price Index ("PPI") data for integral horsepower motors and generators manufacturing spanning the time period of 1969–2023 and for fractional horsepower motors and generators manufacturing between 1967 and 2023 from the Bureau of Labor Statistics ("BLS").[91] The PPI data reflect nominal prices, adjusted for electric motor quality changes. An inflation-adjusted (deflated) price index for integral and fractional horsepower motors and generators manufacturing was calculated by dividing the PPI series by the implicit price deflator for gross domestic product. The deflated price index for integral horsepower motors was found to align with the copper, steel, and aluminum deflated price indices. The extent to which these trends will continue in the future is very

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[91] Series ID PCU3353123353123 and PCU3353123353121 for integral and fractional horsepower motors and generators manufacturing, respectively; *www.bls.gov/ppi/*.

uncertain. In addition, the deflated price index for fractional horsepower motors was mostly flat during the entire period from 1967 to 2023. Therefore, DOE relied on a constant price assumption as the default price factor index to project future electric motor prices.

NEMA commented that motors will need additional active material to meet proposed levels, which generally results in higher costs for new installations and replacement (*i.e.*, a motor purchased to replace a failed motor) compared to motors currently on the market. (NEMA, No. 68 at p. 6) ABB commented that to achieve higher efficiencies, many motors will need redesign or additional material (*i.e.*, windings/stack changes), which will generally result in higher repair/retrofit cost compared to motors currently on the market. (ABB, No. 65 at pp. 3, 5)

DOE agrees that the motor equipment cost increases with higher efficiency, as shown by the increasing MSPs at higher efficiency levels. *See* section IV.C.3 of this document.

DOE did not receive any other comments on price trends in response to the December 2023 NOPR, and DOE retained the same approach in this final rule.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment. Electric motor installation cost data from 2023 RS Means Electrical Cost Data show a variation in installation costs according to the motor horsepower (for three-phase electric motors), but not according to efficiency. DOE found no evidence that installation costs would be impacted by increased efficiency levels. In addition, the engineering analysis assumes that the higher ELs are reached based on design options that do not significantly impact the footprint of the ESEM, and the ESEM would remain in the same frame size (*see* section IV.C.1.d) and would not require modifying the mounting setup. Therefore, in the December 2023 NOPR, DOE did not incorporate changes in installation costs for ESEMs that are more efficient than baseline equipment. DOE assumed there is no variation in installation costs between a baseline-efficiency motor and a higher-efficiency motor, except in terms of shipping costs. These shipping costs were based on weight data from the engineering analysis for the representative units.

Lennox commented that higher motor efficiency levels will have higher installation costs to integrate larger, heavier motors at all ELs without providing energy savings, as it relates to HVACR equipment. (Lennox, No. 69 at p. 12)

ABB commented that DOE should interview OEMs and service providers to obtain information regarding increased installation costs with higher efficiency levels. (ABB, No. 65 at p. 3)

As described in section IV.C.1.d of this document, to develop the higher efficiency levels, DOE maintained the frame size, which remains the same across efficiency levels in the analysis, and constrained the stack length increase of the ESEMs. As discussed in section III.D.2.d of this document, and specifically at TSL 2, the added weight and length for motors to meet higher efficiency levels for low-torque ESEMs are minimal. In particular, DOE notes that at EL 2, the stack length is an additional 0 (*i.e.*, no increase) to 0.46 inches compared to the baseline, and the weight is an additional -1.55 (*i.e.*, weight reduction) to 2.67 lb compared to the baseline, depending on the representative unit considered. Specifically, the stack length increases 0 (*i.e.*, no increase) to 0.23 inches, and the weight increases 1.40 to 2.04 lb for low-torque AO-ESEMs, which are primarily used in HVACR equipment. Similar differences exist across stack length and weight between motors produced by different motor manufacturers for use in the same OEM application today. Therefore, DOE did not account for any changes in installation costs due to changes in size and, in this final rule, DOE retained the approach used in the December 2023 NOPR and assumed there is no variation in installation costs between a baseline-efficiency motor and a higher-efficiency motor, except in terms of shipping costs. In addition, DOE has sufficient information to reach the conclusion that installation costs would not increase with higher efficiency levels, specifically for EL 2. Therefore, DOE did not conduct additional interviews with OEMs and service providers.

DOE further discusses the impacts on OEM conversion costs in section V.B.7 of this document.

For further information on the derivation of installation costs, *see* chapter 8 of the final rule TSD.

3. Annual Energy Consumption

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

4. Energy Prices

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

DOE derived electricity prices in 2023 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 residential sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki

(2018).[92] For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[93]

To estimate energy prices in future years, DOE multiplied the 2023 energy prices by the projection of annual average price changes from the Reference case in *AEO2023*, which has an end year of 2050.[94] To estimate price trends after 2050, the 2050 prices were held constant.

DOE's methodology allows electricity prices to vary by sector and 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 electric motors, DOE relied on variability by region and sector. *See* chapter 8 of the final rule TSD for details.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing components that have failed in equipment; maintenance costs are associated with maintaining the operation of the equipment. Typically, small incremental increases in equipment efficiency entail no,

[92] Coughlin, K., and B. Beraki. 2018. "Residential Electricity Prices: A Review of Data Sources and Estimation Methods." Lawrence Berkeley National Lab. Report No. LBNL-2001169. Available at *ees.lbl.gov/publications/residential-electricity-prices-review*.

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

[94] Energy Information Administration. *Annual Energy Outlook 2023*. Available at *www.eia.gov/outlooks/aeo/* (last accessed May 1, 2023).

or only minor, changes in repair and maintenance costs compared to baseline-efficiency equipment.

In the December 2023 NOPR, for the maintenance costs, DOE did not find data indicating a variation in maintenance costs between baseline-efficiency and higher-efficiency motors. The cost of replacing bearings, which is the most common maintenance practice, is constant across efficiency levels. Therefore, DOE did not include maintenance costs in the LCC analysis. DOE considers a motor repair as including rewinding and reconditioning. In the December 2023 NOPR, DOE did not consider any repair for the ESEM representative units. *See* chapter 8 of the final rule TSD for details.

ABB commented that replacing PSC with CSCR will result in the addition of start capacitors and switches, thereby increasing maintenance cost. Increased size may also prevent backward compatibility. (ABB, No. 65 at p. 4)

DOE's analysis separated PSC and CSCR ESEMs into different equipment classes based on differences in output torque, and the engineering analysis assumes that higher efficiency levels can be achieved using PSC ESEMs. DOE does not expect consumers to replace PSCs with CSCR ESEMs and does not expect any increases in maintenance costs as a result. *See* sections IV.A.1 and IV.A.2 of this document for more information on the equipment classes and design options considered. In addition, as discussed in section IV.F.2 of this document, the size increases at higher efficiency levels are minimal and would not result in compatibility issues, specifically at EL 2, the selected standard level.

6. Equipment Lifetime

In the December 2023 NOPR, DOE established separate average mechanical lifetime estimates for single-phase and polyphase ESEMs and AO-ESEMs. DOE then developed Weibull distributions of mechanical lifetimes (in hours). The lifetime in years for a sampled electric motor is calculated by dividing the sampled mechanical lifetime by the sampled annual operating hours of the electric motor. In addition, DOE considered that ESEMs and AO-ESEMs are typically embedded in a piece of equipment (*i.e.*, an application). For such applications, DOE developed Weibull distributions of application lifetimes expressed in years and compared the sampled motor mechanical lifetime (in years) with the sampled application lifetime. DOE assumed that the electric motor would be retired at the earlier of the two ages. In the December 2023 NOPR, the resulting average lifetimes for ESEMs ranged between 6.8 and 9.3 years, depending on the representative unit considered.

ABB commented that motor lifetime is highly variable depending on maintenance, installation, and application. (ABB, No. 65 at p. 4)

DOE agrees that motor lifetimes can vary depending on maintenance, installation, and application. Recognizing that inputs to the determination of consumer LCC and PBP may be either variable or uncertain, DOE conducts the LCC and PBP analysis by modeling both the uncertainty and variability of the inputs (including lifetimes), using

Monte Carlo simulation and probability distributions for inputs (*i.e.*, Weibull distributions for lifetimes). Appendix 8A provides a detailed explanation of Monte Carlo simulation and the use of probability distributions and discusses the tool used to incorporate these methods.

AHRI commented that reliance on the January 2021 Final Determination Technical Support Document[95] related to SEMs to determine the mechanical lifetime estimates for ESEMs and AO-ESEMs is inappropriate. (AHRI, No. 70 at pp. 10–11)

DOE used average mechanical lifetime estimates based on the "Small Electric Motors January 2021 Final Determination Technical Support Document," which relied on a mechanical lifetime of 30,000 hours for single-phase SEMs and of 40,000 hours for polyphase SEMs. DOE also relied on information from DOE's Advanced Manufacturing Office, which more generally estimates average motor mechanical lifetimes between 30,000 hours and 40,000 hours.[96] DOE found one OEM manufacturer estimating mechanical lifetimes of condenser fan motors (*i.e.*, low-torque ESEMs) up to 50,000 hours and noting that this is longer than the average expected lifetime.[97] However, DOE did not use this 50,000-hours estimate, as it was characterized as representative of low-torque ESEMs with longer lifetimes.

[95] AHRI referenced pages 8–14 of the December 2023 NOPR TSD.
[96] Advanced Manufacturing Office. November 2012. "Energy Tips: Motor Systems." Available at *energy.gov/eere/amo/articles/extend-operating-life-your-motor* (last accessed March 21, 2024).
[97] *See*, for example, *www.hvacpartsshop.com/hb39gq232-fan-motor-1-4-hp/*.

In addition, consistent with the revision of the operating hours for AO-ESEMs and low-torque ESEMs used in residential fan applications, to reflect that these motors are primarily used in residential CAC-HP applications, DOE updated the residential application lifetimes (*i.e.*, lifetime of the equipment incorporating the AO-ESEM or low-torque ESEM) associated to AO-ESEMs and low-torque ESEMs to reflect the CAC-HP lifetimes. As a result of these changes, the average lifetimes across all equipment classes range between 7.6 and 10.6 years in this final rule.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to consumers to estimate the present value of future operating cost savings. DOE estimated a distribution of sector-specific discount rates for ESEMs 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.[98] The LCC analysis estimates net present value over the lifetime of the equipment, so the appropriate discount rate will reflect the general opportunity cost of consumer funds, taking this time scale into account. Given the long time horizon modeled in the LCC, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the

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

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 residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percent shares of the various types of debt and equity by household income group, using data from the Federal Reserve Board's triennial Survey of Consumer Finances[99] ("SCF"), starting in 1995 and ending in 2019. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which the new standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.16 percent.

To establish non-residential discount rates, DOE estimated the weighted-average cost of capital, using data from Damodaran Online.[100] The weighted-average cost of capital is commonly used to estimate the present value of cash flows to be derived from a

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[99] Federal Reserve Board. "Survey of Consumer Finances (SCF)" for 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019.
[100] Damodaran, A. 2021. "Data Page: Historical Returns on Stocks, Bonds and Bills-United States." Available at *pages.stern.nyu.edu/~adamodar/* (last accessed April 26, 2022).

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 commercial and industrial discount rates are 6.8 percent and 7.3 percent, respectively.

See chapter 8 of the final rule TSD for further details on the development of consumer 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) in the compliance year. This approach reflects the fact that some consumers may purchase equipment with efficiencies greater than the baseline levels in the absence of new standards. As described previously, with this approach DOE avoids double counting any energy savings that may already be captured in existing product or equipment level regulations. When estimating the energy savings in each standards case, DOE considers that new ESEM standards would not benefit the fraction of consumers that are already purchasing more efficient ESEMs (*i.e.*, ESEMs with efficiencies that are at or above the considered standards level) and would not result in any energy savings for such consumers. In addition, DOE further considered the potential impacts of equipment-level energy conservation standards by incorporating two sensitivity analyses as further described in this section.

DOE did not separately assess the impacts of each equipment-/product-level energy conservation standard on the no-new-standards case ESEM efficiency distribution. DOE expects the end-use equipment or products for which DOE has recently adopted new or amended standards (e.g., walk-in coolers and freezers, commercial refrigeration equipment, or commercial air conditioners and heat pumps) to have compliance dates within a 1 year period leading up to the compliance date for the amended energy standards in this final rule. Thus, DOE instead collected efficiency data for ESEM currently on the market, which reflects any improvements in ESEM efficiency due to existing DOE equipment-/product-level energy conservation standards. In addition, DOE acknowledges that upcoming equipment-level energy conservations standard could have an impact on future ESEM efficiencies on the market. To reflect this, as part of the NIA, DOE included a sensitivity analysis which accounts for an increase in efficiency over time in the no-new standards case. See Section IV.H.1 for more details. DOE further acknowledges that upcoming equipment-level energy conservations standards could reduce ESEM shipments as some OEMs may decide to switch to ECM motors and accounted for this by conducting a sensitivity analysis based on lower ESEM shipments. See section IV.G of this document for more information.

To estimate the energy efficiency distribution of ESEMs for 2029, DOE relied on model counts by efficiency from 2022 manufacturer catalogs as well as shipments data and assumed no changes in ESEM efficiency over time. The estimated market shares for the no-new-standards case for ESEMs are shown in Table IV-6. As shown in Table IV-6, the standards adopted in this final rule (equivalent to TSL2 or EL2) will only impact the shipments that are at EL0 and EL1. All shipments at or above EL2 would not be impacted. For example, for low torque AO-ESEMs between 0.25 and 3 hp, 35.9 percent of shipment would be impacted (9.6+26.1) while 64.1 percent of shipments would not be impacted (55.4+8.7+0). Accordingly, LCC analysis reflects that a similar percentage of consumers will not be impacted by the standards adopted in this rule.[101] For example, the LCC results for the 0.5 hp low torque AO-ESEMs representative unit shows that 65 percent of consumers would not be impacted by the adopted standards. In the LCC, the Monte Carlo simulations draw from the efficiency distributions and assigns an efficiency to the ESEM purchased by each sample consumer in the no-new-standards case, based on the market share of each efficiency level within each associated horsepower range. The resulting percentage shares within the sample match the market shares in the efficiency distributions for each horsepower range associated with each representative unit. In assigning ESEM efficiencies, DOE determined that, based on the presence of well-understood market failures (discussed at the end of this section), its efficiency assignment methodology best represents consumer behavior in the ESEM market. DOE's methodology for the assignment of efficiencies reflects the full range of consumer behaviors in this market, including consumers who, in the absence of new standards, make economically beneficial decisions and consumers that, due to market failures, do

[101] DOE notes that the percentage of non-impacted consumers is not exactly equal to the market share of non- shipments due to 10,000 unit sample in the Monte Carlo simulation.

not make such economically beneficial decisions. *See* chapter 8 of the final rule TSD for further information on the derivation of the efficiency distributions.

Lennox commented that HVACR OEMs select more efficient motors when it is cost-effective to do so as part of a broader suite of component design options to comply with more stringent system-level efficiency standards. Lennox commented that DOE should not assume no changes in electric motor efficiency over time. (Lennox, No. 69 at p. 7)

In the case of ESEMs, DOE agrees with Lennox that some OEMs are selecting more energy-efficient motors to comply with more stringent system-level efficiency standards. However, these more efficient motors are typically multispeed, variable-speed motors or brushless permanent magnet motors (*e.g.*, ECMs) and would not significantly impact the efficiency distribution of ESEMs, which are AC induction single-speed motors.[102] In addition, as stated in the December 2023 NOPR, DOE acknowledges that some ESEMs could be replaced by non-induction motors such as ECMs, which could result in potentially lower ESEM shipments. To quantify the magnitude of such substitution, DOE conducted a shipments sensitivity analysis to account for the impacts of lower ESEM shipments estimates. (*See* section IV.G.) 88 FR 87062, 87099. In this

[102] *See*, for example, chapter 3, section 3.3.3 of "2016-12 Final Rule Technical Support Document: Energy Efficiency Program for Consumer Products: Residential Central Air Conditioners and Heat Pumps," available at *www.regulations.gov/document/EERE-2014-BT-STD-0048-0098* (last accessed March 26, 2024), which identifies ECM motors as higher-efficiency fan motors compared to PSC motors, and chapter 3, section 3.3.2.4 of "2022-10 Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Consumer Furnace Fans, October 2022," available at *www.regulations.gov/document/EERE-2021-BT-STD-0029-0014* (last accessed March 26, 2024), which identifies PSC motors with airflow-control settings, brushless permanent magnets ("BPMs") (often referred to as "X13"), and constant-airflow BPM motors (often referred to as "ECMs") as higher-efficiency fan motors compared to baseline PSC motors.

final rule, DOE retained the same approach. In addition, to illustrate the impact of ESEM efficiency increase over time due to potential technological improvements, in the NIA, DOE incorporated a sensitivity analysis to reflect a low and high increase in ESEM efficiency over time as described in section IV.H.1 of this document. Results of these sensitivity analyses are available in the NIA spreadsheet model and in appendix 10C. DOE notes that the sensitivity results do not change DOE's conclusion of economic justification of the adopted standards.

Table IV-6 No-New-Standards Case Efficiency Distributions in the Compliance Year

Equipment Class Group	Horsepower Range	EL 0	EL 1	EL 2	EL 3	EL 4
ESEM High/Med Torque	0.25 ≤ hp ≤ 0.50	24.1%	43.1%	16.2%	16.0%	0.7%
	0.5 < hp ≤ 3	37.5%	49.1%	11.9%	1.4%	0.1%
ESEM Low-torque	0.25 hp	4.1%	16.0%	79.9%	0.0%	0.0%
	0.25 < hp ≤ 3	41.5%	22.0%	26.8%	9.8%	0.0%
ESEM Polyphase	0.25 ≤ hp ≤ 3	9.6%	23.1%	53.3%	13.4%	0.5%
AO-ESEM High/Med Torque	0.25 ≤ hp ≤ 0.50	26.7%	33.3%	20.0%	6.7%	13.3%
	0.5 < hp ≤ 3	32.4%	38.2%	17.6%	11.8%	0.0%
AO-ESEM Low-torque	0.25 hp	3.3%	21.5%	57.3%	17.9%	0.0%
	0.25 < hp ≤ 3	9.8%	26.1%	55.4%	8.7%	0.0%
AO-ESEM Polyphase	0.25 ≤ hp ≤ 3	37.7%	26.0%	33.8%	2.6%	0.0%

* May not sum to 100%, due to rounding.

While DOE acknowledges that economic factors may play a role when OEMs or consumers decide on what type of ESEM to purchase, assignment of ESEM efficiency for a given installation, based solely on economic measures such as life-cycle cost or simple payback period, most likely would not fully and accurately reflect actual real-world installations. There are a number of market failures discussed in the economics literature that illustrate how purchasing decisions with respect to energy efficiency are unlikely to be perfectly correlated with energy use, as described subsequently. DOE maintains that the method of assignment is a reasonable approach. It simulates behavior in the ESEM market, where market failures result in purchasing decisions not being perfectly aligned with economic interests, and it does so more realistically than relying only on apparent cost-effectiveness criteria.

DOE further emphasizes that its approach does not assume that all purchasers of ESEMs make economically irrational decisions (*i.e.*, the lack of a correlation is not the same as a negative correlation). As part of the DOE's assignment methodology, some consumers with high operating hours will be assigned higher-efficiency ESEMs, and some consumers with particularly low operating hours will be assigned baseline ESEMs. By using this approach, DOE acknowledges the uncertainty inherent in the data and minimizes any bias in the analysis, as opposed to assuming certain market conditions that are unsupported by the available evidence.

The following discussion provides more detail about the various market failures that affect electric motor purchases. First, a recognized problem in commercial settings is the split-incentive problem, where the building owner (or building developer) selects the equipment and the tenant (or subsequent building owner) pays for energy costs.[103], [104], [105] In the case of ESEMs used in the commercial and industrial sectors, for many

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[103] Vernon, D., and A. Meier. 2012. "Identification and Quantification of Principal–Agent Problems Affecting Energy Efficiency Investments and Use Decisions in the Trucking Industry." *Energy Policy*, 49, 266–273.
[104] Blum, H., and J. Sathaye. 2010. "Quantitative Analysis of the Principal-Agent Problem in Commercial Buildings in the U.S.: Focus on Central Space Heating and Cooling." Lawrence Berkeley National Laboratory, LBNL-3557E. Available at *escholarship.org/uc/item/6p1525mg* (last accessed Jan. 20, 2022).
[105] US DOE, 2015. "Barriers to industrial Energy Efficiency, Report to Congress" . Available at: www.energy.gov/sites/prod/files/2015/06/f23/EXEC-2014-005846_6%20Report_signed_0.pdf (last accessed July 30, 2024)

companies, the energy bills are paid for the company as a whole and not allocated to individual departments. This practice provides maintenance and engineering staff with little incentives to pursue energy-saving investments, because the savings in energy bills provide little benefits to the decision-making maintenance and engineering staff.[106] Second, the nature of the organizational structure and design can influence priorities for capital budgeting, resulting in choices that do not necessarily maximize profitability.[107] In the case of ESEMs, within manufacturing as a whole, motor system energy costs constitute less than 1 percent of total operating costs, and energy efficiency has a low level of priority among capital investment and operating objectives.[108] Third, there are asymmetric information and other potential market failures in financial markets in general, which can affect decisions by firms with regard to their choice among alternative investment options, with energy efficiency being one such option.[109] In the case of electric motors, Xenergy identified the lack of information concerning the nature of motor system efficiency measures—their benefits, costs, and implementation procedures—as a principal barrier to their adoption. In addition, Almeida[110] reported

[106] Nadel, S., *et al*. 2002. *Energy-Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities*, second edition. American Council for an Energy-Efficient Economy.
[107] DeCanio, S. J. 1994. "Agency and Control Problems in US Corporations: The Case of Energy-Efficient Investment Projects." *Journal of the Economics of Business*, 1(1), 105–124; Stole, L. A., and J. Zwiebel. 1996. "Organizational Design and Technology Choice under Intrafirm Bargaining," *The American Economic Review*, 195–222.
[108] *Id*.; Xenergy, Inc. 1998. "United States Industrial Electric Motor Systems Market Opportunity Assessment." Available at *www.energy.gov/sites/default/files/2014/04/f15/mtrmkt.pdf* (last accessed Jan. 20, 2022).
[109] Fazzari, S. M., *et al*. 1988. "Financing Constraints and Corporate Investment." *Brookings Papers on Economic Activity*, 1988(1), 141–206; Cummins, J. G., *et al*. 1994. "A Reconsideration of Investment Behavior Using Tax Reforms as Natural Experiments." *Brookings Papers on Economic Activity*, 1994(2), 1–74; DeCanio, S. J., and W. E. Watkins. 1998. "Investment in Energy Efficiency: Do the Characteristics of Firms Matter?" *Review of Economics and Statistics*, 80(1), 95–107; Hubbard, R.G., and A. Kashyap. 1992. "Internal Net Worth and the Investment Process: An Application to U.S. Agriculture." *Journal of Political Economy,* 100, 506–534.
[110] de Almeida, E. L. F. 1998. "Energy Efficiency and the Limits of Market Forces: The Example of the Electric Motor Market in France." *Energy Policy*, 26(8), 643–653.

that the attitude of electric motor end-users is characterized by bounded rationality, where they adopt "rule of thumb" routines because of the complexity of market structure, which makes it difficult for motor end-users to get all the information they need to make an optimum decision concerning allocation of resources. The rule of thumb is to buy the same type and brand as the failed motor from the nearest retailer. Almeida added that the same problem of bounded rationality exists when end-users purchase electric motors incorporated into larger equipment. In general, end-users are only concerned about the overall performance of a machine, and energy efficiency is rarely a key factor in this performance. Motor selection is, therefore, often left to the OEMs, which are not responsible for energy costs and prioritize price and reliability.

The existence of market failures in the commercial sector is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned ESEM efficiency in the no-new-standards case solely according to energy use or economic considerations such as life-cycle cost or payback period, the resulting distribution of efficiencies within the consumer sample would not reflect any of the market failures or behavioral factors above. Thus, DOE concludes such a distribution would not be representative of the ESEM market. Further, even if a specific consumer is not subject to the market failures above, the purchasing decision of ESEM efficiency can be highly complex and influenced by a number of factors not captured by the consumer characteristics established when developing the consumer sample. These factors can lead to consumers choosing an ESEM efficiency that deviates from the efficiency predicted using only energy use or economic considerations such as life-cycle cost or payback period.

Lennox commented that the use of a Monte Carlo simulation to randomly assign an efficiency level to the ESEM purchased by each sample household is inappropriate for the HVACR sector and does not account for the dynamics of HVACR OEM purchasers. Lennox stated that reports from over 25 years ago concerning end-user motor purchasing decisions are irrelevant today, and the behaviors cited from these reports do not apply to HVACR OEMs. Lennox commented that motors are not purchased by households and are instead carefully selected by OEMs. Lennox stated that motors are specifically designed in joint efforts between HVACR and motor manufacturers to match the criteria for use in HVACR systems for optimization in specific applications. Lennox commented that multiple motor suppliers are frequently engaged in the process, and the sourcing of these motors is carefully considered in the overall design of the product. Lennox further commented that the principal-agent problem does not apply to ESEMs, as these are purchased by HVACR OEMs and not by building owners. Lennox commented that HVACR OEMs provide motor manufacturers with specific criteria, building off of standard frame sizes to include detailed technical specifications, such as temperature rise, bearing type, acceptable bearing temperature, voltage, rpm, efficiency, motor mounting means, motor electrical connection means, motor winding insulation type, shaft size, length, and fan mounting means. Lennox stated that this iterative process is done to optimize various parameters, including performance, cost, quality, reliability, and safety, and the process includes months of testing and development. Lennox further commented with a description of the development and manufacturing process associated with HVACR OEMs incorporating new motor design. Lennox stated that the report used to identify market failures[111] is out of date and irrelevant to the HVACR market. Lennox stated that multiple system-level standards have taken place since then, and the market has significantly changed in the past two decades. (Lennox, No. 69 at pp. 8–9)

Lennox additionally commented that the type or efficiency of the motor used in HVAC products has little to no relationship to the end-consumer's purchase decision of HVAC. (*Id*. at p. 13)

Regarding EL 3 and EL 4, ABB commented that consumer choice is important and that consumers should be trusted to make the right purchasing decisions to reduce energy consumption at a reasonable cost. (ABB, No. 65 at p. 2)

Ravnitzky stated that the proposed standards help remedy market failures such as imperfect information, split incentives, capital constraints, and transaction costs, creating a level playing field for all motor manufacturers and consumers. (Ravnitzky, No. 62 at p. 1)

The LCC analysis analyzes the impacts of standards on consumers of ESEMs that are the end-users of the equipment. As such in the LCC, DOE does not characterize how a specific motor is assigned to an OEM but rather how they are assigned to an end-user. While DOE agrees with Lennox that OEMs select ESEMs based on their specific needs, end-users are mainly concerned about the overall performance of the equipment incorporating the ESEM, and the energy efficiency of the ESEM is rarely a key factor in

[111] Nadel, S., *et al*. 2002. *Energy-Efficient Motor Systems: A Handbook on Technology, Program and Policy Opportunities*.

this performance. Motor selection is, therefore, often left to the OEMs, which are not responsible for energy costs and generally prioritize price and reliability. As noted by Lennox, the efficiency of the ESEMs incorporated in larger equipment is unlikely to be a significant factor in the end-user purchase decision. In addition, as described previously, DOE identified a number of market failures demonstrating that consumers do not typically make optimum decisions concerning the purchase of ESEMs. Therefore, DOE continues to apply a Monte Carlo approach to assign equipment efficiency to consumers in the LCC sample and reflect market failures in the ESEM market. Finally, while some of the report cited by DOE are not recent, the market failures specific to electric motors are still relevant today because the market structure for ESEMs has not changed.

DOE calculates the LLC savings relative to the equipment efficiencies under the no-new-standards case (*i.e.*, the case without new energy conservation standards) in the compliance year. This approach reflects the fact that some consumers may purchase equipment with efficiencies greater than the baseline levels in the absence of new standards.

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 baseline 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. 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 new standards would be required.

G. Shipments Analysis

DOE uses projections of annual equipment shipments of ESEMs to calculate the national impacts of potential new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[112] 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

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[112] 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.

in-service equipment stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

In the December 2023 NOPR, DOE estimated ESEM shipments in the base year (2020). DOE developed a distribution of shipments of ESEMs by equipment class group and horsepower range based on model counts from the 2022 Manufacturer Catalog Data.

ABB commented that DOE could speak with motor market research companies to inform its shipments analysis. (ABB, No. 65 at p. 4) In preparation for the December 2023 NOPR, DOE reviewed the possibility of using information from market research reports.[113] However, these reports provided market data for general categories of AC motors and DC motors and did not provide sufficient disaggregation for the purpose of this analysis. Therefore, DOE did not rely on these market research reports to estimate shipments.

AHRI commented that its own shipment data indicates 4,529,980 central AC/HPs between 33,000 and 65,900 Btu/h were sold in 2020.[114] AHRI stated that, using projected efficiency trends from the last CAC-HP rulemaking, approximately 90 percent of condensing units sold in 2020, or 4,076,982, were single or two stage, likely using a low-

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[113] Including "Fractional Horsepower Motor Report – 2019" (*omdia.tech.informa.com/om004972/fractional-horsepower-motor-report*) and "Electric Motors in Home Appliances and Residential HVAC Applications – 2018" (*omdia.tech.informa.com/om002826/electric-motors-in-home-appliances--residential-hvac-applications*).

[114] *www.ahrinet.org/analytics/statistics/historical-data/central-air-conditioners-and-air-source-heat-pumps* (last accessed on Feb. 13, 2024).

torque 0.25 hp AO-ESEM. AHRI commented that DOE's estimate of 819,000 units in residential applications may cover some blower coil replacements, but it seems low for furnace fan replacements, considering the shipments analysis DOE conducted for the first residential furnace fan rulemaking. Lastly, AHRI commented that low-torque 0.25 hp AO-ESEMs are also used extensively in whole-house fans (10- to 20-inch diameter fans). AHRI commented that it was unable to find any examples of where they are manufactured for general use. (AHRI, No. 70 at p. 13) In addition, AHRI commented that DOE's rationale for estimating AO-ESEM shipments is arbitrary and unsupported. Specifically, AHRI noted DOE's assumption related to the percentage of shipments represented by AO enclosure for single-phase motors (for which DOE relied on a 25-percent market share). AHRI commented that special- and definite-purpose motors are heavily used in consumer products, and DOE's shipment estimate did not include filings by industry experts. AHRI stated that DOE failed to interview finished-goods manufacturers, particularly those that use low-torque AO-ESEMs in residential CAC-HPs. (AHRI, No. 70 at p. 13)

AHRI commented that in the ESEM analysis, DOE did not properly account for the millions in regulated equipment sold every year that include AO-ESEMs between 0.25 and 3 hp, particularly low-torque motors. AHRI commented that common uses for low-torque AO-ESEMs, including residential and commercial air conditioners and heat pumps, were not included in DOE's analysis, significantly skewing the economic impact of the proposal and the technical feasibility of changing the motor's length and weight.

(AHRI, No. 70 at p. 3)

Lennox commented that the AO motors used by these residential CAC-HP applications are generally under 1 horsepower, and thus are not large pieces of equipment that consume significant amounts of energy. (Lennox, No. 69 at p. 4)

In the December 2023 NOPR, DOE estimated AO-ESEMs based on the estimate that 25 percent of single-phase ESEMs (including AO-ESEMs) have an AO enclosure. Based on the feedback from AHRI, using model counts in the 2022 manufacturer catalog database as a proxy for market shares, DOE further reviewed the estimated market shares of AO-ESEMs and revised it approach to collect this information by topology rather than for all single-phase ESEMs. DOE observed that while the single-phase AO-ESEMs represent approximately 25 percent of all single-phase ESEMs, this percentage varies significantly by motor topology and is much higher for low-torque ESEMs compared to other single-phase ESEMs.[115] As a result, the December 2023 NOPR underestimated the shipments of low-torque AO-ESEMs and overestimated the shipments of high- and medium-torque AO-ESEMs. In this final rule, based on the feedback from AHRI, DOE revised the assumptions regarding the market shares of single-phase AO motors to be topology specific. With these revisions, DOE estimates total shipments of low-torque AO-ESEMs in the residential sector (which are all under 1 hp) increased from 0.83 to 1.53 million units in the 0.25 hp size and from 2.13 to 3.91 million units in the 0.26–1 hp range. This corresponds to a revised total number of 5.44 million units of low-torque AO-ESEMs in the residential sector, which is higher than in the December 2023 NOPR. The revised shipments estimate does not change DOE's assessment of the technological

[115] DOE found that the share of AO-ESEM models over total count of ESEM models is 3 percent for CSCR and CSIR ESEMs, 11 percent for split-phase ESEMs, and 76 percent for PSC ESEMs.

feasibility of changing the motor's length and weight, which is discussed in section IV.C of this document.

In the December 2023 NOPR, the shipments of non-AO CSCR and CSIR ESEMs were estimated to be equal to the shipments of currently regulated CSCR and CSIR motors, which only included two-digit frame size motors. In this final rule, DOE revised the value of shipments of non-AO CSCR and CSIR ESEMs to account for three-digit frame size units, which are included in the scope.[116]

In the December 2023 NOPR, DOE projected shipments for ESEMs in the no-new-standards case under the assumption that long-term growth of ESEM shipments will be driven by the following sector-specific market drivers from *AEO2021*: commercial building floor space, housing numbers, and value of manufacturing activity for the commercial, residential, and industrial sector, respectively. DOE also analyzed scenarios that used inputs from variants of the *AEO* Reference case that have lower and higher economic growth (resulting in lower, and higher shipments compared to the reference case, respectively). In addition, DOE kept the distribution of shipments by ECG and horsepower range constant across the analysis period. 88 FR 87062, 87098-87099, 87100

AHRI commented that reliance on the January 2021 Final Determination Technical Support Document related to SEMs to determine the base-year shipments and

[116] DOE estimated that 20 percent of non-AO-ESEMs are three-digit frame size ESEMs based on model counts from the 2022 manufacturer catalog database.

shipment projections for ESEMs and AO-ESEMs is inappropriate. (AHRI, No 70 at pp. 10–11)

The overall methodology for projecting shipments of ESEMs is similar to how DOE previously projected SEM shipments as well as other categories of commercial and industrial equipment.[117] However, in the December 2023 NOPR and in this final rule, DOE relied on ESEM-specific sector distributions, which results in shipment projections that are different from SEMs and specific to ESEMs. For this reason, DOE has determined that the methodology to project ESEM shipments is appropriate. DOE did not receive any other comments on this approach and continued to rely on *AEO*s macroeconomic indicators to project ESEM shipments with one update to account for the more recent *AEO2023* version. DOE further, similar to what was done in the December 2023 NOPR, DOE established two additional shipments sensitivity scenarios to account for the impacts of lower/higher ESEM shipments estimates based on inputs from variants of the *AEO2023* Reference case that have lower and higher economic growth. In addition, DOE relied on the best available data to estimate base-year shipments, as previously described in this section.

As discussed in section IV.F.8, as a sensitivity analysis, DOE relied on the lower shipments estimate to characterize the potential impacts of reduced ESEM shipments due

[117] *See* chapter 9 of "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Pumps" (August 2022), available at *www.regulations.gov/document/EERE-2021-BT-STD-0018-0013* (last accessed April 1, 2024); *see* chapter 9 of "Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Electric Motors" (May 2023), available at *www.regulations.gov/document/EERE-2020-BT-STD-0007-0040* (last accessed April 1, 2024).

to an increase in utilization of ECMs over ESEMs in some applications.[118] DOE notes that a reduction in shipments due to a switch to ECMs would not change the relative comparison of the TSLs and would not change DOE's conclusion of economic justification of the adopted standards, confirming that the conclusion is robust despite some input uncertainty.

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new standards at specific efficiency levels.[119] ("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 ESEMs sold from 2029 through 2058.

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[118] Specifically, the lower shipments projection results in about 3 percent less cumulative shipments over the 30 year analysis period compared to the reference case. Based on the shipments data provided in the respective TSDs for WICFs and circulator pumps, as a proxy, DOE estimates that ESEMs in these two categories of equipment represent about 3 percent of ESEM shipments. Therefore, DOE estimates the low shipments scenario is a reasonable proxy for a potential reduction of ESEMs shipments due to a switch to ECMs due to upcoming energy conservation standards for WICFs and circulator pumps. See Chapter 9 of the NOPR TSD for WICFs, Available at: www.regulations.gov/document/EERE-2017-BT-STD-0009-0046 and Chapter 9 of the Final Rule TSD for Circulator Pumps, Available at: www.regulations.gov/document/EERE-2016-BT-STD-0004-0137 (in addition for circulating pumps, only 4 out of 30 representative units have a horsepower within the scope of the ESEMs included in the scope of this final rule and therefore, DOE estimated shipments of circulator pumps with ESEMs to be 4/30 of the total).

[119] The NIA accounts for impacts in the United States and U.S. territories.

DOE evaluates the impacts of new standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each equipment class in the absence of new energy conservation standards. For this projection, DOE considers any 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 standards at specific energy efficiency levels (*i.e.*, the TSLs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard. As previously described, with this approach, DOE avoids any double counting of energy savings that may be already captured in existing product or equipment levels rulemakings by accounting for any existing ESEM efficiency improvements on the market and reflecting the fact that some ESEMs are projected to be sold at efficiencies greater than the baseline levels, even in the absence of new ESEM standards. With this approach, at each considered TSL, DOE considers that adopting new ESEM standards would not impact the fraction of consumers that are already purchasing more efficient ESEMs (*i.e.*, ESEMs with efficiencies that are at or above the considered standard level) and would not result in any energy savings in this case.

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-7 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 final rule TSD for further details.

In addition, in the NIA DOE considered several sensitivity analysis to reflect alternative efficiency trend scenarios (see section IV.H.1 of this document) and alternative shipments projections (see section IV.G of this document).

Table IV-7 Summary of Inputs and Methods for the National Impact Analysis

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2029
Efficiency Trends	No-new-standards case: 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 (constant trend).
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	Maintenance costs: no change with efficiency level. Repair costs: no repair.
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 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 year of anticipated compliance with a new standard. To project the trend in efficiency absent amended standards for ESEMs over the entire shipments projection period, DOE applied a constant trend. The approach is further described in chapter 10 of the final rule TSD.

For the standards cases, DOE used a "roll-up" scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2029). In this scenario, the market shares of 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 products above the standard would remain unchanged.

To develop standards case efficiency trends after 2029, DOE assumed no change over the forecast period. Further, as discussed in section IV.F.8 of this document, DOE considered two additional efficiency trend sensitivity cases to evaluate the effect of uncertainty regarding efficiency trends in the no-new-standards case and reflect a low and high increase in ESEM efficiency over time. In the low increase scenario, DOE assumed that the shipments-weighted average full load efficiency of ESEMs would increase at an annual rate of 0.01 percent and in the high increase scenario, DOE assumed an annual rate of 0.05 percent.[120] Results of this sensitivity analysis are available in the NIA spreadsheet model and in appendix 10C. DOE notes that in all scenarios the relative comparison of the different TSL analyzed remains the same do not change DOE's conclusion of economic justification of the adopted standards.

2. National Energy Savings

The NES analysis involves a comparison of national energy consumption of the considered equipment between each potential standards case (*i.e.*, TSL) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (*i.e.*, 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.[121] 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 product due to the increase in

[120] The higher rate scenario represents a situation where the shipments-weighted average efficiency of low torque AO-ESEMs (which are more likely to be used in covered HVACR equipment) would match the shipments weighted-average efficiency of AO-ESEMs at TSL1 in 2029.
[121] As previously described, the use of the no-new standards case efficiency distribution ensures that DOE avoids double counting any energy savings that may already be captured in existing product or equipment level regulations.

efficiency. In the March 2022 Preliminary Analysis, DOE requested comment and data regarding the potential increase in utilization of electric motors due to any increase in efficiency. DOE did not find any data on the rebound effect specific to electric motors[122] and did not receive any comments supporting the inclusion of a rebound effect for ESEMs and AO-ESEMs. Therefore, in the December 2023 NOPR, DOE did not apply a rebound effect for ESEMs and AO-ESEMs. In response to the December 2023 NOPR, DOE did not receive any comments related to the rebound effect, and DOE retained the same approach in this final rule.

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 NIAs and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (August 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System ("NEMS") is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[123] that EIA uses to prepare its *Annual Energy Outlook*. The FFC factors incorporate losses in production and delivery in the case of natural gas

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[122] *See, e.g.,* 86 FR 36111 for further discussion regarding DOE's explanation and findings regarding the rebound effect for electric motors, broadly.
[123] For more information on NEMS, refer to *The National Energy Modeling System: An Overview*, DOE/EIA-0581(2009), October 2009, available at *www.eia.gov/analysis/pdfpages/0581(2009)index.php* (last accessed March 29, 2024).

(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 final rule TSD.

3. Net Present Value Analysis

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

As discussed in section IV.F.1 of this document, DOE developed constant ESEM price trends based on historical PPI data. DOE applied the same trends to project prices for each equipment class at each considered efficiency level. DOE's projection of equipment prices is described further in chapter 8 of the final rule TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different equipment price projections on the consumer NPV for the considered TSLs for ESEMs. In addition to the default price trend, DOE considered two product price sensitivity cases: an increasing price trend case and a declining price trend case, based on historical PPI data. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10B of the final rule TSD.

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average energy price changes in the Reference case from *AEO2023* for the industrial, commercial, and residential sectors, which has an end year of 2050. To estimate price trends after 2050, the 2050 prices were held constant 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 and shipments compared to the Reference case. NIA results based on these cases are available in the NIA spreadsheet model.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this final rule, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget ("OMB") to Federal agencies on the development of regulatory analysis.[124] The discount rates for the determination of NPV are in contrast to the

[124] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. Available at *www.whitehouse.gov/omb/information-for-agencies/circulars* (last accessed March 26, 2024). DOE used the prior version of Circular A-4 (September 17, 2003) in accordance with the effective date of the November 9, 2023 version.

discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "social rate of time preference," which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this final rule, DOE analyzed the impacts of the considered standard levels on low-income households (for representative units with consumers in the residential sector),[125] senior-only households (for representative units with consumers in the residential sector), and small businesses. The analysis is based on subsets of the 2020 RECS sample composed of households that meet the criteria for the low-income and senior-only household subgroups. For the small-businesses subgroup, DOE used the same sample of consumers but with subgroup-specific inputs. DOE determined the impact on the ESEM subgroups using the same LCC model, which is used for all

[125] All representative units except for the ESEM polyphase and AO-ESEM polyphase, 0.5 hp are also used in the residential sector.

consumers, but with subgroup-specific inputs as applicable. Chapter 11 in the final rule TSD describes the consumer subgroup analysis.

NEMA commented that it supports analysis of low-income communities, which can lack resources to purchase new products. (NEMA, No. 68 at p. 5)

As described previously, DOE continued to consider low-income consumers as a subgroup.

Lennox commented that the consumer group analysis for HVACR products is not appropriate. Lennox stated that, as indicated by the Motor Coalition agreement, 90 percent of AO motors are used in covered product applications, and these motors are not selected by the consumer but rather are carefully selected by OEMs who integrate motors into end products. Lennox added that the type or efficiency of the motor used in these products has little to no relationship to the end-consumer purchase decision of HVAC. (Lennox, No. 69 at p. 13)

ABB commented that DOE should expand data collection to include OEMs, service providers, and consumers impacted by regulations. (ABB, No. 65 at p. 4)

The purpose of the consumer subgroup analysis is to evaluate the impact on identifiable subgroups of consumers (or end-users) that may be disproportionately affected by a new or amended national standard. DOE does not consider OEMs and service providers as end-users. As noted by Lennox, consumers of ESEMs in HVACR applications represent the majority of AO-ESEM consumers and, therefore, would not be disproportionately affected.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of new energy conservation standards on manufacturers of ESEMs 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 Government Regulatory Impact Model ("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 to domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of 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 manufacturer markup scenarios.

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

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the ESEM manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly available information. This included a top-down analysis of ESEM 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 ESEM manufacturing industry, including company filings of form 10-K from the SEC,[126] corporate annual reports, the U.S. Census Bureau's "Economic Census,"[127] and reports from D&B Hoovers.[128]

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 standards. These factors include annual expected revenues, costs of sales, SG&A and R&D expenses, taxes, and capital expenditures. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) 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 ESEMs in order to develop other key GRIM inputs, including product and capital 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

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[126] *See www.sec.gov/edgar*.
[127] *See www.census.gov/programs-surveys/asm/data/tables.html*.
[128] *See app.avention.com*.

GRIM and to identify key issues or concerns. As part of Phase 3, DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by new standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash flow analysis. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers, niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average. 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 final rule TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to new standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM examines 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 2058. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of ESEMs, DOE used a real discount rate of 9.1 percent, which was the real discount rate used in the MEMs final rule that was published on May 29, 2014. 79 FR 30934, 30938. DOE then asked for feedback on this value during manufacturer interviews conducted during the NOPR phase. Manufacturers agreed that this was still an appropriate value to use. Therefore, DOE used a real discount rate of 9.1 percent for the MIA in this final rule.

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 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, 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 of this document. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the final rule TSD.

a. Manufacturer Production Costs

Manufacturing more efficient 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.

DOE conducted the engineering analysis using a combination of physical teardowns and software modeling. DOE contracted a professional motor laboratory to disassemble various ESEMs and record what types of materials were present and how much of each material was present, recorded in a final bill of materials. To supplement the physical teardowns, software modeling by a subject matter expert was also used to generate a bill of materials for select efficiency levels of directly analyzed representative units.

For a complete description of the MPCs, *see* chapter 5 of the final rule 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 2058 (the end year of the analysis period). *See* chapter 9 of the final rule 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 expenditures that would be needed to comply with each considered efficiency level for each representative unit. 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.

DOE calculated the product and capital conversion costs using a bottom-up approach based on feedback from manufacturers during manufacturer interviews. During manufacturer interviews, DOE asked manufacturers questions regarding the estimated product and capital conversion costs needed to produce ESEMs within an equipment class at each specific efficiency level. DOE used the feedback provided by manufacturers to estimate the approximate amount of engineering time, testing costs, and capital equipment that would need to be purchased in order to redesign a single frame size for each efficiency level. Some of the types of capital conversion costs manufacturers identified were the purchase of lamination die sets, winding machines, frame casts, and assembly equipment, as well as other retooling costs. The two main types of product conversion costs manufacturers shared with DOE during interviews were the number of engineer hours necessary to re-engineer frames to meet higher efficiency standards and testing costs, including thermal protection testing, to comply with higher energy conservation standards.

DOE then took average values (*i.e.,* costs or number of hours) based on the range of responses given by manufacturers to calculate both the product and capital conversion cost necessary for a manufacturer to increase the efficiency of one frame size to a specific efficiency level. DOE multiplied the conversion costs associated with manufacturing a single frame size at each efficiency level by the number of frames each interviewed manufacturer produces. DOE finally scaled this number based on the market share of the manufacturers DOE interviewed to arrive at an industry-wide bottom-up product and capital conversion cost estimate for each representative unit at each efficiency level.

DOE revised the March 2022 Preliminary Analysis to account for space-constrained and non-space-constrained motor designs, which will continue to provide repair options to consumers. As stated in the December 2022 Joint Recommendation, motor manufacturers believe that efficiency levels higher than EL 2 could result in significant increases in the physical size of certain motors. (Motor Coalition, No. 38 at p. 4) As part of the engineering analysis, DOE models representative units that are able to meet the efficiency requirements of EL 2 and below and that would not result in a significant increase in the physical size of the ESEMs. For efficiency levels higher than EL 2 (*i.e.*, EL 3 and EL 4), DOE recognizes that ESEMs may significantly increase in physical size in order to meet those higher efficiency requirements. DOE also recognizes that this may result in a significant disruption to the OEM markets that use ESEMs as an embedded product. In addition, as discussed in section IV.C.3 of this document, DOE accounted for the impacts of any potential changes in speeds at higher efficiency levels.

For this final rule analysis, DOE used the same methodology used in the December 2023 NOPR to estimate the industry conversion costs at each efficiency level for each representative unit. However, DOE updated all costs from 2022 dollars, which were used in the December 2023 NOPR, to 2023 dollars, as used in this final rule analysis. For labor costs, DOE used data from BLS to update the conversion costs estimated in the December 2023 NOPR to the conversion costs estimated in this final rule.[129] For equipment and testing costs, DOE used PPI data specific to the motor and generating manufacturing industry to update the conversion costs estimated in the December 2023 NOPR to the conversion costs estimated in this final rule.[130]

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 new standards. The conversion cost figures used in the GRIM can be found in section V.B.2 of this document. For additional information on the estimated capital and product conversion costs, *see* chapter 12 of the final rule TSD.

d. Manufacturer Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.*, labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.*, SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied non-production cost markups to the MPCs estimated in the engineering analysis for each representative unit and efficiency level. Modifying these manufacturer markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case manufacturer 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 preservation of gross

[129] For this final rule analysis, DOE used data from "Occupational Employment and Wage Statistics," May 2023 (*see www.bls.gov/oes/current/oes172071.htm*), and data from "Employer Costs for Employee Compensation," December 2023 (*see www.bls.gov/news.release/archives/ecec_03132024.pdf.*)
[130] For this final rule analysis, DOE used PPI data specific for NAICS code 335312, series ID PCU335312335312. *See www.bls.gov/ppi/databases/*.

margin scenario, and (2) a preservation of operating profit 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 preservation of gross margin scenario, DOE applied a single uniform "gross margin percentage" across all efficiency levels, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within a representative unit. DOE estimated a manufacturer markup of 1.37 for all ESEMs covered by this rulemaking in the no-new-standards case, which was the manufacturer markup used in the December 2023 NOPR. DOE used this same manufacturer markup of 1.37 for all representative units and efficiency levels at each TSL in the preservation of gross margin scenario in the standards cases. This manufacturer markup scenario represents the upper bound of manufacturer INPV and is the manufacturer markup scenario used to calculate the economic impacts on consumers.

Under the preservation of operating profit scenario, DOE modeled a situation in which manufacturers are not able to increase per-unit operating profit in proportion to increases in manufacturer production costs. Under this scenario, as MPCs increase, manufacturers reduce their manufacturer margins to maintain a cost-competitive offering in the market. However, in this scenario, manufacturers maintain their total operating profit in absolute dollars in the standards case, despite higher MPCs and investment. Therefore, gross margin (as a percentage) shrinks in the standards cases for this manufacturer markup scenario. 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 markup scenarios is presented in section V.B.2.a of this document.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of CO_2, NO_X, SO_2, and Hg. The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, CH_4 and N_2O, as well as the reductions in emissions of other gases due to "upstream" activities in the fuel production chain. These upstream activities comprise the extraction, processing, and transporting of fuels to the site of combustion.

The analysis of electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO*, including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the final rule TSD. The analysis presented in this 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").[131]

[131] Available at *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed July 12, 2021).

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

The emissions intensity factors are expressed in terms of physical units per MWh or MMBtu of site energy savings. For power sector emissions, specific emissions intensity factors are calculated by sector and end use. Total emissions reductions are estimated using the energy savings calculated in the NIA.

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* reflects, to the extent possible, laws and regulations adopted through mid-November 2022, including the emissions control programs discussed in the following paragraphs, and the Inflation Reduction Act.[132]

SO_2 emissions from affected electric generating units ("EGUs") are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia ("D.C."). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-

[132] 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 April 24, 2024).

State Air Pollution Rule ("CSAPR"). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[133] The *AEO* incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016). Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, for States subject to SO_2 emissions limits under CSAPR, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by another regulated EGU.

However, beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards ("MATS") for power plants.[134] 77 FR 9304 (Feb. 16, 2012). The final rule establishes power plant emission standards for mercury, acid gases, and non-mercury metallic toxic pollutants. 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

[133] 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), and EPA issued the CSAPR Update for the 2008 ozone NAAQS. 81 FR 74504 (Oct. 26, 2016).

[134] 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.

decrease electricity generation will generally reduce SO_2 emissions. DOE estimated SO_2 emissions reductions using emissions factors based on *AEO2023*.

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, NO_X emissions would remain near the limit even if electricity generation goes down. Depending on the configuration of the power sector in the different regions and the need for allowances, however, NO_X emissions might not remain at the limit in the case of lower electricity demand. That would mean 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. 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 final 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 final rule.

1. Monetization of Greenhouse Gas Emissions

To monetize the climate benefits of reducing GHG emissions, the December 2023 NOPR used the interim social cost of greenhouse gases ("SC-GHG") 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 SC-GHG ("IWG") ("2021 Interim SC-GHG estimates"). As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, DOE agreed that the 2021 Interim SC-GHG estimates represented the most appropriate estimate of the SC-GHG until revised estimates were developed reflecting the latest, peer-reviewed science. See 87 FR 78382, (Dec. 21, 2022) 78406-78408 for discussion of the development and details of the 2021 Interim SC-GHG estimates. The IWG has continued working on updating the interim estimates but has not published final estimates.

Accordingly, in the regulatory analysis of its December 2023 Final Rule, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review," the EPA estimated climate benefits using a new, updated set of SC-GHG estimates ("2023 SC-GHG estimates"). EPA documented the methodology underlying the new estimates in the RIA for the December 2023 Final Rule and in greater detail in a technical report entitled "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances" that was presented as Supplementary Material to the RIA. [135] The 2023 SC-GHG estimates address the recommendations of the National Academies of Science, Engineering, and Medicine (National Academies) by incorporating recent research and responses to public comments. The public comments include those on an earlier sensitivity analysis contained in EPA's December 2022 proposal in the oil and natural gas sector standards of performance rulemaking along with comments on a 2023 external peer review of the accompanying technical report. [136]

On December 22, 2023, the IWG issued a memorandum directing that when agencies "consider applying the SC-GHG in various contexts… agencies should use their professional judgment to determine which estimates of the SC-GHG reflect the best available evidence, are most appropriate for particular analytical contexts, and best

[135] www.epa.gov/system/files/documents/2023-12/eo12866_oil-and-gas-nsps-eg-climate-review-2060-av16-final-rule-20231130.pdf; https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf (last accessed July 3, 2024)
www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf (last accessed July 3, 2024)

facilitate sound decision-making" consistent with OMB Circular A-4 and applicable law.[137]

DOE has been extensively involved in the IWG process and related work on the SC-GHGs for over a decade. This involvement includes DOE's role as the federal technical monitor for the seminal 2017 report on the SC-GHG issued by the National Academies, which provided extensive recommendations on how to strengthen and update the SC-GHG estimates.[138] DOE has also participated in the IWG's work since 2021. DOE technical experts involved in this work reviewed the 2023 SC-GHG methodology and report in light of the National Academies' recommendations and DOE's understanding of the state of the science.

Based on this review, DOE has preliminarily determined that the updated 2023 SC-GHG estimates, including the approach to discounting, represent a significant improvement in estimating the SC-GHG through incorporating the most recent advancements in the scientific literature and by addressing recommendations on prior methodologies. DOE explained the basis for its preliminary determination and made it available for public comment in a July NODA for consumer gas-fired instantaneous water heaters. 89 FR 59693, 59700. In this final rule, DOE has not made a final decision regarding that preliminary assessment or adoption of the updated 2023 SC-GHG estimates, as such a decision is not necessary for purposes of this rule. DOE will continue to decide, for each particular analytical context, whether to rely on, present for

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www.whitehouse.gov/wp-content/uploads/2023/12/IWG-Memo-12.22.23.pdf (last accessed July 3, 2024)

[138] Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide | The National Academies Press. (available at: https://nap.nationalacademies.org/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of) (last accessed July 3, 2024)

presentation purposes, or use in some other way, the updated 2023 SC-GHG values, the 2021 interim SC-GHG estimates, or both. In this final rule, DOE is presenting estimates using both the updated 2023 SC-GHG values and the 2021 interim SC-GHG estimates, as DOE believes it is appropriate to give the public more complete information regarding the benefits of this rule. DOE notes, however, that the adopted standards would be economically justified using either set of SC-GHG values, and even without inclusion of the estimated monetized benefits of reduced GHG emissions. In future rulemakings, DOE will continue to evaluate the applicability in context and use our professional judgment to apply the SC-GHG estimates that are most appropriate to use at that time.

The 2023 EPA technical report presents SC-GHG values for emissions years through 2080; therefore, DOE did not monetize the climate benefits of GHG emissions reductions occurring after 2080 when using the 2023 estimates for the SC-GHG. DOE expects additional climate impacts to accrue from GHG emissions changes post 2080, but due to a lack of readily available SC-GHG estimates for emissions years beyond 2080 and the relatively small emission effects expected from those years, DOE has not monetized these additional impacts in this analysis. Similarly, the 2021 Interim SC-GHG estimates include values through 2070. DOE expects additional climate benefits to accrue for products still operating after 2070, but a lack of available SC-GHG estimates published by the IWG for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

The overall climate benefits are generally greater when using the higher, updated 2023 SC-GHG estimates, compared to the climate benefits calculated using the older

2021 interim SC-GHG estimates, which were used in the December 2023 NOPR. The net benefits of the rule are positive, however, under either SC-GHG calculation methodology; in fact, the net benefits of the rule are positive without including any monetized climate benefits at all. The adopted standards would be economically justified even without inclusion of the estimated monetized benefits of reduced GHG emissions using either methodology, therefore the conclusions of the analysis (as presented in section V.C) are not dependent on which set of estimates of the SC-GHG are used in the analysis or on the use of any SC-GHG at all. The adopted standard level would remain the same under either SC-GHG calculation methodology (or without using the SC-GHG at all).

DOE's derivations of the SC-CO_2, SC-N_2O, and SC-CH_4 values used for this final rule are discussed in the following sections, and the results of DOE's analyses estimating the benefits of the reductions in emissions of these GHGs are presented in section V.B.6 of this document.

a. Social Cost of Carbon

The SC-CO_2 values used for this final rule are presented using two sets of SC-GHG estimates. One set is the 2023 SC-GHG estimates published by the EPA, which are shown in Table IV-8 in 5-year increments from 2020 to 2050.[139] The set of annual values that DOE used is presented in appendix 14A of the final rule TSD. These estimates include values out to 2080. DOE expects additional climate benefits to accrue

[139] www.epa.gov/system/files/documents/2023-12/eo12866_oil-and-gas-nsps-eg-climate-review-2060-av16-final-rule-20231130.pdf; www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf (last accessed July 3, 2024)

for products still operating after 2080, but a lack of available SC-CO_2 estimates for emissions years beyond 2080 prevents DOE from monetizing these potential benefits in this analysis.

Table IV-8. Annual SC-CO_2 Values Based on 2023 SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton CO_2)

Emissions Year	Near-term Ramsey Discount Rate		
	2.5%	**2.0%**	**1.5%**
2020	117	193	337
2025	130	212	360
2030	144	230	384
2035	158	248	408
2040	173	267	431
2045	189	287	456
2050	205	308	482

DOE also presents results using interim SC-CO_2 values based on the values developed for the February 2021 Interim SC-GHG estimates, which are shown in Table IV-9 in 5-year increments from 2020 to 2050. The set of annual values that DOE used, which was adapted from estimates published by EPA in 2021,[140] is presented in appendix 14A of the final rule TSD. These estimates are based on methods, assumptions, and parameters identical to the estimates published by the IWG (which were based on EPA modeling), and include values for 2051 to 2070. DOE expects additional climate benefits to accrue for products still operating after 2070, but a lack of available SC-CO_2 estimates

[140] *See* EPA, Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis, Washington, D.C., December 2021. Available at *nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf* (last accessed Sep. 4, 2024).

based on the IWG methodology for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in its primary analysis.

Table IV-9. Annual SC-CO_2 Values Based on 2021 Interim SC-GHG Estimates, 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

DOE multiplied the CO_2 emissions reduction estimated for each year by the SC-CO_2 value for that year in all cases. DOE adjusted the values to 2023$ 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 all 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 final rule are presented using two sets of SC-GHG estimates. One set is the 2023 SC-GHG estimates published by the EPA. Table IV-10 shows the updated sets of SC-CH_4 and SC-N_2O estimates in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the final rule TSD. These estimates include values out to 2080.

Table IV-10. Annual SC-CH_4 and SC-N_2O Values Based on 2023 SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton)

Emissions Year	SC-CH_4			SC-N_2O		
	Near-term Ramsey Discount Rate			Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%
2020	1,257	1,648	2,305	35,232	54,139	87,284
2025	1,590	2,025	2,737	39,972	60,267	95,210
2030	1,924	2,403	3,169	44,712	66,395	103,137
2035	2,313	2,842	3,673	49,617	72,644	111,085
2040	2,702	3,280	4,177	54,521	78,894	119,032
2045	3,124	3,756	4,718	60,078	85,945	127,916
2050	3,547	4,231	5,260	65,635	92,996	136,799

DOE also presents results using interim SC-CH_4 and SC-N_2O values based on the values developed for the February 2021 SC-GHG TSD. Table IV-11 shows the updated sets of SC-CH_4 and SC-N_2O estimates from the latest interagency update in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the final rule TSD. These estimates include values out to 2070

Table IV-11. Annual SC-CH_4 and SC-N_2O Values Based on 2021 Interim SC-GHG Estimates, 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	1,500	2,000	3,900	5,800	18,000	27,000	48,000
2025	800	1,700	2,200	4,500	6,800	21,000	30,000	54,000
2030	940	2,000	2,500	5,200	7,800	23,000	33,000	60,000
2035	1,100	2,200	2,800	6,000	9,000	25,000	36,000	67,000
2040	1,300	2,500	3,100	6,700	10,000	28,000	39,000	74,000
2045	1,500	2,800	3,500	7,500	12,000	30,000	42,000	81,000
2050	1,700	3,100	3,800	8,200	13,000	33,000	45,000	88,000

DOE multiplied the CH_4 and N_2O emissions reduction estimated for each year by the SC-CH_4 and SC-N_2O estimates for that year in each of the cases. DOE adjusted the values to 2023$ using the implicit price deflator for 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 final rule, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using benefit-per-ton estimates for that sector from EPA's Benefits Mapping and Analysis Program.[141] Table 5 of the EPA TSD provides a summary of the health impact endpoints quantified in the analysis. DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025, 2030, 2035, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 period; for years beyond 2040, the values are held constant (rather than extrapolated) to be conservative. DOE combined the EPA regional benefit-per-ton estimates with regional information on electricity consumption and emissions from *AEO2023* to define weighted-average national values for NO_X and SO_2 (*see* appendix 14B of the final rule TSD).

[141] U.S. Environmental Protection Agency. Estimating the Benefit per Ton of Reducing Directly Emitted $PM_{2.5}$, $PM_{2.5}$ Precursors and Ozone Precursors from 21 Sectors. Available at *www.epa.gov/benmap/estimating-benefit-ton-reducing-directly-emitted-pm25-pm25-precursors-and-ozone-precursors.*(last accessed August 29, 2024)

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 final rule TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity, and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of potential new or amended energy conservation standards.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts from new or amended energy conservation standards include both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the products subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by: (1) reduced spending by consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the products to which the new standards apply and other goods and services, and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's 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.[142] Bureau of

[142] *See* U.S. Bureau of Labor Statistics. Industry Output and Employment. Available at https://www.bls.gov/emp/data/industry-out-and-emp.htm (last accessed August 19, 2024).

Economic Analysis input-output multipliers also show a lower labor intensity per million dollars of activity for utilities as compared to other industries.[143] There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (*i.e.*, the utility sector) to more labor-intensive sectors (*e.g.*, the retail and service sectors). Thus, these data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this final rule using an input/output model of the U.S. economy called "Impact of Sector Energy Technologies, version 4" ("ImSET").[144] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" ("I-O") model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I-O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

[143] *See* U.S. Department of Commerce–Bureau of Economic Analysis. *Regional Input-Output Modeling System (RIMS II) User's Guide*. Available at: *bea.gov/resources/methodologies/RIMSII-user-guide* (last accessed August 19, 2024).
[144] Livingston, O. V., *et al*. 2015. *ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide*. Pacific Northwest National Laboratory. PNNL-24563.

DOE notes that ImSET is not a general equilibrium forecasting model, and that the uncertainties involved in projecting employment impacts change 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 final rule TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for ESEMs. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for ESEMs, and the standards levels that DOE is adopting in this final rule. Additional details regarding DOE's analyses are contained in the final rule TSD supporting this document.

A. Trial Standard Levels

In general, DOE evaluates potential new 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 price elasticity of consumer purchasing decisions that may change when different standard levels are set.

In the analysis conducted for this final rule, DOE analyzed the benefits and burdens of four TSLs for ESEMs. DOE developed TSLs that combine efficiency levels for each analyzed equipment class. DOE presents the results for the TSLs in this document, while the results for each efficiency level that DOE analyzed are in the NOPR TSD.[145]

Table V-1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential new energy conservation standards for ESEMs. TSL 4 represents the maximum technologically feasible ("max-tech") energy efficiency for all equipment classes. TSL 3 is equivalent to EL 3 for all equipment classes. TSL 2 is equivalent to EL 2 for all equipment classes and corresponds to the Motor Coalition-recommended levels. TSL 1 is equivalent to EL 1 for all equipment classes.

[145] Results by efficiency level are presented in TSD chapters 8, 10, and 12.

Table V-1 Trial Standard Levels for ESEMs

Equipment Class Group	Horsepower Range	TSL 1	TSL 2	TSL 3	TSL 4
		Average of EL 0 and EL 2	Motor Coalition-Recommended Levels	Average of EL 2 and EL 4	Max-tech
ESEM High/Med Torque	0.25 ≤ hp ≤ 0.50	EL 1	EL 2	EL 3	EL 4
	0.5 < hp ≤ 3	EL 1	EL 2	EL 3	EL 4
ESEM Low-torque	0.25 hp	EL 1	EL 2	EL 3	EL 4
	0.25 < hp	EL 1	EL 2	EL 3	EL 4
ESEM Polyphase	0.25 ≤ hp	EL 1	EL 2	EL 3	EL 4
AO-ESEM High/Med Torque	0.25 ≤ hp ≤ 0.50	EL 1	EL 2	EL 3	EL 4
	0.5 < hp ≤ 3	EL 1	EL 2	EL 3	EL 4
AO-ESEM Low-torque	0.25 hp	EL 1	EL 2	EL 3	EL 4
	0.25 < hp	EL 1	EL 2	EL 3	EL 4
AO-ESEM Polyphase	0.25 ≤ hp	EL 1	EL 2	EL 3	EL 4

DOE constructed the TSLs for this final rule to include efficiency levels representative of ELs with similar characteristics (*i.e.*, using similar efficiencies). Specifically, DOE aligned the efficiency levels for AO and non-AO-ESEMs because of the similarities in the manufacturing processes between AO and non-AO-ESEMs. In some cases, an AO-ESEM could be manufactured on the same line as a non-AO-ESEM by omitting the manufacturing steps associated with the fan of a motor. DOE notes this alignment is in line with the Motor Coalition's recommendation in the December 2022 Joint Recommendation.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on ESEM consumers by looking at the effects that potential standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on selected consumer subgroups. These analyses are discussed in the following sections.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) purchase price increases, and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.*, product price plus installation costs), and operating costs (*i.e.*, annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the final rule TSD provides detailed information on the LCC and PBP analyses.

Table V-2 through Table V-21 show the LCC and PBP results for the TSLs considered for each product class. In the first of each pair of tables, the simple payback is measured relative to the baseline equipment. In the second table, the impacts are measured relative to the efficiency distribution in the no-new-standards case in the compliance year (*see* section of this document). Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline equipment 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.

Table V-2 Average LCC and PBP Results for ESEMs—High/Med Torque, 0.25 hp

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	195.5	98.9	563.4	758.9	-	7.9
1	1	201.4	86.6	493.6	695.0	0.5	7.9
2	2	221.1	76.7	437.5	658.6	1.2	7.9
3	3	310.3	68.3	389.7	700.0	3.8	7.9
4	4	455.4	61.9	353.6	809.0	7.0	7.9

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-3 Average LCC Savings Relative to the No-New-Standards Case for ESEMs—High/Med Torque, 0.25 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* *2023$*
1	1	1.8%	63.5
2	2	15.4%	59.3
3	3	49.3%	6.3
4	4	83.8%	-103.8

* The savings represent the average LCC for affected consumers.

Table V-4 Average LCC and PBP Results for ESEMs—High/Med Torque, 1 hp

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	351.6	266.9	1,430.2	1,781.8	-	7.6
1	1	368.3	239.5	1,283.3	1,651.6	0.6	7.6
2	2	395.6	215.4	1,153.9	1,549.5	0.9	7.6
3	3	533.9	207.2	1,109.8	1,643.7	3.1	7.6
4	4	732.8	200.2	1,072.3	1,805.1	5.7	7.6

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-5 Average LCC Savings Relative to the No-New-Standards Case for ESEMs—High/Med Torque, 1 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* *2023$*
1	1	3.2%	133.1
2	2	10.5%	159.9
3	3	48.7%	45.1
4	4	77.6%	-117.0

* The savings represent the average LCC for affected consumers.

Table V-6 Average LCC and PBP Results for ESEMs—Low-torque, 0.25 hp

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	160.1	178.4	1,143.7	1,303.8	-	10.6
1	1	182.9	133.2	856.6	1,039.5	0.5	10.6
2	2	223.8	106.1	685.0	908.8	0.9	10.6
3	3	290.4	95.2	615.6	906.1	1.6	10.6
4	4	384.7	86.0	556.8	941.5	2.4	10.6

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-7 Average LCC Savings Relative to the No-New-Standards Case for ESEMs—Low-torque, 0.25 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* *2023$*
1	1	0.1%	261.6
2	2	1.9%	186.4
3	3	43.9%	40.9
4	4	61.1%	5.5

* The savings represent the average LCC for affected consumers.

Table V-8 Average LCC and PBP Results for ESEMs—Low-torque, 0.5 hp

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	233.9	212.8	1,276.1	1,509.9	-	9.6
1	1	281.7	195.4	1,172.7	1,454.4	2.8	9.6
2	2	289.9	179.4	1,077.3	1,367.2	1.7	9.6
3	3	390.2	158.6	954.3	1,344.5	2.9	9.6
4	4	477.6	141.4	852.3	1,329.8	3.4	9.6

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-9 Average LCC Savings Relative to the No-New-Standards Case for ESEMs—Low-torque, 0.5 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* *2023$*
1	1	8.3%	56.0
2	2	5.5%	124.4
3	3	24.3%	110.8
4	4	32.5%	114.8

* The savings represent the average LCC for affected consumers.

Table V-10 Average LCC and PBP Results for ESEMs—Polyphase Torque, 0.25 hp

TSL	Efficiency Level	Average Costs <u>2023$</u>				Simple Payback <u>*years*</u>	Average Lifetime <u>*years*</u>
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	209.2	77.1	490.3	699.5	-	9.3
1	1	216.5	70.3	447.0	663.5	1.1	9.3
2	2	232.7	64.6	410.8	643.5	1.9	9.3
3	3	290.4	58.1	369.3	659.7	4.3	9.3
4	4	425.0	53.1	337.5	762.5	9.0	9.3

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-11 Average LCC Savings Relative to the No-New-Standards Case for ESEMs—Polyphase, 0.25 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* <u>*2023$*</u>
1	1	1.0%	36.8
2	2	6.8%	31.3
3	3	55.2%	-4.2
4	4	93.6%	-106.4

* The savings represent the average LCC for affected consumers.

Table V-12 Average LCC and PBP Results for AO-ESEMs—High/Med Torque, 0.25 hp

TSL	Efficiency Level	Average Costs <u>2023$</u>				Simple Payback <u>*years*</u>	Average Lifetime <u>*years*</u>
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	182.6	129.7	831.0	1,013.6	-	10.6
1	1	189.0	113.8	729.9	919.0	0.4	10.6
2	2	209.9	100.7	647.1	856.9	0.9	10.6
3	3	296.3	89.8	577.7	874.0	2.9	10.6
4	4	439.9	82.0	528.3	968.2	5.4	10.6

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-13 Average LCC Savings Relative to the No-New-Standards Case for AO-ESEMs—High/Med Torque, 0.25 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* <u>*2023$*</u>
1	1	0.7%	93.5
2	2	5.1%	103.7
3	3	30.1%	60.6
4	4	60.0%	-38.8

* The savings represent the average LCC for affected consumers.

Table V-14 Average LCC and PBP Results for AO-ESEMs—High/Med Torque, 1 hp

TSL	Efficiency Level	Average Costs <u>*2023$*</u>				Simple Payback <u>*years*</u>	Average Lifetime <u>*years*</u>
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	338.1	330.6	1,704.5	2,042.6	-	7.7
1	1	355.2	299.4	1,543.8	1,898.9	0.6	7.7
2	2	382.5	269.7	1,391.0	1,773.5	0.7	7.7
3	3	519.8	259.5	1,338.9	1,858.7	2.6	7.7
4	4	715.8	251.7	1,298.7	2,014.5	4.8	7.7

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-15 Average LCC Savings Relative to the No-New-Standards Case for AO-ESEMs—High/Med Torque, 1 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* <u>*2023$*</u>
1	1	1.6%	143.0
2	2	5.0%	189.6
3	3	39.3%	67.3
4	4	76.1%	-96.4

* The savings represent the average LCC for affected consumers.

Table V-16 Average LCC and PBP Results for AO-ESEMs—Low-torque, 0.25 hp

TSL	Efficiency Level	Average Costs <u>*2023$*</u>				Simple Payback <u>*years*</u>	Average Lifetime <u>*years*</u>
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	147.9	179.3	1,147.3	1,295.1	-	10.4
1	1	171.2	133.8	859.0	1,030.1	0.5	10.4
2	2	211.6	106.5	686.6	898.2	0.9	10.4
3	3	276.6	95.5	617.0	893.6	1.5	10.4
4	4	369.8	86.2	558.0	927.7	2.4	10.4

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-17 Average LCC Savings Relative to the No-New-Standards Case for AO-ESEMs—Low-torque, 0.25 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* <u>*2023$*</u>
1	1	0.1%	266.5
2	2	2.5%	170.3
3	3	32.7%	56.5
4	4	60.7%	12.7

* The savings represent the average LCC for affected consumers.

Table V-18 Average LCC and PBP Results for AO-ESEMs—Low-torque, 0.5 hp

TSL	Efficiency Level	Average Costs <u>*2023$*</u>				Simple Payback <u>*years*</u>	Average Lifetime <u>*years*</u>
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	222.9	215.0	1,372.5	1,595.3	-	10.4
1	1	269.8	197.5	1,261.9	1,531.7	2.7	10.4
2	2	278.5	181.4	1,160.1	1,438.6	1.7	10.4
3	3	375.7	160.6	1,028.8	1,404.5	2.8	10.4
4	4	463.1	143.3	919.9	1,382.9	3.4	10.4

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-19 Average LCC Savings Relative to the No-New-Standards Case for AO-ESEMs—Low-torque, 0.5 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* *2023$*
1	1	1.6%	62.9
2	2	1.7%	109.6
3	3	26.7%	76.0
4	4	33.6%	90.6

* The savings represent the average LCC for affected consumers.

Table V-20 Average LCC and PBP Results for AO-ESEMs—Polyphase, 0.25 hp

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	198.6	92.1	554.7	753.2	-	8.9
1	1	206.3	84.1	506.6	712.9	1.0	8.9
2	2	222.8	77.5	466.7	689.4	1.7	8.9
3	3	280.0	69.7	419.5	699.5	3.6	8.9
4	4	413.3	64.1	386.1	799.3	7.7	8.9

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

Table V-21 Average LCC Savings Relative to the No-New-Standards Case for AO-ESEMs—Polyphase, 0.25 hp

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Percentage of Consumers that Experience Net Cost	Average LCC Savings* *2023$*
1	1	2.4%	40.6
2	2	8.9%	47.2
3	3	44.8%	20.3
4	4	84.7%	-80.1

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households (for representative units with consumers in the residential sector),[146] senior-only households (for representative units with consumers in the residential sector), and small businesses. Table V-22to Table V-24 compare the average LCC savings and PBP at each efficiency level for the consumer subgroups with similar metrics for the entire consumer sample for all equipment classes. In most cases, the average LCC savings and PBP for low-income households, senior-only households, and small businesses at the considered efficiency levels are not substantially different from the average for all. Chapter 11 of the final rule TSD presents the complete LCC and PBP results for the subgroups.

Table V-22 Comparison of LCC Savings and PBP for Low-Income Household Subgroup and All Consumers

TSL	Average LCC Savings* 2023$		Simple Payback Years		Consumers with Net Benefit		Consumers with Net Cost	
	Low-Income	All	Low-Income	All	Low-Income	All	Low-Income	All
	ESEM—High/Med Torque, 0.25 hp							
1	64.0	63.5	0.4	0.5	22.5%	22.7%	1.6%	1.8%
2	61.1	59.3	1.1	1.2	53.2%	52.3%	13.2%	15.4%
3	14.4	6.3	3.5	3.8	37.9%	34.4%	44.2%	49.3%
4	-86.0	-103.8	6.5	7.0	21.7%	15.7%	75.9%	83.8%
	ESEM—High/Med Torque, 1 hp							
1	133.2	133.1	0.6	0.6	34.2%	34.2%	3.1%	3.2%
2	160.4	159.9	0.8	0.9	75.5%	75.4%	9.9%	10.5%
3	48.5	45.1	3.0	3.1	50.7%	49.7%	47.2%	48.7%
4	-109.7	-117.0	5.6	5.7	23.7%	22.3%	75.7%	77.6%
	ESEM—Low-torque, 0.25 hp							
1	260.2	261.6	0.5	0.5	3.9%	4.0%	0.1%	0.1%
2	188.3	186.4	0.8	0.9	18.3%	18.5%	1.8%	1.9%
3	45.7	40.9	1.5	1.6	57.4%	56.1%	40.9%	43.9%

[146] All representative units except for the ESEM polyphase and AO-ESEM polyphase, 0.5 hp, are also used in the residential sector.

4	16.6	5.5	2.3	2.4	41.6%	38.9%	56.8%	61.1%
	ESEM—Low-torque, 0.5 hp							
1	58.3	56.0	2.6	2.8	34.2%	34.1%	7.8%	8.3%
2	126.1	124.4	1.6	1.7	58.1%	58.5%	5.1%	5.5%
3	116.9	110.8	2.7	2.9	66.5%	66.2%	22.9%	24.3%
4	124.5	114.8	3.2	3.4	67.9%	67.5%	30.8%	32.5%
	AO-ESEM—High/Med Torque, 0.25 hp							
1	93.7	93.5	0.4	0.4	25.6%	26.0%	0.7%	0.7%
2	105.1	103.7	0.9	0.9	53.5%	54.2%	4.6%	5.1%
3	67.4	60.6	2.6	2.9	49.6%	48.9%	27.9%	30.1%
4	-22.4	-38.8	5.0	5.4	29.6%	26.4%	55.1%	60.0%
	AO-ESEM—High/Med Torque, 1 hp							
1	143.0	143.0	0.5	0.6	30.9%	31.0%	1.5%	1.6%
2	189.6	189.6	0.7	0.7	66.2%	66.4%	4.9%	5.0%
3	68.9	67.3	2.5	2.6	49.2%	49.1%	38.9%	39.3%
4	-92.5	-96.4	4.7	4.8	24.4%	23.9%	75.2%	76.1%
	AO-ESEM—Low-torque, 0.25 hp							
1	268.2	266.5	0.5	0.5	3.3%	3.4%	0.1%	0.1%
2	172.7	170.3	0.8	0.9	22.4%	22.7%	2.3%	2.5%
3	61.4	56.5	1.4	1.5	50.9%	49.9%	30.5%	32.7%
4	23.1	12.7	2.2	2.4	42.1%	39.3%	56.3%	60.7%
	AO-ESEM—Low-torque, 0.5 hp							
1	66.2	62.9	2.5	2.7	7.6%	7.6%	1.4%	1.6%
2	110.9	109.6	1.5	1.7	32.8%	33.2%	1.6%	1.7%
3	82.4	76.0	2.6	2.8	64.4%	64.5%	25.1%	26.7%
4	101.8	90.6	3.1	3.4	66.6%	66.4%	31.6%	33.6%

Table V-23 Comparison of LCC Savings and PBP for Senior-Only Household Subgroup and All Consumers

TSL	**Average LCC Savings* 2023$**		**Simple Payback Years**		**Consumers with Net Benefit**		**Consumers with Net Cost**	
	Senior-Only	**All**	**Senior-Only**	**All**	**Senior-Only**	**All**	**Senior-Only**	**All**
	ESEM—High/Med Torque, 0.25 hp							
1	63.4	63.5	0.5	0.5	22.7%	22.7%	1.9%	1.8%
2	59.2	59.3	1.2	1.2	52.2%	52.3%	15.5%	15.4%
3	6.2	6.3	3.8	3.8	34.4%	34.4%	49.3%	49.3%
4	-104.0	-103.8	7.0	7.0	15.7%	15.7%	83.8%	83.8%
	ESEM—High/Med Torque 1 hp							
1	133.1	133.1	0.6	0.6	34.2%	34.2%	3.2%	3.2%
2	159.8	159.9	0.9	0.9	75.3%	75.4%	10.5%	10.5%
3	45.0	45.1	3.1	3.1	49.6%	49.7%	48.7%	48.7%
4	-117.1	-117.0	5.7	5.7	22.3%	22.3%	77.6%	77.6%
	ESEM—Low-torque, 0.25 hp							

1	260.6	261.6	0.5	0.5	4.0%	4.0%	0.1%	0.1%
2	185.7	186.4	0.9	0.9	18.5%	18.5%	2.0%	1.9%
3	40.5	40.9	1.6	1.6	55.8%	56.1%	44.2%	43.9%
4	5.0	5.5	2.4	2.4	38.8%	38.9%	61.2%	61.1%
	ESEM—Low-torque, 0.5 hp							
1	55.7	56.0	2.8	2.8	34.1%	34.1%	8.3%	8.3%
2	124.0	124.4	1.7	1.7	58.5%	58.5%	5.5%	5.5%
3	110.3	110.8	2.9	2.9	66.2%	66.2%	24.3%	24.3%
4	114.1	114.8	3.4	3.4	67.5%	67.5%	32.5%	32.5%
	AO-ESEM—High/Med Torque, 0.25 hp							
1	93.3	93.5	0.4	0.4	26.0%	26.0%	0.8%	0.7%
2	103.5	103.7	0.9	0.9	54.1%	54.2%	5.1%	5.1%
3	60.3	60.6	2.9	2.9	48.9%	48.9%	30.0%	30.1%
4	-39.1	-38.8	5.4	5.4	26.5%	26.4%	59.9%	60.0%
	AO-ESEM—High/Med Torque, 1 hp							
1	142.9	143.0	0.6	0.6	31.0%	31.0%	1.6%	1.6%
2	189.3	189.6	0.7	0.7	66.4%	66.4%	4.9%	5.0%
3	67.0	67.3	2.6	2.6	49.1%	49.1%	39.3%	39.3%
4	-96.7	-96.4	4.8	4.8	23.8%	23.9%	76.2%	76.1%
	AO-ESEM—Low-torque, 0.25 hp							
1	264.1	266.5	0.5	0.5	3.4%	3.4%	0.1%	0.1%
2	169.7	170.3	0.9	0.9	22.7%	22.7%	2.6%	2.5%
3	56.3	56.5	1.5	1.5	49.7%	49.9%	33.0%	32.7%
4	12.4	12.7	2.4	2.4	39.1%	39.3%	60.9%	60.7%
	AO-ESEM—Low-torque, 0.5 hp							
1	62.3	62.9	2.7	2.7	7.5%	7.6%	1.6%	1.6%
2	109.3	109.6	1.7	1.7	33.2%	33.2%	1.7%	1.7%
3	75.5	76.0	2.8	2.8	64.4%	64.5%	26.8%	26.7%
4	89.9	90.6	3.4	3.4	66.3%	66.4%	33.7%	33.6%

Table V-24 Comparison of LCC Savings and PBP for Small Business and All Consumers

TSL	Average LCC Savings* 2023$		Simple Payback Years		Consumers with Net Benefit		Consumers with Net Cost	
	Small Business	All	Small Business	All	Small Business	All	Small Business	All
	ESEM—High/Med Torque, 0.25 hp							
1	65.7	63.5	0.5	0.5	22.7%	22.7%	1.8%	1.8%
2	61.8	59.3	1.1	1.2	52.5%	52.3%	15.2%	15.4%
3	9.9	6.3	3.5	3.8	35.6%	34.4%	48.1%	49.3%
4	-99.6	-103.8	6.6	7.0	16.8%	15.7%	82.7%	83.8%
	ESEM—High/Med Torque, 1 hp							
1	136.0	133.1	0.6	0.6	34.2%	34.2%	3.2%	3.2%
2	163.5	159.9	0.8	0.9	75.3%	75.4%	10.6%	10.5%

3	49.1	45.1	2.8	3.1	49.7%	49.7%	48.7%	48.7%
4	-112.4	-117.0	5.3	5.7	23.0%	22.3%	76.9%	77.6%
	ESEM—Low-torque, 0.25 hp							
1	268.6	261.6	0.5	0.5	4.0%	4.0%	0.1%	0.1%
2	192.0	186.4	0.8	0.9	18.5%	18.5%	1.9%	1.9%
3	43.7	40.9	1.5	1.6	58.0%	56.1%	42.0%	43.9%
4	9.8	5.5	2.3	2.4	40.8%	38.9%	59.2%	61.1%
	ESEM—Low-torque, 0.5 hp							
1	58.4	56.0	2.6	2.8	34.0%	34.1%	8.4%	8.3%
2	128.3	124.4	1.6	1.7	58.5%	58.5%	5.5%	5.5%
3	116.5	110.8	2.7	2.9	66.4%	66.2%	24.1%	24.3%
4	122.3	114.8	3.2	3.4	67.9%	67.5%	32.1%	32.5%
	ESEM—Polyphase, 0.25 hp							
1	36.8	36.8	1.0	1.1	9.3%	9.3%	1.0%	1.0%
2	31.2	31.3	1.8	1.9	26.4%	26.6%	7.0%	6.8%
3	-4.3	-4.2	4.0	4.3	30.6%	31.2%	55.8%	55.2%
4	-106.6	-106.4	8.4	9.0	6.4%	5.9%	93.0%	93.6%
	AO-ESEM—High/Med Torque, 0.25 hp							
1	96.0	93.5	0.4	0.4	26.0%	26.0%	0.7%	0.7%
2	107.0	103.7	0.9	0.9	54.3%	54.2%	5.0%	5.1%
3	64.8	60.6	2.7	2.9	50.0%	48.9%	29.0%	30.1%
4	-33.7	-38.8	5.1	5.4	27.8%	26.4%	58.6%	60.0%
	AO-ESEM—High/Med Torque, 1 hp							
1	145.9	143.0	0.5	0.6	31.0%	31.0%	1.6%	1.6%
2	193.5	189.6	0.7	0.7	66.3%	66.4%	5.1%	5.0%
3	71.4	67.3	2.4	2.6	48.8%	49.1%	39.6%	39.3%
4	-92.0	-96.4	4.5	4.8	24.6%	23.9%	75.4%	76.1%
	AO-ESEM—Low-torque, 0.25 hp							
1	273.8	266.5	0.5	0.5	3.4%	3.4%	0.1%	0.1%
2	175.7	170.3	0.8	0.9	22.8%	22.7%	2.4%	2.5%
3	60.0	56.5	1.4	1.5	51.3%	49.9%	31.4%	32.7%
4	17.1	12.7	2.2	2.4	41.3%	39.3%	58.7%	60.7%
	AO-ESEM—Low-torque, 0.5 hp							
1	65.6	62.9	2.5	2.7	7.6%	7.6%	1.5%	1.6%
2	112.9	109.6	1.6	1.7	33.2%	33.2%	1.7%	1.7%
3	80.5	76.0	2.6	2.8	65.2%	64.5%	26.0%	26.7%
4	97.3	90.6	3.1	3.4	67.5%	66.4%	32.5%	33.6%
	AO-ESEM—Polyphase, 0.25 hp							
1	40.6	40.6	0.9	1.0	33.8%	33.9%	2.6%	2.4%
2	47.3	47.2	1.5	1.7	53.6%	54.0%	9.4%	8.9%
3	20.5	20.3	3.4	3.6	51.5%	52.6%	45.9%	44.8%
4	-79.9	-80.1	7.1	7.7	15.9%	15.3%	84.1%	84.7%

c. Rebuttable Presumption Payback

As discussed in section IV.F.9, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedures for ESEMs. In contrast, the PBPs presented in section I.A.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V-25presents the rebuttable-presumption payback periods for the considered TSLs for ESEMs. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

Table V-25 Rebuttable-Presumption Payback Periods

Equipment Class	Payback Period (years)			
	TSL 1	TSL 2	TSL 3	TSL 4
ESEM—High and Medium-torque, 0.25 hp	0.5	1.2	4.0	7.6
ESEM—High and Medium-torque, 1 hp	0.7	0.9	3.2	6.0
ESEM—Low-torque, 0.25 hp	0.5	0.9	1.7	2.6
ESEM—Low-torque, 0.5 hp	2.9	1.8	3.1	3.6
ESEM—Polyphase, 0.25 hp	1.1	2.0	4.5	9.5
AO-ESEM—High and Medium-torque, 0.25 hp	0.4	1.0	3.0	5.7
AO-ESEM—High and Medium-torque, 1 hp	0.6	0.8	2.7	5.1
AO-ESEM—Low-torque, 0.25 hp	0.5	0.9	1.6	2.5
AO-ESEM—Low-torque, 0.5 hp	2.8	1.8	3.0	3.6
AO-ESEM—Polyphase, 0.25 hp	1.0	1.8	3.8	8.1

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of new energy conservation standards on manufacturers of ESEMs. The next section describes the expected impacts on ESEM manufacturers at each considered TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from new standards. The following tables summarize the estimated financial impacts (represented by changes in INPV) of new energy conservation standards on manufacturers of ESEMs, as well as the conversion costs that DOE estimates manufacturers of ESEMs would incur at each TSL.

To evaluate the range of cash flow impacts on the ESEM industry, DOE modeled two manufacturer markup scenarios that correspond to the range of possible market responses to new standards. Each manufacturer markup scenario results in a unique set of cash flows and corresponding INPVs at each TSL.

In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and the standards cases that result from the sum of discounted cash flows from the base year (2024) through the end of the analysis period (2058). The results also discuss the difference in cash flows between the no-new-standards case and the standards cases in the year before the estimated compliance date for new energy conservation standards. This figure represents the size of the required conversion costs relative to the cash flow generated by the ESEM industry in the absence of new energy conservation standards.

To assess the upper (less severe) end of the range of potential impacts on ESEM manufacturers, DOE modeled a preservation of gross margin scenario. This scenario assumes that, in the standards cases, ESEM manufacturers will be able to pass along all the higher MPCs required for more efficient equipment to their customers. Specifically, the industry will be able to maintain its average no-new-standards case gross margin (as a percentage of revenue) despite the higher MPCs in the standards cases. In general, the larger the MPC increases, the less likely manufacturers are to achieve the cash flow from operations calculated in this scenario, because it is less likely that manufacturers will be able to fully pass on these larger production cost increases.

To assess the lower (more severe) end of the range of potential impacts on the ESEM manufacturers, DOE modeled a preservation of operating profit scenario. This scenario represents the lower end of the range of impacts on manufacturers because no additional operating profit is earned on the higher MPCs, which erodes profit margins as a percentage of total revenue.

Table V-26 Industry Net Present Value for ESEM Manufacturers—Preservation of Gross Margin Scenario

	Units	No-New-Standards Case	Trial Standard Level*			
			1	2	3	4
INPV	*2023$ millions*	2,007	1,840	1,847	1,748	1,628
Change in INPV	*2023$ millions*	-	(166)	(160)	(259)	(378)
	%	-	(8.3)	(8.0)	(12.9)	(18.9)

* Numbers in parentheses are negative numbers.

Table V-27 Industry Net Present Value for ESEM Manufacturers—Preservation of Operating Profit Scenario

	Units	No-New-Standards Case	Trial Standard Level*			
			1	2	3	4
INPV	*2023$ millions*	2,007	1,801	1,733	977	(45)
Change in INPV	*2023$ millions*	-	(206)	(274)	(1,029)	(2,052)
	%	-	(10.3)	(13.7)	(51.3)	(102.3)

* Numbers in parentheses are negative numbers.

Table V-28 Cash Flow Analysis for ESEM Manufacturers

	Units	No-New-Standards Case	Trial Standard Level*			
			1	2	3	4
Free Cash Flow (2028)	*2023$ millions*	156	39	10	(341)	(821)
Change in Free Cash Flow (2028)	*2023$ millions*	-	(117)	(146)	(497)	(977)
	%	-	(75)	(94)	(319)	(627)
Product Conversion Costs	*2023$ millions*	-	132	148	339	594
Capital Conversion Costs	*2023$ millions*	-	159	212	847	1,693
Total Conversion Costs	*2023$ millions*	-	291	360	1,186	2,287

* Numbers in parentheses are negative numbers.

TSL 4 sets the efficiency level at EL 4 for all ESEM equipment classes. At TSL 4, DOE estimates the impacts to INPV will range from a decrease of $2,052 million to a decrease of $378 million, which represents decreases to INPV by approximately 102.3 percent and 18.9 percent, respectively. At TSL 4, industry free cash flow (operating cash flow minus capital expenditures) is estimated to decrease to -$821 million, or a drop of 627 percent, compared to the no-new-standards case value of $156 million in 2028, the year leading up to the compliance date of new energy conservation standards. The significantly negative free cash flow in the years leading up to the compliance date implies that most, if not all, ESEM manufacturers will need to borrow funds in order to make the investments necessary to comply with standards at TSL 4. This has the potential to significantly alter the market dynamics, as some smaller ESEM manufacturers may not be able to secure this funding and could exit the market as a result of standards set at TSL 4.

In the absence of new energy conservation standards, DOE estimates that less than 1 percent of ESEM (high/medium-torque), no ESEM (low-torque), less than 1 percent of ESEM (polyphase), 6 percent of AO-ESEM (high/medium-torque), no AO-ESEM (low-torque), and no AO-ESEM (polyphase) shipments will meet the efficiency levels required at TSL 4 in 2029, the compliance year of new standards. DOE estimates that manufacturers will have to redesign models representing over 99 percent of all ESEM shipments by the compliance date. It is unclear if most ESEM manufacturers would have the engineering capacity to complete the necessary redesigns within the 4-year compliance period. If manufacturers require more than 4 years to redesign their non-compliant ESEM models, they will likely prioritize redesigns based on sales volume, which could result in customers not being able to obtain compliant ESEMs covering the entire range of horsepower and motor configurations that they require.

Almost all ESEMs covered by this rulemaking will need to be redesigned at TSL 4. Therefore, DOE estimates that manufacturers will have to make significant investments in their manufacturing production equipment and the engineering resources dedicated to redesigning ESEM models. DOE estimates that manufacturers will incur approximately $594 million in product conversion costs and approximately $1,693 million in capital conversion costs. Product conversion costs include the engineering time to redesign almost all ESEM models and to retest these newly redesigned models to meet the standards set at TSL 4. Capital conversion costs include the purchase of almost all new lamination die sets, winding machines, frame casts, and assembly equipment, as well as other retooling costs to accommodate almost all ESEM models covered by this final rule that will need to be redesigned.

At TSL 4, under the preservation of gross margin scenario, the shipment weighted-average MPC significantly increases by approximately 119.3 percent relative to the no-new-standards case MPC. While this price increase results in additional revenue for manufacturers, the $2,287 million in total conversion costs estimated at TSL 4 outweighs this increase in manufacturer revenue and results in moderately negative INPV impacts at TSL 4 under the preservation of gross margin scenario.

Under the preservation of operating profit scenario, manufacturers earn the same nominal operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. The significant increase in the shipment weighted-average MPC results in a lower average manufacturer margin. This lower average manufacturer margin and the significant $2,287 million in total conversion costs result in significantly negative INPV impacts at TSL 4 under the preservation of operating profit scenario.

TSL 3 sets the efficiency level at EL 3 for all ESEM equipment classes. At TSL 3, DOE estimates the impacts to INPV will range from a decrease of $1,029 million to a decrease of $259 million, which represents decreases to INPV by approximately 51.3 percent and 12.9 percent, respectively. At TSL 3, industry free cash flow is estimated to decrease to -$341 million, or a drop of 319 percent, compared to the no-new-standards case value of $156 million in 2028, the year leading up to the compliance date of new energy conservation standards. The negative free cash flow in the years leading up to the compliance date implies that most, if not all, ESEM 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 ESEM manufacturers may not be able to secure this funding and could exit the market as a result of standards set at TSL 3.

In the absence of new energy conservation standards, DOE estimates that 8 percent of ESEM (high/medium-torque), 8 percent of ESEM (low-torque), 14 percent of ESEM (polyphase), 15 percent of AO-ESEM (high/medium-torque), 11 percent of AO-ESEM (low-torque), and 3 percent of AO-ESEM (polyphase) shipments will meet or exceed the efficiency levels required at TSL 3 in 2029, the compliance year of new standards. DOE estimates that manufacturers will have to redesign models representing approximately 90 percent of all ESEM shipments by the compliance date. It is unclear if most ESEM manufacturers would have the engineering capacity to complete the necessary redesigns within the 4-year compliance period. If manufacturers require more than 4 years to redesign their non-compliant ESEM models, they will likely prioritize redesigns based on sales volume, which could result in customers not being able to obtain compliant ESEMs covering the entire range of horsepower and motor configurations that they require.

The majority of ESEMs covered by this rulemaking will need to be redesigned at TSL 3. Therefore, DOE estimates that manufacturers will have to make significant investments in their manufacturing production equipment and the engineering resources dedicated to redesigning ESEM models. DOE estimates that manufacturers will incur approximately $339 million in product conversion costs and approximately $847 million in capital conversion costs. Product conversion costs include the engineering time to redesign approximately 90 percent of all ESEM models and to retest these newly redesigned models to meet the standards set at TSL 3. Capital conversion costs include the purchase of almost all new lamination die sets, winding machines, frame casts, and assembly equipment as well as other retooling costs for approximately 90 percent of all ESEM models covered by this final rule.

At TSL 3, under the preservation of gross margin scenario, the shipment weighted-average MPC significantly increases by approximately 54.9 percent relative to the no-new-standards case MPC. While this price increase results in additional revenue for manufacturers, the $1,186 million in total conversion costs estimated at TSL 3 outweighs this increase in manufacturer revenue and results in moderately negative INPV impacts at TSL 3 under the preservation of gross margin scenario.

Under the preservation of operating profit scenario, manufacturers earn the same nominal operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. The significant increase in the shipment weighted-average MPC results in a lower average manufacturer margin. This lower average manufacturer margin and the significant $1,186 million in total conversion costs result in significantly negative INPV impacts at TSL 3 under the preservation of operating profit scenario.

TSL 2 sets the efficiency level at EL 2 for all ESEM equipment classes, which is the recommended level from the December 2022 Joint Recommendation. At TSL 2, DOE estimates the impacts to INPV will range from a decrease of $274 million to a decrease of $160 million, which represents decreases to INPV by approximately 13.7 percent and 8.0 percent, respectively. At TSL 2, industry free cash flow is estimated to decrease to $10 million, or a drop of 94 percent, compared to the no-new-standards case value of $156 million in 2028, the year leading up to the compliance date of new energy conservation standards.

In the absence of new energy conservation standards, DOE estimates that 22 percent of ESEM (high/medium-torque), 45 percent of ESEM (low-torque), 67 percent of ESEM (polyphase), 34 percent of AO-ESEM (high/medium-torque), 67 percent of AO-ESEM (low-torque), and 36 percent of AO-ESEM (polyphase) shipments will meet or exceed the efficiency levels required at TSL 2 in 2029, the compliance year of new standards. DOE estimates that manufacturers will have to redesign models representing approximately 53 percent of all ESEM shipments by the compliance date.

DOE estimates that manufacturers will incur approximately $148 million in product conversion costs and approximately $212 million in capital conversion costs. Product conversion costs primarily include engineering time to redesign non-compliant ESEM models and to retest these newly redesigned models to meet the standards set at TSL 2. Capital conversion costs include the purchase of lamination die sets, winding machines, frame casts, and assembly equipment as well as other retooling costs for all non-compliant ESEM models covered by this final rule.

At TSL 2, under the preservation of gross margin scenario, the shipment weighted-average MPC increases by approximately 8.2 percent relative to the no-new-standards case MPC. While this price increase results in additional revenue for manufacturers, the $360 million in total conversion costs estimated at TSL 2 outweighs this increase in manufacturer revenue and results in moderately negative INPV impacts at TSL 2 under the preservation of gross margin scenario.

Under the preservation of operating profit scenario, manufacturers earn the same nominal operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. The increase in the shipment weighted-average MPC results in a slightly lower average manufacturer margin. This lower average manufacturer margin and the $360 million in total conversion costs result in moderately negative INPV impacts at TSL 2 under the preservation of operating profit scenario.

TSL 1 sets the efficiency level at EL 1 for all ESEM equipment classes. At TSL 1, DOE estimates the impacts to INPV will range from a decrease of $206 million to a decrease of $166 million, which represents decreases to INPV by approximately 10.3 percent and 8.3 percent, respectively. At TSL 1, industry free cash flow is estimated to decrease to $39 million, or a drop of 75 percent, compared to the no-new-standards case value of $156 million in 2028, the year leading up to the compliance date of new energy conservation standards.

In the absence of new energy conservation standards, DOE estimates that 68 percent of ESEM (high/medium-torque), 66 percent of ESEM (low-torque), 90 percent of ESEM (polyphase), 70 percent of AO-ESEM (high/medium-torque), 92 percent of AO-

ESEM (low-torque), and 62 percent of AO-ESEM (polyphase) shipments will meet or exceed the efficiency levels required at TSL 1 in 2029, the compliance year of new standards. DOE estimates that manufacturers will have to redesign models representing approximately 21 percent of all ESEM shipments by the compliance date.

DOE estimates that manufacturers will incur approximately $132 million in product conversion costs and approximately $159 million in capital conversion costs. Product conversion costs primarily include engineering time to redesign non-compliant ESEM models and to retest these newly redesigned models to meet the standards set at TSL 1. Capital conversion costs include the purchase of lamination die sets, winding machines, frame casts, and assembly equipment, as well as other retooling costs for all non-compliant ESEM models covered by this final rule.

At TSL 1, under the preservation of gross margin scenario, the shipment weighted-average MPC increases slightly by approximately 2.8 percent relative to the no-new-standards case MPC. While this price increase results in additional revenue for manufacturers, the $291 million in total conversion costs estimated at TSL 1 outweighs this increase in manufacturer revenue and results in moderately negative INPV impacts at TSL 1 under the preservation of gross margin scenario.

Under the preservation of operating profit scenario, manufacturers earn the same nominal operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. The increase in the shipment weighted-average MPC results in a slightly lower average manufacturer margin. This lower average manufacturer margin and the $291 million in total conversion costs result in moderately negative INPV impacts at TSL 1 under the preservation of operating profit scenario.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of new energy conservation standards on direct employment in the ESEM industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period.

DOE used statistical data from the U.S. Census Bureau's 2021 Annual Survey of Manufacturers ("ASM"), the results of the engineering analysis, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures involved with the manufacturing of ESEMs are a function of the labor intensity of the manufacturing process, the sales volume, and an assumption that wages remain fixed in real terms over time.

In the GRIM, DOE used the labor content of each piece of equipment and the MPCs to estimate the annual labor expenditures of the industry. DOE used Census data and interviews with manufacturers to estimate the portion of the total labor expenditures attributable to domestic labor.

The production worker estimates in this employment section cover only workers up to the line-supervisor level who are directly involved in fabricating and assembling ESEMs within a motor facility. Workers performing services that are closely associated with production operations, such as material handling with a forklift, are also included as production labor. DOE's estimates account for only production workers who manufacture the specific equipment covered by this rulemaking.

The employment impacts shown in Table V-29 represent the potential production employment impacts resulting from new energy conservation standards. The upper bound of the results estimates the maximum change in the number of production workers that could occur after compliance with new energy conservation standards when assuming that manufacturers continue to produce the same scope of covered equipment in the same production facilities. It also assumes that domestic production does not shift to lower-labor-cost countries. Because there is a real risk of manufacturers evaluating sourcing decisions in response to new energy conservation standards, the lower bound of the employment results includes the estimated total number of U.S. production workers in the industry who could lose their jobs if some existing ESEM production was moved outside of the United States. While the results present a range of employment impacts following 2029, this section also includes qualitative discussions of the likelihood of negative employment impacts at the various TSLs. Finally, the employment impacts shown are independent of the indirect employment impacts from the broader U.S. economy, which are documented in chapter 16 of the final rule TSD.

Based on 2021 ASM data and interviews with manufacturers, DOE estimates approximately 15 percent of ESEMs covered by this final rule sold in the United States are manufactured domestically. Using this assumption, DOE estimates that in the absence of new energy conservation standards, there would be approximately 790 domestic production workers involved in manufacturing all ESEMs covered by this rulemaking in 2029. Table V-29 shows the range of potential impacts of new energy conservation standards on U.S. production workers involved in the production of ESEMs covered by this rulemaking.

Table V-29 Potential Change in the Number of Domestic ESEM Workers

	No-New-Standards Case	Trial Standard Level*			
		1	2	3	4
Domestic Production Workers in 2029	790	812	854	1,224	1,732
Domestic Non-Production Workers in 2029	453	465	489	701	993
Total Domestic Employment in 2029	1,243	1,277	1,343	1,925	2,725
Potential Changes in Total Domestic Employment in 2029*	-	(22)–34	(64)–100	(434)–682	(790)–1,482

* DOE presents a range of potential impacts. Numbers in parentheses indicate negative values.

At the upper end of the range, all examined TSLs show an increase in the number of domestic production workers for ESEMs. The upper end of the range represents a scenario where manufacturers increase production hiring due to the increase in the labor associated with adding the required components and additional labor (*e.g.,* hand winding, etc.) to make more efficient ESEMs. However, as previously stated, this assumes that in addition to hiring more production employees, all existing domestic production would remain in the United States and not shift to lower-labor-cost countries.

At the lower end of the range, all examined TSLs show a decrease in domestic production employment. The lower end of the domestic employment range assumes that some, or all, ESEM domestic production employment may shift to lower-labor-cost countries in response to energy conservation standards. DOE estimates that approximately 85 percent of all ESEMs sold in the United States are manufactured abroad. At max-tech, TSL 4, DOE conservatively estimates that the remaining 15 percent of domestic production could shift to foreign production locations. DOE estimated this lower bound potential change in domestic employment based on the percent change in the MPC at each TSL. [147]

c. Impacts on Manufacturing Capacity

The December 2022 Joint Recommendation stated that standards set at EL 2 for the ESEM high-/medium-torque equipment class would minimize potential market disruptions by allowing CSIR and split-phase topologies to remain on the market, but only at smaller (0.25–0.5 hp) horsepower ratings. (Motor Coalition, No. 38 at p. 3) The December 2022 Joint Recommendation also stated that standards set at EL 2 for the ESEM low-torque equipment class would not create widespread market disruptions and that standards set at higher ELs could result in significant increases in the physical size and unavailability of product and, in some cases, may be extremely difficult to achieve with current PSC technology. *Id.*

[147] Except for TSL 4, which has an MPC increase of higher than 100 percent. Therefore, DOE assumes all domestic employment moves abroad at this TSL.

ABB commented on the December 2023 NOPR that redesigning a large segment of its ESEM portfolio results in additional demand on engineering resources and that recruitment of experienced electrical engineers is difficult. (ABB, No. 65 at p. 4) ABB stated that manufacturers are not able to recover these large investments related to engineering resources. *Id.* NEMA stated that based on its market survey, a significant portion of ratings would be unavailable at EL 4. NEMA commented that even in cases where EL 4 could be reached, it would take 7–10 years to implement with current manufacturing processes. NEMA added that the elimination of ratings and time to implement would be disruptive to the market. (NEMA, No. 68 at p. 7) NEMA additionally stated that most manufacturers would also not be capable of providing a full portfolio of compliant ESEMs at EL 3. NEMA commented that if DOE set energy conservation standards at EL 3, the residential and light commercial markets would be significantly impacted, and even industrial markets would have an estimated 25 percent of products that would not be able to meet EL 3 standards. *Id.* Lastly, NEMA stated that even if DOE set energy conservation standards at EL 3 for the low-torque ESEMs, it would be extremely disruptive to the market, even allowing for additional frame sizes. *Id.*

Grundfos stated that there would be significant impact to manufacturers that are not able to redesign their ESEMs by the compliance deadline to meet EL 3 and EL 4 standards without increasing the size of the motor. Grundfos commented that these ESEM manufacturers would likely lose their customer base, and this would also reduce competition and cause a disruption in the market overall. (Grundfos, No. 67 at p. 2) Additionally, Grundfos stated that if DOE set energy conservation standards at EL 3 or EL 4, Grundfos would not have any single-phase products available in the market, and the design efforts would be significant, including the impact to the overall size of the affected motors. Grundfos stated that this would cause an issue with its current customers that have these motors installed in their products. (Grundfos, No. 63 at p. 4)

Many ESEM manufacturers do not offer any ESEM models that would meet max-tech levels or one efficiency level below max-tech (*i.e.*, TSL 4 and TSL 3, respectively). Based on the shipments analysis used in the NIA, DOE estimates that less than 1 percent and 10 percent of all ESEM shipments will meet max-tech and one efficiency level below max-tech, respectively, in the no-new-standards case in 2029, the compliance year of new standards. Therefore, at TSL 4 and TSL 3, DOE estimates that manufacturers will have to redesign models representing over 99 percent and approximately 90 percent, respectively, of all ESEM shipments by the compliance date. As NEMA and ABB stated in their comments on the December 2023 NOPR, ESEM manufacturers would not have the engineering capacity to complete the necessary redesigns within the 4-year compliance period. If manufacturers require more than 4 years to redesign their non-compliant ESEM models, they will likely prioritize redesigns based on sales volume, which could result in customers not being able to obtain compliant ESEMs covering the entire range of horsepower and motor configurations that they require.

Lastly, during manufacturer interviews, most manufacturers stated they would not be able to provide a full portfolio of any ESEM equipment class for any standards that would be met using copper rotors. In DOE's engineering analysis, all representative units are modeled to use copper rotors at the max-tech efficiency design (*i.e.,* EL 4), except for the ESEM low-torque, 0.5 hp and AO-ESEM low-torque, 0.5 hp representative units, which are not modeled to use copper rotors at max-tech efficiency designs. No other lower efficiency levels are modeled to use die-cast copper rotors. Most manufacturers stated that they do not currently have the machinery, technology, or engineering resources to produce copper rotors in-house. Some manufacturers stated that the few manufacturers that do have the capability of producing copper rotors are not able to produce these motors in volumes sufficient to fulfill all shipments of that equipment class and would not be able to ramp up those production volumes over the 4-year compliance period. For manufacturers to either completely redesign their motor production lines or significantly expand their very limited copper rotor production line would require a massive retooling and engineering effort, which could take more than a decade to complete. Most manufacturers stated they would have to outsource copper rotor production because they would not be able to modify their facilities and production processes to produce copper rotors in-house within a 4-year time period. Most manufacturers agreed that outsourcing rotor die casting would constrain capacity by creating a bottleneck in rotor production, as there are very few companies that produce copper rotors.

ESEM manufacturers also noted that there is substantial uncertainty surrounding the global availability and price of copper, which has the potential to constrain capacity. Several manufacturers expressed concern that the combination of all these factors would make it impossible to support existing customers while redesigning equipment lines and retooling.

DOE estimates there is a strong likelihood of manufacturer capacity constraints in the near term for any standards that would likely require the use of copper rotors for any equipment class both due to the uncertainty of the global supply of copper and due to the quantity of machinery that would need to be purchased and the engineering resources that would be required to produce copper rotors. Therefore, there could be significant market disruption for any standards set at EL 4 for any equipment class, except for the ESEM low-torque and the AO-ESEM low-torque equipment classes.

Additionally, based on Grundfos's, ABB's, and NEMA's comments on the December 2023 NOPR and feedback from manufacturer interviews, DOE concludes that there would also be a significant disruption to the ESEM market if energy conservation standards were set at EL 3 for any ESEM equipment class.

d. Impacts on Subgroups of Manufacturers

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 equipment manufacturers, and manufacturers exhibiting cost structures substantially different from the industry average could be affected disproportionately. DOE discusses the impacts on small businesses in section VI.B of this document and did not identify any other adversely impacted ESEM-related manufacturer subgroups for this final rule based on results of the industry characterization.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the regulatory actions of other Federal agencies and States 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. 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 evaluates product-specific regulations that will take effect approximately 3 years before or after the 2029 compliance date of any new energy conservation standards for ESEMs. This information is presented in Table V-30.

Table V-30 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting ESEM 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***
Circulator Pumps 89 FR 44464 (May 20, 2024)	10	3	2026	$77.0 (2021$)	21.0%
Dedicated-Purpose Pool Pump Motors 87 FR 66966 (Sep. 28, 2022)	5	5	2026	$56.2 (2020$)	3.3%
Electric Motors 88 FR 36066 (Jun. 1, 2023)	74	74	2027	$468.5 (2021$)	2.6%
External Power Supplies† 88 FR 7284 (Feb. 2, 2023)	658	2	2027	$17.4 (2021$)	0.3%
Consumer Conventional Cooking Products 89 FR 11434 (Feb. 14, 2024)	35	1	2028	$66.7 (2022$)	0.3%
Distribution Transformers 89 FR 29834 (Apr. 22, 2024)	34	3	2029	$228.6 (2022$)	0.9%
Fans and Blowers† 89 FR 3714 (Jan. 19, 2024)	87	1	2030	$888.1 (2023$)	2.4%

* 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 ESEMs 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 timeframe 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.
† Indicates a proposed rulemaking. Final values may change upon the publication of a final rule.

Lennox stated that DOE failed to appropriately consider the cumulative regulatory burden that HVACR OEMs are facing. Lennox noted recent EPA regulations for low-GWP refrigerant triggering massive redesigns of their products as well as multiple increasingly stringent DOE system-level efficiency standards taking effect. (Lennox, No. 69 at p. 10)

AHRI commented that DOE should consider the cumulative effect of burdens from proposed and finalized regulations as it considers the energy conservation standards for this ESEM rulemaking. Specifically, AHRI commented that there are additional industry-wide burdens that conflict with the standards proposed in the December 2023 NOPR to expand the electric motors energy conservation standard scope. AHRI noted that the HVAC industry is preparing for new efficiency metrics and levels for: (1) new efficiency metrics and levels for dedicated outdoor air systems on May 1, 2024; (2) new efficiency metrics and levels for computer room air conditioners on May 28, 2024; (3) new efficiency metrics and levels for air-cooled, three-phase, small CAC-HPs and VRF with a cooling capacity of less than 65,000 Btu/h on January 1, 2025; (4) MEMs and AO-MEMs on June 1, 2027; (5) new Federal efficiency metrics for commercial fans expected in 2029; and (6) new Federal efficiency metrics for commercial package air conditioners and heat pumps with compliance on January 1, 2029. AHRI commented that new test procedures with new metrics are in process for single-package vertical air conditioners and heat pumps, package terminal air conditioners and heat pumps, and water source heat pumps. AHRI commented that the cumulative regulatory burden of these requirements must be fully considered, including the impacts to OEMs who use the impacted motors, and that the current proposal indicates it only considers the impact to motor manufacturers and not the downstream impacts to manufacturers who embed motors into their products. (AHRI, No. 70 at p. 21)

DOE acknowledges that OEMs that have ESEMs embedded in their equipment also manufacture products or equipment that have energy conservation standards that will take effect approximately 3 years before or after the estimated 2029 compliance date of any new energy conservation standards for ESEMs. This information is presented in Table V-31. Additionally, DOE acknowledges that OEMs will have retesting and recertification costs associated with accommodating a more efficient ESEM in commercial equipment and residential products that use non-compliant ESEMs. These costs are discussed in section V.B.7.a.

Table V-31 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Original Equipment Manufacturers that Have ESEMs Embedded in their Equipment

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***
Room Air Conditioner 88 FR 34298 (May 26, 2023)	8	8	2026	$24.8 (*2021$*)	0.4%
Commercial Water Heating Equipment 88 FR 69686 (Oct. 6, 2023)	14	14	2026	$42.7 (*2022$*)	5.3%
Residential Clothes Washers 89 FR 19026 (Mar. 15, 2024)	22	22	2028	$320.0 (*2022$*)	1.8%
Consumer Clothes Dryers 89 FR 18164 (Mar. 12, 2024)	19	19	2028	$180.7 (*2022$*)	1.4%
Consumer Furnaces 88 FR 87502 (Dec. 18, 2023)	15	15	2028	$162.0 (*2022$*)	1.8%
Air-Cooled Commercial Package Air Conditioners and Heat Pumps 89 FR 44052 (May 20, 2024)	13	13	2029	$288.0 (*2022$*)	2.1%
Consumer Water Heaters 89 FR 37778 (May 6, 2024)	16	16	2029	$239.8 (*2022$*)	1.9%
Refrigerators, Refrigerator-Freezers, and Freezers 89 FR 3026 (Jan. 17, 2024)	49	49	2029 and 2030‡	$830.3 (*2021$*)	1.3%
Consumer Boilers† 88 FR 55128 (Aug. 14, 2023)	24	24	2030	$98.0 (*2022$*)	3.6%
Fans and Blowers† 89 FR 3714 (Jan. 19, 2024)	87	87	2030	$888.1 (*2022$*)	2.4%

* 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 equipment that has ESEMs embedded in their equipment 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 timeframe 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.
† Indicates a NOPR publication. The values listed could change upon the publication of a final rule.
‡ Compliance year varies by product/equipment class.

In addition to the rulemakings listed in Table V-31, DOE identified air-cooled, three-phase, small commercial air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h and air-cooled, three-phase, variable refrigerant flow air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h as a rulemaking that may have ESEMs embedded in their equipment.[148] This rulemaking's compliance date is January 1, 2025, which is more than 3 years before the compliance date for this ESEM rulemaking.

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. National Energy Savings

To estimate the energy savings attributable to potential amended standards for ESEMs, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with new standards (2029–2058). Table V-32presents DOE's projections of the national energy savings for each TSL considered for ESEMs. The savings were calculated using the approach described in section IV.H.2 of this document.

[148] *See www.regulations.gov/document/EERE-2022-BT-STD-0008-0011*

Table V-32 Cumulative National Energy Savings for ESEMs; 30 Years of Shipments (2029–2058)

	Trial Standard Level			
	1	2	3	4
	quads			
Primary energy	2.6	8.5	16.9	24.5
FFC energy	2.7	8.8	17.3	25.1

OMB Circular A-4[149] 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.[150] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to ESEMs. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity

[149] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. Available at *www.whitehouse.gov/omb/information-for-agencies/circulars* (last accessed Jan. 19, 2024). DOE used the prior version of Circular A-4 (September 17, 2003) in accordance with the effective date of the November 9, 2023 version.

[150] 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. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)) 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.

analysis results based on a 9-year analytical period are presented in Table V-33. The impacts are counted over the lifetime of ESEMs purchased during the period 2029–2037.

Table V-33 Cumulative National Energy Savings for ESEMs; 9 Years of Shipments (2029–2037)

	Trial Standard Level			
	1	2	3	4
	Quads			
Primary energy	0.7	2.3	4.6	6.7
FFC energy	0.7	2.4	4.7	6.9

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 ESEMs. In accordance with OMB Circular A-4, DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V-34shows the consumer NPV results with impacts counted over the lifetime of equipment purchased during the period 2029–2058.

Table V-34 Cumulative Net Present Value of Consumer Benefits for ESEMs; 30 Years of Shipments (2029–2058)

Discount Rate	Trial Standard Level			
	1	2	3	4
	billion 2023$			
3 percent	14.2	47.5	56.4	43.1
7 percent	6.3	21.1	20.9	9.3

The NPV results based on the aforementioned 9-year analytical period are presented in Table V-35. The impacts are counted over the lifetime of products purchased during the period 2029–2037. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

Table V-35 Cumulative Net Present Value of Consumer Benefits for ESEMs; 9 Years of Shipments (2029–2037)

Discount Rate	**Trial Standard Level**			
	1	**2**	**3**	**4**
	billion 2023$			
3 percent	5.2	17.3	20.6	15.6
7 percent	3.1	10.4	10.2	4.4

The previous results reflect the use of a default trend to estimate the change in price for ESEMs over the analysis period (*see* section IV.F.1 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a price decline and one scenario with a price increase compared to the reference case. The results of these alternative cases are presented in appendix 10B of the final rule TSD. In the price-decline case, the NPV of consumer benefits is higher than in the default case. In the price-increase case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

DOE estimates that new energy conservation standards for ESEMs will reduce energy expenditures for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis.

Therefore, DOE generated results for near-term timeframes (2029–2034), where these uncertainties are reduced.

The results suggest that the adopted standards are likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in section IV.C.1.c of this document, DOE has concluded that the standards adopted in this final rule will not lessen the utility or performance of the ESEMs under consideration in this rulemaking. Manufacturers of these products currently offer units that meet or exceed the adopted standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.I.1.e, EPCA directs the Attorney General of the United States ("Attorney General") to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination in writing to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. To assist the Attorney General in making this determination, DOE provided the Department of Justice ("DOJ") with copies of the NOPR and the TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for ESEMs are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this final rule.

6. Need of the Nation to Conserve Energy

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 final rule TSD presents the estimated impacts on electricity generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from potential energy conservation standards for ESEMs is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V-36provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.L. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

Table V-36 Cumulative Emissions Reduction for ESEMs Shipped in 2029–2058

	Trial Standard Level			
	1	**2**	**3**	**4**
Electric Power Sector Emissions				
CO_2 (*million metric tons*)	43.6	141.4	279.0	404.3
CH_4 (*thousand tons*)	2.9	9.5	18.8	27.2
N_2O (*thousand tons*)	0.4	1.3	2.6	3.7
SO_2 (*thousand tons*)	19.8	64.4	126.7	183.5
NO_X (*thousand tons*)	12.5	40.7	81.1	117.9
Hg (*tons*)	0.1	0.3	0.6	0.8
Upstream Emissions				
CO_2 (*million metric tons*)	4.5	14.6	28.9	41.9
CH_4 (*thousand tons*)	409.2	1,328.5	2,625.1	3,805.9
N_2O (*thousand tons*)	0.0	0.1	0.1	0.2
SO_2 (*thousand tons*)	70.2	227.9	450.3	652.8
NO_X (*thousand tons*)	0.3	0.9	1.7	2.5
Hg (*tons*)	0.0	0.0	0.0	0.0
Total FFC Emissions				
CO_2 (*million metric tons*)	48.1	156.0	307.9	446.2
CH_4 (*thousand tons*)	412.1	1,338.0	2,643.9	3,833.1
N_2O (*thousand tons*)	0.4	1.4	2.7	3.9
SO_2 (*thousand tons*)	90.0	292.3	577.0	836.3
NO_X (*thousand tons*)	12.8	41.6	82.8	120.4
Hg (*tons*)	0.1	0.3	0.6	0.8

As part of the analysis for this rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for ESEMs. Section IV.L of this document discusses the estimated SC-CO_2 values that DOE used. Table V-37and Table V-38presents the value of CO_2 emissions reduction at each TSL for each of the SC-CO_2 cases. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

Table V-37 Present Value of CO_2 Emissions Reduction for Battery Chargers Shipped in 2027–2056 (2023 estimates of SC-GHG)

TSL	SC-CO_2 Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	5.98	10.17	18.06
2	19.39	32.97	58.56
3	37.89	64.53	114.75
4	54.72	93.26	165.91

Table V-38 Present Value of CO_2 Emissions Reduction for ESEMs Shipped in 2029–2058 (2021 interim SC-GHG estimates)

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5% Average	3% Average	2.5% Average	3% 95th percentile
	billion 2023$			
1	0.53	2.20	3.42	6.70
2	1.70	7.13	11.08	21.66
3	3.29	13.83	21.52	42.00
4	4.73	19.93	31.02	60.50

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 ESEMs. Table V-39and Table V-40presents the value of the CH_4 emissions reduction at each TSL, and Table V-41and Table V-42presents the value of the N_2O emissions reduction at each TSL. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

Table V-39 Present Value of Methane Emissions Reduction for Battery Chargers Shipped in 2027–2056 (2023 estimates of SC-GHG)

TSL	SC-CH_4 Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	0.77	1.05	1.48
2	2.51	3.40	4.82
3	4.93	6.69	9.50
4	7.13	9.69	13.77

Table V-40 Present Value of Methane Emissions Reduction for ESEMs Shipped in 2029–2058 (2021 interim SC-GHG estimates)

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5% Average	3% Average	2.5% Average	3% 95th percentile
	billion 2023$			
1	0.21	0.60	0.83	1.58
2	0.67	1.94	2.69	5.13
3	1.29	3.78	5.25	9.98
4	1.86	5.45	7.57	14.40

Table V-41 Present Value of Nitrous Oxide Emissions Reduction for Battery Chargers Shipped in 2027–2056 (2023 estimates of SC-GHG)

TSL	SC-N_2O Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	0.015	0.024	0.040
2	0.049	0.079	0.131
3	0.097	0.156	0.259
4	0.141	0.225	0.376

Table V-42 Present Value of Nitrous Oxide Emissions Reduction for ESEMs Shipped in 2029–2058 (2021 interim SC-GHG estimates)

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5% Average	3% Average	2.5% Average	3% 95th percentile
	billion 2023$			
1	0.002	0.007	0.011	0.018
2	0.006	0.022	0.034	0.059
3	0.011	0.043	0.067	0.116
4	0.016	0.063	0.097	0.167

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the global and U.S. economy continues to evolve rapidly. 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, however, that the adopted standards are economically justified even without inclusion of monetized benefits of reduced GHG emissions.

DOE also estimated the monetary value of the economic benefits associated with NO_X and SO_2 emissions reductions anticipated to result from the considered TSLs for ESEMs. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V-43 Table V-43 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V-44Table V-44 presents similar results for SO_2 emissions reductions. 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 selected TSL in chapter 14 of the final rule TSD.

Table V-43 Present Value of NO_X Emissions Reduction for ESEMs Shipped in 2029–2058

TSL	7% Discount Rate	3% Discount Rate
	million 2023$	
1	1,886	4,544
2	6,084	14,699
3	11,652	28,555
4	16,715	41,164

Table V-44 Present Value of SO_2 Emissions Reduction for ESEMs Shipped in 2029–2058

TSL	3% Discount Rate	7% Discount Rate
	million 2023$	
1	381	903
2	1,234	2,930
3	2,384	5,743
4	3,430	8,304

Not all public health and environmental benefits from the reduction of greenhouse gases, NOx, 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 $PM_{2.5}$ 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. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i)(VII))

a. OEM Retesting and Recertification Costs

In this analysis, DOE also considered any additional OEM retesting and recertification costs needed to accommodate a more efficient ESEM in commercial equipment and residential products that use ESEMs. As discussed in section III.D.2, interested parties commented that the December 2023 NOPR did not account for costs that would be incurred by OEMs as a result of this rulemaking.

To estimate retesting and recertification costs that OEMs would incur due to new energy conservation standards for ESEMs, DOE first estimated the number of commercial equipment and residential product basic models that incorporate an ESEM. For commercial equipment, DOE reviewed the estimate by AHAM and AHRI (AHAM and AHRI, No. 25 at p. 12), and it agrees with the estimate of 6,015 basic models of commercial equipment that would have one or more ESEMs. For residential products, DOE estimated the fraction of CAC-HP basic models with single-speed PSC motors with a horsepower between 0.25 and 3 hp as follows: 22 percent of CACs and 16 percent of HPs, which results in a total estimate of 554 basic models of CAC-HPs that could potentially include an ESEM. Therefore, DOE estimated the total number of basic models of equipment and products potentially incorporating an ESEM as 6,569.

Second, DOE estimated the per-basic-model OEM retesting and recertification costs in two scenarios: (1) by using the cost estimates provided by AHAM and AHRI in response to the March 2022 Preliminary Analysis that estimated a total $304,000 cost per-basic-model (AHAM and AHRI, No. 25 at p. 12), and (2) by using DOE's own estimate. Many of the end-use products identified by AHAM and AHRI often use the same motor across multiple basic models to simplify manufacturing and exploit economies of scale. As such, DOE found that many of the line items in the cost estimate provided by AHAM and AHRI would apply only on a per-product-family (*i.e.*, a group of end-use products that share a motor) basis rather than a per-basic-model basis. DOE estimated that a product family would cover five to 10 basic models, using the more conservative end of the range (five basic models per product family) to estimate the magnitude of reduction from AHAM and AHRI's provided estimates. The line items that fell into this category of per-product-family costs were: "Select higher performance motors that meet the application needs for the product"; "Design and build prototypes. Test for operation."; "Design wiring, markings, labels to complete product design details"; "Manufacturing fixturing, routing and costing activities"; "Development and publication of technical literature"; and "Product aftermarket and launch activities." DOE then identified multiple items that would not apply to this OEM cost estimate and removed them, notably: the "Evaluate motor compliance" item is already included in the MIA because this is done by the motor manufacturer (which in some cases is also the OEM), the "Repeat for models that do not comply" would not apply because these motors are more efficient and would be very unlikely to fail compliance testing, and the "Packaging design and development . . ." item would not apply because these motors are sizes similar to what is already on the market and generally will not need new packaging. DOE accepted and did not modify the cost estimate for the line item "safety agency and approval." Using the modifications identified above to AHAM and AHRI's cost estimate, DOE arrived at an estimate of $50,000 per basic model of costs incurred by OEMs, noting that this estimate is likely a high-end estimate of the costs incurred by OEMs.

Assuming all 6,569 basic models incorporate non-compliant ESEMs, the total OEM retesting and recertification costs are estimated to be between $0.328 billion and $1.97 billion. DOE notes the uncertainty related to these estimates and that these estimates are likely conservative (*i.e.*, high-end estimates), given that some ESEMs used in these basic models would already be compliant, and such basic models incorporating these compliant ESEMs would therefore not need to be included in the calculation of OEM retesting and recertification costs.

For example, at TSL 2, 47 percent of all ESEM shipments already have compliant efficiencies and would not require a redesign (*i.e.*, 53 percent of shipments would be redesigned). Based on this, and assuming a similar ratio of basic models would include compliant ESEMs—assuming 53 percent of 6,569 basic models incorporate non-compliant ESEMs—the total OEM retesting and recertification costs are estimated to be between $0.174 billion and $1.04 billion. These estimates are for illustrative purposes only, given the uncertainty related to the number of basic models with compliant ESEMs at TSL 2.

To put these OEM impacts into context, AHAM and AHRI noted that the total yearly "shipment volume" or "output" for their members and the industries they represent is $50 billion and $44 billion, for a total of $94 billion. (AHAM and AHRI, No. 25 at p. 12) Using AHAM and AHRI's OEM per-model cost estimate yields a total OEM impact of $1.04 billion in costs; noting only 53 percent of ESEMs would be redesigned, this would represent 1.1 percent of their annual revenue. Using DOE's total impact estimate of $0.174 billion, this would be 0.2 percent of their annual revenue.

b. OEM Redesign Costs

As discussed in section IV.C.1.d, DOE received stakeholder comments that at and above EL 3, manufacturers would likely increase the size of ESEMs in order to meet the standards. In such a scenario, OEMs may need to redesign their OEM equipment in order to accommodate a larger ESEM, potentially requiring significant product and capital conversion costs. DOE notes that these redesign costs are distinct from the retest and recertification costs described in the previous subsection. The OEM costs described in the previous section assume that a drop-in replacement motor would be available in the presence of standards and OEM equipment would require only minimal changes as a result, whereas the costs associated with redesigning OEM equipment would be in addition to these retest and certification costs and would primarily be required when a drop-in replacement is not available. To avoid these conversion costs, OEMs may instead choose to replace the ESEM with an out-of-scope ECM, which are comparable to EL 3 ESEMs in terms of full-load efficiency and are typically more compact.

At EL 3 or above, DOE acknowledges that some motor manufacturers may choose to rely on design options that would increase the physical size of motors, creating uncertainty as to whether the size, fit, and function would be maintained at these levels. In that scenario, OEMs would have the option to: (1) replace non-compliant ESEMs with a larger ESEM and incur additional OEM redesign costs, or (2) replace non-compliant ESEMs with an ECM motor. In addition, because option (2) is likely the cheapest option that would avoid the OEM equipment redesign costs, DOE has determined that it is reasonable to expect that OEMs would more likely select Option (2). Stakeholders[151] have also indicated that OEMs may select to use ECM motors (*see* section III.D.2.d), and DOE notes that ECMs are a common design option for embedded motors in HVACR equipment, while using a larger motor is typically not considered. As such, DOE has estimated that using ECM motors would represent the lower-cost options. Given the uncertainty as to whether the size, fit, and function would be maintained at EL 3 and EL 4, DOE conducted a sensitivity analysis in the LCC to analyze the impacts of OEMs selecting option (2). DOE analyzed a scenario where a percentage of ESEMs would be replaced by ECMs at EL 3 and EL 4. At EL 3, DOE assumed that 40 to 70 percent of ESEMs would be replaced by ECMs based on input from NEMA, which indicated that 40 to 70 percent of ratings would not be available in the same frame sizes at EL 3. (NEMA, No.68 at p.5) At EL 4, DOE assumed that 80 percent of ESEMs would be replaced by ECMs. NEMA also indicated that 100 percent of ESEMs would have to increase in size at EL 4 however, based on DOE's engineering analysis DOE has determined that 80 percent is more appropriate for this sensitivity analysis as it has

[151] (Carrier, No. 71 at p. 5; Motor Coalition; No. 77 at p.3)

demonstrated that the ESEMs corresponding to the representative unit horsepower and poles can reach EL 4 without significant increases in size. In addition, because ECMs have variable-speed capability, DOE assumed that the use of ECMs would lead to an additional 20 percent reduction of energy use compared to single-speed ESEMs.[152] Finally to estimate the MSP of ECMs, DOE used the ECM MPCs presented in the TSD of the Final Rule for Circulator Pumps published April 2024. DOE subtracted the portion of the MPC associated with wetted parts to get the MPC of the ECM only and marked it up using the ESEM markup structure. These MSPs were then scaled by horsepower. Results are shown in Table V-45 and show that the LCC savings would be negative for all representative units at EL 3 and EL 4.

Table V-45 ESEM Life-Cycle Cost Sensitivity Analysis – ECMs at EL 3 and EL 4

TSL	Average LCC Savings* 2023$		Simple Payback Years		Consumers with Net Benefit		Consumers with Net Cost	
	ECM option	Reference	ECM option	Reference	ECM option	Reference	ECM option	Reference
ESEM—High/Med Torque, 0.25 hp								
1	63.5	63.5	0.5	0.5	22.7%	22.7%	1.8%	1.8%
2	59.3	59.3	1.2	1.2	52.3%	52.3%	15.4%	15.4%
3	-181.3	6.3	8.4	3.8	15.9%	34.4%	67.8%	49.3%
4	-267.5	-103.8	10.4	7.0	7.0%	15.7%	92.5%	83.8%
ESEM—High/Med Torque, 1 hp								
1	133.1	133.1	0.6	0.6	34.2%	34.2%	3.2%	3.2%
2	159.9	159.9	0.9	0.9	75.4%	75.4%	10.5%	10.5%
3	-68.9	45.1	4.7	3.1	36.4%	49.7%	62.0%	48.7%
4	-168.8	-117.0	6.1	5.7	23.4%	22.3%	76.5%	77.6%
ESEM—Low-torque, 0.25 hp								
1	261.6	261.6	0.5	0.5	4.0%	4.0%	0.1%	0.1%
2	186.4	186.4	0.9	0.9	18.5%	18.5%	1.9%	1.9%

[152] Energy savings from speed control range between 9 and 29 percent based on Newkirk, A., P. Rao, and P. Sheaffer. U.S. Industrial and Commercial Motor System Market Assessment Report Volume 2: Advanced Motors and Drives Supply Chain Review. 2021 (last accessed Jan. 25, 2023). *escholarship.org/uc/item/2k1942nd*. DOE notes this approach overestimates the benefits of ECMs as some application may only operate at a constant load and may not benefit from additional variable-speed capability and assuming fewer consumers benefit from variable-speed capability would further lower the LCC savings.

3	-127.3	40.9	3.8	1.6	26.5%	56.1%	73.5%	43.9%
4	-180.4	5.5	4.5	2.4	14.8%	38.9%	85.2%	61.1%
ESEM—Low-torque, 0.5 hp								
1	56.0	56.0	2.8	2.8	34.1%	34.1%	8.3%	8.3%
2	124.4	124.4	1.7	1.7	58.5%	58.5%	5.5%	5.5%
3	-95.2	110.8	6.0	2.9	36.6%	66.2%	53.9%	24.3%
4	-194.4	114.8	7.2	3.4	25.7%	67.5%	74.3%	32.5%
ESEM— Polyphase, 0.25 hp								
1	36.8	36.8	1.1	1.1	9.3%	9.3%	1.0%	1.0%
2	31.3	31.3	1.9	1.9	26.6%	26.6%	6.8%	6.8%
3	-160.8	-4.2	9.8	4.3	16.6%	31.2%	69.8%	55.2%
4	-293.9	-106.4	14.4	9.0	1.7%	5.9%	97.7%	93.6%
AO-ESEM—High/Med Torque, 0.25 hp								
1	93.5	93.5	0.4	0.4	26.0%	26.0%	0.7%	0.7%
2	103.7	103.7	0.9	0.9	54.2%	54.2%	5.1%	5.1%
3	-111.7	60.6	6.5	2.9	24.3%	48.9%	54.7%	30.1%
4	-192.8	-38.8	8.1	5.4	12.8%	26.4%	73.5%	60.0%
AO-ESEM—High/Med Torque, 1 hp								
1	143.0	143.0	0.6	0.6	31.0%	31.0%	1.6%	1.6%
2	189.6	189.6	0.7	0.7	66.4%	66.4%	5.0%	5.0%
3	-26.3	67.3	3.9	2.6	37.7%	49.1%	50.7%	39.3%
4	-145.2	-96.4	5.1	4.8	25.9%	23.9%	74.1%	76.1%
AO-ESEM—Low-torque, 0.25 hp								
1	266.5	266.5	0.5	0.5	3.4%	3.4%	0.1%	0.1%
2	170.3	170.3	0.9	0.9	22.7%	22.7%	2.5%	2.5%
3	-118.1	56.5	3.8	1.5	24.0%	49.9%	58.6%	32.7%
4	-198.2	12.7	4.6	2.4	14.7%	39.3%	85.3%	60.7%
AO-ESEM—Low-torque, 0.5 hp								
1	62.9	62.9	2.7	2.7	7.6%	7.6%	1.6%	1.6%
2	109.6	109.6	1.7	1.7	33.2%	33.2%	1.7%	1.7%
3	-141.9	76.0	6.1	2.8	31.8%	64.5%	59.4%	26.7%
4	-224.7	90.6	7.3	3.4	22.2%	66.4%	77.8%	33.6%
AO-ESEM— Polyphase, 0.25 hp								
1	40.6	40.6	1.0	1.0	33.9%	33.9%	2.4%	2.4%
2	47.2	47.2	1.7	1.7	54.0%	54.0%	8.9%	8.9%
3	-135.1	20.3	8.3	3.6	28.3%	52.6%	69.1%	44.8%
4	-261.8	-80.1	12.3	7.7	4.7%	15.3%	95.3%	84.7%

DOE notes that because option (1) is likely to be as or more expensive than option (2), the resulting LCC savings would be lower than showed in Table V-45 in a scenario where OEMs were to select a larger compliant ESEM.

As discussed in section V.C, DOE is adopting TSL 2, corresponding to EL 2 for all equipment classes and determined that TSL 4 and TSL 3 (corresponding to EL 4 and EL 3, respectively for all equipment classes) were not economically justified. The results of this sensitivity analysis at EL 3 and EL 4 for option (1) and (2) further support this conclusion.

8. Summary of Economic Impacts

Table V-46 and Table V-47 present the NPV values that result from adding the estimates of the 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. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered ESEMs and are measured for the lifetime of products shipped in 2029–2058. The climate benefits associated with reduced GHG emissions resulting from the adopted standards are global benefits, and are also calculated based on the lifetime of ESEMs shipped in 2029–2058.

Table V-46 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits (2023 estimates of SC-GHG)

Category	TSL 1	TSL 2	TSL 3	TSL 4
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
2.5% Near-term Ramsey DR	26.4	87.0	133.7	154.5
2.0% Near-term Ramsey DR	30.9	101.5	162.1	195.7
1.5% Near-term Ramsey DR	39.2	128.6	215.3	272.6
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
2.5% Near-term Ramsey DR	15.4	50.3	77.8	91.4
2.0% Near-term Ramsey DR	19.8	64.8	106.3	132.6
1.5% Near-term Ramsey DR	28.2	91.9	159.4	209.5

Table V-47 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits (2021 interim SC-GHG estimates)

Category	TSL 1	TSL 2	TSL 3	TSL 4
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
5% average SC-GHG case	20.4	67.5	95.3	99.1
3% average SC-GHG case	22.5	74.2	108.4	118.0
2.5% average SC-GHG case	23.9	78.9	117.6	131.2
3% 95th-percentile SC-GHG case	28.0	91.9	142.8	167.6
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
5% average SC-GHG case	9.3	30.8	39.5	36.0
3% average SC-GHG case	11.4	37.5	52.6	54.9
2.5% average SC-GHG case	12.8	42.2	61.8	68.1
3% 95th-percentile SC-GHG case	16.9	55.2	87.0	104.5

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, 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 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 final rule, DOE considered the impacts of standards for ESEMs at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

1. Benefits and Burdens of TSLs Considered for ESEM Standards

Table V-48 and Table V-49 summarize the quantitative impacts estimated for each TSL for ESEMs. The national impacts are measured over the lifetime of ESEMs purchased in the 30-year period that begins in the anticipated year of compliance with new standards (2029–2058). The energy savings, emissions reductions, and value of emissions reductions refer to FFC results. DOE is presenting monetized benefits of GHG emissions reductions in accordance with the applicable Executive orders, and DOE would reach the same conclusion presented in this notice in the absence of the social cost of greenhouse gases, including the Interim Estimates presented by the IWG. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V-48 Summary of Analytical Results for ESEMs TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4
Cumulative FFC National Energy Savings				
Quads	2.7	8.8	17.3	25.1
Cumulative FFC Emissions Reduction				
CO_2 (<u>*million metric tons*</u>)	48.1	156.0	307.9	446.2
CH_4 (<u>*thousand tons*</u>)	412.1	1,338.0	2,643.9	3,833.1
N_2O (<u>*thousand tons*</u>)	0.4	1.4	2.7	3.9
SO_2 (<u>*thousand tons*</u>)	90.0	292.3	577.0	836.3
NO_X (<u>*thousand tons*</u>)	12.8	41.6	82.8	120.4
Hg (<u>*tons*</u>)	0.1	0.3	0.6	0.8
Present Value of Benefits and Costs (*3% discount rate, billion 2023$*)				
Consumer Operating Cost Savings	17.0	55.8	112.1	163.4
Climate Benefits* (2023 SC-GHG estimate)	11.2	36.5	71.4	103.2
Climate Benefits* (2021 Interim SC-GHG estimate)	2.8	9.1	17.6	25.4
Health Benefits**	5.4	17.6	34.3	49.5
Total Benefits† (2023 SC-GHG estimate)	33.7	109.9	217.7	316.0
Total Benefits† (2021 Interim SC-GHG estimate)	25.3	82.5	164.0	238.3
Consumer Incremental Equipment Costs‡	2.8	8.3	55.6	120.3
Consumer Net Benefits	14.2	47.5	56.4	43.1
Total Net Benefits (2023 SC-GHG estimate)	30.9	101.5	162.1	195.7
Total Net Benefits (2021 Interim SC-GHG estimate)	22.5	74.2	108.4	118.0
Present Value of Benefits and Costs (*7% discount rate, billion 2023$*)				
Consumer Operating Cost Savings	7.8	25.5	50.5	73.2
Climate Benefits* (2023 SC-GHG estimate)	11.2	36.5	71.4	103.2
Climate Benefits* (2021 Interim SC-GHG estimate)	2.8	9.1	17.6	25.4
Health Benefits**	2.3	7.3	14.0	20.1
Total Benefits† (2023 SC-GHG estimate)	21.3	69.3	135.9	196.5
Total Benefits† (2021 Interim SC-GHG estimate)	12.9	41.9	82.1	118.8
Consumer Incremental Equipment Costs‡	1.5	4.4	29.6	63.9
Consumer Net Benefits	6.3	21.1	20.9	9.3
Total Net Benefits (2023 SC-GHG estimate)	19.8	64.8	106.3	132.6
Total Net Benefits (2021 Interim SC-GHG estimate)	11.4	37.5	52.6	54.9

Note: This table presents the costs and benefits associated with ESEMs shipped in 2029−2058. These results include consumer, climate, and health benefits that accrue after 2058 from the products shipped in 2029−2058.

* Climate benefits are calculated using different estimates of the $SC\text{-}CO_2$, $SC\text{-}CH_4$ and $SC\text{-}N_2O$. Climate benefits are estimated using two separate sets of estimates of the social cost for each greenhouse gas, an updated set published in 2023 by the Environmental Protection Agency (EPA) ("2023 SC-GHG") and another interim set of estimates published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which were used in the NOPR. These estimates represent the global SC-GHG. For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 2 percent near-term Ramsey discount rate are shown for the 2023 SC-GHG estimates, and the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown for the 2021 Interim SC-GHG estimates.

** 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 it 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. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 21*

Sectors TSD provides a summary of the health impact endpoints quantified in the analysis. *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 a 2 percent near-term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-GHG with 3-percent discount rate for the 2021 Interim SC-GHG estimates.
‡ Costs include incremental equipment costs.

Table V-49 Summary of Analytical Results for ESEM TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4
Manufacturer Impacts				
Industry NPV (*million 2023$*) (no-new-standards case INPV = 2,007)	1,801–1,840	1,733–1,847	977–1,748	(45)–1,628
Industry NPV (*% change*)	(10.3)–(8.3)	(13.7)–(8.0)	(51.3)–(12.9)	(102.3)–(18.9)
Consumer Average LCC Savings (*2023$*)				
ESEM—High/Medium-torque, 0.25 hp	63.5	59.3	6.3	(103.8)
ESEM—High/Medium-torque, 1 hp	133.1	159.9	45.1	(117.0)
ESEM—Low-torque, 0.25 hp	261.6	186.4	40.9	5.5
ESEM—Low-torque, 0.5 hp	56.0	124.4	110.8	114.8
ESEM—Polyphase, 0.25 hp	36.8	31.3	(4.2)	(106.4)
AO-ESEM—High/Medium-torque, 0.25 hp	93.5	103.7	60.6	(38.8)
AO-ESEM—High/Medium-torque, 1 hp	143.0	189.6	67.3	(96.4)
AO-ESEM—Low-torque, 0.25 hp	266.5	170.3	56.5	12.7
AO-ESEM—Low-torque, 0.5 hp	62.9	109.6	76.0	90.6
AO-ESEM—Polyphase, 0.25 hp	40.6	47.2	20.3	(80.1)
Shipment-Weighted Average*	106.0	120.6	56.0	(2.3)
Consumer Simple PBP (*years*)				
ESEM—High/Medium-torque, 0.25 hp	0.5	1.2	3.8	7.0
ESEM—High/Medium-torque, 1 hp	0.6	0.9	3.1	5.7
ESEM—Low-torque, 0.25 hp	0.5	0.9	1.6	2.4
ESEM—Low-torque, 0.5 hp	2.8	1.7	2.9	3.4
ESEM—Polyphase, 0.25 hp	1.1	1.9	4.3	9.0
AO-ESEM—High/Medium-torque, 0.25 hp	0.4	0.9	2.9	5.4
AO-ESEM—High/Medium-torque, 1 hp	0.6	0.7	2.6	4.8
AO-ESEM—Low-torque, 0.25 hp	0.5	0.9	1.5	2.4
AO-ESEM—Low-torque, 0.5 hp	2.7	1.7	2.8	3.4
AO-ESEM—Polyphase, 0.25 hp	1.0	1.7	3.6	7.7
Shipment-Weighted Average*	1.5	1.3	2.9	4.5
Percentage of Consumers that Experience a Net Cost				
ESEM—High/Medium-torque, 0.25 hp	1.8%	15.4%	49.3%	83.8%
ESEM—High/Medium-torque, 1 hp	3.2%	10.5%	48.7%	77.6%
ESEM—Low-torque, 0.25 hp	0.1%	1.9%	43.9%	61.1%
ESEM—Low-torque, 0.5 hp	8.3%	5.5%	24.3%	32.5%
ESEM—Polyphase, 0.25 hp	1.0%	6.8%	55.2%	93.6%
AO-ESEM—High/Medium-torque, 0.25 hp	0.7%	5.1%	30.1%	60.0%

Category	TSL 1	TSL 2	TSL 3	TSL 4
AO-ESEM—High/Medium-torque, 1 hp	1.6%	5.0%	39.3%	76.1%
AO-ESEM—Low-torque, 0.25 hp	0.1%	2.5%	32.7%	60.7%
AO-ESEM—Low-torque, 0.5 hp	1.6%	1.7%	26.7%	33.6%
AO-ESEM—Polyphase, 0.25 hp	2.4%	8.9%	44.8%	84.7%
Shipment-Weighted Average*	2.4%	6.4%	36.9%	57.4%

Parentheses indicate negative (-) values.
* Weighted by shares of each equipment class in total projected shipments in 2029.

DOE first considered TSL 4, which represents the max-tech efficiency levels. TSL 4 would save an estimated 25.1 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $9.3 billion using a discount rate of 7 percent and $43.1 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 446.2 Mt of CO_2, 836.3 thousand tons of SO_2, 120.4 thousand tons of NO_X, 0.8 tons of Hg, 3,833.1 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 at TSL 4 is $103.2 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 estimates) or $25.4 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $20.1 billion using a 7-percent discount rate and $49.5 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 either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced

GHG emissions, the estimated total NPV at TSL 4 $132.6 billion per year (using the 2023 estimates of the SC-GHG) or is $54.9 billion (using the 2021 Interim SC-GHG estimates). Using a 3-percent discount rate consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 4 is $195.7 billion per year (using the 2023 estimates of the SC-GHG) or $118.0 billion (using the 2021 Interim SC-GHG estimates). The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a standard level is economically justified.

At TSL 4, the average LCC impact for non-AO-ESEMs ranges from -$117.0 to $114.8. At TSL 4, the average LCC impact for AO-ESEMs ranges from -$96.4 to $90.6. Overall, the shipment-weighted average LCC impact is a savings of -$2.3. The PBP for non-AO-ESEMs ranges from 2.4 years to 7.0 years, and the PBP for AO-ESEMs ranges from 2.4 years to 7.7 years. Overall, the shipment-weighted average PBP is 4.5 years. The fraction of consumers experiencing a net LCC cost for non-AO-ESEMs ranges from 32.5 to 93.6 percent, and the fraction of consumers experiencing a net LCC cost for AO-ESEMs ranges from 33.6 to 84.7 percent. Overall, the shipment-weighted average fraction of consumers experiencing a net LCC cost is 57.4 percent.

At TSL 4, the projected change in INPV ranges from a decrease of $2,052 million to a decrease of $378 million, which corresponds to decreases of 102.3 percent and 18.9 percent, respectively. DOE estimates that industry must invest $2,287 million to redesign almost all ESEM models and to purchase new lamination die sets, winding machines, frame casts, and assembly equipment, as well as other retooling costs to manufacturer compliant ESEM models at TSL 4. An investment of $2,287 million in conversion costs represents over 3.7 times the sum of the annual free cash flows over the years between the publication of this final rule and the compliance year (*i.e.*, the time period that these conversion costs would be incurred) and represents over 100 percent of the entire no-new-standards case INPV over the 30-year analysis period.[153]

In the no-new-standards case, free cash flow is estimated to be $156 million in 2028, the year before the compliance date. At TSL 4, the estimated free cash flow is -$821 million in 2028. This represents a decrease in free cash flow of 627 percent, or a decrease of $977 million, in 2028. 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 4. The extremely large drop in free cash flows could cause some ESEM manufacturers to exit the ESEM market entirely, even though recovery may be possible over the 30-year analysis period. At TSL 4, models representing less than 1 percent of all ESEM shipments are estimated to meet the efficiency requirements at this TSL in the no-new-standards case by 2029, the compliance year. Therefore, models representing over 99 percent of all ESEM shipments will need to be remodeled in the 4-year compliance period.

[153] The sum of annual free cash flows is estimated to be $614 million for 2025–2028 in the no-new-standards case, and the no-new-standards case INPV is estimated to be $2,007 million.

Manufacturers are unlikely to have the engineering capacity to conduct this massive redesign effort in 4 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 ESEM industry. The resulting market gaps in equipment offerings could result in suboptimal selection of ESEMs for some applications. Lastly, although DOE's analysis assumes that TSL 4 can be reached without significant increase in size, as discussed in sections IV.C and IV.J.2.c of this final rule and in the December 2022 Joint Recommendation, the Electric Motor Working Group expressed that in order to meet the efficiency requirements at TSL 4, some manufacturers may choose to rely on design options that could significantly increase the physical size of ESEMs. This could result in a significant and widespread disruption to the OEM markets that used ESEMs as an embedded product, as those OEMs may have to make significant changes to their equipment that use ESEMs because those ESEMs could become larger in physical size. Further, instead of selecting ESEMs that are larger in size, OEMs may also choose to replace non-compliant ESEMs with out-of-scope electric motors (*i.e.,* ECMs) which are more compact in size, but cost more than existing ESEMs. As discussed in section V.B.7.b, both options would result in negative LCC savings across all equipment classes.

Under 42 U.S.C. 6316(a) and 42 U.S.C. 6295(o)(2)(B)(i), DOE determines whether a standard is economically justified after considering seven factors. Based on these factors, the Secretary concludes that at TSL 4 for ESEMs, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and 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 over 3.7 times the sum of the annual free cash flows during the time period that these conversion costs will be incurred and over 100 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 102.3 percent), the large negative free cash flows in the years leading up to the compliance date (annual free cash flow is estimated to be -$821 million in the year before the compliance date), the lack of manufacturers currently offering equipment meeting the efficiency levels required at TSL 4 (models representing over 99 percent of shipments will need to be redesigned to meet this TSL), and the likelihood of the significant disruption in the ESEM market. Due to the limited engineering resources each manufacturer has available, it is unclear if most manufacturers will be able to redesign models representing on average 99 percent of their ESEM shipments covered by this rulemaking in the 4-year compliance period. Consequently, the Secretary has concluded that TSL 4 is not economically justified.

DOE then considered TSL 3, which represents EL 3 for all ECGs. TSL 3 would save an estimated 17.3 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $20.9 billion using a discount rate of 7 percent and $50.5 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 307.9 Mt of CO_2, 577.0 thousand tons of SO_2, 82.8 thousand tons of NO_X, 0.6 tons of Hg, 2,643.9 thousand tons of CH_4, and 2.7 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 3 is $71.4 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 estimates) or $17.6 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 Interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $14.0 billion using a 7-percent discount rate and $34.3 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 either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 3 is $106.3 billion per year (using the 2023 estimates of the SC-GHG) or $52.6 billion (using the 2021 Interim SC-GHG estimates). Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 3 is $162.1billion per year (using the 2023 estimates of the SC-GHG) or $108.4 billion (using the 2021 Interim SC-GHG estimates). The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a standard level is economically justified.

At TSL 3, the average LCC impact for non-AO-ESEMs ranges from -$4.2 to $110.8. At TSL 3, the average LCC impact for AO-ESEMs ranges from $20.3 $76.0. Overall, the shipment-weighted average LCC impact is a savings of $56. The PBP for non-AO-ESEMs ranges from 1.6 to 4.3 years, and the PBP for AO-ESEMs ranges from 1.5 to 3.6 years. Overall, the shipment-weighted average PBP is 2.9 years. The fraction of consumers experiencing a net LCC cost for non-AO-ESEMs ranges from 24.3 to 55.2 percent, and the fraction of consumers experiencing a net LCC cost for AO-ESEMs ranges from 26.7 to 44.8 percent. Overall, the shipment-weighted average fraction of consumers experiencing a net LCC cost is 36.9 percent.

At TSL 3, the projected change in INPV ranges from a decrease of $1,029 million to a decrease of $259 million, which corresponds to decreases of 51.3 percent and 12.9 percent, respectively. DOE estimates that industry must invest $1,186 million to redesign the majority of ESEM models and to purchase new lamination die sets, winding machines, frame casts, and assembly equipment, as well as other retooling costs to manufacturer compliant ESEM models at TSL 3. An investment of $1,186 million in conversion costs represents over 1.9 times the sum of the annual free cash flows over the years between the publication of this final rule and the compliance year (*i.e.*, the time period that these conversion costs would be incurred) and represents over 59 percent of the entire no-new-standards case INPV over the 30-year analysis period.[154]

In the no-new-standards case, free cash flow is estimated to be $156 million in 2028, the year before the compliance date. At TSL 3, the estimated free cash flow is -$341 million in 2028. This represents a decrease in free cash flow of 319 percent, or a decrease of $497 million, in 2028. 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 3. The extremely large

[154] The sum of annual free cash flows is estimated to be $614 million for 2025–2028 in the no-new-standards case, and the no-new-standards case INPV is estimated to be $2,007 million.

drop in free cash flows could cause some ESEM manufacturers to exit the ESEM market entirely, even though recovery may be possible over the 30-year analysis period. At TSL 3, models representing approximately 10 percent of all ESEM shipments are estimated to meet the efficiency requirements at this TSL in the no-new-standards case by 2029, the compliance year. Therefore, models representing approximately 90 percent of all ESEM shipments will need to be remodeled in the 4-year compliance period.

Manufacturers are unlikely to have the engineering capacity to conduct this massive redesign effort in 4 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 ESEM industry. The resulting market gaps in equipment offerings could result in suboptimal selection of ESEMs for some applications. Lastly, although DOE's analysis assumes that TSL 3 can be reached without significant increase in size, as discussed in sections IV.C and IV.J.2.c of this final rule and in the December 2022 Joint Recommendation, the Electric Motor Working Group expressed that in order to meet the efficiency requirements at TSL 3, some manufacturers may choose to rely on design options that would significantly increase the physical size of ESEMs. This could result in a significant and widespread disruption to the OEM markets that use ESEMs as an embedded product, as those OEMs may have to make significant changes to their equipment that use ESEMs since those ESEMs could become larger in physical size. Instead of selecting ESEMs that are larger in size, OEMs may also choose to replace non-compliant ESEMs with out-of-scope electric motors (*i.e.*, ECMs), which are more compact in size. As discussed in section V.B.7.b, both options would result in negative LLC savings across all equipment classes.

Under 42 U.S.C. 6316(a) and 42 U.S.C. 6295(o)(2)(B)(i), DOE determines whether a standard is economically justified after considering seven factors. Based on these factors, the Secretary concludes that at TSL 3 for ESEMs, the benefits of energy savings, economic benefit on many consumers, positive NPV of consumer benefits, emission reductions, and estimated monetary value of the emissions reductions would be outweighed by the impacts on manufacturers, including the extremely large conversion costs (representing over 1.9 times the sum of the annual free cash flows during the time period that these conversion costs will be incurred and over 59 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 51.3 percent), the large negative free cash flows in the years leading up to the compliance date (annual free cash flow is estimated to be -$341 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 approximately 90 percent of shipments will need to be redesigned to meet this TSL), and the likelihood of the significant disruption in the ESEM market. Due to the limited engineering resources each manufacturer has available, it is unclear if most manufacturers will be able to redesign models representing on average 90 percent of their ESEM shipments covered by this rulemaking in the 4-year compliance period. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

DOE then considered TSL 2, the standards level recommended in the December 2022 Joint Recommendation, which represents EL 2 for all ECGs. TSL 2 would save an estimated 8.8 quads of energy, an amount DOE considers significant. Under TSL 2, the

NPV of consumer benefit would be $21.1 billion using a discount rate of 7 percent and $47.5 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 156.0 Mt of CO_2, 292.3 thousand tons of SO_2, 41.6 thousand tons of NO_X, 0.3 tons of Hg, 1,338.0 thousand tons of CH_4, and 1.4 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 2 is $36.5 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 estimates) or $9.1 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 Interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 2 is $7.3 billion using a 7-percent discount rate and $17.6 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 either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 2 is $64.8 billion per year (using the 2023 estimates of the SC-GHG) or $37.5 billion (using the 2021 interim SC-GHG estimates). Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 2 is $101.5 billion per year (using the 2023 estimates of the SC-GHG) or $74.2 billion (using the 2021 Interim SC-GHG estimates). The estimated total NPV is provided for additional information;

however, DOE primarily relies upon the NPV of consumer benefits when determining whether a standard level is economically justified.

At TSL 2, the average LCC impact for non-AO-ESEMs is a savings of $59.3 and $159.9 for high-/medium-torque ESEMs (0.25 and 1 hp, respectively); $186.4 and $124.4 for low-torque ESEMs (0.25 and 0.5 hp, respectively); and $31.3 for polyphase ESEMs. At TSL 2, the average LCC impact for AO-ESEMs is a savings of $103.7 and $189.6 for high-/medium-torque AO-ESEMs (0.25 and 1 hp, respectively); $170.3 and $109.6 for low-torque AO-ESEMs (0.25 and 0.5 hp, respectively); and $47.2 for polyphase AO-ESEMs. Overall, the shipment-weighted average LCC impact is a savings of $120.6. The PBP for non-AO-ESEMs is 1.2 and 0.9 years for high-/medium-torque ESEMs (0.25 and 1 hp, respectively); 0.9 and 1.7 years for low-torque ESEMs (0.25 and 0.5 hp, respectively); and 1.9 years for polyphase ESEMs. The PBP for AO-ESEMs is 0.9 and 0.7 years for high-/medium-torque AO-ESEMs (0.25 and 1 hp, respectively); 0.9 and 1.7 years for low-torque AO-ESEMs (0.25 and 0.5 hp, respectively); and 1.7 years for polyphase AO-ESEMs. Overall, the shipment-weighted average PBP is 1.3 years. The fraction of consumers experiencing a net LCC cost for non-AO-ESEMs is 15.4 and 10.5 percent for high-/medium-torque ESEMs (0.25 and 1 hp, respectively); 1.9 and 5.5 percent for low-torque ESEMs (0.25 and 0.5 hp, respectively); and 6.8 percent for polyphase ESEMs. The fraction of consumers experiencing a net LCC cost for AO-ESEMs is 5.1 and 5.0 percent for high-/medium-torque AO-ESEMs (0.25 and 1 hp, respectively); 2.5 and 1.7 percent for low-torque AO-ESEMs (0.25 and 0.5 hp, respectively); and 8.9 percent for polyphase AO-ESEMs. Overall, the shipment-weighted average fraction of consumers experiencing a net LCC cost is 6.4 percent.

At TSL 2, the projected change in INPV ranges from a decrease of $274 million to a decrease of $160 million, which corresponds to decreases of 13.7 percent and 8.0 percent, respectively. DOE estimates that industry must invest $360 million to comply with standards set at TSL 2. An investment of $360 million in conversion costs represents approximately 59 percent of the sum of the annual free cash flows over the years between the publication date of this final rule and the standards year (*i.e.*, the time period that these conversion costs would be incurred) and represents approximately 18 percent of the entire no-new-standards case INPV over the 30-year analysis period.[155]

Under 42 U.S.C. 6316(a) and 42 U.S.C. 6295(o)(2)(B)(i), DOE determines whether a standard is economically justified after considering seven factors. After considering the seven factors and weighing the benefits and burdens, the Secretary has tentatively concluded that standards set at TSL 2 for ESEMs, the recommended TSL from the Motor Coalition, would be economically justified. At this TSL, the average LCC savings for all equipment classes is positive. An estimated 6.4 percent of ESEM consumers would 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 costs to manufacturers. At TSL 2, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent, is over 77 times higher than the maximum estimated manufacturers' loss in INPV. The adopted standard levels at TSL 2 are economically justified even without weighing the estimated monetary value of emissions

[155] The sum of annual free cash flows is estimated to be $614 million for 2025–2028 in the no-new-standards case, and the no-new-standards case INPV is estimated to be $2,007 million.

reductions. When those emissions reductions are included—representing $36.5 billion in climate benefits (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 estimates) or $9.1 billion in climate benefits (associated with the average SC-GHG at a 3-percent discount rate using the 2021 Interim SC-GHG estimates), and $17.6 billion (using a 3-percent discount rate) or $7.3 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

Accordingly, the Secretary has concluded that TSL 2, the TSL recommended by the Motor Coalition, would offer the maximum improvement in efficiency that is technologically feasible and economically justified and would result in the significant conservation of energy. In addition, as discussed in section V.A of this document, DOE is establishing the TSLs by equipment class groups and aligning the AO-ESEM levels with the non-AO-ESEMs. Although results are presented here in terms of TSLs, DOE analyzes and evaluates all possible efficiency levels for each equipment class in its analysis. For all equipment classes, TSL 2 comprises EL 2 and represents two efficiency levels below max-tech. The max-tech efficiency levels (TSL 4) result in negative LCC savings for most equipment classes and a large percentage of consumers that experience a net LCC cost for most equipment classes, in addition to significant manufacturer impacts. The efficiency levels one level below max-tech (TSL 3) result in negative LCC savings for one equipment class and a large percentage of consumers that experience a net LCC cost for some equipment classes. Additionally, the impact to manufacturers is significantly reduced at TSL 2. While manufacturers will have to invest $360 million to comply with standards at TSL 2, annual free cash flows remain positive for all years leading up to the modeled compliance date. DOE also estimates that most ESEM manufacturers will have the engineering capacity to complete these redesigns in a 4-year compliance period. Lastly, as discussed in the December 2022 Joint Recommendation, [156] TSL 2 would not result in ESEMs significantly increasing in physical size and, therefore, would not result in a significant and widespread disruption to the OEM markets that use ESEMs as an embedded product.

The efficiency levels two levels below max-tech (TSL 2), which represent the adopted standard levels as recommended by the Motor Coalition, result in 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 2 in the preceding paragraphs.

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 new energy conservation standards, DOE notes that as compared to TSL 3 and TSL 4, TSL 2 has higher shipment-weighted average LCC savings for consumers, significantly smaller percentages of

[156] *See* EERE-2020-BT-STD-0007-0038 at p. 4.

consumers experiencing a net cost, a lower maximum decrease in INPV, lower manufacturer conversion costs, and a significant decrease in the likelihood of a major disruption to both the ESEM market and the OEM markets that use ESEMs as an embedded product in their equipment, as DOE does not anticipate gaps in ESEM equipment offerings or a significant increase in the physical size of ESEMs at TSL 2.

Although DOE considered adopting new standard levels for ESEMs 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 2 represents the maximum energy savings that do not result in significant negative economic impacts to ESEM manufacturers. At TSL 2, conversion costs are estimated to be $360 million, significantly less than at TSL 3 ($1,186 million) or TSL 4 ($2,287 million). At TSL 2, conversion costs represent a significantly smaller size of the sum of ESEM manufacturers' annual free cash flows for 2025 to 2028 (59 percent) than at TSL 3 (193 percent) or TSL 4 (372 percent) and a significantly smaller portion of ESEM manufacturers' no-new-standards case INPV (18 percent) than at TSL 3 (59 percent) or TSL 4 (114 percent). At TSL 2, ESEM manufacturers will have to redesign a significantly smaller portion of their ESEM models to meet the efficiency levels set at TSL 2 (models representing 53 percent of all ESEM shipments) than at TSL 3 (90 percent) or at TSL 4 (99 percent). Lastly, ESEM manufacturers' free cash flow remains positive at TSL 2 for all years leading up to the compliance date, whereas at TSL 3 annual free cash flow is estimated to be -$341 million and at TSL 4 annual free cash flow is estimated to be -$821 million in 2028, the year before the compliance year. Additionally, the efficiency levels at the adopted TSL result in average positive LCC savings for all ECGs and significantly reduce the number of consumers experiencing a net cost, to the point where DOE has concluded they are economically justified, as discussed for TSL 2 in the preceding paragraphs.

Therefore, based on the previous considerations, DOE adopts the energy conservation standards for ESEMs at TSL 2. The new energy conservation standards for ESEMs, which are expressed as average full-load efficiency, are shown in Table V-50 through Table V-52.

Table V-50 Adopted Energy Conservation Standards for High- and Medium-Torque ESEMs (including AO-ESEMs)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	**2-pole**	**4-pole**	**6-pole**	**8-pole**	**2-pole**	**4-pole**	**6-pole**	**8-pole**
0.25	59.5	59.5	57.5	--	59.5	59.5	57.5	--
0.33	64.0	64.0	62.0	50.5	64.0	64.0	62.0	50.5
0.5	68.0	69.2	68.0	52.5	68.0	67.4	68.0	52.5
0.75	76.2	81.8	80.2	72.0	75.5	75.5	75.5	72.0
1	80.4	82.6	81.1	74.0	77.0	80.0	77.0	74.0
1.5	81.5	83.8	--	--	81.5	81.5	80.0	--
2	82.9	84.5	--	--	82.5	82.5	--	--
3	84.1	--	--	--	84.0	--	--	--

Table V-51 Adopted Energy Conservation Standards for Low-Torque ESEMs (including AO-ESEMs)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	63.9	66.1	60.2	52.5	60.9	64.1	59.2	52.5
0.33	66.9	69.7	65.0	56.6	63.9	67.7	64.0	56.6
0.5	68.8	70.1	66.8	57.1	65.8	68.1	65.8	57.1
0.75	70.5	74.8	73.1	62.8	67.5	72.8	72.1	62.8
1	74.3	77.1	77.3	65.7	71.3	75.1	76.3	65.7
1.5	79.9	82.1	80.5	72.2	76.9	80.1	79.5	72.2
2	81.0	82.9	81.4	73.3	78.0	80.9	80.4	73.3
3	82.4	84.0	82.5	74.9	79.4	82.0	81.5	74.9

Table V-52 Adopted Energy Conservation Standards for Polyphase ESEMs (including AO-ESEMs)

	Average Full-Load Efficiency							
	Open				Enclosed			
hp	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.25	65.6	69.5	67.5	62.0	66.0	68.0	66.0	62.0
0.33	69.5	73.4	71.4	64.0	70.0	72.0	70.0	64.0
0.5	73.4	78.2	75.3	66.0	72.0	75.5	72.0	66.0
0.75	76.8	81.1	81.7	70.0	75.5	77.0	74.0	70.0
1	77.0	83.5	82.5	75.5	75.5	77.0	74.0	75.5
1.5	84.0	86.5	83.8	77.0	84.0	82.5	87.5	78.5
2	85.5	86.5	--	86.5	85.5	85.5	88.5	84.0
3	85.5	86.9	--	87.5	86.5	86.5	89.5	85.5

2. Annualized Benefits and Costs of the Adopted Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2023$) of the benefits from operating products that meet the adopted standards (consisting primarily of operating cost savings from using less energy), minus increases in product purchase costs, and (2) the annualized monetary value of the climate and health benefits.

Table V-53 shows the annualized values for ESEMs under TSL 2, expressed in 2023$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and NOx and SO_2 reductions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for GHG social costs, the estimated cost of the adopted standards for ESEMs is $466 million per year in increased equipment installed costs, while the estimated annual benefits are $2,692 million from reduced equipment operating costs, $1,762 million in climate benefits (using the 2023 estimates of the SC-GHG) or $522 million in climate benefits (using the 2021 interim SC-GHG estimates), and $773 million in health benefits. In this case, the net benefit amounts to $4,760 million per year (using the 2023 estimates of the SC-GHG) or $3,520 million per year (using the 2021 interim SC-GHG estimates).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions results in $477 million per year in increased equipment installed costs, while the estimated annual benefits are $3,202 million from reduced equipment operating costs, $1,762 million in climate benefits (using the 2023 estimates of the SC-GHG) or $522 million in climate benefits (using the 2021 interim SC-GHG estimates), and $1,012 million in health benefits. In this case, the net benefit amounts to $5,499 million per year (using the 2023 estimates of the SC-GHG) or $4,260 million per year (using the 2021 Interim SC-GHG estimates).

Table V-53 Annualized Benefits and Costs of Adopted Standards (TSL 2) for ESEMs

	Million 2023$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	3,202	3,021	3,400
Climate Benefits* (2023 SC-GHG estimates)	1,762	1,708	1,827
Climate Benefits* (2021 Interim SC-GHG estimates)	522	506	541
Health Benefits**	1,012	983	1,048
Total Benefits† (2023 SC-GHG estimates)	5,976	5,711	6,276
Total Benefits† (2021 Interim SC-GHG estimates)	4,737	4,510	4,989
Consumer Incremental Product Costs‡	477	494	468
Net Monetized Benefits (2023 SC-GHG estimates)	5,499	5,218	5,807
Net Monetized Benefits (2021 Interim SC-GHG estimates)	4,260	4,016	4,521
Change in Producer Cash Flow (INPV)‡‡	(26)–(15)	(26)–(15)	(26)–(15)
7% discount rate			
Consumer Operating Cost Savings	2,692	2,552	2,848
Climate Benefits* (2023 SC-GHG estimates)	1,762	1,708	1,827
Climate Benefits* (2021 Interim SC-GHG estimates)	522	506	541
Health Benefits**	773	753	797
Total Benefits† (2023 SC-GHG estimates)	5,226	5,013	5,472
Total Benefits† (2021 Interim SC-GHG estimates)	3,987	3,811	4,186

	Million 2023$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
Consumer Incremental Product Costs‡	466	478	461
Net Monetized Benefits (2023 SC-GHG estimates)	4,760	4,535	5,011
Net Monetized Benefits (2021 Interim SC-GHG estimates)	3,520	3,334	3,725
Change in Producer Cash Flow (INPV)‡‡	(26)–(15)	(26)–(15)	(26)–(15)

Note: This table presents the costs and benefits associated with ESEMs shipped during the period 2029−2058. These results include consumer, climate, and health benefits that accrue after 2058 from the products shipped during the period 2029−2058. 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 and IV.H of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using different estimates of the global SC-GHG. Climate benefits are estimated using two separate sets of estimates of the social cost for each greenhouse gas, an updated set published in 2023 by the Environmental Protection Agency (EPA) ("2023 SC-GHG") and another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (*see* section IV.L of this notice). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 2 percent near-term Ramsey discount rate are shown for the 2023 SC-GHG estimates, and the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown for the 2021 Interim SC-GHG estimates.

** 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 it will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 21 Sectors* TSD provides a summary of the health impact endpoints quantified in the analysis. *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 2 percent near-term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-GHG with 3-percent discount rate for the 2021 Interim SC-GHG estimates.

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

‡‡ Operating Cost Savings are calculated based on the LCC analysis and NIA, 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 product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cash flow, 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 9.1 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 ESEMs, the annualized change in INPV ranges from -$26 million to -$15 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 Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the

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 final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this final rule, the annualized net benefits (2023 SC-GHG estimates) would range from $5,473 million to $5,484 million at 3-percent discount rate and would range from $4,734 million to $4,745 million at 7-percent discount rate.

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 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 final regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit "significant regulatory actions" to OIRA for review. OIRA has determined that this final regulatory action constitutes a "significant regulatory action" within the scope of section 3(f)(1) of E.O. 12866, as amended by E.O. 14094. Accordingly, pursuant to section 6(a)(3)(C) of E.O. 12866, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the final regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments are summarized in this preamble and further detail can be found in the technical support document for this rulemaking.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq*.) requires preparation of an initial regulatory flexibility analysis ("IRFA") and a final regulatory flexibility analysis ("FRFA") for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E.O. 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (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 FRFA for the products that are the subject of this rulemaking.

For manufacturers of ESEMs, 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 ESEMs is classified under NAICS 335312, "Motor and Generator Manufacturing." The SBA sets a threshold of 1,250 employees or fewer for an entity to be considered as a small business for this category.

1. Need for, and Objectives of, Rule

DOE previously established energy conservation standards for some types of electric motors at 10 CFR 431.25. These previous rulemakings did not establish energy conservation standards for ESEMs when establishing or amending energy conservation standards for other electric motors. In the March 2022 Preliminary Analysis, DOE analyzed potential efficiency levels for ESEMs. *See* 87 FR 11650 (March 2, 2022). On December 22, 2022, DOE received a joint recommendation for energy conservation standards for ESEMs. These standard levels were submitted jointly to DOE on November 15, 2022, by groups representing manufacturers, energy and environmental advocates, and consumer groups (the Motor Coalition).[157] The December 2022 Joint Recommendation recommends specific energy conservation standards for ESEMs.

2. Description and Estimated Number of Small Entities Affected

As part of the December 2023 NOPR, DOE estimated the number of companies that could be small business manufacturers of ESEMs covered by this rulemaking. DOE's research involved DOE's publicly available Compliance Certification Database ("CCD"), industry trade association membership directories (including NEMA), and information from previous rulemakings. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers during manufacturer interviews and DOE working groups. DOE used information from these sources to create

[157] The Motor Coalition includes the American Council for an Energy-Efficient Economy ("ACEEE"), Appliance Standards Awareness Project ("ASAP"), NEMA, Natural Resources Defense Council ("NRDC"), Northwest Energy Efficiency Alliance ("NEEA"), Pacific Gas & Electric Company ("PG&E"), San Diego Gas & Electric ("SDG&E"), and Southern California Edison ("SCE"). In a letter comment submitted December 12, 2022, the New York State Energy Research and Development Authority ("NYSERDA") expressed its support of the November 2022 Joint Recommendation and urged DOE to implement it in a timely manner.

a list of companies that potentially manufacture ESEMs covered by this rulemaking. As necessary, DOE contacted companies to determine whether they met the SBA's definition of a small business manufacturer. DOE screened out companies that do not offer equipment covered by this rulemaking, do not meet the definition of a "small business," or are foreign owned and operated.

In the December 2023 NOPR, DOE identified approximately 74 unique potential manufacturers of ESEMs sold in the United States that are covered by this rulemaking. DOE screened out companies that had more than 1,250 employees or companies that were completely foreign owned and operated. Of the 74 manufacturers that potentially manufacture ESEMs covered by this rulemaking, DOE identified three companies that meet SBA's definition of a small business. DOE did not receive any comment on this initial estimate of number of small businesses. Therefore, DOE continues to estimate that there are three companies that meet SBA's definition of a small business in this FRFA.

3. Description of Reporting, Recordkeeping, and Other Compliance Requirements

DOE is adopting new energy conservation standards for ESEMs. The primary value added by these three small businesses is creating ESEMs that serve an application-specific purpose that the OEMs require. This includes combining an ESEM with specific mechanical couplings, weatherproofing, or controls to suit the OEM's needs. Most small businesses manufacture motor housings and couplings but do not manufacture the rotors and stators used in the ESEMs they sell. While these small businesses may have to create new ESEM housings and/or couplings if the ESEM characteristics change in response to the adopted energy conservation standards, DOE was not able to identify any small businesses that own their own lamination die sets and winding machines that are used to manufacture rotors and stators for ESEMs.

The three small businesses identified do not manufacture the rotors and stators of their ESEMs and instead purchase these components from other manufacturers. Thus, they would not need to purchase the machinery necessary to manufacture these components (*i.e.*, would not need to purchase costly lamination die sets and winding machines); nor would they need to spend R&D efforts to develop ESEM designs to meet energy conservation standards. Instead, these small manufacturers may have to create new moldings for ESEM housings (if the ESEM characteristics change in response to the adopted energy conservation standards).

DOE estimated conversion costs associated with redesigning an equipment line for ESEM housings. DOE estimates this will cost approximately $50,000 in molding equipment per ESEM housing; $38,578 in engineering design effort per ESEM housing; and $10,000 in testing costs per ESEM housing. Based on these estimates, each ESEM housing that will need to be redesigned would cost a small business approximately $98,578.

DOE displays in Table VI-1 the estimated average conversion costs per small business compared to the annual revenue for each small business. DOE used D&B Hoovers to estimate the annual revenue for each small business. Manufacturers will have approximately 4 years between the publication of this final rule and the date of compliance with the adopted energy conservation standards. Therefore, DOE presents the estimated conversion costs and testing costs as a percentage of the estimated 4 years of annual revenue for each small business.

Table VI-1 Estimated Conversion Costs and Annual Revenue for Each Small Business

Manufacturer	Number of ESEM Housings That Need to Be Redesigned	Total Conversion Costs	Estimated Annual Revenue	4 Years of Annual Revenue	Conversion Costs as a % of 4 Years of Annual Revenue
Small Business 1	27	$2,661,606	$6,270,000	$25,080,000	10.6%
Small Business 2	19	$1,872,982	$7,680,00	$30,720,000	6.1%
Small Business 3	24	$2,365,872	$37,280,000	$149,120,000	1.6%
Average Small Business	**23**	**$2,300,153**	**$17,076,667**	**$68,306,667**	**3.4%**

4. Significant Alternatives Considered and Steps Taken to Minimize Significant Economic Impacts on Small Entities

The discussion in the previous section analyzes impacts on small businesses that would result from the adopted standards, represented by TSL 2. In reviewing alternatives to the adopted standards, DOE examined energy conservation standards set at lower efficiency levels. While TSL 1 would reduce the impacts on small business manufacturers, it would come at the expense of a reduction in energy savings. TSL 1 achieves 69-percent lower energy savings and 70 percent lower consumer NPV compared to the energy savings and consumer NPV at TSL 2.

Establishing standards at TSL 2 balances the benefits of the energy savings at TSL 2 with the potential burdens placed on ESEM manufacturers, including small business manufacturers. Accordingly, DOE is not adopting one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis and included in chapter 17 of the final rule TSD.

Additional compliance flexibilities may be available through other means. Manufacturers subject to DOE's energy efficiency standards may apply to DOE's Office of Hearings and Appeals for exception relief under certain circumstances. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of ESEMs must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for ESEMs, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including ESEMs. (*See generally* 10 CFR part 429.) The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act ("PRA"). This requirement has been approved by OMB under OMB control number 1910-1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act of 1969 ("NEPA"), DOE has analyzed this rule in accordance with NEPA and DOE's NEPA implementing regulations (10 CFR part 1021). DOE has determined that this rule qualifies for categorical exclusion under 10 CFR part 1021, subpart D, appendix B5.1 because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, none of the exceptions identified in B5.1(b) apply, no extraordinary circumstances exist that require further environmental analysis, and it meets the requirements for application of a categorical exclusion. *See* 10 CFR 1021.410. Therefore, DOE has determined that promulgation of this rule is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA and does not require an environmental assessment or an environmental impact statement.

E. Review Under Executive Order 13132

E.O. 13132, "Federalism," 64 FR 43255 (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 rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the equipment that are the subject of this final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) 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 E.O. 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final rule meets the relevant standards of 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. Pub. L. 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any 1 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)) UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *www.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

DOE has concluded that this final rule may require expenditures of $100 million or more in any 1 year by the private sector. Such expenditures may include (1) investment in research and development and in capital expenditures by ESEM 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 ESEMs, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the final rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of this document and the TSD for this final rule respond to those requirements.

Under section 205 of UMRA, DOE is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(m), this final rule establishes amended energy conservation standards for a subcategory of electric motors, ESEMs, 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 6295(o)(2)(A) and 6295(o)(3)(B). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this final rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. No. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any proposed rule or policy that may affect family well-being. Although this final rule would not have any impact on the autonomy or integrity of the family as an institution as defined, this final rule could impact a family's well-being. When developing a Family Policymaking Assessment, agencies must assess whether: (1) the action strengthens or erodes the stability or safety of the family and, particularly, the marital commitment; (2) the action strengthens or erodes the authority and rights of parents in the education, nurture, and supervision of their children; (3) the action helps the family perform its functions, or substitutes governmental activity for the function; (4) the action increases or decreases disposable income or poverty of families and children; (5) the proposed benefits of the action justify the financial impact on the family; (6) the action may be carried out by State or local government or by the family; and whether (7) the action establishes an implicit or explicit policy concerning the relationship between the behavior and personal responsibility of youth, and the norms of society.

DOE has considered how the benefits of this final rule compare to the possible financial impact on a consumer (the only factor listed that is relevant to this proposed rule). As part of its rulemaking process, DOE must determine whether the energy conservation standards enacted in this final rule are economically justified. As discussed in section V.C.1 of this document, DOE has determined that the standards enacted in this final rule are economically justified because the benefits to consumers would far outweigh the costs to manufacturers. Consumers will also see LCC savings as a result of this final rule. Moreover, as discussed further in section V.B.1 of this document, DOE has determined that for low-income households, average LCC savings and PBP at the considered efficiency levels are improved (*i.e.*, higher LCC savings and lower PBP) as compared to the average for all households. Further, the standards will also result in climate and health benefits for consumers.

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988), DOE has determined that this rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M-19-15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf*. DOE has reviewed this final rule under OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

E.O. 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB a Statement of Energy Effects for any significant energy action. A "significant energy action" is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) is designated by the Administrator of OIRA as a significant energy action. For any significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has concluded that this regulatory action, which sets forth [amended] energy conservation standards for ESEMs, is not a significant energy action because the standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on this final rule.

L. 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 prepared a report describing that peer review.[158] 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.[159]

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The report will state the Office of Information and Regulatory Affairs has determined that this action meets the criteria set forth in 5 U.S.C. 804(2).

N. Description of Materials Incorporated by Reference

UL 674 is an industry accepted test standard used to define high/medium torque explosion-proof ESEMs which are excluded from the scope of this final rule.

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[158] The 2007 "Energy Conservation Standards Rulemaking Peer Review Report" is available at *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed Jan. 19, 2024).

[159] The report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards*.

Specifically, the energy conservation standards codified by this final rule references UL 674 for scope, definitions, components, units of measurement, and terminology. UL 674 is reasonably available from the Underwriters Laboratories at 333 Pfingsten Road, Northbrook, IL 60062, (841) 272–8800, or by visiting *www.ul.com.*

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, 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, and Reporting and recordkeeping requirements.

Signing Authority

This document of the Department of Energy was signed on January 8, 2025, 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 January 8, 2025.

JEFFREY MAROOTIAN Digitally signed by JEFFREY MAROOTIAN Date: 2025.01.08 17:32:52 -05'00'

Jeffrey Marootian
Principal Deputy Assistant Secretary for
Energy Efficiency and Renewable Energy
U.S. Department of Energy

For the reasons stated in the preamble, DOE amends parts 429 and 431 of Chapter II, 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 § 429.64 by revising paragraphs (a)(3), (d)(2), and (e) to read as follows:

§ 429.64 Electric motors.

(a) * * *

(3) On or after April 17, 2023, manufacturers of electric motors subject to the test procedures in appendix B to subpart B of part 431 of this chapter but are not subject to the energy conservation standards in subpart B of part 431 of this chapter, must, if they chose to voluntarily make representations of energy efficiency, follow the provisions in paragraph (e) of this section.

* * * * *

(d) * * *

(2) Testing was conducted using a laboratory other than an accredited laboratory that meets the requirements of paragraph (f) of this section, or the represented value of the electric motor basic model was determined through the application of an AEDM pursuant to the requirements of § 429.70(j), and a third-party certification organization that is nationally recognized in the United States under § 429.73 has

certified the represented value of the electric motor basic model through issuance of a certificate of conformity for the basic model.

(e) *Determination of represented value*. Manufacturers of electric motors that are subject to energy conservation standards in subpart B of part 431 of this chapter, and for which minimum values of nominal full-load efficiency are prescribed, must determine the represented value of nominal full-load efficiency (inclusive of the inverter for inverter-only electric motors) for each basic model of electric motor either by testing in conjunction with the applicable sampling provisions or by applying an AEDM as set forth in this section and in § 429.70(j). Manufacturers of electric motors that are subject to energy conservation standards in subpart B of part 431 of this chapter, and for which minimum values of average full-load efficiency are prescribed, must determine the represented value of average full-load efficiency (inclusive of the inverter for inverter-only electric motors) for each basic model of electric motor either by testing in conjunction with the applicable sampling provisions or by applying an AEDM as set forth in this section and in § 429.70(j).

(1) *Testing* –

(i) *Units to be tested*. If the represented value for a given basic model is determined through testing, the requirements of § 429.11 apply except that, for electric motors, the minimum sample size is five units. If fewer units than the minimum sample size are produced, each unit produced must be tested and the test results must demonstrate that the basic model performs at or better than the applicable standard(s). If one or more units of the basic model are manufactured subsequently, compliance with the default sampling and representations provisions is required.

(ii) *Average Full-load Efficiency*: Determine the average full-load efficiency for the basic model $\bar{x}$, for the units in the sample using equation 4 to this paragraph, where x_i is the measured full-load efficiency of unit i and n is the number of units tested:

Equation 4 to Paragraph (e)(1)(ii)

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

(iii) *Nominal Full-load Efficiency*. Manufacturers of electric motors that are subject to energy conservation standards in subpart B of part 431 of this chapter, and for which minimum values of nominal full-load efficiency are prescribed, must determine the nominal full-load efficiency by selecting an efficiency from the "Nominal Full-load Efficiency" table in appendix B that is no greater than the average full-load efficiency of the basic model as calculated in paragraph (e)(1)(ii) of this section.

(iv) *Represented value*. For electric motors subject to energy conservation standards in subpart B of part 431 of this chapter and for which minimum values of nominal full-load efficiency are prescribed the represented value is the nominal full-load efficiency of a basic model of electric motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (See § 431.31(a) of this chapter.) For electric motors subject to energy conservation standards in subpart B of part 431 of this chapter and for which minimum values of average full-load efficiency are prescribed the represented value is the average full-load efficiency of a basic model of electric motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (See § 431.31(a) of this chapter.)

(v) *Minimum full-load efficiency*: To ensure a high level of quality control and consistency of performance within the basic model, the lowest full-load efficiency in the sample X_{min}, must satisfy the condition in equation 5 to this paragraph, where *Std* is the value of the applicable energy conservation standard. If the lowest measured full-load efficiency of a unit in the tested sample does not satisfy the condition in this section, then the basic model cannot be certified as compliant with the applicable standard.

Equation 5 to Paragraph (e)(1)(v)

$$x_{min} \geq \frac{100}{1 + 1.15\left(\frac{100}{SSSSSS} - 1\right)}$$

(2) *Alternative efficiency determination methods*. In lieu of testing, the represented value of a basic model of electric motor must be determined through the application of an AEDM pursuant to the requirements of § 429.70(j) and the provisions of this section, where:

(i) The average full-load efficiency of any basic model used to validate an AEDM must be calculated under paragraph (e)(1)(ii) of this section; and

(ii) For electric motors subject to energy conservation standards in subpart B of part 431 of this chapter and for which minimum values of nominal full-load efficiency are prescribed the represented value is the nominal full-load efficiency of a basic model of electric motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (See § 431.31(a) of this chapter) Determine the nominal full-load efficiency by selecting a value from the "Nominal Full-Load Efficiency" table in appendix B to subpart B of this part, that is no greater than the simulated full-load efficiency predicted by the

AEDM for the basic model. For electric motors subject to energy conservation standards in subpart B of part 431 of this chapter and for which minimum values of average full-load efficiency are prescribed the represented value is the average full-load efficiency of a basic model of electric motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (See § 431.31(a) of this chapter.)

*   *   *   *   *

3. Amend § 429.70 by revising paragraph (j)(2)(i)(D) to read as follows:

§ 429.70 Alternative methods for determining energy efficiency and energy use.

*   *   *   *   *

(j) *   *   *

(2) *   *   *

(i) *   *   *

(D) Each basic model must have the lowest represented value of nominal full-load efficiency or represented value of average full-load efficiency, as applicable, among the basic models within the same equipment class.

*   *   *   *   *

PART 431 - ENERGY CONSERVATION PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

4. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291-6317; 28 U.S.C. 2461.

5. Amend § 431.12 by adding, in alphabetical order, definitions for “Capacitor start capacitor run motor,” “Capacitor start induction run motor,” “Permanent split capacitor motor,” “Polyphase motor,” “Shaded pole motor,” and “Split-phase motor” to read as follows:

§ 431.12 Definitions.

* * * * *

Capacitor start capacitor run motor means a single-phase induction electric motor equipped with a start capacitor to provide the starting torque, as well as a run capacitor to maintain a running torque while the motor is loaded.

Capacitor start induction run motor means a single-phase induction electric motor equipped with a start capacitor to provide the starting torque, and is capable of operating without a run capacitor.

* * * * *

Permanent split capacitor motor means a single-phase induction electric motor that has a capacitor permanently connected in series with the starting winding of the motor and is permanently connected in the circuit both at starting and running conditions of the motor.

Polyphase motor means an electric motor that has a stator containing multiple distinct windings per motor pole, driven by corresponding time-shifted sine waves.

* * * * *

Shaded pole motor means a self-starting single-phase induction electric motor with a copper ring shading one of the poles.

* * * * *

Split-phase motor means a single-phase induction electric motor that possesses two windings: a main/running winding, and a starting/auxiliary winding.

* * * * *

6. Amend § 431.15 by revising paragraph (a) and adding a new paragraph (g) to read as follows:

§431.15 Materials incorporated by reference.

* * * * *

(a) Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the *Federal Register* and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at DOE and at the National Archives and Records Administration (NARA). Contact DOE at: The 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; phone: (202) 586-9127; email: *Buildings@ee.doe.gov*; website: *www.energy.gov/eere/buildings/appliance-and-equipment-standards-program.* For information on the availability of this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations* or email *fr.inspection@nara.gov.* The material may be obtained from the sources in the following paragraphs:

* * * * *

(g) UL. Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062 ; phone: (841) 272–8800; website: or go to*www.ul.com*.

(1) UL 674 ("UL 674-2022"), Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations, Sixth Edition, dated July 29, 2022; IBR approved for § 431.25.

(2) [Reserved]

7. Revise § 431.25 to read as follows:

§ 431.25 Energy conservation standards and compliance dates.

(a) For purposes of determining the required minimum nominal full-load efficiency or minimum average full-load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in any table of energy conservation standards in paragraphs (b) through (d) of this section, each such electric motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

(1) A horsepower at or above the midpoint between the two consecutive horsepowers shall be rounded up to the higher of the two horsepowers;

(2) A horsepower below the midpoint between the two consecutive horsepowers shall be rounded down to the lower of the two horsepowers; or

(3) A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kilowatt = ($^{1}/_{0.746}$) horsepower. The conversion should be calculated to three

significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraph (a)(1) or (a)(2) of this section, whichever applies.

(b) This paragraph applies to electric motors manufactured (alone or as a component of another piece of equipment) on or after June 1, 2016, but before June 1, 2027, that satisfy the criteria in paragraph (b)(1)(i) of this section, with the exclusion listed in paragraph (b)(1)(ii) of this section.

(1) *Scope*.

(i) The standards in paragraph (b)(2) of this section apply only to electric motors, including partial electric motors, that satisfy the following criteria:

(A) Are single-speed, induction motors;

(B) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(C) Contain a squirrel-cage (MG 1) or cage (IEC) rotor;

(D) Operate on polyphase alternating current 60-hertz sinusoidal line power;

(E) Are rated 600 volts or less;

(F) Have a 2-, 4-, 6-, or 8-pole configuration,

(G) Are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent),

(H) Produce at least one horsepower (0.746 kW) but not greater than 500 horsepower (373 kW); and

(I) Meet all of the performance requirements of one of the following motor types: A NEMA Design A, B, or C motor or an IEC Design N, NE, NEY, NY or H, HE, HEY, HY motor.

(ii) The standards in paragraph (b)(2) of this section do not apply to the following electric motors exempted by the Secretary, or any additional electric motors that the Secretary may exempt:

(A) Air-over electric motors;

(B) Component sets of an electric motor;

(C) Liquid-cooled electric motors;

(D) Submersible electric motors; and

(E) Inverter-only electric motors.

(2) *Standards*.

(i) Each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an electric motor meeting the criteria in paragraph (b)(1) of this section and with a power rating from 1 horsepower through 500 horsepower, but excluding fire pump electric motors, shall have a nominal full-load efficiency of not less than the following:

Table 1 to paragraph (b)(2)(i) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS) AT 60 HZ

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
1/.75	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20/15	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30/22	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40/30	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50/37	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60/45	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75/55	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100/75	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125/90	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
300/224	95.8	95.4	96.2	95.8	95.8	95.8		
350/261	95.8	95.4	96.2	95.8	95.8	95.8		
400/298	95.8	95.8	96.2	95.8				
450/336	95.8	96.2	96.2	96.2				
500/373	95.8	96.2	96.2	96.2				

(ii) Each NEMA Design C motor and IEC Design H (including HE, HEY, or HY variants) electric motor meeting the criteria in paragraph (b)(1) of this section and with a power rating from 1 horsepower through 200 horsepower, shall have a nominal full-load efficiency that is not less than the following:

Table 2 to paragraph (b)(2)(ii) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN C AND IEC DESIGN H, HE, HEY OR HY MOTORS AT 60 HZ

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency (%)					
	4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	92.4	93.0	91.7	91.7	89.5	90.2
20/15	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	93.6	93.6	93.0	93.0	90.2	91.0
30/22	93.6	94.1	93.0	93.6	91.7	91.7
40/30	94.1	94.1	94.1	94.1	91.7	91.7
50/37	94.5	94.5	94.1	94.1	92.4	92.4
60/45	95.0	95.0	94.5	94.5	92.4	93.0
75/55	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.4	95.4	95.0	95.0	93.6	94.1
125/90	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.8	95.8	95.8	95.4	94.1	94.1
200/150	96.2	95.8	95.8	95.4	94.5	94.1

(iii) Each fire pump electric motor meeting the criteria in paragraph (b)(1) of this section and with a power rating of 1 horsepower through 500 horsepower, shall have a nominal full-load efficiency that is not less than the following:

Table 3 to paragraph (b)(2)(iii) — NOMINAL FULL-LOAD EFFICIENCIES OF FIRE PUMP ELECTRIC MOTORS AT 60 HZ

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
1/.75	75.5		82.5	82.5	80.0	80.0	74.0	74.0
1.5/1.1	82.5	82.5	84.0	84.0	85.5	84.0	77.0	75.5

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
2/1.5	84.0	84.0	84.0	84.0	86.5	85.5	82.5	85.5
3/2.2	85.5	84.0	87.5	86.5	87.5	86.5	84.0	86.5
5/3.7	87.5	85.5	87.5	87.5	87.5	87.5	85.5	87.5
7.5/5.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	88.5
10/7.5	89.5	88.5	89.5	89.5	89.5	90.2	88.5	89.5
15/11	90.2	89.5	91.0	91.0	90.2	90.2	88.5	89.5
20/15	90.2	90.2	91.0	91.0	90.2	91.0	89.5	90.2
25/18.5	91.0	91.0	92.4	91.7	91.7	91.7	89.5	90.2
30/22	91.0	91.0	92.4	92.4	91.7	92.4	91.0	91.0
40/30	91.7	91.7	93.0	93.0	93.0	93.0	91.0	91.0
50/37	92.4	92.4	93.0	93.0	93.0	93.0	91.7	91.7
60/45	93.0	93.0	93.6	93.6	93.6	93.6	91.7	92.4
75/55	93.0	93.0	94.1	94.1	93.6	93.6	93.0	93.6
100/75	93.6	93.0	94.5	94.1	94.1	94.1	93.0	93.6
125/90	94.5	93.6	94.5	94.5	94.1	94.1	93.6	93.6
150/110	94.5	93.6	95.0	95.0	95.0	94.5	93.6	93.6
200/150	95.0	94.5	95.0	95.0	95.0	94.5	94.1	93.6
250/186	95.4	94.5	95.0	95.4	95.0	95.4	94.5	94.5
300/224	95.4	95.0	95.4	95.4	95.0	95.4		
350/261	95.4	95.0	95.4	95.4	95.0	95.4		
400/298	95.4	95.4	95.4	95.4				
450/336	95.4	95.8	95.4	95.8				
500/373	95.4	95.8	95.8	95.8				

(c) This paragraph applies to electric motors manufactured (alone or as a component of another piece of equipment) on or after June 1, 2027, but before January 1, 2029, that satisfy the criteria in paragraph (c)(1)(i) of this section, with the exclusion listed in paragraph (c)(1)(ii) of this section.

(1) *Scope.*

(i) The standards in paragraph (c)(2) of this section apply only to electric motors, including partial electric motors, that satisfy the following criteria:

(A) Are single-speed, induction motors;

(B) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(C) Contain a squirrel-cage (MG 1) or cage (IEC) rotor;

(D) Operate on polyphase alternating current 60-hertz sinusoidal line power;

(E) Are rated 600 volts or less;

(F) Have a 2-, 4-, 6-, or 8-pole configuration,

(G) Are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent), or have an air-over enclosure and a specialized frame size,

(H) Produce at least one horsepower (0.746 kW) but not greater than 750 horsepower (559 kW), and

(I) Meet all of the performance requirements of one of the following motor types: A NEMA Design A, B, or C motor or an IEC Design N, NE, NEY, NY or H, HE, HEY, HY motor.

(ii) The standards in paragraph (c)(2) of this section do not apply to the following electric motors exempted by the Secretary, or any additional electric motors that the Secretary may exempt:

(A) Component sets of an electric motor;

(B) Liquid-cooled electric motors;

(C) Submersible electric motors; and

(D) Inverter-only electric motors.

(2) *Standards*.

(i) Each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an electric motor meeting the criteria in paragraph (c)(1) of this section, and with a power rating from 1 horsepower through 750 horsepower, but excluding fire pump electric motors and air-over electric motors, shall have a nominal full-load efficiency of not less than the following:

Table 4 to paragraph (c)(2)(i) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS AND AIR-OVER ELECTRIC MOTORS) AT 60 HZ

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
1/.75	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20/15	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30/22	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40/30	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50/37	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60/45	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75/55	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.0	94.5	96.2	96.2	95.8	95.8	94.5	95.0
125/90	95.4	94.5	96.2	96.2	95.8	95.8	95.0	95.0
150/110	95.4	94.5	96.2	96.2	96.2	95.8	95.0	95.0
200/150	95.8	95.4	96.5	96.2	96.2	95.8	95.4	95.0
250/186	96.2	95.4	96.5	96.2	96.2	96.2	95.4	95.4
300/224	95.8	95.4	96.2	95.8	95.8	95.8		
350/261	95.8	95.4	96.2	95.8	95.8	95.8		

400/298	95.8	95.8	96.2	95.8				
450/336	95.8	96.2	96.2	96.2				
500/373	95.8	96.2	96.2	96.2				
550/410	95.8	96.2	96.2	96.2				
600/447	95.8	96.2	96.2	96.2				
650/485	95.8	96.2	96.2	96.2				
700/522	95.8	96.2	96.2	96.2				
750/559	95.8	96.2	96.2	96.2				

(ii) Each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an air-over electric motor meeting the criteria in paragraph (c)(1) of this section, built in a standard frame size, but excluding fire pump electric motors, and with a power rating from 1 horsepower through 250 horsepower, shall have a nominal full-load efficiency of not less than the following:

Table 5 to paragraph (c)(2)(ii) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY STANDARD FRAME SIZE AIR-OVER ELECTRIC MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS) AT 60 Hz

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
1/.75	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20/15	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30/22	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40/30	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50/37	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60/45	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75/55	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.0	94.5	96.2	96.2	95.8	95.8	94.5	95.0
125/90	95.4	94.5	96.2	96.2	95.8	95.8	95.0	95.0
150/110	95.4	94.5	96.2	96.2	96.2	95.8	95.0	95.0
200/150	95.8	95.4	96.5	96.2	96.2	95.8	95.4	95.0
250/186	96.2	95.4	96.5	96.2	96.2	96.2	95.4	95.4

(iii) Each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an air-over electric motor meeting the criteria in paragraph (c)(1) of this section, and with a power rating from 1 horsepower through 20 horsepower, built in a specialized frame size, but excluding fire pump electric motors, shall have a nominal full-load efficiency of not less than the following:

Table 6 to paragraph (c)(2)(iii) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY SPECIALIZED FRAME SIZE AIR-OVER ELECTRIC MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS) AT 60 HZ

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
1/.75	74.0	--	82.5	82.5	80.0	80.0	74.0	74.0
1.5/1.1	82.5	82.5	84.0	84.0	85.5	84.0	77.0	75.5
2/1.5	84.0	84.0	84.0	84.0	86.5	85.5	82.5	85.5
3/2.2	85.5	84.0	87.5	86.5	87.5	86.5	84.0	86.5
5/3.7	87.5	85.5	87.5	87.5	87.5	87.5	85.5	87.5
7.5/5.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	88.5
10/7.5	89.5	88.5	89.5	89.5	89.5	90.2		
15/11	90.2	89.5	91.0	91.0				
20/15	90.2	90.2	91.0	91.0				

(iv) Each NEMA Design C motor and IEC Design H (including HE, HEY, or HY variants) electric motor meeting the criteria in paragraph (c)(1) of this section, and with a power rating from 1 horsepower through 200 horsepower, but excluding air-over electric motors, shall have a nominal full-load efficiency that is not less than the following:

Table 7 to paragraph (c)(2)(iv) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN C AND IEC DESIGN H, HE, HEY OR HY MOTORS (EXCLUDING AIR-OVER ELECTRIC MOTORS) AT 60 HZ

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency (%)					
	4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	92.4	93.0	91.7	91.7	89.5	90.2
20/15	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	93.6	93.6	93.0	93.0	90.2	91.0
30/22	93.6	94.1	93.0	93.6	91.7	91.7
40/30	94.1	94.1	94.1	94.1	91.7	91.7
50/37	94.5	94.5	94.1	94.1	92.4	92.4
60/45	95.0	95.0	94.5	94.5	92.4	93.0
75/55	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.4	95.4	95.0	95.0	93.6	94.1
125/90	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.8	95.8	95.8	95.4	94.1	94.1
200/150	96.2	95.8	95.8	95.4	94.5	94.1

(v) Each fire pump electric motor meeting the criteria in paragraph (c)(1) of this section, and with a power rating of 1 horsepower through 500 horsepower, but excluding air-over electric motors, shall have a nominal full-load efficiency that is not less than the following:

Table 8 to paragraph (c)(2)(v) — NOMINAL FULL-LOAD EFFICIENCIES OF FIRE PUMP ELECTRIC MOTORS (EXCLUDING AIR-OVER ELECTRIC MOTORS) AT 60 HZ

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
1/.75	75.5		82.5	82.5	80.0	80.0	74.0	74.0
1.5/1.1	82.5	82.5	84.0	84.0	85.5	84.0	77.0	75.5
2/1.5	84.0	84.0	84.0	84.0	86.5	85.5	82.5	85.5
3/2.2	85.5	84.0	87.5	86.5	87.5	86.5	84.0	86.5
5/3.7	87.5	85.5	87.5	87.5	87.5	87.5	85.5	87.5
7.5/5.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	88.5
10/7.5	89.5	88.5	89.5	89.5	89.5	90.2	88.5	89.5
15/11	90.2	89.5	91.0	91.0	90.2	90.2	88.5	89.5
20/15	90.2	90.2	91.0	91.0	90.2	91.0	89.5	90.2
25/18.5	91.0	91.0	92.4	91.7	91.7	91.7	89.5	90.2
30/22	91.0	91.0	92.4	92.4	91.7	92.4	91.0	91.0
40/30	91.7	91.7	93.0	93.0	93.0	93.0	91.0	91.0
50/37	92.4	92.4	93.0	93.0	93.0	93.0	91.7	91.7
60/45	93.0	93.0	93.6	93.6	93.6	93.6	91.7	92.4
75/55	93.0	93.0	94.1	94.1	93.6	93.6	93.0	93.6
100/75	93.6	93.0	94.5	94.1	94.1	94.1	93.0	93.6
125/90	94.5	93.6	94.5	94.5	94.1	94.1	93.6	93.6
150/110	94.5	93.6	95.0	95.0	95.0	94.5	93.6	93.6
200/150	95.0	94.5	95.0	95.0	95.0	94.5	94.1	93.6
250/186	95.4	94.5	95.0	95.4	95.0	95.4	94.5	94.5
300/224	95.4	95.0	95.4	95.4	95.0	95.4		
350/261	95.4	95.0	95.4	95.4	95.0	95.4		
400/298	95.4	95.4	95.4	95.4				
450/336	95.4	95.8	95.4	95.8				
500/373	95.4	95.8	95.8	95.8				

(d) This paragraph applies to electric motors manufactured (alone or as a component of another piece of equipment) on or after January 1, 2029.

(1) The standards in paragraph (d)(1)(ii) of this section apply only to electric motors that satisfy the criteria in paragraph (d)(1)(i)(A) of this section and with the exclusion listed in paragraph (d)(1)(i)(B) of this section

(i) *Scope*.

(A) The standards in paragraph (d)(1)(ii) of this section apply only to electric motors, including partial electric motors, that satisfy the following criteria:

(1) Are single-speed, induction motors;

(2) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(3) Contain a squirrel-cage (MG 1) or cage (IEC) rotor;

(4) Operate on polyphase alternating current 60-hertz sinusoidal line power;

(5) Are rated 600 volts or less;

(6) Have a 2-, 4-, 6-, or 8-pole configuration,

(7) Are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent), or have an air-over enclosure and a specialized frame size,

(8) Produce at least one horsepower (0.746 kW) but not greater than 750 horsepower (559 kW), and

(9) Meet all of the performance requirements of one of the following motor types: A NEMA Design A, B, or C motor or an IEC Design N, NE, NEY, NY or H, HE, HEY, HY motor.

(B) The standards in paragraph (d)(1)(ii) of this section do not apply to the following electric motors exempted by the Secretary, or any additional electric motors that the Secretary may exempt:

(1) Component sets of an electric motor;

(2) Liquid-cooled electric motors;

(3) Submersible electric motors; and

(4) Inverter-only electric motors.

(ii) *Standards*.

(A) Each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an electric motor meeting the criteria in paragraph (d)(1)(i) of this section, and with a power rating from 1 horsepower through 750 horsepower, but excluding fire pump electric motors and air-over electric motors, shall have a nominal full-load efficiency of not less than the following:

Table 9 to paragraph (d)(1)(ii)(A) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS AND AIR-OVER ELECTRIC MOTORS) AT 60 HZ

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
1/.75	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20/15	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30/22	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40/30	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50/37	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60/45	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75/55	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.0	94.5	96.2	96.2	95.8	95.8	94.5	95.0
125/90	95.4	94.5	96.2	96.2	95.8	95.8	95.0	95.0
150/110	95.4	94.5	96.2	96.2	96.2	95.8	95.0	95.0
200/150	95.8	95.4	96.5	96.2	96.2	95.8	95.4	95.0
250/186	96.2	95.4	96.5	96.2	96.2	96.2	95.4	95.4
300/224	95.8	95.4	96.2	95.8	95.8	95.8		

350/261	95.8	95.4	96.2	95.8	95.8	95.8		
400/298	95.8	95.8	96.2	95.8				
450/336	95.8	96.2	96.2	96.2				
500/373	95.8	96.2	96.2	96.2				
550/410	95.8	96.2	96.2	96.2				
600/447	95.8	96.2	96.2	96.2				
650/485	95.8	96.2	96.2	96.2				
700/522	95.8	96.2	96.2	96.2				
750/559	95.8	96.2	96.2	96.2				

(B) Each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an air-over electric motor meeting the criteria in paragraph (d)(1)(i) of this section, and with a power rating from 1 horsepower through 250 horsepower, built in a standard frame size, but excluding fire pump electric motors, shall have a nominal full-load efficiency of not less than the following:

Table 10 to paragraph (d)(1)(ii)(B) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY STANDARD FRAME SIZE AIR-OVER ELECTRIC MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS) AT 60 HZ

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
1/.75	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20/15	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30/22	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40/30	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50/37	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60/45	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75/55	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.0	94.5	96.2	96.2	95.8	95.8	94.5	95.0
125/90	95.4	94.5	96.2	96.2	95.8	95.8	95.0	95.0
150/110	95.4	94.5	96.2	96.2	96.2	95.8	95.0	95.0
200/150	95.8	95.4	96.5	96.2	96.2	95.8	95.4	95.0
250/186	96.2	95.4	96.5	96.2	96.2	96.2	95.4	95.4

(C) Each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an air-over electric motor meeting the criteria in paragraph (d)(1)(i) of this section, and with a power rating from 1 horsepower through 20 horsepower, built in a specialized frame size, but excluding fire pump electric motors, shall have a nominal full-load efficiency of not less than the following:

Table 11 to paragraph (d)(1)(ii)(C) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY SPECIALIZED FRAME SIZE AIR-OVER ELECTRIC MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS) AT 60 HZ

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
1/.75	74.0	--	82.5	82.5	80.0	80.0	74.0	74.0
1.5/1.1	82.5	82.5	84.0	84.0	85.5	84.0	77.0	75.5
2/1.5	84.0	84.0	84.0	84.0	86.5	85.5	82.5	85.5
3/2.2	85.5	84.0	87.5	86.5	87.5	86.5	84.0	86.5
5/3.7	87.5	85.5	87.5	87.5	87.5	87.5	85.5	87.5
7.5/5.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	88.5
10/7.5	89.5	88.5	89.5	89.5	89.5	90.2		
15/11	90.2	89.5	91.0	91.0				
20/15	90.2	90.2	91.0	91.0				

(D) Each NEMA Design C motor and IEC Design H (including HE, HEY, or HY variants) electric motor meeting the criteria in paragraph (d)(1)(i) of this section, and with a power rating from 1 horsepower through 200 horsepower, but excluding air-over electric motors, shall have a nominal full-load efficiency that is not less than the following:

Table 12 to paragraph (d)(1)(ii)(D) — NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN C AND IEC DESIGN H, HE, HEY OR HY MOTORS (EXCLUDING AIR-OVER ELECTRIC MOTORS) AT 60 HZ

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency (%)					
	4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	85.5	85.5	82.5	82.5	75.5	75.5

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency (%)					
	4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1.5/1.1	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	92.4	93.0	91.7	91.7	89.5	90.2
20/15	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	93.6	93.6	93.0	93.0	90.2	91.0
30/22	93.6	94.1	93.0	93.6	91.7	91.7
40/30	94.1	94.1	94.1	94.1	91.7	91.7
50/37	94.5	94.5	94.1	94.1	92.4	92.4
60/45	95.0	95.0	94.5	94.5	92.4	93.0
75/55	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.4	95.4	95.0	95.0	93.6	94.1
125/90	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.8	95.8	95.8	95.4	94.1	94.1
200/150	96.2	95.8	95.8	95.4	94.5	94.1

(E) Each fire pump electric motor meeting the criteria in paragraph (d)(1)(i) of this section, and with a power rating of 1 horsepower through 500 horsepower, but excluding air-over electric motors, shall have a nominal full-load efficiency that is not less than the following:

Table 13 to paragraph (d)(1)(ii)(E) — NOMINAL FULL-LOAD EFFICIENCIES OF FIRE PUMP ELECTRIC MOTORS (EXCLUDING AIR-OVER ELECTRIC MOTORS) AT 60 HZ

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
1/.75	75.5		82.5	82.5	80.0	80.0	74.0	74.0
1.5/1.1	82.5	82.5	84.0	84.0	85.5	84.0	77.0	75.5
2/1.5	84.0	84.0	84.0	84.0	86.5	85.5	82.5	85.5
3/2.2	85.5	84.0	87.5	86.5	87.5	86.5	84.0	86.5

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
5/3.7	87.5	85.5	87.5	87.5	87.5	87.5	85.5	87.5
7.5/5.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	88.5
10/7.5	89.5	88.5	89.5	89.5	89.5	90.2	88.5	89.5
15/11	90.2	89.5	91.0	91.0	90.2	90.2	88.5	89.5
20/15	90.2	90.2	91.0	91.0	90.2	91.0	89.5	90.2
25/18.5	91.0	91.0	92.4	91.7	91.7	91.7	89.5	90.2
30/22	91.0	91.0	92.4	92.4	91.7	92.4	91.0	91.0
40/30	91.7	91.7	93.0	93.0	93.0	93.0	91.0	91.0
50/37	92.4	92.4	93.0	93.0	93.0	93.0	91.7	91.7
60/45	93.0	93.0	93.6	93.6	93.6	93.6	91.7	92.4
75/55	93.0	93.0	94.1	94.1	93.6	93.6	93.0	93.6
100/75	93.6	93.0	94.5	94.1	94.1	94.1	93.0	93.6
125/90	94.5	93.6	94.5	94.5	94.1	94.1	93.6	93.6
150/110	94.5	93.6	95.0	95.0	95.0	94.5	93.6	93.6
200/150	95.0	94.5	95.0	95.0	95.0	94.5	94.1	93.6
250/186	95.4	94.5	95.0	95.4	95.0	95.4	94.5	94.5
300/224	95.4	95.0	95.4	95.4	95.0	95.4		
350/261	95.4	95.0	95.4	95.4	95.0	95.4		
400/298	95.4	95.4	95.4	95.4				
450/336	95.4	95.8	95.4	95.8				
500/373	95.4	95.8	95.8	95.8				

(2) The standards in paragraph (d)(2)(ii) of this section apply only to electric motors that satisfy the criteria in paragraph (d)(2)(i)(A) of this section and with the exclusion listed in paragraph (d)(2)(i)(B) of this section

(i) *Scope*.

(A) The standards in paragraph (d)(2)(ii) of this section apply only to electric motors, including partial electric motors, that satisfy the following criteria:

(1) Are not small electric motors, as defined at § 431.442 and are not a dedicated pool pump motors as defined at § 431.483; and do not have an air-

over enclosure and a specialized frame size if the motor operates on polyphase power;

(2) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(3) Operate on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or are used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power;

(4) Are rated for 600 volts or less;

(5) Are single-speed induction motors capable of operating without an inverter or are inverter-only electric motors;

(6) Produce a rated motor horsepower greater than or equal to 0.25 horsepower (0.18 kW); and

(7) Are built in the following frame sizes: any two-, or three-digit NEMA frame size (or IEC equivalent) if the motor operates on single-phase power; any two-, or three-digit NEMA frame size (or IEC equivalent) if the motor operates on polyphase power, and has a rated motor horsepower less than 1 horsepower (0.75 kW); or a two-digit NEMA frame size (or IEC metric equivalent), if the motor operates on polyphase power, has a rated motor horsepower equal to or greater than 1 horsepower (0.75 kW), and is not an enclosed 56 NEMA frame size (or IEC metric equivalent).

(B) The standards in paragraph (d)(2)(ii) of this section do not apply to the following electric motors exempted by the Secretary, or any additional electric motors that the Secretary may exempt:

(1) Component sets of an electric motor;

(2) Liquid-cooled electric motors;

(3) Submersible electric motors;

(4) Inverter-only electric motors; and

(5) High-torque and medium-torque electric motor with explosion proof certification in accordance with UL 674-2022 (incorporated by reference, see § 431.15) and a rated motor horsepower of greater than or equal to 0.5 horsepower.

(ii) *Standards.*

(A) Each high-torque and medium-torque electric motor (*i.e.*, capacitor start induction run ("CSIR"), capacitor start capacitor run ("CSCR"), and split-phase motor) meeting the criteria in paragraph (d)(2)(i) of this section and with a power rating of greater than or equal to 0.25 horsepower and less than or equal to 3 horsepower, shall have an average full-load efficiency that is not less than the following:

Table 14 to paragraph (d)(2)(ii)(A) — AVERAGE FULL-LOAD EFFICIENCIES OF HIGH AND MEDIUM-TORQUE ELECTRIC MOTOR (*CSIR, CSCR,* AND *SPLIT-PHASE MOTORS*) AT 60 HZ

Motor Horsepower/Standard Kilowatt Equivalent	Average Full-Load Efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
.25/.19	59.5	59.5	59.5	59.5	57.5	57.5		

.33/.25	64.0	64.0	64.0	64.0	62.0	62.0	50.5	50.5
.5/.37	68.0	68.0	67.4	69.2	68.0	68.0	52.5	52.5
.75/.56	75.5	76.2	75.5	81.8	75.5	80.2	72.0	72.0
1/.75	77.0	80.4	80.0	82.6	77.0	81.1	74.0	74.0
1.5/1.1	81.5	81.5	81.5	83.8	80.0			
2/1.5	82.5	82.9	82.5	84.5				
3/2.2	84.0	84.1						

(B) Each low-torque electric motor (i.e., shaded pole and permanent split capacitor motor) meeting the criteria in paragraph (d)(2)(i) of this section and with a power rating of greater than or equal to 0.25 horsepower and less than or equal to 3 horsepower, shall have an average full-load efficiency of not less than the following:

Table 15 to paragraph (d)(2)(ii)(B) — AVERAGE FULL-LOAD EFFICIENCIES OF LOW-TORQUE ELECTRIC MOTOR (*SHADED POLE AND PERMANENT SPLIT CAPACITOR MOTORS*) AT 60 HZ

Motor Horsepower/Standard Kilowatt Equivalent	Average Full-Load Efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
.25/.19	60.9	63.9	64.1	66.1	59.2	60.2	52.5	52.5
.33/.25	63.9	66.9	67.7	69.7	64.0	65.0	56.6	56.6
.5/.37	65.8	68.8	68.1	70.1	65.8	66.8	57.1	57.1
.75/.56	67.5	70.5	72.8	74.8	72.1	73.1	62.8	62.8
1/.75	71.3	74.3	75.1	77.1	76.3	77.3	65.7	65.7
1.5/1.1	76.9	79.9	80.1	82.1	79.5	80.5	72.2	72.2
2/1.5	78.0	81.0	80.9	82.9	80.4	81.4	73.3	73.3
3/2.2	79.4	82.4	82.0	84.0	81.5	82.5	74.9	74.9

(C) Each polyphase electric motor meeting the criteria in paragraph (d)(2)(i) of this section and with a power rating of greater than or equal to 0.25 horsepower and less than or equal to 3 horsepower, shall have an average full-load efficiency of not less than the following:

Table 16 to paragraph (d)(2)(ii)(C) — AVERAGE FULL-LOAD EFFICIENCIES OF POLYPHASE ELECTRIC MOTOR AT 60 HZ

Motor Horsepower/Standard Kilowatt Equivalent	Average Full-Load Efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
.25/.19	66.0	65.6	68.0	69.5	66.0	67.5	62.0	62.0
.33/.25	70.0	69.5	72.0	73.4	70.0	71.4	64.0	64.0
.5/.37	72.0	73.4	75.5	78.2	72.0	75.3	66.0	66.0
.75/.56	75.5	76.8	77.0	81.1	74.0	81.7	70.0	70.0
1/.75	75.5	77.0	77.0	83.5	74.0	82.5	75.5	75.5
1.5/1.1	84.0	84.0	82.5	86.5	87.5	83.8	78.5	77.0
2/1.5	85.5	85.5	85.5	86.5	88.5		84.0	86.5
3/2.2	86.5	85.5	86.5	86.9	89.5		85.5	87.5

8. Amend appendix B to subpart B of part 431 by:

(a) Revising section 1.1;

(b) Adding, in alphabetical order, in section 1.2, the definition for "Expanded scope electric motor (ESEM)";

(c) Removing the definition in section 1.2 for "Small, non-small-electric-motor electric motor ("SNEM")"; and

(d) Revising sections 2.3, 2.3.1, and 2.3.3.

The revisions and addition read as follows:

Appendix B to Subpart B of Part 431: Uniform Test Method for Measuring the Efficiency of Electric Motors

* * * * *

1. * * *

1.1 The test procedure applies to the following categories of electric motors: Electric motors that meet the criteria listed at § 431.25(g); Electric motors above 500 horsepower; Expanded scope electric motors; and Electric motors that are synchronous motors; and excludes the following categories of motors: inverter-only electric motors that are air-over electric motors, component sets of an electric motor, liquid-cooled electric motors, and submersible electric motors.

1.2 * * *

* * * * *

Expanded scope electric motor (ESEM) means an electric motor that:

(a) Is not a small electric motor, as defined at § 431.442 and is not a dedicated-purpose pool pump motor as defined at § 431.483;

(b) Is rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(c) Operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or is used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power;

(d) Is rated for 600 volts or less;

(e) Is a single-speed induction motor capable of operating without an inverter or is an inverter-only electric motor;

(f) Produces a rated motor horsepower greater than or equal to 0.25 horsepower (0.18 kW); and

(g) Is built in the following frame sizes: any two-, or three-digit NEMA frame size (or IEC metric equivalent) if the motor operates on single-phase power; any two-, or three-digit NEMA frame size (or IEC metric equivalent) if the motor operates on polyphase power, and has a rated motor horsepower less than 1 horsepower (0.75 kW); or a two-digit NEMA frame size (or IEC metric equivalent), if the motor operates on polyphase power, has a rated motor horsepower equal to or greater than 1 horsepower (0.75 kW), and is not an enclosed 56 NEMA frame size (or IEC metric equivalent).

*   *   *   *   *

2. *   *   *

2.3. Test Procedures for ESEMs capable of operating without an inverter. Air-over ESEMs must be tested in accordance with section 2.2. of this appendix. Inverter-only ESEMs must be tested in accordance with section 2.4. of this appendix.

2.3.1. The efficiencies and losses of single-phase ESEMs that are not air-over electric motors and are capable of operating without an inverter, are determined using one of the following methods:

*   *   *   *   *

2.3.3. The efficiencies and losses of polyphase ESEMs with rated horsepower equal to or greater than 1 that are not air-over electric motors, and are capable of operating without an inverter, are determined using one of the following methods:

*   *   *   *   *

Note: The following letter will not appear in the Code of Federal Regulations.

U.S. DEPARTMENT OFJUSTICE

Antitrust Division

David G. B. Lawrence

Policy Director

Main Justice Building

950 Pennsylvania Avenue, N.W.

Washington, D.C. 20530-0001

February 20, 2024

Ami Grace-Tardy

Assistant General Counsel for Legislation, Regulation and Energy Efficiency

U.S. Department of Energy Washington, DC 20585

Ami.Grace-Tardy@hq.doe.gov

Re: Energy Conservation Standards for Expanded Scope Electric Motors, DOE Docket No. EERE-202-BT-STD-0007

Dear Assistant General Counsel Grace-Tardy:

I am responding to your December 19, 2023, letter seeking the views of the Attorney General about the potential impact on competition of proposed energy conservation standards for expanded scope electric motors.

Your request was submitted under Section 325(o)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended (ECPA), 42 U.S.C. 6295(o)(2)(B)(i)(V), which requires the Attorney General to make a determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy conservation standards. The Attorney General's responsibility for responding to requests from other departments about the effect of a program on competition has been delegated to the Assistant Attorney General for the Antitrust Division in 28 CFR § 0.40(g). The Assistant Attorney General for the Antitrust Division has authorized me, as the Policy Director for the Antitrust Division, to provide the Antitrust Division's views regarding the potential impact on competition of proposed energy conservation standards on his behalf.

In conducting its analysis, the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice, by placing certain manufacturers at an unjustified competitive disadvantage, or by inducing avoidable inefficiencies in production or distribution of particular products. A lessening of competition could result in higher prices to manufacturers and consumers.

We have reviewed the proposed standards contained in the Notice of proposed rulemaking and request for comment (88 Fed. Reg. 87062, December 15, 2023) and the related Technical Support Document. We have also reviewed public comments and information presented at the Webinar of the Public Meeting held on January 17, 2024.

Based on this review, our conclusion is that the proposed energy conservation standards for expanded scope electric motors are unlikely to have a significant adverse impact on competition.

Sincerely,

David G. B. Lawrence

Policy Director