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: Notice of proposed rulemaking and public meeting.

SUMMARY: The Energy Policy and Conservation Act authorizes the U.S. Department of Energy (DOE) to establish energy conservation standards for various consumer products and commercial and industrial equipment. Such equipment includes those small electric motors for which DOE determines that energy conservation standards would be technologically feasible and economically justified, and would result in significant energy savings. In this notice, DOE proposes energy conservation standards for certain small electric motors and is announcing a public meeting.

DATES: *Public meeting:* DOE will hold a public meeting on Thursday, December 17, 2009, from 9 a.m. to 5 p.m., in Washington, DC. DOE must receive requests to speak at the public meeting before 4 p.m., Thursday, December 3, 2009. DOE must receive a signed original and an electronic copy of statements to be given at the public meeting before 4 p.m., Thursday, December 10, 2009.

Comments: DOE will also accept written comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but received no later than January 25, 2010. See section VII, ''Public Participation,'' of this NOPR for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E–089, 1000 Independence Avenue, SW., Washington, DC 20585. Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures, requiring a 30-day advance notice. If you are a foreign national and wish to participate in the workshop, please inform DOE of this fact as soon as possible by contacting Ms. Brenda Edwards at (202) 586–2945 so that the necessary procedures can be completed.

Any comments submitted must identify the NOPR for Energy Conservation Standards for Small Electric Motors, and provide the docket number EERE–2007–BT–STD–0007 and/or regulatory information number (RIN) number 1904–AB70. Comments may be submitted using any of the following methods:

- *Federal eRulemaking Portal: http://www.regulations.gov.* Follow the instructions for submitting comments.
- *E-mail: small_electric_motors_std.rulemaking@hq.doe.gov.* Include the docket number and/or RIN in the subject line of the message.
- *Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed original paper copy.
- *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024. Telephone: (202) 586–2945. Please submit one signed original paper copy.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section VII of this document (Public Participation).

Docket: For access to the docket to read background documents or comments received, visit the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC, (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. **Please note:** DOE's Freedom of Information Reading Room is no longer housing rulemaking materials.

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) 586–9507, e-mail: *Michael.Kido@hq.doe.gov.*

For information on how to submit or review public comments and on how to participate in the public meeting, contact Ms. Brenda Edwards, 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. Telephone: (202) 586–2945. E-mail: *Brenda.Edwards@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

I. Summary of the Proposed Rule

Pursuant to the Energy Policy and Conservation Act (42 U.S.C. 6291 *et seq.*), as amended, (EPCA or the Act), the Department of Energy (DOE) is proposing new energy conservation standards for capacitor-start and polyphase small electric motors. These standards would achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified for this equipment, and would result in significant conservation of energy. The proposed standards are shown in Table I.1, Table I.2, and Table I.3, and would apply to all equipment manufactured in, or imported into, the United States on and after 5 years following the publication of the final rule.

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Table I.1 Proposed Standard Levels for Polyphase Small Electric Motors (efficiency)

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 correspond to Trial Standard Level 5 for polyphase motors.

Table I.2 Proposed Standard Levels for Capacitor-Start Induction-Run Small Electric Motors (efficiency)

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 correspond to Trial Standard Level 7 for capacitor-start motors.

Table I.3 Proposed Standard Levels for Capacitor-Start Capacitor-Run Small Electric Motors (efficiency)

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 correspond to Trial Standard Level 7 for capacitor-start motors.

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DOE's analyses indicate that the proposed standards would save a significant amount of energy—an estimated 2.46 quads of cumulative energy over 30 years (2015–2045). Of this, 2.13 quads of savings result from standards on capacitor-start (single-phase) motors and 0.33 quads of savings result from standards on polyphase motors.[1] The energy savings results for single-phase motors represent the combined effect of standards on the capacitor-start, induction-run (CSIR)[2] and capacitor-start, capacitor-run (CSCR)[3] motors markets, because general purpose CSIR and CSCR motors generally meet similar performance criteria and can often be used in the same applications.[4] The amount of projected energy savings is equivalent to the total energy 7.8 million U.S. citizens use in 1 year. The economic impacts on owners (hereafter "customers") of equipment containing single-phase small electric motors—*i.e.*, the average life-cycle cost (LCC) savings—are positive. Polyphase small electric motor customers experience, on average, small LCC increases as a result of the standard.

The cumulative national net present value (NPV) of total customer costs and savings from the proposed standards from 2015 to 2065 in 2008$ ranges from

[1] A polyphase motor is an electric motor that uses three-phase electricity and the phase changes of the electrical supply to induce a rotational magnetic field, thereby supplying torque to the rotor.

[2] A capacitor-start induction-run motor is a single-phase motor with a main winding arranged for direct connection to a source of power and an auxiliary winding connected in series with a capacitor. The motor has a capacitor phase, which is in the circuit only during the starting period.

[3] A capacitor-start capacitor-run motor is a single-phase motor which has different values of effective capacitance for the starting and running conditions.

[4] Polyphase, CSIR, and CSCR motors can be found in a range of applications including, but not limited to the following: Pumps, blowers, fans, compressors, conveyors and general industrial equipment.

$1.53 billion (at a 7-percent discount rate) to $14.15 billion (at a 3-percent discount rate). This is the estimated total value of future operating-cost savings minus the estimated increased equipment costs, discounted to 2009. If DOE were to adopt the proposed standards, it expects a −12.86 percent to 10.69 percent change in manufacturer industry net present value (INPV) for single-phase motors and −13.8 percent to 16.9 percent change in manufacturer INPV for polyphase motors, which is approximately −$44.67 to $40.70 million total. As a result, the NPV for customers (at the 7-percent discount rate) of $1.53 billion would thus exceed industry losses by about 33 times. Additionally, based on DOE's interviews with the major manufacturers of small electric motors, DOE does not expect any plant closings or loss of employment. The major small electric motor manufacturers include: A.O. Smith Electrical Products Company, Baldor Electric Company, Emerson Motor Technologies, Regal-Beloit Corporation, and WEG. Except for WEG, all of these manufacturers are U.S.-based. WEG is based in Brazil.

The proposed standards would have significant environmental benefits. All of the energy saved would be in the form of electricity. DOE expects the energy savings to eliminate the need for approximately 2.49 gigawatts (GW) of generating capacity by 2030. The reduction in electricity generation would result in cumulative (undiscounted) greenhouse gas emission reductions of 124.8 million tons (Mt) of carbon dioxide (CO_2) from 2015 to 2045. During this period, the standard would result in power plant emission reductions of 89.6 kilotons (kt) of nitrogen oxides (NO_X) and 0.561 tons of mercury (Hg). These reductions have a value of up to $2,737 million for CO_2, $67.7 million for NO_X, and $5.31 million for Hg, at a discount rate of 7-percent.

The benefits and costs of today's proposed rule can also be expressed in terms of annualized (2008$) values from 2015–2045. Estimates of annualized values are shown in Table I.4. The annualized monetary values are the sum of the annualized national economic value of operating savings benefits (energy, maintenance and repair), expressed in 2008$, plus the monetary value of the benefits of CO_2 emission reductions, otherwise known as the Social Cost of Carbon (SCC), expressed as $20 per metric ton of CO_2, in 2008$. The $20 value is a central interim value from a recent interagency process. The monetary benefits of cumulative emissions reductions are reported in 2008$ 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 V.B.6. 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 CO_2 value of reductions is based on a central value from a range of estimates of imputed marginal SCC from $5 to $56 per metric ton (2008$), which are meant to reflect the global benefits of CO_2 reductions; and (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, is meant to reflect the present value of all future climate related impacts, even those beyond 2065.

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 $515.4 million per year in increased equipment and installation costs, while the annualized benefits are $923.1 million per year in reduced equipment operating costs and $97.8 million in CO_2 reductions, for a net benefit of $505.5 million per year. Using a 3-percent discount rate, the cost of the standards proposed in today's proposed rule is $514.0 million per year in increased equipment and installation costs, while the benefits of today's standards are $1,071.5 million per year in reduced operating costs and $131.8 million in CO_2 reductions, for a net benefit of $689.3 million per year.

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Table I.4 Annualized Benefits and Costs for Small Electric Motors

Category	Primary Estimate (AEO Reference Case)	Low Estimate (Low Growth Case)	High Estimate (High Growth Case)	Units		
				Year Dollars	Disc. Rate	Period Covered
Benefits						
Annualized Monetized (millions$/year)	923.1	897.8	941.9	2008	7%	31
	1071.5	1044.7	1088.4	2008	3%	31
Annualized Quantified	2.68 CO_2 (Mt)	2.68 CO_2 (Mt)	2.68 CO_2 (Mt)	NA	7%	31
	1.83 NO_x (kt)	1.83 NO_x (kt)	1.83 NO_x (kt)	NA	7%	31
	0.019 Hg (t)	0.018 Hg (t)	0.018 Hg (t)	NA	7%	31
	3.61 CO_2 (Mt)	3.61 CO_2 (Mt)	3.61 CO_2 (Mt)	NA	3%	31
	2.56 NO_x (kt)	2.56 NO_x (kt)	2.56 NO_x (kt)	NA	3%	31
	0.019 Hg (t)	0.019 Hg (t)	0.019 Hg (t)	NA	3%	31
CO_2 Monetized Value (at $20/Metric Ton, millions$/year)	97.8	97.8	97.8	2008	7%	31
	131.8	131.8	131.8	2008	3%	31
Total Monetary Benefits (millions$/year)	1020.9	995.6	1039.7	2008	7%	31
	1203.3	1176.4	1220.1	2008	3%	31
Qualitative						
Costs						
Annualized Monetized (millions$/year)	515.4	515.4	515.4	2008	7%	31
	514.0	514.0	514.0	2008	3%	31
Qualitative						
Net Benefits/Costs						
Annualized Monetized, including CO_2 Benefits (million$/year)	505.5	480.2	524.3	2008	7%	31
	689.3	662.4	706.1	2008	3%	31
Qualitative						

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DOE has tentatively concluded that the proposed standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified and would result in significant conservation of energy. Based on the analyses culminating in this proposal, DOE found the benefits (energy savings, consumer LCC savings, national NPV increase, and emission reductions) outweigh the burdens (loss of INPV and LCC increases for some small electric motor users). For a discussion of the energy savings and NPV results, see TSD chapter 10. For LCC results, see TSD chapter 8. For emissions reductions, see TSD chapter 15. For INPV, see TSD chapter 12.

DOE considered higher efficiency levels as trial standard levels, and is still considering them in this rulemaking; however, DOE has tentatively concluded that the burdens of the higher efficiency levels would outweigh the benefits. Based on consideration of public comments DOE receives in response to this notice and related information, DOE may adopt either higher or lower efficiency levels than those presented in this proposal or some level(s) in between.

II. Introduction

A. Consumer Overview

Currently, no mandatory Federal energy conservation standards apply to small electric motors. DOE is proposing standards for the small motors shown in Table I.1, Table I.2, and Table I.3. The proposed standards would apply to equipment manufactured for sale in the United States, beginning 5 years after the final rule is published in the **Federal Register**. The final rule is expected to be published by February 28, 2010; therefore, the effective date would be February 28, 2015.

The proposed standards represent an overall reduction of approximately 40 percent in motor energy losses. The capacitor-start induction-run (CSIR) standards represent a 45-percent reduction in losses for a 0.5 hp CSIR motor, relative to the current market average. The capacitor-start capacitor-run (CSCR) standards represent a 37-percent reduction in losses for a 0.75 hp CSCR motor. The polyphase standards represent a 45-percent reduction in losses for a 1 hp polyphase motor.

DOE's analyses indicate that commercial and industrial customers would benefit from the proposed standards. Although DOE expects the installed cost of the higher-efficiency small motors to be greater (ranging from 9 percent for a 0.75 hp CSCR motor to 26 percent for a 1 hp polyphase motor than the average price of this equipment today, the energy efficiency gains will result in lower energy costs. A 0.5 hp CSIR customer will save an average of $25 per year on energy costs compared with an annual cost of losses of a baseline CSIR motor of $48 per year, while a 1 hp polyphase customer will save an average of $10 per year compared to an operational cost of motor losses of $34 per year for a baseline motor. A 0.75 hp CSCR customer will save $36 per year on their energy bill compared with a baseline CSCR motor that costs $57 per year in losses to operate on average. DOE estimates that the median payback period (PBP) for equipment meeting the proposed standards will be approximately 5 to 14 years. When these savings are summed over the lifetime of the higher efficiency equipment (and discounted to the present), a 0.5 hp CSIR consumer will save $49, on average, compared to a baseline 0.5 hp CSIR motor. A 0.75 hp CSCR consumer will save $28, on average, compared to a baseline CSCR motor, and $121, on average, compared to a baseline 0.75 hp CSIR motor. A consumer who purchases a 1 hp polyphase motor will experience an average net increase of $38 relative to the $1,274 life-cycle cost of a baseline polyphase small electric motor.

DOE estimates that even though there will be a net national savings from the standard, a majority of motor customers may not receive net life-cycle cost benefits. This is because many small electric motors are installed in applications where the motor is running only a few hours per day. On the other hand, because a substantial minority of motors is running at nearly all hours of the day and are replaced more often than motors that run infrequently, these motors obtain relatively large savings from the standard and yield positive net benefits from the standard.

B. 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 types of commercial and industrial equipment, which includes small electric motors.[5] DOE publishes today's notice of proposed rulemaking (NOPR) pursuant to Part A–1, which provides definitions, test procedures, labeling provisions, energy conservation standards, and the authority 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 431.343 and 431.344.

The Act defines "small electric motors" as follows:

> The term "small electric motor" means 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)(F))

Moreover, 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).

EPCA provides several criteria that govern adoption of new standards for small electric motors. After reviewing any comments received regarding today's notice, DOE will evaluate the information before it and decide whether today's proposed standards meet those criteria and are economically justified by determining whether the benefits of the standard exceed its burdens. DOE will make this determination by considering, to the greatest extent practicable, using the following seven factors 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 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;

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

6. The need for national energy conservation; and

7. Other factors the Secretary considers relevant.

42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)

Additionally, pursuant to 42 U.S.C. 6317(c), DOE will consider the criteria outlined in 42 U.S.C. 6295(n)—whether the standards 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)(II) (see criterion 2 listed above). These criteria are largely folded into the seven criteria that DOE routinely analyzes as part of its standards rulemaking analyses. Accordingly, DOE will continue to conduct its more comprehensive analyses under 42 U.S.C. 6295(o) as part of this rulemaking.

DOE also notes that today's notice concerns types of ''covered equipment'' as defined in EPCA (42 U.S.C. 6311(1)(A)), rather than ''covered products'' as defined in EPCA (42 U.S.C. 6291(2)). Under 42 U.S.C. 6316(a), the criteria for prescribing new standards for consumer products (42 U.S.C. 6295(o)) apply when promulgating standards for certain specified commercial and industrial equipment, including small electric motors. EPCA substitutes the term ''equipment'' for ''product'' when the latter term appears in consumer product-related provisions that EPCA also applies to commercial and industrial equipment. (See 42 U.S.C. 6316(a)(3).)

In developing energy conservation standards for small electric motors, DOE is also applying certain other provisions of 42 U.S.C. 6295. First, DOE will not prescribe a standard if interested parties have established by a preponderance of evidence that the standard is likely to result in the unavailability in the United States of any covered equipment type (or class) with performance characteristics, features, sizes, capacities, and volume that are substantially the same as those generally available in the United States. (See 42 U.S.C. 6295(o)(4))

Second, DOE is applying 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. * * *'' in place for that standard.

Third, in setting standards for a type or class of covered product that has two or more subcategories, DOE will specify 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. (See 42 U.S.C. 6295(q)(1).) In determining whether a performance-related feature justifies a different standard for a group of products, DOE considers such factors as the utility to the consumer of such a feature and other factors DOE deems appropriate. Any rule prescribing such a standard will include an explanation of the basis on which DOE established such higher or lower level. (See 42 U.S.C. 6295(q)(2))

Federal energy efficiency requirements for equipment covered by 42 U.S.C. 6317 generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)–(c) and 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 6316(a))

C. Background

1. Current Standards

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

2. History of Standards Rulemaking for Small Electric Motors

Pursuant to the requirements of the Energy Policy Act of 1992 (Pub. L. 102–486), DOE began to gather and analyze information to determine whether standards for small electric motors would meet its criteria. DOE began its determination analysis, by examining what motors were covered and concluded that the EPCA definition of ''small electric motor'' covers only those motors that meet the definition's frame-size requirements and are either three-phase, non-servo motors (polyphase motors) or single-phase, capacitor-start motors, including both CSIR and CSCR motors. 71 FR 38799, 38800–01 (July 10, 2006). DOE reached this conclusion because only these motor categories can meet the performance requirements set forth for general-purpose alternating-current motors by NEMA MG1–1987.

DOE then analyzed the likely range of energy savings and economic benefits that would result from energy conservation standards for these small motors, and prepared a report describing its analysis and provided its projected estimated energy savings from potential standards. In June 2006, DOE made the report, ''Determination Analysis Technical Support Document: Analysis of Energy Conservation Standards for Small Electric Motors,'' available for public comment at *http://www.eere.energy.gov/buildings/appliance_standards/commercial/small_electric_motors.html*.

Pursuant to section 346(b)(3) of EPCA (42 U.S.C. 6317(b)(3)), the analysis did not include motors that are a component of a covered product or equipment. Also, the report made no recommendation as to what determination DOE should make. DOE received comments concerning this analysis from NEMA, the Small Motors and Motion Association (SMMA, now the Motors and Motion Association), and the American Council for an Energy-Efficient Economy (ACEEE).

Thereafter, DOE analyzed whether significant energy savings would result from energy conservation standards for the small electric motors considered in its previous analysis, and incorporated the results of this additional analysis into a technical support document (TSD). Based on these results, DOE 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, DOE will initiate the development of energy efficiency test procedures and standards for certain small electric motors. 71 FR 38807.

DOE initiated this rulemaking to develop standards and another rulemaking to develop test procedures for small motors. DOE began this rulemaking by publishing ''Energy Conservation Standards Rulemaking Framework Document for Small Electric Motors'' on *http://www.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/small_motors_framework_073007.pdf*.

DOE also published a notice announcing the availability of the framework document and a public meeting on the document, and requesting public comments on the matters raised in the document. 72 FR 44990 (August 10, 2007).

On September 13, 2007, DOE held the public meeting at which it presented the contents of the framework document, described the analyses it planned to conduct during the rulemaking, sought comments from interested parties on these subjects, and sought to inform interested parties about, and facilitate their involvement in, the rulemaking. Interested parties that participated in the public meeting discussed eight major issues: the scope of covered small electric motors, definitions, test procedures, horsepower, and kilowatt equivalency, DOE's engineering analysis, life-cycle costs, efficiency levels, and energy savings. At the meeting and during the framework document comment period, DOE received many comments helping it identify and resolve issues involved in this rulemaking.

DOE gathered additional information and performed preliminary analyses to inform the development of energy conservation standards. This process culminated in DOE's announcement of an informal public meeting to discuss and receive comments on the following matters: the product classes DOE planned to analyze; the analytical framework, models, and tools that DOE was using to evaluate standards; the results of the preliminary analyses DOE performed; and potential standard levels that DOE might consider. 73 FR 79723 (December 30, 2008). DOE also invited written comments on these subjects and announced the availability on its Web site of a preliminary TSD. *Id.* A PDF of the preliminary TSD is available at *http://www1.eere.energy.gov/buildings/appliance_standards/commercial/small_electric_motors_nopr_tsd.html*.

Finally, DOE stated its interest in receiving comments on other issues that participants believe would affect energy conservation standards for small electric motors or that DOE should address in this NOPR. *Id.* at 79725.

The preliminary TSD provided an overview of the activities DOE undertook and discussed the comments DOE received in developing standards for small electric motors. It also described the analytical framework that DOE used and each analysis DOE performed up to that point. These analyses included:

- A market and technology assessment that addressed the scope of this rulemaking, identified the potential classes of this equipment, characterized the small electric motor market, and reviewed techniques and approaches for improving the efficiency of small electric motors;
- A screening analysis that reviewed technology options to improve small electric motor efficiency and weighed them against DOE's four prescribed screening criteria;
- An engineering analysis that estimated the manufacturer selling prices (MSPs) associated with more energy efficient small electric motors;
- An energy use and end-use load characterization that estimated the annual energy use of small electric motors;
- A markup methodology that converted average MSPs to consumer-installed prices;
- An LCC analysis that calculated, at the consumer level, the discounted savings in operating costs throughout the estimated average life of the small electric motor, compared to any increase in installed costs likely to result directly from the imposition of the standard;
- A PBP analysis that estimated the amount of time it takes consumers to recover the higher purchase expense of more energy efficient equipment through lower operating costs;
- A shipments analysis that estimated shipments of small electric motors over the time period examined in the analysis, which was used in performing the national impact analysis;
- A national impact analysis that assessed the aggregate impacts at the national level of potential energy conservation standards for small motors, as measured by the net present value of total consumer economic impacts and national energy savings; and
- A preliminary manufacturer impact analysis that took the initial steps in evaluating the effects on manufacturers of new efficiency standards.

The nature and function of the analyses in this rulemaking, including the engineering analysis, energy-use characterization, markups to determine installed prices, LCC and PBP analyses, and national impact analysis, are summarized in the December 2008 notice. *Id.* at 79725.

The public meeting announced in the December 2008 notice took place on January 30, 2009. At this meeting, DOE presented the methodologies and results of the analyses set forth in the preliminary TSD. The comments received since publication of the December 2008 notice have helped DOE resolve the issues in this rulemaking. The submitted comments include a joint comment from Adjuvant Consulting, on behalf of the Northwest Energy Efficiency Alliance (NEEA) and Northwest Power and Conservation Council (NPCC); a comment from Earthjustice; a second joint comment from Energy Solutions, Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company, and San Diego Gas and Electric (SDGE), a comment from NEMA); and a comment from Edison Electric Institute (EEI). This NOPR quotes and summarizes many of these comments and responds to the issues they raised. A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.

III. General Discussion

A. Test Procedures

Final test procedures were published on July 7, 2009 (74 FR 32059). The test procedures 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 (CAN/CSA) Standard C747–94.

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, while maintaining 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.

At the public meeting presenting the preliminary analyses for the energy conservation standards rulemaking, WEG and Emerson voiced their concern about enforcement of energy efficiency standards for small electric motors. WEG stated that they believe that enforcement will become especially problematic for those small electric motors that come into the country embedded in a piece of equipment and are therefore difficult to view the nameplate and to test. (WEG, Public Meeting Transcript, No. 8.5 at pp. 325–26) Additionally, Emerson requested that DOE provide further information on how it plans on enforcing standards on small electric motors. (Emerson, Public Meeting Transcript, No. 8.5 at p. 297) DOE notes certification and enforcement provisions for small electric motors have not yet been developed. DOE plans on proposing such provisions in a separate test procedure supplementary NOPR, at which time DOE will welcome comment on how small electric motor efficiency standards can be effectively enforced.

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis, which it bases on information it has gathered on all current technology options and prototype designs that could improve the efficiency of the product or equipment that is the subject of the rulemaking. In consultation with manufacturers, design engineers, and other interested parties, DOE develops a list of design options for consideration. Consistent with its Process Rule, DOE then determines which of these means for improving efficiency are technologically feasible. ''Technologies incorporated in commercially available products or in working prototypes will be considered technologically feasible.'' 10 CFR 430, subpart C, appendix A, section 4(a)(4)(i).

DOE evaluates each of the acceptable design options in light of the following criteria: (1) Technological feasibility; (2) practicability to manufacture, install, or service; (3) adverse impacts on product utility or availability; and (4) adverse impacts on health or safety. Chapter 4 of the TSD contains a description of the screening analysis. Also, section IV.B includes a discussion of the design options DOE considered, those it screened out, and those that are the basis for the trial standard levels (TSLs) in this rulemaking.

2. Maximum Technologically Feasible Levels

In the engineering analysis, DOE determined the maximum technologically (max-tech) feasible efficiency levels for small electric motors using the most efficient design parameters that lead to the highest equipment efficiencies. (See TSD chapter 5.) Table III.1 lists the max-tech levels that DOE determined for this rulemaking.

Table III.1 Max-Tech Efficiency Levels for Representative Product classes*

Phase	Motor Category	Poles	Horsepower	Efficiency %
Three	Polyphase	4	1	88.3
Single	CSIR	4	0.5	77.0
Single	CSCR	4	0.75	87.3

* 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.6.

DOE developed maximum technology efficiencies by creating motor designs for each product class analyzed that use all of DOE's viable design options. The efficiency levels shown in Table III.1 correspond to designs that use a maximum increase in stack length, a copper rotor design, an exotic low-loss steel type, a maximum slot fill percentage, 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

1. Determination of Savings

DOE used its national energy savings (NES) spreadsheet to estimate energy savings from new standards for the small electric motors that are the subject of this rulemaking. (The NES analysis is described in section IV.G and in chapter 10 of the TSD.) DOE forecasted energy savings beginning in 2015, the year that new standards would go into effect, and ending in 2045 for each TSL. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between the standards case and the base case. The base case represents the forecast of energy consumption in the absence of new energy conservation standards. DOE's base case assumes no change in the efficiency distribution of motors between 2008 and the end of the analysis period in 2045.

The NES spreadsheet model calculates the energy savings in site energy expressed in kilowatt-hours (kWh). Site energy is the energy directly consumed by small electric motors at the locations where they are used. DOE reports national energy savings in terms of the source energy savings, which is the savings in the energy that is used to generate and transmit the site energy. To convert site energy to source energy, DOE derived conversion factors, which change with time, from the American Recovery and Reinvestment Act scenario of the Energy Information Administration's (EIA) *Annual Energy Outlook 2009* (*AEO 2009*), which is the latest forecast available.

2. Significance of Savings

Standards for small electric motors must result in ''significant'' energy savings. (42 U.S.C. 6317(b)) While the term ''significant'' is not defined in the Act, the U.S. Court of Appeals, in *Natural Resources Defense Council* v. *Herrington*, 768 F.2d 1355, 1373 (DC Cir. 1985), indicated that Congress intended ''significant'' energy savings to be savings that were not ''genuinely trivial.'' The energy savings for all of the TSLs considered in this rulemaking are nontrivial, and therefore DOE considers them significant.

D. Economic Justification

1. Specific Criteria

As noted earlier, EPCA provides seven factors to be evaluated in determining whether an energy conservation standard is economically justified. (42 U.S.C. 6295(o)(2)(B)) The following sections discuss how DOE has addressed each of those seven factors as part of its analysis. DOE invites comments on each of these elements.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts on manufacturers of a new or amended standard, DOE first determines the quantitative impacts using an annual cash-flow approach. This includes both a short-term assessment—based on the cost and capital requirements during the period between the announcement of a regulation and when the regulation comes into effect—and a long-term assessment. The impacts analyzed include INPV (which values the industry on the basis of expected future cash flows), cash flows by year, changes in revenue and income, and other measures, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, paying particular attention to impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment, manufacturing capacity, plant closures, and loss of capital investment. Finally, DOE takes into account the cumulative impact of different DOE regulations on manufacturers.

For small electric motor customers, measures of economic impact include the changes in LCC and the PBP for each TSL. The LCC, which is also separately specified as one of the seven factors to be considered in determining the economic justification for a new or amended standard, (42 U.S.C. 6295(o)(2)(B)(i)(II)) is discussed in the following section.

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a product (including its installation) and the operating expense (including energy and maintenance expenditures) discounted over the lifetime of the product. DOE determines these costs by considering (1) total installed price to the purchaser (including manufacturer selling price, distribution channel markups, sales taxes, and installation cost), (2) the operating expenses of the equipment (energy cost and maintenance and repair cost), (3) equipment lifetime, and (4) a discount rate that reflects the real cost of capital and puts the LCC in present value terms.

For each representative small electric motor product class, DOE calculated both LCC and LCC savings for various efficiency levels. The LCC analysis estimated the LCC for representative units used in various representative applications, and accounted for a mixture of space-constrained applications (20 percent) and non-space-constrained applications (80 percent) in the commercial, agricultural, industrial, and residential sectors.

To account for uncertainty and variability in specific inputs, such as equipment lifetime, annual hours of operation, and discount rate, DOE used a distribution of values with probabilities attached to each value. DOE sampled a nationally representative set of input values from the distributions to produce a range of LCC estimates. A distinct advantage of this approach is that DOE can identify the percentage of consumers achieving LCC savings or attaining certain payback values due to an energy conservation standard. Thus, DOE presents the LCC savings as a distribution, with a mean value and a range. DOE assumed in its analysis that the consumer purchases the product in 2015.

c. Energy Savings

While significant conservation of energy is a separate statutory requirement for imposing an energy conservation standard, DOE considers the total projected energy savings that are expected to result directly from the standard in determining the economic justification of that standard. (See 42 U.S.C. 6295(o)(2)(B)(i)(III)) DOE used the NES spreadsheet results in its consideration of total projected savings.

d. Lessening of Utility or Performance of Products

In establishing classes of equipment, and in evaluating design options and the impact of potential standard levels, DOE sought to develop standards for small electric motors that would not lessen the utility or performance of this equipment. None of the TSLs DOE considered would reduce the utility or performance of the small electric motors under consideration in the rulemaking. (See 42 U.S.C. 6295(o)(2)(B)(i)(IV).) The efficiency levels DOE considered maintain motor performance and power factor (*i.e.,* approximately 75 percent for polyphase motors and greater than 60 percent for capacitor start motors) so that consumer utility is not adversely affected. 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). Those designs adhering to the 20-percent increase in stack length maintain all aspects of consumer utility and were created for all efficiency levels, but they may become very expensive at higher efficiency levels when compared with DOE's other designs.

e. Impact of Any Lessening of Competition

DOE considers any lessening of competition likely to result from standards. Accordingly, DOE has requested that the Attorney General transmit to the Secretary, not later than 60 days after the publication of this proposed rule, a written determination of the impact, if any, of any lessening of competition likely to result from today's proposed standards, together with an analysis of the nature and extent of such impact. (See 42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii).) Along with this request, DOE has transmitted a copy of today's proposed rule to the Attorney General. DOE will address the Attorney General's determination in the final rule.

f. Need of the Nation To Conserve Energy

The non-monetary benefits of the proposed standards are likely to be reflected in reductions in the overall demand for electricity, which will result in reduced costs for maintaining reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's power generation capacity. This analysis captures the effects of efficiency improvements on electricity consumption by the covered equipment, including the reduction in electricity generation capacity by fuel type.

The proposed standards will also result in improvements to the environment. In quantifying these improvements, DOE has defined a range of primary energy conversion factors and associated emission reductions based on the estimated level of power generation displaced by energy conservation standards. DOE reports the environmental effects from each TSL in the environmental assessment in chapter 15 of the TSD. (See 42 U.S.C. 6295(o)(2)(B)(i)(VI)).

g. Other Factors

The Act allows the Secretary of Energy, in determining whether a standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) Under this provision, DOE considered three factors: (1) Harmonization of the proposed standards with standards for similar products, (2) the need of some consumers to continue to have access to CSIR motors, and (3) the impacts of reactive power [6] on electricity supply costs.

Medium-sized polyphase general-purpose motors in three-digit frame series with output power of 1 horsepower and above are currently regulated under the Energy Policy Act of 1992 (EPACT 1992). DOE proposes a standard for polyphase small motors with output power of 1 horsepower and above that is closely aligned with the

[6] 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.

EPACT 1992 standard for medium motors.

Some of the highest TSLs for single-phase motors would lead to very high prices for CSIR motors while maintaining lower prices for CSCR motors, or vice versa. This shift in relative price may cause the effective disappearance of the more expensive category of motors from the market. In many applications, CSCR motors can replace CSIR motors. However, in some instances, the space required for a second capacitor is not available so that a CSCR motor may not be used to replace a CSIR motor in some specific applications. Under 42 U.S.C. 6295(o)(4), the Secretary may not prescribe a standard that is ''likely to result in the unavailability in the United States in any covered product type (or class).'' In today's notice, DOE proposes standards that it believes will maintain a supply of both categories of motors in the single-phase motor market.

DOE also notes that induction motors produce reactive power that can result in increased electricity supply costs because reactive power creates extra electrical currents that can require increased electrical distribution capacity. Many individual customers are not charged directly for this cost, but DOE did consider the economic benefits of potential reactive power reductions when evaluating the national benefits of the proposed standards.

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 additional cost to the consumer that meets the standard level is less than three times the value of the first-year energy (and as applicable, water) savings resulting from the standard, as calculated under the applicable DOE test procedure. (42 U.S.C. 6295(o)(2)(B)(iii) and 42 U.S.C. 6316(e)(1)) DOE's LCC and payback period (PBP) analyses generate values that calculate the PBP for customers of potential energy conservation standards, which includes, but is not limited to, the 3-year PBP contemplated under the rebuttable presumption test discussed above. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the 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 provides the results of a rebuttable presumption payback calculation in section V.B.1.d.

IV. Methodology and Discussion

DOE used three spreadsheet tools to estimate the impact of today's proposed standards. The first spreadsheet calculates the LCCs and payback periods of potential new energy conservation standards. The second, the National Impact Analysis (NIA) spreadsheet, provides shipment forecasts and then calculates national energy savings and net present value impacts of potential new energy conservation standards. DOE assessed manufacturer impacts largely through use of the third spreadsheet, the Government Regulatory Impact Model (GRIM).

Additionally, DOE estimated the impacts of energy efficiency standards for small electric motors on utilities and the environment. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The NEMS model simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its *Annual Energy Outlook,* a widely known energy forecast for the United States. The version of NEMS used for appliance standards analysis is called NEMS–BT, and is based on the AEO 2009 version with minor modifications. The NEMS offers a sophisticated picture of the effect of standards because it accounts for the interactions between the various energy supply and demand sectors and the economy as a whole.

The EIA approves the use of the name ''NEMS'' to describe only an AEO version of the model without any modification to code or data. Because the present analysis entails some minor code modifications and runs the model under various policy scenarios that deviate from AEO assumptions, the name ''NEMS–BT'' refers to the model used here. (''BT'' stands for DOE's Building Technologies Program.) For more information on NEMS, refer to *The National Energy Modeling System: An Overview,* DOE/EIA–0581 (98) (Feb. 1998), available at *http://tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf.*

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 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

Except for small electric motors that are components of other products covered by EPCA (see 42 U.S.C. 6317(b)(3)), DOE analyzed all CSIR and CSCR single-phase motors and polyphase motors, including, for example, both open and enclosed motors. DOE determined that standards appear to be warranted for all of them. *71 FR* 38807–08. However, DOE has tentatively concluded that EPCA does not cover certain small motors for which the determination concluded standards were warranted—the most significant group being enclosed motors.

a. Motor Categories

EPCA's definition of ''small electric motor'' is tied to the terminology and performance requirements in NEMA Standards Publication MG1–1987 (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) frames. 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. Therefore, only motors in these categories meet the single-speed induction motor element of EPCA's definition of ''small electric motor.''

In paragraph MG1–1.05, MG1–1987 defines ''general-purpose alternating-current motor'' as follows:

A general-purpose alternating-current motor is an induction motor, rated 200 horsepower and less, which incorporates all of the following: (1) Open construction, (2) rated continuous duty, (3) service factor in accordance with MG1–12.47, and (4) Class A insulation system with a temperature rise as specified in MG1–12.42 for small motors or Class B insulation system with a temperature rise as specified in MG1–12.43 for medium motors. It is designed in standard ratings with standard operating characteristics and mechanical construction for use under usual service conditions without restriction to a particular application or type of application.

During the public meeting held on January 30, 2009, Emerson Motor Technologies commented that split-phase motors, shaded-pole motors, and PSC motors do not meet the torque requirements for NEMA general-purpose motors. Therefore, Emerson indicated that these motors should be excluded from the scope of coverage for this rulemaking. (Emerson, Public Meeting Transcript, No. 8.5 at p. 38) [7]

DOE has examined this issue and, consistent with its position in the preliminary analyses, agrees that split-phase, shaded-pole, or PSC motors do not qualify as general-purpose alternating-current motors. Because split-phase motors are usually designed for specific purposes and applications, they are not designed ''for use under usual service conditions without restriction to a particular application or type of application.'' Additionally, split-phase, shaded-pole, and PSC motors all fail to meet MG1–1987's torque and current requirements for general-purpose motors, and hence are not ''designed in standard ratings with standard operating characteristics.'' The requirements that NEMA MG1–1987 defines for single-phase motors are locked-rotor torque at MG1–12.32.2, locked-rotor current at MG1–12.43, and breakdown torque at MG1–12.32. For small polyphase motors, NEMA MG1–1987 only defines breakdown torque in MG1–12.37. Because of these restrictions, none of the above motor categories are small electric motors as EPCA defines that term. DOE's determination that standards are warranted for small electric motors excluded the above motor categories, and none are covered by today's proposed standards.

As for CSIR, CSCR, and polyphase motors, these motor categories do meet the performance requirements set forth by the MG1–1987 definition of ''general-purpose alternating-current motor'' and are therefore covered by the EPCA definition of a small electric motor.

During the public meeting, PG&E, Earthjustice, and ACEEE expressed concern that small electric motors not covered by the scope of coverage of this rulemaking would be preempted from coverage as a result of energy conservation for standards for the covered small electric motors. (PG&E, Earthjustice, ACEEE, Public Meeting Transcript, No. 8.5 at pp. 320–323) In their comment, Earthjustice also requested that DOE clarify this issue. (Earthjustice, No. 11 at pp. 3–5) DOE appreciates these concerns and would like to clarify the issue of preemption. The statutory definition of small electric motors only gives DOE the authority to cover, CSIR, CSCR, and polyphase motors. Therefore, state standards for other, non-covered motor categories, such as those discussed above, would not be preempted by the standards set by this rulemaking.

b. Motor Enclosures

The first criterion listed in NEMA MG1–1987's definition of a ''general-purpose alternating-current motor'' is that the motor is of open construction. In the latest version of NEMA MG1, MG1–2006 with Revision 1 2007, NEMA modified this criterion and expanded it to include enclosed motors. At the preliminary analyses public meeting, Earthjustice commented that DOE could reinterpret the statutory definition of small electric motor such that NEMA MG1–1987 only applies to the definition of two-digit frame number series and later versions of MG1 could be used to expand coverage to include enclosed motors. Earthjustice reiterated this point in a comment submitted after the public meeting. (Earthjustice, Public Meeting Transcript, No. 8.5 at pp. 47–50; Earthjustice, No. 11 at p. 1) NEMA disagreed with this interpretation of the statutory definition, arguing that MG1–1987 was intended to apply to the entire definition of a small electric motor. Therefore, NEMA recommended that DOE only cover open motors. (NEMA, No. 13 at p. 17)

DOE agrees with NEMA that the reference MG1–1987 applies to all facets of the statutory definition of a small electric motor. The language of the statute specifies that the requirements of MG1–1987 apply in determining what constitutes a small electric motor. DOE's application of that definition is consistent with that language. Similarly, because the statute specifically mentions MG1–1987 as the version of MG1 on which DOE should relay, the 1987 version is the only applicable version of NEMA MG1. Accordingly, consistent with MG1–1987, only CSIR, CSCR, and polyphase motors with open construction meet the statutory definition.

c. Service Factors

Additional CSIR, CSCR, and polyphase motors may fail to meet the NEMA definition because, for example, they fail to meet the service factor requirements. Service factor is a measure of the overload capacity at which a motor can operate without 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). DOE has concluded that motors that fail to meet service factor requirements in MG1–12.47 are not ''small electric motors'' as EPCA uses that term. Therefore, today's proposed standards do not apply to them.

d. Insulation Class Systems

The statutory definition of a small electric motor is bound to the definition of a general-purpose alternating-current motor as defined in NEMA MG 1–1987. Part of that NEMA definition says 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.''

The issue of insulation classes and how it pertains to DOE's scope of coverage was discussed at the preliminary analysis public meeting. Advanced Energy spoke about insulation classes and recommended that DOE's coverage should include Class F insulation systems. (Advanced Energy, Public Meeting Transcript, No. 8.5 at pp. 45–46) Advanced Energy noted that insulation class systems used in small electric motors have improved since this definition of general purpose was first standardized in NEMA MG1–1987. Further, as new insulation technologies have improved and material costs have decreased, it has become increasingly common for manufacturers to use insulation classes higher than A. Advanced Energy requested in written comments that DOE consider all insulation classes as covered (Advanced Energy, No. 16 at p. 4).

[7] A notation in the form ''Emerson, Public Meeting Transcript, No. 8.5 at p. 38'' refers to (1) a statement that was submitted by Emerson Motor Technologies and is recorded in the docket ''Energy Efficiency Program for Certain Commercial and Industrial Equipment: Public Meeting and Availability of the Framework Document for Small Electric Motors,'' Docket Number EERE–2008–BT–STD–0007, as comment number 8.5; and (2) a passage that appears on page 38 of the transcript, ''Small Electric Motors Energy Conservation Standards Preliminary Analyses Public Meeting,'' dated January 30, 2009. Likewise, a notation in the form ''NEMA, No. 13 at p. 5'' refers to (1) a statement by the National Electrical Manufacturers Association and is recorded in the docket as comment number 13; and (2) a passage that appears on page 5 of that document.

Upon further examination of the market, DOE agrees with Advanced Energy. The vast majority of the motors manufactured, and otherwise covered by this rulemaking, satisfy the requirements for Class B or Class F insulation systems. DOE also found that according to MG1–1.66 and paragraph MG1–12.42, NEMA MG 1–1987 defines four insulation class systems. They are divided into classes based on the thermal endurance of the system for temperature rating purposes. A Class A insulation system must have suitable thermal endurance at a temperature rise. Class A insulation is a minimum level of thermal endurance. A Class B insulation system has a greater thermal endurance rating than Class A. Similarly, Class F thermal endurance exceeds Class B and Class H insulation has the highest level of endurance among all four classes. Therefore, the insulation class systems are defined in a way that permits a Class H system to satisfy Classes A, B, and F. DOE believes that this approach satisfies the statute and avoids creating a loophole through which all small electric motors equipped with non-Class A insulation would be eliminated from coverage. Commenters did not suggest that these insulation classes should be exempt from coverage and DOE is proposing to consider covering insulation Classes A or higher as covered under this rule. Therefore, DOE interprets the NEMA MG1–1987 definition of a ''general-purpose, alternating-current motor'' as being applicable to insulation class systems rated A or higher.

e. Metric Equivalents

EPCA defines a small electric motor based on the construction and rating system in 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 MG1–1987, 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 MG1–1987 criteria and English units of measurement. 64 FR 54114 (October 5, 1999)

DOE received two comments on IEC-equivalent motors following the January 30, 2009, public meeting. NEMA commented that IEC-equivalent motors should be considered covered products to prevent the import of virtually identical products that are not compliant with energy efficiency standards. (NEMA, No. 13 at p. 17) A joint comment submitted by PG&E, SCE, SCGC, and SDGE also stated that IEC-equivalent motors should be covered to prevent a potential loophole in the standard. (Joint Comment, No. 12 at p. 2)

Although the statutory definition of ''small electric motor'' does not address metric or kilowatt-rated motors, DOE agrees with the submitted comments. In general, IEC metric or kilowatt-equivalent motors can perform the identical functions of covered small electric motors and provide comparable rotational mechanical power to the same machines or equipment. Moreover, IEC metric or kilowatt-equivalent motors can be interchangeable with covered small electric motors. Therefore, DOE interprets EPCA to apply the definition of a ''small electric motor'' to any motor that is identical or equivalent to a motor constructed and rated in accordance with NEMA MG1.

Additionally, as to motors with a standard kilowatt rating, DOE prescribed energy conservation standards for medium electric motors (*i.e.,* NEMA three-digit frame series motors) in section 431.25(a). In this section of the CFR DOE establishes equivalencies of standard horsepower and kilowatt ratings. As demonstrated by examination of these specified equivalencies in section 431.25(a) and the exact conversions of standard kilowatt ratings to horsepower ratings laid out in 431.25(b)(3)—no standard kilowatt rating exactly equals a standard horsepower rating—and therefore an IEC motor with a standard kilowatt rating must sometimes meet the efficiency standard for the next higher horsepower or the next lower depending on what converted horsepower value is relative to the surrounding standard horsepower ratings. In all cases the standard it must meet is prescribed for a horsepower that is very close to an exact conversion from its kilowatt rating. Second, as to electric motors with non-standard kilowatt or horsepower ratings, section 431.25(b)(3) provides that kilowatt rating would be arithmetically converted to its equivalent horsepower rating, and then, based on whether the motor falls above or below the midpoint between consecutive horsepower ratings, would be required to meet the corresponding higher or lower energy efficiency level, respectively. DOE proposes to adopt similar interpretations for small electric motors.

f. Frame Sizes

As to the frame sizes of motors that would be covered by DOE standards for small electric motors, EPCA defines small electric motor, in part, as a motor ''built in a two-digit frame number series in accordance with MG1–1987.'' (42 U.S.C. 6311(13)(G)) MG1–1987 establishes a system for designating frames of motors, which consists of a series of numbers in combination with letters. The 1987 version of MG1 only explicitly defines 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 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 therefore not covered under the EPCA definition of ''small electric motor.'' DOE is unaware of any other motors with frame sizes that are built in accordance with NEMA MG1–1987. Should such frame sizes appear, DOE will evaluate whether or not they are included equipment at that time.

g. Horsepower Ratings

The definition of a small electric motor does not explicitly limit the scope of coverage to certain horsepower ratings. However, DOE notes that the small electric motor industry generally considers 3 hp as the upper limit for rated capacity of such motors. Nonetheless, some manufacturers produce motors that meet the EPCA definition of small electric motor but have higher horsepower ratings. DOE has tentatively concluded that such motors are still covered by and subject to standards adopted under EPCA.

Chapter 3 of the TSD provides additional detail on the nature of the motors covered by the standards proposed in this 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 preliminary analyses public meeting, DOE presented its rationale for creating 72 product classes. The 72 product classes are based on the combinations of three different ratings or characteristics of a motor based on 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 motor categories: CSIR, CSCR, and polyphase. For each motor category, DOE broke down the product classes by all combinations of the eight different horsepower ratings (*i.e.,* ¼ to ≥ 3) and three different pole configurations (*i.e.,* 2, 4, and 6). A number of reasons support this approach.

First, the motor category depends on the type of energy used and its starting and running electrical characteristics. While all small electric motors use electricity, some motors operate on single phase electricity (which requires certain additional electronics for creating rotational torque) while others operate on polyphase electricity. Polyphase motors do not need additional circuitry to create rotational torque because they use the existing phase difference in the multiple phases of electricity applied to the motor. This difference impacts efficiency, and therefore becomes a factor around which DOE establishes a separate product class for polyphase motors.

Within single phase small electric motors, there are characteristics which are important because they can affect the motor's utility and potential for improving efficiency. The design feature of incorporating a run capacitor into the small electric motor affects motor efficiency, making it more efficient than an induction run motor that does not incorporate a run capacitor.[8] This design constitutes a performance-related feature that affects efficiency. Furthermore, DOE notes that it is not always possible to replace a CSIR motor with a CSCR motor due to the run capacitor, which is often mounted in an external housing on the motor. In certain applications, the run capacitor mounted on the motor will physically prohibit it from replacing a CSIR motor. This is a design feature that affects utility. For all of these reasons, DOE treats CSIR and CSCR motors as separate product classes.

Second, the number of poles in an electric motor determines the synchronous speed (*i.e.,* revolutions per minute). There is an inverse relationship between the number of poles and the maximum speed a motor can run at, meaning that an increase in the number of poles equates to a decrease in the speed of the motor (*e.g.,* going from two to four to six poles, the synchronous speed drops from 3,600 to 1,800 to 1,200 revolutions per minute). Since the full range of motor applications requires a variety of motor speeds, DOE considers motor speed and, therefore, the number of poles to have a distinct impact on the utility of small electric motors. Therefore, DOE uses the number of poles in a motor as a means of differentiating product classes because it is this design change that creates a change in motor speed capabilities.

Third, in general, efficiency scales with horsepower, a capacity-related metric of small electric motors. In other words, a 3 horsepower motor is usually more efficient than a ¼ horsepower motor. Horsepower is a critical performance attribute of an electric motor, and since there is a correlation with efficiency, DOE uses this as a criterion for distinguishing among product classes.

At the public meeting, Emerson and Baldor commented that frame size should be considered as an additional motor characteristic when establishing product classes. They both stated that motors of different frame sizes should not be subjected to the same standards because motors in the smaller frames will not be able to achieve as high an energy efficiency rating as the larger frame size. (Baldor, Public Meeting Transcript, No. 8.5 at pp. 70–71; Emerson, Public Meeting Transcript, No. 8.5 at pp. 75–76)

DOE agrees that motors in a smaller frame size, and therefore made with a potentially smaller diameter, will not be able to achieve the same efficiency rating as a larger frame. 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, DOE believes that frame size does not adequately account for efficiency limits based on the physical size of the motor. The frame size only dictates what the ''D'' dimension (*i.e.,* the dimension comprising the length from the bottom of the feet of a motor to the center of its shaft). For example, a 56 frame motor could have a stator outside diameter ranging from 5.5 inches to 6.15 inches. Therefore, DOE accounts for how changes in diameter can affect product utility and efficiency in the engineering analysis.

Additionally, if DOE were to add frame size to the class-setting criterion the number of product classes would increase from 72 to 216, which is a change by a factor of three for the frame sizes covered: 42, 48, and 56. Such a large number of product classes would result in a large number of basic models, which would be too burdensome on manufacturers when seeking certification of compliance. The three tables below lay out the 72 product classes, including a description of kilowatt and horsepower equivalents.

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[8] The run-capacitor and auxiliary windings in a CSCR motor help simulate a balanced two phase motor at full load, which helps minimize the current required to run the motor, thereby reducing the I^2R losses (which are losses related to current flow).

Table IV.1 Proposed Product classes for Polyphase Motors

Motor Horsepower/Standard Kilowatt Equivalent	Six Poles	Four Poles	Two Poles
1/4 hp/0.18 kW	PC #1	PC #2	PC #3
1/3 hp/0.25 kW	PC #4	PC #5	PC #6
1/2 hp/0.37 kW	PC #7	PC #8	PC #9
3/4 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	PC #21
≥ 3 hp/2.2 kW	PC #22	PC #23	PC #24

Table IV.2 Proposed Product classes for Capacitor-Start Induction-Run Motors

Motor Horsepower/Standard Kilowatt Equivalent	Six Poles	Four Poles	Two Poles
1/4 hp/0.18 kW	PC #25	PC #26	PC #27
1/3 hp/0.25 kW	PC #28	PC #29	PC #30
1/2 hp/0.37 kW	PC #31	PC #32	PC #33
3/4 hp/0.55 kW	PC #34	PC #35	PC #36
1 hp/0.75 kW	PC #37	PC #38	PC #39
1½ hp/1.1 kW	PC #40	PC #41	PC #42
2 hp/1.5 kW	PC #43	PC #44	PC #45
≥ 3 hp/2.2 kW	PC #46	PC #47	PC #48

Table IV.3 Proposed Product classes for Capacitor-Start Capacitor-Run Motors

Motor Horsepower/Standard Kilowatt Equivalent	Six Poles	Four Poles	Two Poles
1/4 hp/0.18 kW	PC #49	PC #50	PC #51
1/3 hp/0.25 kW	PC #52	PC #53	PC #54
1/2 hp/0.37 kW	PC #55	PC #56	PC #57
3/4 hp/0.55 kW	PC #58	PC #59	PC #60
1 hp/0.75 kW	PC #61	PC #62	PC #63
1½ hp/1.1 kW	PC #64	PC #65	PC #66
2 hp/1.5 kW	PC #67	PC #68	PC #69
≥ 3 hp/2.2 kW	PC #70	PC #71	PC #72

Chapter 3 of the TSD accompanying this notice provides additional detail on the product classes defined for the standards proposed in this NOPR.

B. Screening Analysis

DOE uses 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 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 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 height, using high efficiency 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 please see TSD chapter 3. For the NOPR, DOE screened out two of these technology options: PBIP and decreasing the air gap below .0125″.

PBIP is based on an iron powder alloy that is suspended in plastic, and is used in certain motor applications such as fans, pumps, and household appliances. The compound is then shaped into motor components using a centrifugal mold, reducing the number of manufacturing steps. Researchers claim that this technology option could cut losses by as much as 50 percent.[9] The Lund University team already produces inductors, transformers, and induction heating coils using PBIP, but has not yet produced a small electric motor. In addition, it appears that PBIP technology is aimed at torus, claw-pole, and transversal flux motors, none of which fit EPCA's definition of small motors.

Considering the four screening criteria for this technology option, DOE screened out PBIP as a means of improving efficiency. Although PBIP has the potential to improve efficiency while reducing manufacturing costs, DOE does not consider this technology option technologically feasible, because it has not been incorporated into a working prototype of a small electric motor. Also, DOE is uncertain whether the material has the structural integrity to form into the necessary shape of a small electric motor steel frame. Furthermore, DOE is uncertain whether PBIP is practicable to manufacture, install, and service, because a prototype PBIP small electric motor has not been made and little information is available on the ability to manufacture this technology. However, DOE is not aware of any adverse impacts on product utility, product availability, health, or safety that may arise from the use of PBIP in small electric motors.

Reducing the air gap between the rotor and stator can improve motor efficiency as well by reducing the magnetomotive force drop (*i.e.,* the force producing the magnetic flux needed to operate the motor), which occurs across the air gap. Reducing this drop means that the motor will require less current to operate. For small electric motors, the air gap is commonly set at 15 thousandths of an inch. Although reducing this air gap can improve efficiency, there is some point at which the air gap is too tight and becomes impracticable to manufacture. For the preliminary analyses DOE set an air gap reduction limit at 10 thousandths of an inch.

During the public meeting and the comment period following it, DOE received comments on this technology option. At the public meeting, Baldor stated that reducing the air gap between the stator and rotor will not improve motor efficiency, but could potentially worsen it instead. (Baldor, Public Meeting Transcript, No. 8.5 at p. 119) Alternatively, in the comment submitted on behalf of Baldor and other manufacturers by NEMA, they stated that reducing the air gap could have a positive effect on efficiency for some motor designs, but not necessarily all. (NEMA, No. 13 at p. 5) NEMA also stated that a more practical limit on the air gap for small electric motors is 12.5 thousandths of an inch. (NEMA, No. 13 at p. 3)

DOE agrees with NEMA's comments and screened out decreasing the radial air gap below 12.5 thousandths of an inch as a means of improving efficiency. DOE believes air gaps of 10 thousandths of an inch are possible; however, they are more practical in non-continuous, stepper motors (motors whose full rotation is completed in discrete movements) where potential contact is not as much of a concern. DOE considers air gap reduction below 12.5 thousandths of an inch technologically feasible, because smaller air gaps do not present any technological barrier. Also, DOE is not aware of any adverse impacts on health or safety associated with reducing the radial air gap below 12.5 thousandths of an inch. However, DOE believes that this technology option fails the screening criterion of being practicable to manufacture, install, and service because such a tight air gap may cause the rotor to come into contact with the stator and cause manufacturing and service problems. This technology option fails the screening criterion of adverse impacts on consumer utility and reliability, because the motor may experience higher failure rates in service when the manufactured air gaps are less than 12.5 thousandths of an inch.

DOE received comments on two other technology options as well—increasing stack length and the use of different run capacitors. Baldor suggested that DOE screen out changing the stack length of the motor because it will force some original equipment manufacturers (OEMs) that use small electric motors to invest in redesigning their equipment to fit the potentially larger motor. (Baldor, Public Meeting Transcript, No. 8.5 at pp. 121–22) DOE cannot screen out a technology option because of cost, so DOE believes adding stack height and lengthening a motor is a viable technology option that passes all four screening criterion. Accordingly, these technology options will be included in the engineering analysis. See the engineering analysis, section IV.C.

NEMA recommended that DOE consider varying the rating of capacitors used in small electric motors as a technology option. (NEMA, No. 13 at p. 18) In response, DOE notes that though varying capacitor ratings was not explicitly listed as a technology option,

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

it was utilized in the preliminary engineering analysis. DOE agrees that changing the capacitor rating, specifically the run-capacitor rating used in CSCR motors, can provide increases in motor efficiency with minimal redesign effort. DOE believes that changing the capacitor rating meets all four screening criterion and is being included in the engineering analysis of this NOPR.

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

C. Engineering Analysis

The engineering analysis develops cost-efficiency relationships to show the manufacturing costs of achieving increased efficiency. DOE has identified the following three methodologies to generate the manufacturing costs needed for the engineering analysis: (1) The design-option approach, which provides the incremental costs of adding to a baseline model design options that will improve its efficiency; (2) the efficiency-level approach, which provides the relative costs of achieving increases in energy efficiency levels, without regard to the particular design options used to achieve such increases; and (3) the cost-assessment (or reverse engineering) approach, which provides ''bottom-up'' manufacturing cost assessments for achieving various levels of increased efficiency, based on detailed data as to costs for parts and material, labor, shipping/packaging, and investment for models that operate at particular efficiency levels.

1. Approach

In this rulemaking, DOE conducted the engineering analysis using a modified design-option approach where DOE employed a technical expert with motor design software 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 allows DOE to make its engineering analysis methodologies, assumptions, and results publicly available, 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, reduce skew on stack, increase cross-sectional area of rotor conductor bars, increase end-ring size, change gauge of copper wire in stator, manipulate stator slot size, decrease air gap between rotor and stator to 12.5 thousandths of an inch, improve grades of electrical steel, use thinner steel laminations, anneal steel laminations, add stack height, use high efficiency lamination materials, change capacitors ratings, install better ball bearings and lubricant, and install a more efficient cooling system. Chapter 5 of the TSD contains a detailed description of the product classes analyzed and the analytical models DOE used to conduct the small electric motors engineering analysis and chapter 3 of the TSD contains a detailed description of how all the design options increase motor efficiency.

2. Product Classes Analyzed

As discussed in section IV.A.2 of this notice, DOE proposes establishing a total of 72 product classes for small electric motors, based on the motor category (polyphase, CSIR, or CSCR), horsepower, and pole configuration. However, due to scheduling and resource constraints, DOE was not able to conduct a separate engineering analysis for each and every product class. Instead, 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 analyzed. Further discussion of this issue is presented in section IV.C.6.

For the engineering analysis conducted during the preliminary analysis, DOE analyzed three representative product classes, all with the most popular, 4-pole configuration. In response to that analysis, Baldor commented that two and six-pole motors may have significant design differences (such as the rotor outer diameter) from 4-pole motors. (Baldor, Public Meeting Transcript, No. 8.5 at pp. 196–99) Although DOE recognizes that these design differences exist and may affect efficiency, DOE has continued to directly model only 4-pole motors in its engineering analysis because it is the most popular configuration within each motor category and therefore the best basis for scaling. As discussed in section IV.C.3, DOE has revised its scaling relationships between product classes to account for efficiency-related differences between pole configurations.

For the NOPR, similar to its approach in the preliminary analyses, DOE analyzed the three representative product classes depicted in Table IV.4. By choosing these three product classes, DOE ensures that each motor category (polyphase, CSIR, and CSCR) is represented. In addition, DOE has chosen horsepower ratings for each motor category that are commonly available across 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 have the highest shipment volume for 2007. See TSD chapter 5 for additional detail on the product classes analyzed.

Table IV.4 Product classes Analyzed for NOPR Analyses

Motor Category	Horsepower	Number of Poles
Polyphase	1	4
CSIR	½	4
CSCR	¾	4

3. Cost Model

For the preliminary analyses and this NOPR, DOE developed a cost model to estimate the manufacturing production cost (MPC) of small electric motors. The model uses outputs of the design software to generate a complete bill of materials, specifying quantities and dimensions of parts associated with the manufacturing of each design. The bill of materials is multiplied by markups for scrap, overhead [10] (which includes depreciation) and associated non-production costs such as interest payments, research and development, and sales and general administration. The software output also includes 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.

During the public meeting, DOE received two comments regarding inputs to the cost model. Edison Electric Institute expressed concern with how DOE would handle material pricing for input commodity prices since the past several years have seen drastic fluctuations in these prices. (EEI, Public Meeting Transcript, No. 8.5 at pp. 161–62) NEEA reiterated these concerns and suggested that DOE use a distribution of commodity prices and generate various pricing scenarios. (NEEA, Public Meeting Transcript, No. 8.5 at p. 164)

DOE decided to estimate 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. DOE also performed a cost sensitivity analysis in which it examined both a high and low cost scenario for commodities. For all commodity prices, DOE used the PPI to determine the high and low cost points and then input those costs into the cost model. This allowed DOE to generate a high commodities cost case and a low commodities cost case for the engineering analysis results. Please refer to TSD chapter 5 for additional details on DOE's commodities cost scenario.

DOE applied a manufacturer markup to the MPC estimates to arrive at the MSP. MSP is the price of equipment sold at which the manufacturer can recover both production and non-production costs and earn a profit. DOE developed a market-share-weighted average industry markup by examining gross margin information from the annual reports of several major small electric motor manufacturers and Securities and Exchange Commission (SEC) 10–K reports.[11] Because the SEC 10–K reports do not provide gross margin information for different product line offerings, the estimated markups represent the average markups that the company applies over its entire range of motor offerings.

Markups were evaluated for 2003 to 2008. The manufacturer markup is calculated as *100/(100—average gross margin),* where average gross margin is calculated as *revenue—cost of goods sold (COGS).* To validate the information, DOE reviewed its assumptions with motor manufacturers. During interviews (see Chapter 12 of the TSD), motor manufacturers stated that many manufacturers generate different levels of revenue and profit for different product classes, but generally agreed with the end markup that was generated. For the NOPR engineering analysis, DOE used an industry-wide manufacturer markup of 1.45 based on the information described above.

4. Baseline Models

As mentioned above, the engineering analysis calculates the incremental costs for equipment with efficiency levels above the baseline in each product class analyzed. During the preliminary analyses, NEMA provided DOE with baseline efficiency levels for the four motors DOE analyzed. The baseline efficiencies reported by NEMA were from a set of compiled data submitted by its members. The reported baseline efficiency levels also corresponded to the lowest efficiencies of motors manufactured and sold in the market by their members at that time.

For the preliminary analyses, DOE used the expertise of its subcontractor to develop baseline design parameters that included dimensions, steel grades, copper wire gauges, operating temperatures, and other features necessary to calculate the motor's performance. The subcontractor used a software program to create a baseline design that had an efficiency rating equivalent to that provided by NEMA and torque and current restrictions compliant with NEMA MG1–1987.

After the public meeting, a few commenters raised issues related to baseline models. NEMA stated that DOE should use the baseline efficiencies that had been provided for the preliminary analyses to select efficiencies for the baseline models in the NOPR. (NEMA, No. 13 at p. 5)

For the NOPR analysis, DOE reexamined the baseline units selected. To establish the baseline motor for the three representative product classes DOE examined all available catalog data to find motors with the lowest efficiency on the market. The rated efficiencies for the polyphase and CSIR motors that DOE chose corresponded to the baseline efficiency levels that NEMA had recommended. However, for the CSCR motor DOE was unable to find a motor with as low an efficiency as that recommended by NEMA. Therefore, DOE selected the lowest efficiency level it could find in the market, which was 72 percent instead of the 66 percent recommended by NEMA. After purchasing the small electric motors, DOE had its design subcontractor, as well as an accredited laboratory, test the motors according to the appropriate IEEE test procedure. See Table IV.5 for the NEMA recommended efficiencies, the catalog rated efficiencies, and the tested efficiencies of the three baseline models.

Table IV.5 Efficiency Values of Baseline Models

	Polyphase 1 hp, 4 pole, 56 frame	CSIR ½ hp, 4 pole, 48 frame	CSCR ¾ hp, 4 pole 56 frame
NEMA Recommendation	74.0%	59.0%	66.0%
Catalog Rated	74.0%	59.0%	72.0%
Tested Efficiency	77.0%	57.7%	71.0%

[10] DOE used a markup of 17.5% for overhead when the motor design used an aluminum rotor and 18.0% when the motor design used a copper rotor. The difference in markup is to account for increased depreciation of the manufacturing equipment associated with using a copper rotor.

[11] Available at: *http://www.sec.gov/edgar.shtml.*

DOE also received comment on removing a motor that was analyzed for the preliminary analysis from further analysis. In the preliminary analysis, DOE analyzed two CSIR motors of the same horsepower and pole configuration, but with different frame sizes. After the engineering analysis showed little difference in the cost-efficiency relationship, DOE decided not to include the motor with the larger frame size in the subsequent NIA and LCC analyses. Adjuvant Consulting stated that they agreed with this decision (Adjuvant Consulting, No. 9 at p. 4) However, NEMA disagreed with the implication that frame size makes little difference on the cost-efficiency relationship in their comment and stated that they believed the little differences shown between the motors analyzed was due to the differences in other design characteristics of the baseline motor. (NEMA, No. 12 at p. 19)

DOE considered both of these comments when choosing appropriate product classes to analyze. DOE agrees with Adjuvant Consulting and believes that an analysis of two motors with different frame sizes, but in the same product class is not necessary. DOE also agrees with NEMA's assessment that the reason there was little difference between the two CSIR motors was due to the difference in the baseline design and not that there are little differences in cost-efficiency relationships for motors with the same ratings, but in different frame sizes. However, in the NOPR, DOE chose not to analyze two motors in the same product class with different frame sizes. Instead, DOE selected motors with the most restricted frame size seen in the respective product classes. DOE believes this is the best way to assess the efficiency capabilities of motors in the representative product classes.

Emerson stated that the software program used by DOE in developing its baseline models should be validated by actual motor designs that are produced. (Emerson, Public Meeting Transcript, No. 8.5 at pp. 148–49)

DOE established dimensional and performance specifications other than efficiency for the baseline models by examining all outputs of the IEEE test procedures and performing teardowns of the purchased motors. The IEEE test procedures provide several motor performance characteristics including speed, power factor, torque, and line current at various load points. After compiling these test data, DOE's subcontractor tore down each motor purchased to obtain internal dimensions, copper wire gauges, steel grade, and any other pertinent design information. Finally, the purchased motors were created in the designer's software and used as the baseline models in each analyzed product class for the engineering analysis. Again, the three product classes that were analyzed were: CSIR, ½ horsepower, 4-pole; CSCR ¾ horsepower, 4-pole; and polyphase, 1 horsepower, 4-pole motors. The specifications of the baseline models can be found in detail in TSD chapter 5.

5. Design Options and Limitations

In the market and technology assessment for the preliminary analyses, DOE defined an initial list of technologies that could increase the energy efficiency of small electric motors. In the screening analysis for the preliminary analyses, DOE screened out two of these technologies (PBIP and an air gap less than 12.5 thousandths of an inch) based on four screening criteria: technological feasibility; practicability to manufacture, install, and service; impacts on equipment utility or availability; and impacts on health or safety. The remaining technologies became inputs to the preliminary analyses engineering analysis as design options.

In addition to the comments DOE received about the list of design options considered in the screening analysis, DOE also received several comments about design limitations that should be considered. Among these design limitations are limits on how much to apply certain design options and motor performance characteristics that should be monitored and maintained. The comments addressed all of the following issues: manufacturability, motor size, service factor, skew, the air gap between the rotor and stator, power factor, speed, service factor, slot fill, locked-rotor conditions, no-load conditions, breakdown torque, and thermal characteristics of the motor.

a. Manufacturability

Baldor commented during the public meeting that manufacturability was its primary concern and urged DOE to consider this factor. (Baldor, Public Meeting Transcript, No. 8.5 at p. 108) NEMA and the NEEA and the Northwest Power and Conservation Council reiterated this view in their respective comments submitted after the public meeting. (NEMA, No. 13 at p. 6; NEEA and NPCC, No. 9 at p. 4) DOE agrees with these comments and believes that through the application of the design limitations that follow in this section, DOE has maintained manufacturability in all motor designs it presents.

b. Motor Size

Motor size was a topic repeatedly addressed by interested parties. WEG and Emerson both commented that a result of energy conservation standards and increasing the efficiency of small electric motors could be that the motor length, diameter, or both will increase. (WEG, Public Meeting Transcript, No. 8.5 at p. 79; Emerson, Public Meeting Transcript, No. 8.5 at pp. 80–81) This concerned manufacturers because larger motors that result from higher efficiency standards may no longer fit into applications and OEMs would be forced to redesign their equipment. DOE recognizes that lower cost high efficiency motor designs can be produced either with larger diameters or a longer stack length. DOE constrained the motor diameter in its engineering analysis and simplified its analysis of space constrained applications by addressing space constraint issues in only the stack length dimension. DOE assumes that motor users whose applications are not space constrained in terms of diameter, would purchase a motor with the next higher frame size.

At the public meeting, WEG stated that there is no set amount of additional stack height that can be added to a design without affecting end-use application because manufacturers often push those limits (WEG, Public Meeting Transcript, No. 8.5 at p. 129) NEMA suggested that DOE use a maximum stack length increase of less than 20 percent to account for the size restrictions that certain motor applications will have. (NEMA, No. 13 at p. 4)

When establishing design limitations for the motor designs produced, DOE considered these comments. DOE decided that increasing the stack height of a motor can result in the motor no longer fitting into certain applications. Taking the concerns raised during the comment period into account, DOE utilized a maximum increase of stack height of no more than 20 percent from the baseline motor. However, DOE also believes that not all applications would be held to this 20 percent limitation. Because this design limitation has a drastic effect on the cost-efficiency relationship for small electric motors, and not all applications would be bound to that restriction, DOE provides a second set of engineering results for each product class analyzed. This second set of results has a much less stringent limit of increasing the stack height, of 100 percent. That is, DOE has two designs for each motor analyzed, at each efficiency level; one for the motor designs adhering to a maximum stack height increase of 20 percent and one adhering to 100 percent. However, for some of the lower efficiency levels, where a change in steel grade or an increase of stack height above 20 percent is not needed, both sets of designs are the same. DOE uses a weighted average of the MSPs from the 20 percent constrained designs and the 100 percent constrained designs based on the distribution of size-constrained applications that use small electric motors.

c. Service Factor

As discussed in section IV.A.1 service factor is a performance characteristic motor manufacturers must observe when designing their motors. In its comment, NEMA suggested that service factor be considered so that subsequent more efficient designs are still proper replacements of the baseline motor design. (NEMA, No. 13 at p. 7) DOE agrees with this comment and therefore, will maintain the service factor of the baseline motor design for each subsequent, more efficient design produced.

d. Skew and Stay-Load Loss

Another design limitation that was discussed at the public meeting was decreasing the degree of rotor skew. At the preliminary analyses public meeting, Emerson commented that if rotor skew is removed in a single-phase motor, the motor will not start. (Emerson, Public Meeting Transcript, No. 8.5 at p. 134) Regal-Beloit also had concerns about this design option and stated that reducing motor skew could cause the rotor to be noisy when running. (Regal-Beloit, Public Meeting Transcript, No. 8.5 at p. 135–36)

DOE agrees that removing all of the skew from a single-phase motor will prevent it from starting. DOE also agrees that too much reduction of skew could cause the motor to become noisy. However, DOE does believe that reducing the degree of skew could provide efficiency gains depending upon the characteristics of the baseline model. DOE understands that this design option is subjective and relies heavily on the baseline motor design and experience of the motor design engineer. DOE did not use this design option for the motors analyzed in the engineering analysis because the skew of the baseline model was optimized. However DOE did not eliminate it as a design option prior to purchasing and tearing down its baseline motors.

Additionally, Baldor said that changing skew will affect the stray-load losses in a motor. As mentioned DOE did not implement this design option, but did assume 1.0 percent for the value of stray-load loss. Baldor recommended that instead of assuming 1.0 percent, DOE should assume 1.8 percent because that is recommended in the IEEE standard. (Baldor, Public Meeting Transcript, No. 8.5 at p. 176) After examining the IEEE standard, DOE agrees with Baldor and has assumed 1.8 percent for the amount of stray-load loss in its motor designs.

e. Air Gap

The air gap between the rotor and stator was another topic discussed at the preliminary analyses public meeting and DOE received two pertinent comments. As discussed in the screening analysis, Baldor stated that reducing the air gap between the rotor and stator could have negative effects on efficiency. (Baldor, Public Meeting Transcript, No. 8.5 at p. 119) NEMA added that although reducing the air gap could improve small electric motor efficiency, it recommended that DOE not decrease the air gap in its designs to less than 12.5 thousandths of an inch because smaller air gaps could be problematic causing rotor and stator contact, especially as the motors get longer. (NEMA, No. 13, pp. 3, 5)

After careful consideration of these comments, DOE agrees that decreasing the air gap between the stator and rotor down to 12.5 thousandths of an inch is a viable design option. Reducing the gap below that amount would increase the risk of creating potential performance and reliability issues that could arise with contact between the rotor and stator as well introduce manufacturability concerns regarding the ability of manufacturers to build motors with these significantly tighter tolerances. Therefore, DOE set one of its design limitations as maintaining at least 12.5 thousandths of inch for an air gap.

f. Power Factor

The rated power factor of a motor was an issue that was raised at the preliminary analyses public meeting. Baldor commented that the power factors of some designs in the preliminary analyses engineering analysis were extremely low and that such power factors would result in line losses that can negate gains in motor efficiency. (Baldor, Public Meeting Transcript, No. 8.5 at p. 174) NEMA followed up this comment suggesting that a minimum power factor needs to be established as a design limitation. (NEMA, No. 13 at p. 6) PG&E, SCE, SCGC, and SDGE reiterated these sentiments and suggested that a power factor of 75 percent should be maintained for all designs. (Joint Comment, No. 12 at p. 3)

DOE understands that sacrificing power factor to obtain gains in efficiency is counterproductive because of the negative effects on line efficiency. Therefore DOE agrees that power factor must be considered when designing more efficient small electric motors. However, DOE does not believe that it is necessary to maintain a power factor of 75 percent for all designs. Instead, DOE has opted to maintain or increase the power factor of the baseline motor for each more efficient design and therefore does not negate any gains in efficiency.

g. Speed

DOE also received comment about the rated speed of its designs during the preliminary analyses public meeting. Baldor commented that DOE should monitor the trend of full-load speed as motor designs become more efficient and DOE should try to maintain the speed of the baseline as much as possible. (Baldor, Public Meeting Transcript, No. 8.5 at pp. 177–78) NEMA reaffirmed this position and stated that to maintain utility for some applications, for example a fan or pump, as efficiency is increased from design to design, full-load speed must be maintained (NEMA, No. 13 at pp. 6–7)

DOE consulted with its own technical expert when setting a design limitation for full-load speed. DOE found that a decrease in full-load speed could have a negative impact on the utility of the motor design considered a replacement of the baseline. Additionally, DOE understands that speed is directly related to the I^2R losses [12] found in a motor and by maintaining it, those losses are kept reasonable. Subsequently, by not increasing I^2R losses, it is easier to increase the overall efficiency of the motor. Therefore, DOE agreed with the comments and decided that each design created by its subcontractor should maintain or increase the full-load speed of the baseline motor that was tested and modeled.

h. Thermal Performance

After the preliminary analyses public meeting, NEMA suggested that DOE complete a thermal analysis and urged DOE to examine rotor temperature during operation. (NEMA, No. 13 at p. 8)

[12] I^2R losses stem from the current flow through the copper windings in the stator and conductor bars in the rotor. These losses are manifested as waste heat, which can shorten the service life of a motor.

DOE carefully considered this comment for the NOPR phase of this rulemaking. DOE decided to create a baseline design modeled after a small electric motor manufactured and sold on the market today. DOE purchased a baseline motor for each of the product classes analyzed in the engineering analysis. This motor was tested according to the corresponding IEEE test procedure and the rotor squirrel-cage temperature was monitored using thermocouples. DOE believes that by maintaining speed and increasing efficiency, the thermal integrity of the baseline motor will be maintained for each subsequent design of increased efficiency. By maintaining the baseline speed the rotor resistance is not increased and by increasing efficiency there is less heat that must be dissipated in the motor. DOE believes the thermal integrity of each motor design produced for this rulemaking's analysis is preserved as a result these factors.

i. Slot Fill

DOE received comments on the percentages of slot fill used in the designs presented for the preliminary analyses public meeting. The maximum level of slot fill DOE allowed in the preliminary engineering analysis was 75 percent. NEMA stated that a more typical limit of slot fill is 65 percent. (NEMA, No. 13 at p. 3) Emerson stated that manufacturers could surpass current limits on slot fill, but this would require a hand winding technique by individual workers instead of using automated winding machinery. (Emerson, Public Meeting Transcript, No. 8.5 at p. 130) Lastly, NEMA also recommended that DOE use a minimum slot fill. (NEMA, No. 13 at p. 8)

DOE agrees that the level of slot fill is bound by a minimum and a maximum. DOE understands that a minimum slot fill is necessary in order for a motor to work. After consultation with technical experts DOE decided that a minimum slot fill of 50 percent should be maintained for all designs. DOE also agrees with the comments that a maximum level of slot fill is necessary and that that level should be 65 percent. Although it is possible to exceed this slot fill percentage and get closer to 75 percent, DOE found that this would take uncommon techniques that could inhibit mass production.

j. Current and Torque Characteristics

NEMA discussed in its written comments the performance characteristics that should be met for all motor designs produced by DOE for its analysis. These performance specifications include a minimum locked-rotor torque, a maximum locked-rotor current, a minimum breakdown torque, and a maximum no-load current. NEMA pointed out that MG1–1987 does not establish locked-rotor torque standards for polyphase motors, but it made no suggestion of what alternative should be used. NEMA also pointed out that MG1–1987 does not require a maximum locked-rotor current for small polyphase motors, but suggested that DOE use the standards for medium motors of corresponding horsepower, which are shown in MG 1–12.35. (NEMA, No. 13 at p. 6) Breakdown torque was another motor performance characteristic for which NEMA directed DOE to specific sections of MG1–1987 for both single and polyphase motors. (NEMA, No. 13 at p. 6) Finally, NEMA discussed no-load characteristics in their comment. While they made no suggestions for single-phase motors, NEMA believed that an average no-load current for polyphase small electric motors should be 25–35 percent of the rated-load current. (NEMA, No. 13 at p. 7)

DOE appreciates NEMA's comments clarifying the performance specifications set forth by NEMA MG1–1987 for general-purpose small electric motors. DOE agrees with NEMA that any motor design produced should meet the specifications shown in MG1–1987. That is, for single-phase motors all designs should meet the locked-rotor torque shown in MG1–12.32.2, the locked-rotor current shown in MG1–12.33.2, and the breakdown torque shown in MG1–12.32.1. For polyphase motors, the breakdown torque should be in the range shown in MG1–12.37. DOE agrees that the locked-rotor current specifications for medium polyphase motors are a fair gauge, and therefore design limitation for small polyphase motors of corresponding horsepower ratings because of the similarities in design and performance. For the performance requirements not specified in NEMA MG1–1987, DOE believes that the best design limitation is to meet or exceed the performance of the baseline motor used for each product class analyzed because this prevents over-restricting the design.

6. Scaling Methodology

As has been discussed in sections IV.C.2 and IV.C.4, DOE only analyzed three of the 72 product classes defined for small electric motors. Therefore, DOE needed to scale the results for these three product classes to the other 69. DOE presented an approach for scaling at the preliminary analyses public meeting. The first step in the previous scaling methodology was translating efficiency standards for medium motors into motor losses. DOE used two equations to obtain motor losses. DOE then examined these data sets to find a mathematical relationship explaining the change of motor losses relative to changes in horsepower and number of poles for medium motors. Finally, DOE assumed the relationships found in medium motors could be extrapolated to describe how losses, and thus efficiency, would scale for small electric motors.

DOE received comments on the scaling methodology that was presented at the preliminary analyses public meeting. Baldor stated that using medium motor efficiency standards may not be accurate because medium motors are manufactured in three-digit frame sizes, and thus, the relationships found in medium motors may not be accurate for small electric motors with two-digit frames. (Baldor, Public Meeting Transcript, No. 8.5 at p. 191) Additionally, NEMA noted that for medium motor efficiency standards, frame size changes with each change in horsepower. This is not the case for small electric motors where frame sizes are used for a range of horsepower ratings, and in some instances overlap. Therefore, NEMA said medium motors data are not applicable to small electric motors and should not be used. (NEMA, No. 13 at p. 10)

DOE appreciates these comments and considered them when reevaluating scaling relationships for small electric motors in the NOPR. Because there are no current standards for small electric motors, efficiency data are not as widely accessible for them. However, DOE did examine catalog efficiency data for small electric motors to determine if the relationships gleaned from medium motors may be an appropriate approximation for small electric motors. After examining publicly available catalog data, DOE agrees with the conjectures made by Baldor and NEMA that the relationships found in medium motors are not an accurate representation of the relationships found in small electric motors. Therefore, DOE has foregone the use of medium motors efficiency data and has used publicly available catalog data, as well as test data, to scale the results of the three analyzed product classes to the remaining 69.

Baldor made another comment about the two equations DOE used to describe motor losses. Baldor stated that it was inaccurate to use the first equation DOE presented, 100 − efficiency, to describe motor losses. Instead, DOE should only use the second equation they presented, which is also the accepted industry equation, 100 × [(100/efficiency) − 1]. Baldor, along with NEMA, recommended that DOE only use the latter equation when describing motor losses. (Baldor, Public Meeting Transcript, No. 8.5 at pp. 188–90; NEMA, No. 13 at p. 9)

DOE agrees with Baldor's and NEMA's comments about motor losses and has only used the industry accepted equation to calculate them for the NOPR. DOE hopes that by using the one equation it will promote good, industry-accepted equations and also simplify the methodology used to scale efficiencies to all product classes.

As discussed in section IV.A.2. Baldor and Emerson commented at the public meeting that frame size should be a criterion for distinguishing product classes. (Baldor, Public Meeting Transcript, No. 8.5 at pp. 70–71; Emerson, Public Meeting Transcript, No. 8.5 at pp. 75–76) DOE addressed this comment again when developing scaling relationships for small electric motors.

For the NOPR analyses, DOE's scaling approach leveraged a combination of publicly available catalog data and test data. First, DOE developed a database of over 3,000 motors built in a NEMA two-digit frame size. The database was then filtered to create a comprehensive list of motors that meet the statutory definition of a small electric motor. Through this database, DOE could address the issue of frame size and how it pertains to product classes. DOE used the database to find the most restricted frame size seen at each product class. Having these data, DOE filtered the database again to remove all efficiency data points for motors with an unrestricted frame size. For example, for a polyphase ¾ hp 4-pole motor, manufacturers use 48 and 56 frames. Therefore, DOE removed all efficiency points for motors with a 56 frame size because its achievable efficiency is not as restricted as the 48 frame size motor.

DOE filtered the database again to ensure an accurate assessment of market efficiency levels. DOE sorted the database by manufacturer and examined individual product lines. If manufacturers produce two lines of motors based on differences in efficiency, DOE examined that data separately. Product lines for each manufacturer included efficiency data for two, four, and six pole motors where available. This approach allowed DOE to examine how efficiency changes with respect to horsepower and number of poles.

DOE supplemented the catalog data with actual test data to validate conclusions drawn from that catalog data. An accredited lab performed IEEE standard 112, test methods A and B, and IEEE standard 114 to find efficiency data for 19 small electric motors. The motors selected for testing were pulled from the same product line for a given manufacturer. All three motor categories, pole configurations, and a full range of horsepower ratings were represented.

Once these data sets were prepared, DOE then converted the efficiency into motor losses using the industry-accepted equation mentioned above. This allowed DOE to use the most accurate line of best fit to fill in any gaps of data, which then enabled DOE to obtain an aggregated picture of motor losses (and thus efficiency) for the market based on both catalog data and laboratory accredited test data. Finally, the motor loss levels seen for each product class were shifted by a percentage increase corresponding to the difference in efficiency level for the three analyzed motors.

However, because information on CSCR motors was not as widely attainable, DOE relied on the relationships that it ascertained for CSIR motors to scale the results for CSCR motors. From the available catalog data, DOE found that efficiency tracked with horsepower the same way for both motor categories, but CSCR motors were more efficient.

7. Nominal Efficiency

With regard to the efficiency levels analyzed for small electric motors, NEMA recommended that DOE select efficiency values that coincide with ''nominal'' efficiencies listed in Table 12–10 of NEMA MG1–2006, currently being used for polyphase medium motors. NEMA also stated that DOE should not reference the column of ''minimum'' efficiencies seen in that table because those values are based on tolerances in the determination of total losses or efficiency through testing polyphase medium motors in accordance with IEEE standard 112 test method B. (NEMA, No. 13 at pp. 10–11)

Polyphase medium electric motors (those motors manufactured in three-digit frame series) are currently regulated by DOE as a result of EPACT 1992 and EISA 2007. The efficiency levels established by these Acts correspond to ''nominal'' efficiencies selected from a table in NEMA MG1 (Table 12–6A for NEMA MG1–1987 and table 12–10 for NEMA MG1–2006). Each ''nominal'' efficiency level shown in the table contains a corresponding ''minimum'' efficiency. By calculating both an average efficiency and a minimum efficiency from a population of motors tested, and by utilizing the look-up tables referenced, medium electric motor manufacturers report a ''nominal'' efficiency from these tables for compliance and labeling purposes. As the industry standard states, ''nominal efficiency'' represents a value that characterizes the energy consumption of a group of motors, accounting for variations in materials, manufacturing processes, and tests that result in motor-to-motor efficiency variations.

As ''nominal efficiency'' is a widely used and appropriate metric to characterize the efficiency of electric motors, if an equivalent table for small electric polyphase and single phase motors exists, DOE would support its use for the calculation of small electric motor efficiency. However, to DOE's knowledge, and corroborated by NEMA's comment, no such table exists. In addition, DOE agrees with NEMA that the ''minimum efficiency'' values associated with the ''nominal efficiency'' values in the referenced tables are not necessarily appropriate for small electric motors. Additionally, the increments of the ''nominal efficiency'' values in Table 12–10 of NEMA MG1–2006 range from 0.1 percent to 2.0 percent. Since these increments in efficiency do not follow a regular pattern and can, at the larger intervals, constitute significant changes in efficiency, particularly for small electric motors, DOE feels that they cannot simply replicate a similar table without a significant amount of test data that would need to be provided by manufacturers and verified by technical experts. In consideration of the inapplicability of the referenced medium motor tables and the lack of data to produce a similar table for small electric motors, DOE does not feel that it is appropriate to set efficiency standards for small electric motors based on the values in Table 12–10 of NEMA MG1–2006.

DOE also notes that the test procedure for small electric motors requires manufacturers to report a ''nominal full-load efficiency.'' This term, when discussed within the context of electric motors generally, is defined by EPCA as the average efficiency of a population of motors of duplicate design as determined in accordance with MG1–1987. 42 U.S.C. 6311((13)(I). As this term is not defined for small electric motors, to ensure consistency with the statute, DOE proposes to apply this definition for ''nominal full-load efficiency'' to small electric motors and to adopt a definition consistent with such an application into its regulations. Because MG1–1987 (or any later edition of the industry standard) does not contain provisions for nominal full-load efficiency for small electric motors, DOE proposes to adopt a definition for ''nominal full-load efficiency'' of small electric motors that is equivalent to the average full-load efficiency of a population of small electric motors. While DOE considered amending the definition of ''nominal full-load efficiency'' for small electric motors to create a parallel definition as the one used for electric motors (which utilizes tables of minimum and nominal efficiencies), this would require a significant amount of testing and industry collaboration that has not yet occurred. Therefore, to ensure a complete test procedure and fully-defined energy conservation standards, DOE proposes to adopt a definition for ''nominal full-load efficiency'' of small electric motors that is equivalent to the average full-load efficiency of a population of small electric motors. If, in the future, a table for small electric motors similar to Table 12–10 of NEMA MG1–2006 is developed, DOE may conduct a separate rulemaking to consider amending the definition of ''nominal full-load efficiency'' to make it consistent with the approach taken for medium motors, which makes reference to a specific table of efficiencies for ''nominal full-load efficiency.''

8. 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 NOPR. DOE developed two curves for each product class analyzed, one for the set of designs restricted by a 20 percent increase and one for those restricted by a 100 percent increase in stack height from the baseline. The methodology for developing the curves started with determining the energy efficiency for baseline models and MPCs for each product class analyzed. Above the baseline, DOE implemented various combinations of design options. Design options were implemented until all available technologies were employed (*i.e.,* at a max-tech level). See TSD chapter 5 for additional detail on the engineering analysis and the complete set of cost-efficiency results.

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Table IV.6 Efficiency and Manufacturer Selling Price Data for Polyphase Motor

Efficiency Level	Efficiency % (Design 1/Design 2)*	Manufacturer Selling Price $ (Design 1/Design 2)*
Baseline	77.2	97.74
EL 1	78.7	103.81
EL 2	80.0	107.01
EL 3	81.6	112.88
EL 4	82.5	117.01
EL 5	85.2/85.2	229.84/150.86
EL 6	86.7/86.4	236.20/184.73
EL 7 (Max-tech)	88.3/88.4	1,770.27/324.66

*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.7 Efficiency and Manufacturer Selling Price Data for Capacitor-Start, Induction-Run, 48-Frame Motor

Efficiency Level	Efficiency % (Design 1/Design 2)*	Manufacturer Selling Price $ (Design 1/Design 2)*
Baseline	57.7	91.04
EL 1	59.5	95.62
EL 2	62.0	98.54
EL 3	64.2	99.78
EL 4	68.5/68.6	114.57/107.19
EL 5	71.2/71.2	118.98/120.53
EL 6	73.0/73.1	182.28/132.16
EL 7 (Max-tech)	77.0/77.2	1,204.30/150.70

*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.8 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	71.0	110.82
EL 1	74.3	116.06
EL 2	78.3/78.4	136.22/128.60
EL 3	80.3/80.5	141.49/133.71
EL 4	81.6/81.8	145.27/141.10
EL 5	82.7/82.9	152.88/149.23
EL 6	83.7/83.5	237.53/156.85
EL 7	85.4/85.6	245.36/172.75
EL 8 (Max-tech)	87.3/87.3	1,778.48/353.50

*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.

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D. Markups To Determine Equipment Price

The markups analysis develops supply-chain markups and sales taxes that DOE uses to convert MSPs to customer or consumer equipment prices for small electric motors.

1. Distribution Channels

Before it could develop markups, DOE needed to identify distribution channels (*i.e.,* how the equipment is distributed from the manufacturer to the end user) for each category of motor addressed in this rulemaking. Because most of the small electric motors are used as components in larger pieces of equipment, most of the market passes through OEMs that design, assemble, and brand products that contain small electric motors. OEMs obtain their motors either directly from the motor manufacturers or from distributors.

For small electric motors, DOE defined three distribution channels and estimated their respective shares of shipments in its determination analysis: (1) From manufacturers to OEMs and then to end users through OEM distribution; (2) from manufacturers to wholesale distributors to OEMs and then to end users through OEM equipment distribution; and (3) from manufacturers to end users through distributors and retailers. Contractors also play a role in installing motors in equipment. DOE used the same distribution channel types and market shares in the preliminary analysis as it used in the determination analysis.

NEMA and Emerson commented that the proportion of shipments through the three channels as specified in the determination analysis was incorrect, and the correct market shares for each distribution channel are: 65 Percent for direct shipments to OEMs, 30 percent for shipments to OEMs through distributors, and 5 percent for shipments directly to users (Emerson, Public Meeting Transcript, No. 8.5 at pp. 218–19; NEMA, No. 13 at p. 19). The NEEA and the Northwest Power Planning Council recommended that DOE should corroborate distribution channel market shares with industry input (NEEA and NPCC, No. 9 at p. 5). DOE used the distribution market shares recommended by NEMA and Emerson in the NOPR analysis.

2. Estimation of Markups

DOE based its markups on financial data from the U.S. Census Business Expenses Survey (BES). DOE assumed that the sales revenues reported by firms reflect the prices that they charge for products, while the expenses that they reported to the BES reflect costs. DOE organized the financial data into balance sheets that break down cost components incurred by firms that sell the products and related these cost components to revenues to estimate the markups that determine sales price.

DOE's markup analysis developed both baseline and incremental markups to transform the manufacturer sales price into an end-user equipment price. DOE used the baseline markups to determine the price of baseline models. Incremental markups are coefficients that relate the change in the manufacturer sales price of higher-efficiency models to the change in the OEM, retailer, or distributor sales price. These markups refer to higher-efficiency models sold under market conditions with new energy conservation standards.

DOE used financial data from the BES for the ''Electrical Goods Merchant Wholesalers'' category to calculate markups used by distributors of motors for direct distribution; for the ''Machinery, Equipment, and Supplies Merchant Wholesalers'' category to calculate markups used by distributors of equipment containing small electric motors; and for the ''Building materials, hardware, garden supply and mobile home dealers'' category to calculate markups used by OEMs that apply to products containing motors.

DOE based the OEM markups and distributor markups on data from the ''2002 Economic Census Manufacturing Industry Series,'' which reports on the payroll (production and total), cost of materials, capital expenditures, and total value of shipments for manufacturers of various types of machinery. Six years of data are reported for each manufacturer type. DOE collected data for 11 types of OEMs.

DOE calculated baseline markups for each Census industry category. The resulting markups range between 1.20 (industrial machinery, machine tools) and 1.56 (heating equipment), with an average of 1.37. DOE estimated incremental markups using a least squares regression of the value of shipments on payroll and cost of materials. Because there is a large range in the size of OEM types, companies with sales values greater than $10 billion were separated from those with sales values less than $10 billion. The incremental markup for larger companies was 1.28; the incremental markup for smaller companies was 1.33.

WEG and Emerson commented that DOE should include recertification and retesting costs that OEMs may incur due to a change in the motor that is used in OEM equipment (Public Meeting Transcript, No. 8.5 at pp. 244–48). The markup factors that DOE derived for OEMs include average administrative and regulatory overhead costs such as might occur with certification and testing of products for safety. Therefore, when the manufacturer selling price of a more efficient motor is marked up by an OEM, DOE's analysis provides some accounting of increased regulatory overhead costs. In addition, DOE uses the OEM markups to estimate product prices and regulation cost impacts for an analysis period that spans 2015 through 2045, so initial regulatory costs can be averaged over several years. DOE believes that over this forecast period, recertification and testing costs are included in the OEM markups that it estimated.

During the presentation of the preliminary analysis, WEG noted that shipping costs to the customer should be explicitly included in the distribution costs (WEG, Public Meeting Transcript, No. 8.5 at p. 223). DOE agrees with this comment. To estimate shipping costs, DOE surveyed shipping and freight costs quotes available on the Internet and found a median value of $0.5 per pound. In the LCC analysis DOE added shipping costs to the installed cost of the motor based on specific motor weight estimates for each efficiency level from the engineering analysis. The engineering analysis designs provided motor weights for both space-constrained and non-space-constrained motors.

Emerson also commented during the preliminary analysis presentation that more efficient, larger motors with increased stack length could create large costs for OEMs that use small motors in space-constrained equipment designs and that this should be included in distribution costs (Emerson, Public Meeting Transcript, No. 8.5 at p. 241). DOE addressed this issue in the engineering and life-cycle cost analyses by estimating cost and performance characteristics for motors at all efficiency levels for both space-constrained and less-constrained designs. DOE assumed that OEMs addressed their space requirements by purchasing a more expensive space-constrained design for their space-constrained application. DOE then modeled the increased cost of the space constraint by using the higher, space-constrained manufacturer selling price and by applying the same markup factors to these higher incremental costs to estimate the incremental cost to the consumer.

For installation costs, DOE used information from RS Means Electrical

Cost Data [13] to estimate markups used by contractors who install motors and OEM equipment. RS Means estimates material expense markups for electrical contractors as 10 percent, leading to a markup factor of 1.10.

The sales tax represents state and local sales taxes that are applied to the end-user equipment price. DOE derived state and local taxes from data provided by the Sales Tax Clearinghouse. These data represent weighted averages that include county and city rates. DOE then derived population-weighted average tax values for each Census division and large state, and then derived U.S. average tax values using a populated-weighted average of the Census division and large State values. This approach provides a national average tax rate of 6.84 percent.

3. Summary of Markups

Table IV.9 summarizes the markups at each stage in the distribution channel and the overall baseline and incremental markups, and sales taxes, for each of the three identified channels. Weighting the markups in each channel by its share of shipments yields an average overall baseline markup of 2.49 and an average overall incremental markup of 1.83. DOE used these markups for each product class.

Table IV.9 Summary of Small Electric Motor Distribution Channel Markups

	Direct to OEMs <u>65%</u>		Via Distributors to OEMs <u>30%</u>		Via Distributors to End-Users <u>5%</u>	
	Baseline	**Incremental**	**Baseline**	**Incremental**	**Baseline**	**Incremental**
Wholesale Distributor	-	-	1.28	1.10	1.28	1.10
OEM	1.37	1.27	1.37	1.33	-	-
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	2.30	1.76	2.95	2.03	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

DOE's characterization of the energy use for small electric motors estimated the annual energy use and end-use load of small electric motors in the field. The energy use by small electric motors derives from three components: energy converted to useful mechanical shaft power, motor losses, and reactive power.[14] Motor losses consist of I^2R losses, core losses, stray losses and friction and windage losses. Core losses and friction and windage losses are relatively constant with variations in motor loading, while I^2R losses increase with the square of the motor loading. Stray losses are also dependent upon loading. To estimate motor losses, DOE used the empirical estimates of losses as a function of loading for the specific motor designs that were developed in the engineering analysis.

In practice, reactive power may result in significant increases in energy consumption before capacitors in the electrical system compensate (*i.e.,* mitigate) the reactive power that is generated by end-user loads. DOE estimated reactive power costs in the LCC analysis that may arise from reactive power charges and also estimated losses from reactive power that may occur in the electrical system.

In the preliminary analysis public meeting, DOE presented an analysis of energy use that separated motor losses into a constant component and a component that depends on motor loading. Both Baldor and NEMA commented that the approach that DOE used was non-standard and the equations proposed for estimating motor losses were imprecise (Public Meeting Transcript, No. 8.5 at pp. 228–33; NEMA, No. 13 at pp. 12–14). Responding to this comment, DOE modified its approach for the NOPR analysis. Rather than model motor losses with a potentially imprecise simplified equation, DOE used the direct loss estimates provided by the

[13] RS Means Construction Publishers & Consultants, ''Electrical Cost Data, 31st Annual Edition.'' 2008. J.H. Chiang, ed. Kingston, MA.

[14] In an alternating current power system, the reactive power is created when voltage and current are shifted in phase and is calculated from 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 which shifts the phase of the voltage relative to the current.

engineering analysis which are available as an empirical function of motor loading. DOE provides motor losses as a function of loading for each design in motor loading increments of 25 percent for all designs evaluated in the analysis. A more detailed description and accompanying motor loss tables are contained in chapter 6 of the TSD.

The final step in estimating annual energy use from motor losses is estimating the annual hours of motor operation. DOE estimated the annual energy consumed by motor losses as the loss (in watts) times the annual hours of operation. The annual hours of operation of small electric motors is dependent mostly on the particular application to which the motor is being applied.

In its preliminary analysis, DOE modeled each motor in a given application as operating for a fixed number of hours, equal to the average hours of operation determined for that application. As part of updating its motor application and operation analysis, DOE examined published data regarding the distribution of hours of operation for motors. DOE concluded that the available data regarding the distribution of hours of operation of general-purpose motors could be well characterized as the superposition of an exponential distribution and a fraction of motors run nearly continuously (8760 hours per year). DOE used this information to develop distributions for each motor application as a function of the average annual hours of operation.

In written comments submitted following the January 30, 2009, public meeting, NEMA provided estimates for typical hours of operation for motors in compressor, small pumping, and ''general industry'' applications (NEMA, No. 13 at p. 19). DOE developed a model for the national distribution of annual hours of operation within each motor application that maintained as much consistency as possible with all available sources of data including NEMA's comment, estimates developed earlier in the rulemaking, and operating hour distributions available in the technical literature. The operating hour distributions developed by DOE take the form of the superposition of an exponential distribution (in which the number of motors decreases with increasing hours of operation) with a small population of motors that run 100% of the time. DOE found in its analysis that the typical hours of operation as provided by NEMA are substantially lower than average hours of operation as estimated by DOE, but are consistent with DOE's median estimates of annual operating hours for four out of five application categories. Details regarding DOE's estimates of hours of operation are available in chapter 6 of the TSD.

F. Life-Cycle Cost and Payback Period Analysis

The LCC analysis calculates, at the consumer level, the discounted savings in operating costs throughout the estimated average life of the small electric motor, compared to any increase in installed costs likely to result directly from the imposition of the standard. The payback period analysis estimates the amount of time it takes consumers to recover the higher purchase expense of more energy efficient equipment through lower operating costs.

The LCC is the total consumer expense over the life of the equipment, including purchase expense and operating costs (including energy expenditures). To compute LCCs for equipment users, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the equipment. The payback period is the change in purchase expense due to an increased efficiency standard, divided by the change in annual operating cost that results from the standard. That is, the payback period is the time period it takes to recoup the increased purchase cost (including installation) of a more efficient product through energy savings.

Inputs to the calculation of total installed cost include the cost of the product—which includes manufacturer costs and markups, retailer or distributor markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, discount rates, and the year that proposed standards take effect. DOE created distributions of values for some inputs to account for their uncertainty and variability. For example, DOE created a probability distribution of annual energy consumption based in part on a range of annual operating hours. This range of annual operating hours is based on a derived sample of end-use applications for small electric motors. According to this range, the majority of these motors operates only a few hours per day, while a substantial minority of motors run nearly all hours of the day. LCC values reflect the aggregate effect of inputs weighted according to a combination of point values and probability distributions. DOE also used probability distributions to characterize variability in markups, discount rates and product lifetime. Details of all the inputs to the LCC and PBP analysis are contained in chapter 8 of the TSD.

As described above, DOE used samples of a population of motors and motor applications to characterize the variability in energy consumption and energy prices for this equipment. DOE also used a simple partitioning of motor applications to space-constrained and unconstrained applications.

The computer model DOE uses to calculate LCC and PBP, which incorporates Crystal Ball (a commercially available software program), relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and equipment user samples. The model calculated the LCC and PBP for equipment at each efficiency level for 10,000 motor units per simulation run. Details of the spreadsheet model DOE used for analyzing the economic impacts of possible standards on individual consumers, and of all the inputs to the LCC and PBP analysis, are contained in chapter 8 of the TSD.

Table IV.10 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The table provides the data and approach used for the preliminary TSD and the changes made for today's NOPR. The following subsections discuss the initial inputs and the changes made to them.

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Table IV.10 Summary of Inputs and Key Assumptions in the Life-Cycle Cost and Payback Period Analyses

Inputs	Preliminary TSD Description	Changes for the Proposed Rule
Baseline and Standard Efficiency Levels	Interpolated engineering design characteristics to estimate motor characteristics at baseline market efficiency and a range of potential standard levels	Used engineering performance and cost data for specific designs. Baseline engineering design adjusted to closely match market baseline in engineering analysis
Product Cost	Derived by multiplying manufacturer cost by manufacturer, retailer and distributor markups shipping costs and sales tax, as appropriate.	Shipping costs added
Installation Cost	Based on data from RS Means	No change
Motor Applications	Used applications and operating characteristics derived in the determination analysis	Adjusted applications based on comments and Internet-based market evaluation of OEM products.
Space Constraints	Designs constrained to maximum of 100 percent increase in stack length	Applications partitioned into 20 percent space-constrained and 80 percent unconstrained. Space-constrained designs limited to maximum of 20 percent increase in stack length
Annual Energy Use	Used simplified loss equation. Point value of hours of operation estimated as a function of motor application.	Motor loss vs. loading curves taken directly from motor designs derived in the engineering analysis. Distribution of motor hours of operation developed for each type of motor application.
Power Factor	Not included in consumer costs	Reactive power included. Reactive power charges derived from data provided in EEI comment. Reactive power costs assumed for 25% of motors
Energy Prices	Electricity: Based on EIA's 2006 Form 861 data.	Electricity: Updated using data from EIA's 2007 Form 861 data
Energy Price Trends	Forecasted using EIA's AEO 2008.	Forecasts updated using EIA's AEO 2009. Scenario added for electricity prices with potential future carbon regulation
Repair and Maintenance Costs	Not impacted by change in efficiency	No change
Product Lifetime	Average lifetime of 7 years for single-phase motors and 9 years for polyphase motors. Variability and uncertainty characterized using Weibull probability distributions.	Added correlation between hours of operation and motor lifetime. No change in average motor lifetime
Discount Rates	Approach based on the firm cost of capital. Distribution of discount rates adapted from distribution transformers rulemaking	No change
Effective Date of New Standard	2015.	No change.

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1. Baseline and Standard Level Efficiencies

For the preliminary analysis, DOE used mathematical interpolation of specific engineering designs to estimate the costs and losses of motors at baseline efficiencies and a set of candidate standard levels that had performance characteristics different from the initial engineering designs. NEMA commented that it is important for the efficiency levels used in the consumer economic analysis to match the efficiency levels in the engineering analysis so that interested parties can have confidence that concrete designs exist that can satisfy the proposed standard levels (NEMA, No. 13 at p. 16). DOE agrees with this comment and for this NOPR it analyzed efficiency levels for which it developed specific engineering designs.

In response to DOE's preliminary analysis, EEI commented that since medium motors are already regulated by DOE under Section 313(b) of the Energy Independence and Security Act of 2007, Pub. L. 110–140 (Dec. 19, 2007) (EISA 2007), and since polyphase general purpose small electric motors are very similar to polyphase general purpose medium electric motors, it is important for DOE to consider standard levels for small electric motors that are closely aligned with the standard for medium electric motors (EEI, No. 14 at p. 2). DOE agrees with this comment and designed TSL 5 for polyphase small electric motors to be closely aligned with the efficiency level for medium motors regulated under EISA 2007.

2. Installed Equipment Cost

DOE determined the baseline MSP and the MSP increases associated with increases in product efficiency for each small electric motor product class in the engineering analysis (section IV.C.7 of this NOPR and chapter 5 of the TSD). MSPs are the prices of the equipment at the factory door. They do not include distribution markups, but do include manufacturer markups.

DOE determined the installed cost of small electric motors by adding distribution markups and installation costs to the MSPs determined in the engineering analysis. DOE determined the baseline and incremental markups for each point in the small electric motor supply chain, as well as shipping costs and sales taxes, in the markups analysis (section II.E of this ANOPR and chapter 7 of the TSD). The overall baseline (2.35) and incremental (1.70) markups, which include sales tax, are weighted averages based on the share of shipments in each of the three identified distribution channels. DOE applied the same markups for each product class.

DOE derived installation costs for small electric motors from data in the ''RS Means Electrical Cost Data, 2008,'' [15] which provides estimates on the labor required to install electric motors. DOE estimated that the average installation cost is $253. Since it found no information to indicate differences in installation costs among motor applications, DOE used the same installation cost for each product class. DOE determined that installation costs would not be affected with increased energy efficiency levels.

In response to the preliminary analysis, DOE received several comments from interested parties regarding factors that can affect product prices. The comments, along with DOE's responses, are described in the appropriate sections of this notice that address the particular cost component: Costs associated with satisfying motor space and size constraints are addressed in the engineering analysis in IV.C above; costs incurred by OEMs within the motor distribution chain are addressed in the markup analysis in section IV.D; and costs associated with retooling and investments needed to manufacture more efficient motors are addressed in the manufacturer impact analysis described in section IV.I.

3. Motor Applications

For electric motors, the hours of operation and loading characteristics of motor use depend on the particular application to which the motor is applied. In its preliminary analysis, DOE used the same distribution of motor applications that it used in the determination analysis. This distribution included a wide range of applications, including food processing, woodworking tools, and farm machinery. Comments received at the January 30, 2009, public meeting from Emerson, WEG, and Regal-Beloit, (Public Meeting Transcript, No. 8.5 at pp. 270–76) and from NEMA (NEMA, No. 13 at p. 19) indicated that many of these applications utilize enclosed motors (as opposed to those that have an ''open construction'' design), and such motors are not covered under this rulemaking. DOE agrees with these comments, and has removed these applications from its analysis. To the extent that some motors in the applications no longer analyzed in detail may be open construction, and covered by this rule, DOE assumed that they are incorporated in the ''general industry'' category described below.

To improve the classification of motor applications, DOE studied motor manufacturer and OEM catalogs that are publicly available on the Internet to adjust the categories and the proportion of small electric motors covered by this rule used in each application category. DOE consolidated and narrowed the applications of covered small electric motors to four major categories: (1) Commercial and industrial fans and blowers; (2) conveyors, packaging, and material handling; (3) air and gas compressors (outside of HVAC); and (4) pumps. In addition, covered motors are used in a wide and various array of other applications, which DOE characterized under the heading ''general industry.''

4. Annual Operating Hours and Energy Use

To estimate annual energy use, DOE multiplied motor losses by the annual hours of operation. DOE obtained motor losses as a function of motor loading from the performance data for specific designs developed and analyzed in the engineering analysis. DOE estimated motor loading as a function of the motor application. DOE modeled variability in both motor loading and annual operating hours by using distributions for both operational characteristics.

In response to the preliminary analysis, NEMA commented that motors in small compressors have estimated annual hours of operation of 200 to 400 hours per year, motors used in small pumps have annual operating hours of 1,500 to 2,000 hours per year, while small motors used in general machinery in clean environments such as medical equipment will have estimated annual hours of operation of 500 to 1,000 hours per year (NEMA, No. 13 at p. 19). DOE agrees that these figures represent approximate median hours of operation for small compressors, small pumps and medical equipment with small electric motors. DOE included medical equipment in a category of ''general industry and miscellaneous,'' which it estimates has a significant fraction of applications in the range of 500 to 1,000 hours per year, but which also includes a large variety of miscellaneous equipment that DOE estimates has typical operating hours in the range of 1,000 to 2,000 hours per year. This latter estimate is consistent with the average hours of operation estimates developed during the determination analysis phase and is consistent with equipment that runs four to eight hours a day during normal working hours.

[15] RS Means Construction Publishers & Consultants, ''Electrical Cost Data, 31st Annual Edition.'' 2008. J.H. Chiang, ed. Kingston, MA.

5. Space Constraints

In response to DOE's preliminary analysis, several interested parties commented on the possibility that energy conservation standards may affect motors used in space-constrained applications. Baldor commented that DOE needs to correct the statement that a ''majority of small motor applications are not constrained by motor length'' and that the LCC analysis needs to take into account what it will cost to redesign OEM equipment to fit larger motors (Baldor, Public Meeting Transcript, No. 8.5 at pp. 119–21). WEG commented that changes in stack length can force OEMs to redesign their product (WEG, Public Meeting Transcript, No. 8.5 at p. 244). A joint comment by PG&E, SCE, SCGC, and SDGE stated that users with space-constrained applications may be able to resolve the space constraint by changing the motor type (Joint Comment, No. 12 at p. 3).

In the NOPR analysis, DOE addressed the issue of space constraints by calculating the cost and performance characteristics for both tightly constrained and less-constrained engineering designs for motors at each efficiency level. DOE then reviewed the range of applications and OEM equipment that uses the motors covered by the rulemaking and estimated that approximately 20 percent of covered motors are likely to be used in constrained applications. In the LCC analysis, DOE assigned 20 percent of motors to such constrained applications and used the engineering costs and performance associated with the constrained design when calculating consumer economic impacts. At low efficiency levels there is no difference between more and less constrained motors, but at the highest efficiency levels, the space-constrained applications can only be served by the most expensive motor designs because the less expensive motors are too large to fit within constrained spaces. In addition, DOE provides the LCC results for space-constrained applications as one of the consumer subgroups in the LCC subgroup analysis.

6. Power Factor

In its preliminary analysis, DOE presented real power losses and requested comment on power factor effects and the importance of including reactive power in its engineering, economic and national impact analyses. EEI commented that utilities like to see facility-wide power factor above 90 percent and that power factor penalties may affect the economics of small electric motor efficiency. EEI provided DOE with the results of a 2003 survey of power factor charges and costs taken of its members (EEI, No. 14 at p. 6). NEMA noted inaccuracies in the reactive power equations proposed by DOE in the preliminary analysis and urged DOE to carefully estimate and consider power factor effects and constraints (NEMA, No. 13 at pp. 14–15).

DOE appreciates the comments and data provided on this issue and agrees with the interested parties that this information can contribute to a more complete and precise analysis of the consumer and utility impacts of power factor changes that may result from energy conservation standards. DOE addressed power factor and reactive power by first estimating power factor as a function of motor loading for each of the motor designs analyzed in the engineering analysis. DOE then included these data in the LCC analysis tools so that the analysis included estimates of power factor as a function of both motor loading and efficiency level. In the LCC spreadsheet, DOE estimated reactive power for each motor analyzed. DOE then used the data provided by EEI to estimate a reactive power cost associated with the reactive power. It included this cost in both the LCC analysis and in the national impact analysis.

7. Energy Prices

DOE developed nationally representative distributions of electricity prices for different customer categories (industrial, commercial, and residential) from 2007 EIA form 861 data. 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 2008$) for each sector are 6.4 cents for the industrial and agricultural sectors, 8.8 cents for the commercial sector, and 10.1 cents for the residential sector. DOE also estimated an average reactive power charge of $0.47 per kilovolt-amps reactive (kVAr) per month using data provided by EEI for those customers that are subject to a reactive power charge.

8. Energy Price Trend

DOE used recent price forecasts by EIA to estimate future trends in electricity prices in each sector. To arrive at prices in future years through 2030, DOE multiplied the average prices described in the preceding section by the forecast of annual average price changes in EIA's AEO 2009. To estimate the trend after 2030, DOE followed past guidelines provided to the Federal Energy Management Program (FEMP) by EIA and used the average rate of change from 2020 to 2030 for electricity prices.

DOE calculated LCC and PBP using three separate projections from AEO 2009: Reference, Low Price Case, and High Price Case. These three cases reflect the uncertainty of energy prices in the forecast period. For the LCC results presented in this NOPR, DOE used only the energy price forecasts from the Reference case.

DOE received several comments from interested parties regarding its electricity price projection. At the preliminary analysis public meeting, Earthjustice and NEEA commented that DOE should monetize greenhouse gas emissions reductions benefits, possibly by including the cost of carbon regulation in its forecasted price of electricity. Interested parties also noted that DOE should avoid double counting and need only account for the monetary value of emissions reductions or the potential impact on electricity prices and should not count both impacts at the same time. Earthjustice commented that the Energy Information Administration (EIA) had performed an analysis of Lieberman-Warner cap and trade legislation and that DOE could use this forecast to describe electricity prices with carbon caps (Earthjustice, Public Meeting Transcript, No. 8.5 at pp. 249–54).

DOE responds to these comments primarily in the environmental analysis where DOE provides estimates of the potential monetary value of greenhouse gas emissions reductions. DOE also provides a sensitivity analysis in both the LCC and the national impact analysis that includes an electricity price trend estimated by EIA for the case of cap and trade emissions control regulation. Details on the sensitivity analyses performed by DOE for the LCC are provided in chapter 8 of the TSD, while the sensitivity analyses for the national impact analysis are detailed in TSD chapter 10.

9. Maintenance and Repair Costs

Small electric motors are not usually repaired, because they often outlast the equipment wherein they are a component. 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, DOE did not include changes in repair and maintenance costs for motors that are more efficient than baseline products.

10. Equipment Lifetime

In the preliminary analysis, DOE used the information it gathered for the determination analysis to estimate the motor lifetime, which DOE defined as the age when the equipment containing the motor is retired from service. Based on this information, DOE used lifetime distributions with a mean lifetime of 7 years for capacitor-start motors and 9 years for polyphase motors.

In response to the preliminary analysis, DOE received comments indicating that motor lifetimes should be dependent on the annual hours of operation. The NEEA and Northwest Power and Conservation Council requested that DOE further justify the relatively short motor lifetimes used in its analysis and take into account the inverse relationship between operating hours and lifetime (NEEA and NPCC, No. 9 at p. 5). In response to the rulemaking framework meeting, NEMA stated that motor lifetimes depend on the annual hours of use in addition to the variances of motor loading for various applications (NEMA, No. 5.1 at p. 7). DOE agrees that motor lifetime and annual hours of operation should be inversely related and the NOPR analysis has modified the lifetime distribution to account for the effect of annual hours of operation. DOE did not account for the impact of motor loading variance on motor lifetimes because doing so would likely result in an overly complicated consumer economic analysis model without changing the overall analytical results. The details of how DOE estimated the dependence of motor lifetime on annual operating hours are provided in chapter 8 of the TSD.

11. Discount Rate

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 from which the Monte Carlo simulations sample.

For the industrial and commercial sectors, DOE assembled data on debt interest rates and the cost of equity capital for representative firms that use small electric motors. DOE determined a distribution of the weighted-average cost of capital for each class of potential owners using data from the Damodaran online investment survey.[16] The discount rate distribution for each product class DOE analyzed in the LCC analysis is a weighted sample that combines estimated ownership percentages with their respective discount rates. DOE used the same distribution of discount rates for the industrial and agricultural sectors. The average discount rates in DOE's analysis, weighted by the shares of each rate value in the sectoral distributions, are 5.86 percent for commercial end users and 5.92 percent for industrial and agricultural end users.

For the residential sector, DOE assembled a distribution of interest or return rates on various equity investments and debt types from a variety of financial sources, including the Federal Reserve Board's ''Survey of Consumer Finances'' (SCF) in 1989, 1992, 1995, 1998, 2001, and 2004. DOE assigned weights in the distribution based on the shares of each financial instrument in household financial holdings according to SCF data. The weighted-average discount rate for residential product owners is 5.5 percent.

In response to the preliminary analysis, DOE did not receive any comments regarding consumer discount rates.

12. Standard Effective Date

The effective date is the future date when a new standard becomes operative. Under both the report to Congress and the November 6, 2006 Consent Decree entered for the consolidated cases of *New York* v. *Bodman,* No. 05 Civ. 7807 (S.D.N.Y. filed Sept. 7, 2005) and *Natural Resources Defense Council* v. *Bodman,* No. 05 Civ. 7808 (S.D.N.Y. filed Sept. 7, 2005), DOE is required to publish a final rule addressing energy conservation standards for small electric motors no later than February 28, 2010. According to 42 U.S.C. 6317(b)(3), ''(3) Any standard prescribed under paragraph (2) shall apply to small electric motors manufactured 60 months after the date such rule is published * * *'' 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 as if 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

DOE's NIA assesses the national energy savings (NES) and the national net present value (NPV) of total customer costs and savings that would be expected to result from new standards at specific efficiency levels.

To make the analysis more accessible and transparent to all interested parties, DOE used an MS Excel spreadsheet model to calculate the NES and NPV from new standards. MS Excel is the most widely used spreadsheet calculation tool in the United States and there is general familiarity with its basic features. Thus, DOE's use of MS Excel as the basis for the spreadsheet models provides interested parties with access to the models within a familiar context. In addition, the TSD and other documentation that DOE provides during the rulemaking help explain the models and how to use them, and interested parties can review DOE's analyses by changing various input quantities within the spreadsheet.

DOE uses the NIA spreadsheets to calculate NES and NPV based on the annual energy consumption and total installed cost data employed in the LCC analysis. DOE forecasts the energy savings, energy cost savings, equipment costs, and NPV for each product class from 2015 through 2045. The forecasts provide annual and cumulative values for all four output parameters. DOE also examines impact sensitivities by analyzing various scenarios.

DOE develops a base-case forecast for each small electric motor product class that characterizes energy use and customer costs (purchase and operation) in the absence of new energy conservation standards. To evaluate the impacts of such standards, DOE compares the base-case projection with projections characterizing the market if DOE promulgated new standards at specific efficiency levels (*i.e.,* the standards case). In characterizing the base and standards cases, DOE considers the mix of efficiencies sold in the absence of any new standards, and how that mix might change over time.

DOE did not find evidence of historical trends toward increasing market share for more efficient motors within the realm of covered products in this rulemaking. DOE therefore assumed that, in the base case, the market share of different levels of efficiency would remain fixed at current values over the analysis period. For its forecast of standards-case efficiencies, DOE used a ''roll-up'' scenario. In this approach, product energy efficiencies in the base case that do not meet the standard level under consideration would ''roll up'' to meet the new standard level. The market share of energy efficiencies that exceed the standard level under consideration would be the same in the standards case as in the base case.

[16] The survey is available at *http://pages.stern.nyu.edu/adamodar*.

DOE analyzed the relationship between cost and efficiency for three representative product classes (1 hp polyphase, ¾ hp CSCR, and ½ hp CSIR). In order to calculate the national energy savings and NPV of each TSL, DOE scaled both the energy consumption and equipment price to all other product classes. The national energy savings and NPV are developed from shipment-weighted sums of the energy use and equipment price for each product class. See section IV.C.6 for a discussion of the scaling of energy consumption. In order to scale prices, DOE examined motor catalog data from 10 motor manufacturers, available on the Internet. DOE developed an average price for motors in each product class, examined the price trend within each motor category (polyphase, CSCR, or CSIR) and number of poles, and developed a scaling relation to enable forecasts of price changes related to increasing efficiency. The price scaling model is discussed in chapter 8 of the accompanying TSD.

In the preliminary analysis, DOE used data submitted by NEMA for the determination analysis to develop shipments in each product class. It also determined the national impacts of each motor category by multiplying the results for a single product class by the shipments of the category as a whole. For the analysis presented in this NOPR, DOE modified these shipment estimates based on the distribution of currently available motor models to develop updated estimates for shipments in each product class. DOE then used these estimated 2008 shipments for each product class to develop NES and NPV estimates that better reflect the distribution of motor shipments among motor categories, output powers and speeds. NEMA criticized DOE's scaling approach in the preliminary analysis as confusing energy savings and net present value results from a particular product class with the results for the full distribution of motor sizes and speeds (NEMA, No. 13 at p. 20). DOE agrees with this comment, and replaced its preliminary analysis with a more comprehensive accounting.

During the preliminary analysis, DOE received requests from interested parties to provide an estimate of size of the potential savings from the standard relative to the amount of energy used by all small electric motors, including those not covered under the present rulemaking (ACEEE, Public Meeting Transcript, No. 8.5 at p. 234; Joint Comment, No. 12 at p. 2). While such detailed estimates are beyond the scope of this rulemaking, DOE provides a rough estimate of the energy use of small electric motors not covered in this rulemaking in chapter 10 of the TSD.

1. Shipments

Product shipment forecasts are an important component of any estimate of the future impact of a standard. DOE determined forecasts of small motor shipments for the base case and standards cases using the NES spreadsheet. The shipments portion of the spreadsheet forecasts polyphase and capacitor-start motor shipments from 2015 to 2045. DOE developed shipments forecasts by accounting for (1) the combined effects of equipment price, operating cost, and business income level; and (2) different market segments. Additional details on the shipments forecasts are in chapter 9 of the TSD.

DOE developed four shipment scenarios, modeling a range of possible growth for the market of covered small motors. For three of these scenarios, DOE assumed that shipments of covered small electric motors would be driven by growth in the sectors into which the motors are sold (industrial, commercial, and residential). DOE's reference case is based on the American Recovery and Reinvestment Act scenario released as a supplement to AEO 2009. DOE also modeled shipments driven by the High Growth and Low Growth scenarios in the AEO 2009 release. These three AEO scenarios are updated versions of the scenarios analyzed in the preliminary analysis. For the NOPR analysis, DOE also analyzed a ''falling market share'' scenario. At the January 30, 2009, public meeting (Public Meeting Transcript, No. 8.5 at pp 268–70) and during manufacturer interviews (see section IV.I), manufacturers predicted that the market share for motors covered by this rule will fall over time as customers increase their use of other motor technologies. The ''falling market share'' scenario reflects this assessment by modeling a scenario in which motor shipments are fixed at their 2008 levels, regardless of economic growth between 2008 and 2015 or during the analysis period. DOE's examination of equipment product catalogues and economic census data did not support a conclusion of falling market shares for general purpose motors in the application categories in DOE's analysis. DOE therefore provided the ''falling market share'' scenario as a sensitivity analysis rather than incorporating it into the reference case analysis. DOE seeks further information regarding alternative small motor technologies and how they could potentially affect the projected shipments. Chapters 9 and 10 of the TSD, along with the appendices to chapter 10, discuss the scenarios in greater detail and provide NES and NPV results calculated within each scenario to illustrate the effect of this scenario choice.

2. Elasticity Scenarios

DOE modeled three elasticity scenarios that estimate the change in motor shipments in response to increasing customer equipment prices: a scenario with no elasticity, a scenario with an elasticity of −0.25, and a scenario with an elasticity of −0.50. In the preliminary analysis, DOE chose the inelastic scenario as its reference case. At the January 30, 2009, public meeting, DOE asked for input regarding the likelihood of customers moving from covered motors to other motor categories if standards cause prices of the former to increase. In particular, in its preliminary analysis DOE stated that if the price of a baseline motor were to increase by more than 18 percent, some consumers may switch to enclosed motors. DOE believed the 18 percent increase was representative of the difference in price seen between an open motor and an enclosed motor with the same ratings. However, NEMA stated that 18 percent, which was derived from the difference in catalog prices, may not include the additional installation costs if the enclosed motor is a different size. NEMA also stated that the difference in cooling requirements would need to be considered. Finally, NEMA said that they were unaware of a study of the costs of replacing an open motor with an enclosed motor. (NEMA, No. 13 at p. 20) During manufacturer interviews, manufacturers commented that an increased purchase cost of covered motors would increase the rate of consumers switching to other motor technologies, for example, electronically commutated motors (ECMs). However, interested parties did not provide quantitative data which DOE could use to estimate the elasticity of small motor shipments. DOE's reference case for the NOPR analysis retains the ''no elasticity'' scenario. Although there is the potential for consumers to switch to other products, DOE believes that consumers are not likely to do so, even as prices for covered motors increase. Motor technologies such as ECMs are of a different physical size and require the use of an electronic controller to convert AC power into DC power. Whereas the ECM motor is itself typically larger than a capacitor start motor, the AC to DC control must also be physically attached to the motor or remotely located. Thus, consumers wishing to replace a motor covered by this rulemaking with an ECM motor will have additional costs associated with redesigning their application due to the physical size and/or electrical compatibility. Given these complexities, replacing a motor covered by this rule with an ECM motor would require significant installer knowledge and higher installation costs. Furthermore, potential substitution motor technologies such as ECMs are not currently available in distribution in the full range of speeds, service factors, and frame sizes to adequately service the replacement market. DOE seeks input and data regarding how the small motor market will respond to the proposed standards, particularly regarding elasticity between covered motors and other motor technologies, such as ECMs.

DOE notes that capacitor-start motors form a single market in which customers may choose a CSIR or CSCR motor to best meet their requirements. DOE developed a cross-elasticity model to incorporate the market dynamics of CSIR and CSCR motors within this single market. This CSIR/CSCR market share cross-elasticity is independent of the elasticity of the market as a whole, discussed above, which could change the size of the capacitor-start market. DOE calibrated its reference CSIR/CSCR market share model using its estimates of the current market share for CSCR and CSIR motors within each matched pair of product classes sharing a motor power and number of poles. DOE recognizes that there are significant uncertainties in its cross-elasticity model. The model utilizes DOE's shipments estimates in each capacitor-start product class, which are based in part on the number of models currently available, in the absence of direct shipments data from motor manufacturers. In addition, the model relies on DOE's scaling relations for motor losses and motor prices described earlier in this NOPR and detailed in the TSD. DOE provides two alternate model scenarios (''High CSCR'' and ''Low CSCR'' scenarios), described by sets of cross-elasticity model parameters, which it believes bracket the range of possible market share responses to standards. DOE modeled two cases for the timescale of market share response to standards. One case assumed that the market would take 10 years to adjust to the market shares predicted, following the implementation of standards in 2015, while the other assumed that the market shares would adjust prior to the effective date of the standards in 2015. DOE treats these two cases as its reference cases. DOE analyzed several alternate scenarios as sensitivities, including the ''High CSCR'' and ''Low CSCR'' model parameters and a case which treats the market share shift in space-constrained and non-space-constrained applications separately. Further details regarding this model and sensitivities are in TSD chapter 10. DOE recognizes that there are significant uncertainties in the inputs to its cross-elasticity model, and the resulting parameters of the model, and welcomes comments on each of these inputs as well as on the model itself. DOE also welcomes comments regarding the resulting forecast of the impact of standards on motor shipments and product class market shares.

H. Consumer Sub-Group Analysis

In analyzing the potential impact of new or amended standards on customers, DOE evaluates the impact on identifiable groups of customers (*i.e.,* subgroups), such as small businesses, that may not be equally affected by a national standard level. In this rulemaking, this analysis examined the economic impacts on different groups of customers by estimating the average change in LCC and by calculating the fraction of customers that would benefit. DOE analyzed the potential effect of standards for small businesses and customers with space-constrained applications, two consumer sub-groups of interest identified by DOE. Interested parties also supported these selections. For small businesses, DOE analyzed the potential impacts of standards by conducting the analysis with different discount rates, as small businesses do not have the same access to capital as larger businesses. DOE estimated that for businesses purchasing small motors, small companies have an average discount rate which is 4.2 percent higher than the industry average. DOE assumed that customers with space-constrained applications constitute 20 percent of all customers, and are distributed across all applications.

More details on the subgroup analysis and the results can be found in Chapter 11 of the TSD accompanying this notice.

I. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impact of energy conservation standards on small electric motor 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 on the industry cost structure, shipments, and revenues. The key output is the INPV. For this rulemaking, the impact on INPV is reported separately for polyphase and single-phase motors. Due to the market interaction between CSIR and CSCR, all single-phase motor results are presented together. Different sets of assumptions (scenarios) will produce different results. The qualitative part of the MIA addresses factors such as motor characteristics, characteristics of particular firms, market trends, and an assessment of the impacts of standards on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the TSD.

DOE conducted the MIA in three phases. Phase 1, Industry Profile, consisted of preparing an industry characterization. Phase 2, Industry Cash Flow, focused on the industry as a whole. In this phase, DOE used the GRIM to prepare an industry cash-flow analysis. DOE used publicly available information developed in Phase 1 to adapt the GRIM structure to analyze small electric motors energy conservation standards. In Phase 3, Subgroup Impact Analysis, DOE interviewed manufacturers representing the majority of domestic small electric motors sales. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics specific to each company, and also obtained each manufacturer's view of the industry as a whole. The interviews provided valuable information DOE used to help evaluate the impacts of a new standard on manufacturer cash flows, manufacturing capacities, and employment levels.

2. Phase 1, Industry Profile

For phase 1 of the MIA, DOE prepared a profile of the small electric motors industry based on the market and technology assessment prepared for this rulemaking. Before initiating the detailed impact studies, DOE collected information on the market characteristics of the small electric motors industry. This industry profile includes further detail on the overall market, motor characteristics, estimated manufacturer market shares, and the trends in the number of firms in the small electric motors industry.

The industry profile included a top-down cost analysis of the small electric motors manufacturers that DOE used to derive preliminary financial inputs for the GRIM (*e.g.,* revenues; material, labor, overhead, depreciation costs; selling, general, and administration expenses (SG&A); and research and development (R&D) expenses). DOE also used public information to further calibrate its initial characterization of the industry, including U.S. Securities and Exchange Commission (SEC) 10–K reports, Hoovers company financial reports, and U.S. Census data.

3. Phase 2, Industry Cash-Flow Analysis

Phase 2 of the MIA focused on the financial impacts of potential energy conservation standards on the industry as a whole. In Phase 2, DOE used the GRIM to perform a preliminary industry cash-flow analysis to calculate the financial impacts of energy conservation standards on manufacturers. In performing this analysis, DOE used the financial values determined in Phase 1 and the shipment scenarios used in the NIA analysis.

4. Phase 3, Sub-Group Impact Analysis

In Phase 3, DOE conducts interviews with manufacturers, refines its preliminary cash flow analysis, and uses its initial market characterization to evaluate the how groups of manufacturers could be differentially impacted. During the course of the MIA, DOE interviewed manufacturers representing the majority of domestic small electric motors sales. Many of these same companies also participated in interviews for the engineering analysis. The MIA interviews broadened the discussion from primarily technology-related issues to include business-related topics. One key objective for DOE was to obtain feedback from the industry on the assumptions used in the GRIM and to isolate key issues and concerns. See section IV.I.6 for a description of the key issues raised by manufacturers during interviews.

Using average cost assumptions to develop an industry cash-flow estimate does not adequately assess differential impacts among manufacturer subgroups. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that greatly differs from the industry average could be more negatively affected by new energy conservation standards than larger manufacturers. DOE established two subgroups for the MIA corresponding to large and small business manufacturers of small electric motors. Small electric motor manufacturing is classified under the North American Industry Classification System (NAICS) code 335312 (Motor and Generator Manufacturing). In order to be considered a small business under NAICS 335312, small businesses are defined by the Small Business Administration (SBA) as manufacturing enterprises with 1,000 or fewer employees. DOE attempted to interview companies from each subgroup, including subsidiaries, independent firms, and public and private corporations to develop an understanding of how manufacturer impacts vary by TSL.

5. Government Regulatory Impact Model Analysis

The GRIM analysis is a standard annual cash-flow analysis that incorporates MSPs, manufacturing production costs, shipments, and industry financial information as inputs. The analysis models changes in costs, distribution of shipments, investments, and associated margins that would result from new energy conservation standards. The GRIM spreadsheet uses a number of inputs to arrive at a series of annual cash flows, beginning with the base year of the analysis (2010) and continuing to 2044. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period.

DOE used the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between a base case and various TSLs (the standards case). The difference in INPV between the base case and a standards case represents the financial impact of energy conservation standards on manufacturers. DOE collected this information from a number of sources, including publicly available data and interviews with manufacturers. The GRIM results are shown in Table V.18 through Table V.21. Additional details about the GRIM can be found in chapter 12 of the TSD.

6. Manufacturer Interviews

During interviews with manufacturers, manufacturers discussed several key issues of concern if new regulations were imposed. The most significant of these issues are outlined below.

Maintaining Product Availability and Features—Manufacturers expressed concern about the impact on typical motor characteristics that may result after the adoption of new energy conservation standards. Specifically, manufacturers were concerned that standards-compliant small electric motors might require larger housing diameters and shaft lengths. Manufacturers were also greatly concerned that larger dimensions could eliminate the ability to retrofit newer, potentially larger motors into existing applications. However, manufacturers are concerned that their sales could be impacted if larger motors required end-users to modify their existing applications. If existing motor sizes were increased, end users could choose to use other horsepower motors or a different motor category that is not covered by today's rulemaking rather than modify the application to allow installation of the standards-compliant small electric motor. Manufacturers were also concerned that energy conservation standards could consolidate horsepower ratings by eliminating some of today's standard ratings from the market.

Significant Capital Conversion Costs—Manufacturers expressed concern over the potentially large conversion costs required to manufacturer standards-compliant small electric motors. Large manufacturers that produce the vast majority of motors covered by this rulemaking typically also manufacturer many other categories of motors. The majority of manufacturers interviewed indicated that the proportion of covered small electric motors represents a small share of the manufacturer's overall business. The increased stringency at each standard level will require manufacturers to increase the amount of capital conversion costs, potentially necessitating an investment in new lamination dies, winding tooling, testing equipment, and even re-allotting factory floor space. According to the majority of manufacturers, if the standard forces a substantial increase in motor dimensions or redesign costs, manufacturers could simply exit the small electric motors market rather than develop standards-compliant motors. Manufacturers indicated that the resources for manufacturing standard-compliant motors would be taken away from other motor technologies that could potentially provide greater energy savings, such as variable speed motors.

Substitutes—Manufacturers expressed concerns that standard-compliant motor prices would be greater due to more costly components and to compensate the company for the required capital investment. Manufacturers stated that because the small electric motor market is highly price sensitive, higher selling prices could push customers towards other technologies (*e.g.*, ECMs). Manufacturers believed that the economics for customers with equipment that use motors sparingly could not justify using the more-efficient, standards-compliant motors covered by this rulemaking because the energy savings would not compensate for the higher first costs of these motors.

Narrow Focus of the Rulemaking—Manufacturers were concerned that the rulemaking only applies to a small number of motors. Some manufacturers indicated they or some of their competitors could exit the small electric motor market if energy conservation standards were too stringent because this rulemaking applies to a small percentage of their total sales.

Uses of Alternative Metals—All interviewed manufacturers expressed concerned about the use of copper and exotic steels in redesigning their motors. According to manufacturers, copper rotor designs would require new specialized tooling that manufacturers currently do not employ. Some manufacturers reported the need for significant changes to their plants if copper rotors are required to meet standards, including the use of special smelting and casting operations. Also, manufacturers indicated that the use of copper in rotors would require a significant R&D effort because of their lack of experience with the materials and determining how to optimize manufacturing these types of rotors in high volumes. Manufacturers specifically referenced the lack of availability and unproven nature of exotic steels like Hiperco as variables that could reduce energy use. Finally, all interviewed manufacturers were concerned that the extremely higher prices of motors that use these metals could force significant conversion costs that would not be recouped if higher price points led to a decline in sales. Manufacturers reported that most likely they would exit the market if exotic steels were required to meet the energy conservation standard.

Enforcement of Standards—Manufacturers expressed concern about the feasibility of enforcing an energy conservation standard, particularly for motors embedded in other equipment. This concern was a particular concern for domestic manufacturers that indicated foreign companies could potentially import non-compliant motors as a component in other non-regulated equipment and put U.S. manufacturers at a competitive disadvantage.

7. Government Regulatory Impact Model Key Inputs and Scenarios

a. Base-Case Shipments Forecast

The GRIM estimates manufacturer revenues based on shipment forecasts and the distribution by product class and efficiency. Changes in the efficiency mix at each standard level are a key driver of manufacturer finances. For this analysis, the GRIM used the NIA shipments forecasts from 2010 to 2044. The NIA shipments forecast contains several scenarios that account for various economic conditions, motor price elasticity, and shipment interaction between single-phase motors. For all scenarios, the NIA shipments forecast maintains total industry-wide shipments. Total shipments forecasted by the NIA for the base case in 2015 are shown in Table IV.11.

Table IV.11 Base Case Total Industry Shipments by Motor Category for 2015

Motor Category	Estimated Total Industry Shipments by Product class in 2015
Polyphase	815,475
CSIR	3,362,362
CSCR	176,966

Additional shipment scenarios analyzed in the NIA include any combination of the scenarios listed in Table IV.12. While the GRIM is able to model any of the possible combinations, to calculate the likely INPV impacts in the MIA DOE used the reference scenario for the MIA. This scenario uses baseline economic growth, no shipment elasticity, and baseline market share between CSIR and CSCR motors. To see a complete set of results for all scenarios, see Chapter 12 of the TSD. For more information on the different possible shipment scenarios analyzed in the NIA, see chapter 10 of the TSD.

Table IV.12 Shipment Scenarios Modeled in the Government Regulatory Impact Model

Economic Growth Scenarios	Elasticity Scenarios	CSIR/CSCR Market Share Scenarios
Baseline	No Elasticity	Baseline
High	-0.50 Elasticity	Low CSCR
Low	-0.25 Elasticity	High CSCR
No Growth		

In the shipments analysis, DOE also estimated the distribution of efficiencies in the base case for small electric motors (chapter 9 of the TSD). Table IV.13 through Table IV.15 show the distribution of efficiencies in the base case for the polyphase, CSIR, and CSCR representative units, respectively.

Table IV.13 Government Regulatory Model Distribution of Shipments in the Base Case for Polyphase One-Horsepower, Four-Pole Small Electric Motors

TSL Efficiency	Baseline 77.15	EL 1 78.7	EL 2 80.0	EL 3 81.6	EL 4 82.5	EL 5 85.2	EL 6 86.4	EL 7 88.3
Distribution of Shipments %	82.0	4.0	4.0	4.0	6.0	0.0	0.0	0.0

Table IV.14 Government Regulatory Model Distribution of Shipments in the Base Case for Capacitor-Start, Induction-Run One-Half-Horsepower, Four-Pole Small Electric Motors

TSL Efficiency	Baseline 57.7	EL 1 59.5	EL 2 62.0	EL 3 64.2	EL 4 68.5	EL 5 71.2	EL 6 73.0	EL 7 77.0
Distribution of Shipments %	40.0	7.0	20.0	30.0	2.0	1.0	0.0	0.0

Table IV.15 Government Regulatory Model Distribution of Shipments in the Base Case for Capacitor-Start, Capacitor-Run Three-Quarter-Horsepower, Four-Pole Small Electric Motors

TSL Efficiency	Baseline 71.0	EL 1 74.3	EL 2 78.3	EL 3 80.3	EL 4 81.6	EL 5 82.7	EL 6 83.5	EL 7 85.4
Distribution of Shipments %	67.0	10.0	2.0	2.0	5.0	11.0	0.0	0.0

*The remaining capacitor-run, capacitor-start distribution is at an efficiency level not selected as part of any TSL.

b. Standards-Case Shipments Forecast

For each standards case, DOE assumed that shipments at efficiencies below the projected standard levels would roll up to those efficiency levels in response to an energy conservation standard. This scenario assumes that demand for high-efficiency motors is a function of its price without regard to the standard level. In the standards-case scenarios used to calculate INPV, shipments for polyphase and single-phase motors are independent of each other. However, for single-phase motors, the NIA shipments forecast modeled an interaction between shipments of CSIR and CSCR motors at each TSL. This interaction is also captured in the MIA in the standards-case shipments. For further information on the interaction of CSIR and CSCR motors shipments, see chapter 10 of the TSD.

c. Manufacturing Production Costs

Manufacturer production costs include all direct manufacturing costs (*i.e.,* labor, material and overhead). DOE derived manufacturing production costs by using the MSPs found in the engineering analysis. In the MIA, DOE used the weighted average MSPs that combined prices for space constrained and non-spaced constrained motor designs. Further discussion of how DOE calculated projected MSPs is found in chapter 5 of the TSD. To determine manufacturer production costs from MSP, DOE divided MSPs by the manufacturer markup. The manufacturer markup is a multiplier that converts the manufacturer production costs to MSPs. The manufacturer markup covers all non-production costs (*i.e.,* selling, general, and administrative expenses, shipping, and research and development) and profit. The manufacturer markup was calculated using the revenues and cost of goods sold from the annual reports of publicly-traded companies. For additional information on DOE's scaling of MSPs, see section IV.G of today's notice.

d. Manufacturing Markup Scenarios

To understand how baseline and more efficient motors are differentiated, DOE reviewed manufacturer catalogs and information gathered by manufacturers. In the base case, DOE used the MSPs from the engineering analysis. For the MIA, DOE considered different manufacturer markup scenarios for small electric motors. Markup scenarios were used to provide bounds to the range of expected small electric motor prices following new energy conservation standards. DOE learned from interviews that manufacturers typically only offer one line for each product class and that the efficiency levels offered fall near the baseline efficiency level. DOE also learned that manufacturers maintain a constant markup among different product classes. In the base case, DOE applied the same standard manufacturer markup of 1.45 for all product classes.

For the standards case, DOE considered two markup scenarios: (1) The preservation of return on invested capital scenario, and (2) the preservation of operating profit scenario.

Return on invested capital is defined as net operating profit after taxes (NOPAT) divided by the total invested capital. The total invested capital includes fixed assets and working capital, or net plant, property, and equipment plus working capital. In the preservation of return on invested capital scenario, the markups are set so that the return on invested capital the year after the effective date of the energy conservation standards is the same as in the base case. This scenario models the situation in which manufacturers maintain a similar level of profitability from the investments required by amended energy conservation standards as they do from their current business operations. Under this scenario, after standards, manufacturers have higher net operating profits but also greater working capital and investment requirements. This scenario represents the high bound to profitability following standards.

The implicit assumption behind the ''preservation-of-operating profit'' scenario is that the industry can only maintain its base-case operating profit (earnings before interest and taxes) in the year after implementation of the standard. The industry impacts occur in this scenario when manufacturers make the required capital and equipment conversion costs in order to manufacturer more expensive motors, but the operating profit does not change from current conditions. DOE implemented this markup scenario in the GRIM by setting the manufacturer markups at each TSL to yield approximately the same operating profit in both the base case and the standards case in the year after standards take effect.

e. Equipment and Capital Conversion Costs

Energy conservation standards typically cause manufacturers to incur one-time conversion costs to bring their production facilities and designs into compliance with the energy conservation standard. For the purpose of the MIA, DOE classified these conversion costs into two major groups: (1) Equipment conversion costs, and (2) capital conversion costs. Equipment conversion costs are one-time investments in research, development, testing, and marketing, focused on making motor designs comply with the new energy conservation standard. Capital conversion costs are one-time investments in property, plant, and equipment to adapt or change existing production facilities so that new motor designs can be fabricated and assembled.

DOE assessed the equipment conversion costs manufacturers would be required to make at each TSL. DOE considered a number of manufacturer responses for small electric motors at each TSL. In order to estimate the required equipment conversion costs, DOE used the technology options in its engineering analysis to estimate the engineering and product development resources needed at each TSL. Specifically, DOE estimated the equipment conversion costs by the effort required to redesign existing motors as the stack length increases and changes in material to copper for rotors and exotic steels for laminations are required. Additionally, DOE maintained the engineering analysis assumption that a portion of manufactured motors would have space constraints, requiring higher product conversion costs in comparison to non-space constrained motors. To take space constrained designs into account in the equipment conversion costs, at each TSL DOE used a weighted average of its estimate of the product development costs to develop both space constrained and non-space constrained motors. DOE also used the information provided by manufacturers and industry experts to validate its estimates. However, because DOE received limited feedback from manufacturers about the required capital and equipment conversion costs, DOE seeks additional comment from interested parties on the estimated equipment conversion costs.

DOE also evaluated the level of capital conversion costs manufacturers would incur to comply with energy conservation standards. DOE used the manufacturer interviews to gather data on the level of capital investment required at each TSL. Manufacturers explained how different TSLs affected their ability to use existing plants, tooling, and equipment. DOE estimated the tooling and capital that would be necessary to achieve subsequent efficiency levels given the majority of current shipments are at the baseline efficiency. Additionally, DOE maintained the assumption from the engineering analysis that a portion of manufactured motors would have space constraints. At each TSL, DOE estimated the total capital conversion costs that would be required to manufacturer exclusively space constrained and non-space constrained motors. DOE weighted these two estimates by the percentage of motors that would be space constrained and non-spaced constrained to calculate the estimate of the industry-wide capital conversion costs at each TSL. DOE gathered information from industry experts to validate its assumptions for capital conversion costs. However, DOE received limited input from manufacturers regarding the required capital conversion costs to reach the max-tech efficiency levels that require alternative steel such as Hiperco. Consequently, DOE seeks additional comment from interested parties on its assumptions and estimates for the capital conversion costs.

The investment figures used in the GRIM can be found in section V.B.2.a of today's notice. For additional information on the estimated equipment conversion and capital conversion costs and assumptions, see chapter 12 of the TSD.

J. Employment Impact Analysis

Employment impacts are among the factors DOE considers in selecting a proposed standard. Employment impacts are the total impact on employment in the national economy, including the sector that manufactures the equipment being regulated. Thus, DOE estimated both the direct impact of standards on employment (*i.e.*, any changes in the number of employees for small motors manufacturers, their suppliers, and related service firms), and the indirect employment impact of standards (*i.e.*, changes in employment by energy suppliers and by other sectors of the economy). The MIA addresses only the employment impacts on manufacturers of the product being regulated.

Indirect employment impacts from standards are the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, as a consequence of (1) reduced spending by end users on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased spending on the purchase price of new small motors, 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, but there is no standard method for estimating these effects.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sectoral employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS). BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy. (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). 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 BLS data alone, DOE believes net national employment will increase due to shifts in economic activity resulting from the proposed small motors standard.

To investigate the indirect employment impacts, DOE used the Pacific Northwest National Laboratory (PNNL)'s Impact of Sector Energy Technologies (ImSET) model. PNNL developed ImSET, a spreadsheet model of the U.S. economy that focuses on 188 sectors most relevant to industrial, commercial, and residential building energy use, for DOE's Office of Energy Efficiency and Renewable Energy. ImSET is a special-purpose version of the U.S. Benchmark National Input-Output (I–O) model, which has been designed to estimate the national employment and income effects of energy saving technologies that are deployed by DOE's Office of Energy Efficiency and Renewable Energy. The ImSET software includes a computer-based I–O model with structural coefficients to characterize economic flows among 188 sectors. ImSET's national economic I–O structure is based on the 1997 Benchmark Input-Output Data, which have been specially aggregated to cover 188 sectors.

In response to the preliminary analysis, DOE received two comments regarding the employment analysis. NEEA and NPCC recommended that DOE consider a ''2008 study'' on the employment impacts of energy efficiency in California and attempt to extrapolate them to the national scale (NEEA and NPCC, No. 9 at p. 6). DOE examined the study referred to in the comment: ''Energy Efficiency, Innovation, and Job Creation in California'' by David Roland-Holst. DOE concluded that one component of the study that addresses indirect employment impacts due to decreased energy expenditures is similar to DOE's current approach. The second component of the study hypothesizes that ''innovation'' will create additional employment impact and estimated that this impact is approximately the same size as the indirect impacts due to decreased energy expenditures. But the report notes that is forecast is highly uncertain: ''The overall process of technological change is notoriously difficult to forecast, and individual innovation events virtually impossible,'' (David Roland-Holst, ''Energy Efficiency, Innovation, and Job Creation in California'' at p. 81). Given the acknowledged exploratory and potentially speculative nature of employment impacts due to innovation, DOE does not include an estimate of innovation-induced employment impacts in its analysis at this time.

Baldor and NEMA commented that DOE needs to make sure that the ImSET model properly includes pertinent industries that use small electric motors—*i.e.,* OEM manufacturers (Baldor, Public Meeting Transcript, No. 8.5 at 312–13; NEMA, No. 13 at p. 16). DOE has confirmed that ImSET includes the various OEM manufacturing sectors in its analysis. Although commenters expected OEM employment to be adversely impacted, ImSET forecasts increased employment by OEMs. ImSET forecasts employment impacts based on changes in expenditures made in a particular sector. With the implementation of energy conservation standards, small electric motors become more expensive and as the equipment is marked up during OEM product manufacture, the total revenues going to OEMs increases. Because DOE assumes that OEMs are able to pass the increased cost of the motors to their customers, these increased revenues going to the OEM sector result in a forecast of increased employment for OEMs.

For more details on the employment impact analysis, see TSD chapter 14.

K. Utility Impact Analysis

The utility impact analysis estimates the effects of reduced energy consumption due to improved appliance efficiency on the utility industry. This utility analysis compares forecast results for a case comparable to the *AEO2009* Reference Case and forecasts for policy cases incorporating each of the small motors trial standard levels.

The utility impact analysis reports the changes in installed capacity and generation by plant type that result for each trial standard level, as well as changes in electricity sales to the residential, commercial and industrial sectors. The estimated impacts of the standard are the difference between the value forecasted by NEMS–BT and the AEO 2009 Reference Case.

DOE also received a comment from EEI noting that low motor power factors can have adverse impacts on the utility power distribution system (EEI, No. 14 at p. 2). DOE responded to this comment by including an estimate of utility costs as a function of changes in power factor and motor losses with changing standard level. These impacts include costs and energy losses. The national impact analysis estimates costs and benefits of changing power factor and reactive power. DOE's model estimates that the utility system losses due to power factor effects are generally in the range of 10 to 20 percent of total source energy consumption. The estimates of the losses (or savings) from power factor and reactive power effects are included in the inputs to the utility impact analysis.

Chapter 13 of the TSD accompanying this notice presents details on the utility impact analysis.

L. Environmental Analysis

DOE has prepared a draft environmental assessment (EA) pursuant to the National Environmental Policy Act and the requirements of 42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(a) to determine the environmental impacts of the proposed standards. DOE estimated the reduction in power sector emissions of CO_2, NO_X, and Hg using the NEMS–BT model.

1. Power Sector Emissions

NEMS–BT is run similarly to the AEO NEMS, except that small electric motor energy use is reduced by the amount of energy saved due to each TSL. The inputs of national energy savings come from the NIA spreadsheet model; the output is the forecasted physical emissions at each TSL. The net benefit of the standard is the difference between emissions estimated by NEMS–BT at each TSL and the AEO 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. For the preliminary NOPR analysis, DOE used *AEO2008.* For today's NOPR, DOE used the *AEO2009* NEMS (stimulus version). For the final rule, DOE intends to revise the emissions analysis using the most current AEO.

DOE has preliminarily determined that SO_2 emissions from affected Electric Generating Units (EGUs) are subject to nationwide and regional emissions cap and trading programs that create uncertainty about standard's impact 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. The standard 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 plans to use to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2. However, remaining uncertainty prevents DOE from estimating SO_2 reductions from the standard 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 decrease the generation of SO_2 emissions from power production, which can lessen the need to purchase SO_2 emissions allowance credits, and thereby decrease the costs of complying with regulatory caps on emissions.

Much like SO_2, 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 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). 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.

The proposed standard would reduce NO_X emissions in those 22 States not affected by the CAIR. As a result, DOE used the NEMS–BT to forecast emission reductions from the standard that are considered in today's NOPR.

In contrast, 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: This is because of the permanent cap. Energy conservation standards have the potential to produce environmentally related economic impact in the form of lower prices for emissions allowance credits, if they were large enough. However, DOE has preliminarily concluded that the SEM standard would not have such an effect because the estimated reduction in NO_X emissions or the corresponding allowance credits in States covered by the CAIR cap would be too small to affect allowance prices for NO_X under the CAIR.

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.

EEI stated that DOE's analysis should take into consideration trends in emissions reduction for CO_2, NO_X, SO_2 and Hg (EEI, No. 14 at p. 3). DOE's emissions forecasts are based on estimates produced by the *AEO2009* version of NEMS which include the future impacts of current regulation both in the reference and the standard case, but which do not include the impact of future regulations. With existing regulations, the model estimates a steady decline in NO_X and Hg emissions from the power sector based on the future impacts of current regulation. But because of the speculative nature of forecasting future regulations, DOE does not in general include the impact of possible future regulations in its reference case forecasts. However, DOE may examine the impact of specific possible future regulations in a sensitivity analysis.

DOE's projections of CO_2 emissions from electric power generation are based on the *AEO2009* version of NEMS. The emissions projections reflect market factors and policies that affect utility choice of power plants for electricity generation, including existing renewable portfolio standards. In conducting the AEO, EIA generally includes only those policies that are already enacted. As enactment and the features of a national CO_2 cap and trade program are uncertain at this point, DOE believes it would be inappropriate to speculate on the nature and timing of such a policy at this stage of this rulemaking.

2. Valuation of CO_2 Emissions

DOE received comments on the desirability of valuing the CO_2 emissions reductions that result from standards. Both NEEA and Earthjustice urged DOE to value CO_2 emissions reductions and recommended potential models that DOE could use to do so (NEEA, Public Meeting Transcript, No. 8.5 at pp. 251–254; Earthjustice, No. 11 at pp. 2–3). AHRI commented that DOE needs to be careful to examine the uncertainty in potential CO_2 emissions reductions values and how costs may be allocated to different sectors (AHRI, Public Meeting Transcript, No. 8.5 at pp. 255–256).

For today's proposed rule, DOE is relying on a set of values recently developed by an interagency process that conducted a more thorough review of existing estimates of the social cost of carbon (SCC).

The SCC is intended to be a monetary measure of the incremental damage resulting from greenhouse gas (GHG) emissions, including, but not limited to, net agricultural productivity loss, human health effects, property damage from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the harms associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide estimates of the social benefits of reductions in GHG emissions.

For at least three reasons, any single estimate of the SCC will be contestable. First, scientific and economic knowledge about the impacts of climate change continues to grow. With new and better information about relevant questions, including the cost, burdens, and possibility of adaptation, current estimates will inevitably change over time. Second, some of the likely and potential damages from climate change—for example, the value society places on adverse impacts on endangered species—are not included in all of the existing economic analyses. These omissions may turn out to be significant, in the sense that they may mean that the best current estimates are too low. Third, controversial ethical judgments, including those involving the treatment of future generations, play a role in judgments about the SCC (see in particular the discussion of the discount rate, below).

To date, regulations have used a range of values for the SCC. For example, a regulation proposed by the U.S. Department of Transportation (DOT) in 2008 assumed a value of $7 per ton CO_2 (2006$) for 2011 emission reductions (with a range of $0–14 for sensitivity analysis). Regulation finalized by DOE used a range of $0–$20 (2007$). Both of these ranges were designed to reflect the value of damages to the United States resulting from carbon emissions, or the ''domestic'' SCC. In the final Model Year 2011 Corporate Average Fuel Economy rule, DOT used both a domestic SCC value of $2/t$CO_2$ and a global SCC value of $33/t$CO_2$ (with sensitivity analysis at $80/t$CO_2$), increasing at 2.4 percent per year thereafter.

In recent months, a variety of agencies have worked to develop an objective methodology for selecting a range of interim SCC estimates to use in regulatory analyses until improved SCC estimates are developed. The following summary reflects the initial results of these efforts and proposes ranges and values for interim social costs of carbon used in this rule. It should be emphasized that the analysis described below is preliminary. These complex issues are of course undergoing a process of continuing review. Relevant agencies will be evaluating and seeking comment on all of the scientific, economic, and ethical issues before establishing final estimates for use in future rulemakings.

The interim judgments resulting from the recent interagency review process can be summarized as follows: (a) DOE and other Federal agencies should consider the global benefits associated with the reductions of CO_2 emissions resulting from efficiency standards and other similar rulemakings, rather continuing the previous focus on domestic benefits; (b) these global benefits should be based on SCC estimates (in 2007$) of $55, $33, $19, $10, and $5 per ton of CO_2 equivalent emitted (or avoided) in 2007; (c) the SCC value of emissions that occur (or are avoided) in future years should be escalated using an annual growth rate of 3-percent from the current values); and (d) domestic benefits are estimated to be approximately 6 percent of the global values. DOE has escalated the 2007$ values to 2008$ for consistency with other dollar values presented in this notice, resulting in SCC estimates (in 2008$) of approximately $5, $10, $20, $34, and $56. These interim judgments are based on the following:

1. *Global and domestic estimates of SCC.* Because of the distinctive nature of the climate change problem, estimates of both global and domestic SCC values should be considered, but the global measure should be ''primary.'' This approach represents a departure from past practices, which relied, for the most part, on measures of only domestic impacts. As a matter of law, both global and domestic values are permissible; the relevant statutory provisions are ambiguous and allow the agency to choose either measure. (It is true that Federal statutes are presumed not to have extraterritorial effect, in part to ensure that the laws of the United States respect the interests of foreign sovereigns. But use of a global measure for the SCC does not give extraterritorial effect to Federal law and hence does not intrude on such interests.)

It is true that under OMB guidance, analysis from the domestic perspective is required, while analysis from the international perspective is optional. The domestic decisions of one nation are not typically based on a judgment about the effects of those decisions on other nations. But the climate change problem is highly unusual in the sense that it involves (a) a global public good in which (b) the emissions of one nation may inflict significant damages on other nations and (c) the United States is actively engaged in promoting an international agreement to reduce worldwide emissions.

In these circumstances, the global measure is preferred. Use of a global measure reflects the reality of the problem and is expected to contribute to the continuing efforts of the United States to ensure that emission reductions occur in many nations.

Domestic SCC values are also presented. The development of a domestic SCC is greatly complicated by the relatively few region- or country-specific estimates of the SCC in the literature. One potential estimate comes from the DICE (Dynamic Integrated Climate Economy, William Nordhaus) model. In an unpublished paper, Nordhaus (2007) produced disaggregated SCC estimates using a regional version of the DICE model. He reported a U.S. estimate of $1/t$CO_2$ (2007 value, 2007$), which is roughly 11 percent of the global value.

An alternative source of estimates comes from a recent EPA modeling effort using the FUND (Climate Framework for Uncertainty, Negotiation and Distribution, Center for Integrated Study of the Human Dimensions of Global Change) model. The resulting estimates suggest that the ratio of domestic to global benefits varies with key parameter assumptions. With a 3-percent discount rate, for example, the US benefit is about 6 percent of the global benefit for the ''central'' (mean) FUND results, while, for the corresponding ''high'' estimates associated with a higher climate sensitivity and lower global economic growth, the US benefit is less than 4 percent of the global benefit. With a 2 percent discount rate, the U.S. share is about 2 to 5 percent of the global estimate.

Based on this available evidence, a domestic SCC value equal to 6 percent of the global damages is used in this rulemaking. This figure is in the middle of the range of available estimates from the literature. It is recognized that the 6 percent figure is approximate and highly speculative and alternative approaches will be explored before establishing final values for future rulemakings.

2. *Filtering existing analyses.* There are numerous SCC estimates in the existing literature, and it is legitimate to make use of those estimates to produce a figure for current use. A reasonable starting point is provided by the meta-analysis in Richard Tol, ''The Social Cost of Carbon: Trends, Outliers, and Catastrophes, Economics: The Open-Access, Open-Assessment E-Journal,'' Vol. 2, 2008–25. *http://www.economics-ejournal.org/economics/journalarticles/2008-25* (2008). With that starting point, it is proposed to ''filter'' existing SCC estimates by using those that (1) are derived from peer-reviewed studies; (2) do not weight the monetized damages to one country more than those in other countries; (3) use a ''business as usual'' climate scenario; and (4) are based on the most recent published version of each of the three major integrated assessment models (IAMs): FUND, DICE and PAGE (Policy Analysis of the Greenhouse Effect) Policy.

Proposal (1) is based on the view that those studies that have been subject to peer review are more likely to be reliable than those that have not been. Proposal (2) is based on a principle of neutrality and simplicity; it does not treat the citizens of one nation differently on the basis of speculative or controversial considerations. Proposal (3) stems from the judgment that as a general rule, the proper way to assess a policy decision is by comparing the implementation of the policy against a counterfactual state where the policy is not implemented. A departure from this approach would be to consider a more dynamic setting in which other countries might implement policies to reduce GHG emissions at an unknown future date, and the United States could choose to implement such a policy now or in the future.

Proposal (4) is based on three complementary judgments. First, the FUND, PAGE, and DICE models now stand as the most comprehensive and reliable efforts to measure the damages from climate change. Second, the latest versions of the three IAMs are likely to reflect the most recent evidence and learning, and hence they are presumed to be superior to those that preceded them. It is acknowledged that earlier versions may contain information that is missing from the latest versions. Third, any effort to choose among them, or to reject one in favor of the others, would be difficult to defend at this time. In the absence of a clear reason to choose among them, it is reasonable to base the SCC on all of them.

The agency is keenly aware that the current IAMs fail to include all relevant information about the likely impacts from greenhouse gas emissions. For example, ecosystem impacts, including species loss, do not appear to be included in at least two of the models. Some human health impacts, including increases in food-borne illnesses and in the quantity and toxicity of airborne allergens, also appear to be excluded. In addition, there has been considerable recent discussion of the risk of catastrophe and of how best to account for worst-case scenarios. It is not clear whether the three IAMs take adequate account of these potential effects.

3. *Use a model-weighted average of the estimates at each discount rate.* At this time, there appears to be no scientifically valid reason to prefer any of the three major IAMs (FUND, PAGE, and DICE). Consequently, the estimates are based on an equal weighting of estimates from each of the models. Among estimates that remain after applying the filter, the average of all estimates within a model is derived. The estimated SCC is then calculated as the average of the three model-specific averages. This approach ensures that the interim estimate is not biased towards specific models or more prolific authors.

4. *Apply a 3-percent annual growth rate to the chosen SCC values.* SCC is assumed to increase over time, because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed as the magnitude of climate change increases. Indeed, an implied growth rate in the SCC is produced by most studies that estimate economic damages caused by increased GHG emissions in future years. But neither the rate itself nor the information necessary to derive its implied value is commonly reported. In light of the limited amount of debate thus far about the appropriate growth rate of the SCC, applying a rate of 3-percent per year seems appropriate at this stage. This value is consistent with the range recommended by IPCC (2007) and close to the latest published estimate (Hope, 2008).

For climate change, one of the most complex issues involves the appropriate discount rate. OMB's current guidance offers a detailed discussion of the relevant issues and calls for discount rates of 3-percent and 7-percent. It also permits a sensitivity analysis with low rates for intergenerational problems. (''If your rule will have important intergenerational benefits or costs you might consider a further sensitivity analysis using a lower but positive discount rate in addition to calculating net benefits using discount rates of 3 and 7-percent.'') The SCC is being developed within the general context of the current guidance.

The choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law. See, *e.g.,* William Nordhaus, ''The Challenge of Global Warming (2008); Nicholas Stern, The Economics of Climate Change'' (2007); ''Discounting and Intergenerational Equity'' (Paul Portney and John Weyant, eds., 1999). Under imaginable assumptions, decisions based on cost-benefit analysis with high discount rates might harm future generations—at least if investments are not made for the benefit of those generations. See Robert Lind, ''Analysis for Intergenerational Discounting,'' id. at 173, 176–177. At the same time, use of low discount rates for particular projects might itself harm future generations, by ensuring that resources are not used in a way that would greatly benefit them. In the context of climate change, questions of intergenerational equity are especially important.

Reasonable arguments support the use of a 3-percent discount rate. First, that rate is among the two figures suggested by OMB guidance, and hence it fits with existing National policy. Second, it is standard to base the discount rate on the compensation that people receive for delaying consumption, and the 3-percent rate is close to the risk-free rate of return, proxied by the return on long term inflation-adjusted US Treasury Bonds. (In the context of climate change, it is possible to object to this standard method for deriving the discount rate.) Although these rates are currently closer to 2.5 percent, the use of 3-percent provides an adjustment for the liquidity premium that is reflected in these bonds' returns.

At the same time, other arguments support use of a 5 percent discount rate. First, that rate can also be justified by reference to the level of compensation for delaying consumption, because it fits with market behavior with respect to individuals' willingness to trade off consumption across periods as measured by the estimated post-tax average real returns to private investment (*e.g.,* the S&P 500). In the climate setting, the 5 percent discount rate may be preferable to the riskless rate because it is based on risky investments and the return to projects to mitigate climate change is also risky. In contrast, the 3-percent riskless rate may be a more appropriate discount rate for projects where the return is known with a high degree of confidence (*e.g.,* highway guardrails).

Second, 5 percent, and not 3-percent, is roughly consistent with estimates implied by reasonable inputs to the theoretically derived Ramsey equation, which specifies the optimal time path for consumption. That equation specifies the optimal discount rate as the sum of two components. The first reflects the fact that consumption in the future is likely to be higher than consumption today (even accounting for climate impacts), so diminishing marginal utility implies that the same monetary damage will cause a smaller reduction of utility in the future. Standard estimates of this term from the economics literature are in the range of 3 to 5 percent. The second component reflects the possibility that a lower weight should be placed on utility in the future, to account for social impatience or extinction risk, which is specified by a pure rate of time preference (PRTP). A conventional estimate of the PRTP is 2 percent. (Some observers believe that a principle of intergenerational equity suggests that the PRTP should be close to zero.) It follows that discount rate of 5 percent is within the range of values which are able to be derived from the Ramsey equation, albeit at the low end of the range of estimates usually associated with Ramsey discounting.

It is recognized that the arguments above—for use of market behavior and the Ramsey equation—face objections in the context of climate change, and of course there are alternative approaches. In light of climate change, it is possible that consumption in the future will not be higher than consumption today, and if so, the Ramsey equation will suggest a lower figure. Some people have suggested that a very low discount rate, below 3-percent, is justified in light of the ethical considerations calling for a principle of intergenerational neutrality. See Nicholas Stern, ''The Economics of Climate Change'' (2007); for contrary views, see William Nordhaus, The A Question of Balance (2008); Martin Weitzman, ''*Review* of the *Stern Review* on the Economics of Climate Change.'' *Journal of Economic Literature,* 45(3): 703–724 (2007). Additionally, some analyses attempt to deal with uncertainty with respect to interest rates over time; a possible approach enabling the consideration of such uncertainties is discussed below. Richard Newell and William Pizer, ''Discounting the Distant Future: How Much do Uncertain Rates Increase Valuations?'' J. Environ. Econ. Manage. 46 (2003) 52–71.

The application of the methodology outlined above yields estimates of the SCC that are reported in Table IV.16. These estimates are reported separately using 3-percent and 5 percent discount rates. The cells are empty in rows 10 and 11, because these studies did not report estimates of the SCC at a 3-percent discount rate. The model-weighted means are reported in the final or summary row; they are $33 per tCO_2 at a 3% discount rate and $5 per tCO_2 with a 5% discount rate.

Table IV.16 Global Social Cost of Carbon (SCC) Estimates ($/$tCO_2$ in 2007 (2007$)), Based on 3% and 5% Discount Rates*

	Model	Study	Climate Scenario	3%	5%
1	FUND	Anthoff et al. 2009	FUND default	6	-1
2	FUND	Anthoff et al. 2009	SRES A1b	1	-1
3	FUND	Anthoff et al. 2009	SRES A2	9	-1
4	FUND	Link and Tol 2004	No THC	12	3
5	FUND	Link and Tol 2004	THC continues	12	2
6	FUND	Guo et al. 2006	Constant PRTP	5	-1
7	FUND	Guo et al. 2006	Gollier discount 1	14	0
8	FUND	Guo et al. 2006	Gollier discount 2	7	-1
			FUND Mean	**8.25**	**0**
9	PAGE	Wahba & Hope 2006	A2-scen	57	7
10	PAGE	Hope 2006			7
11	DICE	Nordhaus 2008			8
Summary			**Model-weighted Mean**	**33**	**5**

*The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff et al. (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios. All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3-percent annual growth rate in the SCC, and adjusted for inflation using GDP deflator.

Analyses have been conducted at $34 and $5 (in 2008$, escalated from 2007$) as these represent the estimates associated with the 3-percent and 5 percent discount rates, respectively. The 3-percent and 5 percent estimates have independent appeal and at this time a clear preference for one over the other is not warranted. Thus, DOE has also included—and centered its current attention on—the average of the estimates associated with these discount rates, which is approximately $20. (Based on the $20 global value, the domestic value would be approximately $1 per ton of CO_2 equivalent.)

It is true that there is uncertainty about interest rates over long time horizons. Recognizing that point, Newell and Pizer have made a careful effort to adjust for that uncertainty. See Newell and Pizer, supra. This is a relatively recent contribution to the literature.

There are several concerns with using this approach in this context. First, it would be a departure from current OMB guidance. Second, an approach that would average what emerges from discount rates of 3-percent and 5 percent reflects uncertainty about the discount rate, but based on a different model of uncertainty. The Newell-Pizer approach models discount rate uncertainty as something that evolves over time; in contrast, one alternative approach would assume that there is a single discount rate with equal probability of 3-percent and 5 percent.

Table IV.17 reports on the application of the Newell-Pizer adjustments. The precise numbers depend on the assumptions about the data generating process that governs interest rates. Columns (1a) and (1b) assume that ''random walk'' model best describes the data and uses 3-percent and 5 percent discount rates, respectively. Columns (2a) and (2b) repeat this, except that it assumes a ''mean-reverting'' process. As Newell and Pizer report, there is stronger empirical support for the random walk model.

Table IV.17 Global Social Cost of Carbon (SCC) Estimates ($/tCO2 in 2007 (2007$)),* Using Newell & Pizer (2003) Adjustment for Future Discount Rate Uncertainty**

	Model	Study	Climate Scenario	Random- walk model		Mean-reverting model	
				3%	5%	3%	5%
				(1a)	(1b)	(2a)	(2b)
1	FUND	Anthoff et al. 2009	FUND default	10	0	7	-1
2	FUND	Anthoff et al. 2009	SRES A1b	2	0	1	-1
3	FUND	Anthoff et al. 2009	SRES A2	15	0	10	-1
4	FUND	Link and Tol 2004	No THC	20	6	13	4
5	FUND	Link and Tol 2004	THC continues	20	4	13	2
6	FUND	Guo et al. 2006	Constant PRTP	9	0	6	-1
7	FUND	Guo et al. 2006	Gollier discount 1	14	0	14	0
8	FUND	Guo et al. 2006	Gollier discount 2	7	-1	7	-1
			FUND Mean	**12**	**1**	**9**	**0**
9	PAGE	Wahba & Hope 2006	A2-scen	97	13	63	8
10	PAGE	Hope 2006			13		8
11	DICE	Nordhaus 2008			15		9
	Summary		**Model-weighted Mean**	**55**	**10**	**36**	**6**

*The sample includes all peer reviewed, non-equity-weighted estimates included in Tol (2008), Nordhaus (2008), Hope (2008), and Anthoff et al. (2009), that are based on the most recent published version of FUND, PAGE, or DICE and use business-as-usual climate scenarios. All values are based on the best available information from the underlying studies about the base year and year dollars, rather than the Tol (2008) assumption that all estimates included in his review are 1995 values in 1995$. All values were updated to 2007 using a 3-percent annual growth rate in the SCC, and adjusted for inflation using GDP deflator.

**Assumes a starting discount rate of 3-percent. Newell and Pizer (2003) based adjustment factors are not applied to estimates from Guo et al. (2006) that use a different approach to account for discount rate uncertainty (rows 7-8).

The resulting estimates of the social cost of carbon are necessarily greater. When the adjustments from the random walk model are applied, the estimates of the social cost of carbon are $10 and $56 (2008$), with the 5 percent and 3 percent discount rates, respectively. The application of the mean-reverting adjustment yields estimates of $6 and $37 (in 2008$).

Since the random walk model has greater support from the data, analyses are also conducted with the value of the SCC set at $10 and $56 (2008$).

In summary, DOE considered in its decision process for this notice of proposed rulemaking the potential global benefits resulting from reduced CO_2 emissions valued at $5, $10, $20, $34 and $56 per metric ton, and has also presented the domestic benefits derived using a value of approximately $1 per metric ton. All of these unit values represent emissions that are valued in 2008$ and final net present values for cumulative emissions are also reported in 2008$ so that they can be compared with other rulemaking analyses in the same dollar units.

DOE recognizes that scientific and economic knowledge about the contribution of CO_2 and other GHG 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 greenhouse gas 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 proposed rule the most recent values and analyses resulting from the ongoing interagency review process.

3. Valuation of Other Emissions

DOE also investigated the potential monetary benefit of reduced SO_2, NO_X, and Hg emissions from the TSLs it considered. As previously stated, DOE's initial analysis assumed the presence of nationwide emission caps on SO_2 and caps on NO_X emissions in the 28 States covered by the 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 for SO_2, 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 such factors as credit banking can change the trajectory of prices. From its modeling to date, DOE is unable to estimate a benefit from SO_2 emissions reductions at this time. See chapter 15 of the TSD for further details.

Because the courts have decided to allow the CAIR rule to remain in effect, projected annual NO_X allowances from NEMS–BT are relevant. The update to the *AEO2009*-based version of NEMS–BT includes the representation of CAIR. As noted above, standards would not produce an economic impact in the form of lower prices for emissions allowance credits in the 28 eastern States and D.C. covered by the CAIR cap. New or amended energy conservation standards would reduce NO_X emissions in those 22 States that are not affected by the CAIR. For the area of the United States not covered by the CAIR, DOE estimated the monetized value of NO_X emissions reductions resulting from each of the TSLs considered for today's proposed 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 $442 to $4,540 per ton in 2008$). 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. DOE conducted research for today's proposed rule and determined that the impact of mercury emissions from power plants on humans is considered highly uncertain. However, DOE identified two estimates of the environmental damage of mercury based on two estimates of the adverse impact of childhood exposure to methyl mercury on intelligence quotient (IQ) for American children, and subsequent loss of lifetime economic productivity resulting from these IQ losses. The high-end estimate is based on an estimate of the current aggregate cost of the loss of IQ in American children that results from exposure to mercury of U.S. power plant origin ($1.3 billion per year in year 2000$), which works out to $33.3 million per ton emitted per year (2008$). Refer to L. Trasande et al., ''Applying Cost Analyses to Drive Policy that Protects Children,'' 1076 Ann. N.Y. Acad. Sci. 911 (2006) for additional information. The low-end estimate is $0.66 million per ton emitted (in 2004$) or $0.745 million per ton in 2008$. DOE derived this estimate from a published evaluation of mercury control using different methods and assumptions from the first study but also based on the present value of the lifetime earnings of children exposed. See 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.

Earthjustice stated that DOE must also calculate and monetize the value of the reductions in emissions of particulate matter (PM) that will result from standards; even if DOE cannot consider secondary PM emissions, it must consider primary emissions. (Earthjustice, No. 11 at pp. 5–6).

DOE agrees that PM impacts are of concern due to human exposures that can impact health. But impacts of PM emissions reduction are much more difficult to estimate than other emissions reductions due to the complex interactions between PM, other power plant emissions, meteorology and atmospheric chemistry that impact human exposure to particulates. Human exposure to PM usually occurs at a significant distance from the power plants that are emitting particulates and particulate precursors. When power plant emissions travel this distance they undergo highly complex atmospheric chemical reactions. While the Environmental Protection Agency (EPA) does keep inventories of direct PM emissions of power plants, in its source attribution reviews the EPA does not separate direct PM emissions from power plants from the particulates indirectly produced through complex atmospheric chemical reactions. This is in part because SO_2 emissions react with direct PM emissions particles to produce combined sulfate particulates. Thus it is not useful to examine how the standard impacts direct PM emissions independent of indirect PM production and atmospheric dynamics. DOE is not currently able to run a model that can make these estimates reliably at the national level. See chapter 15 of the TSD for a more detailed discussion.

V. Analytical Results

A. Trial Standard Levels

DOE analyzed the benefits and burdens of a number of TSLs for the small electric motors that are the subject of today's proposed rule. Table V.1 and Table V.2 present the trial standard levels and the corresponding efficiencies for the three representative product classes.

Table V.1 Trial Standard Levels for Polyphase Small Electric Motors*

	Polyphase 4-pole 1 Hp %
TSL 1	78.7
TSL 2	80.0
TSL 3	81.6
TSL 4	82.5
TSL 5	85.2
TSL 6	86.4
TSL 7	88.3

*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. 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 is comparable to the efficiency of a three-digit frame series medium electric motor that meets the efficiency requirements of EPACT. TSL 5 is comparable to the efficiency standard of a three-digit frame series medium electric motor that meets the NEMA Premium level, which will become an energy conservation standard for medium motors as prescribed by Section 313(b) of EISA 2007. 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. At TSL 7, the ''max-tech'' level, for the restricted designs DOE has reached the design limitation maximum increase in stack height of 20 percent and increased grades of steel. At this level, DOE has also implemented an exotic steel type (Hiperco 50), a copper die-cast rotor, a max slot fill percentage of nearly 65 percent. For the lesser space constrained design, DOE has decreased the stack height from that seen for the design at TSL 6, however, and has moved to a copper rotor, while also reaching the design limitation maximum slot fill percentage.

Table V.2 Trial Standard Levels for Capacitor-Start Small Electric Motors*

	CSIR 4-pole 0.50 Hp %	CSCR 4-pole 0.75 Hp %
TSL 1	68.5	78.3
TSL 2	68.5	80.3
TSL 3	71.2	80.3
TSL 4	73.0	81.6
TSL 5	73.0	80.3
TSL 6	77.0	87.3
TSL 7	77.0	80.3
TSL 8	77.0	85.4

*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 motors 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 shell on the motor. Standards may 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 NOPR and chapter 10 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 combined CSIR and CSCR market share, there is not a 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 of 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 consists 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 the efficiency levels correspond to what manufacturers would consider an EPACT 1992 equivalent efficiency standard. 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 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. The 80.3 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 81.6 percent efficiency level for CSCR motors, 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 which have more customers who benefit than customers who are harmed according to DOE's LCC analysis. TSL 5 increases energy savings relative to TSL 4 because DOE estimates greater CSCR market share, and the CSCR efficiency level again corresponds with the minimum LCC. At this TSL, the efficiency levels for both CSIR and CSCR motors equate to what manufacturers would consider a NEMA Premium level.

TSL 6 represents ''max-tech'' 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 almost 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 almost 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'' level, TSL 6. TSL 7 pairs the ''max-tech'' requirements for CSIR motors with the minimum LCC efficiency level for CSCR motors, while TSL 8 level pairs max-tech CSIR 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. Economic Justification and Energy Savings

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 Impacts on Customers

DOE analyzed the economic impacts on small electric motor customers by looking at the effects standards would have on the LCC, PBP, and 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 Cost and Payback Period

To evaluate the net economic impact of the trial standard levels on customers, DOE conducted LCC and PBP analyses for each of these levels. Higher-efficiency small electric motors would affect customers in two ways: annual operating expense would decrease and purchase price would increase. DOE analyzed the net effect by calculating the LCC. Section IV.F discusses the inputs used for calculating the LCC and PBP. Inputs used for calculating the LCC include total installed costs (equipment price plus installation costs), annual energy savings, electricity rates, electricity price trends, repair costs, maintenance costs, equipment lifetime, and discount rates.

The key outputs of the LCC analysis are average LCC savings for each product class for each considered efficiency level, relative to the base case, as well as a probability distribution of LCC reduction or increase. The LCC analysis also estimates, for each product class, the fraction of customers for which the LCC will either decrease (net benefit), or increase (net cost), or exhibit no change (no impact) relative to the base case forecast. No impacts occur when the equipment efficiencies of the base case forecast already equal or exceed the considered efficiency level. Small electric motors are used in applications that can have a wide range of operating hours. Motors that are running at all hours will tend to have a large net LCC benefit because of the large operating cost savings, while for some types of applications (*e.g.* portable compressors) a majority of motors may run only a few hours per day. Because of the large benefits seen by a minority of motors that run at all times, a majority of motors may see a net LCC cost even when on average for all motors there is a net LCC benefit.

Other key outputs of the LCC analysis are the mean and median payback periods at each efficiency level. Table V.3, Table V.4, and Table V.5 show the results for the three representative product classes: 1 hp, four-pole, polyphase; 0.5 hp, four-pole, CSIR; and 0.75 hp, four-pole, CSCR motors. Frequency plots of the distributions of life-cycle costs and payback periods for all three motor categories are available in chapter 8 of the TSD.

Table V.3 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 Energy Use kWh/yr	Average Annual Operating Cost $	Average Life-Cycle Cost $	Average Savings $	Customers with Net Cost %	Customers with Net Benefit %	Average	Median
Baseline	77.2	512	1763	132.7	1,274					
1	78.7	524	1734	130.5	1,274	0	62.0	38.0	33.7	10.6
2	80.0	531	1698	127.8	1,265	9	48.9	51.1	23.1	7.2
3	81.6	542	1645	123.8	1,253	21	45.1	55.0	20.4	6.3
4	82.5	550	1629	122.6	1,255	19	48.0	52.0	22.7	7.0
5	85.2	643	1549	116.6	1,312	-38	70.5	29.5	48.2	13.8
6	86.7	697	1529	115.1	1,358	-85	82.0	18.0	62.4	18.9
7	88.3	1,446	1494	112.4	2,089	-818	98.1	1.9	263.1	55.1

For polyphase small electric motors, customers experience net LCC savings, on average, through efficiency level 4. Efficiency level 3 has the minimum average life-cycle cost. The long average payback periods are due to the significant fraction of customers with relatively few annual operating hours. DOE feels that the median payback period better characterizes the distribution.

Table V.4 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 Energy Use kWh/yr	Average Annual Operating Cost	Average Life-Cycle Cost	Average Savings	Customers with Net Cost %	Customers with Net Benefit %	Average	Median
Baseline	57.7	490	1277	96.2	941					
1	59.5	499	1226	92.3	932	9	39.6	60.4	13.9	4.3
2	62.0	505	1164	87.7	916	25	32.7	67.3	10.4	3.2
3	64.2	507	1110	83.6	899	41	27.7	72.3	8.3	2.6
4	68.5	525	1020	76.9	885	55	33.7	66.3	11.0	3.3
5	71.2	543	971	73.2	886	54	39.7	60.3	13.8	4.3
6	73.0	587	942	70.9	919	21	52.8	47.2	23.1	6.7
7	77.0	977	877	66.0	1,284	-346	64.0	36.0	95.5	11.2

For CSIR small electric motors, customers experience net LCC savings, on average, through efficiency level 6. CSIR efficiency level 4 has the minimum average life-cycle cost.

For CSCR small electric motors, customers experience net LCC savings, on average, through efficiency level 5. CSCR efficiency level 3 has the greatest average life-cycle cost savings. Table V.5 also includes the life-cycle cost of a baseline 0.75 horsepower CSIR motor. This motor has an installed cost similar to the baseline-efficient CSCR motor, but significantly higher annual operating costs and life-cycle cost. DOE's national energy savings calculations, described in sections IV.G and V.B.3, model the market share of CSIR and CSCR motors in each product class in order to account for customers selecting CSIR or CSCR motors to reduce their life-cycle costs.

Table V.5 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 Energy Use kWh/yr	Average Annual Operating Cost	Average Life-Cycle Cost	Average Savings	Customers with Net Cost %	Customers with Net Benefit %	Average	Median
CSIR Baseline	63.4	543	1713	129.1	1,148					
Baseline	71.0	542	1451	109.3	1,054					
1	74.3	552	1389	104.7	1,042	12	38.2	61.8	12.7	4.1
2	78.3	580	1278	96.3	1,031	23	45.8	54.2	17.1	5.3
3	80.3	591	1233	92.9	1,025	28	46.3	53.7	17.4	5.4
4	81.6	606	1239	93.3	1,043	10	55.6	44.4	23.2	7.4
5	82.7	620	1226	92.4	1,052	2	59.9	40.1	26.3	8.4
6	83.7	668	1219	91.8	1,098	-44	73.0	27.0	41.6	12.3
7	85.4	686	1175	88.6	1,101	-47	72.6	27.5	40.3	12.1
8	87.3	1,496	1144	86.2	1,897	-846	99.1	0.9	228.9	50.3

b. Life-Cycle Cost Sensitivity Calculations

In addition to the reference case results reported in the tables above, DOE performed extensive sensitivity analyses of the LCC estimates. These sensitivity analyses examined the magnitude by which the estimates varied depending on analysis 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 the sensitivity calculations in chapter 8 of the TSD and the accompanying appendices.

For polyphase motors, DOE performed a sensitivity calculation using a full distribution of motor sizes and poles, the full cost of reactive power, and a purchase year of 2030 (the middle of the forecast period). This sensitivity calculation also examines the proportion of motors with <2% life-cycle cost impact as a measure of the fraction of motors that may have relatively small impacts from a standard. Table V.6 provides the results of this sensitivity calculation. Under this analytical scenario, life-cycle cost savings increase slightly.

Table V.6 Polyphase Small Electric Motors: Life-Cycle Cost and Payback Period Sensitivity Results for a Shipments-weighted Distribution of Motor Capacities and Poles for Purchase Year 2030 and with 100% Power Factor Costs Included

Energy Efficiency Level	Efficiency %	Life-Cycle Cost			Life-Cycle Cost Savings				Payback Period years	
		Average Installed Price $	Average Energy Use kWh/yr	Average Life-Cycle Cost $	Average Savings $	Customers with				
						>2% Net Cost %	<2% Net Impact %	>2% Net Benefit %	Average	Median
Baseline	77.2	510	1875	1,483						
1	78.7	522	1844	1,479	3	2.6	97.3	0.1	28.2	8.7
2	80.0	529	1806	1,466	17	12.6	68.5	18.9	19.3	6.0
3	81.6	540	1750	1,445	38	17.5	36.6	45.8	16.9	5.2
4	82.5	548	1733	1,445	38	24.2	31.6	44.3	18.9	5.8
5	85.2	640	1649	1,493	-10	54.4	16.5	29.2	40.0	11.5
6	86.7	694	1628	1,537	-54	67.0	13.9	19.1	51.8	15.7
7	88.3	1,436	1591	2,261	-778	93.5	4.1	2.4	219.2	44.8

For comparison purposes, DOE calculated the same sensitivity for single-phase motors including CSIR and CSCR motors. The results of these sensitivity calculations are provided in Table V.7 and Table V.8.

Table V.7 Capacitor-Start Induction-Run Small Electric Motors: Life-Cycle Cost and Payback Period Sensitivity Results for a Shipments-Weighted Distribution of Motor Capacities and Poles for Purchase Year 2030 and with 100% Power Factor Costs Included

Energy Efficiency Level	Efficiency %	Life-Cycle Cost			Life-Cycle Cost Savings				Payback Period years	
						Customers with				
		Average Installed Price $	Average Energy Use kWh/yr	Average Life-Cycle Cost $	Average Savings $	>2% Net Cost %	<2% Net Impact %	>2% Net Benefit %	Average	Median
Baseline	57.7	494	1274	1,044						
1	59.5	503	1222	1,031	13	0.2	78.2	21.6	11.8	3.6
2	62.0	509	1159	1,010	34	4.3	41.8	53.9	8.9	2.7
3	64.2	512	1104	987	57	4.1	29.6	66.3	7.1	2.1
4	68.5	530	1013	964	80	14.1	19.0	66.9	9.3	2.8
5	71.2	548	963	965	79	25.5	14.3	60.3	11.8	3.6
6	73.0	593	933	995	49	39.7	11.3	49.0	19.7	5.7
7	77.0	988	867	1,360	-315	53.0	7.8	39.2	82.8	9.3

Table V.8 Capacitor-Start Capacitor-Run Small Electric Motors: Life-Cycle Cost and Payback Period Sensitivity Results for a Shipments-weighted Distribution of Motor Capacities and Poles for Purchase Year 2030 and with 100% Power Factor Costs Included

Energy Efficiency Level	Efficiency %	Life-Cycle Cost			Life-Cycle Cost Savings				Payback Period years	
						Customers with				
		Average Installed Price $	Average Energy Use kWh/yr	Average Life-Cycle Cost $	Average Savings $	>2% Net Cost %	<2% Net Impact %	>2% Net Benefit %	Average	Median
Baseline	71.0	576	2259	1,540						
1	74.3	588	2173	1,505	36	0.2	50.4	49.4	9.5	3.0
2	78.3	619	2018	1,466	75	14.8	23.7	61.5	13.0	3.9
3	80.3	631	1956	1,451	89	18.7	19.7	61.7	13.2	4.0
4	81.6	649	1964	1,457	83	21.9	19.1	59.0	17.4	5.4
5	82.7	663	1947	1,465	76	27.7	18.3	54.0	19.9	6.1
6	83.7	717	1937	1,507	33	42.2	16.3	41.5	31.9	9.0
7	85.4	738	1877	1,507	34	46.1	13.7	40.2	30.8	8.8
8	87.3	1,641	1833	2,391	-851	91.5	4.0	4.5	179.7	36.6

DOE also 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 V.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 V.7 shows the shipments-weighted average of the LCC for CSIR motors including those users that switch to CSCR. The table shows a negative average LCC is forecast for only TSL 6 which is that level where both CSIR and CSCR motors are at the maximum technologically feasible efficiency for space-constrained designs.

Table V.9 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		
	Average Installed Price $	Average Energy Use kWh/yr	Average Annual Operating Cost	Average Life-Cycle Cost	Average Savings	Customers with Net Cost %	Customers with Net Benefit %
Baseline	490	1277	96.2	941			
1	525	1020	76.9	885	56	33.5	66.5
2	525	1020	76.9	885	56	33.5	66.5
3	543	971	73.2	886	55	39.8	60.3
4	586	941	70.9	918	23	52.3	47.7
5	586	941	70.9	918	23	52.3	47.7
6	975	877	66.0	1,284	-343	63.1	37.0
7	580	884	66.6	892	49	50.6	49.4
8	613	873	65.7	921	20	58.0	42.0

c. Customer Sub-Group Analysis

Using the LCC spreadsheet model, DOE determined the impact of the trial standard levels on the following customer sub-groups: small businesses and customers with space-constrained applications.

Small Businesses

For small business owners, the LCC impacts and payback periods are different than for the general population. Table V.10, Table V.11, and Table V.12 show the LCC impacts and payback periods for small businesses purchasing polyphase, CSIR, and CSCR motors, respectively. For polyphase motors, LCC savings are positive for efficiency levels 1, 2, 3, and 4 for motor customers as a whole, but level 1 has negative savings for small businesses. Efficiency level 3 shows the greatest savings for all customers as well as for small businesses. For CSIR motors, LCC savings are somewhat smaller for small businesses, but the results are generally similar between small businesses and motor customers as a whole. For CSCR motors, LCC savings are positive for efficiency levels 1 through 5 for motor customers as a whole, but level 5 has negative savings for small businesses. Efficiency level 3 shows the greatest savings for all customers as well as for small businesses. Small businesses do not have as attractive consumer benefits as the general population because they do not have the same access to capital as larger businesses, resulting in higher average discount rates than the industry average.

Table V.10 Polyphase Motors: Small Business Customer Subgroup

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 Life-Cycle Cost Savings	Consumers with Net Cost %	Consumers with Net Benefit %	Average	Median
Baseline	77.2	512	1743	131.2	1,157					
1	78.7	524	1714	129.0	1,158	-2	68.0	32.0	33.7	10.6
2	80.0	531	1678	126.3	1,152	5	54.7	45.3	23.1	7.2
3	81.6	542	1626	122.3	1,144	13	50.2	49.8	20.4	6.3
4	82.5	550	1610	121.2	1,146	11	53.8	46.2	22.7	7.0
5	85.2	643	1531	115.2	1,209	-52	75.9	24.1	48.2	13.8
6	86.7	697	1512	113.8	1,257	-99	86.7	13.3	62.4	18.9
7	88.3	1,446	1477	111.1	1,991	-835	99.0	1.0	263.1	55.1

Table V.11 Capacitor-Start Induction Run Motors: Small Business Customer Subgroup

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 Life-Cycle Cost Savings	Consumers with Net Cost %	Consumers with Net Benefit %	Average	Median
Baseline	57.7	490	1291	97.6	886					
1	59.5	499	1239	93.7	879	7	44.1	55.9	13.9	4.3
2	62.0	505	1177	89.0	866	20	36.5	63.5	10.4	3.2
3	64.2	507	1122	84.9	852	34	31.1	68.9	8.3	2.6
4	68.5	525	1031	78.0	842	44	37.8	62.2	11.0	3.3
5	71.2	543	982	74.3	845	41	44.2	55.8	13.8	4.3
6	73.0	587	952	72.0	879	6	57.8	42.2	23.1	6.7
7	77.0	977	886	67.0	1,248	-364	67.8	32.2	95.5	11.2

Table V.12 Capacitor-Start Capacitor Run Motors: Small Business Customer Subgroup

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 Life-Cycle Cost Savings	Consumers with Net Cost %	Consumers with Net Benefit %	Average	Median
CSIR Baseline	63.4	543	1732	131.0	1,075					
CSCR Baseline	71.0	542	1467	110.9	992	-	-	-	-	-
1	74.3	552	1404	106.2	983	9	42.4	57.6	12.7	4.1
2	78.3	580	1291	97.7	976	15	50.2	49.8	17.1	5.3
3	80.3	591	1246	94.3	973	18	50.6	49.4	17.4	5.4
4	81.6	606	1252	94.7	990	1	60.5	39.5	23.2	7.4
5	82.7	620	1239	93.7	1,000	-8	65.0	35.1	26.3	8.4
6	83.7	668	1232	93.2	1,046	-54	77.2	22.8	41.6	12.3
7	85.4	686	1188	89.9	1,050	-59	76.8	23.2	40.3	12.1
8	87.3	1,496	1156	87.5	1,849	-859	99.5	0.5	228.9	50.3

Customers With Space-Constrained Applications

One of the design options DOE considered in developing more efficient motors was to increase the motor stack length. Increasing stack length can increase motor efficiency by lowering core losses.[17] Customers with space-constrained applications (defined as those customers whose motor stack length can increase no more than 20 percent), cannot use this design option as effectively as those without constraints. In order to meet efficiency targets without increasing stack length, other, more costly, design options are used. Customers with these constraints, therefore, have less attractive economic benefits to efficiency, particularly for motors at the higher efficiency levels considered by DOE. The LCC results presented in section IV.F assume that 20 percent of customers face space constraints, while 80 percent of customers may use any stack length (up to the 100 percent increase considered by DOE). Customers without space constraints have customer economic benefits which are more attractive than the overall results, particularly at higher levels of efficiency.

Table V.13, Table V.14, and Table V.15 show the results of the LCC analysis for the space-constrained subgroup. Polyphase levels 1 through 4, CSIR levels 1 through 3 and 5, and CSCR level 1 are unchanged for space-constrained consumers because motor designs meeting these efficiency levels have stack length increases of less than or equal to 20 percent. CSIR efficiency level 6 and CSCR efficiency level 5 are the only levels which change from positive LCC average savings for all customers to negative LCC savings for space-constrained customers.

[17] Core losses are generated in the steel components of the motor by two electromagnetic phenomena: hysteresis losses and eddy currents. Hysteresis losses are caused by magnetic domains resisting reorientation to the alternating magnetic field (*i.e.*, 60 times per second, or 60 hertz). Eddy currents are physical currents that are induced in the steel laminations by the magnetic flux of the windings.

Table V.13 Polyphase Motors: Space-Constrained Customer Subgroup

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 Life-Cycle Cost Savings	Consumers with Net Cost %	Consumers with Net Benefit %	Average	Median
Baseline	77.2	512	1728	130.5	1,266					
1	78.7	524	1699	128.3	1,266	0	62.0	38.0	33.7	10.6
2	80.0	531	1664	125.6	1,257	9	48.9	51.1	23.1	7.2
3	81.6	542	1611	121.7	1,246	21	45.1	55.0	20.4	6.3
4	82.5	550	1596	120.5	1,247	19	48.0	52.0	22.7	7.0
5	85.2	757	1511	114.1	1,417	-150	92.2	7.8	88.3	26.9
6	86.7	769	1487	112.3	1,418	-151	91.0	9.0	82.9	25.3
7	88.3	3,573	1445	109.1	4,205	-2,937	100.0	0.0	843.1	258.1

Table V.14 Capacitor-Start Induction Run Motors: Space-Constrained Customer Subgroup

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 Life-Cycle Cost Savings	Consumers with Net Cost %	Consumers with Net Benefit %	Average	Median
Baseline	57.7	490	1308	99.6	943					
1	59.5	499	1256	95.6	933	9	39.6	60.4	13.9	4.3
2	62.0	505	1193	90.9	917	25	32.7	67.3	10.4	3.2
3	64.2	507	1138	86.7	901	41	27.7	72.3	8.3	2.6
4	68.5	535	1037	79.0	893	49	38.9	61.1	13.5	4.1
5	71.2	543	997	75.9	888	54	39.7	60.3	13.8	4.3
6	73.0	659	957	73.0	990	-48	72.3	27.8	39.3	12.0
7	77.0	2,527	884	67.4	2,833	-1,891	100.0	0.0	392.6	119.9

Table V.15 Capacitor-Start Capacitor Run Motors: Space-Constrained Customer Subgroup

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 Life-Cycle Cost Savings	Consumers with Net Cost %	Consumers with Net Benefit %	Average	Median
CSIR Baseline	63.4	543	1756	133.7	1,151					
CSCR Baseline	71.0	542	1490	113.5	1,057	-	-	-	-	-
1	74.3	552	1426	108.7	1,045	12	38.2	61.8	12.7	4.1
2	78.3	589	1328	101.2	1,048	8	55.2	44.8	23.0	7.3
3	80.3	600	1291	98.4	1,046	11	55.0	45.0	22.7	7.2
4	81.6	607	1280	97.5	1,049	7	57.2	42.8	24.2	7.8
5	82.7	622	1271	96.9	1,061	-5	62.9	37.1	28.5	9.1
6	83.7	776	1263	96.2	1,212	-156	95.0	5.0	80.5	25.8
7	85.4	791	1225	93.3	1,214	-157	93.6	6.4	73.2	23.4
8	87.3	3,593	1159	88.3	3,994	-2,937	100.0	0.0	722.4	229.3

d. Rebuttable Presumption Payback

As discussed in section II.C, 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 V.16 and Table V.17 show the rebuttable presumption payback periods for the representative product classes.

Table V.16 Rebuttable-Presumption Payback Periods for Representative Polyphase Small Electric Motors (1 hp, 4 poles)

TSL	Payback Period years
1	3.6
2	3.1
3	3.2
4	3.5
5	7.9
6	9.9
7	40.4

Table V.17 Rebuttable-Presumption Payback Periods for Representative Capacitor-Start Small Electric Motors

TSL	Induction-Run (1/2 hp, 4 poles)		Capacitor-Run (3/4 hp 4 poles)	
	CSIR Level	Payback Period years	CSCR Level	Payback Period years
1	4	1.9	2	2.8
2	4	1.9	3	2.9
3	5	2.4	3	2.9
4	6	3.9	4	3.5
5	6	3.9	3	2.9
6	7	19.6	8	36.2
7	7	19.6	3	2.9
8	7	19.6	7	6.0

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.

2. Economic Impacts on Manufacturers

DOE used the INPV in the MIA to compare the financial impacts of different TSLs on small electric motor manufacturers. 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 in the base case (*i.e.,* no new energy conservation standards) with the INPV for each TSL in the standards case. To evaluate the range of cash-flow impacts on the small electric motors industry, DOE modeled two different scenarios using different assumptions for markups and shipments that correspond to the range of anticipated market responses. Each scenario results in a unique set of cash flows and corresponding industry value at each TSL. The difference in INPV between the base case and a standards case is an estimate of the economic impacts that implementing that standard level would have on the entire industry.

a. Industry Cash-Flow Analysis Results

To assess the potential impacts on manufacturers, DOE used the two markup scenarios described in section IV.I. For both markup scenarios, DOE considered the shipment scenario that uses a reference level of economic growth, no elasticity, and a baseline market share between CSCR and CSIR motors. To assess the lower end of the range of potential impacts on the small electric motors industry, DOE considered the preservation of return on invested capital markup scenario. This scenario assumes that manufacturers would be able to maintain the ratio of net operating profit (after taxes) to invested capital after new energy conservation standards. To assess the higher end of the range of potential impacts on the small electric motors industry, DOE considered the preservation of operating profit markup scenario. This scenario assumes that the industry can only maintain its operating profit (*i.e.*, earnings before interest and taxes) after the effective date of the standard. The industry would do so by not passing through all of the higher costs to customers. Table V.18 through Table V.21 show the low end and high end of the range of MIA results, respectively, for each TSL using the scenarios described above. 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.

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Table V.18 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	5	6	7
INPV	2008$ millions	64	65	65	66	67	75	80	149
Change in INPV	2008$ millions	-	0.52	1.11	1.83	2.41	10.85	15.94	85.23
	%	-	0.80	1.74	2.86	3.76	16.91	24.84	132.87
Equipment Conversion Costs	2008$ millions	-	0.9	0.9	0.9	0.9	1.9	2.8	3.8
Capital Conversion Costs	2008$ millions	-	0.4	0.7	0.8	0.9	4.0	6.3	27.1
Total Investment Required	2008$ millions	-	1.4	1.6	1.7	1.9	5.9	9.2	30.9

Table V.19 Manufacturer Impact Analysis for Polyphase Small Electric Motors (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level						
			1	2	3	4	5	6	7
INPV	2008$ millions	64	63	63	62	62	55	51	4
Change in INPV	2008$ millions	-	(1.14)	(1.56)	(2.01)	(2.39)	(8.83)	(13.09)	(59.74)
	%	-	(1.78)	(2.42)	(3.14)	(3.73)	(13.76)	(20.41)	(93.14)
Equipment Conversion Costs	2008$ millions	-	0.9	0.9	0.9	0.9	1.9	2.8	3.8
Capital Conversion Costs	2008$ millions	-	0.4	0.7	0.8	0.9	4.0	6.3	27.1
Total Investment Required	2008$ millions	-	1.4	1.6	1.7	1.9	5.9	9.2	30.9

Table V.20 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	2008$ millions	279	290	291	297	310	307	467	309	336
Change in INPV	2008$ millions	-	11.21	12.22	18.03	31.21	27.96	187.88	29.80	56.70
	%	-	4.02	4.38	6.47	11.19	10.03	67.39	10.69	20.34
Equipment Conversion Costs	2008$ millions	-	8.2	8.2	12.2	12.4	12.2	16.5	16.0	16.3
Capital Conversion Costs	2008$ millions	-	8.7	9.8	12.4	14.9	12.4	54.4	29.7	34.1
Total Investment Required	2008$ millions	-	16.9	17.9	24.5	27.3	24.5	70.8	45.7	50.4

Table V.21 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	2008$ millions	279	264	263	256	247	250	141	243	226
Change in INPV	2008$ millions	-	(14.87)	(15.64)	(22.87)	(31.57)	(29.01)	(137.53)	(35.84)	(53.30)
	%	-	(5.33)	(5.61)	(8.20)	(11.32)	(10.41)	(49.33)	(12.86)	(19.12)
Equipment Conversion Costs	2008$ millions	-	8.2	8.2	12.2	12.4	12.2	16.5	16.0	16.3
Capital Conversion Costs	2008$ millions	-	8.7	9.8	12.4	14.9	12.4	54.4	29.7	34.1
Total Investment Required	2008$ millions	-	16.9	17.9	24.5	27.3	24.5	70.8	45.7	50.4

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Polyphase Small Electric Motors

DOE estimated the impacts on INPV at TSL 1 to range from $0.52 million to −$1.14 million, or a change in INPV of 0.80 percent to −1.78 percent. At this level industry cash flow decreases by approximately 9.1 percent, to $4.68 million, compared to the base-case value of $5.15 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. 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 number of laminations within both space constrained and non-space constrained motors. Manufacturers indicated that modifications like an increase in 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 $1.11 million to −$1.56 million, or a change in INPV of 1.74 percent to −2.42 percent. At this level industry cash flow decreases by approximately 11.53 percent, to $4.55 million, compared to the base-case value of $5.15 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 allows 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-spaced 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 $1.83 million to −$2.01 million, or a change in INPV of 2.86 percent to −3.14 percent. At this level industry cash flow decreases by approximately 12.35 percent, to $4.51 million, compared to the base-case value of $5.15 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 more laminations than the baseline design within both space constrained and non-spaced constrained motors. These changes do not result in significant impacts on INPV.

At TSL 4, DOE estimated the impacts in INPV to range from $2.41 million to −$2.39 million, or a change in INPV of 3.76 percent to −3.73 percent. At this level industry cash flow decreases by approximately 13.44 percent, to $4.46 million, compared to the base-case value of $5.15 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. However, manufacturers reported that TSL 4 would be the highest efficiency level achievable before required efficiencies could significantly change motor designs and production equipment. However, past TSL 4 the size of the motors may need to be significantly modified.

At TSL 5, DOE estimated the impacts in INPV to range from $10.85 million to −$8.83 million, or a change in INPV of 16.91 percent to −13.76 percent. At this level industry cash flow decreases by approximately 46.20 percent, to $2.77 million, compared to the base-case value of $5.15 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 possibly 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 $15.94 million to −$13.09 million, or a change in INPV of 24.84 percent to −20.41 percent. At this level industry cash flow decreases by approximately 71.78 percent, to $1.45 million, compared to the base-case value of $5.15 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, at TSL 6 DOE estimates that manufacturers would incur close to six times the total conversion costs required at TSL 1 (a total of approximately $9.2 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 $85.23 million to −$59.74 million, or a change in INPV of 132.87 percent to −93.14 percent. At this level industry cash flow decreases by approximately 258.82 percent, to −$8.18 million, compared to the base-case value of $5.15 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. In addition to possibly using copper rotors, at TSL 7 space constrained motor designs could also require exotic steels. 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 exotic steels to general purpose small electric motors. According to manufacturers, requiring this technology could possibly cause some competitors to exit the small electric motor market. If manufacturers' concerns of having to use both copper rotors and new steels materialize, manufactures could be significantly impacted. For non-space constrained motors, DOE estimates that manufacturers would require the use of copper rotors but not exotic steels. If manufacturers are required to redesign non-spaced constrained motors with copper, the total conversion 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 $11.21 million to −$14.87 million, or a change in INPV of 4.02 percent to −5.33 percent. At this level, industry cash flow decreases by approximately 28.51 percent, to $15.99 million, compared to the base-case value of $22.34 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 thinner grade 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, manufactures 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 $17 million to reach TSL 1. TSL 1 would increase production costs, but 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 $12.22 million to −$15.64 million, or a change in INPV of 4.38 percent to −5.61 percent. At this level industry cash flow decreases by approximately 30.58 percent, to $15.53 million, compared to the base-case value of $22.34 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 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 $18.03 million to −$22.87 million, or a change in INPV of 6.47 percent to −8.20 percent. At this level, industry cash flow decreases by approximately 41.16 percent, to $13.17 million, compared to the base-case value of $22.34 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 $25 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 possibly 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 $31.21 million to −$31.57 million, or a change in INPV of 11.19 percent to −11.32 percent. At this level industry cash flow decreases by approximately 46.63 percent, to $11.94 million, compared to the base-case value of $22.34 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 $27.96 million to −$29.01 million, or a change in INPV of 10.03 percent to −10.41 percent. At this level industry cash flow decreases by approximately 41.16 percent, to $13.17 million, compared to the base-case value of $22.34 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 $25 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 $187.88 million to −$137.53 million, or a change in INPV of 67.39 percent to −49.33 percent. At this level, industry cash flow decreases by approximately 131.38 percent, to −$7.02 million, compared to the base-case value of $22.34 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 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 exotic steels. There is a great deal of uncertainty about the impact of Hiperco steel on the industry, primarily due to uncertainty about capital conversion costs required to use a new, exotic steel. Significant R&D in manufacturing processes would be necessary to understand the applications of exotic steels in general purpose small electric motors. Because all space constrained motors could require copper rotors and exotic steel 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 unjustifiable investment for a small segment of their total business.

At TSL 7, DOE estimated the impacts in INPV to range from $29.80 million to −$35.84 million, or a change in INPV of 10.69 percent to −12.86 percent. At this level, industry cash flow decreases by approximately 81.21 percent, to $4.20 million, compared to the base-case value of $22.34 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-spaced 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 level for CSIR). At TSL 7 space constrained CSIR redesigns could require the use of both copper rotors and exotic steels while non-space constrained CSIR motors could require only copper rotors. Manufacturers continue to have the same concerns about copper rotors and exotic steels for CSIR motors as with other efficiency levels that may require these technologies. The impacts on INPV for non-spaced constrained CSIR motors are significantly less because of the exclusion of exotic 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 high cost of CSIR motors would likely cause customers to migrate to CSCR motors. For the analysis, DOE assumes that manufacturers would invest in the alternative technologies for CSIR motors regardless of the modeled migration to CSCR motors because of the variability in that migration. The industry is impacted by the high conversion costs for CSIR motors 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 mitigate the significant redesign costs for CSIR motors.

At TSL 8, DOE estimated the impacts in INPV to range from $56.70 million to −$53.30 million, or a change in INPV of 20.34 percent to −19.12 percent. At this level, industry cash flow decreases by approximately 90.42 percent, to $2.14 million, compared to the base-case value of $22.34 million in the year leading up to 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 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 exotic 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 incur the required conversion costs for both CSCR and CSIR motors, despite the low market share of CSIR motors after the effective date of the energy conservation standards. After standards, the shift to CSCR motors increases total industry revenue and helps to mitigate the significant capital conversion costs necessary for CSIR motors to use both copper and exotic metals.

b. Impacts on Direct Employment

To assess the impacts of energy conservation standards on small electric motors direct manufacturing employment, DOE used the GRIM to estimate domestic labor expenditures and employment levels. DOE used the latest available statistical data from the U.S. Census Bureau's 2006 Annual Survey of Manufacturers (2006 ASM), results from other analyses, and interviews with manufacturers to estimate the inputs necessary to calculate industry-wide domestic labor expenditures and employment levels. In the GRIM, total labor expenditures are a function of the labor content, the sales volume, and the wage rate which remains fixed in real terms over time. The total employment figures presented for the small electric motor industry includes both production and non-production workers.

DOE estimates that there are approximately 1,800 U.S. production and non-production workers in the small electric motors industry.

DOE does not believe that standards would materially alter the domestic employment levels of the small electric motors industry. Most manufacturers indicated that employment levels would stay constant regardless of any changes in regulations. However, some manufacturers stated that if efficiency levels were raised significantly enough for the company to exit the small electric motor market, a small number of jobs could be eliminated. Even in the event that some manufacturers exit the market, the direct employment impact will likely be minimal. 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. For further information and results on direct employment see chapter 12 of the TSD.

c. Impacts on Manufacturing Capacity

New energy conservation standards would not significantly affect the production capacity of small electric motor manufacturers. For small electric motor manufacturers, any necessary redesign will not change the fundamental assembly of the products and there will likely be no long-term capacity constraints. Manufacturers indicated that producing more efficient small electric motors would not be technically difficult and that they would not need to build new facilities to accommodate the manufacturing of a more efficient motor. Additionally, manufacturers indicated that the industry is currently experiencing over capacity. As a result, manufacturers have scaled back manufacturing to cut costs and inventory. Accordingly, DOE believes manufacturers can use any available excess capacity to mitigate any possible capacity constraint as a result of energy conservation standards. The real risk is that some motors would be discontinued due to lower demand after standard rather than constrained capacity. For further explanation of the impacts on manufacturing capacity for small electric motors, see chapter 12 of the TSD.

d. Impacts on Manufacturer Subgroups

As discussed above, using average cost assumptions to develop an industry cash-flow estimate is inadequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche players, and manufacturers exhibiting a cost structure that differs largely from the industry average could be affected differently. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics, which reduced the need to analyze manufacturer subgroups to only investigating small businesses. However, during interviews DOE did not identify any small manufacturers of covered motors. After conducting further research, including the examination of catalogs and contacting manufacturers to discuss their product lines, DOE still did not identify any small manufacturers in the small electric motor industry.

e. Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, DOE understands the combined effects of several existing and impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. For this reason, DOE conducts an analysis of cumulative regulatory burden as part of its appliance efficiency rulemakings.

In addition to the energy conservation standards for small electric motors, other regulations can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can quickly strain profits and possibly cause it to exit the market. DOE has identified other regulations these manufacturers are facing for other products and equipment they manufacture within 3 years prior to and 3 years after the effective date of the new energy conservation standards for small electric motors.

Small electric motor manufacturers described some of the current regulations affecting their business during manufacturer interviews. Manufacturers mentioned the European Union's Restriction of Hazardous Substances (RoHS) and the Registration, Evaluation, Authorization and Restriction of Chemical Substances (REACH). Also, manufacturers indicated both the International Electrotechnical Commission (IEC) and the National Electric Manufacturers Association (NEMA) have implemented voluntary standards for small electric motors. Some manufacturers also indicated that the Canadian Standards Association (CSA) would likely to apply the same standards set by DOE in the final rule. In addition to the energy conservation standards on small electric motor products, several other DOE regulations and pending regulations apply to other products produced by the same manufacturers. DOE recognizes that each regulation has the potential to impact manufacturers' financial operations. For a detail explanation and results for the cumulative regulatory burden, see chapter 12 of the TSD.

3. National Impact Analysis

Examining the national impact of small electric motor standards required DOE to assess a variety of factors. DOE needed to assess the significance of the projected amount of energy savings flowing from an energy conservation standard for small electric motors. It also had to ascertain the cumulative benefits and costs that a standard would be likely to bring. Finally, DOE analyzed the projected employment impacts resulting from a standard.

a. Significance of Energy Savings

To estimate the energy savings due to revised and new energy efficiency standards, DOE compared 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. 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 V.22 through Table V.23 show the forecasted national energy savings through 2045 at each of the TSLs. The tables also show the magnitude of the energy savings if the savings are discounted at rates of 7 and 3-percent. Discounted energy savings represent a policy perspective where energy savings farther in the future are less significant than energy savings closer to the present. The energy savings (undiscounted) due to possible standards for polyphase small electric motors range from 0.04 to 0.41 quads, and the savings for capacitor-start small electric motors range from 1.08 to 2.51 quads. Capacitor-start results are presented as a range of values between DOE's two reference scenarios, which correspond to 1) market share shifts in response to standards complete by 2015 and 2) market shares in 2015 equal to DOE's estimated market shares in 2009, and a shift over 10 years to the shares forecast by DOE's cross-elasticity model.

Table V.22 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	0.04	0.02	0.01
2	0.09	0.05	0.02
3	0.18	0.09	0.04
4	0.20	0.10	0.05
5	0.33	0.17	0.08
6	0.36	0.19	0.09
7	0.41	0.21	0.10

Table V.23 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	1.08	0.56 – 0.57	0.26 – 0.27
2	1.10	0.57	0.27
3	1.28 – 1.29	0.67	0.32
4	1.53	0.80	0.37
5	1.53	0.80	0.37 – 0.38
6	1.91 – 1.92	1.00	0.47
7	2.10 – 2.13	1.09 – 1.11	0.51 – 0.52
8	2.51 – 2.61	1.29 – 1.37	0.59 – 0.64

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 with the relative economic savings and energy savings of different TSLs remaining 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.

For the shipments sensitivity analysis, DOE analyzed the total energy savings from capacitor-start motors in ''low CSCR'' and ''high CSCR'' scenarios, which model different market barriers to adoption of CSCR motors. These scenarios can have a significant impact on the relative energy savings in different TSLs. Table V.24 shows the results for the national energy savings (through 2045) in these scenarios.

Table V.24 Undiscounted Cumulative National Energy Savings for Capacitor-Start Small Electric Motors Under Different CSIR/CSCR Market Share Scenarios (Energy Savings between 2015 and 2045)

Trial Standard Level	National Energy Savings quads		
	Low CSCR Scenario	Reference Scenario	High CSCR Scenario
1	1.05 – 1.06	1.08	1.30 – 1.33
2	1.05 – 1.06	1.10	1.40 – 1.45
3	1.25 – 1.26	1.28 – 1.29	1.51 – 1.54
4	1.47 – 1.48	1.53	1.77 – 1.82
5	1.47 – 1.48	1.53	1.76 – 1.80
6	1.91 – 1.92	1.91 – 1.92	1.91 – 1.92
7	2.09 – 2.12	2.10 – 2.13	2.10 – 2.13
8	2.45 – 2.53	2.51 – 2.61	2.51 – 2.61

b. Net Present Value

The NPV analysis provides a measure of the cumulative benefit or cost to the Nation from customer costs and savings from the proposed standards. In accordance with the Office of Management and Budget (OMB)'s guidelines on regulatory analysis (OMB Circular A–4, section E, September 17, 2003), DOE calculated NPV using both a 7-percent and a 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, and 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 used the 3-percent rate to capture the potential effects of standards on private consumption (*e.g.*, through higher prices for products 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 (*i.e.*, yield on Treasury notes minus 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 American Recovery and Reinvestment Act scenario of the AEO 2009 forecast. In this scenario, shipments are inelastic with respect to motor price, and 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 V.25 and Table V.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. For capacitor-start motors, NPV is positive at all TSLs except TSL 6. The latter TSL corresponds with max-tech for both CSIR and CSCR motors, which have high installed costs and negative lifecycle cost savings.

DOE notes that across motors, for certain for 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 recuperate 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.

DOE's National Impacts Analysis (NIA) estimates positive NPV based on several assumptions. First, DOE assumes a higher replacement rate for the substantial minority of high operating hour motors installed in certain applications. Second, based on EIA's AEO forecast, DOE assumes that electricity prices in the year 2015 will be significantly lower than those later in the analysis period. Because the NIA takes into account purchases beyond the year 2015 (in which consumers obtain larger electricity cost savings), the overall national savings from the standard exceed the life-cycle cost increases calculated. Third, DOE accounts for reactive power differently in the customer life-cycle cost and NIA models. In life-cycle cost, 25 percent of customers were assumed to face a direct cost due to reactive power (a percentage consistent with national data for commercial and industrial customers). By contrast, the NIA analysis includes 100 percent of the cost of reactive power in order to reflect costs to utilities as well as motor users. DOE seeks comment on its use of these assumptions in reaching a positive NPV where the majority of consumers for certain TSLs face life-cycle cost increases.

Table V.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 2008$	
	7% Discount Rate	3% Discount Rate
1	0.05	0.15
2	0.18	0.48
3	0.39	1.01
4	0.40	1.07
5	0.06	0.56
6	-0.29	-0.09
7	-6.38	-12.21

Table V.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 2008$	
	7% Discount Rate	3% Discount Rate
1	2.66 – 2.69	6.47 – 6.52
2	2.72 – 2.75	6.62 – 6.66
3	2.90 – 2.93	7.24 – 7.28
4	2.15 – 2.18	6.00 – 6.05
5	2.27 – 2.34	6.28 – 6.38
6	-12.40 – -12.28	-22.62 – -22.47
7	1.47 – 5.67	7.75 – 13.59
8	0.29 – 4.09	5.51 – 10.84

As discussed above, DOE conducted a wide range of sensitivity analyses, which can have a significant impact on the relative net present value of different trial standard levels. For the shipments sensitivity analysis, DOE analyzed the NPV from capacitor-start motor standards in the ''low CSCR'' and ''high CSCR'' scenarios, which model different market barriers to adoption of CSCR motors. Table V.27 and Table V.28 show the NPV results in these scenarios.

Table V.27 Cumulative Net Present Value for Capacitor-Start Small Electric Motors, Low Capacitor-Start, Capacitor-Run Scenario (Impact for Equipment Sold from 2015 to 2045)

Trial Standard Level	Net Present Value billion 2008$	
	7% Discount Rate	3% Discount Rate
1	2.53 – 2.59	6.18 – 6.28
2	2.55 – 2.61	6.23 – 6.33
3	2.75 – 2.82	6.91 – 7.01
4	1.76 – 1.83	5.15 – 5.26
5	1.79 – 1.86	5.23 – 5.32
6	-12.40 – -12.12	-22.62 – -22.47
7	0.88 – 4.88	6.44 – 12.00
8	-0.86 – 2.56	2.93 – 7.73

Table V.28 Cumulative Net Present Value for Capacitor-Start Small Electric Motors, High Capacitor-Start, Capacitor-Run Scenario (Impact for Equipment Sold from 2015 to 2045)

Trial Standard Level	Net Present Value billion 2008$	
	7% Discount Rate	3% Discount Rate
1	3.42 – 3.62	8.35 – 8.66
2	3.67 – 3.93	8.99 – 9.40
3	3.73 – 3.96	9.27 – 9.61
4	3.28 – 3.68	8.69 – 9.28
5	3.56 – 4.05	9.33 – 10.04
6	-12.40 – -12.28	-22.62 – -22.46
7	1.51 – 5.73	7.85 – 13.71
8	0.43 – 4.28	5.82 – 11.22

Future regulation of greenhouse gas emissions would have a significant impact on electricity prices and on the annual operating cost of small electric motors. DOE analyzed the NPV of trial standard levels in such a carbon cap and trade scenario. Table V.29 and Table V.30 show the NPV results in this scenario. These results show that the significantly higher electricity prices (particularly late in the analysis period) modeled under this scenario would significantly increase the NPV of each TSL compared with the reference cases. Chapter 10 of the NOPR TSD, along with its appendices, presents NPV results for the other sensitivity analyses that DOE conducted.

Table V.29 Cumulative Net Present Value for Polyphase Small Electric Motors in a Carbon Cap and Trade Scenario (Impact for Equipment Sold from 2015 to 2045)

Trial Standard Level	Net Present Value billion 2008$	
	7% Discount Rate	3% Discount Rate
1	0.08	0.24
2	0.25	0.70
3	0.54	1.44
4	0.57	1.56
5	0.34	1.36
6	0.02	0.79
7	-6.03	-11.20

Table V.30 Cumulative Net Present Value for Capacitor-Start Small Electric Motors in a Carbon Cap and Trade Scenario (Impact for Equipment Sold from 2015 to 2045)

Trial Standard Level	Net Present Value billion 2008$	
	7% Discount Rate	3% Discount Rate
1	3.52 – 3.56	8.86 – 8.91
2	3.60 – 3.63	9.05 – 9.09
3	3.97 – 4.01	10.21 – 10.26
4	3.41 – 3.44	9.47 – 9.51
5	3.54 – 3.61	9.76 – 9.87
6	-10.82 – -10.71	-18.28 – -18.14
7	3.13 – 7.35	12.34 – 18.20
8	2.23 – 6.08	10.92 – 16.33

c. Impacts on Employment

In accordance with the Process Rule, section 4(d)(7)(vi), DOE estimated the employment impacts of proposed standards on the economy in general. See 10 CFR part 430, subpart C, appendix A. As discussed above, DOE expects energy conservation standards for small electric motors to reduce energy bills for customers, with the resulting net savings redirected to other forms of economic activity. These shifts in spending and economic activity could affect the demand for labor. To estimate these effects, DOE used an input/output model of the U.S. economy (as described in section, IV.J). As shown in Table V.31 and Table V.32, both of which are detailed in chapter 14 of the TSD, DOE estimates that net indirect employment impacts from the proposed standards are positive.

Neither the BLS data set nor the input/output model DOE uses includes the quality or wage level of the jobs. Taking into consideration these concerns about employment impacts, DOE concludes that the proposed small electric motors standards are likely to result in no appreciable job losses to the Nation because direct employment impacts are expected to be small, while indirect employment impacts are positive.

Table V.31 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	0.056	0.138	0.224	0.289
2	0.102	0.291	0.494	0.638
3	0.180	0.551	0.946	1.221
4	0.221	0.642	1.091	1.407
5	0.651	1.373	2.149	2.742
6	0.888	1.697	2.573	3.264
7	3.870	5.093	6.497	7.984

Table V.32 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	0.99	3.49	5.13 – 5.21	6.63 – 6.74
2	1.00	3.54	5.20 – 5.29	6.73 – 6.85
3	1.41 – 1.42	4.51 – 4.53	6.59 – 6.68	8.50 – 8.64
4	2.24 – 2.27	5.88 – 5.94	8.41 – 8.55	10.80 – 10.97
5	2.18 – 2.25	5.83 – 5.89	8.37 – 8.50	10.75 – 10.92
6	10.02 – 10.05	15.25 – 15.38	19.20 – 19.64	23.87 – 24.42
7	1.66 – 8.41	6.48 – 9.48	9.52 – 9.78	12.36 – 12.69
8	3.27 – 8.66	9.16 – 10.92	12.98 – 13.28	16.74 – 17.07

4. Impact on Utility or Performance of Products

As presented in section III.D.1.d of this notice, DOE concluded that none of the efficiency levels considered in this notice reduces the utility or performance of the small electric motors under consideration in this rulemaking. Furthermore, manufacturers of these products currently offer small electric motors that meet or exceed the proposed standards or are capable of manufacturing motors that meet or exceed the proposed standards. (See 42 U.S.C. 6295(o)(2)(B)(i)(IV))

5. Impact of Any Lessening of Competition

DOE considers any lessening of competition likely to result from standards. The Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination to the Secretary, together with an analysis of the nature and extent of such impact. (See 42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii))

To assist the Attorney General in making such a determination, DOE has provided the U.S. Department of Justice (DOJ) with copies of this notice and the TSD for review. DOE will consider DOJ's comments on the proposed rule in preparing the final rule.

6. Need of the Nation To Conserve Energy

An improvement in the energy efficiency of small electric motors is likely to improve the security of the Nation's energy system by reducing overall demand for energy. Reduced electricity demand also may improve the reliability of the electricity system. As a measure of this reduced demand, DOE expects the proposed standard to eliminate the need for the construction of approximately 2.45 GW of generating capacity and, in 2030, to save an amount of electricity greater than that generated by nine 250 megawatt power plants.

Enhanced energy efficiency also produces environmental benefits. The expected energy savings from the proposed small electric motors standards will reduce the emissions of air pollutants and greenhouse gases associated with electricity production. Table V.33 and Table V.34 show the cumulative CO_2, NO_X, and Hg emissions reductions over the analysis period at each TSL. The cumulative CO_2, NO_X, and Hg emissions reductions from polyphase motors range up to 23.8 Mt, 17.1 kt, and 0.13 tons, respectively, and up to 127.0 Mt, 91.2 kt, and 0.53 tons, respectively, from single-phase motors. DOE reports annual CO_2, NO_X, and Hg emissions reductions for each trial standard level in the environmental assessment, chapter 15 of the TSD.

Table V.33 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	2.2	1.6	0.012
2	5.2	3.7	0.028
3	9.7	6.9	0.053
4	11.1	8.0	0.061
5	18.6	13.3	0.102
6	20.5	14.7	0.112
7	23.8	17.1	0.130

Table V.34 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	57.0 – 58.1	40.9 – 41.7	0.237 – 0.242
2	57.9 – 59.1	41.6 – 42.5	0.241 – 0.247
3	73.8 – 75.2	53.0 – 54.0	0.307 – 0.314
4	84.6 – 86.4	60.8 – 62.0	0.352 – 0.360
5	85.3 – 87.1	61.2 – 62.6	0.355 – 0.363
6	105.8 – 107.5	76.0 – 77.2	0.438 – 0.448
7	106.2 – 110.0	76.3 – 79.0	0.448 – 0.459
8	122.6 – 127.0	88.2 – 91.2	0.518 – 0.529

DOE estimated the cumulative NPV of the monetized benefits associated with CO_2, NO_X, and Hg emissions reductions resulting from amended standards on small electric motors. As discussed in section IV.L, DOE estimated the potential global benefits resulting from reduced CO_2 emissions valued at approximately $5, $10, $20, $34, and $56 (2008$), and has also presented the domestic benefits derived using a value of approximately $1 per metric ton. DOE calculated the present value for each TSL using both a 7-percent and 3-percent discount rate for each emission type so that they can be compared directly to other economic quantities that DOE calculated for this proposed rule (Table V.35 through Table V.42).

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Table V.35 Estimates of Value of Savings from CO_2 Emissions Reductions at All TSLs and CO_2 Prices at a 7-percent Discount Rate for Polyphase Small Electric Motors

		Value of Estimated CO_2 Emission Reductions (million 2008$)**					
TSL	Estimated Cumulative CO_2 (MMt) Emission Reductions	Domestic Value of $1/metric ton CO_2* $	Global Value of $5/metric ton CO_2 $	Global Value of $10/metric ton CO_2 $	Global Value of $20/metric ton CO_2 $	Global Value of $34/metric ton CO_2 $	Global Value of $56/metric ton CO_2 $
1	2.2	1.0	4	8	16	28	47
2	5.2	2.2	10	19	37	64	107
3	9.7	4.2	18	36	69	120	201
4	11.1	4.8	21	42	79	138	230
5	18.6	8.0	35	70	133	231	385
6	20.5	8.8	39	77	146	254	424
7	23.8	10.2	45	90	170	296	493

* This value per ton represents the domestic negative externalities of CO_2 only

** Unit values are approximate and based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

Table V.36 Estimates of Value of Savings from CO_2 Emissions Reductions at All TSLs and CO_2 Prices at a 3-percent Discount Rate for Polyphase Small Electric Motors

		Value of Estimated CO_2 Emission Reductions (million 2008$)**					
TSL	Estimated Cumulative CO_2 (MMt) Emission Reductions	Domestic Value of $1/metric ton CO_2* $	Global Value of $5/metric ton CO_2 $	Global Value of $10/metric ton CO_2 $	Global Value of $20/metric ton CO_2 $	Global Value of $34/metric ton CO_2 $	Global Value of $56/metric ton CO_2 $
1	2.2	2.7	12	24	45	78	131
2	5.2	6.2	27	54	104	180	300
3	9.7	11.6	51	102	194	337	561
4	11.1	13.3	59	117	222	386	644
5	18.6	22.4	98	196	373	647	1079
6	20.5	24.6	108	216	410	712	1186
7	23.8	28.6	125	251	477	828	1380

* This value per ton represents the domestic negative externalities of CO_2 only

** Unit values are approximate and based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

Table V.37 Estimates of Value of Savings from CO_2 Emissions Reductions at All TSLs and CO_2 Prices at a 7-percent Discount Rate for Capacitor-Start Small Electric Motors

		Value of Estimated CO_2 Emission Reductions (million 2008$)**					
TSL	Estimated Cumulative CO_2 (MMt) Emission Reductions	Domestic Value of $1/metric ton CO_2* $	Global Value of $5/metric ton CO_2 $	Global Value of $10/metric ton CO_2 $	Global Value of $20/metric ton CO_2 $	Global Value of $34/metric ton CO_2 $	Global Value of $56/metric ton CO_2 $
1	57.0 – 58.1	25.2 – 25.7	111 – 113	221 – 226	421 – 429	731 – 745	1218 – 1242
2	57.9 – 59.1	25.6 – 26.2	112 – 115	225 – 230	427 – 437	742 – 759	1237 – 1264
3	73.8 – 75.2	32.7 – 33.3	143 – 146	287 – 292	545 – 556	947 – 965	1578 – 1608
4	84.6 – 86.4	37.5 – 38.3	164 – 168	329 – 336	625 – 638	1086 – 1108	1809 – 1847
5	85.3 – 87.1	37.8 – 38.6	166 – 169	332 – 339	630 – 643	1094 – 1117	1824 – 1862
6	105.8 – 107.5	46.8 – 47.6	205 – 209	411 – 418	781 – 794	1356 – 1379	2260 – 2299
7	106.2 – 110.0	47.1 – 48.7	207 – 214	413 – 428	785 – 812	1363 – 1411	2272 – 2352
8	122.6 – 127.0	54.6 – 56.3	239 – 247	479 – 494	910 – 938	1580 – 1629	2633 – 2715

* This value per ton represents the domestic negative externalities of CO_2 only

** Unit values are approximate and based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

Table V.38 Estimates of Value of Savings from CO_2 Emissions Reductions at All TSLs and CO_2 Prices at a 3-percent Discount Rate for Capacitor-Start Small Electric Motors

		Value of Estimated CO_2 Emission Reductions (million 2008$)**					
TSL	Estimated Cumulative CO_2 (MMt) Emission Reductions	Domestic Value of $1/metric ton CO_2* $	Global Value of $5/metric ton CO_2 $	Global Value of $10/metric ton CO_2 $	Global Value of $20/metric ton CO_2 $	Global Value of $34/metric ton CO_2 $	Global Value of $56/metric ton CO_2 $
1	57.0 – 58.1	68.5 – 69.7	300 – 306	600 – 612	1,141 – 1,162	1,982 – 2,019	3,303 – 3,365
2	57.9 – 59.1	69.5 – 71.0	305 – 311	610 – 623	1,159 – 1,183	2,013 – 2,054	3,355 – 3,424
3	73.8 – 75.2	88.6 – 90.3	389 – 396	778 – 792	1,477 – 1,505	2,566 – 2,614	4,277 – 4,356
4	84.6 – 86.4	101.6 – 103.7	446 – 455	891 – 909	1,693 – 1,728	2,941 – 3,001	4,901 – 5,001
5	85.3 – 87.1	102.3 – 104.6	449 – 459	898 – 917	1,706 – 1,743	2,963 – 3,027	4,938 – 5,044
6	105.8 – 107.5	127.0 – 129.0	557 – 566	1,114 – 1,132	2,116 – 2,151	3,676 – 3,735	6,126 – 6,226
7	106.2 – 110.0	127.5 – 132.0	559 – 579	1,119 – 1,158	2,126 – 2,200	3,692 – 3,822	6,154 – 6,370
8	122.6 – 127.0	147.1 – 152.4	645 – 669	1,291 – 1,337	2,452 – 2,540	4,259 – 4,412	7,098 – 7,354

* This value per ton represents the domestic negative externalities of CO_2 only

** Unit values are approximate and based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.

Table V.39 Estimates of Savings from Reducing NO_x and Hg Emissions at All Trial Standard Levels at a 7-percent Discount Rate for Polyphase Small Electric Motors

TSL	Estimated Cumulative NO_x Emission Reductions kt	Value of Estimated NO_x Emission Reductions million 2008$	Estimated Cumulative Hg Emission Reductions tons	Value of Estimated Hg Emission Reductions million 2008$
1	1.6	0.11 – 1.10	0.012	0.00 – 0.10
2	3.7	0.25 – 2.53	0.028	0.01 – 0.24
3	6.9	0.46 – 4.73	0.053	0.01 – 0.45
4	8.0	0.53 – 5.43	0.061	0.01 – 0.51
5	13.3	0.89 – 9.10	0.102	0.02 – 0.86
6	14.7	0.97 – 10.00	0.112	0.02 – 0.95
7	17.1	1.13 – 11.64	0.130	0.03 – 1.10

Table V.40 Estimates of Savings from Reducing NO_x and Hg Emissions at All Trial Standard Levels at a 3-percent Discount Rate for Polyphase Small Electric Motors

TSL	Estimated Cumulative NO_x Emission Reductions kt	Value of Estimated NO_x Emission Reductions million 2008$	Estimated Cumulative Hg Emission Reductions tons	Value of Estimated Hg Emission Reductions million 2008$
1	1.6	0.32 – 3.26	0.012	0.01 – 0.22
2	3.7	0.73 – 7.49	0.028	0.01 – 0.50
3	6.9	1.37 – 14.03	0.053	0.02 – 0.94
4	8.0	1.56 – 16.08	0.061	0.03 – 1.08
5	13.3	2.62 – 26.96	0.102	0.04 – 1.80
6	14.7	2.88 – 29.65	0.112	0.05 – 1.98
7	17.1	3.36 – 34.50	0.130	0.05 – 2.31

Table V.41 Estimates of Savings from Reducing NO_x and Hg Emissions at All Trial Standard Levels at a 7-percent Discount Rate for Capacitor-Start Small Electric Motors

TSL	Estimated Cumulative NO_x Emission Reductions kt	Value of Estimated NO_x Emission Reductions million 2008$	Estimated Cumulative Hg Emission Reductions tons	Value of Estimated Hg Emission Reductions million 2008$
1	40.9 – 41.7	2.9 – 31.0	0.237 – 0.242	0.085 – 2.35
2	41.6 – 42.5	3.0 – 31.5	0.241 – 0.247	0.087 – 2.39
3	53.0 – 54.0	3.8 – 40.1	0.307 – 0.314	0.110 – 3.04
4	60.8 – 62.0	4.4 – 46.0	0.352 – 0.360	0.126 – 3.49
5	61.2 – 62.6	4.4 – 46.4	0.355 – 0.363	0.128 – 3.52
6	76.0 – 77.2	5.5 – 57.3	0.438 – 0.448	0.157 – 4.35
7	76.3 – 79.0	5.5 – 58.6	0.448 – 0.459	0.161 – 4.45
8	88.2 – 91.2	6.5 – 67.7	0.518 – 0.529	0.186 – 5.14

Table V.42 Estimates of Savings from Reducing NO_x and Hg Emissions at All Trial Standard Levels at a 3-percent Discount Rate for Capacitor-Start Small Electric Motors

TSL	Estimated Cumulative NO_x Emission Reductions kt	Value of Estimated NO_x Emission Reductions million 2008$	Estimated Cumulative Hg Emission Reductions tons	Value of Estimated Hg Emission Reductions million 2008$
1	40.9 – 41.7	8.2 – 86.4	0.237 – 0.242	0.101 – 4.58
2	41.6 – 42.5	8.4 – 87.9	0.241 – 0.247	0.103 – 4.66
3	53.0 – 54.0	10.7 – 111.9	0.307 – 0.314	0.131 – 5.92
4	60.8 – 62.0	12.2 – 128.4	0.352 – 0.360	0.151 – 6.80
5	61.2 – 62.6	12.3 – 129.5	0.355 – 0.363	0.152 – 6.86
6	76.0 – 77.2	15.3 – 159.9	0.438 – 0.448	0.188 – 8.47
7	76.3 – 79.0	15.4 – 163.6	0.448 – 0.459	0.192 – 8.66
8	88.2 – 91.2	17.8 – 188.9	0.518 – 0.529	0.222 – 10.0

Table V.43 Estimates of Adding NPV of Customer Savings to NPV of Low- and High-End Global Monetized Benefits from CO_2, NOx, and Hg Emissions Reductions at All TSLs for Polyphase Small Electric Motors at 3- and 7-Percent Discount Rates

TSL	CO_2 Value of $5/metric ton CO_2* and Low Values for NO_x and Hg** billion 2008$		CO_2 Value of $56/metric ton CO_2* and High Values for NO_x and Hg*** billion 2008$	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	0.05	0.16	0.10	0.28
2	0.19	0.50	0.29	0.78
3	0.41	1.06	0.59	1.59
4	0.42	1.13	0.64	1.73
5	0.10	0.66	0.46	1.67
6	(0.25)	0.02	0.15	1.13
7	(6.34)	(12.08)	(5.88)	(10.79)

* These values per ton represent the global negative externalities of CO_2. The unit values are approximate and based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.
** Low Value corresponds to a value of $442 per ton of NO_x emissions and $0.745 million per ton of Hg emissions.
*** High Value corresponds to a value of $4,540 per ton of NO_x emissions and $33.3 million per ton of Hg emissions.

Table V.44 Estimates of Adding NPV of Customer Savings to NPV of Low- and High-End Global Monetized Benefits from CO_2, NOx, and Hg Emissions Reductions at All TSLs for Capacitor-Start Small Electric Motors at 3- and 7-Percent Discount Rates

TSL	CO_2 Value of $5/metric ton CO_2* and Low Values for NO_x and Hg** billion 2008$		CO_2 Value of $56/metric ton CO_2* and High Values for NO_x and Hg*** billion 2008$	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	2.77-2.81	6.79-6.84	3.93-3.97	9.93-9.98
2	2.84-2.86	6.94-6.98	4.02-4.04	10.14-10.18
3	3.05-3.08	7.64-7.69	4.55-4.58	11.71-11.76
4	2.32-2.35	6.47-6.51	4.04-4.08	11.14-11.18
5	2.45-2.52	6.75-6.85	4.18-4.25	11.46-11.56
6	(12.18)-(12.07)	(22.04)-(21.88)	(10.4)-(9.92)	(16.22)-(16.07)
7	1.68-5.89	8.34-14.18	3.88-8.09	14.29-20.13
8	0.54-4.35	6.19-11.53	3.07-6.88	13.06-18.40

* These values per ton represent the global negative externalities of CO_2. The unit values are approximate and based on escalating 2007$ to 2008$ for consistency with other values presented in this notice.
** Low Value corresponds to a value of $442 per ton of NO_x emissions and $0.745 million per ton of Hg emissions.
*** High Value corresponds to a value of $4,540 per ton of NO_x emissions and $33.3 million per ton of Hg emissions.

Table V.45 Estimates of Adding NPV of Customer Savings to NPV of Low- and High-End Monetized Benefits from CO_2 Emissions Reductions at All TSLs for Polyphase Small Electric Motors at 3- and 7-Percent Discount Rates

TSL	CO_2 Value of $5/metric ton CO_2* billion 2008$		CO_2 Value of $56/metric ton CO_2* billion 2008$	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	0.05	0.16	0.10	0.28
2	0.19	0.50	0.28	0.78
3	0.41	1.06	0.59	1.57
4	0.42	1.13	0.63	1.72
5	0.09	0.66	0.45	1.64
6	(0.25)	0.02	0.14	1.10
7	(6.34)	(12.09)	(5.89)	(10.83)

* These values per ton represent the global negative externalities of CO_2.

Table V.46 Estimates of Adding NPV of Customer Savings to NPV of Low- and High-End Monetized Benefits from CO_2 Emissions Reductions at All TSLs for Capacitor-Start Small Electric Motors at 3- and 7-Percent Discount Rates

TSL	CO_2 Value of $5/metric ton CO_2* billion 2008$		CO_2 Value of $56/metric ton CO_2* billion 2008$	
	7-percent discount rate	3-percent discount rate	7-percent discount rate	3-percent discount rate
1	2.77-2.80	6.78-6.83	3.90-3.93	9.84-9.89
2	2.84-2.86	6.93-6.97	3.99-4.01	10.05-10.08
3	3.04-3.07	7.63-7.68	4.51-4.54	11.59-11.64
4	2.32-2.35	6.45-6.50	4.00-4.03	11.00-11.05
5	2.44-2.51	6.74-6.84	4.13-4.20	11.32-11.42
6	(12.19)-(12.07)	(22.05)-(21.90)	(10.10)-(9.98)	(16.39)-(16.24)
7	1.68-5.89	8.32-14.17	3.82-8.02	14.11-19.96
8	0.53-4.34	6.18-11.51	3.00-6.81	12.86-18.20

* These values per ton represent the global negative externalities of CO_2.

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The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V.43 presents the NPV values for polyphase small electric motors that would result if DOE were to apply the low- and high-end estimates of the potential benefits resulting from reduced CO_2, NO_X and Hg emissions to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a 7- and 3-percent discount rate. Table V.44 presents the same NPV values for capacitor-start small electric motors. Table V.45 presents the NPV values for polyphase small electric motors that would result if DOE were to apply the low- and high-end estimates of the potential global benefits resulting from reduced CO_2 emissions to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a 7- and 3-percent discount rate. Table V.46 presents the same NPV values for capacitor-start small electric motors. For CO_2, only the range of global benefit values are used, $5 and $56 in 2008$.

Although comparing the value of consumer savings to the values of emission reductions provides a valuable perspective, please note the following: (1) The national consumer savings are domestic U.S. consumer monetary savings found in market transactions while the values of emission reductions are based on ranges of estimates of imputed marginal social costs, which, in the case of CO_2, are meant to reflect global benefits; and (2) the assessments of consumer savings and emission-related benefits are performed with different computer models, leading to different time frames for the analyses The present value of national consumer savings is measured for the period 2015–2065 (31 years from 2015 to 2045 inclusive, plus the longest lifetime of the equipment shipped in the 31st year). However, the timeframes of the benefits associated with the emission reductions differ. For example, the value of CO_2 emission reductions is meant to reflect the present value of all future climate related impacts, even those beyond 2065.

DOE seeks comment on the above presentation of NPV values and on the consideration of GHG emissions in future energy efficiency standards rulemakings, including alternative methodological approaches to including GHG emissions in its analysis. More specifically, DOE seeks comment on both how it integrates monetized GHG emissions or Social Cost of Carbon values, as well as other monetized benefits or costs, into its analysis and models, and also on suggested alternatives to the current approach.

7. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (See 42 U.S.C. 6295(o)(2)(B)(i)(VI))) The Secretary has decided that harmonization with medium motors was another relevant factor to consider.

California utilities expressed concern in their joint comments over the possible differences in energy efficiency standards between medium electric motors and small electric motors. They believe that if a significantly lower efficiency standard is set for those small electric motors that share overlapping horsepower ratings with medium motors, the medium motor standard would be rendered meaningless, since there would be a risk that demand would shift toward using less efficient (and presumably cheaper) small electric motors instead. The utilities recommended that the new energy efficiency standards for small electric motors be comparable to the medium motor standards in order to avoid ''gaming of the regulatory system.'' (Joint Comment, No. 12 at p. 3)

DOE appreciates this comment and considered it when proposing new standards for small electric motors in this notice. Although harmonization is not a specifically enumerated factor that DOE must consider under EPCA, it was an additional factor considered as permitted by the statute. DOE agrees with the California utilities and recognizes that the harmonization of polyphase small electric motors with medium electric motors is an added benefit of the proposed standard level.

C. Proposed Standard

EPCA 42 U.S.C. 6295(o)(2)(A), specifies that any new or amended energy conservation standard for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) The new or amended standard must also ''result in significant conservation of energy.'' (42 U.S.C. 6295(o)(3)(B))

DOE developed TSLs independently for polyphase and capacitor-start small electric motors. For the capacitor-start motor categories, DOE developed TSLs as a combination of CSIR and CSCR efficiency levels. DOE combined CSCR and CSIR motors into a single set of TSLs because motors in these categories may be used interchangeably in most applications. As a result of this interchangeability, the standard level for CSIR motors affects the demand for CSCR motors, and vice versa. DOE considered 7 TSLs for polyphase motors and 8 TSLs for capacitor start motors.

In selecting the proposed energy conservation standards for both classes of small electric motors for consideration in today's notice of proposed rulemaking, 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. For polyphase small electric motors, the standard level with the highest energy savings corresponded to the max-tech level. However, due to the interaction of the CSIR and CSCR markets and the efficiency differences between the two products, the highest energy savings level for capacitor-start motors does not necessarily correspond to the ''max-tech'' level. With certain combinations of efficiency levels (or TSLs) for the two motor categories it becomes economically beneficial to purchase a CSCR motor instead of a CSIR motor. This migration can cause the energy savings for these TSLs to be higher than the TSLs corresponding to ''max-tech'' for both motor categories.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, Table V.47, Table V.48 and Table V.49, collectively, present summaries of quantitative analysis results for each TSL for polyphase and capacitor-start small electric motors, based on the assumptions and methodology discussed above. These tables present the results or, in some cases, a range of results, for each TSL. The range of values reported in these tables for industry impacts represents the results for the different markup scenarios that DOE used to estimate manufacturer impacts as shown in section IV.I. Additional quantitative results, including the expected migration of shipments between CSIR and CSCR motors, are provided in section IV.G.

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 V.47 presents a summary of the quantitative analysis results for each TSL for polyphase small electric motors.

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Table V.47 Summary of Polyphase Small Electric Motors Analytical Results*

Criteria	Trial Standard Level						
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7
Primary Energy Savings (quads)	0.04	0.09	0.18	0.20	0.33	0.36	0.41
@ 7% Discount Rate	0.01	0.02	0.04	0.05	0.08	0.09	0.10
@ 3% Discount Rate	0.02	0.05	0.09	0.10	0.17	0.19	0.21
Generation Capacity Reduction (GW)	0.04	0.10	0.19	0.22	0.37	0.41	0.48
NPV (2008$ billions)							
@ 7% discount	0.05	0.18	0.39	0.40	0.06	(0.29)	(6.38)
@ 3% discount	0.15	0.48	1.01	1.07	0.56	(0.09)	(12.21)
Industry Impacts Change in INPV (2008$ millions)	(1.14)-0.52	(1.56)–1.11	(2.01)–1.83	(2.39)–2.41	(8.83)–10.9	(13.1)–15.9	(59.7)–149
Change in INPV (%)	(1.78)–0.80	(2.42)–1.74	(3.14)–2.86	(3.73)–3.76	(13.8)–16.9	(20.4)–24.8	(93.1)–133
Cumulative Emission Reduction							
CO_2 (Mt)	2.2	5.2	9.7	11.1	18.6	20.5	23.8
Value of CO_2 reductions at 7% discount rate (2008$ millions)**	4–47	10–107	18–201	21–230	35–385	39-424	45-493
Value of CO_2 reductions at 3% discount rate (2008$ millions)**	12–131	27–300	51–561	59–644	98–1079	108–1186	125–1380
NO_X (kt)	1.6	3.7	6.9	8.0	13.3	14.7	17.1
Value of NO_X reductions at 7% discount rate (2008$ millions)	0.11 – 1.10	0.25 – 2.53	0.46 – 4.73	0.53 – 5.43	0.89 – 9.10	0.97 – 10.00	1.13 – 11.64
Value of NO_X reductions at 3% discount rate (2008$ millions)	0.32 – 3.26	0.73 – 7.49	1.37 – 14.03	1.56 – 16.08	2.62 – 26.96	2.88 – 29.65	3.36 – 34.50
Hg (t)	0.012	0.028	0.053	0.061	0.102	0.112	0.130
Value of Hg reductions at 7% discount rate (2008$ millions)	0 – 0.10	0 – 0.24	0 – 0.45	0 – 0.51	0 – 0.86	0 – 0.95	0 – 1.10
Value of Hg reductions at 3% discount rate (2008$ millions)	0 – 0.22	0 – 0.50	0 – 0.94	0 – 1.08	0 – 1.80	0 – 1.98	0 – 2.31
Life-cycle Cost of Rep. Product Class							
Customers with increase in LCC (%)	62.0	48.9	45.1	48.0	70.5	82.0	98.1
Customers with savings in LCC (%)	38.0	51.1	54.9	52.0	29.5	18.0	1.9
Mean LCC (2008$)	1,274	1,265	1,253	1,255	1,312	1,358	2,089
Mean LCC Savings (2008$)	0	9	21	19	(38)	(85)	(818)
Life-cycle Cost of all Product Classes in 2030 Weighted by Shipments							
Customers with > 2% LCC increase (%)	2.6	12.6	17.5	24.2	54.5	67.0	93.5
Customers with < 2% LCC change (%)	97.3	68.5	36.6	31.6	16.5	13.9	4.1
Customers with > 2% LCC savings (%)	0.1	18.9	45.8	44.3	29.2	19.1	2.4
Mean LCC	1,479	1,466	1,445	1,445	1,493	1,537	2,261
Mean LCC Savings (2008$)	3	17	38	38	(10)	(54)	(778)
Payback Period (years)							
Average	33.7	23.1	20.4	22.4	48.2	62.4	263.1
Median	10.6	7.2	6.3	7.0	13.8	18.9	55.1
Employment Impact							
Indirect Impacts (2045) (jobs, '000)	0.29	0.64	1.22	1.41	2.74	3.26	7.98

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

** Global values based on SCC estimates (in 2008$) of $5 to $56 per ton of CO_2 equivalent emitted (or avoided) in 2007.

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First, DOE considered TSL 7, the most efficient level for polyphase small electric motors. TSL 7 would save an estimated 0.41 quads of energy through 2045, an amount DOE considers significant. Discounted at 7-percent, the projected energy savings through 2045 would be 0.10 quads. For the Nation as a whole, DOE projects that TSL 7 would result in a net decrease of $6.38 billion in NPV, using a discount rate of 7-percent. The emissions reductions at TSL 7 are 23.8 Mt of CO_2, up to 17.1 kt of NO_X, and up to 0.130 tons of Hg. These reductions have a value of up to $493 million for CO_2, $11.6 million for NO_X, and $1.102 million for Hg, at a discount rate of 7-percent. At a $20 per ton value for the social cost of carbon, the estimated monetized benefit of CO_2 emissions reductions is $170 million at a discount rate of 7-percent. DOE also estimates that at TSL 7, total electric generating capacity in 2030 will decrease compared to the base case by 0.48 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 $818 compared to the baseline. DOE estimates the fraction of customers experiencing LCC increases will be 98.1 percent. The median PBP for the average polyphase small electric motor customer at TSL 7, 55.1 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 $778.

The projected change in industry value ranges from a decrease of $59.7 million to an increase of $149 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 93.1 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 initial 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 tentatively concluded that trial standard level 7 is not economically justified.

DOE then considered TSL 6, which would likely save an estimated 0.36 quads of energy through 2045, an amount DOE considers significant. Discounted at 7-percent, the projected energy savings through 2045 would be 0.09 quads. For the Nation as a whole, DOE projects that TSL 6 would result in a net decrease of $290 million in NPV, using a discount rate of 7-percent. The estimated emissions reductions at TSL 6 are 20.5 Mt of CO_2, up to 14.7 kt of NO_X, and up to 0.112 tons of Hg. These reductions have a value of up to $424 million for CO_2, $10.0 million for NO_X, and $0.947 for Hg, at a discount rate of 7-percent. At a $20 per ton value for the social cost of carbon, the estimated monetized benefit of CO_2 emissions reductions is $146 million at a discount rate of 7-percent. Total electric generating capacity in 2030 is estimated to decrease compared to the base case by 0.41 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 $85 compared to the baseline. DOE estimates the fraction of customers experiencing LCC increases will be 82 percent. The median PBP for the average polyphase small electric motor customer at TSL 6, 18.9 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 $54.

The projected change in industry value ranges from a decrease of $13.1 million to an increase of $15.9 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 20.4 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 initial 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 tentatively 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 0.33 quads of energy through 2045, an amount DOE considers significant. Discounted at 7-percent, the projected energy savings through 2045 would be 0.08 quads. For the Nation as a whole, DOE projects that TSL 5 would result in a net increase of $60 million in NPV, using a discount rate of 7-percent. The estimated emissions reductions at TSL 5 are 18.6 Mt of CO_2, up to 13.3 kt of NO_X, and up to 0.102 tons of Hg. These reductions have a value of up to $385 million for CO_2, $9.1 million for NO_X, and $0.861 million for Hg, at a discount rate of 7-percent. At a $20 per ton value for the social cost of carbon, the estimated benefits of CO_2 emissions reductions is $133 million at a discount rate of 7-percent. Total electric generating capacity in 2030 is estimated to decrease compared to the base case by 0.37 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 $38 compared to the baseline representative unit for analysis (1 hp, 4 pole polyphase motor). This corresponds to approximately a 2.9 percent increase in average LCC. Based on this analysis, DOE estimates that approximately 71 percent of customers would experience LCC increases and that the median PBP would be 13.8 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 and examining the impacts on consumers who purchase motors after the year 2015.

At TSL 5, when accounting for the full-range of horsepowers and pole configurations of polyphase motors, the average LCC increase is reduced to $10. This corresponds to approximately 54.5 percent of customers experiencing greater than 2-percent increases. The remaining 44 percent of customers, those with greater operating hours, experience either very small losses (less than 2-percent) or net savings.

The projected change in industry value ranges from a decrease of $8.83 million to an increase of $10.9 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 13.8 percent in INPV to the polyphase small motor industry.

Trial standard level 5 has other advantages that are not directly economic. This level is 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 5 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 5, the Secretary has reached the following tentative conclusion: Trial standard level 5 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 initial 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 and benefits of harmonization with the existing medium polyphase electric motor standards outweigh the potential reduction in INPV for manufacturers and the economic burden on consumers, which is relatively small on average. Therefore, DOE today proposes to adopt the energy conservation standards for polyphase small electric motors at trial standard level 5.

2. Capacitor-Start Small Electric Motors

Table V.48 and Table V.49 present a summary of the quantitative analysis results for each TSL for capacitor-start small electric motors.

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Table V.48 Summary of Capacitor-Start Small Electric Motors Analytical Results, Trial Standards Levels 1 through 3*

Criteria	Trial Standard Level		
	TSL 1	TSL 2	TSL 3
Primary Energy Savings (quads)	1.08	1.10	1.28 – 1.29
@ 7% Discount Rate	0.26 – 0.27	0.27	0.32
@ 3% Discount Rate	0.56 – 0.57	0.57	0.67
Generation Capacity Reduction (GW)	1.10 – 1.12	1.11 – 1.14	1.42 – 1.45
NPV (2008$ billions)			
@ 7% discount	2.66 – 2.69	2.72 – 2.75	2.90 – 2.93
@ 3% discount	6.47 – 6.52	6.62 – 6.66	7.24 – 7.28
Industry Impacts			
Change in INPV (2008$ millions)	(14.87) – 11.21	(15.64) – 12.22	(22.87) – 18.03
Change in INPV (%)	(5.33) – 4.02	(5.61) – 4.38	(8.20) – 6.47
Cumulative Emission Reduction			
CO_2 (Mt)	57.0 – 58.1	57.9 – 59.1	73.8 – 75.2
Value of CO_2 reductions at 7% discount rate (2008$ millions)**	111 – 1,242	112 – 1,264	143 – 1,608
Value of CO_2 reductions at 3% discount rate (2008$ millions)**	300 – 3,365	305 – 3,424	389 – 4,356
NO_X (kt)	40.9 – 41.7	41.6 – 42.5	53.0 – 54.0
Value of NO_X reductions at 7% discount rate (2008$ millions)	2.9 – 31.0	3.0 – 31.5	3.8 – 40.1
Value of NO_X reductions at 3% discount rate (2008$ millions)	8.2 – 86.4	8.4 – 87.9	10.7 – 111.9
Hg (t)	0.242	0.247	0.314
Value of Hg reductions at 7% discount rate (2008$ millions)	0 – 2.35	0 – 2.39	0 – 3.04
Value of Hg reductions at 3% discount rate (2008$ millions)	0 – 4.58	0 – 4.66	0 – 5.92
Life-cycle Cost			
CSIR			
Customers with increase in LCC (%)	33.7	33.7	39.7
Customers with savings in LCC (%)	66.3	66.3	60.3
Mean LCC Savings (2008$)	55	55	54
CSCR			
Customers with increase in LCC (%)	45.8	46.3	46.3
Customers with savings in LCC (%)	54.2	53.7	53.7
Mean LCC Savings (2008$)	23	28	28
Life-cycle Cost of All Product classes in 2030 Weighted by Shipments			
CSIR			
Customers with > 2% LCC increase (%)	0.2	4.3	4.1
Customers with < 2% LCC change (%)	78.2	41.8	29.6
Customers with > 2% LCC savings (%)	21.6	53.9	66.3
Mean LCC	1,031	1,010	987
Mean LCC Savings (2008$)	13	34	57
CSCR			
Customers with > 2% LCC increase (%)	0.2	14.8	18.7
Customers with < 2% LCC change (%)	50.4	23.7	19.7
Customers with > 2% LCC savings (%)	49.4	61.5	61.7
Mean LCC	1,505	1,466	1,451
Mean LCC Savings (2008$)	36	75	89
Market Share*** – CSIR (%)	98	97	97 – 98

Payback Period (years)			
CSIR			
Average	11.0	11.0	13.8
Median	3.3	3.3	4.3
CSCR			
Average	17.1	17.4	17.4
Median	5.3	5.4	5.4
Employment Impact			
Indirect Impacts (2045) (jobs, '000)	6.63 – 6.74	6.73 – 6.85	8.50 – 8.64

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

** Global values based on SCC estimates (in 2008$) of $5 to $56 per ton of CO_2 equivalent emitted (or avoided) in 2007.

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

Table V.49 Summary of Capacitor-Start Small Electric Motors Analytical Results, Trial Standards Levels 4 through 8*

Criteria	Trial Standard Level				
	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
Primary Energy Savings (quads)	1.53	1.53	1.91 – 1.92	2.10 – 2.13	2.51 – 2.61
@ 7% Discount Rate	0.37	0.37 – 0.38	0.47	0.51 – 0.52	0.59 – 0.64
@ 3% Discount Rate	0.80	0.80	1.00	1.09 – 1.11	1.29 – 1.37
Generation Capacity Reduction (GW)	1.63 – 1.66	1.64 – 1.68	2.04 – 2.07	2.05 – 2.12	2.37 – 2.44
NPV (2008$ billions)					
@ 7% discount	2.15 – 2.18	2.27 – 2.34	(12.40) – (12.28)	1.47 – 5.67	0.29 – 4.09
@ 3% discount	6.00 – 6.05	6.28 – 6.38	(22.62) – (22.47	7.75 – 13.59	5.51 – 10.84
Industry Impacts					
Change in INPV (2008$ millions)	(31.57)–31.21	(29.01)–27.96	(137.5)–187.9	(35.84)–29.80	(53.30)–56.70
Change in INPV (%)	(11.32)–11.19	(10.41)–10.03	(49.33)–67.39	(12.86)–10.69	(19.12)–20.34
Cumulative Emission Reduction					
CO_2 (Mt)	84.6 – 86.4	85.3 – 87.1	105.8 – 107.5	106.2 – 110.0	122.6 – 127.0
Value of CO_2 reductions at 7% discount rate (2008$ millions)**	164 – 1,847	166 – 1,862	205 – 2,299	207 – 2,352	239 – 2,715
Value of CO_2 reductions at 3% discount rate (2008$ millions)**	446 – 5,001	449 – 5,044	557 – 6,226	559 – 6,370	645 – 7,354
NO_X (kt)	60.8 – 62.0	61.2 – 62.6	76.0 – 77.2	76.3 – 79.0	88.2 – 91.2
Value of NO_X reductions at 7% discount rate	4.4 – 46.0	4.4 – 46.4	5.5 – 57.3	5.5 – 58.6	6.5 – 67.7
Value of NO_X reductions at 3% discount rate (2008$ millions)	12.2 – 128.4	12.3 – 129.5	15.3 – 159.9	15.4 – 163.6	17.8 – 188.9
Hg (t)	0.360	0.363	0.448	0.459	0.529
Value of Hg reductions at 7% discount rate (2008$ millions)	0 – 3.49	0 – 3.52	0 – 4.35	0 – 4.45	0 – 5.14
Value of Hg reductions at 3% discount rate (2008$ millions)	0 – 6.80	0 – 6.86	0 – 8.47	0 – 8.66	0 – 10.0

Life-cycle Cost					
CSIR					
Customers with increase in LCC (%)	52.8	52.8	64.0	64.0	64.0
Customers with savings in LCC (%)	47.2	47.2	36.0	36.0	36.0
Mean LCC (2008$)	919	919	1,287	1,287	1,287
Mean LCC Savings (2008$)	21	21	(346)	(346)	(346)
CSCR					
Customers with increase in LCC (%)	55.6	46.3	99.1	46.3	72.6
Customers with savings in LCC (%)	44.4	53.7	0.9	53.7	27.5
Mean LCC (2008$)	1,043	1,025	1,897	1,025	1,101
Mean LCC Savings (2008$)	10	28	(846)	28	(47)
CSIR migrating to CSCR weighted results***					
Customers with increase in LCC (%)	52.3	52.3	63.1	50.6	58.0
Customers with savings in LCC (%)	47.7	47.7	37.0	49.4	42.0
Mean LCC (2008$)	918	918	1,287	892	921
Mean LCC Savings (2008$)	23	23	(343)	49	20
Life-cycle Cost of All Product classes in 2030 Weighted by Shipments					
CSIR					
Customers with > 2% LCC increase (%)	39.7	39.7	53.0	53.0	53.0
Customers with < 2% LCC change (%)	11.3	11.3	7.8	7.8	7.8
Customers with > 2% LCC savings (%)	49.0	49.0	39.2	39.2	39.2
Mean LCC	995	995	1,360	1,360	1,360
Mean LCC Savings (2008$)	49	49	(315)	(315)	(315)
CSCR					
Customers with > 2% LCC increase (%)	21.9	18.7	91.5	18.7	46.1
Customers with < 2% LCC change (%)	19.1	19.7	4.0	19.7	13.7
Customers with > 2% LCC savings (%)	59.0	61.7	4.5	61.7	40.2
Mean LCC	1,457	1,451	2,391	1,451	1,507
Mean LCC Savings (2008$)	83	89	(851)	89	34
Market Share**** – CSIR (%)	94	92	99-100	1-20	2-20
Payback Period (years)					
CSIR					
Average	23.1	23.1	95.5	95.5	95.5
Median	6.7	6.7	11.2	11.2	11.2
CSCR					
Average	23.2	17.4	228.9	17.4	40.3
Median	7.4	5.4	50.3	5.4	12.1

Employment Impact Indirect Impacts (2045) (jobs, '000)	10.80 – 10.97	10.75 – 10.92	23.87 – 24.42	12.36 – 12.69	16.74 – 17.07

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

** Global values based on SCC estimates (in 2008$) of $5 to $56 per ton of CO_2 equivalent emitted (or avoided) in 2007.

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

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

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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 2.51 to 2.61 quads of energy through 2045, an amount DOE considers significant. Discounted at 7-percent, the projected energy savings through 2045 would be 0.59 to 0.64 quads. For the Nation as a whole, DOE projects that TSL 8 would result in a net benefit of $290 million to $4.09 billion in NPV, using a discount rate of 7-percent. The estimated emissions reductions at TSL 8 are up to 127.0 Mt of CO_2, up to 91.2 kt of NO_X, and up to 0.529 tons of Hg. These reductions have a value of up to $2,715 million for CO_2, $67.7 million for NO_X, and $5.14 million for Hg, at a discount rate of 7-percent. At a $20 per ton (2008$) value for the social cost of carbon, the estimated benefits of CO_2 emissions reductions is $910 to $938 million at a discount rate of 7-percent. DOE also estimates that at TSL 8, total electric generating capacity in 2030 will decrease compared to the base case by 2.37 to 2.44 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 $346 and $47, respectively. At TSL 8, DOE estimates the fraction of customers experiencing LCC increases will be 64 percent for CSIR motors and 72.6 percent for CSCR motors. The median PBP for the average capacitor-start small electric motor customers at TSL 8, 11.2 years for CSIR motors and 12.1 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. When considering that some CSIR consumers will choose to purchase CSCR motors, the CSIR customers still experience on average LCC savings of approximately $20. This corresponds to 58 percent of CSIR consumers experiencing LCC increases.

DOE also examined LCC savings for a sensitivity case where the calculation was performed in the middle of the forecast period (*i.e.,* the year 2030), with a full distribution of motor sizes and speeds and where the full cost of reactive power was included. Under these conditions, for the average customer, the LCC of a CSIR and CSCR motor will increase by $315 and decrease by $34, respectively, compared to the baseline. DOE also examined what fraction of motors would have changes in LCC that are greater than 2-percent. At TSL 8, DOE estimates the fraction of customers experiencing LCC increases of greater than 2-percent will be 53.0 percent for CSIR motors and 46.1 percent for CSCR motors.

The projected change in industry value ranges from a decrease of $53.3 million to an increase of $56.7 million. The impacts are driven primarily by the assumptions regarding the ability to pass on larger increases in MPCs to the customer. 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 19.1 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 initial 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 tentatively concluded that trial standard level 8 is not economically justified.

DOE then considered TSL 7, which would likely save an estimated 2.10 to 2.13 quads of energy through 2045, an amount DOE considers significant. Discounted at 7-percent, the projected energy savings through 2045 would be 0.51 to 0.52 quads. For the Nation as a whole, DOE projects that TSL 7 would result in a net benefit of $1.47 to $5.67 billion in NPV, using a discount rate of 7-percent. The estimated emissions reductions at TSL 7 are up to 110.0 Mt of CO_2, up to 79.0 kt of NO_X, and up to 0.459 tons of Hg. These reductions have a value of up to $2,352 million for CO_2, $58.6 million for NO_X, and $4.45 million for Hg, at a discount rate of 7-percent. At a $20 per ton value for the social cost of carbon, the estimated benefits of CO_2 emissions reductions is $785 to $812 million at a discount rate of 7-percent. Total electric generating capacity in 2030 is estimated to decrease compared to the base case by 2.05 to 2.12 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 $346 for CSIR motors and decrease by $28 for CSCR motors compared to the baseline. At TSL 7, DOE estimates the fraction of CSIR customers experiencing LCC increases will be 64 percent, but only 46.3 percent for CSCR motor customers. However, DOE believes that at this TSL, which is the "max-tech" 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 users, but believes that the market share of CSCR motors could grow from 5 percent to 80 to 99 percent once standards are effective. This would mean that the high LCC increases that CSIR motor users would experience would be mitigated and many of those users would switch to CSCR motors with a decrease in LCC on average. When taking into account this potential migration, the average CSIR customer experiences net LCC savings of $49. Even though CSIR motors with switching may result in a net LCC savings, DOE estimates that approximately 51 percent of CSIR customers would still experience an LCC increase.

DOE also examined LCC savings for a sensitivity case where the calculation was performed in the middle of the forecast period (*i.e.,* the year 2030), with a full distribution of motor sizes and speeds and where the full cost of reactive power was included. Under these conditions, for the average customer, compared to the baseline, the LCC of a CSIR and CSCR motor will increase by $315 and decrease by $89, respectively. DOE also examined what fraction of motors would have changes in LCC that are greater than 2-percent. At TSL 8, DOE estimates the fraction of customers experiencing LCC increases of greater than 2-percent will be 53.0 percent for CSIR motors and 18.7 percent for CSCR motors.

The economics literature provides a wide-ranging discussion of how consumers trade-off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. This undervaluation suggests that regulation that promotes energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution). There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information, (2) a lack of sufficient savings to warrant delaying or altering purchases (*e.g.,* an inefficient ventilation fan in a new building or the delayed replacement of a water pump), (3) inconsistent (*e.g.,* excessive short-term) weighting of future energy cost savings relative to available returns on other investments, (4) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (5) a divergence in incentives (*e.g.,* renter versus owner; builder v. purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may tradeoff these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings. While DOE is not prepared at present to provide a fuller quantifiable framework for this discussion, DOE seeks comments on how to assess these possibilities.

The projected change in industry value ranges from a decrease of $35.8 million to an increase of $29.8 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 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 12.9 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 initial 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 initial 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 of $20) would increase NPV by between $785 million and $812 million (2008$) at a 7% discount rate and between $2.12 billion and $2.20 billion at a 3% discount rate. 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 proposes to adopt the energy conservation standards for capacitor-start small electric motors at trial standard level 7.

However, DOE recognizes that this conclusion assumes that CSIR customers can and will migrate to CSCR motors at this level. This shift in motor usage and the magnitude of its impacts are based on several assumptions made throughout the analyses, including: the costs associated with purchasing motors for space-constrained applications, the portion of space-constrained applications in the market, shipments in each product class, the scaling of motor losses and prices between product classes, and the mathematical form of DOE's cross-elasticity model. DOE requests comment on these assumptions and the combined effect that they may have on the uncertainties in DOE's forecasts. DOE also invites comment on what migration levels would be expected at TSL 7, and whether it should adopt a different TSL for capacitor-start small electric motors given the range of uncertainty in its forecasts.

VI. 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 proposed 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 proposed rule and that the Office of Information and Regulatory Affairs (OIRA) in the OMB review this proposed rule. DOE presented to OIRA for review the draft proposed 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 RIA is contained in the TSD prepared for the rulemaking. 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 the proposed standards.

The RIA calculates the effects of feasible policy alternatives to small electric motors standards, and provides a quantitative comparison of the impacts of the alternatives. 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. DOE analyzed these alternatives using a series of regulatory scenarios as inputs to the NES/shipments model for small electric motors, which it modified to allow inputs for these measures.

DOE identified the following major policy alternatives for achieving increased energy efficiency in small electric motors:

- No new regulatory action
- Financial incentives
  - ► Tax credits
  - ► Rebates
- Voluntary energy efficiency targets
- Bulk government purchases
- The proposed approach (performance standards)

DOE evaluated each alternative in terms of its ability to achieve significant energy savings at reasonable costs (see Table IV.1), and compared it to the effectiveness of the proposed rule.

Table VI.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 5 (Polyphase) and TSL 5 (Single-Phase)	0.07	0.25	0.57
Consumer Rebates at TSL 5 (Polyphase) and TSL 2 (Single-Phase)	0.19	0.52	1.24
Consumer Rebates at TSL 5 (Polyphase) and TSL 5 (Capacitor-Start Capacitor-Run Only)	0.13	0.43	1.00
Consumer Tax Credits	0.06	0.21	0.47
Manufacturer Tax Credits	0.05	0.18	0.41
Voluntary Efficiency Targets	0.82	0.35	1.61
Bulk Government Purchases	0.34	-0.01	0.36
Proposed Standards at TSL 5 (Polyphase) and TSL 7 (Capacitor-Start)	2.43 – 2.46	1.53 – 5.73	8.31 – 14.15

* 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 2008$.

The net present value amounts shown in Table VI.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 VI.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 VI.1. (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 3.65 quads of primary energy (in the form of losses), while polyphase small electric motors purchased in or after 2015 are expected to consume 0.90 quads 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 5 for polyphase motors, and evaluated several target efficiency levels for capacitor-start motors (including TSLs 7, 5, and 2). Existing rebate programs for polyphase motors target three-digit frame series motors with efficiencies equivalent to TSL 5 for small polyphase motors. At rebate efficiency levels corresponding to TSL 7 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 5 and 2 have larger energy savings. TSLs 7, 5, and 2 correspond to the same efficiency level (EL 3) for CSCR motors.

For rebate programs TSL 5 for both polyphase and 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 0.3 percent for capacitor-start, induction-run motors, and from 21.0 to 29.5 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 0.07 quads of national energy savings and an NPV of $0.25 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 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 3.0 percent to 13.2 percent. Combined with unchanged polyphase motor rebates targeting TSL 5, DOE estimates these rebates would provide 0.19 quads of national energy savings and an NPV of $0.52 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 by 23.9 percent to 44.9 percent. In addition, DOE estimates that this rebate would increase shipments of capacitor-start capacitor-run motors over the period from 2015 to 2045 by 5.7 million to 12.6 million. Combined with unchanged polyphase motor rebates at TSL 5, DOE estimates these rebates would provide 0.13 quads of national energy savings and an NPV of $0.43 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 5 for both polyphase and capacitor-start motors would increase by 0.1 percent to 0.1 percent for polyphase motors, by 0.2 percent to 0.2 percent for capacitor-start, induction-run motors, and by 5.1 percent to 26.1 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 trial standard level 5 for polyphase small electric motors and trial standard level 5 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 by 0.04 percent to 0.04 percent (*i.e.*, 50 percent of the impact of consumer tax credits) for polyphase motors, by 0.1 percent to 0.1 percent for capacitor-start, induction-run motors, and by 2.6 percent to 23.6 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 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 trial standard level 5 for polyphase small electric motors or trial standard level 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 0.82 quads of national energy savings and an NPV of $0.35 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 5 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 0.34 quads of national energy savings and an NPV of −$0.01 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. DOE proposes to adopt the efficiency levels listed in section VI.C. As indicated in the paragraphs above, none of the alternatives DOE examined would save as much energy as today's proposed standards. Also, several of the alternatives would require new enabling legislation, since authority to carry out those alternatives does not presently exist.

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 proposed 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 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.*

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.

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 Small Business Administration (SBA) 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.

On the basis of the foregoing, DOE certifies that the proposed rule, if promulgated, would have no significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared a regulatory flexibility analysis for this rulemaking. DOE will transmit the certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

DOE seeks comment on the above analysis, as well as any information concerning small businesses that may be impacted by this rulemaking and what those impacts may be.

C. Review Under the Paperwork Reduction Act

This rulemaking will impose no new information or record-keeping 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 has prepared a draft environmental assessment (EA) of the impacts of the proposed rule pursuant to the National Environmental Policy Act of 1969 (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 the National Environmental Policy Act (10 CFR part 1021). This assessment includes an examination of the potential effects of emission reductions likely to result from the rule in the context of global climate change, as well as other types of environmental impacts. The draft EA has been incorporated into the TSD. Before issuing a final rule for small electric motors, DOE will consider public comments and, as appropriate, determine whether to issue a finding of no significant impact as part of a final EA or to prepare an environmental impact statement (EIS) for this rulemaking.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (August 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined today's proposed rule and has determined that it would not preempt State law or have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform'' (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, this proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

DOE reviewed this regulatory action under Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) (UMRA), which requires each Federal agency to assess the effects of Federal regulatory actions on State, local and Tribal governments and the private sector. For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted for inflation), section 202 of UMRA requires an agency to publish a written statement assessing the costs, benefits, and other effects of the rule on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA (62 FR 12820) (also available at *http://www.gc.doe.gov*).

Although today's proposed rule does not contain a Federal intergovernmental mandate, today's proposed rule will likely result in a final rule that could impose 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 proposed rule using the results of the national impacts analysis. The national impact analysis results expressed as annualized values are $923–$1,137 million in total annualized benefits from the proposed rule, $292–$786 million in annualized costs, and $183–$845 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 proposed 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 proposed 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 proposed 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 of 1999

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

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), that this regulation would not result in any takings that might require compensation under the Fifth Amendment to the United States Constitution.

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

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); DOE's guidelines were published at 67 FR 62446 (October 7, 2002). DOE has reviewed today's notice 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. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) Is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

Today's regulatory action, which proposes standards to increase the energy efficiency of 72 product classes of small electric motors, would not have a significant adverse effect on the supply, distribution, or use of energy. The rule was also not designated by OIRA as a significant energy action. Therefore, today's proposed rule is not a significant energy action. Accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under the Information Quality Bulletin for Peer Review

In consultation with the Office of Science and Technology (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. Under the Bulletin, the energy conservation standards rulemaking analyses are ''influential scientific information.'' The Bulletin defines ''influential scientific information'' as ''scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions.'' 70 FR 2667 (January 14, 2005).

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses. DOE prepared the ''Energy Conservation Standards Rulemaking Peer Review Report,'' dated February 2007, which pertains to these rulemaking analyses. DOE disseminated the report, and it is available at *http://www.eere.energy.gov/buildings/appliance_standards/peer_review.html.*

VII. Public Participation

A. Attendance at Public Meeting

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. To attend the public meeting, please notify Ms. Brenda Edwards at (202) 586–2945 or *Brenda.Edwards@ee.doe.gov*. As explained in the **ADDRESSES** section, foreign nationals visiting DOE Headquarters are subject to advance security screening procedures.

B. Procedure for Submitting Requests To Speak

Any person who has an interest in today's notice, or who is a representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation. Such persons may hand-deliver requests to speak, along with a computer diskette or CD in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format, to the address shown in the **ADDRESSES** section at the beginning of this notice of proposed rulemaking between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Requests may also be sent by mail, or by e-mail to *Brenda.Edwards@ee.doe.gov.*

Persons requesting to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. DOE requests persons selected to be heard to submit an advance copy of their statements at least one week before the public meeting. At its discretion, DOE may permit any person who cannot supply an advance copy of their statement to participate, if that person has made advance alternative arrangements with the Building Technologies Program. The request to give an oral presentation should ask for such alternative arrangements.

C. Conduct of Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA, 42 U.S.C. 6306. A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings as well as on any aspect of the rulemaking until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for presentations by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a prepared general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will permit other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions from DOE and from other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

DOE will make the entire record of this proposed rulemaking, including the transcript from the public meeting, available for inspection at the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, SW., Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Any person may purchase a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding the proposed rule before or after the public meeting, but no later than the date provided at the beginning of this notice of proposed rulemaking. Comments, data, and information submitted to DOE's e-mail address for this rulemaking should be provided in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format. Interested parties should avoid the use of special characters or any form of encryption and, wherever possible, comments should carry the electronic signature of the author. Comments, data, and information submitted to DOE via mail or hand delivery/courier should include one signed original paper copy. No telefacsimiles (faxes) will be accepted.

According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: One copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include (1) a description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

E. Issues on Which DOE Seeks Comment

DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. The proposal of product classes based on motor category, pole configuration, and horsepower.
2. The proposal to include other insulation class systems besides A, in particular B and F insulation class systems.
3. The baseline models and efficiencies used in the engineering analysis.
4. The various markups used in the engineering analysis, in particular the difference in overhead markups for designs that use a copper rotor and those that use an aluminum rotor.
5. The design options and limitations presented in the engineering analysis such as the limitations on motor size, the air gap between the rotor and stator, and the power factor.
6. The approach to scale the engineering analysis results to product classes for which a complete analysis was not performed, especially the decision to use the relationships found for CSIR motors to scale results for CSCR motors.
7. The proposal to define nominal efficiency as the average full-load efficiency of a large population of motors of the same design.
8. The preservation of operating profits as the lower bound scenario and the preservation of return on invested capital as the upper bound scenario for the INPV results generated in the manufacturer impact analysis.
9. The capital investment costs needed to reach each efficiency level.
10. Input and data regarding how the single-phase small motor market will respond to the proposed standards. In particular, DOE seeks comment regarding its CSIR/CSCR cross-elasticity model; the current market shares of CSIR and CSCR motors in each combination of motor power and number of poles; the barriers the customers face if they switch from CSIR to CSCR motors or vice versa; and the timescale over which market share shifts would take place in response to standards. DOE also welcomes additional comments and data regarding the scaling of motor losses and prices between product classes.
11. Input and data regarding how the small electric motors market will respond to the proposed standards. In particular, DOE seeks comment regarding alternative small electric motor technologies and how elasticity between the market for these alternative technologies and the market for covered motors could potentially affect the projected shipments and energy savings.
12. The behavior of customers with space-constrained applications, the costs they face, and the time-frame over which they may need to redesign a system or large piece of equipment to accommodate a larger-component small electric motor. DOE also seeks further information regarding the population and distribution of space-constrained customers among motor applications.
13. The combined effect of the several assumptions and estimates that DOE makes in order to estimate the impact of standards under expected market shifts. DOE seeks comment regarding its approach and suggestions on how forecast uncertainty can be estimated and weighed against the potential increases in benefits when selecting a higher standard level that may induce a shift in motor purchases.
14. The appropriateness of using other discount rates in addition to seven percent and three percent real to discount future emissions reductions; and
15. The determination of the anticipated environmental impacts of the proposed rule, particularly with respect to the methods for valuing the expected CO_2 and NO_X emissions savings due to the proposed standards.
16. The proposed standard level for polyphase small electric motors.
17. The proposed standard level for single-phase (capacitor-start) small electric motors.

VIII. Approval of the Office of the Secretary

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

List of Subjects in 10 CFR Part 431

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

Issued in Washington, DC, on October 27, 2009.

Cathy Zoi,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons stated in the preamble, DOE proposes to amend chapter II of title 10, Code of Federal Regulations, part 431 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 431.442 is amended by adding, in alphabetical order, a new definition for ''nominal full load efficiency'' to read as follows:

§ 431.442 Definitions concerning small electric motors.

* * * * *

Nominal Full Load Efficiency means the arithmetic mean of the full load efficiencies of a population of electric motors of duplicate design, where the full load efficiency of each motor in the population is the ratio (expressed as a percentage) of the motor's useful power output to its total power input when the motor is operated at its full rated load, rated voltage, and rated frequency.

* * * * *

3. Section 431.446 is added to read as follows:

§ 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 a nominal full load efficiency of not less than the following:

Motor horsepower/standard kilowatt equivalent	Nominal full load efficiency								
	Polyphase (number of poles)			CSIR (number of poles)			CSCR (number of poles)		
	6	4	2	6	4	2	6	4	2
0.25 / 0.18	77.4	72.7	69.8	65.4	69.8	71.4	63.9	68.3	70.0
0.33 / 0.25	79.1	75.6	73.7	70.7	72.8	74.2	69.2	71.6	72.9
0.5 / 0.37	81.1	80.1	76.0	77.0	77.0	76.3	75.8	76.0	75.1
0.75 / 0.55	84.0	83.5	81.6	81.0	80.9	78.1	79.9	80.3	77.0
1 / 0.75	84.2	85.2	83.6	84.1	82.8	80.0	83.2	82.0	79.0
1.5 / 1.1	85.2	87.1	86.6	87.7	85.5	82.2	87.0	84.9	81.4
2 / 1.5	89.2	88.0	88.2	89.8	86.5	85.0	89.1	86.1	84.2
3 / 2.2	90.8	90.0	90.5	92.2	88.9	85.6	91.7	88.5	84.9

(b) For purposes of determining the required minimum nominal 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.

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