AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket Number EERE–2007–BT–STD–0007]

RIN 1904–AB70

Energy Conservation Program: Energy Conservation Standards for Small Electric Motors

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

ACTION: Final rule.

SUMMARY: The U.S. Department of Energy (DOE) is adopting energy conservation standards for small electric motors. DOE has determined that these standards will result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: *Effective Date:* The effective date of this rule is April 8, 2010. The standards established in today's final rule will be applicable starting March 9, 2015.

ADDRESSES: For access to the docket to read background documents, the technical support document, transcripts of the public meetings in this proceeding, or comments received, visit the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., 6th Floor, Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards at the above telephone number for additional information regarding visiting the Resource Room. (Note: DOE's Freedom of Information Reading Room no longer houses rulemaking materials.) You may also obtain copies of certain previous rulemaking documents in this proceeding (*i.e.,* framework document, notice of public meeting and availability of preliminary technical support document, notice of proposed rulemaking, draft analyses, public meeting materials, and related test procedure documents from the Office of Energy Efficiency and Renewable Energy's Web site at *http://www.eere.energy.gov/buildings/appliance_standards/commercial/small_electric_motors.html).*

FOR FURTHER INFORMATION CONTACT: Mr. James Raba, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–8654, e-mail: *Jim.Raba@ee.doe.gov.*

Mr. Michael Kido, U.S. Department of Energy, Office of General Counsel, GC–72, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–8145, e-mail: *Michael.Kido@hq.doe.gov.*

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Summary of the Final Rule and Its Benefits

A. Energy Conservation Standards Levels

The Energy Policy and Conservation Act, as amended (42 U.S.C. 6291 *et seq.;* EPCA or the Act), directs the U.S. Department of Energy (DOE) to adopt energy conservation standards for those small electric motors for which standards would be technologically feasible and economically justified, and would result in significant energy savings (42 U.S.C. 6317(b)(1)–(2)). The standards in today's final rule satisfy these requirements and will achieve the maximum improvements in energy efficiency that are technologically feasible and economically justified. Table I.1 and Table I.2 show these standard levels, which will apply to all small electric motors manufactured for sale in the United States, or imported into the United States, starting five years after publication of this final rule.

TABLE I.1—STANDARD LEVELS FOR POLYPHASE SMALL ELECTRIC MOTOR

Motor output power	Six poles	Four poles	Two poles
0.25 Hp/0.18 kW	67.5	69.5	65.6
0.33 Hp/0.25 kW	71.4	73.4	69.5
0.5 Hp/0.37 kW	75.3	78.2	73.4
0.75 Hp/0.55 kW	81.7	81.1	76.8
1 Hp/0.75 kW	82.5	83.5	77.0
1.5 Hp/1.1 kW	83.8	86.5	84.0
2 Hp/1.5 kW	N/A	86.5	85.5
3 Hp/2.2 kW	N/A	86.9	85.5

* Standard levels are expressed in terms of average full-load efficiency.

** These efficiencies correspond to a modified Trial Standard Level 4b for polyphase motors. For horsepower/pole configurations with efficiency standards higher than the for general purpose electric motors (subtype I), DOE reduced the standard level to align with regulations in 10 CFR 431.25. See section VI for further discussion.

TABLE I.2—STANDARD LEVELS FOR CAPACITOR-START INDUCTION-RUN AND CAPACITOR-START CAPACITOR-RUN SMALL ELECTRIC MOTORS

Motor output power	Six poles	Four poles	Two poles
0.25 Hp/0.18 kW	62.2	68.5	66.6
0.33 Hp/0.25 kW	66.6	72.4	70.5
0.5 Hp/0.37 kW	76.2	76.2	72.4
0.75 Hp/0.55 kW	80.2	81.8	76.2
1 Hp/0.75 kW	81.1	82.6	80.4
1.5 Hp/1.1 kW	N/A	83.8	81.5
2 Hp/1.5 kW	N/A	84.5	82.9
3 Hp/2.2 kW	N/A	N/A	84.1

* Standard levels are expressed in terms of full-load efficiency.

** These efficiencies correspond to a modified Trial Standard Level 7 for capacitor-start motors. DOE reduced efficiency standards for capacitor-start induction run motors such that they harmonize with adopted capacitor-start capacitor-run motor efficiency standards. See section VI for further discussion.

B. Benefits and Burdens to Customers of Small Electric Motors

Table I.3 presents the implications of today's standards for consumers of small electric motors. The economic impacts of the standards on consumers as measured by the average life-cycle cost (LCC) savings are positive, even though the standards may increase some initial costs. For example, a typical polyphase motor has an average installed price of $517 and average lifetime operating costs (discounted) of $751. To meet the amended standards, DOE estimates that the average installed price of such equipment will increase by $72, which will be more than offset by savings of $100 in average lifetime operating costs (discounted).

TABLE I.3—IMPLICATIONS OF STANDARDS FOR COMMERCIAL CONSUMERS

Equipment class	Energy conservation standard %	Average installed price* $	Average installed price increase %	Average life-cycle cost savings $	Median payback period years
Polyphase, 1-horsepower, 4-pole	83.5	589	72	28	7.8
Capacitor-start induction-run, ½-horsepower, 4-pole	76.2	996	502	−369	12.4
Capacitor-start capacitor-run, ¾-horsepower, 4-pole	81.8	599	51	24	5.9

* For a baseline model.

C. Impact on Manufacturers

Using a real corporate discount rate of 9.7 percent, which DOE calculated by examining the financial statements of motor manufacturers, DOE estimates the industry net present value (INPV) of the small electric motor manufacturing industry to be $70 million for polyphase small electric motors and $279 million for capacitor-start, or single-phase motors (both figures in 2009$). DOE expects the impact of the standards on the INPV of manufacturers of small electric motors to range from a increase of 4.8 percent to a loss of 7.8 percent (an increase of $3.4 million to a loss of $5.4 million) for polyphase motors and an increase of 6.6 percent to a loss of 12.2 percent (an increase of $32.2 million to a loss of $42.2 million) for single-phase motors. Based on DOE's interviews with the major manufacturers of small electric motors, DOE expects minimal plant closings or loss of employment as a result of the standards.

D. National Benefits

The standards will provide significant benefits to the Nation. DOE estimates the standards will save approximately 2.2 quads (quadrillion (10^{15}) British thermal units (BTU)) of energy over 30 years (2015–2045). This is equivalent to about 2.2% of total annual U.S. energy consumption.

By 2045, DOE expects the energy savings from the standards to eliminate the need for approximately eight new 250-megawatt (MW) power plants. These energy savings will result in cumulative greenhouse gas emission reductions of approximately 112 million tons (Mt) of carbon dioxide (CO_2), or an amount equal to that produced by approximately 25 million new cars in a year. Additionally, the standards will help alleviate air pollution by resulting in approximately 81 thousand tons (kt) of nitrogen oxides (NO_X) emission reductions and approximately 0.49 ton of cumulative mercury (Hg) emission reductions from 2015 through 2045. The estimated net present monetary value of these emissions reductions is between $385 and $6,081 million for CO_2, (expressed in 2009$). The estimated net present monetary values of these emissions reductions are between $13.2 and $63.4 million for NO_X (expressed in 2009$) and $0.12 and $5.14 million for Hg (expressed in 2009$) at a 7-percent discount rate (discounted to 2010). At a 3 percent discount rate, the estimated net present values of these emissions reductions are between $17.1 and $175.5 million (2009$) for NO_X and $0.22 and $9.66 million (2009$) for Hg.

The national NPV of the standards is $5.3 billion using a seven-percent discount rate and $12.5 billion using a three-percent discount rate, cumulative from 2015 to 2045 in 2009$. This is the estimated total value of future savings minus the estimated increased equipment costs, discounted to the year 2009.

The benefits and costs of today's rule can also be expressed in terms of annualized (2009$) values from 2015–2045. Estimates of annualized values are shown in Table I.4. The annualized monetary values are the sum of the annualized national economic value of operating savings benefits (energy, maintenance and repair), expressed in 2009$, plus the monetary value of the benefits of CO_2 emission reductions, otherwise known as the Social Cost of Carbon (SCC), calculated using the average value derived using a 3% discount rate (equivalent to $21.40 per metric ton of CO_2 emitted in 2010, in 2007$). This value is a central value from a recent interagency process. The monetary benefits of cumulative emissions reductions are reported in 2009$ so that they can be compared with the other costs and benefits in the same dollar units. The derivation of this value is discussed in section IV.M. Although comparing the value of operating savings to the value of CO_2 reductions provides a valuable perspective, please note the following: (1) The national operating savings are domestic U.S. consumer monetary savings found in market transactions while the value of CO_2 reductions is based on a global value. Also, note that the central value is only one of four SCC developed by the interagency workgroup. Other marginal SCC values for 2010 are $4.70, $35.10, and $64.90 per metric ton (2007$ for emissions in 2010), which reflect different discount rates and, for the highest value, the possibility of higher-than-expected impacts further out in the tails of the SCC distribution. (2) The assessments of operating savings and CO_2 savings are performed with different computer models, leading to different time frames for analysis. The national operating cost savings is measured for the lifetime of small electric motors shipped in the 31-year period 2015–2045. The value of CO_2, on the other hand, reflects the present value of all future climate related impacts due to emitting a ton of carbon dioxide in that year, out to 2300.

Using a 7-percent discount rate for the annualized cost analysis, the combined cost of the standards proposed in today's proposed rule for small electric motors is $263.9 million per year in increased equipment and installation costs, while the annualized benefits are $855.1 million per year in reduced equipment operating costs, $115.6 million in CO_2 reductions, $3.89 million in reduced NO_X emissions, and $0.30 million in reduced Hg emissions, for a net benefit of $711.0 million per year. Using a 3-percent discount rate, the cost of the standards proposed in today's rule is $263.7 million per year in increased equipment and installation costs, while the benefits of today's standards are $989.5 million per year in reduced operating costs, $115.6 million in CO_2 reductions, $5.58 million in reduced NO_X emissions, and $0.29 million in reduced Hg emissions, for a net benefit of $847.3 million per year.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS FOR SMALL ELECTRIC MOTORS

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered
Benefits						
Energy Annualized Monetized (millions$/year).	855.1	831.8	870.3	2009	7%	31
	989.5	964.8	1000.5	2009	3%	31
Annualized Quantified	2.29 CO_2 (Mt)	2.29 CO_2 (Mt)	2.29 CO_2 (Mt)	NA	7%	31
	1.55 NO_X (kt)	1.55 NO_X (kt)	1.55 NO_X (kt)	NA	7%	31
	0.017 Hg (t)	0.017 Hg (t)	0.017 Hg (t)	NA	7%	31
	3.13 CO_2 (Mt)	3.13 CO_2 (Mt)	3.13 CO_2 (Mt)	NA	3%	31
	2.22 NO_X (kt)	2.22 NO_X (kt)	2.22 NO_X (kt)	NA	3%	31
	0.017 Hg (t)	0.017 Hg (t)	0.017 Hg (t)	NA	3%	31

TABLE I.4—ANNUALIZED BENEFITS AND COSTS FOR SMALL ELECTRIC MOTORS—Continued

Category	Primary estimate (AEO reference case)	Low estimate (low energy price case)	High estimate (high energy price case)	Units		
				Year dollars	Disc. rate	Period covered
CO_2 Monetized Value (at $4.7/Metric Ton, millions$/year)*.	31.5	31.5	31.5	2009	5%	31
CO_2 Monetized Value (at $21.4/Metric Ton, millions$/year)*.	115.6	115.6	115.6	2009	3%	31
CO_2 Monetized Value (at $35.1/Metric Ton, millions$/year)*.	179.2	179.2	179.2	2009	2.5%	31
CO_2 Monetized Value (at $64.9/Metric Ton, millions$/year)*.	352.5	352.5	352.5	2009	3%	31
NO_X Monetized Value (at $2,437/Metric Ton, millions$/year).	3.89	3.89	3.89	2009	7%	31
	5.58	5.58	5.58	2009	3%	31
Hg Monetized Value (at $17 million/Metric Ton, millions$/year).	0.3	0.3	0.3	2009	7%	31
	0.29	0.29	0.29	2009	3%	31
Total Monetary Benefits (millions$/year)**.	890.8–1211.8	867.5–1188.5	906.0–1227.0	2009	7% Range	31
	974.9	951.6	990.1	2009	7%	31
	1111.0	1086.3	1121.9	2009	3%	31
	1026.9–1347.9	1002.2–1323.2	1037.8–1358.8	2009	3% Range	31
Costs						
Annualized Monetized (millions$/year)	263.9	263.9	263.9	2009	7%	31
	263.7	263.7	263.7	2009	3%	31
Net Benefits/Costs						
Annualized Monetized, including CO_2 Benefits (million$/year)**.	626.9–947.9	603.6–924.6	642.1–963.1	2009	7% Range	31
	711.0	687.7	726.2	2009	7%	31
	847.3	822.6	858.3	2009	3%	31
	763.2–1084.3	738.5–1059.6	774.2–1095.2	2009	3% Range	31

* These values represent global values (in 2007$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. See section IV.M for details.

** Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate (averaged across three IAMs), which is equal to $21.4/ton in 2010 (in 2007$). The rows labeled as "7% Range" and "3% Range" calculate consumer, Hg, and NO_X cases with the labeled discount rate but add these values to the full range of CO_2 values with the $4.7/ton value at the low end, and the $64.9/ton value at the high end.

E. Conclusion

DOE has concluded that the benefits (energy savings, consumer LCC savings, national NPV increases, and emissions reductions) to the Nation of today's standards for small electric motors outweigh their costs (loss of manufacturer INPV and consumer LCC increases for some users of small electric motors). DOE has also concluded that these standards are technologically feasible and economically justified, and will result in significant energy savings. Small electric motors that are commercially available or working prototypes use or have used the technologies needed to meet the new standard levels.

II. Introduction

A. Authority

Title III of EPCA sets forth a variety of provisions designed to improve energy efficiency. Part A of Title III (42 U.S.C. 6291–6309) provides for the Energy Conservation Program for Consumer Products Other than Automobiles. Part A–1 of Title III (42 U.S.C. 6311–6317) establishes a similar program for "Certain Industrial Equipment," which includes small electric motors, the subject of this rulemaking.[1] DOE publishes today's final rule pursuant to Part A–1 of Title III, which provides for test procedures, labeling, and energy conservation standards for small electric motors and certain other equipment, and authorizes DOE to require information and reports from manufacturers. The test procedures DOE recently adopted for small electric motors, 74 FR 32059 (July 7, 2009), appear at Title 10, Code of Federal Regulations (CFR), sections 431.443, 431.444, and 431.445.

The Act defines "small electric motor" as follows:

> [A] NEMA [National Electrical Manufacturers Association] general purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987.

(42 U.S.C. 6311(13)(G)) EPCA requires DOE to prescribe energy conservation standards for those small electric motors for which DOE: (1) Has determined that standards would be technologically feasible and economically justified and would result in significant energy savings, and (2) has prescribed test procedures. (42 U.S.C. 6317(b)) However, pursuant to section 346(b)(3) of EPCA (42 U.S.C. 6317(b)(3)), no standard prescribed for small electric motors shall apply to any such motor that is a component of a covered product under section 322(a) of EPCA (42 U.S.C. 6292(a)), or of covered equipment under section 340 (42 U.S.C. 6311).

Additionally, EPCA requires DOE, in establishing standards for small electric motors, to consider whether the standards themselves will result in a significant conservation of energy, are technologically feasible, and are cost effective as described in 42 U.S.C. 6295(o)(2)(B)(i). (42 U.S.C. 6316(a)) These criteria, along with requirements that any standards be economically justified, are largely incorporated into

---

[1] These two parts were titled Parts B and C in EPCA, but were codified as Parts A and A–1 in the United States Code for editorial reasons.

42 U.S.C. 6295(o), which sets forth the criteria for prescribing standards for "covered products," *i.e.,* consumer products as defined in EPCA. (42 U.S.C. 6291(1) and (2)) Under 42 U.S.C. 6316(a), portions of 42 U.S.C. 6295, including subsection (o), also apply when DOE promulgates standards for certain specified commercial and industrial equipment—"covered equipment" as defined in EPCA (42 U.S.C. 6311(1))—including small electric motors. (EPCA states that the term "equipment" shall be substituted for "product" in applying the consumer product-related provisions of EPCA to commercial and industrial equipment. (42 U.S.C. 6316(a)(3))

Therefore, as indicated above, DOE analyzed whether today's standards for small electric motors will achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Additionally, DOE examined whether each of today's standards for this equipment is economically justified, after receiving comments on the proposed standards, by determining whether the benefits of the standard exceed its burdens by considering, to the greatest extent practicable, the following seven factors that are set forth in 42 U.S.C. 6295(o)(2)(B)(i):

1. The economic impact of the standard on manufacturers and consumers of the equipment subject to the standard;
2. The savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered equipment that are likely to result from the imposition of the standard;
3. The total projected amount of energy savings likely to result directly from the imposition of the standard;
4. Any lessening of the utility or the performance of the covered equipment likely to result from the imposition of the standard;
5. The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard;
6. The need for national energy conservation; and
7. Other factors the Secretary [of Energy] considers relevant.

In developing today's energy conservation standards, DOE also has applied certain other provisions of 42 U.S.C. 6295 as it is required to do. First, DOE would not prescribe a standard for small electric motors if interested persons established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States of any type (or class) of this product with performance characteristics, features, sizes, capacities, and volume that are substantially the same as those generally available in the United States. (42 U.S.C. 6295(o)(4))

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

Third, in setting standards for a type or class of equipment that has two or more subcategories, DOE specifies a different standard level than that which applies generally to such type or class of equipment "for any group of covered products which have the same function or intended use, if * * * products within such group—(A) consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard" than applies or will apply to the other products. (42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies such a different standard for a group of products, DOE considers such factors as the utility to the consumer of such a feature and other factors DOE deems appropriate. Any rule prescribing such a standard must include an explanation of the basis on which DOE establishes such higher or lower level. (42 U.S.C. 6295(q)(2))

Federal energy efficiency requirements for equipment covered under EPCA generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)–(c) and 42 U.S.C. 6316(a)) DOE can, however, grant waivers of preemption for particular State laws or regulations, in accordance with the procedures and other provisions of section 327(d) of the Act. (42 U.S.C. 6297(d) and 42 U.S.C. 6316(a))

B. Background

1. Current Energy Conservation Standards

As indicated above, at present there are no national energy conservation standards for small electric motors.

2. History of Standards Rulemaking for Small Electric Motors

To determine the small electric motors for which energy conservation standards would be technologically feasible and economically justified, and would result in significant energy savings, DOE first concluded that the EPCA definition of "small electric motor" covers only those motors that meet the definition's frame-size requirements, and that are either three-phase, non-servo motors (referred to below as polyphase motors) or single-phase, capacitor-start motors, including both capacitor-start, induction run (CSIR) and capacitor-start, capacitor-run (CSCR) motors. 71 FR 38799, 38800–01 (July 10, 2006). In June 2006, DOE issued a report in which it analyzed and estimated the likely range of energy savings and economic benefits that would result from standards for these motors.[2] The report did not address motors that are a component of a covered product or equipment, consistent with 42 U.S.C. 6317. After receiving comments on the report, DOE performed further analysis to determine whether standards are warranted for small electric motors and then issued the following determination on June 27, 2006:

> Based on its analysis of the information now available, the Department [of Energy] has determined that energy conservation standards for certain small electric motors appear to be technologically feasible and economically justified, and are likely to result in significant energy savings. Consequently, the Department [of Energy] will initiate the development of energy efficiency test procedures and standards for certain small electric motors. 71 FR 38807.

Thereafter, in 2007, DOE initiated this rulemaking by issuing and seeking public comment on the "Energy Conservation Standards Rulemaking Framework Document for Small Electric Motors," which described the approaches DOE anticipated using to develop energy conservation standards for small electric motors and the issues to be resolved in the rulemaking. See 72 FR 44990 (August 10, 2007). This document is also available on the aforementioned DOE Web site. On September 13, 2007, DOE held a public

---

[2] *http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/small_motors_tsd.pdf.*

meeting to present the contents of the framework document, describe the analyses DOE planned to conduct during the rulemaking, obtain public comment on these subjects, and facilitate the public's involvement in the rulemaking. Manufacturers, trade associations, electric utilities, environmental advocates, regulators, and other interested parties provided comments at this meeting, and submitted written comments, on the Framework Document. They addressed a range of issues.

On December 19, 2008, after having considered these comments, gathering additional information, and performing preliminary analyses as to standards for small electric motors, DOE announced an informal public meeting and the availability on its Web site of a preliminary technical support document (preliminary TSD). 73 FR 79723 (December 30, 2008). The preliminary TSD discussed the comments DOE had received in this rulemaking and described the actions DOE had taken, the analytical framework DOE was using, and the content and results of DOE's preliminary analyses. *Id.* at 79724–25. DOE's preliminary analyses were largely based on comments received from industry; including those focusing on what constitutes small electric motors and corresponding shipment estimates. DOE convened the public meeting to discuss, and receive comments on, these subjects, DOE's proposed product classes, potential standard levels that DOE might consider, and other issues participants believed were relevant to the rulemaking. *Id.* at 79723, 79725. DOE also invited written comments on all of these matters. The public meeting took place on January 30, 2009. Eighteen interested parties participated, and ten submitted written comments during the comment period.

On November 24, 2009, DOE published a notice of proposed rulemaking (NOPR) to establish small electric motor energy conservation standards. 74 FR 61410. Shortly after, DOE also published on its Web site the complete technical support document (TSD) for the proposed rule, which incorporated the completed analyses DOE conducted and technical documentation for each analysis. These analyses were developed using, in part, NEMA-supplied data. The TSD included the LCC spreadsheet, the national impact analysis spreadsheet, and the manufacturer impact analysis (MIA) spreadsheet—all of which are available at *http://www.eere.energy.gov/buildings/appliance_standards/commercial/small_electric_motors.html.* The energy efficiency standards DOE proposed in the NOPR were as follows:

TABLE II.1—PROPOSED STANDARD LEVELS FOR POLYPHASE SMALL ELECTRIC MOTORS

Motor output power	Six poles	Four poles	Two poles
0.25 Hp/0.18 kW	77.4	72.7	69.8
0.33 Hp/0.25 kW	79.1	75.6	73.7
0.5 Hp/0.37 kW	81.1	80.1	76.0
0.75 Hp/0.55 kW	84.0	83.5	81.6
1 Hp/0.75 kW	84.2	85.2	83.6
1.5 Hp/1.1 kW	85.2	87.1	86.6
2 Hp/1.5 kW	89.2	88.0	88.2
≥3 Hp/2.2 kW	90.8	90.0	90.5

* Standard levels are expressed in terms of full-load efficiency.
** These efficiencies corresponded to NOPR Trial Standard Level 5 for polyphase motors.

TABLE II.2—PROPOSED STANDARD LEVELS FOR CAPACITOR-START INDUCTION-RUN SMALL ELECTRIC MOTORS

Motor output power	Six poles	Four poles	Two poles
0.25 Hp/0.18 kW	65.4	69.8	71.4
0.33 Hp/0.25 kW	70.7	72.8	74.2
0.5 Hp/0.37 kW	77.0	77.0	76.3
0.75 Hp/0.55 kW	81.0	80.9	78.1
1 Hp/0.75 kW	84.1	82.8	80.0
1.5 Hp/1.1 kW	87.7	85.5	82.2
2 Hp/1.5 kW	89.8	86.5	85.0
≥3 Hp/2.2 kW	92.2	88.9	85.6

* Standard levels are expressed in terms of full-load efficiency.
** These efficiencies corresponded to NOPR Trial Standard Level 7 for capacitor-start motors.

TABLE II.3—PROPOSED STANDARD LEVELS FOR CAPACITOR-START CAPACITOR-RUN SMALL ELECTRIC MOTORS

Motor output power	Six poles	Four poles	Two poles
0.25 Hp/0.18 kW	63.9	68.3	70.0
0.33 Hp/0.25 kW	69.2	71.6	72.9
0.5 Hp/0.37 kW	75.8	76.0	75.1
0.75 Hp/0.55 kW	79.9	80.3	77.0
1 Hp/0.75 kW	83.2	82.0	79.0
1.5 Hp/1.1 kW	87.0	84.9	81.4
2 Hp/1.5 kW	89.1	86.1	84.2
≥3 Hp/2.2 kW	91.7	88.5	84.9

* Standard levels are expressed in terms of full-load efficiency.
** These efficiencies corresponded to NOPR Trial Standard Level 7 for capacitor-start motors.

In the NOPR, DOE also identified issues on which it was particularly interested in receiving the comments and views of interested parties. DOE requested comment on the proposed energy efficiency levels for polyphase and single-phase motors, product classes, covered insulation class systems, its selection of baseline models, markups used in the engineering analysis, design option and limitations used in the engineering analysis, the approach to scaling the results of the engineering analysis, the proposed definition of nominal efficiency, the manufacturer impact analysis scenarios, capital investment costs used, market interaction between CSIR and CSCR motors, market response to standards, behavior of customers with space constraints, the combined effect of certain market assumptions, the appropriateness of other discount rates besides seven and three percent to discount future emissions, and the anticipated environmental impacts. The NOPR also included additional background information on the history of this rulemaking. 74 FR 61416–17.

DOE held a public meeting in Washington, DC on December 17, 2009, to hear oral comments on, and solicit information relevant to, the proposed rule. DOE has also received written comments and information in response to the NOPR.

III. General Discussion

A. Test Procedures

On July 7, 2009, DOE published a final rule that incorporated by reference Institute of Electrical and Electronics Engineers, Inc. (IEEE) Standard 112–2004 (Test Method A and Test Method B), IEEE Standard 114–2001, and Canadian Standards Association Standard C747–94 as the DOE test procedures to measure energy efficiency small electric motors. 74 FR 32059.

In addition to incorporating by reference the above industry standard test procedures, the small electric motors test procedure final rule also codified the statutory definition for the term "small electric motor;" clarified the definition of the term "basic model"; and the relationship of the term to certain product classes and compliance certification reporting requirements; and codified the ability of manufacturers to use an alternative efficiency determination method (AEDM) to reduce testing burden when certifying their equipment as compliant but maintaining efficiency measurement accuracy and ensuring compliance with potential future energy conservation standards. The test procedure notice also discussed matters of laboratory accreditation, compliance certification, and enforcement of energy conservation standards for small electric motors.

DOE notes that complete certification and enforcement provisions for small electric motors have not yet been developed. DOE intends to propose such provisions in a separate test procedure supplementary NOPR, at which time DOE will invite comments on how small electric motor efficiency standards can be effectively enforced. Section V.B of this final rule summarizes comments received in response to the NOPR that will be further addressed in the test procedure supplemental NOPR.

B. Technological Feasibility

1. General

As stated above, any standards that DOE establishes for small electric motors must be technologically feasible. (42 U.S.C. 6295(o)(2)(A); 42 U.S.C. 6316(a)) DOE considers a design option to be technologically feasible if it is in use by the respective industry or if research has progressed to the development of a working prototype. "Technologies incorporated in commercially available equipment or in working prototypes will be considered technologically feasible." 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i). This final rule considers the same design options as those evaluated in the NOPR. (See chapter 5 of the TSD.) All the evaluated technologies have been used (or are being used) in commercially available products or working prototypes. Therefore, DOE has determined that all of the efficiency levels evaluated in this notice are technologically feasible.

2. Maximum Technologically Feasible Levels

As required by EPCA, (42 U.S.C. 6295(p)(1) and 42 U.S.C. 6316(a)), in developing the NOPR, DOE identified the efficiency levels that would achieve the maximum improvements in energy efficiency that are technologically feasible (max-tech levels) for small electric motors. 74 FR 61418. Table III.1 lists the max-tech levels that DOE determined for this rulemaking. DOE identified these levels as part of the engineering analysis (chapter 5 of the TSD), using the most efficient design parameters that lead to the highest full-load efficiencies for small electric motors.

TABLE III.1—MAX-TECH EFFICIENCY LEVELS FOR REPRESENTATIVE PRODUCT CLASSES *

Motor category	Poles	Horsepower	Efficiency %
Polyphase	4	1	87.7
CSIR	4	0.5	77.6
CSCR	4	0.75	87.5

* These max-tech efficiency levels are only for the representative product classes described in section IV.C.2. Max-tech efficiency levels for the remaining product classes are determined using the scaling methodology outlined in section IV.C.5.

DOE developed maximum technologically feasible efficiencies by creating motor designs for each product class analyzed, which use all the viable design options that DOE considered. The efficiency levels shown in Table III.1 correspond to designs that use a maximum increase in stack length, a copper rotor design, a premium electrical steel (Hiperco 50), a maximum slot-fill percentage (65-percent), a change in run-capacitor rating (CSCR motors only), and an optimized end ring design. All of the design options used to create these max-tech motors remain in the analysis and are options that DOE considers technologically feasible.

C. Energy Savings

DOE forecasted energy savings in its national energy savings (NES) analysis, through the use of an NES spreadsheet tool, as discussed in the NOPR. 74 FR 61418, 61440–42, 61470–72.

One of the criteria that govern DOE's adoption of standards for small electric motors is that the standard must result in "significant" energy savings. (42 U.S.C. 6317(b)) While the term "significant" is not defined by EPCA, a D.C. Circuit indicated that Congress intended "significant" energy savings to be savings that were not "genuinely trivial." *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (D.C. Cir. 1985) The energy savings for the standard levels DOE is adopting today are non-trivial, and therefore DOE considers them "significant" as required by 42 U.S.C. 6317.

D. Economic Justification

1. Specific Criteria

The following section discusses how DOE has addressed each of the seven factors that it uses to determine if energy conservation standards are economically justified.

a. Economic Impact on Motor Customers and Manufacturers

DOE considered the economic impact of today's new standards on purchasers and manufacturers of small electric motors. For purchasers of small electric motors, DOE measured the economic impact as the change in installed cost and life-cycle operating costs, *i.e.,* the LCC. (See section IV.F of this preamble, and chapter 12 of the TSD.) DOE investigated the impacts on manufacturers through the manufacturer impact analysis (MIA). (See sections IV.I and VI.C.2 of this preamble and chapter 13 of the TSD.) The economic impact on purchasers and manufacturers is discussed in detail in the NOPR. 74 FR 61418–19, 61436–40, 61442–46, and 61454–70.

b. Life-Cycle Costs

DOE considered life-cycle costs of small electric motors, as discussed in the NOPR. 74 FR 61436–40, 61442, 61454–64. In considering these costs, DOE calculated the sum of the purchase price and the operating expense—discounted over the lifetime of the equipment—to estimate the range in LCC savings that small motors purchasers would expect to achieve due to the standards.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for imposing an energy conservation standard, EPCA also requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III) and 42 U.S.C. 6316(a)) As in the NOPR (74 FR 61440–42, 61470–72), for today's final rule, DOE used the NES spreadsheet results in its consideration of total projected energy savings that are directly attributable to the standard levels DOE considered.

d. Lessening of Utility or Performance of Equipment

In selecting today's standard levels, DOE avoided selection of standards that lessen the utility or performance of the equipment under consideration in this rulemaking. (See 42 U.S.C. 6295(o)(2)(B)(i)(IV) and 42 U.S.C. 6316(a)) 74 FR 61419, 61476. The efficiency levels DOE considered maintain both motor performance and power factor in order to preserve consumer utility. DOE considered end-user size constraints by developing designs with size increase restrictions (limited to a 20-percent increase in stack length), as well as designs with less stringent constraints (100-percent increase in stack length). The designs adhering to the 20-percent increase in stack length maintain all aspects of consumer utility and were created for all efficiency levels, but these designs may become very expensive at higher efficiency levels when compared with DOE's other designs.

e. Impact of Any Lessening of Competition

DOE considered any lessening of competition that is likely to result from standards. As discussed in the NOPR, 74 FR 61419, 61476, and as required under EPCA, DOE requested that the Attorney General transmit to the Secretary a written determination of the impact, if any, of any lessening of competition likely to result from the standards proposed in the NOPR, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii) and 42 U.S.C. 6316(a))

To assist the Attorney General in making such a determination, DOE provided the Department of Justice (DOJ) with copies of the November 24, 2009 proposed rule and the NOPR TSD for review. The Attorney General's response is discussed in IV.F.7 below, and is reprinted at the end of this rule. DOJ concluded that TSL 5 for polyphase small electric motors and TSL 7 for single-phase small electric motors are likely to affect the replacement market for certain applications. DOJ requested that DOE consider this potential impact and, as warranted, allow exemptions from the proposed standard levels the manufacture and marketing of certain replacement small electric motors.

f. Need of the Nation To Conserve Energy

In considering standards for small electric motors, the Secretary must consider the need of the Nation to conserve energy. (42 U.S.C. 6295(o)(2)(B)(i)(VI) and 42 U.S.C. 6316(a)) The Secretary recognizes that energy conservation benefits the Nation in several important ways. The non-monetary benefits of the standard are likely to be reflected in improvements to the security and reliability of the Nation's energy system. Today's standard will also result in environmental benefits. As discussed in the NOPR, 74 FR 61419, 61447–61453, 61476–61484, and in section VI.C.6 of this final rule, DOE considered these factors in adopting today's standards.

g. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, considers any other factors that the Secretary of Energy deems relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII) and 42 U.S.C. 6316(a)) In adopting today's standards, the Secretary considered the following: (1) Harmonization of standards for small electric motors with existing standards under EPCA for medium-sized polyphase general purpose motors; (2) the impact, on consumers who need to use CSIR motors, and on the prices for such motors at potential standard levels; and (3) the potential for standards to reduce reactive power demand and thereby lower costs for supplying electricity.[3] 74 FR 61419–20, 61484. These issues are addressed in section VI.C.7 below.

2. Rebuttable Presumption

Section 325(o)(2)(B)(iii) of EPCA states that there is a rebuttable presumption that an energy conservation standard is economically justified if the increased installed cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard, as calculated under the applicable DOE test procedure. (42 U.S.C. 6295(o)(2)(B)(iii) and 42 U.S.C. 6316(a)) DOE's LCC and payback period (PBP) analyses generate values that calculate the PBP of potential energy conservation standards. The calculation includes, but is not limited to, the three-year PBP contemplated under the rebuttable presumption test just described. However, DOE routinely

---

[3] In an alternating current power system, the reactive power is the root mean square (RMS) voltage multiplied by the RMS current, multiplied by the sine of the phase difference between the voltage and the current. Reactive power occurs when the inductance or capacitance of the load shifts the phase of the voltage relative to the phase of the current. While reactive power does not consume energy, it can increase losses and costs for the electricity distribution system. Motors tend to create reactive power because the windings in the motor coils have high inductance.

conducts a full economic analysis that considers the full range of impacts, including those to the customer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i) and 42 U.S.C. 6316(a). The results of this analysis serve as the basis for DOE to evaluate definitively the economic justification for a potential standard level (thereby supporting or rebutting any presumption of economic justification).

IV. Methodology and Discussion of Comments on Methodology

DOE used several analytical tools that it developed previously and adapted for use in this rulemaking. One is a spreadsheet that calculates LCC and PBP. Another tool calculates national energy savings and national NPV that would result from the adoption of energy conservation standards. DOE also used the Government Regulatory Impact Model (GRIM), along with other data obtained from interviews with manufacturers, in its MIA to determine the impacts of standards on manufacturers. Finally, DOE developed an approach using the National Energy Modeling System (NEMS) to estimate impacts of standards for small electric motors on electric utilities and the environment. The NOPR discusses each of these analytical tools in detail, 74 FR 61420, 61436–53, as does the TSD.

As a basis for this final rule, DOE has continued to use the spreadsheets and approaches explained in the NOPR. DOE used the same general methodology as applied in the NOPR, but revised some of the assumptions and inputs for the final rule in response to public comments. DOE also added new analysis based on the comments it received from interested parties. The following paragraphs address these revisions.

A. Market and Technology Assessment

When beginning an energy conservation standards rulemaking, DOE develops information that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, and market characteristics. This activity includes both quantitative and qualitative assessments based primarily on publicly available information. The subjects addressed in the market and technology assessment for this rulemaking include scope of coverage, product classes, manufacturers, quantities, and types of equipment sold and offered for sale; retail market trends; and regulatory and non-regulatory programs. See chapter 3 of the TSD for further discussion of the market and technology assessment.

1. Definition of Small Electric Motor

EPCA defines a small electric motor as "a NEMA general purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987." 42 U.S.C. 6311(13)(G). NEMA Standards Publication MG1–1987 is an industry guidance document that addresses, among other things, various aspects related to small and medium electric motors. As denoted in the title, this version of MG1 was prepared in 1987, more than 20 years before the date of today's final rule. NEMA has since published updated versions of this document, the latest of which was released in 2006. Of particular significance is the difference in what was considered in 1987 a general purpose, alternating current motor (only open construction motors) compared to what NEMA currently considers a general purpose alternating current motor (both open and enclosed construction motors).[4]

DOE explained its view in the NOPR as to how it currently reads 42 U.S.C. 6311(13)(G). 74 FR 61421. DOE indicated that the statute refers to MG1–1987 for purposes of ascertaining what constitutes a small electric motor. The agency explained and articulated certain assumptions in the NOPR regarding the scope of categories of motors, frame sizes, performance characteristics, insulation systems, and motor enclosures that it examined within the proposed scope of this rulemaking.

DOE received several comments criticizing the scope of DOE's coverage in its analyses. Manufacturers indicated that DOE's scope was too broad because, in their view, many of the motors DOE examined in ascertaining the energy savings potential for small electric motors, were not small electric motors under MG1–1987. For example, Emerson commented that in order for standards to be enforceable, DOE should adhere strictly to MG1–1987 in defining scope. (Emerson, No. 28 at p. 2) NEMA made similar comments echoing the same concern and argued that DOE's analysis should have been limited to the performance characteristics contained in MG1–1987. (See, *e.g.,* NEMA, No. 8 at pp. 2–5)

In contrast, Earthjustice and UL both commented that DOE was unnecessarily constraining itself by adhering to NEMA MG1–1987. See Earthjustice, Public Meeting Transcript, No. 20.4 at pp. 49–50; UL, Public Meeting Transcript, No. 20.4 at pp. 89–90. UL asserted that DOE's scope would create a negligible impact on the market, which has been shifting from the motors covered under the NOPR to other motor types (such as electronically commutated motors). (UL, Public Meeting Transcript, No. 20.4 at p. 182, UL, No. 21 at pp. 2) Earthjustice advised DOE that it should expand the scope of the rulemaking to include any "covered equipment" that it finds are justified. (Earthjustice, No. 22 at pp. 1–3) It had also noted during the preliminary analysis public meeting, that DOE could adopt a different reading of the definition by applying the phrase MG1–1987 only to the two digit frame number series requirement. Earthjustice, Public Meeting Transcript, at 47–49 (January 30, 2009).

After careful consideration of all of the comments, DOE believes that its scope of coverage in this final rule is appropriate. As such, DOE is declining to revise its scope of coverage for this equipment within this rulemaking. While DOE is continuing to adhere to the approach proposed in its NOPR and accompanying TSD, DOE may revisit this issue in the future and re-examine its interpretation of the small electric motor definition in 42 U.S.C. 6311(13)(G). Any such re-examination would be performed within the context of the rulemaking process and offer an opportunity for public comment.

a. Motor Categories

The motor categories examined by DOE are tied in part to the terminology and performance requirements in NEMA MG1–1987. These requirements were established for (1) general-purpose alternating-current motors, (2) single-speed induction motors, and (3) the NEMA system for designating (two-digit) frame sizes. 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), permanent-split capacitor (PSC), and polyphase. Of these five motor categories, DOE determined for purposes of this rulemaking that only CSIR, CSCR, and polyphase motors are able to meet performance requirements in NEMA MG1 and are widely considered general purpose alternating current motors, as shown by the listings found in manufacturers' catalogs. Therefore, in the NOPR DOE proposed

---

[4] An open motor is constructed with ventilating openings that permit external cooling air to pass over and around the windings of the motor. An enclosed motor is constructed to prevent the free exchange of air between the inside and outside of the housing.

to only cover those three motor categories.

Underwriters Laboratories stated that they believe DOE should cover the split-phase, shaded-pole, and PSC motor categories because they are much more common in the current market. (Underwriters Laboratories, No. 21 at p. 2) It is DOE's understanding that the motors suggested for coverage by UL do not meet the requirements for a NEMA general purpose motors and, consequently, are outside the scope of this rulemaking despite being more common. As a result, DOE continues to maintain that CSIR, CSCR, and polyphase motors are the only motor categories that are general purpose motors for purposes of this rulemaking.

b. Horsepower Ratings

In DOE's preliminary and NOPR analyses on small electric motors, DOE presented a range of horsepower ratings from ¼-horsepower up to 3-horsepower. The range of horsepower ratings was the same for all three motor categories covered: CSIR, CSCR, and polyphase motors as well as all three pole configurations: Two, four, and six. This range of horsepower ratings was consistent with what DOE believed to be the range of ratings where manufacturers build NEMA general purpose motors in a two-digit frame number series.

In response to the NOPR, NEMA and Baldor commented that the horsepower range for the products classes DOE proposed was incorrect. Baldor stated that horsepower ratings higher than ½-horsepower for six-pole motors, ¾-horsepower for four-pole motors, and 1-horsepower for two-pole motors are not standard ratings for small electric motors as defined in NEMA MG1, in particular, as listed in Table 10–1 of MG1–1987. Therefore, NEMA and Baldor stated that motors with such ratings are not NEMA general purpose motors and should be excluded from DOE's scope of coverage. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 38–41; NEMA, No. 24 at pp. 1–5, 7)

DOE understands that NEMA MG1–1987 does not provide ratings for small motors of the identified higher horsepower ratings. However, DOE does not believe this precludes certain higher horsepower ratings built in a two-digit NEMA frame consistent with NEMA MG1–1987 from coverage. In addition, upon review of NEMA manufacturer product catalogs, DOE noted that two-digit frame size motors of higher horsepower ratings are commonly marketed as general purpose. DOE also observed from NEMA shipment data provided to DOE for the determination analysis that when NEMA surveyed its members and requested shipments of general purpose motors built in a two-digit frame number series, responding manufacturers provided shipments data in horsepower ratings exceeding those listed in the comments above. Although NEMA argued that these motors do not fall within this rulemaking, NEMA did not deny that these motors are considered general purpose motors. Thus, DOE believes that even though NEMA MG1–1987 does not provide standard ratings for higher horsepower small electric motors, many of these motors are considered NEMA general purpose motors that could be considered for coverage by DOE.

DOE notes that there is precedent for clarifying the scope of coverage of these motors. At industry's request during the test procedure rulemaking for small electric motors, DOE clarified the small electric motor definition to incorporate metric-equivalent motors that are built in accordance with the International Electrotechnical Commission's requirements. See Baldor, Public Meeting Transcript, No. 8 at p. 75; NEMA, No. 12 at p. 2. This expansion of the small electric motor definition, which was added to ensure that DOE provided adequate coverage over small electric motors generally, was incorporated into 10 CFR 431.442. See also 74 FR 32061–62 and 32072.

While DOE believes that many of the horsepower ratings recommended for exclusion by NEMA and Baldor could be included in the definition of small electric motors, upon examining manufacturer catalogs, DOE found that motors did not exist for some horsepower ratings/pole configuration combinations included in NOPR. Specifically, DOE found that no open construction, two-digit frame size motors have horsepower ratings greater than 3-horsepower. In addition, DOE found no small electric polyphase motors built with a 2- or 3-horsepower rating and a six-pole configuration. DOE also found that small electric single-phase motors (CSIR and CSCR) do not exist with a 1½-horsepower rating or higher for six-poles or a 3-horsepower rating for four-poles. As there is no evidence that these motors, if manufactured, would be considered general purpose motors, and because DOE lacks data on which to base energy conservation standards for these motors, DOE is not including them in the scope of this rulemaking. Today's final rule reflects this decision as no standards are being adopted in those product classes. Table IV.1 presents the horsepower ratings for which DOE believes no small electric motors are currently commercially available.

TABLE IV.1—HORSEPOWER RATINGS FOR WHICH NO MOTORS EXIST

Motor category	Two-pole	Four-pole	Six-pole
Polyphase			≥ 2 Hp.
Single-Phase		≥ 3 Hp	≥ 1.5 Hp.

c. Performance Requirements

NEMA defines several performance requirements, including breakdown torque, locked rotor torque, and locked rotor current that motors must meet in order to be considered general-purpose. Because DOE's assessment of the small electric motors market (through analysis of commercially-available products sold) indicates that the vast majority of motors meet the previously listed requirements, DOE believes that a motor must meet these performance characteristics as a condition for coverage.

PG&E commented that a loophole exists in the rulemaking since the current definition of a small general purpose motor is so narrow with respect to design and performance characteristics. (PG&E, Public Meeting Transcript, No. 20.4 at pp. 259–60) PG&E added that DOE's reliance on MG1–1987 provides another loophole where NEMA could update its standards such that manufacturers could still make a NEMA general purpose motor that is not covered under today's rulemaking. (PG&E, Public Meeting Transcript, No. 20.4 at pp. 260–61) NEEA/NPCC agreed with PG&E that a manufacturer could easily circumvent any standards whose coverage was based around NEMA performance requirements, by simply constructing the motor such that it slightly deviates from NEMA requirements, but still provides similar utility to the consumer. (NEEA/NPCC, No. 27, pp. 2–3) Baldor stated that the tables of performance requirements in NEMA MG1 are designed to let customers know how motors will perform from manufacturer to manufacturer and they have been established for many years and there would be no reason to change them. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 266–67)

DOE understands the concerns expressed by PG&E, but agrees with Baldor that considering that the relevant performance requirements in NEMA MG1 have not changed substantially in over 20 years, these performance standards are unlikely to change should NEMA develop a new version of MG1. DOE believes that to do so would constitute a major change to the industry and performance characteristics that customers have been accustomed to over the years. Therefore, DOE believes that small electric motors must meet certain requirements in NEMA MG1–1987 shown in Table IV.6. For those combinations of horsepower rating and pole configuration that do not have performance requirements for two-digit frame sizes, DOE has no performance requirements. Instead, DOE will cover only those motors widely considered general purpose and marketed as such in manufacturer catalogs.

d. Motor Enclosures

In the NOPR, DOE stated that in ascertaining what constitutes a small electric motor, only the 1987 version of MG1 applies within the context of the statutory definition. Under that interpretation, DOE stated that only open construction motors were considered covered products. DOE is continuing to adhere to this approach.

As DOE's proposed scope did not extend beyond open motors as covered products, Baldor and NEMA commented that the revision to 10 CFR Part 431 proposed in the NOPR should clearly mention that the table of efficiency values for section 431.446 applies only to open motors. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 47–48, NEMA, No. 24 at p. 5) To clarify the application of the new efficiency values, DOE is modifying the efficiency standards tables in section 431.446 from today's final rule to include the words, "open motors" in the headings.

e. Frame Sizes

As for the frame sizes of motors that are covered by DOE standards for small electric motors, EPCA defines a small electric motor, in relevant part, as a motor "built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987." (42 U.S.C. 6311(13)(G)) MG1–1987 establishes a system for designating motor frames that consisting of a series of numbers in combination with letters that correspond to a specific size. The 1987 version of MG1 designates three two-digit frame series: 42, 48, and 56. These frame series have standard dimensions and tolerances necessary for mounting and interchangeability that are specified in sections MG1–11.31 and MG1–11.34.

DOE understands that manufacturers produce motors in other two-digit frame sizes, namely a 66 frame size. The 66 frame size is used for definite-purpose or special-purpose motors and not used in general-purpose applications and are not covered under the EPCA definition of "small electric motor." In the NOPR, DOE stated that it was unaware of any other motors with two-digit frame sizes that are built in accordance with NEMA MG1–1987. Should such frame sizes appear on the market, DOE will consider evaluating whether to include that equipment. For the NOPR, DOE received no comments regarding this issue and as a result, is maintaining its stance on this topic for this final rule.

f. Insulation Class Systems

Because DOE's interpretation of the statutory definition of a small electric motor is largely influenced by what NEMA defines as a general-purpose alternating-current motor under MG1–1987, DOE has taken into account the criteria that comprise a general purpose motor. Among these criteria are the applicable insulation classes. NEMA MG1–1987 paragraph 1–1.05, provides that a general-purpose motor must incorporate a "Class A insulation system with a temperature rise as specified in MG 1–12.42 for small motors or Class B insulation system with a temperature rise as specified in MG 1–12.43 for medium motors."

In NEMA MG1–1987, paragraphs 1.66 and 12.42.1 define four insulation class systems: Class A, Class B, Class F, and Class H. They are divided into classes based on the thermal endurance and each system has a different temperature rise[5] that the insulating material must be able to withstand without degradation. The temperature rise requirement for Class A systems is the lowest of the four systems defined in NEMA MG1–1987, which means that all other insulation classes meet Class A requirements. Because all insulation class systems meet the Class A requirements, DOE proposed to cover motors that incorporate any of the other insulation class systems in the NOPR. A joint comment submitted by Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company (SCGC), and San Diego Gas and Electric Company (SDGE) supported DOE's decision to include insulation Classes B, F, and H in addition to Class A. (Joint Comment, No. 23 at p. 2) NEMA and Baldor commented that although it is prudent to cover insulation class systems other than Class A, in order for a motor to be considered covered it must adhere to the temperature rise limits required of Class A motors by NEMA MG1. For example, if a motor contains a Class B insulation system, but the temperature rise exceeds the threshold for Class A insulation systems, the commenters stated that that motor should be excluded from coverage. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 25–26; Baldor, No. 15 at p. 3–4, NEMA, No. 24 at pp. 5–7)

DOE disagrees with Baldor and NEMA's assessment regarding temperature rise and in today's final rule maintains that the scope of coverage includes motors with any insulation class system Class A or higher, regardless of whether a motor meets the Class A temperature rise requirements. First, DOE notes that NEMA MG1 does not require small motors to meet the temperature rise for a Class A insulation system. Rather, it only requires that the motor incorporates an insulation system that meets Class A requirements, which DOE has determined could be Class A, B, F, or H.

Second, DOE believes that it is unreasonable to apply a more stringent temperature rise requirement on motors with higher insulation class systems. These motors often incorporate the higher insulation class systems in order to protect the motors from degradation at high temperatures. As a result, the accompanying temperature rise, which serves as a marker of how much heat a particular insulation class can withstand to prevent the motor from damage, will generally increase as a higher grade of insulation is used. Baldor's suggestion that a lower temperature rise (70 °C) must be used for each higher grade of insulation that offers protection at higher temperatures is one that DOE declines to adopt.

Furthermore, according to NEMA Standards publication MG1–1987, paragraph 10.39.1, although insulation class system designation is a required

---

[5] Temperature rise refers to the increase in temperature over the ambient temperature of the motor when operated at service factor load. NEMA MG1 provides maximum temperature rises (as measured on the windings of the motor) for each insulation class system.

marking on the nameplate of small electric motors, temperature rise is not. If DOE were to limit scope based on the temperature rise requirements of Class A systems, DOE would have no way of determining whether motors of insulation class systems greater than Class A meet the required temperature rise and are therefore subject to energy conservation standards. As only 2 percent of small electric motor models sold are labeled with Class A insulation systems, 98 percent of small electric models would have unknown temperature rises (relative to Class A requirements). DOE believes that including all insulation classes and temperature rises satisfies the statutory definition and avoids creating an unenforceable standard for a large number of motors that do not list temperature rise.

g. Service Factors

Some CSIR, CSCR, and polyphase motors may fail to meet the NEMA definition of general purpose alternating current motor because they do not meet NEMA service factor requirements. See, *e.g.* NEMA MG1–1987 Table 12–2. Service factor is a measure of the overload capacity at which a motor can operate without thermal damage, while operating normally within the correct voltage tolerances. The rated horsepower multiplied by the service factor determines that overload capacity. For example, a 1-horsepower motor with a 1.25 service factor can operate at 1.25 horsepower (1-horsepower × 1.25 service factor). For the NOPR, DOE concluded that motors that fail to meet service factor requirements in MG1–12.47 of MG1–1987 (now 12.51.1 of MG1–2006) are not "small electric motors" as EPCA uses that term. Receiving no comments to the contrary, DOE maintains that position in today's final rule and energy efficiency standards do not apply to them.

h. Metric Equivalents and Non-Standard Horsepower and Kilowatt Ratings

DOE's interpretation of a small electric motor is largely based on the construction and rating system in NEMA MG1–1987. (42 U.S.C. 6311(13)(G)) This system uses English units of measurement and power output ratings in horsepower. In contrast, general-purpose electric motors manufactured outside the United States and Canada are defined and described with reference to the International Electrotechnical Commission (IEC) Standard 60034–1 series, "Rotating electrical machines," which employs terminology and criteria different from those in EPCA. The performance attributes of these IEC motors are rated pursuant to IEC Standard 60034–1 Part 1: "Rating and performance," which uses metric units of measurement and construction standards different from MG1, and a rating system based on power output in kilowatts instead of power output in horsepower. The Institute of Electrical and Electronics Engineers (IEEE) Standard 112 recognizes this difference in the market and defines the relationship between horsepower and kilowatts. Furthermore, in 10 CFR 431.12, DOE defined "electric motor" in terms of both NEMA and IEC equivalents even though EPCA's corresponding definition and standards were articulated in terms of MG1 criteria and English units of measurement. 64 FR 54114 (October 5, 1999) The test procedure final rule adopted a definition for small electric motor that explicitly indicated that IEC equivalent motors are considered small electric motors. 10 CFR 431.442. 74 FR 32062, 72.

In the NOPR, DOE addressed how IEC metric or kilowatt-equivalent motors can perform identical functions as NEMA small electric motors and provide comparable rotational mechanical power to the same machines or equipment. Moreover, IEC metric or kilowatt-equivalent motors can generally be interchangeable with covered small electric motors. Consistent with the codified definition of "small electric motor in 10 CFR 431.442, DOE interpreted EPCA to apply the term "small electric motor" to any motor that is identical or equivalent to a motor constructed and rated in accordance with NEMA MG1, which includes IEC metric motors. DOE also proposed that motors with non-standard kilowatt and horsepower ratings would be required to meet small electric motor energy conservation standards. 74 FR 61422.

A joint comment submitted by PG&E, SCE, SCGC, and SDGE indicated support for DOE's decision to include IEC-rated motors in today's rulemaking. (Joint Comment, No. 23 at p. 2) NEMA and Baldor commented that, even though they agreed with DOE's approach in the NOPR, they believed that given the statutory definition's dependence on MG1–1987 (and the ratings contained in that standard) more justification is needed to include non-standard metric or English-rated motors in its scope of coverage. (Public Meeting Transcript, No. 20.4 at pp. 288–89; NEMA, No. 24 at pp. 24–25)

DOE appreciates these comments and in this final rule maintains its position regarding the inclusion of non-standard IEC metric and English-rated motors. Though NEMA MG1 does not provide ratings for these non-standard motors, DOE recognizes that they can perform identical functions as those NEMA motors with standard horsepower ratings. Therefore, as DOE did within the context of its codified definition of the term "small electric motor" found in 10 CFR 431.442 to include IEC metric-equivalent motors, DOE believes that non-standard horsepower and kilowatt rated motors should be considered NEMA general purpose and included in the scope of coverage of this rulemaking.

i. Summary

During the public meeting, Baldor and NEMA commented that DOE did not include the definition of NEMA general purpose motor in 10 CFR 431.442, and suggested that DOE include the definition for clarity and completeness. (Baldor, Public Meeting Transcript, No. 20.4 at p. 46; NEMA, No. 24 at p. 5) A.O. Smith also requested clarification of the term "small electric motor," and suggested that the definition align with NEMA established guidelines. (A.O. Smith, No. 26 at p. 2)

DOE has discussed the covered motor categories, horsepower ratings, motor enclosures, frame sizes, insulation class systems, service factors, and metric equivalents. As discussed in section IV.A.1.b, because DOE has found several horsepower/pole configurations for which small electric motors are not commercially available, DOE has made slight modifications in the range of horsepower ratings for which it is adopting standards in this final rule. The motors covered by today's rule include polyphase motors from ¼- to 3-horsepower for motors equipped with two poles, ¼- to 3-horsepower for motors with four poles, and ¼- to ½-horsepower for motors with six pole motors as long as they are built in a two-digit frame number series and with an open construction; the CSIR and CSCR motors covered by today's rule include motors from ¼- to 3-horsepower motors equipped with two poles, ¼- to 2-horsepower for motors with four poles, and ¼- to 1-horesepower for motors with six poles as long as they are built in a two-digit frame number series and with an open construction. A motor will not be excluded because of its insulation class system or its temperature rise. However, it will be excluded if it fails to meet NEMA general purpose service factor requirements. Any metric-equivalent motor or motor with a non-standard horsepower or kilowatt rating that has performance characteristics and construction equivalent to those listed above is also a covered product and must meet the energy efficiency standards of this rulemaking. Although today's final rule DOE does not codify a definition for "NEMA general purpose motor", DOE will consider proposing a definition for this term in the electric motor test procedure supplemental NOPR.

2. Product Classes

When evaluating and establishing energy conservation standards, DOE generally divides covered equipment into classes by the type of energy used, capacity, or other performance-related features that affect efficiency. (42 U.S.C. 6295(q)) DOE routinely establishes different energy conservation standards for different product classes based on these criteria.

At the NOPR public meeting, DOE presented its rationale for creating 72 product classes. The 72 product classes were based on combinations of three different characteristics: motor category, number of poles, and horsepower. As these motor characteristics change, so does the utility and efficiency of the small electric motor.

The motor category divides the small electric motors market into three major groups: CSIR, CSCR, and polyphase. For each motor category, DOE divided the product classes by all combinations of eight different horsepower ratings (*i.e.,* ¼ to ≥ 3) and three different pole configurations (*i.e.,* 2, 4, and 6). A change in motor category can constitute a change in the type of power used, three-phase power for polyphase motors versus single-phase power for capacitor-start motors. Alternatively, it might be a change in consumer utility that affects efficiency. The addition of a run-capacitor on a CSCR motors can make the motor more efficient as well as constitute dimensional changes as the run-capacitor is usually mounted externally on the housing. Horsepower rating is directly related to a motor's capacity, and its pole configuration is directly related to the theoretical maximum speed at which a motor can operate. For the NOPR, DOE received no comments contrary to disaggregating product classes with these characteristics, but did receive other comments regarding product classes.

Consistent with their comments on scope (discussed in section IV.A.1), NEMA and Baldor stated that certain combinations of horsepower and speed (or pole-configuration) ratings should be excluded from DOE's product classes because, in their view, they are not small electric motors within the context of MG1–1987. Specifically, they stated that motors with horsepower ratings greater than 1-horsepower for two-pole motors, greater than ¾-horsepower for four-pole motors, and greater than ½-horsepower for six-pole motors do not meet the statutory definition. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 39–41; NEMA, No. 24 at pp. 3–4) As discussed in section IV.A.1, DOE examined the statutory definition of small electric motor and disagrees that the aforementioned horsepower and speed ratings are not covered under this rulemaking. Therefore, in this final rule DOE is maintaining coverage of combinations of horsepower and pole configurations higher than those recommended by NEMA and Baldor. However, as discussed in section IV.A.1.b, DOE is not adopting standards for motors which are not currently commercially available. Accordingly, DOE has removed these proposed product classes in the final rule, resulting in 62 total product classes.

NEMA and Baldor also commented that DOE should include frame size among the characteristics that define a product class. They stated that smaller frame size motors will not be able to achieve as high an energy efficiency rating as the larger frame sized motors, thus warranting separate product classes. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 43–44, NEMA, No. 24 at pp. 4–5, 23)

DOE acknowledges that motors built with smaller dimensions, namely core diameters, may not be able to achieve the same efficiency as a motor with larger dimensions. The smaller diameter limits the amount of active material that is used to reduce motor losses and therefore limits the maximum efficiency rating possible as well. However, frame size, which relates to the frame housing and not the core diameter, is a measurement of height from the bottom of the mounting feet to the center of the shaft of the motor. Frame size does not always correlate to the core diameter of the motor and amount active material. For example, DOE found that some motors with larger frame sizes have core diameters equivalent to those motors built in smaller frame sizes, which means that these motors have an efficiency potential equivalent to that of a motor in a smaller frame size. Consequently, frame size alone does not necessarily change the efficiency of a small electric motor.

Additionally, NEMA MG1 does not differentiate breakdown torque, locked-rotor torque, and locked-rotor current requirements for small general-purpose motors by frame size. DOE believes that if performance requirements other than efficiency for small motors are not different for different frame sizes, there is no need or precedent for DOE to differentiate efficiency standards for small electric motors based on frame size.

However, as stated earlier, DOE recognizes that core diameter affects efficiency. If DOE were to set a standard based on an analysis of a motor of larger core diameter, it could potentially be eliminating from market smaller core diameter motors. However, because core diameter is not a standardized dimension across all small electric motors, DOE has chosen to address this issue in the engineering analysis. As discussed in section IV.C DOE based its representative unit and scaling analyses on what it perceived as the greatest dimensionally constrained motors on the market for each product class. By doing this, DOE ensures that all existing consumer utility in the marketplace of smaller core diameter motors is maintained with energy conservation standards.

Chapter 3 of the TSD accompanying today's notice provides additional detail on the product classes defined for the standards proposed in this final rule, and Table IV.2 through Table IV.4 below enumerate these product classes. For the final rule, DOE considers 62 product classes.

TABLE IV.2—PRODUCT CLASSES FOR POLYPHASE MOTORS WITH AN OPEN CONSTRUCTION

Motor horsepower/standard kilowatt equivalent	Six poles	Four poles	Two poles
¼ hp/0.18 kW	PC #1	PC #2	PC #3.
⅓ hp/0.25 kW	PC #4	PC #5	PC #6.
½ hp/0.37 kW	PC #7	PC #8	PC #9.
¾ hp/0.55 kW	PC #10	PC #11	PC #12.
1 hp/0.75 kW	PC #13	PC #14	PC #15.
1½ hp/1.1 kW	PC #16	PC #17	PC #18.
2 hp/1.5 kW		PC #19	PC #20.

TABLE IV.2—PRODUCT CLASSES FOR POLYPHASE MOTORS WITH AN OPEN CONSTRUCTION—Continued

Motor horsepower/standard kilowatt equivalent	Six poles	Four poles	Two poles
3 hp/2.2 kW		PC #21	PC #22.

TABLE IV.3—PRODUCT CLASSES FOR CAPACITOR-START INDUCTION-RUN MOTORS WITH AN OPEN CONSTRUCTION

Motor horsepower/standard kilowatt equivalent	Six poles	Four poles	Two poles
¼ hp/0.18 kW	PC #23	PC #24	PC #25.
⅓ hp/0.25 kW	PC #26	PC #27	PC #28.
½ hp/0.37 kW	PC #29	PC #30	PC #31.
¾ hp/0.55 kW	PC #32	PC #33	PC #34.
1 hp/0.75 kW	PC #35	PC #36	PC #37.
1½ hp/1.1 kW		PC #38	PC #39.
2 hp/1.5 kW		PC #40	PC #41.
3 hp/2.2 kW			PC #42.

TABLE IV.4—PRODUCT CLASSES FOR CAPACITOR-START CAPACITOR-RUN MOTORS WITH AN OPEN CONSTRUCTION

Motor horsepower/standard kilowatt equivalent	Six poles	Four poles	Two poles
¼ hp/0.18 kW	PC #43	PC #44	PC #45.
⅓ hp/0.25 kW	PC #46	PC #47	PC #48.
½ hp/0.37 kW	PC #49	PC #50	PC #51.
¾ hp/0.55 kW	PC #52	PC #53	PC #54.
1 hp/0.75 kW	PC #55	PC #56	PC #57.
1½ hp/1.1 kW		PC #58	PC #59.
2 hp/1.5 kW		PC #60	PC #61.
3 hp/2.2 kW			PC #62.

B. Screening Analysis

The purpose of the screening analysis is to evaluate the technology options identified as having the potential to improve the efficiency of equipment, to determine which technologies to consider further and which to screen out. DOE consulted with industry, technical experts, and other interested parties to develop a list of technologies for consideration. DOE then applied the following four screening criteria to determine which design options are suitable for further consideration in a standards rulemaking:

1. *Technological feasibility.* DOE considers technologies incorporated in commercial products or in working prototypes to be technologically feasible.

2. *Practicability to manufacture, install, and service.* If mass production and reliable installation and servicing of a technology in commercial products could be achieved on the scale necessary to serve the relevant market at the time the standard comes into effect, then DOE considers that technology practicable to manufacture, install, and service.

3. *Adverse impacts on product utility or product availability.* If DOE determines 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 consider this technology further.

4. *Adverse impacts on health or safety.* If DOE determines that a technology will have significant adverse impacts on health or safety, it will not consider this technology further.

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

DOE identified the following technology options that could improve the efficiency of small electric motors: Utilizing a copper die-cast rotor, reducing skew on the rotor stack (*i.e.* straightening the rotor conductor bars), increasing the cross-sectional area of rotor conductor bars, increasing the end ring size, changing the copper wire gauge used in the stator, manipulating the stator slot size, changing capacitor ratings, decreasing the air gap between the rotor and stator, improving the grades of electrical steel, using thinner steel laminations, annealing steel laminations, adding stack length, using high efficiency steel lamination materials, using plastic bonded iron powder (PBIP), installing better ball bearings and lubricant, and installing a more efficient cooling system. For a description of how each of these technology options improves small electric motor efficiency see TSD chapter 3. For the NOPR, DOE screened out two of these technology options: PBIP and decreasing the air gap below .0125 inch. DOE received no comments regarding these two technology options and therefore maintains its exclusion of these technology options in today's final rule. However, DOE did receive comments concerning the availability of premium electrical steels (such as Hiperco) and copper rotors, two design options that it did not screen out in the NOPR. Please see section IV.I for a discussion of those issues.

DOE believes that all of the efficiency levels discussed in today's notice are technologically feasible. The technologies that DOE examined have been used (or are being used) in commercially available equipment or working prototypes. These technologies all incorporate materials and components that are commercially available in today's supply markets for the motors that are the subject of this final rule.

C. Engineering Analysis

The engineering analysis develops cost-efficiency relationships to show the manufacturing costs of achieving increased energy efficiency. As discussed in the NOPR, to conduct the engineering analysis, DOE used a combined design-option and efficiency level approach in which it employed a motor design software technical expert to develop motor designs at several efficiency levels for each analyzed product class. Based on these simulated designs and manufacturer and component supplier data, DOE calculated manufacturing costs and selling prices associated with each efficiency level. DOE decided on this approach after receiving insufficient response to its request for the manufacturer data needed to execute an efficiency-level approach for the preliminary analyses. The design-option approach allowed DOE to make its engineering analysis methodologies, assumptions, and results publicly available in the NOPR, thereby permitting all interested parties the opportunity to review and comment on this information. The design options considered in the engineering analysis include: Copper die-cast rotor, reduced skew on the rotor stack, increased cross-sectional area of rotor conductor bars, increase end-ring size, changing the gauge of copper wire in the stator, manipulating stator slot size, decreased air gap between rotor and stator to .0125 inch, improved grades of electrical steel, use thinner steel laminations, annealed steel laminations, increased stack height, modified capacitors ratings, improved ball bearings and lubricant, and more efficient cooling systems. Chapter 5 of the TSD contains a detailed description of the engineering analysis methodology and chapter 3 of the TSD contains a detailed description of how the design options listed above increase motor efficiency.

1. Product Classes Analyzed

As discussed in section IV.A.2 of this notice, DOE is establishing a total of 62 product classes for small electric motors, based on the motor category (polyphase, CSIR, or CSCR), horsepower rating, and pole configuration. DOE carefully selected certain product classes to analyze, and then scaled its analytical findings for those representative product classes to other product classes that were not directly analyzed. Further discussion of DOE's scaling methodology is presented in section IV.C.5

For the NOPR, DOE analyzed three representative product classes: (1) 1-horsepower, four-pole, polyphase motor, (2) ½-horsepower, four-pole, CSIR motors, and (3) ¾-horsepower, four-pole, CSCR motor. By choosing these three product classes, DOE ensured that each motor category (polyphase, CSIR, and CSCR) was represented. DOE achieved this by selecting horsepower ratings for each motor category that are commonly available from most manufacturers, thus increasing the quantity of available data on which to base the analysis. Finally, DOE chose four-pole motors for each motor category, consistent with NEMA-provided shipments data (see TSD chapter 9), which indicated that these motors had the highest shipment volume in 2007. See TSD chapter 5 for additional detail on the product classes analyzed.

In response to the NOPR, Baldor and NEMA commented that the product class selected for polyphase motors was inappropriate. They asserted that according to NEMA's standard ratings in MG1–1987, a 1-horsepower, four-pole, polyphase motor would not be considered a small motor or NEMA general purpose small motor, and therefore falls out of the scope of this rulemaking. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 62–63; NEMA, No. 24 at p. 7) However, as discussed in section IV.A.1, DOE disagrees with Baldor and NEMA's interpretation of scope, and in this final rule, DOE is including small electric motors with horsepower ratings ranging from ¼- to 3-horsepower and pole configurations of two, four, and six poles. In consideration of this scope, DOE believes that the representative product classes selected in the NOPR engineering analysis are appropriate and is continuing to use these same representative product classes in today's final rule.

2. Baseline Models

The engineering analysis DOE conducted calculates the incremental costs for equipment with efficiency levels above the baseline in each product class analyzed. For the NOPR analysis, DOE established the baseline motor efficiency and design for the three representative product classes by purchasing what it believed to be the lowest efficiency motors on the market for each of these classes. To select these baseline motors, DOE interviewed manufacturers and used catalog data on motor efficiency and physical dimensions. DOE recognizes that motors with smaller core diameters, may be unable to achieve efficiencies as high as those with larger core diameters. In order to preserve the availability of these smaller core diameter motors, DOE selected baselines which it believed represented the most dimensionally constrained, in terms of core diameter, and least efficient motors currently available on the market.

After purchasing the three baseline small electric motors, DOE tested the motors according to the appropriate IEEE test procedures (as dictated by DOE's small electric motor test procedure discussed in section III.A). After performing the appropriate test procedures, DOE then tore down each baseline motor to obtain internal dimensions, copper wire gauges, steel grade, and any other pertinent design information. Those parameters and tests were then used as inputs into the design software, allowing DOE to model the motor and calibrate its software to the tested efficiencies. All subsequent higher-efficiency motor designs employed the design options discussed earlier to model incremental improvements in efficiency and increases in cost over the baseline.

a. Baseline Efficiencies

At the NOPR public meeting, DOE received several comments regarding the validity of the baseline motor efficiencies used in the engineering analysis. Emerson Motor Company pointed out that it is common to see a spread in efficiencies within a population of motors of a particular design. Emerson questioned if an analysis was conducted to determine if the baseline polyphase motor chosen and tested had an efficiency value that was at the high-end, low-end, or near the average compared to the population of motors of that model type. (Emerson, Public Meeting Transcript, No. 20.4 at pp. 73–75) Similarly, Baldor and NEMA noted that the baseline polyphase motor's tested efficiency (77 percent) varied significantly from the catalog efficiency (74 percent). They commented that using 77 percent as the efficiency of the baseline motor in the engineering analysis assumed that a single tested value of efficiency is equal to the true arithmetic mean of the full-load efficiencies of the population of motors. They argued that given the distribution of efficiencies commonly seen across a population of motors, due in part to factors such as manufacturing variability, this would be an inappropriate assumption. In addition, they also cited the electric motor compliance provisions (in 10 CFR 431.17) for support. These provisions state that the lowest full-load efficiency in a sample can differ from the nominal full load efficiency by as much as 15 percent due to variations in losses attributable to variability in manufacturing and testing facilities. Baldor and NEMA asserted that similar conditions should be expected for small motors. Baldor and NEMA recommended that absent any other data, DOE should use the manufacturer-rated catalog efficiency of the polyphase motor (74 percent) as the baseline efficiency. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 120–121, 125; NEMA, No. 24 at p. 11, 13)

DOE agrees that it is possible that one tested efficiency value does not represent the average efficiency over a population of motors. Inconsistencies in motor laminations and processing during manufacturing can result in motors of a single design having a distribution of efficiencies, most commonly seen as variability in core and stray load losses. However, as manufacturers were not required to report its catalog efficiencies for these motors based on the results of the DOE test procedures, DOE does not agree with NEMA's assertion that catalog efficiencies should be used as the baseline efficiencies.

In consideration of the comments received, DOE conducted additional testing to validate the polyphase baseline efficiency. DOE tested five additional polyphase motors (for a total of six tests, exceeding the minimum five required by the DOE sampling requirements for electric motors in 10 CFR 431.17) of the same baseline model, purchased from five separate warehouses in order to ensure the maximum variability in production. DOE then used the average of the six tests as the baseline efficiency for the polyphase motor. For the single-phase baseline motors, because the tested values did not deviate significantly from the catalog efficiency values and as DOE did not receive specific comments opposing these values, DOE used the single-tested efficiency values as the baseline efficiencies.

Because DOE modified the efficiencies of the baseline designs relative to that which was calculated in the motor design software, DOE felt it necessary to evaluate whether the efficiencies of the higher efficiency designs modeled in the software would also change. As stated earlier, DOE calibrated its software model to the NOPR tested efficiencies of the baseline models, and all subsequent higher efficiency motor designs were generated as incremental efficiency gains and cost increases over this baseline design. Thus, a change in the baseline efficiency would likely affect the efficiencies of the other motor designs. Therefore, for this final rule, DOE shifted the baseline modeled efficiencies to match the tested values described above. Similarly, subsequent, more efficient designs were shifted by the same percentage change in losses as the baseline shifts. For example, the baseline polyphase model in the design software predicted an efficiency of 77.7 percent. This value was decreased to the average tested efficiency value of 75.3 percent, constituting an increase in motor losses of roughly 14 percent. The modeled efficiencies of the more efficient designs were then shifted down in efficiency by a 14 percent increase in motor losses as well.

TABLE IV.5—EFFICIENCY VALUES OF BASELINE MODELS

	Polyphase 1 hp, 4 pole	CSIR ½ hp, 4 pole	CSCR ¾ hp, 4 pole
Catalog Rated Efficiency (%)	74.0	59.0	72.0
Software Modeled Efficiency (%)	77.7	57.9	70.7
Baseline/Tested Efficiency (%)	[6] 75.3	[7] 57.9	[7] 71.4
Shift in Losses from Modeled Values (%)	14	0	−3

In the NOPR, DOE stated that an accredited laboratory performed IEEE Standard 112 Test Methods A and B and IEEE Standard 114 to find efficiency data for its baseline models. However, at the public meeting on December 17, 2009, Baldor commented that according to NEMA and the National Voluntary Laboratory Accreditation Program Handbook 150–10, accreditation is based on motor testing in accordance with IEEE Standard 112 Test Method B only, and that it does not currently cover testing in accordance with IEEE Standard 112 Method A or IEEE Standard 114. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 114–115) Therefore, Baldor suggested that DOE's statement about motor tests was misleading because no accreditation exists for two of the three listed methods. DOE clarifies its previous statement to say that a laboratory accredited to perform IEEE Standard 112 Test Method B performed the tests.

b. Baseline Temperature Rise

NEMA MG1 defines several temperature rise requirements for general purpose alternating current single-speed induction motors. In the NOPR TSD, DOE reported the modeled temperature rise characteristics of the baseline motors selected in the engineering analysis. In response to those values, Baldor reasoned that because the reported temperature rises (78 °C for the polyphase motor and 86 °C for the CSIR motor at full load) would far exceed the NEMA temperature rise limit of 70 °C at service factor load, for a Class A motor, the selected baseline motors were inappropriate selections. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 27–30) After receiving Baldor's comments, DOE reviewed the data from thermal tests conducted on the purchased baseline motors and found that the winding temperature tests indicated that all three baseline motors in fact meet NEMA temperature rise requirements for Class A insulation systems. See chapter 5 of the TSD for the tested temperature rise data for each baseline motor. However, because the modeled temperature rises in the design software were inconsistent with these tests, DOE revised the operating temperature inputs to the design software to agree with the tested temperature rise data. This change in operating temperature results in slight changes in the baseline modeled efficiencies. Namely as operating temperature decreases, motor efficiency generally increases. Though these motors meet temperature rise requirements for Class A insulation systems, DOE emphasizes again, that its scope of coverage is not bound to those motors with temperature rises of less than Class A requirements, but rather motors that contain insulation class systems rated A or higher.

c. Baseline Motor Performance

In the NOPR TSD, DOE presented the modeled performance characteristics for the baseline motors selected. Baldor and NEMA both commented that none of the baseline motors meet all of the general purpose performance characteristics for locked-rotor torque, locked-rotor

---

[6] This efficiency represents the average of tests conducted on six separate units of the same model number.

[7] These values were incorrectly presented in the NOPR as 57.7 and 71.0 for CSIR and CSCR, respectively. These values presented in the NOPR represent the NOPR modeled efficiencies. 74 FR 61427.

current, and breakdown torque as defined in NEMA MG1–1987. They argued that these motors cannot be considered small electric motors (under the statutory definition) and therefore, should have never been chosen as baseline motors. For polyphase motors, they cited comparisons to performance characteristics in NEMA MG1–1987 intended for "medium" motors. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 64–67; NEMA, No. 24 at pp. 7–8) The NEEA/NPCC disagreed and stated that because the performance of the motors selected by DOE were representative of products on the market, they were appropriate baseline models. (NEEA/NPCC, No. 27 at pp. 8–9)

DOE examined the performance characteristics of the three baseline motors, and determined that they meet all small electric motor performance requirements of NEMA MG1. Thus, DOE believes that they are appropriate baseline motors and are representative of covered small electric motors on the market. Table IV.6 below presents references to NEMA MG1–1987 sections containing performance characteristics that DOE believes are relevant to single-phase and polyphase small electric motors.

TABLE IV.6—NEMA MG1–1987 PERFORMANCE REQUIREMENTS RELEVANT TO GENERAL PURPOSE SMALL MOTORS

	Single phase	Polyphase
Breakdown Torque	12.32.1	12.37.
Locked Rotor Current	12.33.2	None.*
Locked Rotor Torque	12.32.2	None.

* Because NEMA MG1–1987 section 12.35 is labeled as applying to only medium motors, DOE does not believe there are polyphase locked rotor current requirements for small motors. However, NEMA commented at the preliminary analysis stage that it is common industry practice to use the limits for Design B medium motors for small motors. (NEMA. No. 13, p. 6).

DOE notes that in the NOPR TSD, DOE presented these performance characteristics at full load, steady state operating temperature. When extrapolated down to an ambient temperature of 25° C, the temperature at which NEMA specifies that breakdown torque requirements must be met, all baseline motors meet the necessary small motor performance requirements in MG1. A direct comparison of those values, as requested by Baldor (Baldor, No. 25 at p. 2; Baldor, Public Meeting Transcript, No. 20.4 at p. 66) is available in TSD chapter 5.

3. Higher Efficiency Motor Designs

After establishing baseline models, DOE next used the motor design software to incorporate design options (generated in the market and technology assessment and screening analysis) to increase motor efficiency. In response to the NOPR engineering analysis, DOE received several comments that addressed issues regarding the application of the design options in the engineering analysis and the validity of the results outputted from the design software.

In general, manufacturers questioned whether DOE adequately verified that its design software accurately predicts motor efficiency. NEMA and Baldor stated that DOE seemingly used an AEDM to generate motor designs and scaled efficiencies for other product classes without meeting DOE's own substantiation requirements of an AEDM. Emerson stated that in order for manufacturers to use an AEDM for compliance and certification with energy conservation standards, DOE requires that the AEDM must be applied to 5 basic models of small electric motors, and it be shown to accurately predict motor efficiency under real-world testing. Collectively, this constitutes a total of 25 tests manufacturers must complete in order to verify their design software. (Emerson, Public Meeting Transcript, No. 20.4 at p. 105) Baldor and NEMA contended that DOE must be held to these same verification standards if it uses an AEDM in establishing energy conservation standards. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 118–24, 145–146; NEMA, No. 24 at p. 11–12)

NEEA/NPCC disagreed with these comments, stating that requirements of certification and compliance with Federal efficiency regulations are wholly unrelated and inapplicable to DOE's analysis methodology. The motor design software used in the engineering analysis was simply being used to create motor models for analysis, not as an alternative compliance tool. Thus, DOE is under no obligation to meet the verification standards of an AEDM. NEEA/NPCC stated that based on the description of the design software, the technical qualifications of the consultants, and the motor testing and teardowns conducted to verify the accuracy of software tools, it has satisfied with DOE's engineering analysis methodology. (NEEA/NPCC, No. 27 at pp 6–7).

DOE agrees with NEEA/NPCC that substantiation of an AEDM is a concept intended for certifying compliance with energy efficiency standards. It is a tool for manufacturers to use to help ensure that equipment they manufacture comply with the standards that DOE sets. It is not a tool for assessing whether a particular energy efficiency level under consideration by DOE satisfies the EPCA criteria. Accordingly, the use of the AEDM in the manner suggested by industry would not be relevant for the purposes of this engineering analysis, which is geared toward DOE's standards rulemaking.

Moreover, on the bases of the baseline motor efficiency verification process which included physical teardowns for numerous small motors, DOE has confidence in the software program it has selected and believes it to be appropriate to analyze efficiency levels for small electric motors.[8] Though the supporting data for these tests are based on confidential manufacturer data, the performances of these motors verify the software predictions.

In addition, as discussed in the NOPR, to the extent that it was feasible, DOE substantiated the resulting cost-efficiency curves by testing and tearing down higher efficiency motors. In response to that NOPR discussion, NEMA asserted that as seen in Table 12.1 and Table 12.2 in appendix 5A of the NOPR, DOE did not compare the test results to the calculated results for the representative product classes. (NEMA, No. 24 at p. 24) DOE wishes to clarify that Table 12.1 and Table 12.2 in appendix 5A of the NOPR TSD contained test results for motors that were used as part of DOE's scaling methodology. The results of the cost-efficiency curve validation testing for representative product classes are shown in Figure 4.1 through Figure 4.3 of appendix 5A of the NOPR and final rule TSDs.

---

[8] DOE notes that the software used for its analysis has been employed by numerous motor manufacturers to develop designs that have then been used to produce lines of motors, including capacitor-start and polyphase motors.

a. Electrical Steel

In the NOPR engineering analysis, DOE modeled the use improved grades of electrical steel and thinner laminations to achieve higher motor efficiency. In response to that analysis Baldor and NEMA commented that because DOE's design software bases loss calculations on Epstein core loss values, they believe DOE's modeled efficiencies using improved steel types may overestimate the actual achievable efficiency for a particular motor design. Baldor cited its experience with building and testing multiple motors using various steel types, stating that it has never been shown that the core loss in a motor with round laminations and rotating flux field is directly related to the results of Epstein testing. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 276–80, Baldor, No. 25 at pp. 5–7; NEMA, No. 24 at pp. 23–24) As a result, Baldor asserted that DOE should not rely on steel manufacturer core loss data unless it is able to produce an actual motor to verify its design assumptions. (Baldor, Public Meeting Transcript, No. 20.4 at p. 277) NEEA/NPCC encouraged DOE to investigate the claims made by Baldor at the public meeting and revise the engineering analysis if necessary. (NEEA/NPCC, No. 27 at pp. 9–10)

DOE recognizes that in analyzing motor performance, calculated core losses based on Epstein tests may deviate from actual core losses in the motor.[9] This is primarily due to the harmonic effects created by the distortion of the flux density waveform. When motor core losses are modeled or measured at solely the fundamental frequency, it is possible that additional losses due to these harmonics may not be accounted for, which may yield an overall underestimation of losses. While DOE acknowledges that this phenomenon exists, DOE also believes it has accounted for this effect in its analysis.

As Baldor suggests, one way to ensure that a software model is calibrated correctly to account for effects such as these is to build prototype motors and examine their performance characteristics. Though DOE did not perform such an exercise specifically for this rulemaking, the design software DOE employed for this analysis has been used in the past to design many small motors, whose performance characteristics compare favorably with the model predictions. Baldor did not provide any additional data from which DOE could refine its analysis or perform sensitivity analyses, even though it stated the values of core loss used in DOE's software model were inaccurate.

DOE believes that the variances between Epstein losses and actual motor losses are not an issue for its engineering analysis. It is DOE's understanding that the Epstein core loss data begin to vary significantly from actual motor core losses when various components of the core steel are driven into magnetic saturation. Magnetic saturation is when the amplitude of the magnetic field excitation is large enough to force the flux density (of the magnetic field) into the nonlinear region of the B–H curve. At this point the harmonic components of the electromagnetic field increase.[10] As these harmonic components increase, motor efficiency may be adversely affected and predicted core losses from the Epstein tests will deviate from actual core losses seen in the motor. In order to assess the degree to which these harmonic effects may impact the efficiency of motors analyzed in the engineering analysis, DOE examined the magnetic flux densities at full-load for each motor design. By using steel manufacturer-provided magnetization curves, DOE first determined the saturation point for each of the lamination types. DOE then evaluated each of its motor designs to determine whether it operates near magnetic saturation. The results of this analysis indicated that only two motor designs, the CSIR baseline design and the polyphase efficiency level (EL) 1 design, operate close to the point of magnetic saturation at full load. Based on these results, DOE believes that for all other motor designs, reliance on the Epstein core loss data is appropriate to model motor efficiency.

DOE recognizes that for motors designs operating near the point of magnetic saturation (*i.e.,* CSIR baseline and polyphase EL 1 designs), the modeled efficiency might deviate from a tested efficiency if a prototype were built. With regards to the CSIR baseline design, DOE notes that, as discussed in section IV.C.2.a, the efficiency associated with that design was based on a tested efficiency, rather than a modeled efficiency. Therefore, the baseline efficiency for the CSIR motor should adequately account for any harmonic core loss effects. For the polyphase EL 1 design, DOE recognizes that there may be significant uncertainty in its modeled efficiency. However, as discussed in section VI DOE has found that an efficiency level higher than EL 1 is technologically feasible and economically justified based on the net benefits to the nation and individual consumers. Therefore, DOE's standards-setting decisions in this final rule are not dependent on any uncertainties associated with the polyphase EL1 motor design. Please refer to TSD chapter 5 for additional information regarding the steels used in DOE engineering analysis, their respective saturation levels, and the flux densities of the designs using those steels.

Baldor also questioned the validity of using several higher efficiency steel types in small motors, citing an AK steel publication. Baldor commented that several of the lamination types modeled, namely 24M19 and 29M15, are not recommended for use in motors with less than a 100 horsepower rating. (Baldor, No. 25 at p. 7) DOE has reviewed the referenced AK Steel publication[11] and disagrees with Baldor's assertion. The AK Steel publication does not suggest that 24M19 and 29M15 steels should not be used in motors with less than a 100 horsepower rating; rather it only indicates that small electric motors currently on the market do not typically use these steel grades. In addition, DOE has not received any comments explaining why these lamination types, commonly used in medium motors, would not be applicable to small electric motors. Therefore, in this final rule, DOE continues to use higher efficiency steel grades and thinner laminations in the engineering analysis.

b. Thermal Analysis

NEMA and Baldor also questioned whether a thermal analysis was conducted for the higher efficiency motors modeled, stating the importance of verifying the thermal viability of motor designs. (NEMA, No. 24 at pp. 6–7, Baldor, Public Meeting Transcript, No. 20.4 at pp. 28–29) Emerson commented that the NOPR analysis disregarded MG1 performance requirements, including operating temperatures, potentially cause conflicts with the National Electrical Code. (Emerson, No. 28, p. 2) In response to these comments, DOE has refined its thermal analysis methodology to ensure that it is accurately modeling motor efficiency and that all motor designs

---

[9] Epstein tests are performed by steel manufacturers to determine expected core loss values in electrical steel. The results of these tests are usually provided by steel manufacturers and are used by motor design engineers to predict motor performance.

[10] Yamazaki, Katsumi; Watanabe, Yuta. "Stray Load Loss Calculation of Induction Motors Using Electromagnetic Field Analysis." IEEJ Transactions on Industry Applications, Volume 128, Issue 1, pp. 56–63.

[11] AK Steel Product Data Bulletin. Nonoriented Electrical Steels. *http://www.aksteel.com/pdf/markets_products/electrical/Non_Oriented_Bulletin.pdf.*

evaluated are thermally viable. As mentioned in section IV.C.2.b, to establish the baseline motors' operating temperatures, DOE conducted tests in accordance with the relevant IEEE test procedures and monitored the temperature rises of the motors. DOE was then able to calculate a thermal resistance for each of the baseline motors. The thermal resistance of each subsequent design was modified to reflect the improved thermal transfer of the more efficient design. As each higher efficiency design was modeled, DOE calculated a new temperature rise. These calculations indicate that as motor efficiency increases (through an increase in the amount of active material and decrease in I^2R losses[12]), the temperature rise of the motor continually decreases. For this reason, DOE believes that all higher efficiency motor designs analyzed in the engineering analysis have lower temperature rises than their respective baseline motors and are thermally viable. See TSD chapter 5 for additional information regarding the actual temperature rises calculated for each of DOE's designs.

c. Performance Requirements

As discussed in section IV.C.2.c, NEMA, through its MG1 publication, lays out a number of performance requirements (breakdown torque, locked rotor torque, and locked rotor current) that motors must meet in order to be considered "general purpose." In response to the small electric motor designs presented in the NOPR, manufacturers commented that some of DOE's more efficient designs do not meet certain performance requirements. Emerson added that many of the design changes that would be necessary to meet these requirements, such as increasing resistance at locked rotor or increasing the number of turns of the stator coils, could actually decrease efficiency. (Baldor, No. 25 at p. 4; Baldor, Public Meeting Transcript, No. 20.4 at pp. 67, 86–87; Baldor, No. 25 at pp. 1–3; Emerson, Public Meeting Transcript, No. 20. 4 at pp. 192–93; Emerson, No. 28, p. 1) Emerson also noted that the costs for the designs might increase when the motors are adjusted to meet these performance characteristics. (Emerson, Public Meeting Transcript, No. 73) In light of these comments, DOE revisited its engineering designs and found that when new performance values were calculated at operating temperatures of 25 °C (as was done for the baseline designs), the vast majority of motors met applicable NEMA standards. For the motors that did not meet breakdown torque, locked rotor torque, or locked rotor current requirements (as presented in TSD Chapter 5), DOE revised these designs such that they adhered to all performance requirements. DOE notes that in some cases, as predicted by manufacturers, the design revisions led to increases in costs to maintain the same level of efficiency. See Chapter 5 of the TSD for further details on the performance characteristics of motor designs analyzed in the engineering analysis and comparisons to NEMA performance requirements.

Baldor also noted that many small electric motors are rated in a broad voltage range (208V to 230V) and asserted (without clarifying) that the NEMA standard specifies these motors must be able to meet NEMA performance requirements over the entire voltage range. Baldor questioned whether DOE's proposed efficiency levels are achievable when motors are operated across this entire voltage range (specifically at 208V). (Baldor, Public Meeting Transcript, No. 20.4 at pp. 271–72) As indicated by Emerson (Emerson, Public Meeting Transcript, No. 20.4 at pp. 273–74), it is DOE's understanding the 208V rating constitutes an unusual service condition. Thus, DOE's engineering analysis was based on motor operation at 230V.

DOE notes that although the NEMA standard may require that certain performance characteristics (such as breakdown torque) be met through the entire rated voltage range, there is no such requirement for Federal efficiency standards. In fact, DOE's test procedures for small electric motors, IEEE 112 (Section 6.1) and IEEE 114 (Section 8.2.1) state that efficiency shall be determined at the rated voltage, without specifying which voltage shall be used in cases where motors are rated with broad voltages or dual voltages. DOE understands that it is at the manufacturer's discretion under which single voltage condition to test its motor. Because the test procedure outputs an efficiency value at a single input voltage, DOE did not conduct an additional analysis at 208V.

Baldor and NEMA stated that MG1 has additional requirements for small electric motors such as voltage unbalance, variation from rated speed, occasional excess current, stall time, overspeed, and sound quality. (Baldor, No. 25 at p. 3; NEMA, No. 24 at p. 9) In examining the variation from rated speed requirements, DOE notes that these are only applicable to medium motors, and thus not relevant to DOE's small electric motor designs. With regard to the other specifications, DOE believes that because it purchased the baseline motors from NEMA manufacturers, it is reasonable to assume that the motors meet NEMA MG1 requirements.

In addition DOE has evaluated each of its motor designs and believes for the following reasons that because the baseline motors likely meet all specifications, then the higher efficiency motors are expected to meet them as well. Specifically, whether a motor is able to meet voltage unbalance, excess current, and stall time requirements is often related to whether a motor overheats at those specified conditions. As the I^2R losses in higher efficiency motors modeled are generally lower than that of the baseline motors (thus, resulting in a lower temperature rise), DOE believes that overheating effects will not be exacerbated with higher efficiency.

For the overspeed requirement, DOE understands that there are several mechanical failure modes that may cause the motor to be unable to withstand speeds above the rated speed. Two primary reasons are the failure of the motor bearings and the potential for the motor shaft to bend, causing the rotor and stator to contact. In addition, DOE understands this issue to be more problematic for medium motors (with larger inertia) than small motors. Finally, for sound quality, decreased current and magnetic flux densities in higher efficiency motors will likely cause the magnitude of the torque pulsations of the motor to decrease during running conditions, reducing noise. The added mass of higher efficiency motors also serves as a dampener to reduce motor vibrations and noise. Given all of these reasons, DOE believes that all motor designs analyzed in the engineering analysis meet the additional performance requirements identified by the commenters.

DOE also received comments at the public meeting regarding the power factor associated with its designs. Baldor commented that during the preliminary analysis stage of the rulemaking some parties preferred that the power factor levels be above 85 percent, but that DOE's analyses utilized a power factor around 71 to 73 percent for polyphase motors. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 275–76) As discussed in the NOPR, DOE understands that sacrificing power factor to obtain gains in efficiency is counterproductive because of the

---

[12] I^2R losses refer to resistive losses, stemming from current flow through the copper windings in the stator and conductor bars in the rotor and manifest as waste heat which adversely affects the efficiency of a motor.

negative effects on line efficiency. 74 FR 61429 For this reason, DOE maintained or increased the power factor of the baseline motor for each more efficient design. While power factor is generally considered when evaluating the potential benefits related to a particular efficiency level, it is not a design option that necessarily improves the energy efficiency of small electric motors. Increasing power factor could yield results that reduce the energy efficiency of individual units or impose higher costs without an increase in energy efficiency. For this reason, DOE opted not to require its designs to have an 85 percent power factor in its design analysis.

d. Stray Load Loss

In the NOPR, DOE presented values of stray load loss that were modeled in the design software for the baseline and higher efficiency motor designs. The polyphase designs had a value of 2.4 percent for stray load loss, while the CSIR and CSCR designs had a value of 1.8 percent. In response to the NOPR, DOE received several comments regarding the stray load loss values used in its designs. Baldor commented that in the absence of a tested stray load loss value, the IEEE Standard 112 Test Method A (which is referenced as the DOE test procedure for polyphase motors of 1-horsepower or lower) indicates that a value of 1.8 percent should be used. As a result, Baldor questioned the source of DOE's polyphase motor stray load loss value. Baldor was concerned that DOE actually performed IEEE Standard 112 Test Method B, which calculates stray load loss but may yield a different tested efficiency value than Test Method A. In Baldor's view, using Test Method B could potentially skew the analysis. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 280–82; NEMA, No. at pp. 23–24)

Baldor and NEMA also questioned why the stray load loss value of 1.8 percent was used for the single-phase motors when the IEEE Standard 114 test procedure calls for a measurement of stray load losses. (Baldor, Public Meeting Transcript, No. 20.4 at p. 282; NEMA, No. 24 at p. 24) They were concerned that DOE did not follow the IEEE Standard 114 test procedure for the single-phase motors since the stray load loss value used did not appear to be a measured value. (Baldor, Public Meeting Transcript, No. 20.4 at p. 286) Advanced Energy supported DOE's assumptions, commenting that even though IEEE Standard 114 calls for a separation of losses, it also allows an assumed stray load loss value of 1.8 percent when a measured value cannot be determined. (Advanced Energy, Public Meeting Transcript, No. 20.4 at pp. 285–87) NEEA/NPCC also commented that DOE's stray load loss assumptions were appropriate. (NEEA/NPCC, No. 27 at p. 10)

To clarify, DOE tested the polyphase baseline motor according to both the IEEE Standard 112 Method A and Method B test procedures. While Method A is the appropriate DOE test procedure for a 1-horsepower, four-pole small electric motor, Method B determines efficiency by segregating motor losses. When DOE compared the results of Method A and Method B, it found that there was no material difference between the resulting tested efficiencies for this particular motor. Therefore, DOE assumed that it would be most accurate to model the stray load losses determined by IEEE Standard 112 Method B (*i.e.* 2.4 percent) rather than an assumed value (*i.e.* 1.8 percent).

The two baseline single-phase motors were tested according to IEEE Standard 114. As stated by Advanced Energy, the IEEE Standard 114 test procedure provides that if stray load loss is not measured, then the value of stray load loss at rated load may be assumed to be 1.8 percent of the rated load, consistent with DOE's assumption for CSCR and CSIR motors. DOE recognizes that losses can be segregated using the IEEE Standard 114 test procedure and therefore also calculated the stray load losses for the baseline motors. The results of these tests showed that the stray load losses for the CSIR and CSCR baseline motors were 1.8 percent and 1.7 percent. Given the similarity to IEEE Standard 114 assumed value and NEMA's previous recommendation to use this value, DOE believes that the use of 1.8 percent stray load loss for the single-phase motors was appropriate and has used it again for today's final rule.

Additionally, NEMA and Baldor questioned DOE's decision to maintain a constant stray load loss across its designs within a representative product class, stating that it would be unlikely that the use of thinner electrical steels in a longer core length would have resulted in the same level of stray load loss as in the baseline design. (NEMA, No. 24 at p. 24; Baldor, Public Meeting Transcript, No. 20.4 at pp. 281–83) In response, DOE affirms that its assumptions of stray load loss for higher efficiency motor designs are appropriate. DOE recognizes that several factors, such as manufacturing process and harmonic effects, may affect the quantity of stray load loss for a particular motor. However, as discussed earlier, DOE has determined that the majority of motor designs evaluated operate below the point of magnetic saturation, thus reducing the impact of harmonic effects. Additionally, DOE understands that it is common practice for motor design engineers to assume a value of stray load loss either based on experience or as recommended by IEEE test procedures when creating new, potentially more efficient, motor designs. Finally, DOE also notes that both the polyphase and single-phase IEEE test procedures provide precedent for the assumption of constant stray load losses across several motor designs.

e. Stack Length and Core Diameter

In the NOPR, DOE considered an increase in stack length as a viable option for increasing motor efficiency. DOE recognized, however, that limitations for certain motor applications exist because an increase in stack length may cause the motor to exceed the space constraints of the application into which it would reside. Thus, DOE followed a suggestion made by NEMA during the preliminary analysis stage and limited the stack length increases for space-constrained applications to no more than a 20 percent increase over the baseline motor. (NEMA, No. 13, at p. 4) For applications that DOE considered non-space constrained, the stack length of the motor was allowed to increase by up to 100 percent of the stack length of the baseline motor (*i.e.* it could double).

In response to the NOPR analysis, several interested parties commented on DOE's assumptions of space constraints and stack length increases. WEG questioned if the 20 percent increase in stack length for space constrained applications is an appropriate tolerance. (WEG, Public Meeting Transcript, No. 20.4 at p. 83) A.O. Smith commented that doubling the stack length in non-space constrained applications will be somewhat impractical for customers' applications. (A.O. Smith, Public Meeting Transcript, No. 20.4 at p. 81).

In response to the manufacturers' comments, DOE maintains that the 20 percent increase in stack length for space-constrained applications that was used in the NOPR is still an acceptable tolerance. DOE notes that NEMA reiterated its support for this design constraint in its comments responding to the NOPR, by citing its recommendation from the preliminary analysis. (NEMA, No. 24 at p. 9) Regarding doubling the stack length of the motor, DOE also believes this is an appropriate tolerance for non-space constrained applications. When DOE solicited engineering cost-efficiency curves from manufacturers for the preliminary analysis, all participating manufacturers suggested that increasing stack height would be one of the first design options used to achieve greater efficiencies because of the relative cost of this design option versus a change in steel type lamination. In designs provided by all of these manufacturers, stack increases of well over 100 percent relative to the baseline were used to achieve target efficiency levels that DOE provided to manufacturers. Accordingly, DOE believes that for those applications that are non-space constrained, a stack increase of 100 percent is an appropriate and even a likely design option that manufacturers could employ. DOE accounts for the costs associated with increasing a motor's stack length in markups analysis (see section IV.D).

Emerson also commented that the NOPR efficiency levels would require several motors to increase in frame size. (Emerson, No. 28 at p.1) However, DOE disagrees with Emerson's comments and notes that for all higher efficiency designs developed in the engineering analysis, core diameter was held constant to the baseline value. As only an increase in core diameter would force a frame size increase, DOE believes that all efficiency levels analyzed can be achieved without increasing frame size.

4. Cost Model

For the NOPR engineering analysis, DOE estimated the manufacturing production cost (MPC) of small electric motors by using outputs of the design software to generate a complete bill of materials. The bill of materials was marked up to account for scrap, overhead (which includes depreciation) and associated non-production costs such as interest payments, research and development, and sales and general administration. To account for the increased depreciation of equipment associated with manufacturing a copper rotor, DOE used separate overhead markups for motor designs using copper and aluminum rotors. The software output also included an estimate of labor time associated with each step of motor construction. DOE multiplied these estimates by a fully burdened labor rate to obtain an estimate of labor costs.

DOE estimated input costs by using an inflation-adjusted 5-year average of prices for each of the input commodities: Steel laminations, copper wiring, and aluminum and copper for rotor die-casting. This method for calculating costs is consistent with past rulemakings where material costs were a significant part of manufacturers' costs. In calculating the 5-year average prices for these commodities, DOE adjusted historical prices to 2008 terms using the historical Producer Price Index (PPI) for that commodity's industry. For this final rule, DOE updated material prices using the PPI to reflect 2009$. After calculating the MPC, DOE applied a 1.45 manufacturer markup to arrive at the MSP.

Emerson commented that it was concerned that DOE had not appropriately accounted for the significant costs associated with implementing the technology to manufacture motors with copper die-cast rotors in the engineering analysis. (Emerson, Public Meeting Transcript, No. 20.4 at p. 94) DOE recognizes that there are additional costs associated with implementing copper die-cast rotors and has incorporated higher depreciation costs in the Engineering Analysis for designs requiring this technology.

With regard to the accounting of higher depreciation for equipment used to manufacture copper die-cast rotors, NEEA/NPCC supported DOE's approach to using different overhead markups for designs with copper rotors and those with aluminum rotors. (NEEA/NPCC, No. 27 at p. 9) NEMA commented that since motor manufacturers typically standardize its production process for a product line, the higher overhead attributable to the application of advanced technologies will be applied over all production unless the manufacturer exits that portion of the market. (NEMA, No. 24 at p. 9) As all comments supported the use of higher markups when manufacturing copper rotors, DOE maintained this approach in the engineering analysis for the final rule. See section IV.C.4 for further details.

5. Efficiency Scaling

For the NOPR, in order to scale efficiency levels from the representative product classes to the other product classes, DOE used data on commercially-available motors to investigate how changing horsepower or pole configuration affects efficiency, DOE evaluated product lines of different manufacturers separately. In developing these efficiency relationships, DOE considered only motors of the most restrictive frame size for a given product class to ensure that the most dimensionally-constrained motors on the market would be able to meet all efficiency levels derived. DOE then converted these efficiency relationships across product class into motor loss relationships. DOE applied these relationships (as a percentage change in motor losses) to each efficiency level analyzed for the representative product classes, ultimately deriving corresponding efficiency levels for product classes not directly analyzed in the engineering analysis. DOE repeated this analysis for each manufacturer's product line for which sufficient data were available. Finally, DOE averaged the results based on each of the manufacturer's product lines to obtain aggregated scaled efficiency levels for all product classes.

DOE received several comments on the results and methodology of the proposed scaling analysis. While NEAA/NPCC supported DOE's scaling methodology (NEEA/NPCC, No. 27 at p. 9), Baldor stated that the scaling presented is likely not accurate because of the difficulty in predicting efficiencies when changing frame sizes, horsepower, and pole configurations. Instead, Baldor commented that DOE should create a motor design for each non-representative product class to verify the scaled efficiencies. (Baldor, Public Meeting Transcript, No. 20.4 at p. 97; Baldor, No. 25 at p. 8) WEG also commented that the scaling should take into account not only the change in efficiency associated with altering horsepower or pole configuration, but also the drop in efficiency associated with moving from a 56-frame to a 48-frame, and potentially a smaller core diameter. (WEG, Public Meeting Transcript, No. 20.4 at p. 220)

In addition, with regard to the polyphase motor scaling, several manufacturers pointed to the efficiencies at high horsepower ratings as evidence that DOE scaling was flawed. Specifically, they remarked that although the proposed level for the representative polyphase product class harmonized with medium motor NEMA Premium efficiency standards, the 3-horsepower, six-pole polyphase motor had a scaled efficiency greater than the NEMA Premium level.[13] They also noted that because the comparable medium motor for that product class is built in a 213 T-frame (larger than a 56-frame), it may be unreasonable to require a 56-frame motor to have a higher efficiency. (A.O. Smith, No. 26 at p. 2; Baldor, No. 25 at p. 8; Baldor, Public Meeting Transcript, No. 20.4 at pp. 100–101, 212–213; Regal-Beloit,

---

[13] NEMA Premium refers to efficiency levels for three-digit frame series medium electric motors developed by NEMA to identify high efficiency motors. Congress subsequently adopted those levels for medium electric motors. See EISA 2007, Sec. 313(b).

Public Meeting Transcript, No. 20.4 at pp.105)

DOE agrees that the efficiency behavior at high horsepower ratings for polyphase motors indicated a lack of accuracy in the NOPR scaling, and has revised its analysis for the final rule. Baldor's recommendation to generate motor designs to validate scaling essentially constitutes developing an additional engineering analysis for every product class, which is atypical for DOE rulemakings and unnecessary because it defeats the purpose of using a scaling methodology. In addition, DOE notes that in its comments on the preliminary analysis, NEMA recommended that DOE utilize product literature to derive efficiency levels for product classes not directly analyzed in the engineering analysis, which was a significant reason why DOE maintained a scaling approach based partially on publicly available data. (NEMA, No. 13, at p. 10) Thus, DOE believes scaling is an appropriate approach to developing efficiency levels. As interested parties did not recommend a new methodology for scaling, DOE based it revised scaling on the same general methodology (establishing relationships in efficiency across horsepower ratings and pole configurations), but utilized additional sources of data to refine its inputs.

One new source of data DOE utilized was the NEMA recommended standard levels for polyphase, CSIR, and CSCR motors built in small frames (42- and 48-frames) and in 56-frames. These recommended standard levels included efficiencies for motors with horsepower ratings less than and equal to 1-horsepower and with two-, four-, or six-pole configurations. (NEMA, No. 24 at p. 1) DOE first examined this data to see how it compared to the efficiency data of motors currently on the market. DOE noted that the efficiency relationships that NEMA presented between product classes were comparable to the market data that DOE had collected for the NOPR. For this reason, DOE concludes that NEMA's recommended standard levels can be used to establish appropriate efficiency (or loss) relationships for lower horsepower polyphase, CSIR, and CSCR motors.

For the high horsepower (greater than or equal to 1-horsepower) polyphase motors, DOE utilized the relationships found in the NEMA Premium standards for electric motors. As seen in Table IV.7, the majority of the NEMA Premium standards between 1- and 3-horsepower are based on motors with a frame size in the 140T series, which has the same foot to shaft dimension as the 56-frame motor. Therefore, for these 140T series product classes, DOE used NEMA Premium efficiencies to develop relationships across horsepower ratings and poles. DOE did not use the efficiency relationships found from NEMA Premium classes associated with larger frame sizes (182T). For these horsepower/pole configurations, DOE did not have sufficient efficiency data to determine appropriate scaling relationships. Thus, though efficiency generally increases with horsepower, in order to ensure that all efficiency levels are technologically feasible, DOE decided that the 3-horsepower, four-pole motor and 1½-horsepower, two pole motor would have the same minimum efficiency standards as the 2-horsepower, four-pole motor and 1-horsepower, two-pole motor, respectively.

TABLE IV.7—FRAME SIZES ASSOCIATED WITH NEMA PREMIUM STANDARDS

Motor horsepower/standard kilowatt equivalent	Six poles	Four poles	Two poles
1 hp/0.75 kW	56	143T	145T
1½ hp/1.1 kW	143T	145T	182T
2 hp/1.5 kW	145T	145T	
3 hp/2.2 kW	145T	182T	

In the absence of any standardized efficiency levels above 1-horsepower for CSIR motors (such as those provided in the NEMA Premium table for polyphase motors), DOE continued to use market efficiency data. Since this approach, when used in the NOPR, resulted in some aberrations (abnormally high efficiencies) for high horsepower polyphase motors, DOE modified its methodology slightly for the final rule to result in more appropriate scaling relationships. As stated earlier, for the NOPR, because some manufacturers showed larger increases in efficiency with increasing horsepower than others, DOE averaged data from several manufacturer product lines to create efficiency relationships. However, for this final rule, to ensure the technological feasibility of all scaled efficiency levels, instead of averaging data from all manufacturers, DOE selected the product line which resulted in the most achievable efficiency levels.

As mentioned in the NOPR, DOE was unable to locate sufficient market data for CSCR motors. However, DOE data indicate that CSCR motors exhibit scaling relationships similar to CSIR motors. For these reasons, DOE decided to continue utilizing CSIR market data to characterize the efficiency (or loss) relationships present in the CSCR market at high horsepower ratings.

Next, DOE addressed changes in physical dimensions of motors across horsepower ratings and pole configurations. As discussed earlier, DOE recognizes that core diameter affects the amount of active material that is used to reduce motor losses, thus impacting efficiency. If DOE were to set a standard based on an analysis of a motor of larger core diameter, it could potentially eliminate smaller core diameter motors from the market. Therefore, after establishing the efficiency relationships (by using the NEMA recommended levels, the NEMA Premium levels, and market data), DOE accounted for the fact that for some horsepower/pole configurations, 48-frame size motors are commercially available, while for others, only 56-frame size motors are commercially available.

As stated by WEG at the NOPR public meeting, a reduction in frame size (or core diameter) should accompanied by a reduction in efficiency. To determine the appropriate efficiency reduction of shifting from a motor with a core diameter representative of a 56-frame to a core diameter representative of a 48-frame, DOE again utilized the NEMA recommended efficiencies. From these efficiency values, DOE noted that according to NEMA a shift in frame size constitutes approximately a 20 percent change in losses. DOE applied this 20 percent reduction in losses to product classes for which 42 frame or 48-frame motors are commercially available. DOE intends for its loss scaling analysis to reflect motors in the smallest commercially available frame size for each product class.

After deriving efficiency relationships accounting for changes in horsepower, pole configuration, and core diameter, DOE then applied these relationships (as a percentage change in motor losses) to each efficiency level of the representative product classes, ultimately deriving corresponding efficiency levels for the non-representative product classes.

6. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency data (or "curves") in the form of MSP (in dollars) versus full-load efficiency (in percentage). These data form the basis for subsequent analyses in the final rule. As discussed in the NOPR, DOE developed two curves for each product class analyzed, one for the space-constrained set of designs restricted by a 20-percent increase in stack height and one for the non-space constrained set of designs restricted by a 100-percent increase in stack height relative to the baseline.

NEMA recommended efficiency levels for small electric motors that it believed would be technologically feasible to implement by 2015. NEMA presented six separate sets of efficiency levels, one for 56-frame size motors in each of the three motor categories and one for 42- and 48-frame size motors in each of the three motor categories. (NEMA, No. 24 at p. 1) When DOE revised its engineering analysis, it ensured that each of its representative units had an efficiency level that corresponded to one of those sets of standards. For CSIR motors, NEMA proposed an efficiency value of 72.0 percent for a 48-frame size, four-pole ½-horsepower motor. This proposal roughly corresponds to DOE's efficiency level 4 for CSIR motors. For CSCR motors NEMA proposed an efficiency value of 80.0 percent for a 56-frame size, four-pole, ¾-horsepower motor. This proposal corresponds to DOE's efficiency level 2 for CSCR motors.

For polyphase motors, NEMA did not present an efficiency value for the four-pole, 1-horsepower product class. In light of this, DOE utilized its scaling model to identify the projected efficiency for the four-pole, 1-horsepower product class according to NEMA's recommendations for the 42- and 48-frame size motors. DOE used the 42/48-frame size proposed levels to apply to its representative product class because the core diameter of its baseline model is representative of 48-frame size motors. DOE projects this efficiency value to be approximately 82.6 percent for the representative polyphase motor. As this efficiency lies between the designs analyzed for EL 4 and EL5, DOE created an additional efficiency level at 82.6 percent, denoted EL 4b. DOE developed a new space constrained and non-space constrained design at this efficiency level that adhered to all of DOE's design limitations.

Table IV.8 through Table IV.10 show the efficiency value and manufacturer selling price data for each EL examined in the final rule.

TABLE IV.8—EFFICIENCY AND MANUFACTURER SELLING PRICE DATA FOR POLYPHASE MOTOR

Efficiency level	Efficiency (%) (Design 1/Design 2) *	Manufacturer selling price ($) (Design 1/Design 2) *
Baseline	75.3	98.54
EL 1	77.3	104.83
EL 2	78.8	108.17
EL 3	80.5	114.24
EL 4	81.1	118.54
EL 4b	83.5/83.5	135.62/134.04
EL 5	85.3/85.2	230.92/153.92
EL 6	86.2/86.3	237.70/186.37
EL 7 (Max-tech)	87.7/87.8	1,766.06/326.18

* Design 1 denotes the space-constrained design, and Design 2 denotes the non-space-constrained design. If only one value is listed, then the space-constrained design is the same as the non-space-constrained design.

TABLE IV.9—EFFICIENCY AND MANUFACTURER SELLING PRICE DATA FOR CAPACITOR-START, INDUCTION-RUN MOTOR

Efficiency level	Efficiency (%) (Design 1/Design 2) *	Manufacturer selling price ($) (Design 1/Design 2) *
Baseline	57.9	91.24
EL 1	61.1	95.43
EL 2	63.5	98.45
EL 3	65.7	99.58
EL 4	70.6/70.5	114.31/106.99
EL 5	71.8/71.8	117.07/118.00
EL 6	73.1/73.3	182.09/132.22
EL 7 (Max-tech)	77.6/77.7	1,200.98/151.25

* Design 1 denotes the space-constrained design, and Design 2 denotes the non-space-constrained design. If only one value is listed, then the space-constrained design is the same as the non-space-constrained design.

TABLE IV.10—EFFICIENCY AND MANUFACTURER SELLING PRICE DATA FOR CAPACITOR-START, CAPACITOR-RUN MOTOR

Efficiency level	Efficiency (%) (Design 1/Design 2) *	Manufacturer selling price ($) (Design 1/Design 2) *
Baseline	71.4	111.72
EL 1	75.1	117.13
EL 2	79.5/79.5	137.20/129.88

TABLE IV.10—EFFICIENCY AND MANUFACTURER SELLING PRICE DATA FOR CAPACITOR-START, CAPACITOR-RUN MOTOR—Continued

Efficiency level	Efficiency (%) (Design 1/Design 2) *	Manufacturer selling price ($) (Design 1/Design 2) *
EL 3	81.7/81.8	142.63/135.56
EL 4	82.8/82.8	146.44/142.76
EL 5	84.1/84.0	154.55/151.91
EL 6	84.8/84.6	236.98/158.25
EL 7	86.8/86.7	244.03/175.75
EL 8 (Max-tech)	88.1/87.9	1,771.47/327.69

* Design 1 denotes the space-constrained design, and design 2 denotes the non-space-constrained design. If only one value is listed, then the space-constrained design is the same as the non-space-constrained design.

D. Markups To Determine Equipment Price

To calculate the equipment prices faced by small electric motor purchasers, DOE multiplied the manufacturing costs developed from the engineering analysis by the supply chain markups it developed (along with sales taxes). In the NOPR, DOE explained how it developed the distribution channel markups used. 74 FR 61434.

DOE did not receive comments on these markups; however, in written comments, NEMA and DOJ commented that some original equipment manufacturers (OEMs) could incur additional design costs to redesign their products to accommodate the increased size of more efficient motor designs. (NEMA, No. 24 at p.19 and DOJ No. 29 at p. 2) DOE recognizes that motors produced following the introduction of the standards described in this rule will likely be different in size and shape from motors produced today. In particular, the designs produced in DOE's engineering analysis exhibit longer stack length to increase efficiency. DOE also projects that the standards may result in significant increases in market share for CSCR motors (which have an extra external capacitor). DOE understands that these changes may result in the need for some OEMs who incorporate these motors to redesign their products. Nationally, about 2.5% of U.S. gross domestic product is spent on research and development (R&D; National Science Board. 2010. Science and Engineering Indicators 2010. Arlington, VA: National Science Foundation (NSB 10–01)). DOE estimates that R&D by equipment OEMs, including the design of new products, generally represents approximately 2 percent of company revenue. This percentage is slightly less than the national average to account for high technology companies that generally spend a much larger fraction of revenue on R&D than OEMs of equipment that incorporate small motors. DOE accounted for the additional costs to redesign products and incorporate differently-shaped motors by adding 2% to the OEM markup, increasing the baseline OEM markup from 1.37 to 1.39 and the incremental OEM markup from 1.27 to 1.29 for OEMs without a distributor, and 1.33 to 1.35 for OEMs that purchase motors through distributors.

DOE used these markups, along with sales taxes, installation costs, and manufacturer selling prices (MSPs) developed in the engineering analysis, to arrive at the final installed equipment prices for baseline and higher efficiency small electric motors. As explained in the NOPR (74 FR 61434), DOE defined three distribution channels for small electric motors to describe how the equipment passes from the manufacturer to the customer. DOE retained the same distribution channel market shares described in the NOPR.

Table IV.11 summarizes for each of the three identified distribution channels the baseline and incremental markups at each stage and the overall markups, including sales taxes. Weighting the markups in each channel by its share of shipments yields an average overall baseline markup of 2.52 and an average overall incremental markup of 1.86. DOE used these markups for all three types of motors.

TABLE IV.11—SUMMARY OF SMALL ELECTRIC MOTOR DISTRIBUTION CHANNEL MARKUPS

	Direct to OEMs 65%		Via distributors to OEMs 30%		Via distributors to end-users 5%	
	Baseline	Incremental	Baseline	Incremental	Baseline	Incremental
Wholesale Distributor			1.28	1.10	1.28	1.10
OEM	1.39	1.29	1.39	1.35		
Retail and Post-OEM Distributor	1.43	1.18	1.43	1.18	1.44	1.18
Contractor or Installer	1.10	1.10	1.10	1.10	1.10	1.10
Sales Tax	1.0684		1.0684		1.0684	
Overall	2.34	1.79	2.99	2.06	2.17	1.53

Using these markups, DOE generated motor end-user prices for each efficiency level it considered, assuming that each level represents a new minimum efficiency standard. Because it generated a range of price estimates, DOE describes prices within a range of uncertainty.

Chapter 7 of the TSD provides additional detail on the markups analysis.

E. Energy Use Characterization

The energy use characterization estimates the annual energy consumption of small electric motors. This estimate is used in the subsequent LCC and PBP analyses (chapter 8 of the TSD) and National Impacts Analysis (NIA) (chapter 11 of the TSD). DOE determined the annual energy consumption of small electric motors by multiplying the energy use while in operation by the annual hours of operation. The energy use in operation is a function of the motor loading and the losses resulting from motor operation, based on the motor designs characterized in the engineering analysis. DOE's motor designs are also characterized by their power factor, which allows DOE to estimate the reactive power requirements of each analyzed motor.

1. Applications

DOE's shipments analysis indicates that small electric motors are used in five application categories: Pumps; fans and blowers; air compressors; conveyors and material handling; and general industrial or miscellaneous applications. Motor energy use depends on application because different applications have different annual hours of operation and different average motor loading.

In the NOPR, DOE presented the results of an analysis of motor shipments into the five application categories. Table IV.12 shows the distribution of motor shipments by application presented in the NOPR.

TABLE IV.12—DISTRIBUTION OF MOTORS BY APPLICATION AND MOTOR TYPE

Motor application	Polyphase (%)	CSIR (%)	CSCR (%)
Reference Case:			
Air and gas compressors	17.3	14.9	14.9
Conveyors & packaging equipment	13.3	11.9	11.9
General industrial machinery	11.3	12.5	12.5
Indus. and comm. fans and blowers	7.3	6.9	6.9
Pumps and pumping equipment	50.7	53.7	53.7
Service industry	0.0	0.0	0.0
Total	100.0	100.0	100.0
Sensitivity (NEMA Survey):			
Air and gas compressors	45	22	45
Conveyors & packaging equipment	5	2	2
General industrial machinery	7	1	1
Indus. and comm. fans and blowers	23	51	29
Pumps and pumping equipment	15	13	12
Service industry	5	11	11
Total	100.0	100.0	100.0

In written comments, NEMA submitted the results of a survey of their OEM customers for motors which NEMA considers to be covered products. (NEMA, No. 24 at pp. 19 to 21) The survey reports distributions by application and owner type, estimates of annual hours of operation, and the fraction of motors that are space-constrained. NEMA also provided information on a sixth application not included in DOE's NOPR, service industry motors. The distribution by application and motor type provided by NEMA is also shown in Table IV.13.

DOE has concerns about the accuracy of the results of this survey. It is not clear which OEMs were contacted for the survey, how many responded, how representative the respondents are of the small motor market, and what specific questions were asked. It is also not clear that the survey results represent an accurate picture of the entire U.S. market for small motors, or how all OEMs will respond to today's rule. In contrast, the distributions by motor application that DOE used in the NOPR were based on analysis conducted in the early stages of the rulemaking, supplemented by a review of U.S. Census and U.S. Customs data regarding production and imports of motors and equipment containing motors. For these reasons, DOE retained its assumptions regarding the distribution of motors by application and sector; however, DOE did run a sensitivity case that reflects the results of the NEMA survey. This sensitivity is discussed in Section VI, and the detailed results are presented in the TSD.

Table IV.13 shows the distributions of motors by sector within each application used in the NOPR, as well as the results provided by the NEMA survey.

TABLE IV.13—DISTRIBUTION OF MOTORS BY APPLICATION AND SECTOR

Application	Sector				Total (%)
	Industrial (%)	Commercial (%)	Agricultural (%)	Residential (%)	
Reference Case:					
Air and gas compressors	40	40	10	10	100
Conveyors & Packaging Equipment	40	50	10	0	100
General industrial machinery	50	40	10	0	100
Indus. and comm. fans and blowers	50	50	0	0	100

TABLE IV.13—DISTRIBUTION OF MOTORS BY APPLICATION AND SECTOR—Continued

Application	Sector				Total (%)
	Industrial (%)	Commercial (%)	Agricultural (%)	Residential (%)	
Pumps and pumping equipment	40	35	20	5	100
Service industry	0	0	0	0	N/A
Sensitivity (NEMA Survey):					
Air and gas compressors	0	15	15	70	100
Conveyors & Packaging Equipment	65	35	0	0	100
General industrial machinery	80	20	0	0	100
Indus. and comm. fans and blowers	20	80	0	0	100
Pumps and pumping equipment	10	40	20	30	100
Service industry	10	80	0	10	100

2. Annual Hours of Operation and Motor Loading

In the NOPR, and in today's final rule, DOE characterized the motor loading and annual hours of operation with distributions for each analyzed motor application. DOE's estimates of the average motor loading in each application are unchanged from the NOPR to today's final rule. Table IV.14 shows the average loading in each application. DOE assumed that the motor loading distribution took the form of a normal distribution, centered on the average value, with a standard deviation equal to one fifth of the average loading. Details on these calculations are provided in chapter 6 of the TSD.

TABLE IV.14—AVERAGE MOTOR LOADING BY APPLICATION

Application	Average loading (%)
Air and gas compressors	85
Conveyors & Packaging Equipment	50
General industrial machinery	70
Indus. and comm. fans and blowers	80
Pumps and pumping equipment	65
Service industry	70

In the NOPR, DOE assumed distributions of the annual hours of operation in each application with means and medians as shown in Table IV.15. At the December 17, 2009 public meeting, Emerson commented that the average hours of operation within each application assumed by DOE are too high (Emerson, Public Meeting Transcript No. 20.4 at pp. 197–99). According to Emerson, the distribution of hours of operation that DOE assumed for each application, detailed in the TSD, is a highly skewed distribution in which the mean and median can be significantly different. As a result of its survey of OEMs, NEMA reported lower hours of operation only for compressors, and reported that service industry motors run 1000 hours per year on average, with a median of 400 hours. However, by including in the table in their written comments the operating hour assumptions DOE used in the NOPR for the other applications, NEMA appears to accept DOE's assumptions of hours of operation for conveyors, general industrial machinery, fans and blowers, and pumps. The mean and median hours of operation in each application in the reference and sensitivity case are shown in Table IV.15.

TABLE IV.15—MEDIAN AND MEAN ANNUAL HOURS OF OPERATION AND FRACTION THAT RUN ALL THE TIME, BY MOTOR APPLICATION

Application	Annual Hours of Operation		Fraction of motors that run all the time (%)
	Median	Mean	
Reference Case:			
Air and gas compressors	375	600	0
Conveyors & Packaging Equipment	2000	3000	8
General industrial machinery	1200	2000	4
Indus. and comm. fans and blowers	2825	4500	40
Pumps and pumping equipment	1850	3000	12
Service industry	NA	NA	NA
Sensitivity (NEMA Survey):			
Air and gas compressors	100	200	0
Conveyors & Packaging Equipment	2000	3000	0
General industrial machinery	1200	2000	4
Indus. and comm. fans and blowers	2825	4500	10
Pumps and pumping equipment	1850	3000	12
Service industry	400	1000	2

F. Life-Cycle Cost and Payback Period Analysis

In response to the requirements of section 325(o)(2)(B)(i) of the Act, DOE conducted LCC and PBP analyses to evaluate the economic impacts of possible amended energy conservation standards on small electric motor customers. This section of the notice describes these analyses. DOE conducted the analysis using a spreadsheet model developed in Microsoft (MS) Excel for Windows 2003.

The LCC is the total consumer expense over the life of the equipment, including purchase and installation expense and operating costs (energy expenditures, repair costs, and maintenance costs). The PBP is the number of years it would take for the consumer to recover the increased costs of a higher-efficiency equipment through energy savings. To calculate the LCC, DOE discounted future operating costs to the time of purchase and summed them over the lifetime of the equipment. DOE measured the change in LCC and the change in PBP associated with a given efficiency level relative to a base case forecast of equipment efficiency. The base case forecast reflects the market in the absence of amended mandatory energy conservation standards. As part of the LCC and PBP analyses, DOE developed data that it used to establish equipment prices, installation costs, annual energy consumption, energy and water prices, maintenance and repair costs, equipment lifetime, and discount rates.

Table IV.16 summarizes the approaches and data DOE used to derive the inputs to the LCC and PBP calculations for the NOPR. For today's final rule, DOE did not introduce changes to the LCC and PBP analyses methodology described in the NOPR, but incorporated changes to the inputs to the analysis to account for updates to the engineering analysis and energy price trends and to analyze the sensitivity of the results using the survey data NEMA provided. Chapter 8 of the TSD contains detailed discussion of the methodology utilized for the LCC and PBP analyses as well as the inputs developed for the analyses.

TABLE IV.16—SUMMARY OF INPUTS AND KEY ASSUMPTIONS IN THE LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSES

Inputs	NOPR	Changes for the Final Rule
Affecting Installed Costs		
Equipment Price	Derived by multiplying manufacturer cost by manufacturer, distributor and OEM markups, and sales tax.	No change.
Installation Cost	Based on data from RSMeans	No change.
Affecting Operating Costs		
Annual Energy Use	Derived by multiplying hours of operation by losses, accounting for motor loading. Reactive power demand calculated from power factor.	No change in operating hours in the reference case; changes to operating hours of compressors in the sensitivity cases. Losses, loading and reactive power changed slightly, as a result of the updated engineering analysis.
Energy Prices	Electricity: Distribution of values for each sector, updated using EIA's 2007 Form 861 data.	No change.
Energy Price Trends	Energy: Reference Case forecast updated with EIA's *AEO 2009* April Release. High-Price and Low-Price forecasts updated with EIA's *AEO 2009* March Release. Carbon Cap and Trade case from Lieberman-Warner.	*AEO 2010* for the reference; ratios from *AEO 2009* March release used for high and low.
Repair and Maintenance Costs	Unchanging with efficiency	No change.
Affecting Present Value of Annual Operating Cost Savings		
Equipment Lifetime	Mean of 7 and 9 years. Lifetime is correlated with annual hours of operation.	No change.
Discount Rates	Approach based on cost of capital of publicly traded firms in the sectors that purchase small electric motors. Primary data source is Damodaran Online.[14]	No change.
Affecting Installed and Operating Costs		
Space Constraints	Assumed 20% of motors in OEM applications face space constraints.	No change in reference case; analyzed 62% and 95% sensitivity cases.
Effective Date of New Standard	2015	No change.

1. Installation Cost

Installation costs include labor, overhead, and any miscellaneous materials and parts. For the NOPR and today's final rule, DOE used data from the RS Means *Mechanical Cost Data,* 2008 on labor requirements to estimate installation costs for small electric motors. DOE estimates that installation costs do not increase with equipment efficiency.

2. Energy Prices

For both the NOPR and today's final rule, DOE developed nationally representative distributions of electricity prices for different customer categories (industrial, commercial, and residential) from 2007 Energy Information Administration (EIA) Form 861 data, the most recent data available.

---

[14] Please see the following Web site for further information: *http://pages.stern.nyu.edu/adamodar/.*

DOE estimates that marginal energy prices for electric motors are close to average prices, which vary by customer type and utility. The average prices (in 2009$) for each sector are 7.5 cents for the industrial and agricultural sectors, 10.4 cents for the commercial sector, and 11.7 cents for the residential sector. DOE also estimated an average reactive power charge of $0.51 per kilovolt-amps reactive (kVAr) per month using survey data provided in written comments submitted during the preliminary analysis stage of the rulemaking by Edison Electric Institute. The data identified those customers who are subject to a reactive power charge. (EEI, No. 14 at p. 6)

3. Energy Price Trend

To estimate the trends in electricity prices for the NOPR, DOE used the price forecasts in the 2009 Annual Energy Outlook (*AEO 2009)* April Release.[15] To arrive at prices in future years, DOE multiplied the average prices described above by the forecast of annual average price changes. Because the *AEO 2009* forecasts prices only to 2030, DOE followed past guidelines provided to the Federal Energy Management Program by EIA and used the average rate of change during 2020–2030 to estimate the price trends beyond 2030. For today's final rule, DOE had updated its analysis to use the price forecasts in the *AEO 2010* Early Release, which includes price forecasts until 2035. DOE used the average rate of change from 2025 to 2035 to estimate price trends beyond 2035.

The spreadsheet tools used to conduct the LCC and PBP analysis allow users to select either the *AEO's* high-price case or low-price case price forecasts to estimate the sensitivity of the LCC and PBP to different energy price forecasts. The *AEO 2009* April Release and *AEO 2010* Early Release only provide forecasts for the Reference Case. Therefore, for the NOPR, DOE used the *AEO 2009* March Release high-price or low-price forecasts directly to estimate high-price and low-price trends. For today's final rule, DOE updated the low-price ad high-price forecasts to be based on the ratio between the *AEO 2009* March Release low- or high-price forecasts and the *AEO 2009* March Release reference case. DOE then applied these ratios to the *AEO 2010* Early Release reference case to construct its high-price and low-price forecasts.

4. Maintenance and Repair Costs

Small electric motors are not usually repaired, because they often outlast the equipment in which they are installed. DOE found no evidence that repair or maintenance costs would increase with higher motor energy efficiency. In response to the preliminary analysis, no interested parties provided any comments or data indicating that maintenance or repair costs are likely to change with motor efficiency. Thus, in today's final rule DOE did not change the repair and maintenance costs for motors that are more efficient than baseline products that were presented in the NOPR.

5. Equipment Lifetime

For the NOPR and today's final rule, DOE developed motor lifetime distributions for each motor application, with a mean of seven years for capacitor-start motors and a mean of nine years for polyphase motors. Each distribution incorporates a correlation between the motor annual hours of operation and the motor lifetime. Motor lifetime is governed by two Weibull distributions. One characterizes the motor lifetime in total operating hours while the other characterizes the lifetime in years of use in the application. Motors are retired from service at the age when they reach either of these limits.

6. Discount Rates

The discount rate is the rate at which future expenditures are discounted to estimate their present value. DOE used the classic economic definition that discount rates are equal to the cost of capital. The cost of capital is a combination of debt interest rates and the cost of equity capital to the affected firms and industries. For each end-use sector, DOE developed a distribution of discount rates. DOE's methodology and inputs for calculating discount rates are unchanged from the NOPR (74 FR 61440), and details are available in chapter 8 of the TSD. In response to the NOPR, DOE did not receive any comments regarding customer discount rates.

7. Space-Constrained Applications and the After-Market

Comments at the NOPR public meeting (WEG, Emerson, and Regal-Beloit, Public Meeting Transcript, No. 20.4 at pp. 184–85, 191–92), and in written comments (NEMA, No. 24 at p. 19; DOJ, No. 29 at p. 2), expressed concerns regarding the challenges faced by users who purchase motors to replace existing motors within their applications. (This market is referred to as the "after-market.") In particular, these customers might face difficulty replacing motors in space-constrained applications with new motors of different size. Motors are sold to these customers through distributors or OEMs. DOE was unable to obtain data on the size and structure of the space-constrained portion of this market. However, DOE's motor lifetime function, which differentiates between motors retired due to mechanical failure and motors retired when the application in which they reside is retired, indicates that approximately 25-percent of small electric motors retire because of mechanical failure. Only users of these motors would be participants in the after-market, as other users replace their complete application rather than the motor alone. DOE has assumed that 20-percent of motor application are space-constrained, indicating that approximately 5-percent of motors are both space-constrained and retire due to mechanical failure—these users would participate in the after-market.

As discussed above in section IV.E, the NEMA survey reported on the fraction of motors purchased by OEMs that face space constraints inside their application. NEMA reported that 62 percent of the OEMs responding to the survey stated that any increase in size would negatively impact their ability to use the motor in their current applications, and that 33-percent stated that their applications could accept "only a slight increase" in size; only 5 percent stated that their application had few space constraints.

While DOE appreciates the information provided by NEMA, the agency has concerns regarding how well the sample represents total U.S. small motor shipments and possible survey response bias. In addition, as part of its written comments, NEMA has proposed alternative standards. These alternative standards appear to indicate that if nearly all OEMs face space constraints for motors in their products, it would be difficult for motor manufacturers to achieve the efficiency level called for in the NEMA standard levels without large cost increases. For these reasons, DOE has retained its assumption that 20-percent of the small motors are installed in applications that cannot accommodate any size increases.

OEMs that manufacture applications with space constraints on their motors have several options: (1) Redesign their application to accommodate a motor with a longer stack and/or a run capacitor; (2) purchase a stockpile of motors not covered by today's rule to install in future production of their application; (3) replace a less efficient

---

[15] All AEO publications are available online at: *http://www.eia.doe.gov/oiaf/aeo/.*

CSIR motor with a more efficient CSCR motor without increasing stack length; or (4) replace their motor with a motor not covered by today's rule. DOE estimates the likelihood and effect of each of these outcomes in its analysis of national impacts, by: Increasing the OEM baseline and incremental markups by 2 percent to either pay for redesign of their products to accommodate larger motors or purchase a stockpile of existing motors of the correct size; applying a model that estimates the migration from CSIR to CSCR motors, based on the relative difference in equipment and operating costs of the two types of motors and the assumed fraction that are space-constrained; and changing the assumption in the reference case regarding the elasticity of demand for small electric motors to a change in purchase price (from zero, or inelastic, to −0.25), thereby increasing the number of motors expected to migrate to totally enclosed motors not covered by today's rule. These assumptions result in nearly the entire CSIR market migrating to CSCR motors under the proposed standards, with net benefits to the average motor customer.

In response to this comment, DOE analyzed the impact of increasing the space-constrained fraction to 62 percent and to 95 percent of all motors in its sensitivity case (the additional 2-percent markup is not included in these two scenarios). These results are summarized in section VI below.

Emerson also pointed out that the OEMs whose products have space constraints are typically smaller companies that have a hard time re-engineering their product when changes in size occur. (Emerson, Public Meeting Transcript, No. 20.4 at pp. 83–85) DOE recognizes that smaller OEMs that manufacture products which cannot readily be altered to accommodate a larger motor may be adversely affected by today's rule. In analyzing the potential impact of today's standards on customers, DOE evaluated the impact on identifiable groups of end-use motor customers (*i.e.,* subgroups), such as small businesses, that may not be equally affected by a national standard level. The results of the subgroup analysis for small businesses can be found in section VI.C.1.b of this notice.

8. Standard Compliance Date

The date by which all small electric motor manufacturers must manufacture motors that satisfy the new standards announced in today's rule is statutorily-prescribed under EPCA. See 42 U.S.C. 6317(b). Therefore, the effective date of any new energy conservation standards for these products will be February 2015. DOE calculated the LCC for all end users assuming that each one would purchase a new piece of equipment in the year the standard takes effect.

G. National Impact Analysis—National Energy Savings and Net Present Value Analysis

1. General

DOE's National Impact Analysis (NIA) assesses the national energy savings, as well as the national Net Present Value (NPV) of total consumer costs and savings, expected to result from new standards at specific efficiency levels. DOE applied the NIA spreadsheet to perform calculations of energy savings and NPV, using the annual energy consumption and total installed cost data from the LCC analysis. DOE forecasted the energy savings, energy cost savings, equipment costs, and NPV for each equipment class from 2015 to 2045. The forecasts provide annual and cumulative values for all four parameters. In addition, DOE incorporated into its NIA spreadsheet the capability to analyze the sensitivity of the results to forecasted energy prices and equipment efficiency trends. Table IV.17 summarizes the approach and data DOE used to derive the inputs to the NES and NPV analyses for the NOPR. It also summarizes the changes DOE made in this analysis for today's final rule. These changes are described in the following sections, and more details are available in chapter 11 of the final rule TSD.

TABLE IV.17—APPROACH AND DATA USED TO DERIVE THE INPUTS TO THE NATIONAL ENERGY SAVINGS AND NPV ANALYSES

Inputs	2009 NOPR description	Changes for the final rule
Shipments	Annual shipments from Shipments Model. Shipments inelastic to changes in motor price. Two CSIR–CSCR cross-elasticity cases.	Updated shipments drivers to *AEO 2010* for reference case. Total shipments elasticity changed from 0 to −0.25. Single cross-elasticity case in which market shares are fixed beginning in 2015.
Space Constraints	Assumed 20% of motors in OEM applications face space constraints.	No change in reference case; analyzed 62% and 95% sensitivity cases.
Effective Date of Standard	2015	No change.
Base-Case Forecasted Efficiencies.	Efficiency distribution determined by the number of currently available models meeting the efficiency requirements of each TSL.	Efficiency distribution updated to reflect changes in engineering analysis, including the additional polyphase motor design
Standards-Case Forecasted Efficiencies.	Roll-up scenario. Efficiency distribution held constant over forecast period.	No change.
Annual Energy Consumption per Unit.	Annual weighted-average values as a function of efficiency distribution.	Updated to account for correlation between average energy use and motor age.
Total Installed Cost per Unit	Annual weighted-average values as a function of efficiency distribution.	No change.
Energy Cost per Unit	Annual weighted-average values a function of the annual energy consumption per unit and energy prices.	No change.
Repair Cost and Maintenance Cost per Unit.	None	No change.
Escalation of Energy Prices	Energy Prices: *AEO 2009* April Release forecasts for the Reference Case. *AEO 2009* April Release does not provide High-Price and Low-Price forecasts; used *AEO 2009* March Release High-Price and Low-Price forecasts to estimate high- and low-growth price trends.	Updated to *AEO 2010* Early Release forecasts for the Reference Case. High-Price and Low-Price forecasts created using ratios of *AEO 2009* March release High- and Low-Price forecasts to the *AEO 2009* March Reference Case.

TABLE IV.17—APPROACH AND DATA USED TO DERIVE THE INPUTS TO THE NATIONAL ENERGY SAVINGS AND NPV ANALYSES—Continued

Inputs	2009 NOPR description	Changes for the final rule
Energy Site-to-Source Conversion.	Conversion varies yearly and is generated by DOE/EIA's NEMS program (a time-series conversion factor; includes electric generation, transmission, and distribution losses).	No change.
Effect of Standards on Energy Prices.	Determined but found not to be significant	No change.
Discount Rate	3% and 7% real	No change.
Present Year	Future expenses discounted to year 2009	Future expenses discounted to year 2010.

2. Shipments

The shipments portion of the NIA spreadsheet is a shipments model based on macroeconomic drivers for small electric motor shipments. In the NOPR, DOE estimated that shipments to the industrial sector are proportional to the manufacturing output, shipments to the commercial sector are proportional to commercial floor-space, and shipments to the residential sector are proportional to the number of households. DOE used the *AEO 2009* April Release to forecast these three drivers. For today's final rule, DOE has updated the drivers in the reference case to the *AEO 2010* Early Release.

In the NOPR, DOE examined three alternate shipments scenarios. Two of these scenarios were based on the *AEO 2009* March Release High-Growth and Low-Growth cases, while the third was a "falling market share" case, in which forecast shipments remain constant at their 2008 levels independent of economic growth. The NEEA/NPCC commented that DOE should retain the falling market share case because of uncertainties regarding the size of the future demand for small motors covered by this rule, as well as the current economic climate. NEEA/NPCC added that DOE should give additional weight to this scenario when making its policy decision (NEEA, No. 27 at p. 10). These shipments scenarios are presented in Chapter 9 of the TSD.

In its analysis for the NOPR, DOE assumed that customers would not respond to standards by changing to enclosed motors, due to different ventilation requirements, and analyzed two different elasticities to enclosed motors, −0.25 and −0.5, as sensitivities. Several comments (Emerson, Public Meeting Transcript, No. 20.4 at pp. 176–77; NEEA/NPCC, No. 27 at pp. 5–6; NEMA, No. 24 at p. 19), pointed out that if, as a result of standards, open-construction motors become more expensive than enclosed motors, customers may choose to purchase enclosed motors. DOE's analysis indicates that enclosed small electric motors are, on average, 18-percent more expensive than open motors. For today's final rule, DOE has changed its reference scenario to the −0.25 elasticity scenario for both polyphase and capacitor-start motors. As a result, DOE estimates that, depending on the TSL selected, up to 12 percent of the capacitor-start motor market might migrate to enclosed motors; however, today's rule would result in a reduction of less than 1 percent for the capacitor-start motor market. DOE has retained the inelastic and −0.5 elasticity scenarios as sensitivities.

For the NOPR, DOE developed a cross-elasticity model to forecast the impact of standards on the relative market shares of CSIR and CSCR motors within each combination on motor horsepower and number of poles. DOE used this model to develop two reference cases for the NIA analysis. One case assumed that the market share shift described by the model would be complete by 2015, the date by which manufacturers must comply with the standard, while the other case arbitrarily assumed that the transition would begin in 2015 and be complete by 2025. At the December 17, 2009, Public Meeting, WEG Electric commented that their engineers had examined motor designs necessary to meet the CSIR and CSCR standard levels proposed in the NOPR. Their engineers concluded that motors meeting these efficiencies were manufacturable, but that the designs would include a run capacitor (making them all CSCR motors) that might present another issue for space constrained applications. (WEG, Public Meeting Transcript No. 20.4 at pp. 185–86)

When examining the cross-elasticity between CSIR and CSCR motors, DOE built a demand-based model that assumed that manufacturers would produce the products demanded by the modeled motor customer behavior. This model has significant uncertainty because of the difficulty in predicting the extent and timeframe of the market response to standards and an absence of data on changes in the small electric motor market. However, in view of WEG's comment, DOE has placed greater emphasis on the influence of decisions made by manufacturers on market share. In particular, in cases where DOE's model predicts that the market will result in a complete or nearly complete shift from CSIR to CSCR motors, DOE expects that the market share shift will take place prior to the introduction of standards in 2015 because manufacturers will change their production by that date. Therefore, for today's final rule, DOE has decided to use the scenario in which the market share shift is complete by 2015 as its single reference case for the shipments model.

NEMA disagreed with DOE's statement that the standard levels proposed in the NOPR would "maintain a supply of both categories of motors (CSIR and CSCR) in the single-phase motor market," especially since DOE was estimating that the purchase price of a CSIR motor would increase dramatically over that of the baseline motor. DOE wishes to clarify that the NOPR analysis predicted that nearly all, but not the entire, CSIR market would migrate to CSCR motors under the proposed standard level, TSL 7. DOE's elasticity model for capacitor-start motors incorporates both elasticity to products not covered by today's final rule (enclosed motors) and cross-elasticity between CSIR and CSCR motors. DOE expects that the open-construction CSIR motor market will migrate to open CSCR motors, rather than enclosed CSIR motors, because enclosed CSIR motors are only less expensive than open CSCR motors in the case of relatively inefficient enclosed CSIR motors.

Chapter 9 of the TSD describes the shipments and elasticity models and their results in detail.

3. Space Constraints

As discussed above in Section F, DOE retained its assumption that 20-percent of the small motors are installed in applications that cannot accommodate any size increases. DOE has added 2-percent to the OEM markups in its reference case to account for estimated increases in OEM costs to redesign their products to accommodate larger, more efficient motors, or to purchase a stockpile of replacement motors of the correct size. In addition, in response to the survey results presented by NEMA, DOE has analyzed the impact of increasing the space-constrained fraction from 20 percent to 62 percent and to 95 percent of all motors in a pair of sensitivity case (the additional 2 percent markup is not included in these two scenarios). These sensitivity cases have little impact on the national impacts for capacitor-start motors because at the capacitor-start efficiency levels in today's rule, DOE estimates that 97 percent of the CSIR market will migrate to CSCR motors assuming only 20 percent of the market is space-constrained. Therefore, increasing the assumption of the fraction of space-constrained CSIR motors to 95-percent only affects the 3-percent of the CSIR market that had not already migrated to CSCR motors under DOE's reference case, and has little effect on the estimates of national energy savings. Appendices 9A and 10A of the TSD present the results of this and other sensitivity cases in more detail.

4. Base-Case and Standards-Case Efficiency Distributions

In its analysis for the NOPR, DOE developed base-case and standards-case efficiency distributions based on the distribution of currently available models for which motor catalogs list efficiency. In preparing today's final rule, DOE developed new scaling relationships governing the relationship between the efficiency of each product class to the efficiency of the representative product class for its motor category. These changes resulted in some motor models that met the criteria for one TSL in the NOPR analysis also meeting the criteria for a different TSL in the analysis for today's rule. The resulting base-case efficiency distributions are shown in Table IV.18 DOE's use of a roll-up method to determine the efficiency in the standards-cases is unchanged from the NOPR to the final rule analysis.

TABLE IV.18—BASE CASE EFFICIENCY MARKET SHARES BY MOTOR TYPE

Motor type									
Base Case Market Share (%) by Efficiency Level	Baseline	EL 1	EL 2	EL 3	EL 4	EL 4b	EL 5	EL 6	EL 7
Polyphase	54	6	13	7	12	5	3	0	0
	Baseline	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6	EL 7	EL 8
CSIR	40	30	13	15	2	0	0	0	NA
CSCR	37	33	4	11	11	0	4	0	0

5. Annual Energy Consumption per Unit

In the analysis conducted for the NOPR, DOE developed a model for motor lifetime that incorporates a correlation between annual hours of motor operation and the lifetime of the motor. This correlation was incorporated into the life-cycle cost analysis, which provides average energy use values for the NIA. In the analysis developed for today's final rule, DOE added a correction factor related to this correlation to its NIA model. This correction factor accounts for the higher removal rate of motors with higher annual energy usage levels when compared to motors with lower annual energy usage levels. This relationship is reflected in DOE's lifetime model.

H. Customer Sub-Group Analysis

For the NOPR and today's final rule, DOE analyzed the potential effects of small electric motor standards on two subgroups: (1) Customers with space-constrained applications, and (2) small businesses. For customers with space-constrained applications, DOE used the price and energy use estimates developed for space-constrained designs from the engineering analysis to conduct its life-cycle cost analysis. For small businesses, DOE analyzed the potential impacts of standards by conducting the analysis with different discount rates, because small businesses do not have the same access to capital as larger businesses. DOE estimated that for businesses purchasing small electric motors, the average discount rate for small companies is 4.2 percent higher than the industry average. Due to the higher costs of conducting business, as evidenced by their higher discount rates, the benefits of small electric motor standards for small businesses are estimated to be slightly lower than for the general population of small electric motor owners.

More details on the consumer subgroup analysis can be found in chapter 12 of the final rule TSD.

I. Manufacturer Impact Analysis

DOE conducted a manufacturer impact analysis (MIA) to estimate the financial impact of new energy conservation standards on small electric motors manufacturers, and to calculate the impact of such standards on domestic manufacturing employment and capacity. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the GRIM—an industry-cash-flow model customized for this rulemaking. The GRIM inputs are data characterizing the industry cost structure, investments, shipments, and revenues. The key output is the industry net present value (INPV). Different sets of assumptions (scenarios) produce different results. The qualitative part of the MIA addresses factors such as equipment characteristics, market and equipment trends, as well as an assessment of the impacts of standards on subgroups of manufacturers. DOE outlined its methodology for the MIA in the NOPR. 74 FR 61442–46. The complete MIA for the NOPR is presented in chapter 12 of the NOPR TSD.

For today's final rule, DOE updated the MIA to reflect changes in the outputs of two other key DOE analyses, which feed into the GRIM. In the Engineering Analysis, DOE updated manufacturer production costs (MPCs) and inflated them to 2009$ from 2008$ using the producer price index (PPI). In the NIA, DOE updated its shipment forecasts and efficiency distributions. In turn, DOE updated the GRIM for these new estimates. DOE also inflated its capital and equipment conversion costs to 2009$ from 2008$ using the PPI for Motor and Generator Manufacturing (North American Industry Classification System (NAICS) 335312). Based on these changes, DOE used the GRIM to revise the MIA results from the NOPR.

For direct employment calculations, DOE revised the GRIM to include the U.S. Census information that was revised for 2007.

The following sections discuss interested parties comments on the NOPR MIA. In general, the format is as follows: DOE provides background on an issue that was raised by interested parties, summarizes the interested parties' comment, and discusses whether and how DOE modified its analysis in light of the comments.

1. Capital Conversion and Equipment Conversion Costs

For the NOPR, DOE estimated capital conversion costs for a typical manufacturer using estimates provided by manufacturers and information provided by industry experts. DOE estimated the tooling cost for each separate design at each incremental efficiency level. In addition to these capital expenditures, DOE also estimated equipment conversion expenses such as research and development, testing, and product literature development associated with new energy conservation standards. Because DOE did not receive specific feedback from all manufacturers in the industry, DOE then scaled these costs from a typical manufacturer to account for the entire industry where appropriate.

More specifically, DOE estimated the tooling costs for: (1) Total number of laminations over baseline designs; (2) grade of steel including the use of premium electrical steels; (3) increases in stack length; (4) necessary rewiring; (5) replacement of end rings; and (6) rotor redesigns to use copper (if applicable). For rotor redesigns to use copper, DOE estimated the costs to purchase new presses, new end rings, and additional tooling. For changes to the grade of steel, DOE estimated the costs for punch press dyes. For increases in stack length, DOE estimated the costs of switching more production equipment to accommodate a higher volume of larger sized small electric motors. For necessary rewiring, DOE estimates the cost of crimp tools. For replacement of end rings, DOE estimated the tooling changes for different dimensional changes to the end rings. For increases in laminations, DOE estimated the purchase of presses and tooling for winding machinery.

In written comments, NEMA stated that the capital conversion costs DOE assumed in the NOPR represent only 25- to 30-percent of the capital investments required by manufacturers at the proposed level for CSCR and CSIR. Specifically, NEMA argued that DOE did not account for progressive lam dies, new winding retooling, and other equipment conversion costs (*e.g.,* engineering time, and manufacture and customer agency approvals). (NEMA, No. 24 at p.18) Emerson and A.O. Smith added that such investments needed to reach the proposed standards could cause manufacturers to exit the small electric motors market. (Emerson, No. 28 at p. 1; A.O. Smith, No. 27 at p. 2)

As discussed above, in the NOPR and in today's final rule, DOE accounts for lam dies, new winding retooling and other capital investments at the TSLs that require such tooling. DOE also notes that equipment conversion costs associated with R&D, testing, and other non-capital expenses are included in its equipment conversion costs assumptions. However, in part because the proposed TSL did not require copper rotors or premium electric steel for the CSCR or polyphase markets, DOE cannot reconcile its investment totals at TSL 7 for CSCR and CSIR with the $150 million to $180 million range implied by NEMA's comment. However, in response to other comments, discussed immediately below, DOE has modified its approach to calculating the investments required of a typical manufacturer producing space constrained and non-space constrained motors.

In the NOPR, DOE examined the complete tooling requirements necessary for both space-constrained and non-space constrained designs. That is, DOE first calculated tooling costs assuming shipments were 100-percent space constrained, then calculated tooling costs assuming shipments were 100-percent non-space constrained. Next, DOE calculated the overall tooling costs by weighting these values by the fraction of shipments dedicated to space-constrained and non-space-constrained applications as forecast in the shipments model (20-percent and 80-percent, respectively).

Emerson and NEMA commented that the proposed TSLs require the use of different materials for electrical steel and rotors for different types of motors, which will lead to high capital costs. (Emerson, No. 28 at p. 1; NEMA, No. 24 at p. 18). Baldor Electric commented that manufacturers would lose economies of scope at the proposed TSLs because they would not be able to standardize along one type of steel for different classes of motors. Combined with the high capital costs, particularly for CSIR, this lack of standardization may lead manufacturers to choose to exit portions of the market. (Baldor Electric, Public Meeting Transcript, No. 20.4 at pp. 246–47; Emerson, Public Meeting Transcript, No. 20.4 at pp. 248)

For today's final rule, DOE modified its calculation of investments based on changes to the shipments forecasts related to the split between space-constrained and non-space constrained motors. For many manufacturers, it will not be possible to invest in tooling equipment for space constrained and non-space-constrained motors in a manner that is proportional to the relative market share of the two types of motors. Particularly given the uncertainty with regard to the future market demand and the resulting product mix, DOE believes it is more appropriate to look at the specific investment needs of a typical manufacturer at each TSL for both space constrained and non-space constrained investments for each motor design. For many design options, this leads to investments that are additive—not weighted by shipment share—across space-constrained and non-space constrained motors. Furthermore, DOE does not assume economies of scope in its assumptions regarding capital investments among the three classes of motors. That is, DOE assumed investment in each class independently and assumed they were additive when appropriate across the classes. To be clear, DOE is not modifying the shipments scenarios from the NIA in this scenario. It is modifying the capital investment assumptions to more completely capture the business decisions firms will likely have to make.

As mentioned in the comments referenced above, the business case for making the large capital investments required for certain types of motors becomes less compelling as shipment volumes decrease at higher TSLs (including the TSL established in today's final rule). DOE agrees with Emerson and A.O. Smith that some manufacturers are likely to exit this portion of their market, as is reflected by the shipments analysis, which shows a dramatic migration away from CSIR motors. For space-constrained motors within the CSIR class DOE projects no shipments after standards take effect. To capture this dynamic, at certain TSLs DOE calculated investments to include those associated with the CSCR line and the CSIR non-space constrained line. Without forecasting a significant volume of space-constrained CSIR shipments, it would be inappropriate to assume all manufacturers would invest in the premium electrical steel and copper technologies required to meet the standard level. For further details of the investments, see chapter 12 of the TSD and or section IV.I of today's notice.

In written comment, Emerson further argues that the exit of the market by certain manufacturers in response to amended standards would reduce competition and domestic employment. (Emerson, No. 28 at p. 1)

As previously discussed, DOE believes that some manufacturers could exit the small electric motors market segment covered by this rule in response to amended standards. However, it should be noted that covered small electric motors comprise only a small portion of overall motor sales for these companies. At the efficiency levels established by this final rule, DOE's analysis and manufacturer interviews indicated that the majority of manufacturers would likely remain in the small electric motors market following the implementation of amended standards. Additionally, DOE learned that a number of covered motors are already manufactured overseas and that foreign competition continues to make inroads into the covered motors segment. As for a potential reduction in domestic employment, DOE's analysis indicates that even with the potential departure by some manufacturers from segments of the small electric motors market, overall direct employment will remain relatively constant due to the increased labor content of more efficient motors.

2. Manufacturer Selling Prices

In the NOPR, DOE calculated weighted manufacturer selling prices (MSPs) based on a shipments split of 20-percent space-constrained and 80-percent non-space constrained motors. However, the shipments analysis in today's final rule models a mix of space-constrained and non-space constrained motors that varies by TSL. As such, DOE has updated its MSPs in the GRIM using the same shipment weights used in the shipments analysis at each TSL. For further information on the shipment analysis, see chapter 9 of the TSD.

3. Markup Scenarios

In the NOPR, DOE analyzed two markup scenarios in the MIA: the preservation-of-return-on-invested-capital scenario and the preservation-of-operating-profits scenario. These scenarios reflected the upper and lower bounds of industry profitability, respectively. In written comments, NEMA contended that DOE had inappropriately discounted the likelihood of the lower-bound scenario occurring when it stated its belief that design changes necessary for TSL 5 would not force all manufacturers to significantly redesign all of their polyphase small electric motors and production processes. (NEMA, No. 24 at p. 16)

In response, DOE first clarifies that it did not and is not assigning probabilities to the preservation of operating profit scenario or the preservation of return on invested capital scenario. The two markup scenarios are meant to estimate the range of potential impacts. Second, in the NOPR, and for this final rule, DOE accounted for equal investments in the GRIM under both the lower and upper bound profitability scenarios. Therefore, changes in markup assumptions—not changes in investments—drive the profitability difference between the scenarios. For example, in this final rule DOE assumes industry wide capital conversion investments for TSL 5 of approximately $7.1 million for polyphase small motors in each markup scenario. Thus, the likelihood of either scenario occurring with respect to the other is independent of the investment level assumed in the GRIM.

NEMA further argued that in discounting the likelihood of the lower-bound profitability scenario, DOE ignored cost increases and equipment investments associated with specialty steels and copper rotors necessary for polyphase motors to meet TSL 5. (NEMA, No. 24 at p. 16).

DOE disagrees with NEMA's suggestion that TSL 5 requires copper rotors and premium electrical steels (such as Hiperco) for polyphase motor designs. DOE continues to believe, as discussed in the Engineering Analysis, that both space-constrained and non-space constrained motors can achieve TSL 5 through the use of additional laminations. As discussed above, DOE included the attendant costs of the additional lams, steel-grade lam dies, end ring investment for both space constrained and non-space constrained motors, and a crimping tool. No investments for copper rotors design were assumed at TSL 5 for polyphase motors. NEMA ostensibly agreed that the proposed TSL did not require copper rotors when it commented that the "proposed standards for polyphase and CSCR small electric motors are based on the use of cast aluminum rotors." (NEMA, No. 24 at p. 18)

Baldor and NEMA stated that the proposed levels of efficiency in the NOPR are based on the assumption that manufacturers must use three different types of electrical steel including 24M19, 29M15, and Hiperco 50. According to NEMA, each type of electrical steel requires different methods for processing the rolled steel into laminations acceptable for use in electric motors. NEMA further adds that to remain competitive, manufacturers must minimize the number of different types of materials and processes used in a manufacturing facility and suggested that DOE adopt a standard level that is achievable with the same electrical steel for all motor categories. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 246–47; NEMA, No. 24 at p. 17.

In the NOPR, DOE predicted that manufacturers would achieve the proposed efficiency levels with three types of steels including 24M19, 29M15, and Hiperco 50. During manufacturer interviews, DOE requested information on the type of processes needed to achieve each efficiency level, as well as the costs associated with each process. In regard to types of steel used and the cost of switching from one steel process to another, all interviewed manufacturers reported the use of additional lamination dies to accommodate the different thickness of steel. Accordingly, DOE included additional lamination dies per manufacturer in its estimates whenever a change of steel grade was applicable, as described in chapter 12 of the TSD. The cost per die was derived based on manufacturer's estimates and information provide by industry experts. See chapter 12 of the TSD for additional details on each type of investment at each efficiency level including all design options analyzed. DOE acknowledges that manufacturers in general, regardless of industry, reduce the number of manufacturing processes to lower costs and thus increase margins. For today's amended standards, DOE does not prescribe designs nor how manufacturers achieve each efficiency level. Because DOE accounts for all the relevant costs associated with using the various steel types in both the engineering analysis and MIA, it believes it accurately captures the potential costs to manufacturers in using different steel grades. Therefore, DOE believes that potential burden on manufacturers has been accounted for in today's final rule.

In response to the NOPR, NEMA commented that manufacturers are not aware of any other pathways to achieving the proposed efficiencies for space constrained CSIR motors but the ones analyzed in this rulemaking. NEMA argued that because there are no other pathways to achieving the proposed efficiencies, DOE is dictating that manufacturers use different electrical steels and different materials for the rotor construction in order to meet the proposed efficiencies for the three motor types. (NEMA, No. 24 at p. 16).

DOE acknowledges that TSL 7 reflects the max-tech efficiency levels for CSIR; as such, DOE estimates manufacturers may have to employ both copper rotors and premium electrical steels to achieve that level. In the engineering analysis, which subsequently carries over to the MIA, DOE models a pathway for space-constrained and non-space constrained application motors with the use of these technologies. However, in setting new standards for small electric motors, as described in today's notice, DOE selects efficiency levels for each motor category and does not prescribe designs.

4. Premium Electrical Steels

In response to the NOPR, Regal-Beloit and NEMA argue that DOE proposed an efficiency level for motors that would force manufacturers to utilize specific electrical steels that are in scarce supply. NEMA further argues that DOE should not establish standards that require manufacturers to use materials that are supply constrained. NEMA stated that a market analysis for the scarce materials is needed to prove otherwise. (Regal-Beloit, Public Meeting Transcript, No. 20.4 at pp. 245–46; NEMA, No. 24 at pp. 17–18). Similarly, NEMA asked DOE to consider any spillover effects on the supply of steel for medium electric motors. (NEMA, No. 24 at p.18)

DOE acknowledges the concern that Hiperco may be supply constrained in the short run should manufacturers pursue that design option. As such, to investigate these steel concerns, DOE contacted Hiperco 50 steel and other premium electrical steel suppliers and used steel manufacturer's annual reports to examine past shipment volumes of premium steels. DOE then compared estimated shipments of these steel to volumes that would be necessary for motors if should the base case mix of space constrained and non space constrained persist at all TSLs. Based on that analysis, DOE estimates that the entire small electric motor industry would need approximately 1.3 million pounds of premium steels (such as Hiperco) in 2015 for the level established by this rule. For the steel manufacturer that had available annual reports, the estimated pounds of premium steels needed by the motor manufacturers constitutes less than one percent of total steel shipments for 2008. How much of that volume reflects premium steels is not publically available. However, annual reports for the publicly traded manufacturer of premium steels suggest that shipments of these steels have decreased by close to 20 percent from the previous year, suggesting this manufacturer has over capacity and the ability to meet the possible increase in demand of premium steels. Given the time lag for the market to prepare for the compliance date of the standard and the low volumes of motors that may require premium steel, DOE believes that the proposed standard level will not threaten the supply of the steel, even if manufacturers decide to pursue this option. DOE's analysis does not forecast shipments of motors that require premium steel and, as a result, DOE does not believe that, based on the available data, there will be a significant impact ("spillover") on the medium motor market due to higher demand of the material in the small motor market.

NEMA stated that the proposed efficiency level mandates the use of copper rotor casting technology along with aluminum rotor casting technology in the same manufacturing facilities. NEMA argued that copper rotor casting technology is in its infancy and is not a fully developed process that can be adapted in all present facilities where small electric motors are built. Additionally, NEMA and A.O. Smith are concerned that copper rotor casting technology has significant safety issues related to the high temperatures needed for the process. According to NEMA, manufacturers may be required to use a few outside companies that may not have sufficient capacity to meet all of the copper rotor volume required to meet the needs for all of the CSIR small electric motors. Additionally, NEMA argues that standards must be based on the use of aluminum rotors only. (A.O. Smith, No. 26 at p. 2; NEMA, No. 24 at p. 18)

DOE acknowledges manufacturers' concerns related to the processes for die-casting copper rotors. In its analysis, DOE accounted for the increased capital requirements as they would likely occur depending on the efficiency level and motor type at issue. As stated in the NOPR, the use of copper rotors could lead manufacturers to outsource their die-casting processes, as indicated by NEMA in its comments. (74 FR 61467–68). Ultimately, this is a business decision. In its engineering analysis for this rulemaking, DOE included a copper rotor design at efficiency level 6 or above for polyphase motors, efficiency level 5 or above for CSIR motors, and efficiency level 4 or above for CSCR motors. The inclusion of copper rotor designs at each efficiency level varies depending on the necessary efficiency and space constraints. However, DOE reiterates that different manufacturers will not necessarily employ the same design options to make their motors achieve higher efficiency levels where DOE estimates copper rotors may be used, with the exception of the max-tech efficiency levels. In fact, for the NOPR and today's final rule, DOE has analyzed motors up to efficiency level 5 for CSIR motors and efficiency level 6 for CSCR motors that use an aluminum die-cast rotor.

J. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a proposed standard. Employment impacts include direct and indirect impacts. Direct employment impacts are changes in the number of employees for manufacturers of equipment subject to standards, their suppliers, and related service firms. The MIA addresses these impacts.

Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, due to: (1) Reduced spending by end users on energy (electricity, gas (including liquefied petroleum gas), and oil); (2) reduced spending on new energy supply by the utility industry; (3) increased spending on the purchase price of new equipment; and (4) the effects of those three factors throughout the economy. DOE expects the net monetary savings from standards to be redirected to other forms of economic activity. DOE also expects these shifts in spending and economic activity to affect the demand for labor in the short term, as explained below.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare employment statistics in different economic sectors, which are compiled and published by the Bureau of Labor Statistics (BLS). The BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy. There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital intensive and less labor intensive than other sectors. (See Bureau of Economic Analysis, *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System* (RIMS II), Washington, DC, U.S. Department of Commerce, 1992.) Efficiency standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (*i.e.,* the utility sector) to more labor-intensive sectors (*e.g.,* the retail and manufacturing sectors). Thus, based on the BLS data alone, DOE believes net national employment will increase due to shifts in economic activity resulting from standards for small electric motors.

In developing the NOPR, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies (ImSET).[16] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" (I–O) model designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among 188 sectors most relevant to industrial, commercial, and residential building energy use. For today's final rule, DOE has made no change to its method for estimating employment impacts. For further details, see chapter 15 of the final rule TSD.

K. Utility Impact Analysis

The utility impact analysis estimates the change in the forecasted power generation capacity for the Nation that would be expected to result from adoption of new standards. For the NOPR and today's final rule, DOE calculated this change using the NEMS–BT computer model. NEMS–BT models certain policy scenarios such as the effect of reduced energy consumption by fuel type. The analysis output provides a forecast for the needed generation capacities at each TSL. While DOE was able to use the forecasts from the *AEO 2010* Early Release for energy prices and macroeconomic indicators, the NEMS–BT model corresponding to this case is not yet available. The estimated net benefit of the standard in today's final rule is the difference between the forecasted generation capacities by NEMS–BT and the *AEO 2009* April Release Reference Case. DOE obtained the energy savings inputs associated with efficiency improvements to small electric motors from the NIA. These inputs reflect the effects of both fuel (natural gas) and electricity consumption savings. Chapter 14 of the final rule TSD presents results of the utility impact analysis.

NEEA/NPCC claimed that only a small fraction of the total costs of avoided generation are currently counted in any rulemaking. They note that DOE uses the NEMS–BT model to calculate the avoided generation facilities produced by a standard and that the cost of construction and operation of these plants are rolled into average rates that all electricity consumers must pay, not just those purchasing the product in question. As a result, they believe that the NPV difference in the value of total electricity sales between the NEMS–BT forecasts with and without the standards may serve as a reasonable proxy for the economic value to all electricity consumers of the proposed standards. The difference value of total retail electricity sales is necessary to capture all of the cost of the avoided generation, since as noted above, users of small general purpose motors impacted by the standard will pay only a portion of those cost at embedded rates. (NEEA/NPPC, No. 27, p. 7–8)

DOE investigated the possibility of estimating the impact of specific standard levels on electricity prices in its rulemaking for general service fluorescent lamps and incandescent reflector lamps. (See U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy: Energy Conservation Standards for General Service Fluorescent Lamps and Incandescent Reflector Lamps; Proposed Rule, 74 FR 16920, 16978–979 (April 13, 2009).) It concluded that caution is warranted in reporting impacts of appliance standards on electricity prices due to the complexity of the power industry (including the variety of utility regulation in the U.S.) and the relatively small impact of equipment efficiency standards on demand. In addition, electricity price reductions cannot be viewed as equivalent to societal benefits because part of the price reductions result from transfers from producers to consumers. The electric power industry is a complex mix of fuel suppliers, producers, and distributors. While the distribution of electricity is regulated everywhere, its institutional structure varies, and upstream components are complex. Because of the difficulty in accurately estimating electricity price impacts, and the uncertainty with respect to transfers from producers to consumers, DOE did not estimate the value of potentially reduced electricity costs for all consumers associated with standards for small electric motors.

L. Environmental Assessment

Pursuant to the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 *et seq.*) 42 U.S.C. 6295(o)(2)(B)(i)(VI), DOE prepared a draft environmental assessment (EA) of the potential impacts of the standards for small electric motors in today's final rule, which it has included as chapter 15 of the TSD. DOE found that the environmental effects associated with the standards for small electric motors were not significant. Therefore, DOE is issuing a Finding of No Significant Impact (FONSI), pursuant to NEPA, the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with NEPA (10 CFR part 1021). The FONSI is available in the docket for this rulemaking.

In the EA, DOE estimated the reduction in power sector emissions of CO_2, NO_X, and Hg using the NEMS–BT computer model. In the EA, NEMS–BT is run similarly to the AEO NEMS, except that small electric motor energy use is reduced by the amount of energy saved (by fuel type) due to the TSLs. The inputs of national energy savings come from the NIA analysis; the output is the forecasted physical emissions. The estimated net benefit of the standard in today's final rule is the difference between the forecasted emissions by NEMS–BT at each TSL and the *AEO 2009* April Early Release Reference Case. NEMS–BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects.

DOE has determined that sulfur dioxide (SO_2) emissions from affected Electric Generating Units (EGUs) are subject to nationwide and regional emissions cap and trading programs that create uncertainty about the impact of energy conservation standards on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for all affected EGUs. SO_2 emissions from 28 eastern States and the District of Columbia (D.C.) are also limited under the Clean Air Interstate Rule (CAIR, published in the **Federal Register** on May 12, 2005; 70 FR 25162 (May 12, 2005), which creates an allowance-based trading program that will gradually replace the Title IV program in those States and D.C. (The recent legal history surrounding CAIR is discussed below.) The attainment of the emissions caps is flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Energy conservation standards

---

[16] More information regarding ImSET is available online at: *http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15273.pdf.*

could lead EGUs to trade allowances and increase SO_2 emissions that offset some or all SO_2 emissions reductions attributable to the standard. DOE is not certain that there will be reduced overall SO_2 emissions from the standards. The NEMS–BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2. The above considerations prevent DOE from estimating SO_2 reductions from standards at this time.

Even though DOE is not certain that there will be reduced overall emissions from the standard, there may be an economic benefit from reduced demand for SO_2 emission allowances. Electricity savings from standards decrease the generation of SO_2 emissions from power production, which can lessen the need to purchase emissions allowance credits, and thereby decrease the costs of complying with regulatory caps on emissions.

Much like SO_2 emissions, NO_X emissions from 28 eastern States and the District of Columbia (D.C.) are limited under the CAIR. Although CAIR has been remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit), it will remain in effect until it is replaced by a rule consistent with the Court's July 11, 2008, opinion in *North Carolina* v. *EPA.* 531 F.3d 896 (D.C. Cir. 2008); see also *North Carolina* v. *EPA,* 550 F.3d 1176 (D.C. Cir. 2008). These court positions were taken into account in the analysis conducted for the NOPR and in today's final rule. Because all States covered by CAIR opted to reduce NO_X emissions through participation in cap and trade programs for electric generating units, emissions from these sources are capped across the CAIR region.

In the 28 eastern States and D.C. where CAIR is in effect, DOE's forecasts indicate that no NO_X emissions reductions will occur due to energy conservation standards because of the permanent cap. Energy conservation standards have the potential to produce an economic impact in the form of lower prices for NO_X emissions allowances, if their impact on electricity demand is large enough. However, DOE has concluded that the standards in today's final rule will not have such an effect because the estimated reduction in electricity demand in States covered by the CAIR cap would be too small to affect allowance prices for NO_X under the CAIR.

New or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by the CAIR. DOE used the NEMS–BT to forecast emission reductions from the small electric motor standards in today's final rule.

Similar to emissions of SO_2 and NO_X, future emissions of Hg would have been subject to emissions caps. The Clean Air Mercury Rule (CAMR) would have permanently capped emissions of mercury from new and existing coal-fired plants in all States beginning in 2010 (70 FR 28606). However, the CAMR was vacated by the D.C. Circuit in its decision in *New Jersey* v. *Environmental Protection Agency,* 517 F 3d 574 (D.C. Cir. 2008) Thus, DOE was able to use the NEMS–BT model to estimate the changes in Hg emissions resulting from the proposed rule.

NEMA noted that the TSD for the NOPR provides a qualitative assessment of upstream emissions (*i.e.,* emissions from energy losses during coal and natural gas production) in addition to quantifying the emissions at power plants. NEMA states that if DOE is making an assessment of upstream emissions, it should also account for the emissions related to the construction of more efficient small electric motors, such as those related to the mining of additional raw materials, processing of the additional materials, transportation of the additional materials, and the manufacture of the motor itself. (NEMA, No. 24 at p. 22)

As noted in the TSD for the NOPR, DOE developed qualitative estimates of affects on upstream fuel-cycle emissions because NEMS–BT does a thorough accounting only of emissions at the power plant due to downstream energy consumption. In other words, NEMS–BT does not account for upstream emissions. Therefore, the Environmental Assessment for today's final rule reports only power plant emissions.

When setting performance standards for industrial equipment, EPCA prescribes that an energy efficiency standard be a minimum level of energy efficiency or maximum allowable energy use. EPCA defines the term "energy use" within this limited context for commercial and industrial equipment as being the quantity of energy directly consumed by an article of industrial equipment at the point of use. See 42 U.S.C. 6311(4). In ascertaining the appropriate level of efficiency, DOE must balance seven criteria to develop a standard that is economically justified and technically feasible. While DOE believes that the majority of the energy and other costs associated with the manufacturing of more efficient motors are reflected in its analysis, some of the costs associated with certain environmental impacts and other externalities are not incorporated. Even though DOE estimates and considers the impacts of standards on the energy and emissions associated with electricity generation, it does not specifically assess the energy and emissions associated with the manufacturing of more efficient motors or the manufacturing of the equipment required to produce and supply energy. The main reason for not assessing such indirect costs and benefits is the absence of a reliable and comprehensive method of doing so. Such an assessment would require accounting for a variety of variables, including the energy required to build and service the energy production, generation, and transmission infrastructure needed to deliver the energy, as well as accounting for the energy expended to manufacture energy-using equipment.

M. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this final rule, DOE considered the estimated monetary benefits likely to result from the reduced emissions of CO_2 and other pollutants that are expected to result from each of the Trial Standard Levels considered. This section summarizes the basis for the estimated monetary values used for each of these emissions and presents the benefits estimates considered.

For today's final rule, DOE is relying on a new set of values for the social cost of carbon SCC that were recently developed by an interagency process. A summary of the basis for these new values is provided below, and a more detailed description of the methodologies used is provided as an Annex to Chapter 15 of the Technical Support Document.

1. Social Cost of Carbon

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

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change.

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

The interagency group selected four SCC values for use in regulatory analyses. Three values are based on the average SCC from three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95th percentile SCC estimate across all three models at a 3 percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution.

TABLE IV.19—SOCIAL COST OF CO_2, 2010–2050

[In 2007 dollars]

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

a. Monetizing Carbon Dioxide Emissions

The "social cost of carbon" (SCC) is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the social cost of carbon are provided in dollars per metric ton of carbon dioxide.[17]

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A recent report from the National Academies of Science (*Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.* National Academies Press. 2009) points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions. Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to make it possible for agencies to incorporate the social benefits from reducing carbon dioxide emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions. Most Federal regulatory actions can be expected to have marginal impacts on global emissions.

For such policies, the benefits from reduced (or costs from increased) emissions in any future year can be estimated by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years. This approach assumes that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global carbon dioxide emissions. For policies that have a large (non-marginal) impact on global cumulative emissions, there is a separate question of whether the SCC is an appropriate tool for calculating the benefits of reduced emissions; we do not attempt to answer that question here.

An interagency group convened on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key inputs and assumptions in order to generate SCC estimates. Agencies that actively participated in the interagency process include the Environmental Protection Agency, and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury. This process was convened by the Council of Economic Advisers and the Office of Management and Budget, with active participation and regular input from the Council on Environmental Quality,

---

[17] In this document, DOE presents all values of the SCC as the cost per metric ton of CO_2 emissions. Alternatively, one could report the SCC as the cost per metric ton of carbon emissions. The multiplier for translating between mass of CO_2 and the mass of carbon is 3.67 (the molecular weight of CO_2 divided by the molecular weight of carbon = 44/12 = 3.67).

National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions that are grounded in the existing literature. In this way, key uncertainties and model differences can more transparently and consistently inform the range of SCC estimates used in the rulemaking process.

The interagency group selected four SCC estimates for use in regulatory analyses. For 2010, these estimates are $5, $21, $35, and $65 (in 2007 dollars). The first three estimates are based on the average SCC across models and socio-economic and emissions scenarios at the 5, 3, and 2.5 percent discount rates, respectively. The fourth value is included to represent the higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. For this purpose, we use the SCC value for the 95th percentile at a 3 percent discount rate. The central value is the average SCC across models at the 3 percent discount rate. For purposes of capturing the uncertainties involved in regulatory impact analysis, we emphasize the importance and value of considering the full range. These SCC estimates also grow over time. For instance, the central value increases to $24 per ton of CO_2 in 2015 and $26 per ton of CO_2 in 2020. See Appendix A of the Annex to Chapter 15 of the Technical Support Document for the full range of annual SCC estimates from 2010 to 2050.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improve over time. Specifically, we have set a preliminary goal of revisiting the SCC values within two years or at such time as substantially updated models become available, and to continue to support research in this area. In the meantime, we will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Social Cost of Carbon Values Used in Past Regulatory Analyses

To date, economic analyses for Federal regulations have used a wide range of values to estimate the benefits associated with reducing carbon dioxide emissions. In the final model year 2011 CAFE rule, the Department of Transportation (DOT) used both a "domestic" SCC value of $2 per ton of CO_2 and a "global" SCC value of $33 per ton of CO_2 for 2007 emission reductions (in 2007 dollars), increasing both values at 2.4 percent per year. It also included a sensitivity analysis at $80 per ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per ton CO_2 (in 2006 dollars) for 2011 emission reductions (with a range of $0–$14 for sensitivity analysis), also increasing at 2.4 percent per year. A regulation finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per ton CO_2 for 2007 emission reductions (in 2007 dollars). In addition, EPA's 2008 Advance Notice of Proposed Rulemaking for Greenhouse Gases identified what it described as "very preliminary" SCC estimates subject to revision. EPA's global mean values were $68 and $40 per ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006 dollars for 2007 emissions).

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted.

The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006 dollars) of $55, $33, $19, $10, and $5 per ton of CO_2. The $33 and $5 values represented model-weighted means of the published estimates produced from the most recently available versions of three integrated assessment models—DICE, PAGE, and FUND—at approximately 3 and 5 percent discount rates. The $55 and $10 values were derived by adjusting the published estimates for uncertainty in the discount rate (using factors developed by Newell and Pizer (2003)) at 3 and 5 percent discount rates, respectively. The $19 value was chosen as a central value between the $5 and $33 per ton estimates. All of these values were assumed to increase at 3 percent annually to represent growth in incremental damages over time as the magnitude of climate change increases.

These interim values represent the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules and were offered for public comment in connection with proposed rules, including the joint EPA–DOT fuel economy and CO_2 tailpipe emission proposed rules.

c. Approach and Key Assumptions

Since the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates considered for this final rule. Specifically, the group considered public comments and further explored the technical literature in relevant fields.

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Academy of Science (2009) points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of concerns and problems that should be addressed by the research community, including research programs housed in many of the agencies participating in the interagency process to estimate the SCC.

The U.S. Government will periodically review and reconsider estimates of the SCC used for cost-benefit analyses to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling. In this context, statements recognizing the limitations of the analysis and calling for further research take on exceptional significance. The interagency group offers the new SCC values with all due humility about the uncertainties embedded in them and with a sincere promise to continue work to improve them.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the most recent values identified by the interagency process, adjusted to 2009$ using the standard GDP deflator values for 2008 and 2009. For each of the four cases specified, the values for emissions in 2010 used were approximately $5, $22, $36, and $67 per metric ton avoided (values expressed in 2009$). To monetize the CO_2 emissions reductions expected to result from amended standards for small electric motors in 2015–2045, DOE used the values identified in Table A1 of the "Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866," which is reprinted as an Annex to Chapter 15 of the Technical Support Document, appropriately escalated to 2009$.

2. Monetary Values of Non-Carbon Emissions

As previously stated, DOE's analysis assumed the presence of nationwide emission caps on SO_2 and caps on NO_X emissions in the 28 States covered by CAIR. In the presence of these caps, the NEMS–BT modeling system that DOE used to forecast emissions reduction indicated that no physical reductions in power sector emissions would occur (although there remains uncertainty about whether physical reduction of SO_2 will occur), but that the standards could put slight downward pressure on the prices of emissions allowances in cap-and-trade markets. Estimating this effect is very difficult because factors such as credit banking can change the trajectory of prices. From its modeling to date, DOE is unable to estimate a benefit from energy conservation standards on the prices of emissions allowances at this time. See the environmental assessment in the final rule TSD for further details.

DOE also investigated the potential monetary benefit of reduced NO_X and Hg emissions from the TSLs it considered. As noted above, new or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by CAIR, in addition to the reduction in site NO_X emissions nationwide. DOE estimated the monetized value of NO_X emissions reductions resulting from each of the TSLs considered for today's final rule based on environmental damage estimates from the literature. Available estimates suggest a very wide range of monetary values for NO_X emissions, ranging from $370 per ton to $3,800 per ton of NO_X from stationary sources, measured in 2001$ (equivalent to a range of $447 to $4,591 per ton in 2009$). Refer to the OMB, Office of Information and Regulatory Affairs, "2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities," Washington, DC, for additional information.

For Hg emissions reductions, DOE estimated the national monetized values resulting from the TSLs considered for today's rule based on environmental damage estimates from the literature. The impact of mercury emissions from power plants on humans is considered highly uncertain. However, DOE identified two estimates of the environmental damage of Hg based on estimates of the adverse impact of childhood exposure to methyl mercury on IQ for American children, and subsequent loss of lifetime economic productivity resulting from these IQ losses. The high-end estimate of $1.3 billion per year in 2000$ (which works out to $33.7 million per ton emitted per year in 2009$) is based on an estimate of the current aggregate cost of the loss of IQ in American children that results from exposure to Hg of U.S. power plant origin.[18] DOE's low-end estimate of $0.66 million per ton emitted in 2004$ ($0.764 million per ton in 2008$) was derived from an evaluation of mercury control that used different methods and assumptions from the first study, but was also based on the present value of the lifetime earnings of children exposed to Hg.[19]

V. Discussion of Other Comments

Since DOE opened the docket for this rulemaking, it has received more than 20 comments from a diverse set of parties, including manufacturers and their representatives, States, energy conservation advocates, and electric utilities. Section IV of this preamble discusses comments DOE received on the analytical methodologies it has used in this rulemaking. Additional comments DOE received in response to the NOPR addressed the information DOE used in its analyses, results of and inferences drawn from the analyses, impacts of standards, the merits of the different TSLs and standards options DOE considered, other issues affecting adoption of standards for small electric motors, and the DOE rulemaking process. DOE addresses these comments below.

A. Trial Standard Levels

In selecting the proposed energy conservation standards for both classes of small electric motors for consideration in today's final rule, DOE started by examining the standard levels with the highest energy savings, and determined whether those levels were economically justified. If DOE found those levels not to be justified, DOE considered TSLs sequentially lower in energy savings until it reached the level with the greatest energy savings that was both technologically feasible and economically justified. In the NOPR document, DOE proposed TSL 5 for polyphase motors and TSL 7 for single-phase motors.

Emerson commented that while it is in favor of efficiency standards in general, it is not in favor of the proposed standards for small electric motors. This is because it diverts a manufacturer's attention and funding away from other energy efficient technologies that it is developing, which are actually being used to replace these covered motors. In its written comments, Emerson asked that DOE not regulate small electric motors. (Emerson, Public Meeting Transcript, No. 20.4 at pp. 267–69; Emerson, No. 28 at p. 3) Underwriters Laboratories (UL) submitted written comments stating that over the past five years the majority of fractional horsepower motors it has seen have been electronically commutated motors (ECM), which reach efficiency levels in the high 90 percent range. However, UL continued on to state that DOE should not set efficiency levels for the covered motors that reinforce the status quo, but rather encourage greater efficiency, which it states the proposed standard levels would not achieve. (UL, No. 21 at pp. 1–2) QM Power added that high standards would cause alternative technologies to be sold in higher volumes and as a result bring their relative prices down. (QM Power, Public Meeting Transcript, No. 20.4 at pp. 290–91) Finally, a joint comment submitted by PG&E, SCE, SCGC, and SDGE indicated support for the standard levels chosen by DOE in the NOPR phase. (Joint Comment, No. 23 at p. 2)

DOE notes that it is legally required to issue standards for small electric motors and reiterates that it selects the standard level with the highest energy savings that is both technologically feasible and economically justified. The standards set in today's final rule represent the efficiency level with the greatest energy savings that is both technologically feasible and economically justified. While other classes of motors, such as electronically commutated motors (ECMs) may offer higher efficiency levels than the levels selected by DOE in today's rulemaking,

---

[18] Trasande, L., *et al.*, "Applying Cost Analyses to Drive Policy that Protects Children," 1076 Ann. N.Y. Acad. Sci. 911 (2006).

[19] Ted Gayer and Robert Hahn, "Designing Environmental Policy: Lessons from the Regulation of Mercury Emissions," Regulatory Analysis 05–01, AEI-Brookings Joint Center for Regulatory Studies, Washington, DC (2004). A version of this paper was published in the *Journal of Regulatory Economics* in 2006. The estimate was derived by back-calculating the annual benefits per ton from the net present value of benefits reported in the study.

DOE must consider and evaluate the covered motors when selecting efficiency levels.

NEMA commented that a statement in the NOPR indicated that the proposed polyphase standard was closely aligned with the EPACT 1992 efficiency levels. NEMA was confused by this statement because the levels proposed in the NOPR were greater than the EPACT 1992 levels. (NEMA, No. 24 at p. 22) NEMA also stated that the NOPR indicates "TSL 7 corresponds to the NEMA Premium equivalent efficiency for CSCR motors," (74 FR 61469) but that there is no defined level of NEMA Premium efficiency for any ¾-horsepower, four-pole motor. (NEMA, No. 24 at p. 24)

DOE would like to clarify these statements. In the NOPR, DOE stated "DOE proposes a standard for polyphase small motors * * * that is closely aligned with the EPACT 1992 standard for medium motors." 74 FR 61419–20. This text should have read that DOE proposed efficiency levels (TSL 5) for polyphase small electric motors are closely aligned with the NEMA Premium efficiency levels for 1-horsepower, four-pole medium electric motors. This statement was restated and asserted at other times throughout the NOPR document and DOE regrets any confusion it may have caused.

In this final rule, due to revisions in the baseline efficiencies, modeling of higher efficiency motor designs, and scaling analysis, TSL 4b now most closely aligns with NEMA Premium efficiency levels (and medium electric motor standards) for motors greater than 1 horsepower. DOE recognizes the value to manufacturers of having a single efficiency requirement for similar models of motors. Because some efficiency values associated with TSL 4b are slightly higher than the NEMA Premium efficiency requirements, DOE is reducing these values to harmonize with NEMA Premium efficiency. DOE does not anticipate that this reduction will result in a significant loss of energy savings. For this reason, DOE is implementing this change after conducting its analyses and in the final stage of standard-setting. For further detail on the polyphase efficiencies analyzed for TSL 4b, see chapter 5 of the TSD.

DOE also understands that NEMA Premium levels exist neither for any ¾-horsepower, four-pole motors nor single-phase. DOE drew this comparison to NEMA Premium because manufacturers had recommended, during the preliminary analysis, that DOE examine such a standard level for its CSCR motor with the aforementioned ratings, and the manufacturers used that terminology when providing their recommendations to DOE.

In addition, Regal-Beloit and A.O. Smith commented that a CSCR motor should be able to generate a higher efficiency level than a comparable CSIR motor, but pointed out that DOE's NOPR proposed efficiency levels would require CSIR motors to have higher efficiencies than corresponding CSCR motors. (Regal-Beloit, Public Meeting Transcript, No. 20.4 at pp. 107–08; A.O. Smith, Public Meeting Transcript, No. 20.4 at p. 108) NEMA also questioned the validity of DOE's scaling analysis, citing the fact that the proposed CSIR levels were in fact slightly higher than the proposed CSCR levels. (NEMA, No. 24 at pp. 9–10) They added that though DOE indicated that the proposed efficiency levels for CSIR and CSCR were the same, they were not exactly equivalent. (NEMA, No. 24 at pp. 25–26)

DOE would like to clarify that it was not alleging that CSCR motors cannot be as efficient as CSIR motors. DOE is aware that CSCR motors are inherently more efficient than CSIR motors, as indicated by the NOPR and final rule's max-tech efficiency levels for these two types of motors. DOE had proposed a standard level where the pairing of efficiency standards for both motor categories were approximately equivalent. DOE analyzed several TSLs for single-phase motors, some of which result in higher minimum efficiency requirements for CSCR motors than CSIR motors. However, as discussed in section VI.D, TSL 7, which adopt levels for CSIR and CSCR that are approximately equivalent, has been determined to the level that achieves the maximum energy savings, while being technologically feasible and economically justified.

In consideration of the comments received regarding the exact equivalence of the CSIR and CSCR levels, DOE believes it appropriate to harmonize the levels of the two categories of motors for the standard selected in today's final rule. Because the TSL 7 represents the maximum technologically feasible level for CSIR motors, DOE has opted to lower these levels to equal the CSCR standard levels for TSL 7. DOE does not expect that this shift in CSIR motor efficiency will have a significant impact on the comparative economics or energy savings of the varying TSLs, and thus will not change the decision of which TSL to adopt. For this reason, DOE has decided to apply this efficiency shift at the standard-setting phase of the analyses. For further detail on the CSIR efficiencies analyzed for TSL 7, see chapter 5 of the TSD.

B. Enforcement

Thus far in the rulemaking process, DOE has not laid out any plans for the enforcement of efficiency standards for small electric motors. Typically, efficiency standard rulemakings do not outline a plan for enforcement, which occurs independently from the rulemaking process.

DOE received a number of comments pertaining to the enforcement of today's final rule and what steps DOE will take to enforce these efficiency standards. Regal-Beloit, A.O. Smith, and WEG all expressed the concern that some manufacturers, most notably from overseas, may not comply with the standards, and they wished to see a plan for how these standards would be enforced. (Regal-Beloit, Public Meeting Transcript, No. 20.4 at pp. 182–83; A.O. Smith, No. 26 at p. 3; WEG, Public Meeting Transcript, No. 20.4 at pp. 261–66) A joint comment submitted by PG&E, SCE, SCGC, and SDGE also stressed the importance of developing a plan for enforcement. (Joint Comment, No. 23 at p. 2) Emerson agreed with the joint commenters that a lack of enforcement would put the domestic manufacturers who comply with today's standard at a disadvantage in the marketplace because they would incur the costs necessary to increase efficiency. (Joint Comment, No. 23 at p. 2; Emerson, No. 28 at p. 2)

Additionally, DOE received comments offering suggestions for how to improve the enforcement of today's rule. Both Regal-Beloit commented that DOE should require a marking on the motor to indicate that it complies with the efficiency standard, such as is done with NEMA Premium motors. (Regal-Beloit, Public Meeting Transcript, No. 20.4 at pp. 229–30) Regal-Beloit also suggested that DOE perform some sort of audit of the motors on the market to ensure compliance with today's rule. (Regal-Beloit, Public Meeting Transcript, No. 20.4 at p. 230) Finally, Earthjustice requested that today's final rule outline a specific date on which DOE will layout plans for enforcement of the small electric motors standards. (Earthjustice, Public Meeting Transcript, No. 20.4 at pp. 20–21)

NEMA's written comment reiterated these concerns about enforcement, and outlined several steps DOE should take to ensure proper compliance. First, it recommended that DOE expand its present Compliance Certification number system that is used for electric motors to include small electric motors. Second, it recommended a means to notify DOE of potential violations. Third, it suggested maintaining a Web site that lists manufacturers and OEMs who have submitted compliance certificates. Fourth, it supported penalties for repeat violations of the law. Finally, it stressed the importance of securing the appropriate funds for implementing and maintaining an enforcement program. (NEMA, No. 24 at pp. 26–27) NEEA and NPCC also commented on the importance of appropriating funds for enforcement of today's standards. (NEEA/NPCC, No. 27 at p. 7)

Additionally, NEMA's written comment indicated that DOE must publish the small electric motors SNOPR soon in order for manufacturers to have sufficient time to ensure compliance with today's standards. (NEMA, No. 24 at p. 25)

DOE agrees that the plans for enforcing today's final rule are very important, and appreciates the suggestions provided by manufacturers. While it is uncommon for a standard rulemaking to address issues of enforcement, DOE would like to highlight its intention to outline concrete steps for enforcing today's efficiency standards. Given the numerous rulemakings that the agency must promulgate pursuant to its court consent decree and statutory requirements, DOE plans to issue this supplemental notice as expeditiously as possible to invite comment from interested parties and to ensure that the motor industry has sufficient time to adjust to any new provisions that DOE proposes.

C. Nominal Full-Load Efficiency

As discussed in section IV.C.2 of today's final rule, it is common in the motor industry to observe variation in motor performance for a population of motors of identical designs, including tested efficiency. This variation can be due to variations in material quality, manufacturing processes, and even testing equipment. NEMA has established the term "nominal full-load efficiency" and uses the term for medium electric motors customers with a guaranteed efficiency given the variations in motor manufacturing and testing. As the tolerances due to manufacturing and testing variations guaranteed by NEMA's definition of nominal full load efficiency are based on test procedures and data for medium electric motors, DOE elected to alter the definition in its NOPR and as it pertains to small electric motors. In the NOPR, DOE defined the term nominal full-load efficiency as the arithmetic mean of the full load efficiency of a population of motors of duplicate design.

At the NOPR public meeting, Baldor made several comments regarding DOE's proposed definition for "nominal full-load efficiency" pertaining to small electric motors. First, Baldor commented that the proposed definition was too similar to the existing definition for "average full-load efficiency," and that it differed from the definition in NEMA MG–1, which would create confusion for users. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 112, 126–27) Next, Baldor commented that the proposed definition provided no stipulation for what constitutes a population of motors, and suggested that the term be clarified. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 112–13) These two comments were reiterated by NEMA in its written comments. (NEMA, No. 24 at pp. 10–16) Finally, Baldor commented that the proposed definition infers that the arithmetic mean of the full-load efficiencies of the population of motors is known and that the nominal full-load efficiency must be specified to be equal to the arithmetic mean, which would provide no limit to the number of different values of efficiency that might be marked on nameplates. As such, Baldor requested further clarification on the determination of any relationship between nominal full-load efficiency and calculated efficiency. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 114, 125)

Additionally, Baldor recommended improvements to DOE's usage of nominal full-load efficiency. Baldor stated that the standard levels set by DOE should follow a pattern similar to the one already established in Table 12–6(a), which provides a logical sequence of numbers, and is familiar to motor users. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 129–31) Baldor also pointed out that DOE is able to use the nominal values in Table 12–6(a) without using the minimum values, which are just provided for user information but not for compliance. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 142–43) Again, NEMA supported these statements in its written comments. (NEMA, No. 24 at p. 14) Finally, Baldor and NEMA stated that DOE does not need to establish energy conservation standards in terms of nominal efficiency, but rather identify the characteristic of the efficiency value assigned to a motor to which a value in the table applies. (Baldor, Public Meeting Transcript, No. 20.4 at pp. 134–35; NEMA, No. 24 at pp. 15–16)

DOE considered all of these comments when it established energy conservation standards for small electric motors in today's final rule. DOE agrees with NEMA and Baldor that its energy efficiency standards are not mandated to be in terms of nominal full-load efficiency. Instead, DOE believes that nominal efficiency is an issue more related to certifying compliance. Therefore, DOE has elected to establish energy conservation standards in terms of average full-load efficiency. DOE will address comments related to nominal efficiency and propose provisions for certifying compliance with small electric motor energy efficiency standards in its supplemental test procedure NOPR for electric motors.

VI. Analytical Results and Conclusions

A. Trial Standard Levels

DOE examined eight TSLs for polyphase small electric motors and eight for capacitor-start small motors. Table VI.1 and Table VI.2 present the TSLs and the corresponding efficiencies for the three representative product classes analyzed for today's final rule. TSL 8 is the max-tech efficiency level for the polyphase motors, and TSL 7 is the max-tech level for the capacitor-start motors.

TABLE VI.1—TRIAL STANDARD LEVELS FOR POLYPHASE SMALL ELECTRIC MOTORS *

	Polyphase four-pole 1-horsepower %
TSL 1	77.3
TSL 2	78.3
TSL 3	80.5
TSL 4	81.1
TSL 4b	83.5
TSL 5	85.2
TSL 6	86.2
TSL 7	87.7

* Standard levels are expressed in terms of full-load efficiency.

DOE's polyphase TSLs represent the increasing efficiency of the range of motors DOE modeled in its engineering analysis. DOE incorporated one additional TSL since the NOPR, which is the new TSL 4b. This TSL approximately aligns with the efficiency values proposed by NEMA in their written comments.

TSLs 1, 2, and 3 represent incremental improvements in efficiency as a result of increasing the stack height and the slot fill percentage. TSL 4 represents the efficiency level possible by increasing stack height by 20 percent while maintaining the baseline steel grade and an aluminum rotor. TSL 4b approximately aligns with the efficiency levels proposed by NEMA in its written comment, and for the representative product class is comparable to the efficiency of a three-digit frame series medium electric motor that meets the efficiency requirements of EPCA. TSL 5 represents the highest efficiency value for a space-constrained design before switching to a copper rotor. TSL 6 represents a level at which DOE has reached the 20 percent limit of increased stack height, increased grades of steel and included a copper die-cast rotor. Also, TSL 6 is comparable to the efficiency standard of a three-digit frame series medium electric motor that meets the NEMA Premium level, which Congress has set as an energy conservation standard for medium motors through section 313(b) of EISA 2007. At TSL 7, the max-tech efficiency level, for the restricted designs DOE has reached the design limit using the maximum increase in stack height of 20 percent and increased grades of steel. At this level, DOE has also implemented a premium steel type (Hiperco 50), a copper die-cast rotor, a maximum slot fill percentage of nearly 65 percent. For the lesser space-constrained design, DOE has decreased the stack height from the design used at TSL 6. This design incorporates a copper rotor while reaching the design limitation maximum slot fill percentage.

TABLE VI.2—TRIAL STANDARD LEVELS FOR CAPACITOR-START SMALL ELECTRIC MOTORS*

	Capacitor-start, induction-run 4-pole 0.50 horsepower motors (%)	Capacitor-start, capacitor-run 4-pole 0.75 horsepower motors (%)
TSL 1	70.5 (EL 4)	79.5 (EL 2)
TSL 2	70.5 (EL 4)	81.7 (EL 3)
TSL 3	71.8 (EL 5)	81.7 (EL 3)
TSL 4	73.1 (EL 6)	82.8 (EL 4)
TSL 5	73.1 (EL 6)	81.7 (EL 3)
TSL 6	77.6 (EL 7)	87.9 (EL 8)
TSL 7	77.6 (EL 7)	81.7 (EL 3)
TSL 8	77.6 (EL 7)	86.7 (EL 7)

* Standard levels are expressed in terms of full-load efficiency.

Each TSL for capacitor-start small motors consists of a combination of efficiency levels for induction-run and capacitor-run motors. CSIR and CSCR motors are used in similar applications and generally can be used interchangeably provided the applications are not bound by strict space constraints and will allow the presence of a second capacitor housing of the motor. DOE believes that the standards set by today's rule will impact the relative market share of CSIR and CSCR motors for general-purpose single-phase applications by changing the upfront cost of motors as well as their estimated losses. Section IV.G of this final rule and chapter 9 of the TSD describe DOE's model of this market dynamic.

DOE developed seven possible efficiency levels for CSIR motors and eight possible efficiency levels for CSCR motors. Rather than present all possible combinations of these efficiency levels, DOE chose a representative set of 8 TSLs that span the range from low energy savings to the maximum national energy savings. Because of the interaction between the CSIR and CSCR market share, there is no simple relationship between the combination of efficiency levels and the resulting energy savings. DOE's capacitor-start cross-elasticity model was used to evaluate the impacts of each TSL on motor shipments in each product class. The model predicts that TSLs 1 through 5 result in relatively minor changes in product class market shares, while TSLs 6, 7, and 8 result in more significant changes. Uncertainties in the cross-elasticity model, and in the timescale of market share response to standards, lead to greater uncertainty in the national impacts of TSLs 6, 7, and 8, than with TSLs 1 through 5. A summary of results for all combinations of CSIR and CSCR efficiency levels is presented in chapter 10 of the TSD.

TSL 1 is a combination consisting of the fourth efficiency level analyzed for CSIR motors and the second efficiency level for CSCR motors. This TSL uses similar engineering design options for both CSIR and CSCR motors and corresponds to an efficiency level roughly equivalent to the standards levels recommend for 42/48-frame-size CSIR motors and 56-frame size CSCR motors by NEMA. TSL 2 increases the efficiency level of the CSCR motor to the third efficiency level, which corresponds to the minimum life-cycle cost. The efficiency level for the CSIR motor remains the same as in TSL 1. TSL 3 raises the CSIR efficiency level, which DOE's model meets by implementing a copper die-cast rotor, increasing slot fill, and reaching the 20 percent limit on increased stack height, or by doubling the original stack height and increasing slot fill. However, the CSCR efficiency level remains at the minimum LCC.

TSLs 4 and 5 both show the same efficiency level for CSIR motors, but different efficiency levels for CSCR motors. To obtain the efficiency level for CSIR motors, DOE had to use either a copper rotor in combination with a thinner and higher grade of steel and a stack increase of 20 percent, or only a higher grade of steel with a stack exceeding a 20-percent increase but no longer than a 100-percent increase. The 82.2-percent efficiency level for CSCR motors in TSL 5 corresponds again to the same design and efficiency level for TSL 2 and 3. To achieve the 83.2-percent efficiency level for CSCR motors in TSL 4, DOE created designs with a 20-percent increase in stack height and a higher grade of steel or used a copper rotor with a stack height above a 20-percent increase. TSL 4 represents the combination of the highest CSIR and CSCR levels that have more customers who benefit than customers who do not according to DOE's LCC analysis. TSL 5 increases energy savings relative to TSL 4 because DOE anticipates there will be a greater CSCR market share, and the CSCR efficiency level again corresponds with the minimum LCC.

TSL 6 represents max-tech efficiency levels for CSIR and CSCR motors, as determined by DOE's engineering analysis; at this level CSCR motors are very expensive relative to CSIR motors, and DOE forecasts a nearly complete market shift to CSIR motors. TSLs 7 and 8 represent cases in which CSIR motors are, on average, very expensive relative to CSCR motors as a result of standards, and DOE forecasts near-to-complete market shifts to CSCR motors in both of its reference scenarios. Because CSCR motors are more efficient at these levels, national energy savings are increased beyond that of the max-tech efficiency level, TSL 6. TSL 7 pairs the max-tech efficiency requirements for CSIR motors with the minimum LCC efficiency level for CSCR motors, while TSL 8 pairs max-tech CSIR efficiency requirements with the second-highest CSCR motor efficiency level that DOE analyzed. The ordering of TSLs 5, 6, 7, and 8, with respect to energy savings is robust in the face of uncertainties in the inputs to, and the parameters of, DOE's cross-elasticity model.

B. Significance of Energy Savings

To estimate the energy savings through year 2045 from potential standards, DOE compared the energy consumption attributable to small electric motors under the base case (no new standards) to energy consumption attributable to this equipment under each standards case (each TSL that DOE has considered). Table VI.3 and Table VI.4 show DOE's national energy savings estimates, which are based on the *AEO 2010* Early Release, for each TSL for polyphase and capacitor-start small electric motors, respectively. Chapter 10 of the TSD describes these estimates in more detail. DOE reports both undiscounted and discounted values of energy savings. Discounted energy savings represent a policy perspective where energy savings farther in the future are less significant than energy savings closer to the present.

Estimating the energy savings due to revised and new energy efficiency standards required DOE to compare the energy consumption of small electric motors under the base case to energy consumption of these products under the trial standard levels. As described in section IV.G DOE used scaling relations for energy use and equipment price to extend its average energy use and price for representative product classes (analyzed in the LCC analysis) to all product classes, and then developed shipment-weighted sums to estimate the national energy savings. As described in section IV.G, DOE conducted separate national impact analyses for polyphase and capacitor-start (single-phase) motors. Efficiency standards for CSIR and CSCR motors are reflected in the capacitor-start energy savings and NPV results, which account for the interchangeability of CSIR and CSCR motors in many applications.

Table VI.3 and Table VI.4 show the forecasted national energy savings through year 2045 at each of the TSLs. The tables also show the magnitude of the energy savings if the savings are discounted at rates of seven and three percent. The energy savings (undiscounted) from implementing standards for polyphase small electric motors range from 0.05 to 0.37 quad and the savings for capacitor-start small electric motors range from 1.18 to 2.33 quads.

TABLE VI.3—SUMMARY OF CUMULATIVE NATIONAL ENERGY SAVINGS FOR POLYPHASE SMALL ELECTRIC MOTORS

[Energy savings between 2015 and 2045]

Trial standard level	National energy savings (quads)		
	Not discounted	Discounted at 3%	Discounted at 7%
1	0.05	0.03	0.01
2	0.09	0.05	0.02
3	0.17	0.09	0.04
4	0.19	0.10	0.05
4b	0.29	0.15	0.07
5	0.34	0.18	0.09
6	0.37	0.19	0.09
7	0.37	0.20	0.09

TABLE VI.4—SUMMARY OF CUMULATIVE NATIONAL ENERGY SAVINGS FOR CAPACITOR-START SMALL ELECTRIC MOTORS

[Energy savings between 2015 and 2045]

Trial standard level	National energy savings (quads)		
	Not discounted	Discounted at 3%	Discounted at 7%
1	1.18	0.63	0.31
2	1.19	0.64	0.31
3	1.36	0.73	0.36
4	1.47	0.79	0.39
5	1.47	0.79	0.39
6	1.61	0.87	0.43
7	1.91	1.03	0.51
8	2.33	1.25	0.62

DOE conducted a wide range of sensitivity analyses, including scenarios demonstrating the effects of variation in shipments, response of customers to higher motor prices, the cost of electricity due to a carbon cap and trade regime, reactive power costs, and (for capacitor-start motors) the dynamics of CSIR/CSCR consumer choice. These scenarios show a range of possible outcomes from projected energy conservation standards, and illustrate the sensitivity of these results to different input and modeling assumptions. In general, however, they do not dramatically change the relationship between results at one TSL with those at another TSL and the relative economic savings and energy savings of different TSLs remain roughly the same. The estimated overall magnitude of savings, however, can change substantially, which can be due to a change in the estimated total number of small electric motors in use. Details of each scenario are available in chapter 10 of the TSD and its appendices, along with the national energy savings estimated for each scenario.

Customers currently appear to favor CSIR motors over CSCR motors, even if their initial costs and losses are almost identical. DOE's market-share model includes an "unfamiliarity cost" parameter that attempts to account for this observed behavior. For the shipments sensitivity analysis, DOE analyzed the total energy savings from capacitor-start motors when this unfamiliarity cost is significantly lower (high CSCR model) or higher (low CSCR model) than DOE's reference case. These scenarios can have a significant impact on the relative energy savings in different TSLs. Table VI.5 shows the results for the national energy savings (through year 2045) in these scenarios.

TABLE VI.5—UNDISCOUNTED CUMULATIVE NATIONAL ENERGY SAVINGS FOR CAPACITOR-START SMALL ELECTRIC MOTORS UNDER DIFFERENT CSIR/CSCR MARKET SHARE SCENARIOS

[Energy savings between years 2015 and 2045]

Trial standard level	National energy savings quads		
	Low CSCR scenario	Reference scenario	High CSCR scenario
1	1.17	1.18	1.30
2	1.17	1.19	1.38
3	1.34	1.36	1.52
4	1.43	1.47	1.67
5	1.43	1.47	1.65
6	1.61	1.61	1.62
7	1.87	1.91	1.92
8	2.17	2.33	2.37

C. Economic Justification

In examining the potential for energy savings for small electric motors, DOE analyzed whether standards would be economically justified. As part of this examination, a variety of elements were examined. These elements are based on the various criteria specified in EPCA. See generally, 42 U.S.C. 6295.

1. Economic Impact on Motor Customers

DOE analyzed the economic impacts on small electric motor customers by looking at the effects standards would have on the LCC, PBP, and on various subgroups. DOE also examined the effects of the rebuttable presumption payback period set out in 42 U.S.C. 6295. All of these analyses are discussed below.

a. Life-Cycle Costs and Payback Period

Customers of equipment affected by new or amended standards usually experience higher purchase prices and lower operating costs. Generally, these impacts are best captured by changes in life-cycle costs. Therefore, DOE calculated the LCC and PBP for the standards levels considered in this proceeding. DOE's LCC and PBP analyses provided five key outputs for each TSL, which are reported in Table VI.6 through Table VI.8 below. The first three outputs are the proportion of small motor purchases where the purchase of a design that complies with the TSL would create a net life-cycle cost, no impact, or a net life-cycle savings for the consumer. The fourth output is the average net life-cycle savings from the purchase of a complying design.

Finally, the fifth output is the average PBP for the consumer purchase of a design that complies with the TSL. The PBP is the number of years it would take for the customer to recover, as a result of energy savings, the increased costs of higher-efficiency equipment, based on the operating cost savings from the first year of ownership. The payback period is an economic benefit-cost measure that uses benefits and costs without discounting. DOE's PBP analysis and its analysis under the rebuttable presumption test both address the payback period for a standard. DOE based its estimates of the average PBPs for small electric motors on energy consumption under conditions of actual use of these motors and also analyzed the amount of energy consumption for purposes of the rebuttable presumption calculations using the conditions prescribed by the DOE test procedure. See 42 U.S.C. 6295(o)(2)(B)(iii). Moreover, as discussed above, while DOE examined the rebuttable-presumption criteria (see TSD section VI.C.1.d), it determined today's standard levels to be economically justified through a more detailed analysis of the economic impacts of increased efficiency pursuant to section 325(o)(2)(B)(i) of EPCA. (42 U.S.C. 6295(o)(2)(B)(i)) Detailed information on the LCC and PBP analyses can be found in TSD Chapter 8.

DOE analyzed the life-cycle cost for three representative motors, as shown in Table VI.6 through Table VI.8. A Monte Carlo simulation was performed to incorporate uncertainty and variability into the analysis. A random sample of 10,000 motors was drawn from the distributions of current national shipments by motor type, application, owner type, operating hours, and other inputs, using Crystal Ball, a commercially available software program. The model calculated the LCC and PBP for equipment at each efficiency level for each of the 10,000 motors sampled. For a 1-horsepower polyphase motor, customers experience net LCC savings, on average, through efficiency level 4b. Efficiency level 3 has the minimum average life-cycle cost. For a ½-horsepower CSIR motor, customers experience net LCC savings, on average, through efficiency level 6. CSIR efficiency level 4 has the minimum average life-cycle cost. For a ¾-horsepower CSCR motor, customers experience net LCC savings, on average, through efficiency level 5. CSCR efficiency level 3 has the greatest average life-cycle cost savings. The average payback periods in the tables are substantially longer than the median payback periods because a fraction of customers run their motors very few hours per year. This results in extraordinarily long payback periods for this fraction of customers and results in average payback periods that far exceed the median payback period. DOE believes that the median payback period represents the anticipated experience of the typical customer more accurately than the average payback period.

TABLE VI.6—POLYPHASE SMALL ELECTRIC MOTORS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A ONE HORSEPOWER MOTOR

Energy efficiency level	Efficiency %	Life-cycle cost				Life-cycle cost savings			Payback period years	
		Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average savings $	Customers with		Average	Median
							Net cost %	Net benefit %		
Baseline	74.0	517	1,892	130	1,268	....	....	....	....	....
1	76.1	530	1,729	127	1,261	8	46.8	53.2	21.8	7.1
2	77.7	537	1,686	123	1,249	19	41.3	58.7	17.8	5.8
3	79.4	549	1,630	119	1,237	31	40.6	59.4	17.7	5.6
4	80.1	558	1,615	118	1,240	29	45.1	54.9	20.4	6.5
4b	82.6	589	1,540	113	1,240	28	51.2	48.8	24.8	7.8
5	84.4	655	1,508	110	1,291	−23	65.8	34.3	41.5	12.4
6	85.3	711	1,488	109	1,339	−71	77.4	22.6	54.2	16.9
7	87.0	1,477	1,462	107	2,095	−827	96.8	3.2	243.0	51.1

TABLE VI.7—CAPACITOR-START INDUCTION-RUN MOTORS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A ONE-HALF HORSEPOWER MOTOR

Energy efficiency level	Efficiency %	Life-cycle cost				Life-cycle cost savings			Payback period years	
		Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average savings $	Customers with		Average	Median
							Net cost %	Net benefit %		
Baseline	59.0	494	1,250	91	915	....	....	....	....	....
1	62.2	502	1,170	85	896	19	27	73	8.6	2.7
2	64.5	508	1,116	81	884	31	28	72	8.8	2.8
3	66.7	511	1,064	77	869	46	24	76	7.5	2.3
4	71.5	529	976	71	857	58	32	68	10.5	3.2
5	72.7	549	951	69	868	47	42	58	15.1	4.7
6	74.0	593	920	67	902	13	55	45	24.9	7.2
7	78.4	996	860	63	1,285	−369	66	34	108.2	12.4

TABLE VI.8—CAPACITOR-START CAPACITOR-RUN MOTORS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A THREE-QUARTER HORSEPOWER MOTOR

Energy efficiency level	Efficiency %	Life-cycle cost				Life-cycle cost savings			Payback period years	
		Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average savings $	Customers with		Average	Median
							Net cost %	Net benefit %		
Baseline	72.0	548	1,425	104	1,026	....	....	....	....	....
1	75.7	559	1,360	99	1,014	12	36	64	13.4	4.3
2	80.0	587	1,250	91	1,005	21	46	54	18.5	5.8
3	82.2	599	1,205	88	1,002	24	48	52	19.1	5.9
4	83.2	612	1,214	88	1,015	11	55	45	24.4	7.8
5	84.5	630	1,201	88	1,029	−3	62	38	29.5	9.4
6	85.2	670	1,179	86	1,062	−36	70	30	40.3	11.8
7	87.1	697	1,146	84	1,078	−52	75	25	43.5	13.1
8	88.4	1,485	1,115	81	1,856	−830	99	1	250.0	49.0

DOE analyzed the average life-cycle cost for a shipment-weighted distribution of product classes, as shown in Table VI.9, Table VI.10 and Table VI.11. The results in these tables account for motors of different horsepower and pole configuration from the three representative motors shown in Table VI.6 through Table VI.8.

TABLE VI.9—POLYPHASE MOTORS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A SHIPMENT-WEIGHTED PRODUCT CLASS DISTRIBUTION

Energy efficiency level	Efficiency %	Life-cycle cost				Life-cycle cost savings			Payback period years	
		Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average savings $	Customers with		Average	Median
							Net cost %	Net benefit %		
Baseline	78.8	515	1934	139.52	1,323	....	....	....	....	....
1	80.6	528	1883	135.85	1,314	9	44.7	55.3	21.1	6.6
2	82.0	535	1836	132.45	1,302	22	39.2	60.8	17.2	5.3
3	83.4	547	1775	128.07	1,287	36	38.7	61.3	17.1	5.2

TABLE VI.9—POLYPHASE MOTORS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A SHIPMENT-WEIGHTED PRODUCT CLASS DISTRIBUTION—Continued

Energy efficiency level	Efficiency %	Life-cycle cost				Life-cycle cost savings			Payback period years	
		Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average savings $	Customers with		Average	Median
							Net cost %	Net benefit %		
4	84.0	556	1759	126.91	1,289	34	42.7	57.3	19.6	6.0
4b	86.1	587	1678	121.06	1,288	36	49.2	50.8	23.9	7.3
5	87.6	651	1643	118.52	1,337	−13	63.2	36.8	39.1	11.5
6	88.4	707	1622	116.99	1,383	−60	74.8	25.2	51.8	15.7
7	89.7	1,465	1594	114.96	2,131	−808	96.2	3.8	220.4	47.8

TABLE VI.10—CAPACITOR-START INDUCTION-RUN MOTORS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A SHIPMENT-WEIGHTED PRODUCT CLASS DISTRIBUTION

Energy efficiency level	Average efficiency %	Life-cycle cost				Life-cycle cost savings			Payback period years	
		Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average savings $	Customers with		Average	Median
							Net cost %	Net benefit %		
Baseline	49.9	496	1265	92.12	920	....	....	....	....	....
1	53.2	504	1182	86.03	900	20	26.9	73.1	8.5	2.5
2	55.7	510	1125	81.89	888	33	27.7	72.3	8.7	2.6
3	58.1	513	1071	77.96	871	49	24.0	76.0	7.4	2.2
4	63.5	531	979	71.28	859	62	30.7	69.3	10.4	3.1
5	64.8	551	953	69.40	870	51	40.2	59.8	14.9	4.5
6	66.3	595	920	67.00	903	17	54.1	45.9	24.5	7.0
7	71.5	1,000	858	62.48	1,287	−367	65.1	34.9	104.4	11.7

TABLE VI.11—CAPACITOR-START CAPACITOR-RUN MOTORS: LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A SHIPMENT-WEIGHTED PRODUCT CLASS DISTRIBUTION

Energy efficiency level	Average efficiency %	Life-cycle cost				Life-cycle cost savings			Payback period years	
		Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average savings $	Customers with		Average	Median
							Net cost %	Net benefit %		
Baseline	73.2	582	2310	167.38	1,349	....	....	....	....	....
1	76.7	594	2208	160.02	1,325	24	29.3	70.7	10.9	3.3
2	80.9	626	2036	147.55	1,299	50	38.4	61.6	14.9	4.4
3	83.0	639	1965	142.43	1,289	60	39.7	60.3	15.4	4.6
4	84.0	653	1979	143.43	1,304	45	46.1	53.9	19.8	5.9
5	85.2	673	1959	141.96	1,318	32	52.6	47.4	23.9	7.2
6	85.9	719	1923	139.37	1,351	−1	60.2	39.9	32.5	8.9
7	87.8	749	1873	135.72	1,364	−15	65.1	35.0	35.1	10.1
8	89.0	1,629	1824	132.17	2,228	−879	94.7	5.3	200.0	36.4

b. Life-Cycle Cost Sensitivity Calculations

DOE made sensitivity calculations for the case where CSIR motor owners switch to CSCR motors. DOE reports the details of the sensitivity calculations in chapter 8 of the TSD and the accompanying appendices. Section VI.C.1.a above describes the relationship between efficiency levels for the two categories of capacitor-start motors and the TSLs. For TSLs where there is a large increase in first cost for CSIR motors and only a moderate increase in price for CSCR motors, DOE forecasts that a large fraction of CSIR motor customers will switch to CSCR motors. Table VI.12 shows the shipments-weighted average of the LCC for CSIR motors including those users that switch to CSCR. The table shows that a negative average LCC is forecast for TSL 6, the level at which both CSIR and CSCR motors are at the maximum technologically feasible efficiency for space-constrained designs, and at TSL 8, the level with the greatest energy savings.

TABLE VI.12—CAPACITOR-START INDUCTION-RUN MOTORS: SHIPMENT-WEIGHTED LIFE-CYCLE COST AND PAYBACK PERIOD RESULTS FOR A ONE-HALF HORSEPOWER MOTOR WITH SWITCHING TO CSCR

Trial standard level	Life-cycle cost				Life-cycle cost savings		
						Customers with	
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life cycle cost $	Average savings $	Net cost %	Net benefit %
Baseline							
1	528	969	70.8	854	58	32.5	67.5
2	528	969	70.8	854	58	32.5	67.5
3	547	945	69.0	865	47	41.7	58.3
4	590	913	66.7	897	15	55.0	45.0
5	589	913	66.7	897	15	55.0	45.0
6	994	854	62.4	1,282	−370	66.0	34.0
7	601	863	63.1	891	23	53.7	46.3
8	633	847	61.9	917	−3	60.6	39.4

Additional sensitivity analyses examined the magnitude by which the estimates varied when the results of the NEMA survey of OEMs (motor distributions by application and sector, operating hours, and the fraction of motors that are space-constrained in their applications) were used. Other sensitivities were conducted by varying inputs such as the cost of electricity, the purchase year of the motor, the motor capacity, the number of poles and other inputs and assumptions of the analysis. DOE reports the details of all of the sensitivity calculations in chapter 8 of the TSD and the accompanying appendices.

As discussed in section IV.E.1 above, NEMA submitted the results of a survey of their OEM customers that install motors covered by today's rule in their products. The survey reports distributions by application and owner type, estimates of annual hours of operation, and the fraction of motors that are space-constrained. NEMA also provided information on a sixth application not included in DOE's NOPR, service industry motors. DOE ran a sensitivity analysis using the data NEMA provided on motor distributions. Under this sensitivity, LCC savings are reduced and payback periods are increased for polyphase and CSCR motor customers, while LCC savings are increased and payback periods reduced for CSIR motor customers. This is the result of average operating hours of polyphase and CSCR motors being reduced by about 30 percent from the DOE reference case, while operating hours of CSIR motors are increased by about 10 percent.

Details on these and other LCC sensitivity cases can be found in TSD appendix 8A.

c. Customer Subgroup Analysis

Using the LCC spreadsheet model, DOE estimated the impacts of the TSLs on the following customer subgroups: Small businesses and customers with space-constrained applications. DOE analyzed the small business subgroup because this group has typically had less access to capital than larger businesses, which results in higher financing costs and a higher discount rate than the industry average. 74 FR 61442, 61459. DOE estimated the LCC and PBP for the small business subgroup, as shown in Table VI.13 through Table VI.15. The analysis indicates that the small business subgroup is expected to have lower LCC savings and longer payback periods than the industry average.

Chapter 12 of the TSD provides more detailed discussion on the LCC subgroup analysis and results.

TABLE VI.13—POLYPHASE MOTORS: SMALL BUSINESS CUSTOMER SUBGROUP

Energy efficiency level	Life-cycle cost				Life-cycle cost savings			Payback period years	
						Consumers with			
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average life-cycle cost savings $	Net cost %	Net benefit %	Average	Median
Baseline	516	1888	137.84	1,192	....	....	....	....	....
1	529	1838	134.21	1,186	6	51.9	48.1	22.0	6.9
2	536	1792	130.85	1,177	15	46.1	54.0	18.0	5.6
3	548	1733	126.54	1,167	25	45.5	54.5	17.9	5.5
4	556	1718	125.39	1,170	22	49.7	50.3	20.6	6.3
4b	588	1639	119.63	1,174	18	56.5	43.5	25.1	7.7
5	652	1604	117.13	1,226	−34	69.6	30.4	41.8	12.2
6	708	1584	115.60	1,274	−82	80.2	19.9	54.7	16.7
7	1,460	1557	113.63	2,017	−825	97.4	2.6	243.1	50.2

TABLE VI.14—CAPACITOR-START INDUCTION RUN MOTORS: SMALL BUSINESS CUSTOMER SUBGROUP

Energy efficiency level	Life-cycle cost				Life-cycle cost savings			Payback period years	
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average life-cycle cost savings $	Consumers with		Average	Median
						Net cost %	Net benefit %		
Baseline	497	1261	91.33	869	....	....	....	....	....
1	506	1178	85.28	852	16	31.3	68.7	8.5	2.6
2	512	1121	81.16	842	27	32.4	67.6	8.7	2.7
3	514	1067	77.25	828	41	28.0	72.0	7.4	2.3
4	533	976	70.63	819	50	35.8	64.2	10.4	3.2
5	553	950	68.75	832	37	45.3	54.7	14.9	4.6
6	597	917	66.37	866	3	58.6	41.4	24.7	7.1
7	995	855	61.89	1,246	−377	68.5	31.5	108.4	11.9

TABLE VI.15 CAPACITOR-START CAPACITOR RUN MOTORS: SMALL BUSINESS CUSTOMER SUBGROUP

Energy efficiency level	Life-cycle cost				Life-cycle cost savings			Payback period years	
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average life-cycle cost savings $	Consumers with		Average	Median
						Net cost %	Net benefit %		
CSCR Baseline	586	2339	169.80	1,273	....	....	....	....	....
1	598	2236	162.36	1,253	20	33.6	66.4	10.8	3.3
2	630	2062	149.73	1,234	39	43.4	56.6	15.0	4.4
3	643	1991	144.55	1,226	47	44.7	55.3	15.5	4.6
4	657	2005	145.59	1,241	32	51.1	48.9	19.7	6.0
5	678	1985	144.09	1,256	17	58.0	42.0	23.9	7.3
6	723	1949	141.51	1,290	−17	65.1	34.9	32.8	9.1
7	754	1898	137.82	1,306	−33	69.7	30.4	35.4	10.2
8	1,633	1849	134.23	2,171	−898	96.0	4.0	205.3	37.3

DOE has analyzed customers with space-constrained applications, *i.e.,* customers whose motor stack length can increase by no more than 20 percent, because they cannot realize the full economic benefit of efficiency improvements in small electric motors. Increasing the stack length of small motors is one way to improve their efficiency. But customers with space-constrained applications cannot increase the stack length of the motors they use without being subject to burdens to which other small motor users are not. Furthermore, although small electric motors without increased stack length could meet the TSLs DOE has evaluated in this rulemaking, such motors use other, more costly design options. Table VI.16 through Table VI.18 show the mean LCC savings and the mean PBP (in years) for equipment that meets the energy conservation standards in today's final rule for the subgroup of customers with space-constrained applications.

The analysis indicates that the economic benefits of efficiency improvements in small electric motors will be lower for customers subject to space constraints than for those who do not face such constraints, as well as for the industry average, particularly for motors at the higher efficiency levels. For the standard levels promulgated by today's rule, customers will still realize net benefits from space-constrained polyphase and CSCR motors, but not from space-constrained CSIR motors. OEMs whose applications have space constraints can replace a less efficient CSIR motor with a more efficient CSCR motor without increasing stack length, and still realize net benefits, as shown in Table VI.12 above. If these applications cannot accommodate a motor with a run capacitor, OEMs can either redesign their application to accommodate a CSCR motor, purchase a stockpile of motors not covered by today's rule to install in future production of their application, or replace their motor with a fully enclosed motor not covered by today's rule.

Chapter 11 of the TSD explains DOE's method for conducting the customer subgroup analysis and presents the detailed results of that analysis.

TABLE VI.16—POLYPHASE MOTORS: SPACE-CONSTRAINED APPLICATIONS SUBGROUP

Energy efficiency level	Life-cycle cost				Life-cycle cost savings			Payback period years	
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average life-cycle cost savings $	Consumers with		Average	Median
						Net cost %	Net benefit %		
Baseline	512	1903	140.60	1,318	....	....	....	....	....
1	524	1853	136.90	1,308	9	45.6	54.4	21.5	6.8
2	531	1807	133.49	1,296	22	40.2	59.8	17.5	5.5
3	543	1748	129.13	1,282	36	39.6	60.4	17.4	5.4
4	552	1732	127.96	1,284	34	43.7	56.3	20.0	6.3
4b	582	1650	121.98	1,280	37	49.7	50.3	24.2	7.5
5	756	1610	119.00	1,437	−120	84.8	15.2	71.8	22.3
6	769	1590	117.55	1,441	−123	84.3	15.7	70.7	22.1

TABLE VI.16—POLYPHASE MOTORS: SPACE-CONSTRAINED APPLICATIONS SUBGROUP—Continued

Energy efficiency level	Life-cycle cost				Life-cycle cost savings			Payback period years	
						Consumers with			
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average life-cycle cost savings $	Net cost %	Net benefit %	Average	Median
7	3,548	1543	114.11	4,201	−2,883	100.0	0.0	728.2	226.0

TABLE VI.17—CAPACITOR-START INDUCTION RUN MOTORS: SPACE-CONSTRAINED APPLICATIONS CUSTOMER SUBGROUP

Energy efficiency level	Life-cycle cost				Life-cycle cost savings			Payback period years	
						Consumers with			
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average life-cycle cost savings $	Net cost %	Net benefit %	Average	Median
Baseline	494	1274	92.66	923					
1	503	1190	86.56	903	20	26.7	73.3	8.5	2.6
2	509	1133	82.42	890	33	27.5	72.5	8.8	2.6
3	511	1079	78.48	873	49	23.6	76.4	7.5	2.2
4	539	976	71.00	867	56	37.2	62.8	12.9	3.9
5	544	955	69.45	864	58	38.0	62.0	13.4	4.0
6	665	925	67.28	976	−53	74.0	26.0	42.3	12.6
7	2,559	848	61.68	2,843	−1,921	100.0	0.0	418.9	124.7

TABLE VI.18—CAPACITOR-START CAPACITOR RUN MOTORS: SPACE-CONSTRAINED APPLICATIONS CUSTOMER SUBGROUP

Energy efficiency level	Life-cycle cost				Life-cycle cost savings			Payback period years	
						Consumers with			
	Average installed price $	Average annual energy use kWh	Average annual operating cost $	Average life-cycle cost $	Average life-cycle cost savings $	Net cost %	Net benefit %	Average	Median
Baseline	579	2313	167.74	1,355					
1	591	2212	160.38	1,331	24	29.2	70.8	10.9	3.3
2	633	2053	148.85	1,320	35	47.4	52.6	19.0	5.8
3	645	1998	144.88	1,312	43	47.2	52.8	19.2	5.9
4	653	1991	144.36	1,316	40	49.3	50.7	21.1	6.5
5	671	1981	143.61	1,330	26	55.4	44.6	25.3	7.8
6	839	1914	138.80	1,476	−121	84.3	15.7	60.1	18.4
7	854	1862	135.02	1,473	−118	82.5	17.5	56.3	17.1
8	3,992	1815	131.61	4,597	−3,242	100.0	0.0	634.4	193.1

d. Rebuttable Presumption Payback

As discussed in section III.D.2, EPCA provides a rebuttable presumption that, in essence, an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the customer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i) and 42 U.S.C. 6316(e)(1). The results of this analysis serve as the basis for DOE to evaluate definitively the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification).

For comparison with the more detailed analysis results, DOE calculated a rebuttable presumption payback period for each TSL. Table VI.19 and Table VI.20 show the rebuttable presumption payback periods for the representative product classes. No polyphase TSL has a rebuttable presumption payback period of less than 3 years. For CSIR and CSCR motors, TSLs 1 through 3 have rebuttable presumption payback periods of less than 3 years.

TABLE VI.19—REBUTTABLE-PRESUMPTION PAYBACK PERIODS FOR REPRESENTATIVE POLYPHASE SMALL ELECTRIC MOTORS (1 HP, 4 POLES)

TSL	Payback period years
1	3.3
2	3.0
3	3.3
4	3.8
4b	4.9
5	7.9
6	10.2
7	45.7

TABLE VI.20—REBUTTABLE-PRESUMPTION PAYBACK PERIODS FOR REPRESENTATIVE CAPACITOR-START SMALL ELECTRIC MOTORS

TSL	Induction-run (½ hp, 4 poles)		Capacitor-run (¾ hp 4 poles)	
	CSIR level	Payback period years	CSCR level	Payback period years
1	4	1.7	2	1.5
2	4	1.7	3	2.7
3	5	2.5	3	2.7
4	6	4.1	4	3.3
5	6	4.1	3	2.7
6	7	17.7	8	35.5
7	7	17.7	3	2.7
8	7	17.7	7	6.0

2. Economic Impact on Manufacturers

For the NOPR, DOE used the INPV in the MIA to compare the financial impacts of different TSLs on small electric motor manufacturers. 74 FR 61464–69. The INPV is the sum of all net cash flows discounted by the industry's cost of capital (discount rate). DOE used the GRIM to compare the INPV of the base case (no new energy conservation standards) to that of each TSL for the small electric motor industry. To evaluate the range of cash-flow impacts on this industry, DOE constructed different scenarios using two different assumptions for manufacturer markups: (1) The preservation-of-return-on-invested-capital scenario, and (2) the preservation-of-operating-profit (absolute dollars) scenario. These two scenarios correspond to the range of anticipated market responses, and results in a unique set of cash flows and corresponding industry value at each TSL. These steps allowed DOE to compare the potential impacts on the industry as a function of TSLs in the GRIM. The difference in INPV between the base case and the standards case is an estimate of the economic impacts that implementing that standard level would have on the entire industry. For today's notice, DOE continues to use the above methodology and presents the results in the subsequent sections. See chapter 12 of the TSD for additional information on MIA methodology and results.

a. Industry Cash-Flow Analysis Results

Using the two different markup scenarios, DOE estimated the impact of new standards for small electric motors on the INPV of the small electric motors manufacturing industry. The impact consists of the difference between the INPV in the base case and the INPV in the standards case. INPV is the primary metric used in the MIA, and represents one measure of the fair value of the industry in today's dollars. DOE calculated the INPV by summing all of the annual net cash flows, discounted at the small electric motor industry's cost of capital or discount rate.

To assess the lower end of the range of potential impacts for the small electric motor industry, DOE considered a scenario where a manufacturer's percentage return on working capital and capital invested in fixed assets (net plant, property, and equipment), the year after the new energy conservation standards become effective, is the same as in the base case. This scenario is called the preservation-of-return-on-invested-capital scenario. To assess the higher end of the range of potential impacts for the small electric motor industry, DOE considered a scenario in which the absolute dollar amount of the industry's base-case operating profit (earnings before interest and taxes) remains the same and does not increase in the year after implementation of the standards. This scenario is called the preservation-of-operating-profit (absolute dollars) scenario. For both markup scenarios, DOE considered the same reference shipment scenario found in the NIA. Table VI.21 through Table VI.24 show the range of changes in INPV that DOE estimates could result from the TSLs DOE considered for this final rule. The results present the impacts of energy conservation standards for polyphase small electric motors separately and combine the impacts for CSIR and CSCR small electric motors. The tables also present the equipment conversion costs and capital conversion costs that the industry would incur at each TSL.

TABLE VI.21—MANUFACTURER IMPACT ANALYSIS FOR POLYPHASE SMALL ELECTRIC MOTORS

[Preservation of return on invested capital markup scenario]

	Units	Base case	Trial standard level							
			1	2	3	4	4b	5	6	7
INPV	2009$ millions	70	69	70	71	70	73	82	88	165
Change in INPV	2009$ millions		(0.19)	0.34	0.98	0.57	3.37	12.62	18.54	95.27
	%		(0.27)	0.49	1.41	0.82	4.84	18.15	26.65	136.95
Equipment Conversion Costs	2009$ millions		1.9	1.9	1.9	3.8	3.8	3.8	5.8	7.7
Capital Conversion Costs	2009$ millions		0.4	0.7	0.7	0.9	1.9	7.1	10.7	37.3
Total Investment Required	2009$ millions		2.3	2.6	2.7	4.7	5.7	10.9	16.5	45.0

TABLE VI.22—MANUFACTURER IMPACT ANALYSIS FOR POLYPHASE SMALL ELECTRIC MOTORS

[Preservation of operating profit markup scenario]

	Units	Base case	Trial standard level							
			1	2	3	4	4b	5	6	7
INPV	2009$ millions	70	68	68	67	66	64	58	52	0

TABLE VI.22—MANUFACTURER IMPACT ANALYSIS FOR POLYPHASE SMALL ELECTRIC MOTORS—Continued

[Preservation of operating profit markup scenario]

	Units	Base case	Trial standard level							
			1	2	3	4	4b	5	6	7
Change in INPV	2009$ millions		(1.49)	(1.86)	(2.26)	(3.58)	(5.43)	(11.80)	(17.51)	(69.47)
	%		(2.15)	(2.67)	(3.25)	(5.15)	(7.80)	(16.96)	(25.16)	(99.85)
Equipment Conversion Costs.	2009$ millions		1.9	1.9	1.9	3.8	3.8	3.8	5.8	7.7
Capital Conversion Costs	2009$ millions		0.4	0.7	0.7	0.9	1.9	7.1	10.7	37.3
Total Investment Required.	2009$ millions		2.3	2.6	2.7	4.7	5.7	10.9	16.5	45.0

TABLE VI.23—MANUFACTURER IMPACT ANALYSIS FOR CSIR AND CSCR SMALL ELECTRIC MOTORS

[Preservation of return on invested capital markup scenario]

	Units	Base case	Trial standard level							
			1	2	3	4	5	6	7	8
INPV	2009$ millions	279	287	289	295	311	308	466	297	325
Change in INPV	2009$ millions		8.40	9.46	16.27	32.15	28.48	186.60	18.40	46.35
	%		3.01	3.39	5.83	11.52	10.20	66.87	6.59	16.61
Equipment Conversion Costs.	2009$ millions		16.7	16.7	24.9	25.3	24.9	33.7	24.9	25.3
Capital Conversion Costs	2009$ millions		9.4	10.5	16.5	21.7	18.3	79.9	20.7	29.0
Total Investment Required.	2009$ millions		26.1	27.2	41.4	47.0	43.2	113.6	45.5	54.3

TABLE VI.24—MANUFACTURER IMPACT ANALYSIS FOR CSIR AND CSCR SMALL ELECTRIC MOTORS

[Preservation of operating profit markup scenario]

	Units	Base case	Trial standard level							
			1	2	3	4	5	6	7	8
INPV	2009$ millions	279	259	258	247	236	239	127	245	226
Change in INPV	2009$ millions		(19.99)	(20.79)	(32.42)	(43.15)	(40.09)	(152.05)	(34.05)	(52.58)
	%		(7.16)	(7.45)	(11.62)	(15.46)	(14.37)	(54.49)	(12.20)	(18.84)
Equipment Conversion Costs.	2009$ millions		16.7	16.7	24.9	25.3	24.9	33.7	24.9	25.3
Capital Conversion Costs	2009$ millions		9.4	10.5	16.5	21.7	18.3	79.9	20.7	29.0
Total Investment Required.	2009$ millions		26.1	27.2	41.4	47.0	43.2	113.6	45.5	54.3

Polyphase Small Electric Motors

DOE estimated the impacts on INPV at TSL 1 to range from $0.19 million to −$1.49 million, or a change in INPV of −0.27 percent to −2.15 percent. At this level, industry cash flow decreases by approximately 13.3 percent, to $4.84 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 1 represents an efficiency increase of 2 percent over the baseline for polyphase motors. The majority of manufacturers have motors that meet this efficiency level. All manufacturers that were interviewed stated that their existing motor designs allow for simple modifications that would require minor capital and equipment conversion costs to reach TSL 1. A possible modification analyzed in the engineering analysis is a roughly 7 percent increase in the number of laminations within both space-constrained and non space-constrained motors. Manufacturers indicated that modifications like increased laminations could be made within existing baseline motor designs without significantly altering their size. In addition, these minor design changes will not raise the production costs beyond the cost of most motors sold today, resulting in minimal impacts on industry value.

DOE estimated the impacts in INPV at TSL 2 to range from $0.34 million to −$1.86 million, or a change in INPV of 0.49 percent to 2.67 percent. At this level, industry cash flow decreases by approximately 15.6 percent, to $4.71 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 2 represents an efficiency increase of 4 percent over the baseline for polyphase motors. Similar to TSL 1, at TSL 2 manufacturers stated that their existing motor designs allow for simple modifications that would entail only minor capital and equipment conversion costs. A possible modification analyzed in the engineering analysis increases the number of laminations by approximately 15 percent from the baseline within both space-constrained and non space-constrained motors. Manufacturers indicated that these modifications could be made within baseline motor designs without significantly changing their size. At TSL 2, the production costs of standards compliant motors do not increase enough to significantly affect INPV.

At TSL 3, DOE estimated the impacts in INPV to range from $0.98 million to −$2.26 million, or a change in INPV of 1.41 percent to −3.25 percent. At this level, industry cash flow decreases by approximately 16.4 percent, to $4.67 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 3 represents an efficiency increase of 6 percent over the baseline for polyphase motors. Similar to TSL 1 and TSL 2, at TSL 3 manufacturers stated that their existing motor designs would still allow for simple modifications that would not require significant capital and equipment conversion costs. In the engineering analysis, standards compliant motors that meet the efficiency requirements at TSL 3 have 17-percent increase in the number of laminations compared to the baseline design within both space-constrained and non space-constrained motors. These changes do not result in significant impacts on INPV.

At TSL 4, DOE estimated the impacts in INPV to range from $0.57 million to −$3.58 million, or a change in INPV of 0.82 percent to −5.15 percent. At this level, industry cash flow decreases by approximately 27.7 percent, to $4.03 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 4 represents an efficiency increase of 7 percent over the baseline for polyphase motors. Most manufacturers that were interviewed are able to reach this level without significant redesigns. At TSL 4, a possible design pathway for manufacturers could be to increase the number of laminations by approximately 20 percent over the baseline designs within space-constrained and non space-constrained motors.

At TSL 4b, DOE estimated the impacts in INPV to range from $3.37 million to −$5.43 million, or a change in INPV of 4.84 percent to −7.80 percent. At this level, industry cash flow decreases by approximately 36.0 percent, to $3.57 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 4b represents an efficiency increase of 8 percent over the baseline for polyphase motors. Most manufacturers that were interviewed are able to reach this level without significant redesigns. A possible redesign for non space-constrained motors would include increasing the number of laminations by 47 percent relative to the baseline motor design. For space-constrained motors, redesigns could require up to 20 percent more laminations of better grade electrical steel. However, manufacturers reported that efficiency levels similar to TSL 4b would be the highest achievable before required efficiencies could significantly change motor designs and production equipment. However, setting a level higher than TSL 4b may require significant motor size changes.

At TSL 5, DOE estimated the impacts in INPV to range from $12.62 million to −$11.80 million, or a change in INPV of 18.15 percent to −16.96 percent. At this level industry cash flow decreases by approximately 77.7 percent, to $1.24 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 5 represents an efficiency increase of 10 percent over the baseline for polyphase motors. TSL 5 is equivalent to the current NEMA premium level that manufacturers produce for medium-sized electric motors.

Although some manufacturers reported having existing small electric motors that reach TSL 5, the designs necessary are more complex than their cost optimized designs at lower TSLs. A possible redesign for non space-constrained motors would include adding up to 49 percent more laminations relative to the baseline motor design and improving the grade of steel. For space-constrained motors, redesigns could require up to 114 percent more laminations of a thinner and higher grade of steel. Manufacturers are concerned that redesigns at TSL 5 could increase the size of the motors if they do not currently have motors that reach the NEMA premium efficiency levels. A shift to larger motors could be detrimental to sales due to the inability of OEMs to use standards-compliant motors as direct replacements in some applications.

According to manufacturers, at TSL 5, the industry would incur significantly higher capital and equipment conversion costs in comparison to the lower efficiency levels analyzed. DOE estimates that the capital and equipment conversion costs required to make the redesigns at TSL 5 would be approximately four times the amount required to meet TSL 1. At TSL 5 manufacturers would also be required to shift their entire production of baseline motors to higher priced and higher efficiency motors, making their current cost-optimized designs obsolete. These higher production costs could have a greater impact on the industry value if operating profit does not increase. Manufacturers indicated that setting energy conservation standards at TSL 5 could cause some manufacturers to consider exiting the small electric motor market because of the lack of resources, potentially unjustifiable investments for a small segment of their business, and the possibility of lower revenues if OEMs will not accept large motors.

At TSL 6, DOE estimated the impacts in INPV to range from $18.54 million to −$17.51 million, or a change in INPV of 26.65 percent to −25.16 percent. At this level industry cash flow decreases by approximately 117.2 percent, to −$0.96 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 6 represents an efficiency increase of 12 percent over the baseline for polyphase motors. Currently, no small electric motors are rated above the equivalent to the NEMA premium standard (TSL 5). Possible redesigns for space-constrained motors at TSL 6 include the use of copper rotors and a 114-percent increase in the number of laminations of a thinner and higher grade of steel. These changes would cause manufacturers to incur significant capital and equipment conversion costs to redesign their space-constrained motors due to the lack of experience in using copper.

According to manufacturers, copper tooling is significantly costlier and not currently used by any manufacturers for the production of small electric motors. If copper rotor designs are required, manufacturers with in-house die-casting capabilities will need completely new machinery to process copper. Manufacturers that outsource rotor production would pay higher prices for their rotor designs. In both cases, TSL 6 results in significant equipment conversion costs to modify current manufacturing processes in addition to redesigning motors to use copper in the applications of general purpose small electric motors. Largely due to the significant changes to space-constrained motors, DOE estimates that at TSL 6 manufacturers would incur close to seven times the total conversion costs required at TSL 1 (a total of approximately $16.5 million). However, for non space-constrained motors, manufacturers are able to redesign their existing motors without the use of copper rotors by using twice the number of laminations that are contained in the baseline design. Therefore, for non space-constrained motors the impacts at TSL 6 are significantly less because manufacturers can maintain existing manufacturing processes without the potentially significant changes associated with copper rotors. At TSL 6 the impacts for non space-constrained motors are mainly due to higher motor costs and the possible decrease in profitability if manufacturers are unable to fully pass through their higher production costs.

At TSL 7, DOE estimated the impacts in INPV to range from $95.27 million to −$69.47 million, or a change in INPV of 136.95 percent to −99.85 percent. At this level industry cash flow decreases by approximately 342.4 percent, to −$13.52 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 7 represents an efficiency increase of 14 percent over the baseline for polyphase motors.

Currently, the market does not have any motors that reach TSL 7. At TSL 7, space-constrained motor designs may require the use of copper rotors and premium electrical steels, such as the Hiperco steel used in DOE's design. There is some uncertainty about the magnitude of the impacts on the industry of using Hiperco steel. Manufacturers were unsure about the required conversion costs to reach TSL 7 because of the unproven properties and applicability of the technology in the general purpose motors covered by this rulemaking.

Significant R&D for both manufacturing processes and motor redesigns would be necessary to understand the applications of premium steels to general purpose small electric motors. According to manufacturers, requiring this technology could cause some competitors to exit the small electric motor market. If manufacturers' concerns of having to use both copper rotors and new steels materialize, manufacturers could be significantly impacted. For non space-constrained motors, DOE estimates that manufacturers would require the use of copper rotors but not premium steels. If manufacturers are required to redesign non-spaced constrained motors with copper, the total conversion costs for the industry increases greatly because all motors require substantially different production equipment. Finally, the production costs of motors that meet TSL 7 could be up to 18 times higher than the production costs of baseline motors. The cost to manufacture standards-compliant motors could have a significant impact on the industry if operating profit does not increase with production costs.

Capacitor-Start, Induction Run and Capacitor-Start, Capacitor-Run Small Electric Motors

At TSL 1, DOE estimated the impacts in INPV to range from $8.4 million to –$19.99 million, or a change in INPV of 3.01 percent to –7.16 percent. At this level, industry cash flow decreases by approximately 41.3 percent, to $13.13 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 1 represents an efficiency increase of 19-percent over the baseline for CSIR motors and 10-percent over the baseline for CSCR motors. At TSL 1 for CSIR motors, DOE estimates manufacturers would need to increase the number of laminations for space-constrained motors by approximately 33 percent and use a thinner and higher grade of steel. For non space-constrained CSIR motors, manufacturers could increase laminations by approximately 61 percent with the use of a better grade of electric steel. For space-constrained CSCR motors, manufacturers could increase laminations by ten percent and use a higher grade of steel. For non space-constrained CSCR motors, manufacturers could increase laminations by approximately 37 percent. For both CSIR and CSCR motors, the additional stack length needed to reach TSL 1 is still within the tolerances of many manufacturers' existing motors. DOE estimates that these changes would cause the industry to incur capital and equipment conversion costs of approximately $26.1 million to reach TSL 1. While TSL 1 would increase production costs, the cost increases are not enough to severely affect INPV under the scenarios analyzed.

At TSL 2, DOE estimated the impacts in INPV to range from $9.46 million to −$20.79 million, or a change in INPV of 3.39 percent to –7.45 percent. At this level, industry cash flow decreases by approximately 43.5 percent, to $12.65 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 2 represents an efficiency increase of 19 percent over the baseline for CSIR motors and 13-percent over the baseline for CSCR motors. For CSIR motors, the same changes to meet TSL 1 are necessary for TSL 2. For CSCR motors, TSL 2 represents what manufacturers would consider a NEMA Premium equivalent efficiency level. The changes required for CSCR motors could cause manufacturers to incur additional capital conversion costs to accommodate the required increase in laminations. Imposing standards at TSL 2 would increase production costs for both CSIR and CSCR motors, but the cost increases for both types of motors are not enough to severely affect INPV.

At TSL 3, DOE estimated the impacts in INPV to range from $16.27 million to –$32.42 million, or a change in INPV of 5.83 percent to –11.62 percent. At this level, industry cash flow decreases by approximately 66.5 percent, to $7.51 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 3 represents an efficiency increase of 23 percent over the baseline for CSIR motors and 13 percent over the baseline for CSCR motors. At TSL 3, space-constrained CSIR motors could require redesigns that use copper rotors. Using copper rotors for space-constrained CSIR motors could cause manufacturers to incur approximately $41.4 million in capital and equipment conversion costs, largely to purchase the equipment necessary to produce these redesigned motors.

As with polyphase motors, manufacturers reported that copper rotor tooling is significantly costlier than traditional aluminum rotor tooling and not currently used by the industry for the production of small electric motors. Similarly, in-house die-casting capabilities would need completely new machinery to process copper and the alternative of outsourcing rotor production would greatly increase material costs. For non space-constrained CSIR motors, manufacturers could redesign motors by increasing the number of laminations without the use of copper rotors, resulting in significantly smaller impacts. At TSL 3, the impacts for non-space-constrained motors are mainly due to higher motor material costs and a possible decline in profit margins. TSL 3 represents what manufacturers would consider a NEMA Premium equivalent efficiency level for CSCR motors. The required efficiencies for space-constrained CSCR motors could be met by manufacturers by increasing the number of laminations by 15 percent and using higher steel grades. The required efficiencies for non-spaced constrained CSCR motors could be met by increasing the number of laminations by 53 percent. Because the redesigns for CSCR motors are less substantial, the impacts at TSL 3 are driven largely by the required CSIR efficiencies.

At TSL 4, DOE estimated the impacts in INPV to range from $32.15 million to –$43.15 million, or a change in INPV of 11.52 percent to −15.46 percent. At this level, industry cash flow decreases by approximately 77.5 percent, to $5.02 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 4 represents an efficiency increase of 27 percent over the baseline for CSIR motors and 15 percent over the baseline for CSCR motors. TSL 4 currently represents a NEMA premium equivalent level for CSIR motors. Possible redesigns for both CSIR and CSCR motors to meet TSL 4 involve both increasing the number of laminations as well as using higher grades of steel.

For space-constrained CSIR motors, redesigns could require the use of copper rotors. Because of these redesigns, standards-compliant motors at TSL 4 have significantly higher costs than manufacturers' baseline motors.

These changes increase the engineering and capital resources that must be employed, especially for CSCR motors. The negative impacts at TSL 4 are driven by the conversion costs that potentially require some single-phase motors to use copper rotors, and the higher production costs of standards-compliant motors.

At TSL 5, DOE estimated the impacts in INPV to range from $28.48 million to –$40.09 million, or a change in INPV of 10.20 percent to –14.37 percent. At this level, industry cash flow decreases by approximately 70.2 percent, to $6.66 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 5 represents an efficiency increase of 27 percent over the baseline for CSIR motors and 13 percent over the baseline for CSCR motors. TSL 5 represents NEMA premium equivalent efficiency levels for both CSIR and CSCR motors.

At TSL 5, space-constrained CSIR motors could require the use of copper rotors. The required efficiencies for non space-constrained CSIR motors could be met by manufacturers by increasing the number of laminations by 82 percent and using a higher grade of steel. The required efficiencies for space-constrained CSCR motors could be met by manufacturers by increasing the number of laminations by 15 percent and using higher steel grades. The required efficiencies for non-spaced constrained CSCR motors could be met by increasing the number of laminations by 53 percent.

Although manufacturers reported that meeting TSL 5 is feasible, the production costs of motors at TSL 5 increase substantially and require approximately $43.2 million in total capital and equipment conversion costs. The negative impacts at TSL 5 are driven by these conversion costs that potentially require some CSIR motors to use copper rotors, and the impacts on profitability if the higher production costs of standards-compliant motors cannot be fully passed through to customers.

At TSL 6, DOE estimated the impacts in INPV to range from $186.60 million to –$152.05 million, or a change in INPV of 66.87 percent to –54.49 percent. At this level, industry cash flow decreases by approximately 205.8 percent, to –$22.67 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 6 represents an efficiency increase of 33 percent over the baseline for CSIR motors and 23 percent over the baseline for CSCR motors.

Currently, the market does not have any CSIR and CSCR motors that reach TSL 6. TSL 6 represents the max-tech efficiency level for both CSIR and CSCR motors. In addition to the possibility of using copper rotors for both CSIR and CSCR motors, at TSL 6, space-constrained motor designs could require premium steels, such as Hiperco. There is uncertainty about the impact of Hiperco steel on the industry, primarily due to uncertainty about capital conversion costs required to use a new type of steel. Significant R&D in manufacturing processes would be necessary to understand the applications of these premium steels in general purpose small electric motors. Because all space-constrained motors could require copper rotors and premium steels and all non-spaced constrained motors could require copper rotors, the capital conversion costs are a significant driver of INPV at TSL 6. Finally, the production costs of motors that meet TSL 6 can be as high as 13 times the production cost of baseline motors, which impact profitability if the higher production costs cannot be fully passed through to OEMs. Manufacturers indicated that the potentially large impacts on the industry at TSL 6 could force some manufacturers to exit the small electric motor market because of the lack of resources and what could be an unjustifiable investment for a small segment of their total business.

At TSL 7, DOE estimated the impacts in INPV to range from $18.40 million to –$34.05 million, or a change in INPV of 6.59 percent to –12.20 percent. At this level, industry cash flow decreases by approximately 74.7 percent, to $5.66 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 7 represents an efficiency increase of 33 percent over the baseline for CSIR motors and 13 percent over the baseline for CSCR motors.

TSL 7 corresponds to the NEMA premium equivalent efficiency for CSCR motors. The required efficiencies for space-constrained CSCR motors could be met by manufacturers by increasing the number of laminations by 15 percent and using higher steel grades. The required efficiencies for non space-constrained CSCR motors could be met by increasing the number of laminations by 53 percent. Consequently, the industry is not severely impacted by the CSCR efficiency requirements at TSL 7 because these design changes could be met with relatively minor changes to baseline designs.

However, there are no CSIR motors currently on the market that reach TSL 7 (the max-tech efficiency level for CSIR). At TSL 7 space-constrained CSIR redesigns could require the use of both copper rotors and premium steels while non space-constrained CSIR motors could require only copper rotors. Manufacturers continue to have the same concerns about copper rotors and premium steels for CSIR motors as with other efficiency levels that may require these technologies. The impacts on INPV from CSIR motors are mainly associated with estimated shipments of non-space constrained CSIR motors and how investments exclude premium steels in motor redesigns. The INPV impacts for all single-phase motors at TSL 7 are less severe than at TSL 6 due to a change in balance of shipments between CSIR and CSCR motors. At TSL 7, the possible high cost of CSIR motors would likely cause customers to migrate to CSCR motors.

In its analysis, DOE assumed that manufacturers would not invest in all the alternative technologies for CSIR motors in light of the expected migration to CSCR motors. At TSL 7, the industry is impacted (though to a lesser extent than at TSL 6) by the high conversion costs for CSIR motors, for which manufacturers must invest even though these are a small portion of total shipments after standards. However, because the total volume of single-phase motors does not decline with the shift from CSIR to CSCR motors, the higher revenues from standards-compliant CSCR motors mitigate redesign costs for CSIR motors.

At TSL 8, DOE estimated the impacts in INPV to range from $46.35 million to –$52.58 million, or a change in INPV of 13.07 percent to –16.17 percent. At this level, industry cash flow decreases by approximately 92.1 percent, to $1.77 million, compared to the base-case value of $22.38 million in the year leading up to the compliance date for the energy conservation standards. TSL 8 represents an efficiency increase of 33 percent over the baseline for CSIR motors and 20 percent over the baseline for CSCR motors.

As with TSL 7, CSIR motors are at the max-tech efficiency level at TSL 8. However, the impacts on INPV are worse at TSL 7 because the efficiency requirements for CSCR motors increase. At TSL 8, both space-constrained and non space-constrained CSCR motors could require the use of copper, which increases the total conversion costs for the industry. Manufacturers continue to share the same concerns about the copper and premium steel investments for CSCR and CSIR motors as at TSL 6 and TSL 7. Like TSL 7, TSL 8 causes a migration of CSIR motors to CSCR motors. DOE assumed that manufacturers would fully incur the required conversion costs for CSCR, but partially for CSIR motors, due to the low market share of CSIR motors after the energy conservation standards must be met. After these standards apply, the shift to CSCR motors increases total industry revenue and helps to mitigate impacts related to capital conversion costs necessary for CSIR motors to use alternative technologies.

b. Impacts on Employment

As discussed in the NOPR and for today's final rule, DOE does not believe that standards would materially alter the domestic employment levels of the small electric motors industry under any of the TSLs considered for today's final rule. 74 FR 61469. Even if DOE set new efficiency levels high enough to cause some manufacturers to exit the small electric motor market, the direct employment impact would likely be minimal. Id. Most covered small motors are manufactured on shared production lines and in factories that also produce a substantial number of other products. If a manufacturer decided to exit the market, these employees would likely be used in some other capacity, reducing the number of headcount reductions. These manufacturers estimated that no production jobs would be lost due to energy conservation standards, but rather the engineering departments could be reduced by up to one engineer per dropped product line.

The employment impacts calculated by DOE are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 15 of the TSD accompanying this notice and discussed in section VI.C.3. Based on available data and its analyses, DOE does not believe that the effects of today's rule would substantially impact employment levels in the small electric motor industry. For further information and results on direct employment see chapter 12 of the TSD.

c. Impacts on Manufacturing Capacity

As detailed in the NOPR, no change in the fundamental assembly of small electric motors would be required by DOE adoption of any of the TSLs considered for today's rule, and none of the TSLs would require replacing or adding to existing facilities to manufacture. 74 FR 61469–70. For today's final rule, DOE continues to believe manufacturers can use any available excess capacity to mitigate any possible capacity constraint as a result of energy conservation standards. In DOE's view, it is more likely that some motors would be discontinued due to lower demand after the promulgation of a standard. For further explanation of the impacts on manufacturing capacity for small electric motors, see chapter 12 of the TSD.

d. Impacts on Subgroups of Manufacturers

For the reasons stated in the NOPR, including its conclusion that no small manufacturers produced small electric motors, DOE did not analyze manufacturer subgroups in the small electric motor industry. 74 FR 61470. DOE did not receive further information or comment that would otherwise change its views.

e. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of several regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden.

DOE recognizes that each regulation can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can reduce manufacturers' profits and may cause manufacturers to exit from the market. DOE did not identify any additional DOE regulations that would affect the manufacturers of small electric motors apart from the ones discussed in the NOPR. 74 FR 61470. These included other DOE regulations and international standards. DOE recognizes that each regulation has the potential to impact manufacturers' financial operations. For further information about the cumulative regulatory burden on the small electric motors industry, see chapter 12 of the TSD.

3. National Net Present Value and Net National Employment

The NPV analysis estimates the cumulative benefits or costs to the Nation, discounted to 2009$ in the year 2010, of particular standard levels relative to a base case of no new standard. In accordance with OMB guidelines on regulatory analysis (OMB Circular A–4, section E, September 17, 2003), DOE estimated NPVs using both a 7 percent and 3 percent real discount rate. The 7 percent rate is an estimate of the average before tax rate of return to private capital in the U.S. economy. This rate reflects the returns to real estate and small business capital as well as corporate capital. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, since recent OMB analysis has found the average rate of return to capital to be near this rate. DOE also used the 3 percent discount rate to capture the potential effects of standards on private consumption (*e.g.,* through higher prices for equipment and purchase of reduced amounts of energy). This rate represents the rate at which society discounts future consumption flows to their present value. This rate can be approximated by the real rate of return on long-term Government debt (*e.g.,* the yield on Treasury notes minus the annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the last 30 years.

The NPV was calculated using DOE's reference shipments forecast, which is based on the *AEO 2010* Early Release forecast. In this scenario, shipments display an elasticity of –0.25, which allows for a market shift to enclosed motors when open motors become more expensive than their enclosed equivalents. DOE used its calibrated reference model for the market dynamics of CSIR and CSCR motors. DOE's reference scenario also includes 100 percent of the cost or benefit from changes in reactive power charges, which are faced either by electricity customers or by utilities (which then include them in electricity rates). Table VI.25 and Table VI.26 show the estimated NPV at each of the TSLs for polyphase and capacitor-start small electric motors. For polyphase motors, the NPV is positive at TSLs 1 through 5 using a 7-percent discount rate, and is positive for TSLs 1 through 6 using a 3-percent discount rate. For capacitor-start motors, NPV is positive at all TSLs except TSL 6. The latter TSL corresponds to max-tech efficiency levels for both CSIR and CSCR motors, which have high installed costs and negative lifecycle cost savings. See TSD Chapter 10 for more detailed NPV results.

Across motors, for certain TSLs, DOE estimates there will be a net national savings or positive NPV from the standard, even though a majority of motor customers may face life-cycle cost increases. Life-cycle cost increases result from the large number of small electric motors installed in applications with very low operating hours. The consumers of these motors cannot recover the increased equipment costs through decreased electricity costs, thus experiencing life-cycle cost increases. On the other hand, a substantial minority of motors run at nearly all hours of the day and thus obtain relatively large savings from the standard.

Table VI.25 and Table VI.26 show DOE's estimates of net present value for each TSL DOE considered for this final rule.

TABLE VI.25—CUMULATIVE NET PRESENT VALUE FOR POLYPHASE SMALL ELECTRIC MOTORS (IMPACT FOR EQUIPMENT SOLD FROM 2015 TO 2045)

Trial standard level	Net present value billion 2009$	
	7% Discount rate	3% Discount rate
1	0.10	0.26
2	0.22	0.55
3	0.41	1.01
4	0.42	1.05
4b	0.54	1.44
5	0.16	0.77
6	−0.22	0.06
7	−6.82	−12.65

TABLE VI.26—CUMULATIVE NET PRESENT VALUE FOR CAPACITOR-START SMALL ELECTRIC MOTORS (IMPACT FOR EQUIPMENT SOLD FROM 2015 TO 2045)

Trial standard level	Net present value billion 2009$	
	7% Discount rate	3% Discount rate
1	3.01	7.03
2	3.05	7.13
3	2.83	6.87
4	1.97	5.35
5	2.08	5.57
6	−9.29	−16.23
7	4.74	11.08
8	3.03	8.14

As discussed in section VI.C.1.b above, DOE estimated LCC and payback periods under a sensitivity case using data on motor shipments distributions provided by OEMs via a survey conducted by NEMA. Under this sensitivity case lifecycle costs increase for polyphase and CSCR motor users, but decrease for CSIR motor users. DOE estimates there is a net increase in national benefits from the standards promulgated in today's rule using the new information provided by NEMA, with energy savings increasing from 2.20 to 2.68 quads, and NPV increasing from $12.52 to $19.75 billion, using a 3 percent discount rate.

DOE also analyzed the effect of NEMA's assertion that 95 percent of motors are used in space-constrained applications. However, at the capacitor-start efficiency levels in today's rule, DOE estimates that 97 percent of the CSIR market will migrate to CSCR motors assuming only 20 percent of the market is space-constrained. Therefore, increasing the assumption of the fraction of CSIR motors that is space-constrained to 95-percent only affects the 3-percent of the CSIR market that had not already migrated to CSCR motors under DOE's reference case, and has little effect on the estimates of national energy savings.

Chapter 10 of the TSD has details on the national impacts for the reference case, while the national impacts for these sensitivity cases are presented in appendix 10A.

DOE also estimated for each TSL the indirect employment impact of standards—the impact on the economy in general—in addition to considering the direct employment impacts on manufacturers of products covered in this rulemaking as discussed in section VI.C.2.b. DOE expects the net monetary savings from standards to be redirected to other forms of economic activity. DOE also expects these shifts in spending and economic activity to affect the demand for labor. As shown in Table VI.27 and Table VI.28, DOE estimates that net indirect employment impacts from energy conservation standards for small electric motors would be positive but very small relative to total national employment. Specifically, DOE's analysis indicates that the number of jobs that may be generated by 2045 through indirect impacts ranges from 47 to 6,300 for the TSLs for polyphase small motors, and from 1,100 to 18,700 for the TSLs for capacitor-start small motors. These increases would likely be sufficient to offset fully any adverse impacts on employment that might occur in the small electric motors industry. For details on the employment impact analysis methods and results, see TSD Chapter 14.

TABLE VI.27—NET INCREASE IN NATIONAL INDIRECT EMPLOYMENT UNDER POLYPHASE SMALL ELECTRIC MOTOR TRIAL STANDARDS LEVELS

Trial standard level	2015 thousands	2020 thousands	2030 thousands	2045 thousands
1	0.047	0.136	0.222	0.299
2	0.084	0.254	0.418	0.565
3	0.151	0.463	0.761	1.030
4	0.190	0.539	0.874	1.178

TABLE VI.27—NET INCREASE IN NATIONAL INDIRECT EMPLOYMENT UNDER POLYPHASE SMALL ELECTRIC MOTOR TRIAL STANDARDS LEVELS—Continued

Trial standard level	2015 thousands	2020 thousands	2030 thousands	2045 thousands
4b	0.356	0.915	1.446	1.942
5	0.661	1.347	2.016	2.668
6	0.901	1.679	2.448	3.219
7	2.349	3.621	4.921	6.343

TABLE VI.28—NET INCREASE IN NATIONAL INDIRECT EMPLOYMENT UNDER CAPACITOR-START SMALL ELECTRIC MOTOR TRIAL STANDARDS LEVELS

Trial standard level	2015 thousands	2020 thousands	2030 thousands	2045 thousands
1	1.113	3.645	5.249	7.062
2	1.119	3.674	5.293	7.123
3	1.577	4.512	6.398	8.557
4	2.287	5.561	7.716	10.236
5	2.248	5.529	7.686	10.204
6	8.042	12.159	15.350	19.569
7	1.776	5.795	8.340	11.216
8	2.322	9.591	13.880	18.701

4. Impact on Utility or Performance of Equipment

As explained in sections III.D.1.d and V.B.4 of the NOPR, users of these motors will not face a reduction in small electric motor utility or performance under the levels examined under this rulemaking. DOE has not received any additional information suggesting that such a reduction would occur. Accordingly, DOE has concluded that no lessening of the utility or performance of the small electric motors under consideration in this rulemaking would result from adoption of any of the TSLs considered for this final rule. 74 FR 61419, 61476.

5. Impact of Any Lessening of Competition

As discussed in the November 2009 NOPR, 74 FR 61419, 61476, and in section III.D.1.e of this final rule, DOE considers any lessening of competition that is likely to result from standards. The Attorney General determines the impact, if any, of any such lessening of competition.

The DOJ concluded that the standards DOE proposed for small electric motors in the November 2009 NOPR could increase costs for consumers who need to replace either a polyphase or capacitor-start small electric motor in existing equipment. This is because compliance with these standards may require manufacturers to increase the size of their motors such that the larger motors may not fit into existing space-constrained equipment. In turn, owners with a broken motor may need to replace the entire piece of equipment or attempt to have the motor repaired, which could be costly. DOJ requested that DOE consider this impact, and, as warranted, consider exempting from the standard the manufacture and marketing of certain replacement small electric motors for a limited period of time. (DOJ, No. 29 at pp. 1–2) DOJ does not believe the proposed standard would likely lead to a lessening of competition.

For its final rule on energy conservations standards for small electric motors, DOE considered the issue raised by DOJ. DOE believes it adequately accounts for the impacts on those consumers that purchase motors for space-constrained applications by developing motors with higher costs for what it estimates as space-constrained. Furthermore, DOE does not believe it is necessary to exempt motors manufactured to replace motors in space-constrained applications because these motors are not marketed as “for replacement purposes,” enforcing such a standard could be problematic. In addition, an exemption for replacement motors would also apply to motors in non-space constrained applications potentially significantly reducing energy savings of this rule. Lastly, DOE believes that the five-year period before the effective date will give customers or OEMs sufficient time to account for any changes to motor sizes or to stockpile replacement motors for their applications.

The Attorney General’s response is reprinted at the end of this rule.

6. Need of the Nation To Conserve Energy

Improving the energy efficiency of small electric motors, where economically justified, would likely improve the security of the Nation’s energy system by reducing overall demand for energy, thus reducing the Nation’s reliance on foreign sources of energy. Reduced electricity demand might also improve the reliability of the electricity system, particularly during peak-load periods. As a measure of this reduced demand, DOE expects the energy savings from today’s standards to eliminate the need for approximately 2.16 gigawatts (GW) of generating capacity by 2045 and in 2045, to save an amount of electricity greater than that generated by eight 250 megawatt power plants.

Enhanced energy efficiency also produces environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production. Table VI.29 and Table VI.30 provide DOE’s estimate of cumulative CO_2, NO_X, and Hg emissions reductions that would result from the TSLs considered in this rulemaking. The expected energy savings from these standards may also reduce the cost of maintaining nationwide emissions standards and constraints. In the environmental assessment (EA; chapter 15 of the TSD accompanying this notice), DOE reports estimated annual changes in CO_2, NO_X, and Hg emissions attributable to each TSL. The cumulative CO_2, NO_X, and Hg emissions reductions from polyphase motors range up to 23.2 Mt, 16.9 kt, and

0.12 ton, respectively, and up to 121.7 Mt, 88.9 kt, and 0.47 ton, respectively, from single-phase motors.

TABLE VI.29—POLYPHASE SMALL ELECTRIC MOTORS: CUMULATIVE CO_2 AND OTHER EMISSIONS REDUCTIONS

[Cumulative reductions for products sold from 2015 to 2045]

Trial standard level	Emissions reductions		
	CO_2 Mt	NO_X kt	Hg tons
1	2.3	1.6	0.013
2	4.6	3.3	0.025
3	8.3	5.9	0.046
4	9.3	6.7	0.051
4b	15.4	11.0	0.085
5	18.3	13.1	0.101
6	19.5	13.9	0.108
7	21.2	15.2	0.117

TABLE VI.30—CAPACITOR-START SMALL ELECTRIC MOTORS: CUMULATIVE CO_2 AND OTHER EMISSIONS REDUCTIONS

[Cumulative reductions for products sold from 2015 to 2045]

Trial standard level	Emissions reductions		
	CO_2 Mt	NO_X kt	Hg tons
1	62.9	45.1	0.265
2	63.5	45.5	0.267
3	71.7	51.4	0.302
4	80.5	57.7	0.339
5	81.0	58.1	0.341
6	88.5	63.5	0.373
7	96.8	69.5	0.408
8	111.4	80.0	0.469

As noted in section IV.L of this final rule, DOE does not report SO_2 emissions reductions from power plants because DOE is uncertain that an energy conservation standard would affect the overall level of U.S. SO_2 emissions due to emissions caps. DOE also did not include NO_X emissions reduction from power plants in states subject to CAIR because an energy conservation standard would likely not affect the overall level of NO_X emissions in those states due to the emissions caps mandated by CAIR.

In the NOPR, DOE also investigated and considered the potential monetary benefit of any reduced CO_2, SO_2, NO_X, and Hg emissions that could result from the TSLs it considered. 74 FR 61448–53, 61477–84. To estimate the likely monetary benefits of CO_2 emission reductions associated with the potential standards, DOE valued the potential global benefits resulting from such reductions at the interim values of $5, $10, $20, $34 and $57 per metric ton in 2007 (in 2008$), and also valued the domestic benefits at approximately $1 per metric ton. 74 FR 61452. For today's final rule DOE has updated its analysis to reflect the outcome of the most recent interagency process regarding the social cost of carbon dioxide emissions (SCC). See section IV.M for a full discussion. The four values of CO_2 emissions reductions resulting from that process are $4.70/ton (the average value from a distribution that uses a 5% discount rate), $21.40/ton (the average value from a distribution that uses a 3% discount rate), $35.10/ton (the average value from a distribution that uses a 2.5% discount rate), and $65/ton (the 95th percentile value from a distribution that uses a 3% discount rate). These values are expressed in 2007$ and correspond to the value of emission reductions in 2010; the values for later years are higher due to increasing damages as the magnitude of climate change increases. Table VI.31 and Table VI.32 present the global values of emissions reductions at each TSL. Domestic values are calculated as a range from 7% to 23% of the global values, and these results are presented in Table VI.33 and Table VI.34.

TABLE VI.31—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER POLYPHASE SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT SCC-SCENARIO-CONSISTENT DISCOUNT RATE

TSL	Estimated cumulative CO_2 emission reductions, Mt	Global value of CO_2 emission reductions, million 2009$			
		5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
1	2.3	8	40	68	122
2	4.6	16	81	138	248
3	8.3	28	146	248	445
4	9.3	32	165	280	502
4b	15.4	52	272	462	828
5	18.3	62	323	550	986

TABLE VI.31—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER POLYPHASE SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT SCC-SCENARIO-CONSISTENT DISCOUNT RATE—Continued

TSL	Estimated cumulative CO_2 emission reductions, Mt	Global value of CO_2 emission reductions, million 2009$			
		5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
6	19.5	66	344	585	1049
7	21.2	72	375	638	1144

* Columns are labeled by the discount rate used to calculate the social cost of emissions and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.32—ESTIMATES OF GLOBAL PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER CAPACITOR-START SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT SCC-SCENARIO-CONSISTENT DISCOUNT RATE

TSL	Estimated cumulative CO_2 emission reductions, Mt	Global value of CO_2 emission reductions, million 2009$			
		5% discount rate, average*	3% discount rate, average*	2.5% discount rate, average*	3% discount rate, 95th percentile*
1	62.9	216	1118	1900	3410
2	63.5	218	1129	1918	3444
3	71.7	246	1275	2167	3890
4	80.5	277	1432	2432	4367
5	81.0	278	1441	2448	4394
6	88.5	304	1574	2674	4801
7	96.8	333	1722	2926	5253
8	111.4	383	1982	3368	6046

* Columns are labeled by the discount rate used to calculate the social cost of emissions and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.33—ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER POLYPHASE SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT SCC-SCENARIO-CONSISTENT DISCOUNT RATE

TSL	Domestic value of CO_2 emission reductions, million 2009$ *			
	5% discount rate, average**	3% discount rate, average**	2.5% discount rate, average**	3% discount rate, 95th percentile**
1	0.5–1.8	2.8–9.2	4.8–15.7	8.5–28.1
2	1.1–3.6	5.7–18.7	9.7–31.8	17.3–57.0
3	2.0–6.4	10.2–33.5	17.4–57.1	31.1–102.3
4	2.2–7.3	11.5–37.9	19.6–64.4	35.1–115.5
4b	3.7–12	19.0–62.5	32.3–106.3	58.0–190.5
5	4.3–14.3	22.6–74.4	38.5–126.5	69.0–226.8
6	4.6–15.2	24.1–79.1	41.0–134.6	73.4–241.2
7	5.0–16.6	26.3–86.3	44.7–146.7	80.1–263.0

* Domestic values are presented as a range between 7% and 23% of the global values.

** Columns are labeled by the discount rate used to calculate the social cost of emissions and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

TABLE VI.34—ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER CAPACITOR-START SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT SCC-SCENARIO-CONSISTENT DISCOUNT RATE

TSL	Domestic value of CO_2 emission reductions, million 2009$ *			
	5% discount rate, average**	3% discount rate, average**	2.5% discount rate, average**	3% discount rate, 95th percentile**
1	15–50	78–257	133–437	239–784
2	15–50	79–260	134–441	241–792
3	17–57	89–293	152–498	272–895
4	19–64	100–329	170–559	306–1004
5	19–64	101–331	171–563	308–1011
6	21–70	110–362	187–615	336–1104
7	23–77	121–396	205–673	368–1208

TABLE VI.34—ESTIMATES OF DOMESTIC PRESENT VALUE OF CO_2 EMISSIONS REDUCTIONS FOR THE PERIOD 2015–2045 UNDER CAPACITOR-START SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT SCC-SCENARIO-CONSISTENT DISCOUNT RATE—Continued

TSL	Domestic value of CO_2 emission reductions, million 2009$ *			
	5% discount rate, average**	3% discount rate, average**	2.5% discount rate, average**	3% discount rate, 95th percentile**
8	27–88	139–456	236–775	423–1391

* Domestic values are presented as a range between 7% and 23% of the global values.

** Columns are labeled by the discount rate used to calculate the social cost of emissions and whether it is an average value or drawn from a different part of the distribution. Values presented in the table are based on escalating 2007$ to 2009$ for consistency with other values presented in this notice, and incorporate the escalation of the SCC with each year.

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

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X and Hg emissions reductions anticipated to result from amended standards for SEMs. The dollar per ton values that DOE used are discussed in section IV.M of this final rule. Table VI.35 through Table VI.38 present the estimates calculated using seven percent and three percent discount rates, respectively.

TABLE VI.35—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X AND HG EMISSIONS UNDER POLYPHASE SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT A SEVEN PERCENT DISCOUNT RATE

Polyphase TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$	Cumulative Hg emission reductions, t	Value of Hg emission reductions, million 2009$
1	1.62	0.11 to 1.18	0.013	0.00 to 0.12.
2	3.29	0.23 to 2.39	0.025	0.01 to 0.25.
3	5.91	0.42 to 4.29	0.046	0.01 to 0.45.
4	6.67	0.47 to 4.84	0.051	0.01 to 0.51.
4b	11.00	0.78 to 7.99	0.085	0.02 to 0.84.
5	13.09	0.92 to 9.51	0.101	0.02 to 1.00.
6	13.93	0.98 to 10.11	0.108	0.02 to 1.06.
7	15.19	1.07 to 11.03	0.117	0.03 to 1.16.

TABLE VI.36—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X AND HG EMISSIONS UNDER POLYPHASE SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT A THREE PERCENT DISCOUNT RATE

Polyphase TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$	Cumulative Hg emission reductions, t	Value of Hg emission reductions, million 2009$
1	1.62	0.34 to 3.46	0.013	0.01 to 0.24.
2	3.29	0.68 to 7.01	0.025	0.01 to 0.48.
3	5.91	1.22 to 12.59	0.046	0.02 to 0.87.
4	6.67	1.38 to 14.21	0.051	0.02 to 0.98.
4b	11.00	2.28 to 23.45	0.085	0.04 to 1.62.
5	13.09	2.71 to 27.90	0.101	0.04 to 1.93.
6	13.93	2.89 to 29.68	0.108	0.05 to 2.05.
7	15.19	3.15 to 32.37	0.117	0.05 to 2.24.

TABLE VI.37—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X AND Hg EMISSIONS UNDER CAPACITOR-START SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT A SEVEN PERCENT DISCOUNT RATE

Capacitor-start TSL	Cumulative NO_X emission reductions, kt	Value of NO_X emission reductions, million 2009$	Cumulative Hg emission reductions, t	Value of Hg emission reductions, million 2009$
1	45.10	3.50 to 35.97	0.265	0.06 to 2.79.
2	45.54	3.53 to 36.23	0.267	0.06 to 2.82.
3	51.44	3.99 to 41.03	0.302	0.07 to 3.18.
4	57.74	4.48 to 46.05	0.339	0.08 to 3.57.
5	58.11	4.51 to 46.34	0.341	0.08 to 3.60.
6	63.48	4.93 to 50.63	0.373	0.09 to 3.93.
7	69.47	5.39 to 55.40	0.408	0.10 to 4.30.
8	79.95	6.20 to 63.76	0.469	0.11 to 4.95.

TABLE VI.38—ESTIMATES OF VALUE OF REDUCTIONS OF NO_X AND Hg EMISSIONS UNDER CAPACITOR-START SMALL ELECTRIC MOTOR TRIAL STANDARD LEVELS AT A THREE PERCENT DISCOUNT RATE

Capacitor-start TSL	Cumulative NO_X emission reductions (kt)	Value of NO_X emission reductions million 2009$	Cumulative Hg emission reductions (t)	Value of Hg emission reductions million 2009$
1	45.10	9.60 to 98.70	0.265	0.12 to 5.22.
2	45.54	9.69 to 99.66	0.267	0.12 to 5.27.
3	51.44	10.95 to 112.58	0.302	0.13 to 5.95.
4	57.74	12.29 to 126.37	0.339	0.15 to 6.68.
5	58.11	12.37 to 127.17	0.341	0.15 to 6.72.
6	63.48	13.52 to 138.94	0.373	0.17 to 7.34.
7	69.47	14.79 to 152.03	0.408	0.18 to 8.04.
8	79.95	17.02 to 174.97	0.469	0.21 to 9.25.

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table VI.40 through Table VI.43 present the NPV values for small electric motors that would result if DOE were to add the estimates of the potential benefits resulting from reduced CO_2, NO_X, and Hg emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a seven percent and three percent discount rate. The CO_2 values used in the columns of each table correspond with the four scenarios for the valuation of CO_2 emission reductions presented in section IV.M. Table VI.39 shows an example of the calculation of the NPV including benefits from emissions reductions for the case of TSL 7 for capacitor-start motors and TSL 4b for polyphase motors.

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, the following should be considered: (1) The national consumer savings are domestic U.S. consumer monetary savings found in market transactions, while the values of emissions reductions are based on estimates of marginal social costs, which, in the case of CO_2, are based on a global value. (2) The assessments of consumer savings and emission-related benefits are performed with different computer models, leading to different time frames for analysis. For small electric motors, the present value of national consumer savings is measured for the period in which units shipped from 2015 to 2045 continue to operate. However, the time frames of the benefits associated with the emission reductions differ. For example, the value of CO_2 emissions reductions reflects the present value of all future climate-related impacts due to emitting a ton of carbon dioxide in that year, out to 2300.

TABLE VI.39—ESTIMATE OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS TO PRESENT VALUE OF GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND Hg EMISSIONS REDUCTIONS AT TSL 7 FOR CAPACITOR-START MOTORS AND TSL 4b FOR POLYPHASE MOTORS (2015–2045)

Category	Present value billion 2009$	Discount rate (percent)
Benefits		
Operating Cost Savings	7.6	7
	17.1	3
CO_2 Monetized Value (at $4.7/Metric Ton)*	0.38	5
CO_2 Monetized Value (at $21.4/Metric Ton)*	1.99	3
CO_2 Monetized Value (at $35.1/Metric Ton)*	3.39	2.5

TABLE VI.39—ESTIMATE OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS TO PRESENT VALUE OF GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND Hg EMISSIONS REDUCTIONS AT TSL 7 FOR CAPACITOR-START MOTORS AND TSL 4b FOR POLYPHASE MOTORS (2015–2045)—Continued

Category	Present value billion 2009$	Discount rate (percent)
CO_2 Monetized Value		
(at $64.9/Metric Ton)*	6.08	3
NO_X Monetized Value		
(at $2,437/Metric Ton)	0.03	7
	0.10	3
Hg Monetized Value		
(at $17 million/Metric Ton)	0.003	7
	0.005	3
Total Monetary Benefits **	9.7	7
	19.2	3
Costs		
Total Monetary Costs	2.4	7
	4.5	3
Net Benefits/Costs		
Including CO_2, NO_X, and Hg**	7.3	7
	14.6	3

* These values represent global values (in 2007$) of the social cost of CO_2 emissions in 2010 under several scenarios. The values of $4.7, $21.4, and $35.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $64.9 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. See section IV.M for details.

** Total Monetary Benefits for both the 3% and 7% cases utilize the central estimate of social cost of CO_2 emissions calculated at a 3% discount rate (averaged across three IAMs), which is equal to $21.4/ton in 2010 (in 2007$).

TABLE VI.40—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 7% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND Hg EMISSIONS REDUCTIONS AT ALL TRIAL STANDARD LEVELS FOR POLYPHASE SMALL ELECTRIC MOTORS (2015–2045)

TSL	Consumer NPV at 7% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low values for NO_X and Hg** billion 2009$	CO_2 value of $21.4/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $35.1/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $64.9/metric ton CO_2* and high values for NO_X and Hg**** billion 2009$
1	0.11	0.14	0.17	0.22
2	0.24	0.30	0.36	0.47
3	0.44	0.56	0.66	0.86
4	0.45	0.59	0.70	0.93
4b	0.59	0.82	1.01	1.38
5	0.22	0.49	0.72	1.16
6	(0.15)	0.13	0.37	0.84
7	(6.75)	(6.44)	(6.18)	(5.66)

* These label values per ton represent the global negative externalities of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. See section IV.M for a full discussion of the derivation of these values.

** Low Values correspond to $447 per ton of NO_X emissions and $0.764 million per ton of Hg emissions.

*** Medium Values correspond to $2,519 per ton of NO_X emissions and $17.2 million per ton of Hg emissions.

**** High Values correspond to $4,591 per ton of NO_X emissions and $33.7 million per ton of Hg emissions.

TABLE VI.41—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 3% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND HG EMISSIONS REDUCTIONS AT ALL TRIAL STANDARD LEVELS FOR POLYPHASE SMALL ELECTRIC MOTORS (2015–2045)

TSL	Consumer NPV at 3% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low values for NO_X and Hg** billion 2009$	CO_2 value of $21.4/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $35.1/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $64.9/metric ton CO_2* and high values for NO_X and Hg**** billion 2009$
1	0.27	0.30	0.33	0.39
2	0.57	0.64	0.69	0.81
3	1.04	1.16	1.27	1.47
4	1.08	1.22	1.34	1.57
4b	1.49	1.73	1.92	2.29

TABLE VI.41—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 3% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND HG EMISSIONS REDUCTIONS AT ALL TRIAL STANDARD LEVELS FOR POLYPHASE SMALL ELECTRIC MOTORS (2015–2045)—Continued

TSL	Consumer NPV at 3% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low values for NO_X and Hg** billion 2009$	CO_2 value of $21.4/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $35.1/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $64.9/metric ton CO_2* and high values for NO_X and Hg**** billion 2009$
5	0.83	1.11	1.34	1.79
6	0.13	0.42	0.66	1.14
7	(12.57)	(12.26)	(11.99)	(11.47)

* These label values per ton represent the global negative externalities of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. See section IV.M for a full discussion of the derivation of these values.

** Low Values correspond to $447 per ton of NO_X emissions and $0.764 million per ton of Hg emissions.

*** Medium Values correspond to $2,519 per ton of NO_X emissions and $17.2 million per ton of Hg emissions.

**** High Values correspond to $4,591 per ton of NO_X emissions and $33.7 million per ton of Hg emissions.

TABLE VI.42—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 7% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND HG EMISSIONS REDUCTIONS AT ALL TRIAL STANDARD LEVELS FOR CAPACITOR-START SMALL ELECTRIC MOTORS (2015–2045)

TSL	Consumer NPV at 7% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low values for NO_X and Hg** billion 2009$	CO_2 value of $21.4/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $35.1/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $64.9/metric ton CO_2* and high values for NO_X and Hg**** billion 2009$
1	3.23	4.15	4.93	6.46
2	3.27	4.20	4.99	6.53
3	3.08	4.13	5.02	6.76
4	2.25	3.43	4.43	6.39
5	2.36	3.55	4.56	6.52
6	(8.98)	(7.69)	(6.59)	(4.43)
7	5.08	6.50	7.70	10.05
8	3.42	5.05	6.44	9.14

TABLE VI.43—ESTIMATES OF ADDING NET PRESENT VALUE OF CONSUMER SAVINGS (AT 3% DISCOUNT RATE) TO NET PRESENT VALUE OF LOW, CENTRAL, AND HIGH-END GLOBAL MONETIZED BENEFITS FROM CO_2, NO_X, AND HG EMISSIONS REDUCTIONS AT ALL TRIAL STANDARD LEVELS FOR CAPACITOR-START SMALL ELECTRIC MOTORS (2015–2045)

TSL	Consumer NPV at 3% discount rate added with:			
	CO_2 value of $4.7/metric ton CO_2* and low values for NO_X and Hg** billion 2009$	CO_2 value of $21.4/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 value of $35.1/metric ton CO_2* and medium values for NO_X and Hg*** billion 2009$	CO_2 Value of $64.9/metric ton CO_2* and high values for NO_X and Hg**** billion 2009$
1	7.26	8.21	8.99	10.54
2	7.36	8.32	9.11	10.68
3	7.13	8.21	9.10	10.88
4	5.64	6.85	7.86	9.85
5	5.86	7.08	8.09	10.10
6	(15.91)	(14.58)	(13.48)	(11.28)
7	11.43	12.89	14.09	16.49
8	8.54	10.22	11.61	14.37

* These label values per ton represent the global negative externalities of CO_2 in 2010, in 2007$. Their present values have been calculated with scenario-consistent discount rates. See section IV.M for a full discussion of the derivation of these values.

** Low Values correspond to $447 per ton of NO_X emissions and $0.764 million per ton of Hg emissions.

*** Medium Values correspond to $2,519 per ton of NO_X emissions and $17.2 million per ton of Hg emissions.

**** High Values correspond to $4,591 per ton of NO_X emissions and $33.7 million per ton of Hg emissions.

7. Other Factors

In developing today's standards, the Secretary took into consideration the following additional factors: (1) Harmonization of standards for small electric motors with existing standards under EPCA for medium-sized polyphase general purpose motors; (2) the impact, on consumers who need to use CSIR motors, of substantially higher prices for such motors caused by some potential standard levels; and (3) the potential for standards to reduce reactive power, and thereby cause lower costs for supplying electricity.

D. Conclusion

EPCA contains criteria for prescribing new or amended energy conservation standards. DOE must prescribe standards only for those small electric motors for which DOE: (1) Has determined that standards would be technologically feasible and economically justified and would result in significant energy savings, and (2) has prescribed test procedures. (42 U.S.C. 6295(o)(2)(B), 6316(a), and 6317(b)) Moreover, any standards for this equipment must achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 6316(a)) In determining whether a standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens when considering the seven factors discussed in section III.D.1. (42 U.S.C. 6295(o)(2)(B)(i) and 6316(a))

In evaluating standards for small electric motors, DOE analyzed polyphase and capacitor-start motors independently of one another, and considered eight TSLs for polyphase equipment and eight TSLs for capacitor-start equipment. For reasons explained in the NOPR, DOE combined CSCR and CSIR motors into a single set of TSLs for capacitor-start motors, with each TSL being a combination of CSIR and CSCR efficiency levels. 74 FR 61484.

In selecting today's energy conservation standards for small electric motors, DOE started by examining the TSL with the highest energy savings, and determined whether that TSL was economically justified. Upon finding a TSL not to be justified, DOE considered sequentially lower TSLs until it identified the highest level that was economically justified. (Such level would necessarily also be technologically feasible and result in a significant conservation of energy because all of the TSLs considered for this final rule meet those criteria.) DOE notes that for polyphase small electric motors, the TSL with the highest energy savings is also the max-tech efficiency level, but, as explained in the NOPR, the same is not true for capacitor-start motors. 74 FR 61484.

Table VI.44 and Table VI.45 summarize the results of DOE's quantitative analysis, based on the assumptions and methodology discussed above, of each TSL DOE considered for this rule. They will aid the reader in the discussion of costs and benefits of each TSL. In some cases, the tables present a range of results. The range of values reported for industry impacts represents the results for the two markup scenarios—preservation-of-return-on-invested-capital and preservation-of-operating-profit (absolute dollars)—that DOE used to estimate manufacturer impacts.

In addition to the quantitative results, DOE also considers other burdens and benefits that affect economic justification. These include pending standards for medium motors as a result of EISA 2007.

1. Polyphase Small Electric Motors

Table VI.44 presents a summary of the quantitative analysis results for each TSL for polyphase small electric motors.

TABLE VI.44—SUMMARY OF POLYPHASE SMALL ELECTRIC MOTORS ANALYTICAL RESULTS *

Criteria	Trial standard level							
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 4b	TSL 5	TSL 6	TSL 7
Primary Energy Savings (quads)	0.05	0.09	0.17	0.19	0.29	0.34	0.37	0.37
@ 7% Discount Rate	0.01	0.02	0.04	0.05	0.07	0.09	0.09	0.09
@ 3% Discount Rate	0.03	0.05	0.09	0.10	0.15	0.18	0.19	0.20
Generation Capacity Reduction (GW)	0.05	0.09	0.16	0.19	0.31	0.36	0.39	0.42
NPV (2009$ billions)								
@ 7% discount	0.10	0.22	0.41	0.42	0.54	0.16	(0.22)	(6.82)
@ 3% discount	0.26	0.55	1.01	1.05	1.44	0.77	(0.06)	(12.65)
Industry Impacts								
Change in INPV (2009$ millions)	(0.19)–(1.49)	0.34–(1.86)	0.98–(2.26)	0.57–(3.58)	3.37–(5.43)	12.62–(11.80)	18.54–(17.51)	95.27–(69.47)
Change in INPV (%)	(0.27)–(2.15)	0.49–(2.67)	1.41–(3.25)	0.82–(5.15)	4.84–(7.80)	18.15–(16.96)	26.65–(25.16)	136.95–(99.85)
Cumulative Emission Reduction								
CO$_2$ (Mt)	2.3	4.6	8.3	9.3	15.4	18.3	19.5	21.2
Value of CO$_2$ reductions (2009$ millions) **	8–122	16–248	28–445	32–502	52–828	62–986	66–1049	72–1144
NO$_X$ (kt)	1.6	3.3	5.9	6.7	11.0	13.1	13.9	15.2
Value of NO$_X$ reductions at 7% discount rate (2009$ millions)	0.11–1.18	0.23–2.39	0.42–4.29	0.47–4.84	0.78–7.99	0.92–9.51	0.98–10.11	1.07–11.03
Value of NO$_X$ reductions at 3% discount rate (2009$ millions)	0.34–3.46	0.68–7.01	1.22–12.59	1.38–14.21	2.28–23.45	2.71–27.90	2.89–29.68	3.15–32.37
Hg (t)	0.013	0.025	0.046	0.051	0.085	0.101	0.108	0.117
Value of Hg reductions at 7% discount rate (2009$ millions)	0.00–0.12	0.01–0.25	0.01–0.45	0.01–0.51	0.02–0.84	0.02–1.00	0.02–1.06	0.03–1.16
Value of Hg reductions at 3% discount rate (2009$ millions)	0.01–0.24	0.01–0.48	0.02–0.87	0.02–0.98	0.04–1.62	0.04–1.93	0.05–2.05	0.05–2.24
Life-cycle Cost of Rep. Product Class								
Customers with increase in LCC (%)	46.8	41.3	40.6	45.1	51.2	65.8	77.4	96.8
Customers with savings in LCC (%)	53.2	58.7	59.4	54.9	48.8	34.3	22.6	3.2
Mean LCC (2009$)	1,261	1,249	1,237	1,240	1,240	1,291	1,339	2,095
Mean LCC Savings (2009$)	8	19	31	29	28	(23)	(71)	(827)

TABLE VI.44—SUMMARY OF POLYPHASE SMALL ELECTRIC MOTORS ANALYTICAL RESULTS *—Continued

Criteria	Trial standard level							
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 4b	TSL 5	TSL 6	TSL 7
Life-cycle Cost of all Product Classes, Weighted by Shipments								
Customers with increase in LCC (%)	44.7	39.2	38.7	42.7	49.2	63.2	74.8	96.2
Customers with savings in LCC (%)	55.3	69.8	61.3	57.3	50.8	36.8	25.2	3.8
Mean LCC (2009$)	1,314	1,302	1,287	1,289	1,288	1,337	1,383	2,131
Mean LCC Savings (2009$)	9	22	36	34	36	(13)	(60)	(808)
Payback Period (years)								
Average	21.1	17.3	17.2	19.8	24.1	40.2	52.6	234.6
Median	6.7	5.4	5.3	6.2	7.4	11.7	16.1	48.7
Employment Impact								
Indirect Impacts (2045) (jobs, '000)	0.30	0.57	1.03	1.18	1.94	2.67	3.22	6.34

* Parentheses indicate negative (−) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

** Range of global values for the SCC of emissions reductions, representing a range of scenarios as described in section IV.M and summarized in Table VI.31, with discount rates ranging from 2.5% to 5%.

First, DOE considered TSL 7, the most efficient level for polyphase small electric motors. TSL 7 would save an estimated 0.37 quad of energy through 2045, an amount DOE considers significant. Discounted at seven percent, the projected energy savings through 2045 would be 0.09 quad. For the Nation as a whole, DOE projects that TSL 7 would result in a net decrease of $6.82 billion in NPV, using a discount rate of seven percent. The emissions reductions at TSL 7 are 21.2 Mt of CO_2, up to 15.2 kt of NO_X, and up to 0.117 ton of Hg. These reductions have a value of up to $1,144 million for CO_2 (using the 95th percentile value at a 3 percent discount rate), and a value of up to $11.0 million for NO_X, and $1.16 million for Hg at a discount rate of seven percent. At the central value for the social cost of carbon, the estimated monetized benefit of CO_2 emissions reductions is $375 million at a discount rate of three percent. DOE also estimates that at TSL 7, total electric generating capacity in 2030 will decrease compared to the base case by 0.42 GW.

At TSL 7, DOE projects that the average polyphase small electric motor customer purchasing equipment in 2015 will experience an increase in LCC of $827 compared to the baseline. DOE estimates the fraction of customers experiencing LCC increases will be 96.8 percent. The median PBP for the average polyphase small electric motor customer at TSL 7, 48.7 years, is projected to be substantially longer than the mean lifetime of the equipment. When all polyphase product classes are considered and weighted by shipments, DOE estimates that small electric motor customers experience slightly lower increases in LCC of $808.

The projected change in industry value ranges from a decrease of $69.5 million to an increase of $95.3 million. The impacts are driven primarily by the assumptions regarding the ability to pass on larger increases in MPCs to the customer. At TSL 7, DOE recognizes the risk of very large negative impacts if manufacturers' expectations about reduced profit margins are realized. In particular, if the high end of the range of impacts is reached as DOE expects, TSL 7 could result in a net loss of 99.9 percent in INPV to the polyphase small motor industry. DOE believes manufacturers would likely have a more difficult time maintaining current gross margin levels with larger increases in manufacturing production costs, as standards increase the need for capital conversion costs, equipment retooling, and increased research and development spending. Specifically, at this TSL, the majority of manufacturers would need to significantly redesign all of their polyphase small electric motors.

After carefully considering the analysis and weighing the benefits and burdens of TSL 7, the Secretary has reached the following conclusion: At TSL 7, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), would be outweighed by the economic burden of a net cost to the Nation (over 30 years), the economic burden to customers (as indicated by the large increase in life-cycle cost) and the potentially large reduction in INPV for manufacturers resulting from large conversion costs and reduced gross margins. Consequently, the Secretary has concluded that trial standard level 7 is not economically justified.

DOE then considered TSL 6, which would likely save an estimated 0.37 quad of energy through 2045, an amount DOE considers significant. Discounted at seven percent, the projected energy savings through 2045 would be 0.09 quad. For the Nation as a whole, DOE projects that TSL 6 would result in a net decrease of $220 million in NPV, using a discount rate of seven percent. The estimated emissions reductions at TSL 6 are 19.5 Mt of CO_2, up to 13.9 kt of NO_X, and up to 0.108 ton of Hg. These reductions have a value of up to $1,049 million for CO_2 (using the 95th percentile value at a 3 percent discount rate), and a value of up to $10.1 million for NO_X, and $1.06 million for Hg, at a discount rate of seven percent. At the central value for the social cost of carbon, the estimated monetized benefit of CO_2 emissions reductions is $344 million at a discount rate of three percent. Total electric generating capacity in 2030 is estimated to decrease compared to the base case by 0.39 GW under TSL 6.

At TSL 6, DOE projects that the average polyphase small electric motor customer purchasing equipment in 2015 will experience an increase in LCC of $71 compared to the baseline. DOE estimates the fraction of customers experiencing LCC increases will be seven percent. The median PBP for the average polyphase small electric motor customer at TSL 6, 16.1 years, is projected to be substantially longer than the mean lifetime of the equipment. When all polyphase product classes are considered and weighted by shipments, DOE estimates that small electric motor customers experience slightly lower increases in LCC of $60.

The projected change in industry value ranges from a decrease of $17.5 million to an increase of $18.5 million. The impacts are driven primarily by the assumptions regarding the ability to pass on larger increases in MPCs to the customer. At TSL 6, DOE recognizes the risk of very large negative impacts if manufacturers' expectations about reduced profit margins are realized. In particular, if the high end of the range of impacts is reached as DOE expects, TSL 6 could result in a net loss of 25.2 percent in INPV to the polyphase small motor industry. DOE believes manufacturers would likely have a more difficult time maintaining current gross margin levels with larger increases in manufacturing production costs, as standards increase the need for capital conversion costs, equipment retooling, and increased research and development spending. Specifically, at this TSL, the majority of manufacturers would need to significantly redesign all of their polyphase small electric motors.

After carefully considering the analysis and weighing the benefits and burdens of TSL 6, the Secretary has reached the following conclusion: At TSL 6, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), would be outweighed by the economic burden of a net cost to the Nation (over 30 years), the economic burden to consumers (as indicated by the increased life-cycle cost), and the potential reduction in INPV for manufacturers resulting from large conversion costs and reduced gross margins. Consequently, the Secretary has concluded that trial standard level 6 is not economically justified.

DOE then considered TSL 5, which provides for polyphase small electric motors the maximum efficiency level that the analysis showed to have positive NPV for the Nation. TSL 5 would likely save an estimated 0.34 quad of energy through 2045, an amount DOE considers significant. Discounted at seven percent, the projected energy savings through 2045 would be 0.09 quad. For the Nation as a whole, DOE projects that TSL 5 would result in a net increase of $160 million in NPV, using a discount rate of seven percent. The estimated emissions reductions at TSL 5 are 18.3 Mt of CO_2, up to 13.1 kt of NO_X, and up to 0.101 ton of Hg. These reductions have a value of up to $986 million for CO_2 (using the 95th percentile value at a 3 percent discount rate), and a value of up to $9.5 million for NO_X, and $1.0 million for Hg, at a discount rate of seven percent. At the central value for the social cost of carbon, the estimated benefit of CO_2 emissions reductions is $323 million at a discount rate of three percent. Total electric generating capacity in 2030 is estimated to decrease compared to the base case by 0.36 GW under TSL 5.

At TSL 5, DOE projects that the average polyphase small electric motor customer purchasing the equipment in 2015 will experience an increase in LCC of $23 compared to the baseline representative unit for analysis (1 hp, 4 pole polyphase motor). This corresponds to approximately a 1.8 percent increase in average LCC. Based on this analysis, DOE estimates that approximately 66 percent of customers would experience LCC increases and that the median PBP would be 11.7 years, which is longer than the mean lifetime of the equipment. However, in consideration of the relatively small percentage increase in LCC at TSL 5, DOE examined sensitivity analyses to assess the likelihood of consumers in fact experiencing significant LCC increases. These included calculating a shipment-weighted LCC savings.

At TSL 5, when accounting for the full-range of horsepowers and pole configurations of polyphase motors, the average LCC increase is reduced to $13. This corresponds to approximately 63 percent of customers experiencing an increase in LCC, with the remaining 37 percent, those with greater operating hours, realizing net savings.

The projected change in industry value ranges from a decrease of $11.8 million to an increase of $12.6 million. The impacts are driven primarily by the assumptions regarding the ability to pass on larger increases in MPCs to the customer. At TSL 5, DOE recognizes the risk of negative impacts if manufacturers' expectations about reduced profit margins are realized. If the high end of the range of impacts is reached, TSL 5 could result in a net loss of 17.0 percent in INPV to the polyphase small motor industry.

After carefully considering the analysis and weighing the benefits and burdens of TSL 5, the Secretary has reached the following conclusion: At TSL 5, the benefits of energy savings and emissions reductions (both in physical reductions and the monetized value of those reductions) would be outweighed by the economic burden to consumers (as indicated by the increased life-cycle cost). Consequently, the Secretary has concluded that trial standard level 5 is not economically justified.

DOE then considered TSL 4b, which is at an efficiency level added to the analysis in response to comments presented on the NOPR. TSL 4b would likely save an estimated 0.29 quad of energy through 2045, an amount DOE considers significant. Discounted at seven percent, the projected energy savings through 2045 would be 0.07 quad. For the Nation as a whole, DOE projects that TSL 4b would result in a net increase of $540 million in NPV, using a discount rate of seven percent. The estimated emissions reductions at TSL 4b are 15.4 Mt of CO_2, up to 11.0 kt of NO_X, and up to 0.085 ton of Hg. These reductions have a value of up to $828 million for CO_2 (using the 95th percentile value at a 3 percent discount rate), and a value of up to $8.0 million for NO_X, and $0.8 million for Hg, at a discount rate of seven percent. At the central value for the social cost of carbon, the estimated benefit of CO_2 emissions reductions is $272 million at a discount rate of three percent. Total electric generating capacity in 2030 is estimated to decrease compared to the base case by 0.31 GW under TSL 4b.

At TSL 4b, DOE projects that the average polyphase small electric motor customer purchasing the equipment in 2015 will experience a reduction in LCC of $28 compared to the baseline representative unit for analysis (1 hp, 4 pole polyphase motor). This corresponds to approximately a 2.2 percent reduction in average LCC. Based on this analysis, DOE estimates that approximately 51 percent of customers would experience LCC increases and that the median PBP would be 7.4 years, which is only slightly longer than the mean lifetime of the equipment. However, in consideration of the relatively small percentage decrease in LCC at TSL 4b, DOE examined sensitivity analyses to assess the likelihood of consumers experiencing significant LCC increases. These included calculating a shipment-weighted LCC savings.

At TSL 4b, when accounting for the full-range of horsepowers and pole configurations of polyphase motors, the average LCC savings increase to $36. This corresponds to approximately 49 percent of customers experiencing an increase in LCC, with the remaining 51 percent realizing net savings.

The projected change in industry value ranges from a decrease of $5.4 million to an increase of $3.4 million. The impacts are driven primarily by the assumptions regarding the ability to pass on larger increases in MPCs to the customer. At TSL 4b, DOE recognizes the risk of negative impacts if manufacturers' expectations about reduced profit margins are realized. If the high end of the range of impacts is reached, TSL 4b could result in a net loss of 7.8 percent in INPV to the polyphase small motor industry.

Trial standard level 4b has other advantages that are not directly economic. This level sets standards for many product classes that are approximately harmonized with the efficiency level for medium motors to be implemented in 2010 which requires four-pole, 1-hp polyphase motors to be at least 85.5% efficient. Since many—but not all—three digit frame size polyphase motors of this size can also be used in two-digit frames with minimal adjustment, DOE believes that there is a benefit to harmonizing small polyphase and medium polyphase motor efficiency standards in this size range. In particular, DOE does not believe the design changes necessary for TSL 4b would force all manufacturers to significantly redesign all of their polyphase small electric motors or their production processes. Therefore, DOE believes manufacturers are not at a significant risk to experience highly negative impacts.

After considering the analysis and the benefits and burdens of trial standard level 4b, the Secretary has reached the following conclusion: Trial standard level 4b offers the maximum improvement in energy efficiency that is technologically feasible and economically justified, and will result in significant conservation of energy. The Secretary has reached the conclusion that the benefits of energy savings and emissions reductions (both in physical reductions and the monetized value of those reductions) outweigh the potential reduction in INPV for manufacturers and the economic burden on consumers, which is relatively small on average. Therefore, DOE today adopts the energy conservation standards for polyphase small electric motors at trial standard level 4b.

2. Capacitor-Start Small Electric Motors

Table VI.45 presents a summary of the quantitative analysis results for each TSL for capacitor-start small electric motors.

TABLE VI.45—SUMMARY OF CAPACITOR-START SMALL ELECTRIC MOTORS ANALYTICAL RESULTS *

Criteria	Trial standard level							
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Primary Energy Savings (quads)	1.18	1.19	1.36	1.47	1.47	1.61	1.91	2.33
@ 7% Discount Rate	0.31	0.31	0.36	0.39	0.39	0.43	0.51	0.62
@ 3% Discount Rate	0.63	0.64	0.73	0.79	0.79	0.87	1.03	1.25
Generation Capacity Reduction (GW)	1.21	1.22	1.38	1.54	1.55	1.70	1.86	2.14
NPV (2009$ billions)								
@ 7% discount	3.01	3.05	2.83	1.97	2.08	(9.29)	4.74	3.03
@ 3% discount	7.03	7.13	6.87	5.35	5.57	(16.23)	11.08	8.14
Industry Impacts								
Change in INPV (2009$ millions)	8.40–(19.99)	9.46–(20.79)	16.27–(32.42)	32.15–(42.15)	28.48–(40.09)	186.60–(152.05)	18.40–(34.05)	46.35–(52.58)
Change in INPV (%)	3.01–(7.16)	3.39–(7.45)	5.83–(11.62)	11.52–(15.46)	10.20–(14.37)	66.87–(54.49)	6.59–(12.20)	16.61–(18.84)
Cumulative Emission Reduction								
CO_2 (Mt)	6.29	63.5	71.7	80.5	81.0	88.5	96.8	111.4
Value of CO_2 reductions (2009$ millions) **	216–3410	218–3444	246–3890	277–4367	278–4394	304–4801	333–5253	383–6046
NO_X (kt)	45.1	45.54	51.44	57.74	58.11	63.48	69.47	79.95
Value of NO_X reductions at 7% discount rate (2009$ millions)	3.5–36.0	3.5–36.2	4.0–41.0	4.5–46.0	4.5–46.3	4.9–50.6	5.4–55.4	6.2–63.8
Value of NO_X reductions at 3% discount rate (2009$ millions)	9.6–98.7	9.7–100.0	11.0–112.6	12.3–126.4	12.4–127.2	13.5–138.9	14.8–152.0	17.0–175.0
Hg (t)	0.265	0.267	0.302	0.339	0.341	0.373	0.408	0.469
Value of Hg reductions at 7% discount rate (2009$ millions)	0.06–2.79	0.06–2.82	0.07–3.18	0.08–3.57	0.08–3.60	0.09–3.93	0.10–4.30	0.11–4.95
Value of Hg reductions at 3% discount rate (2009$ millions)	0.12–5.22	0.12–5.27	0.13–5.95	0.15–6.68	0.15–6.72	0.17–7.34	0.18–8.04	0.21–9.25
Life-cycle Cost of Rep. Product Class								
CSIR								
Customers with increase in LCC (%)	32.0	32.0	41.6	54.9	54.9	65.6	65.6	65.6
Customers with savings in LCC (%)	68.0	68.0	58.4	45.1	45.1	34.5	34.5	34.5
Mean LCC (2009$)	857	857	868	902	902	1,285	1,285	1,285
Mean LCC Savings (2009$)	58	58	47	13	13	(369)	(369)	(369)
CSCR								
Customers with increase in LCC (%)	46.5	47.8	47.8	54.9	47.8	98.6	47.8	74.7
Customers with savings in LCC (%)	53.6	52.2	52.2	45.1	52.2	1.4	52.2	25.3
Mean LCC (2009$)	1,005	1,002	1,002	1,015	1,002	1,856	1,002	1,078
Mean LCC Savings (2009$)	21	24	24	11	24	(830)	24	(52)
CSIR migrating to CSCR weighted results ***								
Customers with increase in LCC (%)	32.5	32.5	41.7	55.0	55.0	66.0	53.7	60.6
Customers with savings in LCC (%)	67.5	67.5	58.3	45.0	45.0	34.0	46.3	39.4
Mean LCC (2009$)	854	854	865	899	899	1,282	891	917

TABLE VI.45—SUMMARY OF CAPACITOR-START SMALL ELECTRIC MOTORS ANALYTICAL RESULTS *—Continued

Criteria	Trial standard level							
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Mean LCC Savings (2009$)	58	58	47	15	15	(370)	23	(3)
Life-cycle Cost of all Product Classes, Weighted by Shipments								
CSIR								
Customers with increase in LCC (%)	30.7	30.7	40.2	54.1	54.1	65.1	65.1	65.1
Customers with savings in LCC (%)	69.3	69.3	59.8	45.9	45.9	34.9	34.9	34.9
Mean LCC (2009$)	859	859	870	903	903	1,287	1,287	1,287
Mean LCC Savings (2009$)	62	62	51	17	17	(367)	(367)	(367)
CSCR								
Customers with increase in LCC (%)	38.4	39.7	39.7	46.1	39.7	94.7	39.7	65.0
Customers with savings in LCC (%)	61.6	60.3	60.3	53.9	60.3	5.3	60.3	35.0
Mean LCC (2009$)	1,299	1,289	1,289	1,304	1,289	2,228	1,289	1,364
Mean LCC Savings (2009$)	50	60	60	45	60	(879)	60	(15)
Market Share ****—CSIR (%)	99	98	98	96	95	100	3	7
Payback Period (years)								
CSIR								
Average	10.5	10.5	15.1	24.9	24.9	108.5	108.5	108.5
Median	3.1	3.1	4.5	7.0	7.0	11.9	11.9	11.9
CSCR								
Average	14.8	15.3	15.3	19.5	15.3	200.0	15.3	34.8
Median	4.4	4.5	4.5	5.9	4.5	37.6	4.5	10.0
Employment Impact								
Indirect Impacts (2045) (jobs, '000) −	7.06	7.12	8.56	10.24	10.20	19.57	11.22	18.70

* Parentheses indicate negative (−) values. For LCCs, a negative value means an increase in LCC by the amount indicated.

** Range of global values for the SCC of emissions reductions, representing a range of scenarios as described in section IV.M and summarized in Table VI.31, with discount rates ranging from 2.5% to 5%.

*** Shipments-weighted based on market share product switching model.

**** Base case market share is 95 percent CSIR and 5 percent CSCR.

First, DOE considered TSL 8, the combination of CSIR and CSCR efficiency levels generating the greatest national energy savings. TSL 8 would likely save an estimated 2.33 quads of energy through 2045, an amount DOE considers significant. Discounted at seven percent, the projected energy savings through 2045 would be 0.62 quad. For the Nation as a whole, DOE projects that TSL 8 would result in a net benefit of $3.03 billion in NPV, using a discount rate of seven percent. The estimated emissions reductions at TSL 8 are up to 111.4 Mt of CO_2, up to 80.0 kt of NO_X, and up to 0.469 ton of Hg. These reductions have a value of up to $6,046 million for CO_2 (using the 95th percentile value at a 3 percent discount rate), and a value of up to $63.8 million for NO_X, and $4.95 million for Hg at a discount rate of seven percent. At the central value for the social cost of carbon, the estimated benefit of CO_2 emissions reductions is $1,982 million at a discount rate of three percent. DOE also estimates that at TSL 8, total electric generating capacity in 2030 will decrease compared to the base case by 2.14 GW.

At TSL 8, DOE projects that for the average customer, compared to the baseline, the LCC of a CSIR and CSCR motor will increase by $369 and $52, respectively. At TSL 8, DOE estimates the fraction of customers experiencing LCC increases will be 66 percent for CSIR motors and 75 percent for CSCR motors. The median PBP for the average capacitor-start small electric motor customers at TSL 8, 11.9 years for CSIR motors and 10.0 years for CSCR motors, is projected to be substantially longer than the mean lifetime of the equipment. DOE also considered market migration between CSIR and CSCR users and how that would affect the LCC of CSIR users at TSL 8. DOE estimates that at this TSL it will be more cost-effective for many CSIR consumers to purchase a CSCR motor instead, with only a slight $3 increase in the average LCC over that of the baseline CSIR motor. In total, 61 percent of consumers who migrate from a CSIR to a CSCR motor will experience LCC increases.

DOE also examined LCC savings using a full distribution of motor sizes and speeds. Under these conditions, for the average customer, the LCC of a CSIR and CSCR motor will increase by $367 and $15, respectively, compared to the baseline. At TSL 8, DOE estimates the fraction of customers experiencing LCC increases will be 65 percent for both CSIR and CSCR motors.

The projected change in industry value ranges from a decrease of $52.58 million to an increase of $46.35 million. The impacts are driven primarily by the assumptions regarding the ability to pass on larger increases in MPCs to the customer as well as the necessary estimated investments. At TSL 8, DOE recognizes the risk of negative impacts if manufacturers' expectations about reduced profit margins are realized. In particular, if the high end of the range of impacts is reached as DOE expects, TSL 8 could result in a net loss of 18.84 percent in INPV to the capacitor-start small motor industry. DOE believes manufacturers would likely have a more difficult time maintaining current gross margin levels with larger increases in manufacturing production costs, as standards increase the need for capital conversion costs, equipment retooling, and increased research and development spending. Specifically, at this TSL, the majority of manufacturers would need to significantly redesign all of their capacitor-start small electric motors.

After carefully considering the analysis and weighing the benefits and burdens of TSL 8, the Secretary has reached the following conclusion: At TSL 8, the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), and the positive net economic savings (over 30 years) would be outweighed by the economic burden on existing CSCR customers and CSIR customers who do not migrate from CSIR to CSCR motors (as indicated by the large increase in LCC) and the potentially large reduction in INPV for manufacturers resulting from large conversion costs and reduced gross margins. Consequently, the Secretary has concluded that trial standard level 8 is not economically justified.

DOE then considered TSL 7, which would likely save an estimated 1.91 quads of energy through 2045, an amount DOE considers significant. Discounted at seven percent, the projected energy savings through 2045 would be 0.51 quad. For the Nation as a whole, DOE projects that TSL 7 would result in a net benefit of $4.74 billion in NPV, using a discount rate of seven percent. The estimated emissions reductions at TSL 7 are up to 96.8 Mt of CO_2, up to 69.5 kt of NO_X, and up to 0.408 ton of Hg. These reductions have a value of up to $5,253 million for CO_2 (using the 95th percentile value at a 3 percent discount rate), and a value of up to $55.4 million for NO_X, and $4.30 million for Hg at a discount rate of seven percent. At the central value for the social cost of carbon, the estimated benefit of CO_2 emissions reductions is $1,722 million at a discount rate of three percent. Total electric generating capacity in 2030 is estimated to decrease compared to the base case by 1.86 GW under TSL 7.

At TSL 7, DOE projects that for the average customer, the LCC of capacitor-start small electric motors will increase by $369 for CSIR motors and decrease by $24 for CSCR motors compared to the baseline. At TSL 7, DOE estimates the fraction of CSIR customers experiencing LCC increases will be 66 percent, but only 48 percent for CSCR motor customers. However, DOE believes that at this TSL, which is the max-tech efficiency level for CSIR motors, the relative difference in cost between a CSIR motor and a CSCR motor becomes substantial and will have large effects on customers. Rather than buy an expensive CSIR motor, those customers whose applications permit them to will purchase a CSCR motor with the same number of poles and horsepower ratings. DOE is unsure of the magnitude of the migration of CSIR users to CSCR motors, but estimates that customers that purchase a CSCR motor rather than a CSIR motor will reduce their LCC by $23 on average, compared to the baseline CSIR motor. On a national level, DOE estimates that the market share of CSCR motors could grow from 5 percent of all capacitor-start motors to 97 percent once the compliance date for these standards is effective. Even though switching from a CSIR to a CSCR motor would result in a reduction in LCC on average, DOE estimates that approximately 54 percent of CSIR customers that switch would still experience an LCC increase.

DOE also examined LCC savings with a full distribution of motor sizes and speeds. Under these conditions, for the average customer, compared to the baseline, the LCC of a CSIR and CSCR motor will increase by $367 and decrease by $60, respectively. DOE also examined what fraction of motors would have increases in LCC. At TSL 7, DOE estimates that 65 percent of CSIR motor customers who do not switch to CSCR motors, and 40 percent of CSCR motor customers, will experience increased LCC.

The projected change in industry value ranges from a decrease of $34.05 million to an increase of $18.40 million. The impacts are driven primarily by the assumptions regarding the ability to pass on larger increases in MPCs to the customer as well as the necessary estimated investments. At TSL 7, DOE recognizes the risk of negative impacts if manufacturers' expectations about reduced profit margins are realized. In particular, if the high end of the range of impacts is reached as DOE expects, TSL 7 could result in a net loss of 12.20 percent in INPV to the capacitor-start small motor industry. At this TSL, the combination of efficiency levels could cause a migration from CSIR motors to CSCR motors; however, DOE believes that the capital conversion costs, equipment retooling and R&D spending associated with this migration would not be severe.

After carefully considering the analysis and weighing the benefits and burdens of TSL 7, the Secretary has reached the following conclusion: Trial standard level 7 offers the maximum improvement in energy efficiency that is technologically feasible and economically justified and will result in significant conservation of energy. The Secretary has reached the conclusion that the benefits of energy savings, emissions reductions (both in physical reductions and the monetized value of those reductions), the positive net economic savings to the Nation (over 30 years) and the harmonization of efficiency requirements between CSIR and CSCR motors would outweigh the potential reduction in INPV for manufacturers and the economic burden on those CSIR customers who are unable to switch to CSCR motors. Further, benefits from carbon dioxide reductions (at a central value calculated using a three percent discount rate) would increase NPV by $1,722 million (2009$). These benefits from carbon dioxide emission reductions, when considered in conjunction with the consumer savings NPV and other factors described above support DOE's tentative conclusion that trial standard level 7 is economically justified. Therefore, DOE today adopts the energy conservation standards for capacitor-start small electric motors at trial standard level 7.

VII. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

Section 1(b)(1) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (October 4, 1993), requires each agency to identify the problem the agency intends to address that warrants new agency action (including, where applicable, the failures of private markets or public institutions), as well as assess the significance of that problem, to enable assessment of whether any new regulation is warranted. EPCA requires DOE to establish standards for the small motors covered in today's rulemaking. In addition, today's standards also address the following: (1) Misplaced incentives, which separate responsibility for selecting equipment and for paying their operating costs; and (2) Lack of consumer information and/or information processing capability about energy efficiency opportunities. The market for small electric motors is dominated by the presence and actions of OEMs, who sell small electric motors to end-users as a component of a larger piece of equipment. There is a very large diversity of equipment types that use small electric motors and the market for any particular type of equipment may be very small. Consumers lack information and choice regarding the motor component. OEMs and consumers may be more concerned with other aspects of the application system than with selecting the most cost effective motor for the end user. Space constraints may also restrict the ability of the consumer to replace the motor with a more efficient model.

In addition, DOE has determined that today's regulatory action is a "significant regulatory action" under section 3(f)(1) of Executive Order 12866. Accordingly, section 6(a)(3) of the Executive Order required that DOE prepare a regulatory impact analysis (RIA) on today's final rule and that the Office of Information and Regulatory Affairs (OIRA) in the OMB review this rule. DOE presented to OIRA for review the final rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. They are available for public review in the Resource Room of DOE's Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

The NOPR contained a summary of the RIA, which evaluated the extent to which major alternatives to standards for small electric motors could achieve significant energy savings at reasonable cost, as compared to the effectiveness of the proposed rule. 74 FR 61493–96. The complete RIA (Regulatory Impact Analysis for Proposed Energy Conservation Standards for Small Electric Motors) is contained in the TSD prepared for today's rule. The RIA consists of: (1) A statement of the problem addressed by this regulation and the mandate for government action, (2) a description and analysis of the feasible policy alternatives to this regulation, (3) a quantitative comparison of the impacts of the alternatives, and (4) the national economic impacts of today's standards.

The major alternatives DOE analyzed were: (1) No new regulatory action; (2) financial incentives, including tax credits and rebates; (3) revisions to voluntary energy efficiency targets; and (4) bulk government purchases. DOE evaluated each alternative in terms of its ability to achieve significant energy savings at reasonable costs, and compared it to the effectiveness of the proposed rule.

TABLE VII.1—NON-REGULATORY ALTERNATIVES FOR SMALL ELECTRIC MOTORS

Policy alternatives	Energy savings quads *	Net present value† billion $	
		7% Discount rate	3% Discount rate
No New Regulatory Action	0.00	0.00	0.00
Consumer Rebates at TSL 4b (Polyphase) and TSL 3 (Single-Phase)	0.17	0.49	1.13
Consumer Rebates at TSL 4b (Polyphase) and TSL 2 (Single-Phase)	0.27	0.72	1.69
Consumer Rebates at TSL 4b (Polyphase) and TSL 3 (Capacitor-Start Capacitor-Run Only)	0.60	1.76	4.03
Consumer Tax Credits	0.11	0.35	0.80
Manufacturer Tax Credits	0.07	0.25	0.56
Voluntary Efficiency Targets	0.42	0.95	2.29
Bulk Government Purchases	0.18	0.44	1.04
Proposed Standards at TSL 4b (Polyphase) and TSL 7 (Capacitor-Start)	2.20	5.28	12.52

* Energy savings are in source quads from 2015 and 2045.

† Net present value (NPV) is the value of a time series of costs and savings. DOE determined the NPV from 2015 to 2065 in billions of 2009$.

The net present value amounts shown in Table VII.1 refer to the NPV for consumers. The costs to the government of each policy (such as rebates or tax credits) are not included in the costs for the NPV since, on balance, consumers are both paying for (through taxes) and receiving the benefits of the payments. For each of the policy alternatives other than standards, Table VII.1 shows the energy savings and NPV in the case where the CSIR and CSCR market share shift in response to the policy prior to 2015, or immediately in 2015 when compliance with the standards would be required. The NES and NPV in the case of the proposed standard are shown as a range between this scenario and a scenario in which the market shift takes ten years to complete, and begins in 2015 . The following paragraphs discuss each of the policy alternatives listed in Table VII.1. (For more details see TSD, RIA.)

No new regulatory action. The case in which no regulatory action is taken with regard to small electric motors constitutes the "base case" (or "No Action") scenario. In this case, between 2015 and 2045, capacitor-start small electric motors purchased in or after 2015 are expected to consume 1.91 quads of primary energy (in the form of losses), while polyphase small electric motors purchased in or after 2015 are expected to consume 0.29 quad of primary energy. Since this is the base case, energy savings and NPV are zero by definition.

Rebates. DOE evaluated the possible effect of a rebate consistent with current motor rebate practices in the promotion of premium efficiency motors which cover a portion of the incremental price difference between equipment meeting baseline efficiency levels and equipment meeting improved efficiency requirements. The current average motor rebate for an efficient 1-horsepower motor is approximately $25, and DOE scaled this rebate to be approximately proportional to the retail price of the motor. DOE evaluated rebates targeting TSL 4b for polyphase motors, and evaluated several target efficiency levels for capacitor-start motors (including TSLs 7, 5, 3, and 2). Existing rebate programs for polyphase motors target three-digit frame series motors with efficiencies equivalent to TSL 4b for small polyphase motors. At rebate efficiency levels corresponding to TSL 7 and 5 for capacitor-start motors, DOE estimates that rebates consistent with current practice would have an insignificant impact on increasing the market share of CSIR motors. For this case, meeting the target level requires the purchase of a motor with a very high average first cost because for TSL 7, CSIR motors are at the maximum technologically feasible efficiency. As a result, rebates targeting TSLs 3 and 2 have larger energy savings. TSLs 7, 5, 3, and 2 correspond to the same efficiency level (EL 3) for CSCR motors.

For rebate programs targeting TSL 4b for polyphase motors and TSL 3 for capacitor start motors, DOE estimates the market share of equipment meeting the energy efficiency levels targeted would increase from 0 percent to 0.4 percent for polyphase motors, from 0 percent to 0.2 percent for capacitor-start, induction-run motors, and from 26.0 to 42.6 percent for capacitor-start, capacitor-run motors. DOE assumed the impact of this policy would be to permanently transform the market so that the shipment-weighted efficiency gain seen in the first year of the program would be maintained throughout the forecast period. At the estimated participation rates, the rebates would provide 0.17 quad of national energy savings and an NPV of $0.49 billion (at a 7-percent discount rate).

DOE found that a rebate targeting the efficiency levels corresponding to TSL 2 for capacitor-start motors would result in larger energy savings than one targeting the efficiency levels of TSL 3, TSL 5 or TSL 7. Such rebates would increase the market share among capacitor-start induction-run motors meeting the efficiency level corresponding to TSL 2 from 2.0 percent to 11.7 percent. Combined with unchanged polyphase motor rebates targeting TSL 4b, DOE estimates these rebates would provide 0.27 quad of national energy savings and an NPV of $0.72 billion (at a 7-percent discount rate).

DOE also analyzed an alternative rebate program for capacitor-start motors which would give rebates of twice the value of the previously-analyzed rebate for CSCR motors which meet the requirements of TSL 7 (a $50 rebate for a 1 HP motor, scaled to other product classes), and no rebates for CSIR motors. DOE estimates that these rebates would have no effect on the efficiency distribution of capacitor-start induction-run motors, and would increase the market share among capacitor-start capacitor-run motors meeting TSL 7 from 26.0 percent to 89.4 percent. Combined with unchanged polyphase motor rebates at TSL 4b, DOE estimates these rebates would provide 0.60 quad of national energy savings and an NPV of $1.76 billion (at a 7-percent discount rate).

Although DOE estimates that rebates will provide national benefits, they are much smaller than the benefits resulting from national performance standards. Thus, DOE rejected rebates as a policy alternative to national performance standards.

Consumer Tax Credits. If customers were offered a tax credit equivalent to the amount mentioned above for rebates, DOE's research suggests that the number of customers buying a small electric motor that would take advantage of the tax credit would be approximately 60 percent of the number that would take advantage of rebates. Thus, as a result of the tax credit, the percentage of customers purchasing the products with efficiencies corresponding to TSL 4b or higher for polyphase motors would increase from 8.0 percent to 15.0 percent; the market share of capacitor-start motors meeting TSL 3 would increase from 0 percent to 0.1 percent for capacitor-start, induction-run motors, and from 26.0 percent to 36.0 percent for capacitor-start, capacitor-run motors. DOE assumed the impact of this policy would be to permanently transform the market so that the shipment-weighted efficiency gain seen in the first year of the program would be maintained throughout the forecast period. DOE estimated that tax credits would yield a fraction of the benefits that rebates would provide. DOE rejected rebates, as a policy alternative to national performance standards, because the benefits that rebates provide are much smaller than those resulting from performance standards. Thus, because consumer tax credits provide even smaller benefits than rebates, DOE also rejected consumer tax credits as a policy alternative to national performance standards.

Manufacturer Tax Credits. DOE believes even smaller benefits would result from availability of a manufacturer tax credit program that would effectively result in a lower price to the consumer by an amount that covers part of the incremental price difference between products meeting baseline efficiency levels and those meeting TSL 4b for polyphase small electric motors and TSL 3 for capacitor-start small electric motors. Because these tax credits would go to manufacturers instead of customers, DOE believes that fewer customers would be aware of this program relative to a consumer tax credit program. DOE assumes that 50 percent of the customers who would take advantage of consumer tax credits would buy more-efficient products offered through a manufacturer tax credit program. Thus, as a result of the manufacturer tax credit, the percentage of customers purchasing the more-efficient products would increase from 8.0 percent to 11.5 percent (*i.e.,* 50 percent of the impact of consumer tax credits) for polyphase motors, from 0 percent to 0.1 percent for capacitor-start, induction-run motors, and from 26.0 percent to 31.0 percent for capacitor-start, capacitor-run motors.

DOE assumed the impact of this policy would be to permanently transform the market so that the shipment-weighted efficiency gain seen in the first year of the program will be maintained throughout the forecast period. DOE estimated that manufacturer tax credits would yield a fraction of the benefits that consumer tax credits would provide. DOE rejected consumer tax credits as a policy alternative to national performance standards because the benefits that consumer tax credits provide are much smaller than those resulting from performance standards. Thus, because manufacturer tax credits provide even smaller benefits than consumer tax credits, DOE also rejected manufacturer tax credits as a policy alternative to national performance standards.

Voluntary Energy-Efficiency Targets. There are no current Federal or industry marketing efforts to increase the use of efficient small electric motors which meet the requirements of TSL 4b for polyphase small electric motors or TSL 7 for capacitor-start small electric motors. NEMA and the Consortium for Energy Efficiency promote "NEMA Premium" efficient three-digit frame series motors, and DOE analyzed this program as a model for the market effects of a similar program for small electric motors. DOE evaluated the potential impacts of such a program that would encourage purchase of products meeting the trial standard level efficiency levels. DOE modeled the voluntary efficiency program based on this scenario and assumed that the resulting shipment-weighted efficiency gain would be maintained throughout the forecast period. DOE estimated that the enhanced effectiveness of voluntary energy-efficiency targets would provide 0.42 quad of national energy savings and an NPV of $0.95 billion (at a 7-percent discount rate). Although this would provide national benefits, they are much smaller than the benefits resulting from national performance standards. Thus, DOE rejected use of voluntary energy-efficiency targets as a policy alternative to national performance standards.

Bulk Government Purchases. Under this policy alternative, the government sector would be encouraged to purchase increased amounts of polyphase equipment that meet the efficiency levels in trial standard level 4b and capacitor-start equipment that meets the efficiency levels in trial standard level 7. Federal, State, and local government agencies could administer such a program. At the Federal level, this would be an enhancement to the existing Federal Energy Management Program (FEMP). DOE modeled this program by assuming an increase in installation of equipment meeting the efficiency levels of the target standard levels among the commercial and public buildings and operations which are run by government agencies. DOE estimated that bulk government purchases would provide 0.18 quad of national energy savings and an NPV of $0.44 billion (at a 7-percent discount rate), benefits which are much smaller than those estimated for national performance standards. DOE rejected bulk government purchases as a policy alternative to national performance standards.

National Performance Standards. None of the regulatory alternatives DOE examined would save as much energy or have an NPV as high as the standards in today's final rule. Also, several of the alternatives would require new enabling legislation, because DOE does not have authority to implement those alternatives. Additional detail on the regulatory alternatives is found in the RIA chapter in the TSD.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's Web site, *http://www.gc.doe.gov.*

DOE reviewed today's final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. A regulatory flexibility analysis examines the impact of the rule on small entities and considers alternative ways of reducing negative impacts.

In the context of this rulemaking, "small businesses," as defined by the Small Business Administration (SBA), for the small electric motor manufacturing industry are manufacturing enterprises with 1,000 employees or fewer. See *http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf.* DOE used this small business definition to determine whether any small entities would be required to comply with the rule. (65 FR 30836, 30850 (May 15, 2000), as amended at 65 FR 53533, 53545 (September 5, 2000) and codified at 13 CFR part 121. The size standards are listed by NAICS code and industry description. The manufacturers impacted by this rule are generally classified under NAICS 335312, "Motor and Generator Manufacturing," which sets a threshold of 1,000 employees or less for an entity in this category to be considered a small business.

As explained in the NOPR, DOE identified producers of equipment covered by this rulemaking, which have manufacturing facilities located within the United States and could be considered small entities, by two methods: (1) Asking larger manufacturers in MIA interviews to identify any competitors they believe may be a small business, and (2) researching NEMA-identified fractional horsepower motor manufacturers. DOE then looked at publicly-available data and contacted manufacturers, as necessary, to determine if they meet the SBA's definition of a small manufacturing company. In total, DOE identified 11 companies that could potentially be small businesses. During initial review of the 11 companies in its list, DOE either contacted or researched each company to determine if it sold covered small electric motors. Based on its research, DOE screened out companies that did not offer motors covered by this rulemaking. Consequently, DOE estimated that only one out of 11 companies listed were potentially small business manufacturers of covered products. DOE then contacted this potential small business manufacturer and determined that the company's equipment would not be covered by this proposed rulemaking. Thus, based on its initial screening and subsequent interviews, DOE did not identify any company as a small business manufacturer based on SBA's definition of a small business manufacturer for this industry. (74 FR 61410, 61496). For today' final rule, DOE did not identify any additional companies that would be potential small business manufacturer based on SBA's definition of a small business manufacturer for the small electric motor industry.

DOE reviewed the standard levels considered in today's final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. On the basis of the foregoing, DOE reaffirms the certification. Therefore, DOE has not prepared a final regulatory flexibility analysis for this rule.

C. Review Under the Paperwork Reduction Act

This rulemaking imposes no new information or recordkeeping requirements. Accordingly, OMB clearance is not required under the Paperwork Reduction Act. (44 U.S.C. 3501, *et seq.*)

D. Review Under the National Environmental Policy Act

DOE prepared an environmental assessment of the impacts of today's standards which it published as chapter 15 within the TSD for the final rule. DOE found the environmental effects associated with today's standard levels for small electric motors to be insignificant. Therefore, DOE is issuing a FONSI pursuant to NEPA (42 U.S.C. 4321 *et seq.*), the regulations of the Council on Environmental Quality (40 CFR parts 1500–1508), and DOE's regulations for compliance with NEPA (10 CFR part 1021). The FONSI is available in the docket for this rulemaking.

E. Review Under Executive Order 13132

DOE reviewed this rule pursuant to Executive Order 13132, "Federalism," 64 FR 43255 (August 4, 1999), which imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. In accordance with DOE's statement of policy describing the intergovernmental consultation process it will follow in the development of regulations that have federalism implications, 65 FR 13735 (March 14, 2000), DOE examined the November 2009 proposed rule and determined that the rule would not have a substantial direct effect on the States, on the relationship between the National Government and the States, or on the distribution of power and responsibilities among the various levels of Government. See 74 FR 61497. DOE received no comments on this issue in response to the NOPR, and its conclusions on this issue are the same for the final rule as they were for the proposed rule. Therefore, DOE has taken no further action in today's final rule with respect to Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform" (61 FR 4729 (February 7, 1996)) imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. 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, the final regulations meet the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

As indicated in the NOPR, DOE reviewed the proposed rule under Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) (UMRA), which imposes requirements on Federal agencies when their regulatory actions will have certain types of impacts on State, local, and Tribal governments and the private sector. See 74 FR 61497. DOE concluded that this rule would not contain an intergovernmental mandate, but would likely result in expenditures of $100 million or more after 2015 for private sector commercial and industrial users of equipment with small electric motors. DOE estimated annualized impacts for the final standards using the results of the national impacts analysis. The national impact analysis results expressed as annualized values are $961–$1,146 million in total annualized benefits from the final rule, $264 million in annualized costs, and $698–$882 million in annualized net benefits. Details are provided in chapter 10 of the TSD. Therefore, DOE must publish a written statement assessing the costs, benefits, and other effects of the rule on the national economy.

Section 205 of UMRA also requires DOE to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which UMRA requires such a written statement. DOE must select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule, unless DOE publishes an explanation for doing otherwise or the selection of such an alternative is inconsistent with law.

Today's energy conservation standards for small electric motors would achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A discussion of the alternatives considered by DOE is presented in the regulatory impact analysis section of the TSD for this rule. Also, Section 202(c) of UMRA authorizes an agency to prepare the written statement required by UMRA in conjunction with or as part of any other statement or analysis that accompanies the proposed rule. (2 U.S.C. 1532(c)) The TSD, preamble, and regulatory impact analysis for today's final rule contain a full discussion of the rule's costs, benefits, and other effects on the national economy, and therefore satisfy UMRA's written statement requirement.

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

DOE determined that, for this rulemaking, it need not prepare a Family Policymaking Assessment under Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277). See 74 FR 61497. DOE received no comments concerning Section 654 in response to the NOPR, and, therefore, has taken no further action in today's final rule with respect to this provision.

I. Review Under Executive Order 12630

DOE determined under Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988), that today's rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution. See 74 FR 61497–98. DOE received no comments concerning Executive Order 12630 in response to the NOPR, and, therefore, has taken no further action in today's final rule with respect to this Executive Order.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (February 22, 2002), and DOE's guidelines were published at 67 FR 62446 (October 7, 2002). DOE has reviewed today's final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001) requires Federal agencies to prepare and submit to the Office of Information and Regulatory Affairs (OIRA) a Statement of Energy Effects for any proposed significant energy action. DOE determined that today's rule, which sets energy conservation standards for small electric motors, is not a "significant energy action" within the meaning of Executive Order 13211. See 74 FR 61498. Accordingly, DOE did not prepare a Statement of Energy Effects on the proposed rule. DOE received no comments on this issue in response to the NOPR. As with the proposed rule, DOE has concluded that today's final rule is not a significant energy action within the meaning of Executive Order 13211, and has not prepared a Statement of Energy Effects on the final rule.

L. Review Under the Information Quality Bulletin for Peer Review

In consultation with the Office of Science and Technology Policy (OSTP), OMB issued on December 16, 2004, its "Final Information Quality Bulletin for Peer Review" (the Bulletin). 70 FR 2664. (January 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.

As set forth in the NOPR, DOE held formal in-progress peer reviews of the types of analyses and processes that DOE has used to develop the energy efficiency standards in today's rule, and issued a report on these peer reviews. The report is available at *http://www.eere.energy.gov/buildings/appliance_standards/peer_review.html.* See 74 FR 61498.

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will submit to Congress a report regarding the issuance of today's final rule prior to the effective date set forth at the outset of this notice. The report will state that it has been determined that the rule is a "major rule" as defined by 5 U.S.C. 804(2). DOE also will submit the supporting analyses to the Comptroller General in the U.S. Government Accountability Office

(GAO) and make them available to each House of Congress.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's final rule.

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation test procedures, Reporting and recordkeeping requirements.

Issued in Washington, DC, on February 22, 2010.

Cathy Zoi,

Assistant Secretary, Energy Efficiency and Renewable Energy.

■ For the reasons stated in the preamble, DOE amends part 431 of chapter II of title 10, of the Code of Federal Regulations, to read as set forth below.

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

■ 2. Section 431.446 is revised to read as follows:

Energy Conservation Standards

§ 431.446 Small electric motors energy conservation standards and their effective dates.

(a) Each small electric motor manufactured (alone or as a component of another piece of non-covered equipment) after February 28, 2015, shall have an average full load efficiency of not less than the following:

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Polyphase		
	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

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Capacitor-start capacitor-run and capacitor-start induction-run		
	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

(b) For purposes of determining the required minimum average full load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in any table of efficiency standards in paragraph (a) of this section, each such motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

(1) A horsepower at or above the midpoint between the two consecutive horsepower ratings shall be rounded up to the higher of the two horsepower ratings;

(2) A horsepower below the midpoint between the two consecutive horsepower ratings shall be rounded down to the lower of the two horsepower ratings; or

(3) A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kilowatt = (1/0.746) hp, without calculating beyond three significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraphs (b)(1) or (b)(2) of this section, whichever applies.

Appendix

[The following letter from the Department of Justice will not appear in the Code of Federal Regulations.]

Department of Justice, Antitrust Division, Main Justice Building, 950 Pennsylvania Avenue, NW., Washington, DC 20530–0001, (202) 514–2401/(202) 616–2645(f), *antitrust.atr@usdoj.gov, http://www.usdoj.gov/atr.*

January 25, 2010.

Robert H. Edwards, Jr., Deputy General Counsel for Energy Policy, Department of Energy, Washington, DC 20585.

Dear Deputy General Counsel Edwards: I am responding to your November 19, 2009 letter seeking the views of the Attorney General about the potential impact on competition of proposed energy conservation standards for small electric motors. Your request was submitted pursuant to Section 325(o)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended, ("EPCA"), 42 U.S.C. § 6295(o)(B)(i)(V), which requires the Attorney General to make a determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy conservation standards. The Attorney General's responsibility for responding to requests from other departments about the effect of a program on competition has been delegated to the Assistant Attorney General for the Antitrust Division in 28 CFR § 0.40(g).

In conducting its analysis the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice, leaving consumers with fewer competitive alternatives, placing certain manufacturers of a product at an unjustified competitive disadvantage compared to other manufacturers, or by inducing avoidable inefficiencies in production or distribution of particular products.

We have reviewed the proposed standards contained in the Notice of Proposed Rulemaking ("NOPR")(74 Fed. Reg. 61410) and attended the December 17, 2009 public hearing on the proposed standard.

Based on our review of the record, the proposed standards for small electric motors could increase costs for consumers who need to replace small electric motors in existing equipment. Proposed Trial Standard Level (TSL) 5 for polyphase small electric motors and TSL 7 for all capacitor-start small electric motors apply to motors sold as replacements as well as to those built into original equipment. We understand that compliance with those standards could require manufacturers to increase the size of their motors such that the larger motors will not fit into existing space constrained equipment. In such a case, owners of existing equipment with a broken motor would have to either replace the entire piece of equipment or attempt to repair the motor. Such equipment owners would not have the option of simply replacing the existing small electric motor, thus limiting the range of competitive alternatives available to them. This may be quite onerous to consumers when the motor is only a small component of the total cost of the item and repairing the motor is difficult or costly. We ask the Department of Energy to take this possible impact into account and consider, as is warranted, exempting from the proposed standard the manufacture and marketing of certain replacement small electric motors for a limited period in time.

Sincerely,

Christine A. Varney,
Assistant Attorney General.

[FR Doc. 2010–4358 Filed 3–8–10; 8:45 am]

BILLING CODE 6450–01–P