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DEPARTMENT OF ENERGY

10 CFR Part 431

[EERE–2019-BT-STD-0008]

RIN 1904-AD29

Energy Conservation Program: Energy Conservation Standards for Small Electric Motors

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

ACTION: Final determination.

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 small electric motors (“SEMs”). EPCA also requires the U.S. Department of Energy (“DOE”) to periodically determine whether more-stringent standards would be technologically feasible and economically justified, and would result in significant conservation of energy. In this final determination, DOE has determined that more stringent SEMs standards would not be cost effective, and thus has determined that standards for SEMs should not be amended.

DATES: The effective date of this final determination is [**INSERT DATE OF PUBLICATION IN THE *FEDERAL REGISTER***].

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

The docket web page can be found at: *https://www.regulations.gov/docket?D=EERE-2019-BT-STD-0008*. The docket webpage contains instructions on how to access all documents, including public comments, in the docket.

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

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Final Determination

Title III, Part C[1] of the Energy Policy and Conservation Act, as amended ("EPCA"),[2] established the Energy Conservation Program for Certain Industrial Equipment, (42 U.S.C. 6311-6317), which includes small electric motors ("SEMs"), the subject of this final determination.

Pursuant to the EPCA requirement that not later than 6 years after issuance of any final rule establishing or amending an energy conservation standard for covered equipment, DOE must publish either a notice of determination that standards for the equipment do not need to be amended, or a notice of proposed rulemaking ("NOPR") including new proposed energy conservation standards. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m))

DOE analyzed the SEMs currently subject to the standards found at title 10 of the Code of Federal Regulations ("CFR") part 431. See 10 CFR 431.446. Of these motors, DOE first analyzed the technological feasibility of more efficient SEMs. For currently available SEMs with efficiencies exceeding the levels of the current energy conservation standards, DOE determined that more stringent standards would be technologically feasible. For these SEMs, DOE evaluated whether more stringent standards would also be

[1] For editorial reasons, upon codification in the U.S. Code, Part C was re-designated Part A-1.
[2] All references to EPCA in this document refer to the statute as amended through America's Water Infrastructure Act of 2018, Public Law 115-270 (October 23, 2018).

cost effective by conducting preliminary life-cycle cost ("LCC") and payback period ("PBP") analyses.

Based on these analyses, as summarized in section V of this document, DOE has determined that more stringent energy conservation standards would not be cost effective. Therefore, DOE has determined that the current standards for SEMs do not need to be amended.

II. Introduction

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

A. Authority and Background

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part C of EPCA includes the small electric motors that are the subject of this final determination. (42 U.S.C. 6311(13)(G)) As discussed in the following paragraphs, EPCA directed DOE to establish test procedures and prescribe energy conservation standards for SEMs. (42 U.S.C. 6317(b))

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

EPCA directed DOE to establish a test procedure for those SEMs for which DOE determined that energy conservation standards would (1) be technologically feasible and economically justified and (2) result in significant energy savings. (42 U.S.C. 6317(b)(1)) Manufacturers of covered equipment must use the Federal test procedures as the basis for: (1) certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(a); 42 U.S.C. 6295(s)), and (2) making representations about the efficiency of that equipment (42 U.S.C. 6314(d)). The DOE test procedures for SEMs appear at 10 CFR part 431, subpart X.

EPCA further directed DOE to prescribe energy conservation standards for those SEMs for which test procedures were established. (42 U.S.C. 6317(b)(2)) Additionally, EPCA prescribed that any such standards shall not apply to any SEM which is a component of a covered product under 42 U.S.C. 6292(a) or covered equipment under 42 U.S.C. 6311 of EPCA. (42 U.S.C. 6317(b)(3)) Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (See 42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297(a)-(c)).

EPCA requires that, not later than 6 years after the issuance of any final rule establishing or amending a standard, DOE evaluate the energy conservation standards for each type of covered equipment, including those at issue here, and publish either a notice of determination that the standards do not need to be amended, or a NOPR that includes new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)). EPCA further provides that, not later than 3 years after the issuance of a final determination not to amend standards, DOE must make a new determination not to amend the standards or issue a NOPR including new proposed energy conservation standards. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(3)(B)) DOE must make the analysis on which a determination is based publicly available and provide an opportunity for written comment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(2))

In making a determination that the standards do not need to be amended, DOE must evaluate under the criteria of 42 U.S.C. 6295(n)(2) whether amended standards (1) will result in significant conservation of energy, (2) are technologically feasible, and (3) are cost effective as described under 42 U.S.C. 6295(o)(2)(B)(i)(II). (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)) Under 42 U.S.C. 6295(o)(2)(B)(i)(II), an evaluation of cost effectiveness requires DOE to consider savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products which are likely to result from the imposition of the standard.

DOE is publishing this document in accordance with its authority under EPCA, and in satisfaction of its statutory requirement under EPCA.

1. Current Standards

The current energy conservation standards for SEMs are located in title 10 CFR 431.446, and are presented in Table II-1 and Table II-2.

Table II-1 Federal Energy Conservation Standards for Polyphase Small Electric Motors

Motor horsepower/standard kilowatt equivalent	Average full load efficiency
	Open motors (number of poles)

	6	4	2
0.25/0.18	67.5	69.5	65.6
0.33/0.25	71.4	73.4	69.5
0.5/0.37	75.3	78.2	73.4
0.75/0.55	81.7	81.1	76.8
1/0.75	82.5	83.5	77.0
1.5/1.1	83.8	86.5	84.0
2/1.5	N/A	86.5	85.5
3/2.2	N/A	86.9	85.5

Table II-2 Federal Energy Conservation Standards for Capacitor-Start Induction-Run and Capacitor-Start Capacitor-Run Small Electric Motors

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Open motors (number of poles)		
	6	4	2
0.25/0.18	62.2	68.5	66.6
0.33/0.25	66.6	72.4	70.5
0.5/0.37	76.2	76.2	72.4
0.75/0.55	80.2	81.8	76.2
1/0.75	81.1	82.6	80.4
1.5/1.1	N/A	83.8	81.5
2/1.5	N/A	84.5	82.9
3/2.2	N/A	N/A	84.1

2. History of Standards Rulemakings for Small Electric Motors

In 2006, DOE determined that energy conservation standards for certain single-phase, capacitor-start, induction-run, SEMs are technologically feasible and economically justified, and would result in significant energy savings. 71 FR 38799 (July 10, 2006). Later, in 2010, DOE issued a final rule (the “March 2010 Final Rule”) establishing energy conservation standards for SEMs manufactured starting on March 9, 2015.[3] 75 FR 10874 (March 9, 2010).

In April 2019, DOE published a request for information (“April 2019 ECS RFI”) to solicit input and data from interested parties to aid in the development of the technical analyses for the determination of whether new and/or amended standards for SEMs are warranted. 84 FR 14027 (April 9, 2019). The comment period was re-opened in response

[3] In a technical correction, DOE revised the compliance date for energy conservation standards to March 9, 2015, for each small electric motor manufactured (alone or as a component of another piece of non-covered equipment), or March 9, 2017, in the case of a small electric motor which requires listing or certification by a nationally recognized safety testing laboratory. 75 FR 17036 (April 5, 2010).

to a request from an interested party, see NEMA, No. 4 at p. 1, until June 7, 2019. See 84 FR 25203 (May 31, 2019).

In April 2020, DOE published a notice of proposed determination ("April 2020 NOPD") with the tentative determination that energy conservation standards for SEMs do not need to be amended. 85 FR 24146 (April 30, 2020). The comment period for this notice closed on June 29, 2020. On September 18, 2020, DOE published a notification of webinar public meeting and a limited reopening of the comment period ("September 2020 Notice"), which extended the comment period to October 20, 2020. 85 FR 58299. On October 6, 2020, DOE held a webinar to present the results from the April 2020 NOPD.

DOE received nine relevant comments from interested parties in response to the April 2020 NOPD and the September 2020 Notice. These comments are listed in Table II-3.[4] NEMA and CA IOUs each had two separate comment submissions: one in response to the April 2020 NOPD and another as a follow up to the September 2020 Notice.

[4] DOE received two comments unrelated to the issues raised by the Notice of Proposed Determination (See Crosby, No. 30 and Crosby, No. 31).

Table II-3 April 2020 NOPD and September 2020 Notice Written Comments

Commenter / Organization(s)	Reference in this NOPD	Organization Type
Air-Conditioning, Heating, and Refrigeration Institute ("AHRI") and Association of Home Appliance Manufacturers ("AHAM")	AHRI and AHAM	Trade Associations
Appliance Standards Awareness Project ("ASAP"), Alliance to Save Energy, American Council for an Energy-Efficient Economy, the California Energy Commission, and Northwest Energy Efficiency Alliance	ASAP, et al.	Advocacy Groups and State Governmental Agency
California Investor-Owned Utilities ("CA IOUs") -- Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison	CA IOUs	Utilities
General Electric Appliances ("GEA")	GEA	Manufacturer
Lennox International Inc.	Lennox	Manufacturer
National Electrical Manufacturers Association ("NEMA")	NEMA	Trade Association

DOE also notes that NEMA submitted a comment related to certification, compliance and enforcement issues, but this comment fell outside the scope of this rulemaking and is not addressed in this document. Additionally, DOE received a comment from an individual commenter (Tyler Crosby) who noted the potential impact of small electric motors standards to increase the number electric bicycle users – an outcome that the commenter supported. While DOE appreciates this feedback, it also falls outside of the specific issues raised in the NOPD. The remaining relevant comments and DOE's responses are provided in the appropriate sections of this document.

III. General Discussion

A. Scope of Coverage and Equipment Classes

This document covers equipment meeting the definition of "small electric motor," as codified in 10 CFR 431.442 and consistent with the statutory definition set by Congress for this 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, including IEC metric equivalent motors." 10 CFR 431.442.[5] The scope of coverage for these motors is discussed in further detail in section IV.A.1 of this document.

When evaluating and establishing energy conservation standards, DOE divides covered equipment into equipment classes by the type of energy used, or by capacity or other performance-related features that justify a different standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)) In determining whether capacity or another performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE deems appropriate. (*Id.*) The equipment classes for this final determination are discussed further in section IV.A.2 of this document.

B. Test Procedure

As noted, EPCA directed DOE to establish a test procedure for those SEMs for which DOE determined that energy conservation standards would (1) be technologically feasible and economically justified and (2) result in significant energy savings. (42 U.S.C. 6317(b)(1))

In April 2019, DOE proposed amending its test procedure for SEMs ("April 2019 NOPR"). 84 FR 17004 (April 23, 2019). In the April 2019 NOPR, DOE proposed to harmonize its procedure with industry practice by incorporating a new industry standard that manufacturers would be permitted to use in addition to the three industry standards currently incorporated by reference as options for use when testing SEM efficiency. 84 FR 17004, 17012-17014. The proposed industry standards from the Institute of Electrical

[5] The term "IEC" refers to the International Electrotechnical Commission.

and Electronics Engineers ("IEEE"), Canadian Standards Association ("CSA"), and the International Electrotechnical Commission ("IEC") are listed in Table III-1. In addition, DOE proposed to adopt industry provisions related to the test conditions used to ensure the comparability of test results for SEMs. 84 FR 17004, 17014-17018.

Table III-1 April 2019 NOPR Proposed Industry Standards for Small Electric Motors

Equipment Description	Industry Test Procedure
Single-phase small electric motors	IEEE 114-2010 CSA C747-09 IEC 60034-2-1:2014 Method 2-1-1A
Polyphase small electric motors less than or equal to 1 horsepower	IEEE 112-2017 Test Method A CSA C747-09 IEC 60034-2-1:2014 Method 2-1-1A
Polyphase small electric motors greater than 1 horsepower	IEEE 112-2017 Test Method B CSA C390-10 IEC 60034-2-1:2014 Method 2-1-1B

C. Technological Feasibility

1. General

In evaluating potential amendments to energy conservation standards, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the product or equipment at issue. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially available equipment or in working prototypes to be technologically feasible. See 10 CFR part 430, subpart C, appendix A, sections 6(c)(3)(i) and 7(b)(1); 10 CFR 431.4.

After DOE has determined that particular options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on equipment utility or availability; (3) adverse impacts on health or safety; and (4) unique-pathway proprietary technologies. 10 CFR part 430, subpart C, appendix A, sections 6(c)(3)(ii)-(v) and 7(b)(2)-(5); 10 CFR 431.4.

Section IV.B of this final determination discusses the results of the screening analysis for SEMs, particularly the designs DOE considered, those it screened out, and those that are the basis for the final determination. In this final determination, based on its review of the market and comments received in response to the April 2020 NOPD and September 2020 Notice, DOE has determined that no significant technical advancements in induction motor technology within the scope of SEMs have been made since publication of the March 2010 Final Rule.

2. Maximum Technologically Feasible Levels

When DOE evaluates the potential for new or amended standards, DOE must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible ("max tech") improvements in energy efficiency for SEMs using the design parameters for the most efficient equipment available on the market or in working prototypes. The max-tech levels that DOE has determined are described in section IV.C of this final determination.

D. Significance of Energy Savings

In determining whether to amend the current energy conservation standards for SEMs, DOE must assess whether amended standards will result in significant conservation of energy. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A). See also 42 U.S.C. 6295(n)(2).) While the term "significant" is not defined in EPCA, DOE has established a significance threshold for energy savings. See 10 CFR part 430, subpart C, appendix A, section 6(b); 10 CFR 431.4. In evaluating the significance of energy savings, DOE conducts a two-step approach that considers both an absolute site energy savings threshold and a threshold that is percent reduction in the covered equipment energy use. *Id.* DOE first evaluates the projected energy savings from a potential maximum technologically feasible ("max-tech") standard over a 30-year period against a 0.3 quads of site energy threshold. 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, section 6(b)(2). If the 0.3 quad-threshold is not met, DOE then compares the max-tech savings to the total energy usage of the covered equipment to calculate a percentage reduction in energy usage. 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, section 6(b)(3). If this comparison does not yield a reduction in site energy use of at least 10 percent over a 30-year period, the analysis ends and DOE proposes that no significant energy savings would likely result from setting new or amended standards. 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, section 6(b)(3). The two-step approach allows DOE to ascertain whether a potential standard satisfies EPCA's significant energy savings requirements in EPCA to ensure that DOE avoids setting a standard that "will not result in significant conservation of energy."

EPCA defines "energy efficiency" as the ratio of the useful output of services from an article of industrial equipment to the energy use of such article, measured according to the Federal test procedures. (42 U.S.C. 6311(3)) EPCA defines "energy use" as the quantity of energy directly consumed by an article of industrial equipment at the point of use, as measured by the Federal test procedures. (42 U.S.C. 6311(4))

As discussed in section V.B of this document, DOE has determined that amended standards would not satisfy the cost-effectiveness criterion as required by EPCA when determining whether to amend its standards for a given covered product or equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)(C)) See also sections IV.F and V.B (discussing in greater detail DOE's analysis of the available data in reaching this determination). Consequently, DOE did not separately determine whether the potential energy savings would be significant for the purpose of 42 U.S.C. 6295(n)(2).

E. Cost Effectiveness

In making a determination of whether amended energy conservation standards are needed, EPCA requires DOE to consider the cost effectiveness of amended standards in the context of the savings in operating costs throughout the estimated average life of the covered equipment class compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered equipment that are likely to result from a standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A); 42 U.S.C. 6295(n)(2))

In determining cost effectiveness, DOE conducted LCC and PBP analyses that estimate the costs and benefits to users from standards. The LCC is the sum of the initial price of equipment (including its installation) and the operating expense (including energy, maintenance, and repair expenditures) discounted over the lifetime of the equipment. The LCC analysis requires a variety of inputs, such as equipment prices, equipment energy consumption, energy prices, maintenance and repair costs, equipment lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as equipment lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

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

For its LCC and PBP analyses, DOE assumes that consumers would purchase the covered equipment in the first year of compliance with any 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 amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F of this final determination.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE performed for this final determination regarding SEMs. Separate subsections address each component of DOE's analyses and responses to related comments. DOE used a spreadsheet tool that calculates the LCC savings and PBP of potential energy conservation standards. This spreadsheet tool is available on the website: *https://www.regulations.gov/docket?EERE–2019-BT-STD-0008*

Lennox supported DOE's proposed determination not to amend energy conservation standards for SEMs. (Lennox, No. 21 at p. 1) NEMA concurred with DOE that it is not cost effective to increase the stringency of SEM energy conservation standards. (NEMA, No. 22 at p. 5; NEMA, No. 32 at p. 2-3) CA IOUs also concurred with DOE that there is limited opportunity for additional energy efficiency in the current scope of regulation for SEMs. (CA IOUs, No. 24 at p. 2; CA IOUs, No. 33 at p. 2) As discussed previously, based on the analyses summarized in section V of this document, DOE has determined that more stringent energy conservation standards would not be cost effective. Therefore, DOE has determined that the current standards for SEMs do not need to be amended under the relevant criteria in 42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2). See also 42 U.S.C. 6316(a) (applying 42 U.S.C. 6295(m) and 42 U.S.C. 6295(n) to small electric motors).

A. Market and Technology Assessment

DOE has conducted a market and technology assessment in support of the final determination for SEMs. DOE develops information in the market and technology assessment that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, manufacturers, market characteristics, and technologies used in the equipment. This activity includes both quantitative and qualitative assessments, based primarily on publicly available information. The subjects addressed in the market and technology assessment for this final determination include (1) a determination of the scope and equipment 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 SEMs. The key findings of DOE's market assessment are summarized in the following sections. See chapter 3 of the final determination technical support document ("TSD") for further discussion of the market and technology assessment.

1. Scope of Coverage

By statute, a "small electric motor" is "a NEMA general purpose alternating-current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG 1–1987." (42 U.S.C. 6311(13)(G)) DOE later clarified by regulation that this definition also includes IEC metric equivalent motors – i.e. those motors that otherwise satisfy the statutory definition of "small electric motor" but that happen to be built in accordance with metric units. See 10 CFR 431.442. Equipment meeting this definition are within DOE's scope of coverage but not all may be subject to DOE's current standards.

DOE's standards regulate the energy efficiency of those SEMs that fall within three topologies (i.e. arrangements of component parts): capacitor-start induction-run ("CSIR"), capacitor-start capacitor-run ("CSCR"), and polyphase motors. See 10 CFR 431.446. EPCA prescribes that standards for SEMs do not apply to any SEM which is a component of a covered product or covered equipment under EPCA. (42 U.S.C. 6317(b)(3)) DOE's current energy conservation standards only apply to SEMs manufactured alone or as a component of another piece of non-covered equipment. 10 CFR 431.446(a).

Subpart X of part 431 includes energy conservation standards and test procedures for the SEMs listed in Table IV-1. In the April 2020 NOPD, DOE did not propose any changes to the scope of SEMs subject to energy conservation standards (i.e., "scope of applicability").

Table IV-1 Small Electric Motors Currently Subject to Energy Conservation Standards (manufactured alone or as a component of another piece of non-covered equipment)

<table>
<tr><th colspan="2">Motor Topology</th><th>Pole Configuration</th><th>Motor Output Power</th></tr>
<tr><td rowspan="2">Single-phase</td><td>CSIR</td><td>2, 4, 6</td><td>0.25 – 3 hp
(0.18 – 2.2 kW)*</td></tr>
<tr><td>CSCR</td><td>2, 4, 6</td><td>0.25 – 3 hp
(0.18 – 2.2 kW)</td></tr>
<tr><td colspan="2">Polyphase</td><td>2, 4, 6</td><td>0.25 – 3 hp
(0.18 – 2.2 kW)</td></tr>
<tr><td colspan="4">Certain motor categories are not currently subject to standards. These include:
• Polyphase, 6-pole, 2 and 3 hp motors;
• CSCR and CSIR, 6-pole, 1.5, 2, and 3 hp motors;
• CSCR and CSIR, 4-pole, 3 hp motors.
*The values in parentheses are the equivalent metric ratings.</td></tr>
</table>

In response to the April 2020 NOPD and September 2020 Notice, DOE received a number of comments relevant to the scope of applicability of energy conservation standards for SEMs. Lennox, AHRI and AHAM supported maintaining the existing standards scope for SEMs. (Lennox, No. 21 at p. 2; AHRI and AHAM, No. 25 at p. 2) In addition, NEMA stated that motor efficiency has reached its peak of practicality, and that system efficiency in applications must be the focus. NEMA commented in support of DOE's efforts investigating or already establishing Extended Product Rulemakings (*e.g.,* pumps) which set a system efficiency, rather than continue to focus on components (*i.e,.* the motor). (NEMA, No. 32 at p. 2)

The Efficiency Advocates asserted that given DOE’s mandate to carry out the energy conservation purposes of the Energy Policy and Conservation Act, DOE must consider expanding the scope of its motor standards, either in this docket or the electric motors docket. (Efficiency Advocates, No. 23 at p. 2) Similarly, the CA IOUs commented that there is limited opportunity for additional energy efficiency gains in the current scope of regulation for SEMs and added that the industry technical standards on which the current SEM definition is based – NEMA MG1-1987 -- is no longer representative of the market. (CA IOUs, No. 24 at p. 2; No. 33 at p. 2)

In the view of the CA IOUs, DOE should expand the scope of the SEM rulemaking to consider advances in motor technology and incorporate brushless direct current (DC) and synchronous permanent magnet AC ("PMAC") motors, irrespective of the limits already defined by Congress. See 42 U.S.C. 6311(13)(G) (defining the term "small electric motor") and 10 CFR 431.442 (incorporating motors meeting the statutory definition that are built in metric units). The CA IOUs provided an analysis and market data and technical information as to the energy savings potential, cost, and technical feasibility of brushless DC motors such as electronically commutated motors ("ECMs") and PMAC motors compared to other available motor technologies such as permanent-split capacitor ("PSC") motors. The CA IOUs further commented that motor consumers and regulators in other markets are already considering advanced motor technologies as substitutes for SEMs within the current scope of DOE's energy conservation standards. (CA IOUs, No. 24 at p. 2-7; No. 33 at p. 2-8)

In addition, the CA IOUs recommended that DOE consider expanding the definition of SEMs beyond the "general purpose motor" definition included in NEMA MG1-1987 (and as specified in the statute) to include additional motors used in general purpose applications such as split-phase, shaded pole, and PSC motors. In cases where the application requirements rely on part-load operation, the CA IOUs recommended that these motors be compared in a technology-neutral manner against other motor designs optimized for part load operation (i.e., brushless DC, synchronous PMAC/Q-Sync). (CA IOUs, No. 24 at p. 7; No. 33 at p. 8-9)

Regarding the potential coverage of ECMs, NEMA commented that ECMs were not squirrel cage induction motors but instead are permanent magnet synchronous motors with electronic controls/drives integral to the machine and were not included in the scope of SEMs (NEMA, No. 32 at p. 2)[6]. In addition, NEMA commented that ECMs tend to be more expensive than single-speed SEMs, and typically installed as components in appliances that DOE already regulates. In these instances, strict energy efficiency requirements on those appliances and the use of better motor controls outweigh the increased expense of using ECMs. NEMA added that making ECMs more efficient would not make regulated appliances more efficient because of component efficiency tradeoffs in satisfying efficiency requirements and protections from double-regulation. (NEMA, No. 32 at p. 2-3) NEMA commented that bringing ECMs into scope could have significant impacts on Original Equipment Manufacturers ("OEMs"). NEMA added that ECMs are not drop-in fit replacements for SEMs and that DOE has not sufficiently examined the downstream impacts of adding such motors in scope on OEMs. (NEMA, No. 32 at p. 2) Regarding PMAC/Q-sync designs, NEMA noted that such PMAC/Q-sync motors did not meet NEMA MG-1-1987 torque requirements and were not effective substitutes for SEMs, as indicated by their small market share. (NEMA, No. 32 at p. 3)

As previously stated in section III.A, this document 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: split-phase, shaded-pole, capacitor-start (both CSIR and CSCR), PSC, and polyphase. Of these five motor categories, DOE determined in the March 2010 Final Rule that only CSIR, CSCR, and polyphase motors were able to meet

[6] DOE notes that the definition of a SEM only includes single speed induction motors.

the relevant performance requirements in NEMA MG1-1987 and fell within the general purpose alternating current motor category, as indicated by the listings found in manufacturers' catalogs. 75 FR 10874, 10882-10883. Therefore, for this determination, DOE only considered the regulated SEMs currently subject to energy conservation standards.[7]

AHAM and AHRI referenced the statutory exemption regarding the application of energy conservation standards for SEMs that are components of covered products (42 U.S.C. 6317(b)(3)) and requested that DOE interpret the exemption to apply to all SEMs destined for or used in covered products or equipment. (AHAM and AHRI, No. 25 at p. 4) Lennox commented that it opposes regulating components used in products and equipment already regulated by DOE, instead it supports a finished-product approach to energy efficiency regulation. (Lennox, No. 21 at p. 2) GEA commented that any regulation of individual components in products whose energy consumption is regulated on a product level will provide little to no energy savings for consumers, will disrupt the complex balance of component selection and design, and will likely increase cost for consumers for no benefit to consumers. (GEA, No. 26 at p. 2) NEMA commented that because SEMs are always used as a component in larger product systems that consume electricity, there already exist dozens of appliance- and device-level regulations that address energy consumption of those end-use products. NEMA suggested examining and measuring energy savings at the end-use device makes the most sense, as system

[7] DOE also notes that were it to determine that expansion of the scope is warranted and permissible, it would first need to establish test methods for any such motors. See 10 CFR 431.4; 10 CFR part 430 subpart C appendix A section 8(d). Nothing DOE has reviewed – or that commenters have submitted – suggests that the existing test procedures for SEM are appropriate for motors that fall outside of the already prescribed small electric motor scope set by Congress and the definition of small electric motor. Comments related to the scope of applicability of the DOE test procedure for small electric motors were discussed as part of DOE’s test procedure NOPR. 84 FR 17004, 17009 (April 23, 2019).

dynamics can vary for designs within each product class and from class to class. (NEMA, No. 22 at p. 2)

As noted, EPCA directs DOE to establish test procedures and energy conservation standards for SEMs, see 42 U.S.C. 6317(b), both of which DOE has already done. EPCA further provides that standards shall not apply to any SEM which is a component of a covered product or covered equipment. (42 U.S.C. 6317(b)(3)) DOE has evaluated the scope of the SEM standards in this final determination in accordance with EPCA.

2. Equipment Classes

When evaluating and establishing energy conservation standards, DOE divides covered equipment into equipment classes by the type of energy used, or by capacity or other performance-related features that justify a different standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)) In determining whether capacity or another performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE deems appropriate. (*Id.*) For the April 2020 NOPD, DOE assessed the 62 equipment classes currently established based on phase count (i.e., single-phase versus polyphase), topology of single-phase motors, number of poles, and horsepower. This section reviews the motor characteristics used to delineate equipment classes for SEMs.

The first characteristic used to establish equipment classes is phase count. Polyphase and single-phase equipment classes are used to differentiate motors based on the fundamental differences in how the two types of motors operate. 10 CFR 431.446(a). For a rotor to move, the stator (i.e., the stationary part of the motor) must produce a rotating magnetic field. To operate on single-phase alternating current ("AC") power, the single-phase motor uses an auxiliary winding (or start winding) with current and voltage out of phase with the original (main) winding to produce a net rotating magnetic field. To operate on three-phase power, the polyphase motor uses windings arranged such that when supplied by three-phase alternating current, a rotating magnetic field is produced. In short, three-phase power in a polyphase motor naturally produces rotation, whereas a single-phase motor requires the auxiliary winding to "engineer" the conditions for rotation. Due to these differences, polyphase motors are inherently more efficient but require use of a three-phase power source. Based on the differences in efficiency and consumer utility, DOE separated equipment classes based on phase count in the March 2010 Final Rule. 75 FR 10874, 10886. DOE relied on the same approach for the proposed determination. See 85 FR 24146, 24153.

In addition to differentiating equipment classes by phase count, equipment classes are differentiated by the topology of single-phase motors. 10 CFR 431.446(a). DOE identified two topologies of single-phase motors meeting the statutory definition of SEMs: CSIR and CSCR. CSIR and CSCR motors both utilize a capacitor ("start-capacitor") and two windings ("start-winding" and "run-winding"). The difference between the two motors occurs when reaching operating speed; while CSIR motors run on the run-winding alone with no capacitor, CSCR motors run using an additional "run-capacitor" and both windings. While this additional capacitor can boost CSCR motor efficiency to levels higher than those exhibited by CSIR motor designs, it usually constitutes dimensional changes due to the need to mount the run-capacitor externally on the motor housing. This additional spatial requirement could potentially limit the use of CSCR motors in space-constrained applications, and would cause motor topology to directly impact consumer utility. Given that motor topology can affect motor performance and consumer utility, DOE differentiated single-phase equipment classes by topology in the March 2010 Final Rule. 75 FR 10886. DOE proposed to use the same approach in the April 2020 NOPD. See 85 FR 24146, 24153.

The current energy conservation standards also differentiate classes based on the number of poles in a motor. 10 CFR 431.446(a). The number of poles in an induction motor determines the synchronous speed (i.e., revolutions per minute). There is an inverse relationship between the number of poles and speed: as a motor design increases from two to eight poles, the synchronous speed drops from 3,600 to 900 revolutions per minute. The desired synchronous speed varies by end use application, making the number of poles in a motor a factor directly impacting consumer utility. By examining the efficiency ratings for 1–200 horsepower polyphase electric motors (10 CFR 431.25),[8] motors meeting the NEMA Premium Motor standard, and manufacturer catalogs, DOE observed that full-load efficiency percentages tend to decrease with the number of poles. Therefore, DOE determined that the number of poles has a direct impact on the motor's performance and consumer utility, and consequently, the number of poles is a further means of differentiating among equipment classes. 75 FR 10886. DOE relied on the same approach for the proposed determination. See 85 FR 24146, 24153.

Finally, DOE employs motor horsepower as an equipment class setting factor under the current energy conservation standards. 10 CFR 431.446(a). Average full load efficiency generally correlates with motor horsepower (*e.g.*, a 3-horsepower motor is usually more efficient than a ¼-horsepower motor). DOE found that motor efficiency varies with motor horsepower by evaluating manufacturers' catalog data, the efficiency

[8] While there is no overlap between the scope of applicability for electric motor standards at 10 CFR 431.25 and small electric motors standards at 10 CFR 431.446, the pole-efficiency relationships observed in the electric motor standards from 1 to 3 horsepower can be considered when determining appropriate pole-efficiency relationships for small electric motors in this horsepower range.

ratings of the established SEM energy conservation standards (10 CFR 431.446), and the efficiency requirements of the NEMA Premium Motor program. Additionally, motor horsepower dictates the maximum load that a motor can drive, which means that a motor's rated horsepower can influence and limit the end use applications where that motor can be used. Horsepower is a critical performance attribute of a small electric motor, and since horsepower has a direct relationship with average full load efficiency and consumer utility, DOE used this element as a criterion for distinguishing among equipment classes in the March 2010 Final Rule. 75 FR 10886. DOE relied on the same approach for the proposed determination. See 85 FR 24146, 24153.

DOE did not receive any comments on the current structure of the equipment classes as assessed in the April 2020 NOPD. Accordingly, in this final determination DOE continues to assess the SEM equipment classes as currently established. Table IV-2 summarizes the structure of the equipment classes identified for this final determination and as designated by the current standards at 10 CFR 431.446.

Table IV-2 Summary of Small Electric Motor Equipment Classes

Motor Topology		**Pole Configuration**	**Motor Output Power *hp***
Single-phase	CSIR	2, 4, 6	0.25 - 3
	CSCR	2, 4, 6	0.25 - 3
Polyphase		2, 4, 6	0.25 - 3

See chapter 3 of the final determination TSD for further discussion of the equipment classes.

3. Technology Options for Efficiency Improvement

The purpose of the technology assessment is to develop a list of technology options that could improve the efficiency of SEMs. For the motors covered in this determination, energy efficiency losses are grouped into four main categories: I^2R losses,[9] core losses, friction and windage losses, and stray load losses. The technology options considered in this section are categorized by these four categories of losses.

The SEMs evaluated in this determination are all AC induction motors. Induction motors have two core components: a stator and a rotor. The components work together to convert electrical energy into rotational mechanical energy. This is done by creating a rotating magnetic field in the stator, which induces a current flow in the rotor. This current flow creates an opposing magnetic field in the rotor, which creates rotational forces. Because of the orientation of these fields, the rotor field follows the stator field. The rotor is connected to a shaft that also rotates and provides the mechanical energy output.

Table IV-3 summarizes the technology options identified in the April 2020 NOPD.

[9] I^2R losses refer to conductor losses. In AC circuits, these losses are computed as the square of the current ("I") multiplied by the conductor resistance ("R").

Table IV-3 Summary of Technology Options for Improving Efficiency

Type of Loss to Reduce	Technology Option Applied
I^2R Losses	Use a copper die-cast rotor cage
	Reduce skew on conductor cage
	Increase cross-sectional area of rotor conductor bars
	Increase end ring size
	Changing gauges of copper wire in stator
	Manipulate stator slot size
	Decrease radial air gap
	Change run-capacitor rating
Core Losses	Improve grades of electrical steel
	Use thinner steel laminations
	Anneal steel laminations
	Add stack height (i.e., add electrical steel laminations)
	Use high-efficiency lamination materials
	Use plastic bonded iron powder
Friction and Windage Losses	Use better bearings and lubricant
	Install a more efficient cooling system

85 FR 24146, 24155.

DOE did not receive comments on the technology options identified in the April 2020 NOPD. Accordingly, DOE continued to consider the technology options identified in the April 2020 NOPD in developing this final determination. Chapter 3 of the TSD provides details on the DOE's market and technology assessment for SEMs.

B. Screening Analysis

DOE uses the following five screening criteria to determine which technology options are suitable[10] for further consideration of new or amended energy conservation standards:

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

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

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

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

[10] DOE refers to the technology options that pass the screening criteria as "design options."

5) *Unique-Pathway Proprietary Technologies*. If a design option utilizes proprietary technology that represents a unique pathway to achieving a given efficiency level, that technology will not be considered further due to the potential for monopolistic concerns.

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

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

Table IV-3 provides a summary of all the technology options DOE considered for improving SEM efficiency. For a description of how each of these technology options improves SEM efficiency, see final determination TSD chapter 3. For the April 2020 NOPD, DOE initially screened out three of the identified technology options: reducing the air gap below .0125 inches, amorphous metal laminations, and plastic bonded iron powder ("PBIP").

Reducing the air gap between the rotor and stator can improve motor efficiency. For SEMs, the air gap is commonly set at 15 thousandths of an inch. A reduction in air gaps is technologically feasible and DOE is unaware of any adverse impacts on health or safety associated with reducing the radial air gap below 12.5 thousandths of an inch. However, this technology option fails the screening criterion of being practicable to manufacture, install, and service. Such a tight air gap may cause problems in manufacturing and service, with the rotor potentially coming into contact with the stator. This technology option also fails the screening criterion of avoiding adverse impacts on consumer utility and reliability, because the motor may experience higher failure rates in service when the manufactured air gaps are less than 12.5 thousandths of an inch.

Using amorphous metals in the rotor laminations is another potential technology option to improve the efficiency of SEMs. Amorphous metal is extremely thin, has high electrical resistivity, and has little or no magnetic domain definition. Because of amorphous steel's high resistance, it exhibits a reduction in hysteresis and eddy current losses, which in turn reduces overall losses in SEMs. However, amorphous steel is a very brittle material which makes it difficult to punch into motor laminations.[11]

Although amorphous metals have the potential to improve efficiency, DOE does not consider this technology option technologically feasible, because it has not been incorporated into a working prototype of a small electric motor. Furthermore, DOE is uncertain whether amorphous metals are practicable to manufacture, install, and service, because a prototype amorphous metal-based SEM has not been made and little information is available on the feasibility of adapting this technology for manufacturing SEMs to reach any conclusions regarding the practicability of using this option. DOE is not aware of any adverse impacts on consumer utility, reliability, health, or safety associated with amorphous metal laminations.

Using PBIP to manufacture SEMs could cut production costs while increasing production output. Although other researchers may be working on this technology option, DOE notes that a research team at Lund University in Sweden published a paper in 2007 about using PBIP in manufacturing, which is the most recent applicable paper on the

[11] 1 S.R. Ning, J. Gao, and Y.G. Wang. Review on Applications of Low Loss Amorphous Metals in Motors. 2010. ShanDong University. Weihai, China.

subject. This technology option is based on an iron powder alloy that is suspended in plastic, and is used in certain motor applications such as fans, pumps, and household appliances.[12] The compound is then shaped into motor components using a centrifugal mold, reducing the number of manufacturing steps. Researchers claim that this technology option could cut losses by as much as 50 percent. The Lund University study, which is the most recent research paper to address the use of PBIP in the production context, indicated that its study team already produced inductors, transformers, and induction heating coils using PBIP, but had not yet produced a small electric motor. In addition, it appears that PBIP technology is aimed at torus, claw-pole, and transversal flux motors, none of which are with in the regulatory definition of SEMs at 10 CFR 431.442. DOE has found no evidence of any significant research or technical advancement in PBIP methodologies that could be applied to SEMs since publication of the March 2010 Final Rule or the April 2020 NOPD.

Although PBIP has the potential to improve efficiency while reducing manufacturing costs, DOE does not consider this technology option technologically feasible because it has not been incorporated into a working prototype of a small electric motor. Also, DOE is uncertain whether the material has the structural integrity to form into the necessary shape of a SEM steel frame. Specifically, properties of PBIP can differ depending on the processing. If the metal particles are too closely compacted and begin to touch, the material will gain electrical conductivity, counteracting one of its most important features of preventing electric current from developing, which is critical because this essentially eliminates losses in the core due to eddy currents. If the metal

[12] Horrdin, H., and E. Olsson. Technology Shifts in Power Electronics and Electric Motors for Hybrid Electric Vehicles: A Study of Silicon Carbide and Iron Powder Materials. 2007. Chalmers University of Technology. Göteborg, Sweden.

particles are not compacted closely enough, its structural integrity could be compromised because the resulting material will be very porous.

Furthermore, DOE is uncertain whether PBIP is practicable to manufacture, install, and service, because a prototype PBIP SEM has not yet been made and little information is available on the feasibility of adapting this option for manufacturing SEMs. DOE continues to be unaware of any adverse impacts on product utility, product availability, health, or safety that may arise from the use of PBIP in SEMs.

In the April 2020 NOPD, DOE tentatively determined that the remaining technology options listed in Table IV-2 are technologically feasible. The evaluated technologies all have been used (or are being used) in commercially available products or working prototypes. These technologies all incorporate materials and components that are commercially available in today's supply markets for the SEMs that are the subject of this document.

DOE did not receive comments on the screening analysis in the April 2020 NOPD. Accordingly, DOE considered the same screening analysis from the April 2020 NOPD in this final determination and is screening out the following technology options: reducing the air gap below .0125 inches, amorphous metal laminations, and plastic bonded iron powder ("PBIP"). DOE also finds that all of the remaining technology options meet the other screening criteria (i.e., practicable to manufacture, install, and service and do not result in adverse impacts on consumer utility, product availability, health, or safety, and do not represent unique pathway proprietary technologies). Chapter 4 of the TSD provides details on the DOE's screening analysis for SEMs.

C. Engineering Analysis

The engineering analysis establishes the relationship between the efficiency and cost of an SEM. 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 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). The following sections provide further details on the engineering analysis methodology.

1. Summary of Significant Data Sources

DOE utilized two principal data sources for the engineering analysis: (1) the database of SEM manufacturer suggested retail price ("MSRP") and performance data based on the current market (as evaluated in the April 2020 NOPD), and (2) motor modeling data, test data, and performance specifications from the March 2010 Final Rule. DOE determined that relying on the data from the March 2010 Final Rule was reasonable because a review of the catalog data suggested that there were no significant technological advancements in the motor industry that could lead to more efficient or lower cost motor designs relative to the motors modeled for the March 2010 Final Rule. In response to the April 2020 NOPD, NEMA also commented that the motor designs and associated efficiency levels adopted from the March 2010 Final Rule analysis are appropriate. (NEMA, No. 22 at p. 3) Accordingly, in preparing this determination, DOE continued to evaluate the motor designs that were modeled for the March 2010 Final Rule analysis.

DOE collected MSRP and performance data from product literature and catalogs distributed by four major motor manufacturers: ABB (which includes the manufacturer formerly known as Baldor Electric Company), Nidec Motor Corporation (which includes the US Motors brand), Regal-Beloit Corporation (which includes the Marathon and Leeson brands), and WEG Electric Motors Corporation.[13] Based on market information from the Low-Voltage Motors World Market Report,[14] DOE estimates that the four major motor manufacturers noted comprise the majority of the U.S. SEM market and are consistent with the motor brands considered in the March 2010 Final Rule. (Throughout this document this data will be referred to as the "manufacturer catalog data.")

2. Representative Equipment Classes

Due to the large number of equipment classes, DOE did not directly analyze all 62 equipment classes of SEMs considered under this final determination. Instead, DOE selected representative classes based on two factors: (1) the quantity of motor models available within an equipment class and (2) the ability to scale to other equipment classes.

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[13] ABB (Baldor-Reliance): Online Manufacturer Catalog, accessed January 3, 2019. Available at *https://www.baldor.com/catalog#category=2*; Nidec: Online Manufacturer Catalog, accessed December 26, 2018. Available at *ecatalog.motorboss.com/Catalog/Motors/ALL*; Regal (Marathon and Leeson): Online Manufacturer Catalog, accessed December 27, 2018. Available at *https://www.regalbeloit.com/Products/Faceted-Search?category=Motors&brand=Leeson,Marathon%20Motors*; WEG: Online Manufacturer Catalog, accessed December 24, 2018. Available at *http://catalog.wegelectric.com/*

[14] Based on the Low-Voltage Motors, World Market Report (IHS Markit Report September 2017, Edition 2017-2018) Table 5.15: Market Share Estimates for Low-voltage Motors: Americas; Suppliers 'share of the Market in 2015 and 2016.

DOE notes that the minimum energy conservation standards adopted in the March 2010 Final Rule correspond to the efficiency level that represented the maximum technologically feasible efficiency for CSIR motors. As discussed previously, DOE was unable to identify any additional design options that passed the screening criteria that would indicate that a motor design meeting a higher efficiency level is technologically feasible and commercially viable. In addition, DOE was unable to identify any CSIR motors in the manufacturer catalog data that exhibited efficiency levels exceeding the current energy conservation standards for CSIR motors. From this information, DOE proposed in the April 2020 NOPD that more stringent energy conservation standards for CSIR motors do not appear to be technologically feasible. Consequently, DOE did not include a representative CSIR equipment class as part of the engineering analysis.

The minimum energy conservation standards adopted in the March 2010 Final Rule corresponded to efficiency levels below the maximum technologically feasible levels for the CSCR and polyphase topologies, and therefore DOE elected to analyze one representative equipment class for each of these motor topologies. Equipment classes in both the polyphase and CSCR topologies were directly analyzed due to the fundamental differences in their starting and running electrical characteristics. These differences in operation have a direct impact on performance and indicate that polyphase motors are typically more efficient than single-phase motors. In addition, the efficiency relationships across horsepower and pole configuration are different between single-phase and polyphase motors.

DOE did not vary the pole configuration of the representative classes it analyzed because analyzing the same pole configuration provided the strongest relationship upon which to base its scaling. See section IV.C.5 of this document for details on DOE's scaling methodology. Keeping as many design characteristics constant as possible enabled DOE to more accurately identify how design changes affect efficiency across horsepower ratings. For each motor topology, DOE directly analyzed the most common pole-configuration. For both motor topologies analyzed, 4-pole motors constitute the largest fraction of motor models on the market.

When DOE selected its representative equipment classes, DOE chose the horsepower ratings that constitute a high volume of motor models and approximate the middle of the range of covered horsepower ratings so that DOE could develop a reasonable scaling methodology. DOE notes that the representative equipment classes for polyphase and CSCR motors that were selected for the engineering analysis align with the representative classes that were directly analyzed in the March 2010 Final Rule. 75 FR 10874, 10888. The proposed representative equipment classes from the April 2020 NOPD are outlined in Table IV-4.

Table IV-4 Representative Equipment Classes

Motor Topology	Pole Configuration	Motor Output Power hp
Polyphase	4	1.00
Single-phase CSCR	4	0.75

NEMA commented that the selected representative equipment classes are appropriate because there have not been any significant changes to design practices which might warrant modification. (NEMA, No. 22 at p. 2) DOE did not receive any other comments regarding the representative equipment classes. Accordingly, DOE continued to analyze the same representative equipment classes from the April 2020 NOPD in preparing this final determination.

3. 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).

In the March 2010 Final Rule DOE and in the April 2020 NOPD, DOE relied on the design option approach. DOE maintained the design option approach for this final determination. In this design option approach, DOE considers efficiency levels corresponding to motor designs that meet or exceed the efficiency requirements of the current energy conservation standards at 10 CFR 431.446. DOE has determined that there are no additional technology options that pass the screening criteria that would enable the consideration of any additional efficiency levels representing higher efficiency levels than the maximum technologically feasible level analyzed in the March 2010 Final Rule.

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

DOE considered the current minimum energy conservation standards to establish the baseline efficiency levels for each representative equipment class. As discussed previously, DOE selected representative equipment classes that align with the classes analyzed in the March 2010 Final Rule. See March 2010 Final Rule TSD, sec. 5.2.1. DOE identified specific motor designs from the March 2010 Final Rule engineering analysis that exhibit full-load efficiency ratings that are representative of the minimum energy conservation standards for SEMs. DOE used these motor designs to form the baseline against which to compare improved efficiency design options in DOE's analysis. Each increase in efficiency over the baseline level that DOE analyzed was assigned an efficiency level ("EL") number.

For the March 2010 Final Rule engineering analysis, DOE purchased and tested motors with the lowest catalog efficiency rating available in the market for each representative equipment class. DOE's technical expert tore down each motor to obtain dimensions, a BOM, and other pertinent design information. DOE worked with a subcontractor to reproduce these motor designs using modeling software and then applied design options to a modeled motor that would increase that motor's efficiency to develop a series of motor designs spanning a range of efficiency levels. For the current evaluation, DOE continued to base its analysis on the modeled motor designs. In light of its catalog review, DOE discerned no significant technological advancements in the motor industry that could lead to more efficient or lower cost motor designs relative to the motors modeled for the March 2010 Final Rule. In addition, DOE did not receive any contrasting comments suggesting any significant technological advancements for small electric motors within current scope.

In developing the modeled motor designs and associated costs, DOE also considered both space-constrained and non-space-constrained scenarios. DOE prepared designs of increased efficiency covering both scenarios for each representative equipment class. The design levels prepared for the space-constrained scenario included baseline and intermediate levels, a level for a design using a copper rotor, and a max-tech level with a design using a copper rotor and exotic core steel. The high-efficiency space-constrained designs incorporate copper rotors and exotic core steel in order to meet comparable levels of efficiency to the high-efficiency non-space-constrained designs while meeting the parameters for minimally increased stack length. The design levels created for the non-space-constrained scenario corresponded to the same efficiency levels created for the space-constrained scenario. Further information on the development of modeled motor designs is available in section 5.3 of the March 2010 Final Rule TSD.

NEMA commented that improving efficiency in SEMs may not always result in overall equipment-level efficiency improvements. It noted that any modification to energy conservation standards or scope of regulated SEMs would require a revised analysis of the downstream impact of SEM design changes on OEM devices and appliances. NEMA asserted that changes in motor size, weight, rotational speed, slip,[15] and other factors due to more stringent energy conservation standards have not been sufficiently evaluated. It added that because of the potential increase in the speed of the motor due to increases in efficiency, more stringent energy conservation standards could have significant downstream impacts in OEM devices which use these motors and would not always guarantee higher efficiency or better performance by that end-use device. (NEMA, No. 22 at pp. 1-2, 5; No. 32 at p. 2)

DOE continued to use the designs analyzed for the March 2010 Final Rule in preparing this final determination. The designs analyzed in the engineering analysis did not show a significant (less than 2 percent) and consistent increase in speed with increasing efficiency (some more efficient designs had slightly lower speeds) across all ELs (See Final Determination TSD Chapter 5). In addition, as discussed previously, to account for motor size and weight limitations, DOE also analyzed both space-constrained and non-space-constrained scenarios. However, in this final determination, DOE is not considering amending the current energy conservation standards for this equipment.

Given that DOE was unable to identify any additional design options for improving efficiency that passed the screening criteria and were not already considered in the March 2010 Final Rule engineering analysis, DOE analyzed the same motor designs that were developed for the March 2010 Final Rule except for CSIR motors (which, as indicated earlier, did not appear to have any technologically-feasible options available to improve their efficiency). For each representative equipment class, DOE established an

[15] "Motor slip" is the difference between the speed of the rotor (operating speed) and the speed of the rotating magnetic field of the stator (synchronous speed). When net rotor resistance of a motor design is reduced, efficiency of the motor increases but slip decreases, resulting in higher operating speeds.

efficiency level for each motor design that exhibited improved efficiency over the baseline design. As discussed previously, DOE considered the current minimum energy conservation standards as the baseline efficiency levels for each representative equipment class. These April 2020 NOPD efficiency levels are summarized in Table IV-5.

Table IV-5 Summary of Efficiency Levels

Representative Equipment Class	EL	Efficiency (%)
Single-phase CSCR, 4-pole, 0.75-hp	0	81.8
	1	82.8
	2	84.0
	3	84.6
	4	86.7
	5	87.9
Polyphase, 4-pole, 1-hp	0	83.5
	1	85.2
	2	86.3
	3	87.8

As mentioned previously, NEMA commented that the motor designs and associated efficiency levels adopted into this analysis from the March 2010 Final Rule analysis are appropriate. (NEMA, No. 22 at p. 3) Accordingly, similar to the April 2020 NOPD, DOE adopted the motor modeling approach used in support of the March 2010 Final Rule to analyze and establish efficiency levels and incremental motor MSPs. DOE did not identify any additional design options in the market for improving efficiency that were not already considered in the March 2010 Final Rule.

4. 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 ("BOM") for the product.

- Price surveys: If neither a physical nor catalog teardown is feasible (for example, for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable) or cost-prohibitive and otherwise impractical (*e.g.* large commercial boilers), DOE conducts price surveys using publicly available pricing data published on major online retailer websites and/or by soliciting prices from distributors and other commercial channels.

In the present case, a standard BOM was constructed for each motor design that includes direct material costs and labor time estimates along with costs. DOE notes that the costs established for direct material costs and labor time were initially determined in terms of $2009 for the March 2010 Final Rule. For the April 2020 NOPD, DOE updated these material and labor costs to be representative of the market in 2018. DOE adjusted historical material prices to $2018 using the historical Bureau of Labor Statistics Producer Price Indices ("PPI")[16] for each commodity's industry. In addition, DOE

[16] *www.bls.gov/ppi/.*

updated labor costs and markups based on the most recent and complete version (i.e. 2012) of the Economic Census of Industry by the U.S. Census Bureau.[17]

DOE did not receive comments on the cost analysis presented in the April 2020 NOPD. Accordingly, using the same methodology presented in the April 2020 NOPD, in this final determination DOE updated the material and labor costs to be representative of the market in 2019$.

5. Scaling Relationships

In analyzing the equipment classes, DOE developed a systematic approach to scaling efficiency across horsepower ratings and pole configurations, while retaining reasonable levels of accuracy, in a manner similar to the March 2010 Final Rule. DOE's current energy conservation standards for SEMs found at 10 CFR 431.446 list minimum required efficiencies over a range of horsepower and pole configurations, providing a basis for scaling efficiency across horsepower and pole configurations for polyphase and single-phase motors. The efficiency relationships in the established standards are based on a combination of NEMA recommended efficiency standards, NEMA premium designations, catalog data, and test data for individual manufacturer motor product lines.

In the April 2020 NOPD, DOE proposed to apply the same scaling methodologies used to support the March 2010 Final Rule to the engineering analysis. This includes scaling to two additional representative units needed in the energy use and life-cycle cost

[17] U.S. Census Bureau, 2012 Economic Census of Industry Series Reports for Industry, U.S. Department of Commerce, 2012; NAICS code 3353121 "Fractional Horsepower Motors" Production workers hours and wages. Although some summary statistics of the 2017 Economic Census for Manufacturing is currently available, the detailed statistics for the U.S. is estimated to be released in the time frame of November 2020-September 2021. *https://www.census.gov/programs-surveys/economic-census/about/release-schedules.html*.

analyses to separately analyze consumers of integral (i.e., with horsepower greater than or equal to 1 hp) single-phase CSCR SEMs and fractional (i.e*.,* with horsepower less than 1 hp) polyphase SEMs. This scaling approach has been presented previously to stakeholders and has been updated based on stakeholder input. Additionally, the approach has the added advantage of reducing the analytical complexity associated with conducting a detailed engineering analysis of the cost-efficiency relationship on all 62 equipment classes. 75 FR 10874, 10894-10895.

NEMA commented that the previously developed scaling methodologies remain effective and appropriate. (NEMA, No. 22 at p. 3) DOE did not receive any other comments on the scaling analysis methodology proposed in the April 2020 NOPD. DOE continues to apply the scaling analysis methodology from the April 2020 NOPD in this final determination. Chapter 5 of the TSD provides details on the DOE's engineering analysis for SEMs.

D. Markups Analysis

To account for manufacturers' non-production costs and profit margin, DOE applies a non-production cost 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 10-K reports filed by publicly-traded manufacturers primarily engaged in appliance manufacturing and whose combined product range includes SEM.

The markups analysis develops appropriate markups (*e.g.*, retailer markups, distributor markups, contractor markups) in the distribution chain to convert the MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis. At each step in the distribution channel, companies mark up the price of the equipment to cover business costs and profit margin. For SEMs, the main parties in the distribution chain are manufacturers, distributors, contractors or installers, OEMs of equipment incorporating SEMs, and consumers.

DOE relied on estimates provided by NEMA during the March 2010 Final Rule to establish the proportion of shipments through each distribution channel.[18] In response to the April 2020 NOPD, DOE did not receive any comments or data to support alternative distribution channels for SEMs. In this final determination, DOE relied on the same distributions of shipments by distribution channels as in the April 2020 NOPD. Further, DOE did not receive any comments on the approach used to develop markups. DOE continued to rely on the same methodology for developing markups and updated relevant data sources to the most recent information available in preparation of this final determination. DOE used data from the U.S. Census Bureau and US Economic Census[19] and the Sales Tax Clearinghouse[20] to develop distribution channel markups and sales tax estimates.

DOE used the same approach as in the April 2020 NOPD and developed baseline and incremental markups for each actor in the distribution chain. Baseline markups are applied to the price of equipment with baseline efficiency, while incremental markups are

[18] For more details see chapter 7 of the 2010 small electric motors final rule TSD, at *https://www.regulations.gov/document?D=EERE-2007-BT-STD-0007-0036.*

[19] U.S. Census Bureau. 2017 Annual Wholesale Trade Report. 2017. Washington, D.C. (Last accessed June 19, 2019.) *https://www.census.gov/wholesale/index.html*; U.S. Census Bureau. 2017 Annual Retail Trade Survey, 2017. (Last accessed June 19, 2019.) *https://www.census.gov/programs-surveys/arts/data/tables.2017.html.* ; 2017 Economic Census: Manufacturing: Summary Statistics for the U.S., States, and Selected Geographies: 2017. 2020. U.S. Census Bureau. (Last accessed October 21, 2020.) *https://www.census.gov/data/tables/2017/econ/economic-census/naics-sector-31-33.html*

[20] Sales Tax Clearinghouse Inc. State Sales Tax Rates Along with Combined Average City and County Rates. October 21, 2020. (Last accessed October 21, 2020.) *http://thestc.com/STrates.stm.*

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

Further, in the space-constrained scenario, DOE developed a modified OEM markup to account for the costs faced by those OEMs of equipment incorporating SEMs needing to redesign their products in order to incorporate SEMs of different, including larger, sizes. Nationally, businesses spend about 2.7 percent of U.S. gross domestic product on research and development ("R&D").[22] DOE estimates that R&D by equipment OEMs, including the design of new products, approximately represents at most 2.7 percent of company revenue. DOE followed the same approach used in the March 2010 Final Rule and accounted for the additional costs to redesign products and incorporate differently-shaped motors by adding 2.7 percent to the OEM markups.[23]

Table IV-6 summarizes the overall baseline and incremental markups for each distribution channel considered for SEMs. These markups were updated since the April 2020 NOPD to reflect updates to relevant data sources to the most recent information available.

[21] Because the projected price of standards-compliant products (and equipment) is typically higher than the price of baseline products (and equipment), 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 imposing more stringent standards would lead to a sustainable increase in profitability in the long run.
[22] National Science Board. January 15, 2020. Science and Engineering Indicators 2020. Research and Development: U.S Trends and International Comparisons. Figure 4-3, Ratio of U.S. R&D to gross domestic product, by roles of federal, business, and other nonfederal funding for R&D: 1953–2017. 2020. National Science Board: Arlington, VA: National Science Foundation (NSB-2020-3)
[23] For more details see chapter 7 of the 2010 small electric motors final rule TSD, at *https://www.regulations.gov/document?D=EERE-2007-BT-STD-0007-0036*

Table IV-6: Small Electric Motors Distribution Channel Markups

Distribution Channel (From manufacturer)	Direct to OEMs (65%)		Via Wholesalers to OEMs (30%)		Via Wholesalers to End-Users (5%)	
Main Party	**Baseline**	**Incremental**	**Baseline**	**Incremental**	**Baseline**	**Incremental**
Motor Wholesaler	-	-	1.35	1.20	1.35	1.20
Original Equipment Manufacturer (OEM)*	1.45/1.48	1.20/1.23	1.45/1.48	1.20/1.23	-	-
Equipment Wholesaler	1.41	1.20	1.41	1.20	-	-
Retailer	-	-	-	-	1.53	1.27
Contractor	1.1	1.1	1.1	1.1	1.1	1.1
Sales Tax	1.0727		1.0727		1.0727	
Overall	2.42/2.47	1.69/1.73	3.26/3.33	2.04/2.08	2.44	1.80

* Non-space-constrained scenario/space-constrained scenario

Chapter 6 of the TSD provides details on the DOE's markup analysis for SEMs.

E. Energy Use Analysis

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

The analysis focuses on the two representative units identified in the engineering analysis (see section IV.C) for which engineering analysis results were obtained at levels at and above the baseline. Two additional representative units were included to separately analyze consumers of integral (i.e., with horsepower greater than or equal to 1 hp) single-phase CSCR SEMs and fractional (i.e., with horsepower less than 1 hp) polyphase SEMs (see Table IV-7).[24] For each representative unit, DOE determined the annual energy consumption value by multiplying the motor input power by the annual operating hours for a representative sample of motor consumers.

Table IV-7: Representative Units Analyzed in the Energy Use and Life-cycle Cost Analyses

Representative Unit	Equipment class Group	Pole Configuration	Rated Horsepower
1	Single-phase, CSCR	4-pole	0.75
2	Polyphase	4-pole	1
3	Single-phase, CSCR	4-pole	1
4	Polyphase	4-pole	0.5

In response to the April 2020 NOPD, NEMA commented that the inputs used to characterize the energy use of SEMs were appropriate. (NEMA, No. 22 at p. 3) Additionally, NEMA commented that improving SEM efficiency may not always result in overall equipment-level efficiency improvements. NEMA commented that any modification to energy conservation standards or scope of regulated SEMs would require a revised analysis of the downstream impact of SEM design changes on OEM devices and appliances, before proceeding to modify energy savings methodology and estimates. (NEMA, No. 22 at p. 5)

As discussed previously, to account for motor size and weight limitations (including in OEM devices and appliances), DOE analyzed both space-constrained and non-space-constrained scenarios. DOE did not modify the scope or amend the current

[24] Similar to the approach used in the engineering analysis when selecting representative units, DOE reviewed model counts from the manufacturer online catalog data to identify these additional units. DOE reviewed counts of CSCR, 4-poles small electric motors and polyphase, 4-poles, small electric motors models. For CSCR motors, the 1 horsepower value had the most counts and DOE selected a unit at 1 horsepower. For polyphase motors, the 0.33, 0.5, and 0.75 horsepower values had the most counts (and similar counts) and DOE selected a unit at 0.5 horsepower (i.e. the mid-range of these horsepower values).

energy conservation standards for this equipment. Chapter 7 of the TSD provides details on the DOE's energy use analysis for SEMs.

1. Consumer Sample

DOE used the same approach as in the April 2020 NOPD and created consumer samples for each representative unit, including three individual sectors: residential, commercial, and industrial. DOE used the samples to determine SEM annual energy consumption as well as for conducting the LCC and PBP analyses. Each consumer in the sample was assigned a sector and an application. DOE used data from the March 2010 Final Rule to establish distributions of SEMs by sector. Five main motor applications were selected as representative applications (compressors, fans, pumps, material handling, and others). In order to characterize the distributions of SEMs across applications in the industrial sector, DOE used data from hundreds of field assessments aggregated in two databases: (1) a database of motor nameplate and field data and;[25] (2) a database of motor nameplate and field data compiled by the Industrial Assessment Center at Oregon University ("field assessment data").[26] For the commercial and residential sectors, DOE used data from a previous DOE publication to estimate distribution of SEMs by application.[27] DOE also assumed that 20 percent of consumers had space-constraints and 80 percent were non-space-constrained based on data from the March 2010 Final Rule. In response to the April 2020 NOPD, NEMA commented that the inputs used to characterize the distributions of consumers across sectors and applications were

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[25] Database of motor nameplate and field measurement data compiled by the Washington State University Extension Energy Program (WSU) and Applied Proactive Technologies (APT) under contract with the New York State Energy Research and Development Authority (NYSERDA)

[26] Strategic Energy Group (January 2008), Northwest Industrial Motor Database Summary. Regional Technical Forum. Available at *http://rtf.nwcouncil.org/subcommittees/osumotor/Default.htm*

[27] W. Goetzler, T. Sutherland, C. Reis. "Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment" U.S. Department of Energy, December 4, 2013. Available at *https://energy.gov/sites/prod/files/2014/02/f8/Motor%20Energy%20Savings%20Potential%20Report%202013-12-4.pdf*

appropriate. (NEMA, No. 22 at p. 3) DOE used the same consumer sample as in the April 2020 NOPD for this final determination.

See Chapter 7 of the TSD for more details on the resulting distribution of consumers by sector and applications.

2. Motor Input Power

DOE used the same approach as in the April 2020 NOPD and calculated the motor input power as the sum of the motor rated horsepower multiplied by the motor operating load (i.e., the motor output power) and of the losses at the operating load (i.e., part-load losses). 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 manufacturer catalogs to model motor part-load losses as a function of the motor's operating load. DOE estimated the operating load using operating load data specific to motors in the 0.25 – 3 hp range, which was based on additional field assessments data collected since the publication of the March 2010 Final Rule.[28]

In response to the April 2020 NOPD, NEMA commented that an upcoming publication from DOE's Advanced Manufacturing Office "Motor System Market Assessment" may provide additional information regarding load. (NEMA, No. 22 at p. 4) DOE is aware of this upcoming report but notes that it is not yet available. Accordingly, DOE used the same load distributions as in the April 2020 NOPD for this final determination.

[28] This horsepower range was selected as it corresponds to the motor horsepower of small electric motors that are currently subject to standards (see section IV.A.1)

See chapter 7 of the TSD for the resulting distribution of load for each application.

3. Annual Operating Hours

DOE used the same approach as in the April 2020 NOPD and DOE developed distributions of operating hours by application and sector. For the industrial sector, DOE used data specific to motors in the 0.25 - 3 hp range from the field assessment data to establish distributions of annual operating hours by application.[29] For the commercial and residential sectors, DOE used operating hours data from the March 2010 Final Rule.[30] In response to the April 2020 NOPD, NEMA commented in support of the annual operating hours values used in the NOPD. NEMA commented that if DOE were to consider standards for a different scope, these assumptions would no longer be adequate. (NEMA, No. 22 at p. 4) As discussed previously, DOE is not modifying the scope of the energy conservation standards for SEMs. Accordingly, DOE used the same operating hour distributions as in the April 2020 NOPD for this final determination. Table IV-8 shows the estimated average annual energy use at each efficiency level analyzed.

The annual energy use values are calculated as an intermediate result in the LCC and PBP analysis. As further discussed section IV.F, the computer model DOE uses to calculate the LCC and PBP relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. Although the energy use calculation performed in preparation of this final rule relied on the same probability distributions as used in the April 2020 NOPD, each Monte Carlo simulation run randomly samples input values from

[29] Database of motor nameplate and field measurement data compiled by the Washington State University Extension Energy Program (WSU) and Applied Proactive Technologies (APT) under contract with the New York State Energy Research and Development Authority (NYSERDA)
[30] For more details see chapter 6 of the 2010 small electric motors final rule TSD, at *https://www.regulations.gov/document?D=EERE-2007-BT-STD-0007-0036.*

the probability distributions and consumer samples, which resulted in updated annual energy use results.

Table IV-8 Small Electric Motors Annual Energy Use Results

Rep. Unit	Description	kilowatt-hours per year					
		EL 0	**EL 1**	**EL 2**	**EL 3**	**EL 4**	**EL5**
1	Single-phase, CSCR, 4-pole, 0.75 hp	1,653.6	1,628.2	1,598.5	1,583.8	1,536.0	1,509.0
2	Polyphase, 4-pole, 1 hp	2,092.8	2,047.7	2,020.8	1,983.8	-	-
3	Single-phase, CSCR, 4-pole, 1 hp	2,191.9	2,159.1	2,122.7	2,103.9	2,043.2	2,008.0
4	Polyphase, 4-pole, 0.5 hp	1,152.6	1,117.9	1,096.7	1,068.1	-	-

See Chapter 7 of the TSD for more details on the distributions of annual operating hours by application and sector.

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 SEMs. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase price. 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 simple 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 simple 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 SEMs in the absence of new or amended energy conservation standards. In contrast, the simple PBP for a given efficiency level is measured relative to the baseline equipment. The analysis focuses on the four representative units identified in Table IV-7.

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 a sample based on distributions of consumers across sectors and applications, as well as across efficiency levels. For each sample consumer, DOE determined the unit energy consumption and 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 SEMs.

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

The computer model DOE uses to calculate the LCC and PBP relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and consumer samples. The model calculated the LCC and PBP for equipment at each efficiency level for 10,000 consumers per representative unit 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 and PBP calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient equipment, DOE avoids overstating the potential benefits from increasing equipment efficiency.

DOE calculated the LCC and PBP for all consumers as if each were to purchase a new motor in the expected year of compliance with amended standards. For purposes of its analysis, DOE estimated that any amended standards would apply to SEMs manufactured 5 years after the date on which the amended standard is published. DOE estimated publication of a final rule in the first half of 2023. Therefore, for purposes of its analysis, DOE used 2028 as the first full year of compliance.

Table IV-9 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. DOE updated relevant data sources to the most recent information available in preparation of this final determination. The subsections that follow provide further discussion.

Table IV-9 Summary of Inputs and Methods for the LCC and PBP Analysis*

Inputs	Source/Method
Equipment Cost	Derived by multiplying MSPs by distribution channel markups and sales tax, as appropriate.
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: Based on plant surveys and previous DOE study.
Energy Prices	Electricity: Used average and marginal prices methodology from (Coughlin and Beraki) and updated data from Edison Electric Institute Typical Bill and Average Rates Reports Winter 2019, Summer 2019.
Energy Price Trends	Based on *AEO 2020* price projections.
Repair and Maintenance Costs	Assumed no change with efficiency level.
Equipment Lifetime	Estimated using information from March 2010 Final Rule and from DOE's Advanced Manufacturing Office.
Discount Rates	Residential: approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances. Commercial: Calculated as the weighted average cost of capital for entities purchasing small electric motors. Primary data source was Damodaran Online.
Compliance Date	2028

* References for the data sources mentioned in this table are provided in the sections following the table.

1. Equipment Cost

To calculate consumer equipment costs, DOE multiplied the MSPs developed in the engineering analysis by the distribution channel markups described in section IV.D (along with sales taxes). DOE used different markups for baseline motors and higher-efficiency motors, because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency equipment. Further, in this final determination, DOE assumed the prices of SEMs would remain constant over time (no decrease in price).

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment. In response to the April 2020 NOPD, DOE did not receive any information on SEM consumer installation costs and has relied on the same approach to estimate installations costs for this final determination. Based on information from the March 2010 Final Rule and installation cost data from RS Means Electrical Cost Data 2020,[31] DOE estimated that installation costs do not increase with equipment efficiency except in terms of shipping costs depending on the weight of the more efficient motor.[32] To arrive at total installed costs, DOE included shipping costs as part of the installation costs. These were based on weight data from the engineering analysis, which accounted for updated manufacturer catalog data collected by DOE.

See Chapter 8 of the TSD for more information on the installation costs for SEMs.

3. Annual Energy Consumption

For each sampled consumer, DOE determined the energy consumption for SEMs in each standards case analyzed using the approach described in section IV.E of this final determination.

4. Energy Prices

In response to the April 2020 NOPD, DOE did not receive any comments on electricity prices and relied on the same approach to develop national annual marginal and average prices and estimate energy prices in future years. DOE updated data sources to the most recent information available. For electricity prices, DOE used average and marginal electricity prices. As in the April 2020 NOPD, DOE estimated these prices

[31] RS Means. *Electrical Cost Data, 43rd Annual Edition*, 2020. Rockland, MA. p. 315.
[32] For more details see chapter 8 of the 2010 small electric motors final rule TSD, at *https://www.regulations.gov/document?D=EERE-2007-BT-STD-0007-0036*.

using the methodology provided in two Lawrence Berkeley National Laboratory reports (Coughlin and Beraki).[33] In addition, in preparation for this final determination, DOE used updated data published from the Edison Electric Institute Typical Bills and Average Rates reports for summer and winter 2019 to reflect the latest electricity price information available. To estimate energy prices in future years, DOE multiplied the energy prices by a projection of annual change in average price consistent with the projections in the Energy Information Administration's (EIA's) Annual Energy Outlook 2020 (*AEO 2020)*[34], which has an end year of 2050. To estimate price trends after 2050, DOE used the average annual rate of change in prices from 2028 to 2050.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing SEM components that have failed; maintenance costs are associated with maintaining the operation of the equipment. SEMs are usually not repaired. Most small motors are mass produced and are not constructed or designed to be repaired because the manufacturing process uses spot welding welds and rivets to fasten or secure the frame and assembled components, not nuts and bolts – meaning that the SEM cannot be readily disassembled and reassembled. In addition, during the rulemaking for the March 2010 Final Rule, DOE found no evidence that repair or maintenance costs, if any, would increase with higher motor energy efficiency.[35] DOE reviewed more recent motor repair cost data for SEMs and

[33] *See* Coughlin, K. and B. Beraki. Residential Electricity Prices: A Review of Data Sources and Estimation Methods. 2018. Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States). Report No. LBNL-2001169. (Last accessed May 21, 2019.) *https://ees.lbl.gov/publications/residential-electricity-prices-review.* *See also* Coughlin, K. and B. Beraki. Non-residential Electricity Prices: A Review of Data Sources and Estimation Methods. 2019. Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States). Report No. LBNL-2001203. (Last accessed May 21, 2019.) *https://ees.lbl.gov/publications/non-residential-electricity-prices*
[34] U.S. Energy Information Administration, Office of Energy Analysis, U.S. Department of Energy. *U.S. Energy Information Administration. Annual Energy Outlook 2020 with projections to 2050. 2020.* Washington, DC. 20585 (Last accessed August 11, 2020). *https://www.eia.gov/outlooks/AEO/pdf/AEO2020.pdf*
[35] For more details see chapter 8 of the 2010 small electric motors final rule TSD, at *https://www.regulations.gov/document?D=EERE-2007-BT-STD-0007-0036.*

found no evidence that maintenance and repair costs increase with efficiency for SEMs in scope.[36] In response to the April 2020 NOPD, NEMA supported DOE's finding that SEMs are generally not repaired (NEMA, No. 22 at p. 4)

Accordingly, similar to what was done in the April 2020 NOPD, DOE did not account for any repair costs in the LCC calculation.

See Chapter 8 of the TSD for more information on the repair and maintenance costs for SEMs.

6. Motor Lifetime

To characterize lifetimes in a manner to reflect that this factor depends on an SEM's application, DOE used two Weibull distributions.[37] One characterizes the motor lifetime in total operating hours (i.e., mechanical lifetime), while the other characterizes the lifetime in years of use in the application (*e.g.*, a pump).

In response to the April 2020 NOPD, NEMA commented in support of the lifetime distributions developed by DOE. (NEMA, No. 22 at pp. 4-5) Consistent with the approach used in the April 2020 NOPD, DOE used mechanical lifetime data from the March 2010 Final Rule analysis and from a 2012 report from DOE's Advanced Manufacturing Office[38] to derive an estimated average mechanical lifetime of 30,000 hours for CSCR motors and 40,000 hours for polyphase motors. The Weibull parameters

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[36] Vaughen's (2013), Vaughen's Motor & Pump Repair Price Guide, 2013 Edition. Available at *www.vaughens.com*.

[37] The Weibull distribution is one of the most commonly used distributions in reliability. It is commonly used to model time to fail, time to repair and material strength.

[38] U.S. Department of Energy. Advanced Manufacturing Office. *Motors Systems Tip Sheet #3. Energy Tips: Motor Systems. Extending the Operating Life of Your Motor*. 2012. *https://www.energy.gov/sites/prod/files/2014/04/f15/extend_motor_operlife_motor_systemts3.pdf.*

from the March 2010 Final Rule were used to derive these lifetime distributions.[39] In the course of the LCC analysis, DOE's current analysis further combines these two distributions with OEM application lifetimes to estimate the distribution of SEM lifetimes. DOE determined the mechanical lifetime of each motor in years by dividing its mechanical lifetime in hours by its annual hours of operation. DOE then compared this mechanical lifetime (in years) with the sampled application lifetime (also in years), and assumed that the motor would be retired at the younger of these two ages. In the March 2010 Final Rule, this approach resulted in projected average lifetimes of 7 years for single-phase CSCR motors and 9 years for polyphase motors. Because of updates made to the annual operating hours (see section IV.E.3) and calculation rounding, the updated analysis for this final determination yielded average lifetimes of 7.0 years for single-phase CSCR motors and 8.7 years for polyphase motors.

See Chapter 8 of the TSD for more information on the lifetime of SEMs.

7. Discount Rates

In calculating LCC, DOE applies discount rates appropriate to commercial, industrial, and residential consumers to estimate the present value of future operating costs. DOE estimated a distribution of discount rates for SEMs based on the cost of capital of publicly traded firms in the sectors that purchase SEMs.

As part of its analysis, DOE also applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount

[39] For more details see chapter 8 of the 2010 small electric motors final rule TSD, at *https://www.regulations.gov/document?D=EERE-2007-BT-STD-0007-0036.*

rates.[40] DOE notes that the LCC does not analyze the equipment purchase decision, so the implicit discount rate is not relevant in this model. The LCC estimates net present value over the lifetime of the equipment, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long time horizon modeled in the LCC, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

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 percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances[41] ("SCF") for 1995, 1998, 2001, 2004, 2007, 2010, 2013, and 2016. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect.

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

[41] Board of Governors of the Federal Reserve System. *Survey of Consumer Finances*. 1995, 1998, 2001, 2004, 2007, 2010, 2013, and 2016. Available at: *http://www.federalreserve.gov/econresdata/scf/scfindex.htm*.

For commercial and industrial consumers, DOE used the cost of capital to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so the cost of capital is the weighted-average cost to the firm of equity and debt financing. This corporate finance approach is referred to as the weighted-average cost of capital. DOE used currently available economic data in developing discount rates. In response to the April 2020 NOPD, DOE did not receive any comments on discount rates. DOE used the same approach for developing discount rates as in the April 2020 NOPD for this final determination. DOE updated data sources to the most recent information available. See chapter 8 of the TSD for details on the development of end-user discount rates.

8. 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 in the "no-new-standards" case (i.e., the case without amended or new energy conservation standards) in the compliance year. In its analysis for the March 2010 Final Rule, DOE developed no-new standards case efficiency distributions based on the distributions of then currently available models for which SEM efficiency is included in catalog listings. In preparation for the April 2020 NOPD, DOE collected updated catalog data and analyzed the distribution of SEMs in the manufacturer catalog data for CSCR and polyphase SEMs.[42] DOE projected that these efficiency distributions would remain constant throughout 2028. In response to the April 2020 NOPD, DOE did not receive any comments related to efficiency distributions and efficiency trends. Accordingly, DOE

[42] DOE relied on 140 models of CSCR small electric motors and 229 models of polyphase small electric motors identified in the manufacturer catalog data. More details on the distributions of currently available models for which motor catalog list efficiency is available in Chapter 8 of the TSD.

retained the same efficiency distributions used in the April 2020 NOPD in preparing this final determination. See chapter 8 of the TSD for the estimated efficiency distributions.

9. Payback Period Analysis

The PBP is the amount of time it takes the consumer to recover the additional installed cost of more-efficient equipment, compared to baseline equipment, through energy cost savings. PBPs are expressed in years. PBPs 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 simple 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. The simple PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for SEMs examined by DOE. It addresses the ELs examined by DOE and the projected impacts of each of these levels. Additional details regarding DOE's analyses are contained in the NOPD TSD supporting this document.

A. Energy Savings

For each standards case considered, DOE estimated the per unit lifetime energy savings for SEMs purchased in the expected compliance year of any potential standards.

The per unit energy savings were used in the calculation of the LCC and PBP values. DOE did not separately evaluate the significance of the potential energy conservation under the considered amended standards because it has determined that the potential standards would not be cost-effective as defined in EPCA.[43] (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A); 42 U.S.C. 6295(n)(2))

B. Cost Effectiveness

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

Table V-1 through Table V-7 show the LCC and PBP results for the ELs considered for each equipment class. These results were updated since the April 2020 NOPD to reflect updates of relevant data sources to the most recent information available. Results for each representative unit are presented by two tables: 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

[43] The March 2010 Final Rule estimated the national energy savings achieved by the current energy conservation standards to be 2.2 quads of primary energy savings (i.e., 0.29 quad at TSL 4b for polyphase SEMs and 1.91 quad at TSL 7 for single phase SEMs). The March 2010 Final Rule also estimated that the TSL resulting in the maximum national energy savings would provide a total of 2.7 quads of primary energy savings (i.e., 0.37 quad at TSL 7 for polyphase SEMs and 2.33 quad at TSL 8 for single phase SEMs). 75 FR 10874, 10916 (March 9, 2010) Although DOE did not separately evaluate the significance of the potential energy conservation under the considered amended standards, this previous analysis indicates an upper limit of 0.5 quad of primary energy savings (2.7 - 2.2 = 0.5) which corresponds to 0.2 quad site national energy savings and is below the 0.3 quad threshold for determining whether energy savings would be significant.

no-new-standards case in the expected compliance year for the potential standards considered. Because some consumers purchase equipment with higher efficiency in the no-new-standards case, the average savings are greater than the difference between the average LCC of the baseline equipment and the average LCC at each EL. The savings refer only to consumers who are affected by a standard at a given EL. Those who already purchase SEMs with an efficiency at or above a given EL are not affected. Consumers for whom the LCC-increases at a given EL experience a net cost.

Table V-1 Average LCC and PBP Results by Efficiency Level for Representative Unit 1: Single-phase, CSCR, 4-pole, 0.75 hp

Efficiency Level	Average Costs 2019$				Simple Payback years Total Installed Cost	Average Lifetime years First Year's Operating Cost
	Total Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
0	488.1	156.8	631.5	1,119.5	-	6.97
1	504.4	154.4	621.8	1,126.2	6.8	6.97
2	525.7	151.6	610.6	1,136.3	7.3	6.97
3	567.1	150.3	605.0	1,172.0	12.0	6.97
4	594.7	145.8	586.8	1,181.5	9.6	6.97
5	1,411.4	143.2	576.6	1,988.0	67.9	6.97

Note: The results for each EL represent the average value if all purchasers in the sample use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

Table V-2 LCC Savings Relative to the No-New Standards Case Efficiency Distribution for Representative Unit 1: Single-phase, CSCR, 4-pole, 0.75 hp

Efficiency Level	Life-Cycle Cost Savings	
	% of Customers that Experience	Average Savings*
	Net Cost	2019$
1	81.4%	-6.4
2	83.3%	-16.2
3	91.7%	-51.4
4	88.8%	-59.9
5	100.0%	-855.0

* The savings represent the average LCC for affected consumers.

Table V-3 Average LCC and PBP Results by Efficiency Level for Representative Unit 2: Polyphase, 4-pole, 1 hp

Efficiency Level	Average Costs 2019$				Simple Payback years	Average Lifetime years
	Total Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC	Total Installed Cost	First Year's Operating Cost
0	451.0	193.1	969.5	1,420.5	-	8.73
1	520.7	189.0	948.8	1,469.5	16.9	8.73
2	580.0	186.5	936.4	1,516.3	19.5	8.73
3	1,395.5	183.1	919.3	2,314.8	94.5	8.73

Note: The results for each EL represent the average value if all purchasers in the sample use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

Table V-4 LCC Savings Relative to the No-New Standards Case Efficiency Distribution for Representative Unit 2: Polyphase, 4-pole, 1 hp

Efficiency Level	Life-Cycle Cost Savings	
	% of Customers that Experience	Average Savings*
	Net Cost	2019$
1	89.5%	-48.1
2	99.1%	-92.3
3	100.0%	-878.7

* The savings represent the average LCC for affected consumers.

Table V-5 Average LCC and PBP Results by Efficiency Level for Representative Unit 3: Single-phase, CSCR, 4-pole, 1 hp

Efficiency Level	Average Costs 2019$				Simple Payback years	Average Lifetime years
	Total Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC	Total Installed Cost	First Year's Operating Cost

0	554.8	208.4	831.5	1,386.4	-	6.95
1	573.5	205.3	819.2	1,392.6	6.0	6.95
2	597.8	201.9	805.4	1,403.2	6.6	6.95
3	643.6	200.1	798.3	1,441.9	10.7	6.95
4	675.1	194.4	775.4	1,450.5	8.6	6.95
5	1,581.3	191.0	762.1	2,343.4	59.2	6.95

Note: The results for each EL represent the average value if all purchasers in the sample use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

Table V-6 LCC Savings Relative to the No-New Standards Case Efficiency Distribution for Representative Unit 3: Single-phase, CSCR, 4-pole, 1 hp

Efficiency Level	Life-Cycle Cost Savings	
	% of Customers that Experience	Average Savings*
	Net Cost	2019$
1	76.9%	-6.0
2	79.7%	-16.2
3	88.5%	-54.3
4	85.6%	-61.8
5	100.0%	-942.1

* The savings represent the average LCC for affected consumers.

Table V-7 Average LCC and PBP Results by Efficiency Level for Representative Unit 4: Polyphase, 4-pole, 0.5 hp

Efficiency Level	Average Costs 2019$				Simple Payback years	Average Lifetime years
	Total Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC	Total Installed Cost	First Year's Operating Cost
0	375.7	106.6	535.2	910.9	-	8.70
1	433.1	103.5	519.2	952.2	18.0	8.70
2	482.6	101.5	509.3	991.9	20.8	8.70
3	1,148.6	98.9	496.1	1,644.7	99.6	8.70

Note: The results for each EL represent the average value if all purchasers in the sample use equipment with that efficiency level. The PBP is measured relative to the baseline equipment.

Table V-8 LCC Savings Relative to the No-New Standards Case Efficiency Distribution for Representative Unit 4: Polyphase, 4-pole, 0.5 hp

Efficiency Level	Life-Cycle Cost Savings	
	% of Customers that Experience	Average Savings*
	Net Cost	2019$
1	91.7%	-40.5
2	99.6%	-77.9
3	100.0%	-721.4

* The savings represent the average LCC for affected consumers.

C. Final Determination

For this final determination, DOE analyzed whether amended standards for SEMs would be technological feasible and cost effective. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)) EPCA mandates that DOE consider whether amended energy conservation standards for SEMs would be technologically feasible. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A) and 42 U.S.C. 6295(n)(2)(B)) DOE has determined that there are technology options that would improve the efficiency of SEMs. These technology options are being used in commercially available SEMs and therefore are technologically feasible. (See section IV.B for further information.) Hence, DOE has determined that amended energy conservation standards for SEMs are technologically feasible.

EPCA requires DOE to consider whether energy conservation standards for SEMs would be cost effective through an evaluation of the savings in operating costs throughout the estimated average life of the covered product/equipment compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered products/equipment which are/is likely to result from the imposition of an amended standard. (42 U.S.C. 63136(a); 42 U.S.C. 6295(m)(1)(A), 42 U.S.C. 6295(n)(2)(C), and 42 U.S.C. 6295(o)(2)(B)(i)(II)) As presented in the prior section, the average customer purchasing a representative SEM would experience an increase in LCC at each evaluated standards case as compared to the no new standards case. The simple PBP for the average of a representative SEM customer at each EL is projected to be generally longer than the mean lifetime of the equipment. Based on the above considerations, DOE has determined that more stringent amended energy conservation standards for SEMs cannot satisfy the relevant statutory requirements because such standards would not be cost effective as required under EPCA. (See 42 U.S.C. 6295(n)(2); 42 U.S.C. 6295(o)(2)(B)(II); 42 U.S.C. 6316(a))

Having determined that amended energy conservation standards for SEMs would not be cost-effective, DOE did not separately evaluate the significance of the amount of energy conservation under the considered amended standards because it has determined that the potential standards would not be cost-effective (and by extension, would not be economically justified) as required under EPCA. (42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)(A); 42 U.S.C. 6295(n)(2); 42 U.S.C. 6295(o)(2)(B))

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866

This final determination has been determined to be not significant for purposes of Executive Order ("E.O.") 12866, "Regulatory Planning and Review." 58 FR 51735 (Oct. 4, 1993). As a result, the Office of Management and Budget ("OMB") did not review this final determination.

B. Review Under Executive Orders 13771 and 13777

On January 30, 2017, the President issued E.O. 13771, "Reducing Regulation and Controlling Regulatory Costs." E.O. 13771 stated the policy of the executive branch is to be prudent and financially responsible in the expenditure of funds, from both public and private sources. E.O. 13771 stated it is essential to manage the costs associated with the governmental imposition of private expenditures required to comply with Federal regulations.

Additionally, on February 24, 2017, the President issued E.O. 13777, "Enforcing the Regulatory Reform Agenda." See 82 FR 12285 (March 1, 2017). E.O. 13777 required the head of each agency to designate an agency official as its Regulatory Reform Officer ("RRO"). Each RRO oversees the implementation of regulatory reform initiatives and policies to ensure that agencies effectively carry out regulatory reforms, consistent with applicable law. Further, E.O. 13777 requires the establishment of a regulatory task force at each agency. The regulatory task force is required to make recommendations to the agency head regarding the repeal, replacement, or modification of existing regulations, consistent with applicable law. At a minimum, each regulatory reform task force must attempt to identify regulations that:

1) Eliminate jobs, or inhibit job creation;
2) Are outdated, unnecessary, or ineffective;
3) Impose costs that exceed benefits;
4) Create a serious inconsistency or otherwise interfere with regulatory reform initiatives and policies;
5) Are inconsistent with the requirements of the Information Quality Act, or the guidance issued pursuant to that Act, particularly those regulations that rely in whole or in part on data, information, or methods that are not publicly available or that are insufficiently transparent to meet the standard for reproducibility; or

6) Derive from or implement Executive Orders or other Presidential directives that have been subsequently rescinded or substantially modified.

DOE concludes that this final determination is consistent with the directives set forth in these executive orders. As discussed in this document, DOE is not amending the current energy conservation standards for SEMs and will not have any cost impact on manufacturers of SEMs. Therefore, this determination is an E.O. 13771 Other Action.

C. 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 Executive Order 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 (*http://energy.gov/gc/office-general-counsel*).

DOE reviewed this final determination pursuant to the Regulatory Flexibility Act and the procedures and policies discussed above. DOE has concluded that, based on the data and available information it has been able to review, amended energy conservation standards for SEMs would not be cost-effective. Therefore, DOE is not amending the current energy conservation standards for SEMs. On the basis of the foregoing, DOE certifies that this final determination will not have a significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared an FRFA for this final determination. DOE has transmitted its certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

D. Review Under the Paperwork Reduction Act

Manufacturers of SEMs must certify to DOE that their equipment comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their equipment according to the DOE test procedures, 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 SEMs. 76 FR 12422 (March 7, 2011); 80 FR 5099 (Jan. 30, 2015). 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 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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. This final determination, which concludes that amended energy conservation standards for SEMs would not be cost effective (and by extension, not economically justified) as required under the relevant statute, imposes no new information or recordkeeping requirements. Accordingly, clearance from the OMB is not required under the Paperwork Reduction Act. (44 U.S.C. 3501 et seq.)

E. Review Under the National Environmental Policy Act of 1969

DOE analyzed this final determination in accordance with the National Environmental Policy Act ("NEPA") and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for actions which are interpretations or rulings with respect to existing regulations. 10 CFR part 1021, Subpart D, Appendix A4. DOE has determined that this action qualifies for categorical exclusion A4 because it is an interpretation or ruling in regards to an existing regulation and otherwise meets the requirements for application of a categorical exclusion. See 10 CFR 1021.410.

F. Review Under Executive Order 13132

Executive Order 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. As this final determination does not amend the standards for SEMs, there is no impact on the policymaking discretion of the States. Therefore, no action is required by Executive Order 13132.

G. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, “Civil Justice Reform,” imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation (1) clearly specifies the preemptive effect, if any, (2) clearly specifies any effect on existing Federal law or regulation, (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction, (4) specifies the retroactive effect, if any, (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final determination meets the relevant standards of Executive Order 12988.

H. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (“UMRA”) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and

Tribal governments and the private sector. Public Law 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *http://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.* This final determination does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by State, local, and Tribal governments, in the aggregate, or by the private sector. As a result, the analytical requirements of UMRA do not apply.

I. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Public Law 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This final determination will not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

J. Review Under Executive Order 12630

Pursuant to Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988), DOE has determined that this final determination will not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

K. 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). 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 https://www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf. DOE has reviewed this final determination under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

L. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to the Office of Information and Regulatory Affairs ("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.

Because this final determination does not amend the current standards for SEMs, it is not a significant energy action, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects.

M. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy ("OSTP"), issued its Final Information Quality Bulletin for Peer Review ("the Bulletin"). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are "influential scientific information," which the Bulletin defines as "scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions." 70 FR 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The "Energy Conservation Standards Rulemaking Peer Review Report" dated February 2007 has been disseminated and is available at: *http://www.energy.gov/eere/buildings/peer-review*.

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final determination.

Signing Authority

This document of the Department of Energy was signed on January 5, 2021, by Daniel R Simmons, 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 6, 2021.

Treena V. Garrett
Federal Register Liaison Officer,
U.S. Department of Energy

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