CHAPTER 12. MANUFACTURER IMPACT ANALYSIS

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CHAPTER 12. MANUFACTURER IMPACT ANALYSIS

12.1 INTRODUCTION

In determining whether a standard is economically justified, the Secretary of Energy is required to consider "the economic impact of the standard on the manufacturers and on the consumers of the equipment subject to such a standard.” The legislation also calls for an assessment of the impact of any lessening of competition as determined in writing by the Attorney General. The U.S. Department of Energy (DOE) conducted a manufacturer impact analysis (MIA) to estimate the financial impact of higher efficiency standards on manufacturers of small electric motors (SEM) and to assess the impact of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects.

The quantitative portion of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model adapted for this rulemaking. GRIM inputs are industry cost structure, shipments, and pricing strategies. The GRIM’s key output is industry net present value (INPV). The model estimates the financial impact of higher energy conservation standards by comparing changes in INPV between a base case and various trial standard levels (TSLs).

The qualitative portion of the MIA addresses factors such as equipment characteristics, characteristics of particular firms, and market and equipment trends, and includes an assessment of the impacts of standards on sub-groups of manufacturers.

12.2 METHODOLOGY

DOE conducted the MIA in three phases. Phase I, Industry Profile, consisted of the preparation of an industry characterization including data on market share, sales volumes and trends, pricing, employment, and financial structure. Phase II, Industry Cash-Flow Analysis and Interview Guide, focused on the industry as a whole. In this phase, DOE used the GRIM to prepare an industry cash-flow analysis. For the quantitative portion of the MIA analysis, DOE analyzed the same 72 product classes used in the national impact analysis (NIA) and the life-cycle cost (LCC) analysis. In this phase DOE also used publicly available information developed in Phase I to adapt the GRIM’s structure to facilitate analysis of new SEM standards. In Phase III, Sub-Group Impact Analysis, DOE conducted interviews with several manufacturers comprising the majority of the SEM industry. During these interviews, DOE discussed financial topics specific to each company and obtained each manufacturer’s view of the industry as a whole. The interviews provided valuable information that DOE used to evaluate the impacts of a new standard on manufacturer cash flows, manufacturing capacities, and employment levels. The following subsections describe more specifically the steps DOE took in developing information for the MIA.

12.2.1 Phase I: Industry Profile

In Phase I of the MIA, DOE prepared a profile of the SEM industry that built on the market and technology assessments prepared for this rulemaking (chapter 3 of this TSD). Before initiating the detailed impact studies, DOE collected information on the past and present structure and market characteristics of the SEM industry. This included estimated market shares of SEM manufacturers, corporate operating ratios, wages, employment, and production cost ratios. The industry profile included a top-down cost analysis of the SEM manufacturing industry that DOE used to derive cost and financial inputs for the GRIM (*e.g.*, revenues; material; labor; overhead; depreciation; sales, general, and administration expenses (SG&A); and research and development (R&D) expenses). DOE used additional sources of information to further calibrate its characterization of the industry, including company Securities and Exchange Commission (SEC) 10–K reports, Standard & Poor's (S&P) stock reports, and corporate annual reports. DOE also relied on information from its engineering analysis, LCC analysis, NIA, and analysis of markups to characterize the SEM manufacturing industry.

12.2.2 Phase II: Industry Cash-Flow Analysis and Interview Guide

In Phase II, DOE performed a preliminary industry cash-flow analysis and prepared written guidelines for interviewing manufacturers.

12.2.2.1 Industry Cash-Flow Analysis

The industry cash-flow analysis focused on the financial impacts of new standards on the SEM industry as a whole. New energy conservation standards can affect SEM manufacturers in three distinct ways: (1) require additional investment, (2) raise production costs, and (3) affect revenues through variations in prices and shipments. The analytical tool DOE uses for calculating the financial impacts of new energy conservation standards on manufacturers is the GRIM. DOE performed a cash-flow analysis using the GRIM on the SEM industry to quantify these impacts.

12.2.2.2 Interview Guide

During Phase III of the MIA, DOE conducted interviews with manufacturers to gather information on the effects of new energy conservation standards on revenues and finances, direct employment, capital assets, and industry competitiveness. Before the interviews, DOE distributed an interview guide to help identify the impacts of new energy conservation standards on individual manufacturers, and sub-groups of manufacturers. Manufacturers received the guide before the interviews to allow them to prepare their responses in advance. The interview guide led interviewers through a series of questions on current organizational characteristics, industry infrastructure, manufacturer cash flow, competitive impacts, employment impacts, and manufacturing capacity impacts. The interview guides used to conduct the manufacturer and customer interviews are found in Appendix 12A of this TSD.

12.2.3 Phase III: Sub-Group Impact Analysis

Many of the same companies that participated in the MIA interviews also participated in interviews for the engineering analysis. However, the MIA interviews broadened the discussion from primarily technology-related issues to business-related topics. The objectives were to obtain feedback from industry on the GRIM's assumptions and to isolate key issues and concerns. DOE defined two distinctive sub-groups that could be affected by the new energy conservation standards: major manufacturers and small businesses. The following sections summarize the methodology and findings of this assessment.

12.2.3.1 Manufacturer Interviews

DOE supplemented the information gathered in Phase I and the cash-flow analysis performed in Phase II with information gathered during interviews with manufacturers during Phase III. The interview process has a key role in the manufacturer impact analyses since it provides an opportunity for interested parties to express their views privately on important issues, allowing confidential or sensitive information to be considered in the rulemaking process.

DOE's contractor contacted companies from its database of manufacturers, which provided names of manufacturers across the SEM industry. DOE's contractor interviewed all relevant companies interested in participating, subsidiaries and independent firms. DOE scheduled interviews well in advance in order to provide every opportunity for key individuals to be available for comment. Although a written response to the questionnaire was acceptable, DOE prefers interactive interviews because they help clarify responses and provide the opportunity to identify additional issues.

DOE's contractor conducted detailed interviews with all manufacturers, who agreed to participate, to gain insight into the range of potential impacts and how these impacts vary with each TSL. During the interviews, DOE's contractor solicited information on the possible impacts of energy conservation standards on sales, direct employment, capital assets, and industry competitiveness. Both qualitative and quantitative information are valuable to the interview process. DOE's contractor then used the information gathered during manufacturer interviews to tailor the GRIM to incorporate unique financial characteristics from each equipment class.

12.2.3.2 Revised Industry Cash-Flow Analysis

In Phase II of the MIA, DOE provided manufacturers with preliminary financial input figures from the GRIM for review and evaluation. During the interviews, DOE requested comments on the values DOE selected for the parameters. Upon completion of the interviews, DOE revised its industry cash-flow model where applicable.

12.2.3.3 Manufacturer Sub-Group Analysis

Using average cost assumptions to develop an industry cash-flow estimate is not adequate for assessing differential impacts among sub-groups of manufacturers. Smaller manufacturers, niche players, or manufacturers exhibiting a cost structure that differs significantly from the industry average could be more negatively affected. Ideally, DOE would consider the impact on every manufacturer individually; however, it typically uses the results of the industry characterization to group manufacturers exhibiting similar characteristics. During the interviews, DOE discussed the potential sub-groups and sub-group members identified for the analysis. DOE looked to the manufacturers and other stakeholders to suggest what sub-groups or characteristics are most appropriate for the analysis.

12.2.3.4 Small-Business Manufacturer Sub-Group

DOE used the small business size standards published on August 18, 2008, as amended, by the Small Business Administration (SBA) to determine whether any small entities would be required to comply with the rule. 61 FR 3286 and codified at 13 CFR Parts 121. The North American Industry Classification System (NAICS) code lists the size standards for various industries. SEM manufacturing is classified under NAICS 335312 (Motor and Generator Manufacturing). To be categorized as a small business, a SEM manufacturer and its affiliates may employ a maximum of 1,000 employees.

DOE reviewed NEMA's listing of SEM members and surveyed the industry to develop a list of every manufacturer. DOE then examined publicly available data and contacted manufacturers, when needed, to determine if they meet the SBA's definition of a small business manufacturer and if their manufacturing facilities are located in the United States. Based on this analysis, DOE estimates that there are no small SEM manufacturers that make equipment that are covered by this rulemaking.

Therefore, since DOE has not indentified any SEM small business manufacturer, DOE believes the GRIM analysis, which models each product class separately and aggregates the results to produce an industry-wide impact, is representative of the manufacturers that would be affected by standards.

12.2.3.5 Manufacturing Capacity Impact

One of the significant outcomes of new energy conservation standards could be the obsolescence of existing manufacturing assets, including tooling and investment. The manufacturer interview guide helped identify impacts on manufacturing capacity, specifically capacity utilization and plant location decisions in the United States and North America with and without an energy conservation standard; the ability of manufacturers to upgrade or remodel existing facilities to accommodate the new requirements due to new energy conservation standards; the nature and value of stranded assets, if any; and estimates for any one-time restructuring and other charges, where applicable.

12.2.3.6 Employment Impact

The impact of new energy conservation standards on employment is an important consideration in the rulemaking process. To assess how domestic employment patterns might be affected, DOE used the GRIM to calculate employment impacts at each TSL. During interviews, DOE explored current employment trends in the SEM industry. In addition, DOE solicited manufacture views on changes in employment patterns that may result from more stringent standard levels. The employment impacts section of the interview guide focused on current employment levels associated with manufacturers at each of their production facilities, expected future employment levels with and without new energy conservation standards, and differences in workforce skills and issues related to employee retraining.

12.2.3.7 Cumulative Regulatory Burden

DOE seeks to mitigate the overlapping effects on manufacturers of new energy conservation standards and other regulatory actions affecting the same equipment. DOE analyzed and considered the impact on manufacturers of multiple equipment-specific regulatory actions.

Based on its own research and discussions with manufacturers, DOE identified several regulations relevant to the SEM industry, including the Restriction of Hazardous Substance Directive (RoHS) and the Registration, Evaluation and Authorization of Chemical substances (REACH), and energy conservation standards for other equipment made by SEM manufacturers.

12.3 MANUFACTURING IMPACT ANALYSIS KEY ISSUES

The first question each of the MIA interview guides asks is the following: "What are the key issues for your company regarding energy conservation standards for commercial refrigeration equipment and this rulemaking?" This open question initiated dialogue with manufacturers, prompting them to identify key points that DOE could explore during the interview. This section describes the issues that the manufacturers raised most often[a].

12.3.1 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.

12.3.2 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

[a] Manufacturers indicated that the risks associated with these issues generally increase with increasing TSL.

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.

12.3.3 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.*, electronic commutated (ECM) motors). 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.

12.3.4 Narrow Focus of the Rulemaking

Manufacturers were concerned that the market covered by this rulemaking is extremely narrow and only applies to a small number of motors. As a result, many of the manufacturers indicated that since the motors affected by this rule make up such a small percentage of total sales, they would simply exit the market if energy conservation standards became too stringent.

12.3.5 National Energy Savings As a Result of the rulemaking

A number of manufacturers argued that there was no payback period in regards to national energy savings. Manufacturers said that the annual usage of its motors was in the hundreds of hours per year, not thousands. Thus, even a significant increase in efficiency would not result in material national energy savings. As a result, several manufacturers urged DOE to examine system efficiencies rather than specific component efficiencies.

12.3.6 Use of Alternative Metals

All interviewed manufacturers expressed concerned about the use of copper and premium electrical 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 very low-loss 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 premium electrical steels were required to meet the energy conservation standard.

12.3.7 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.

12.4 GRIM INPUTS AND ASSUMPTIONS

The GRIM serves as the main tool for assessing the impact on the SEM industry due to the imposition of new energy conservation standards. DOE relied on several sources to obtain inputs for the GRIM. Data and assumptions from these sources are then fed into an accounting model that details the cash flow on a base case basis, as well as calculates the impacts on manufacturers due to new energy conservation standards.

12.4.1 Overview of the GRIM

The basic structure of the GRIM, illustrated in Figure 12.4.1, is a standard annual cash-flow analysis that uses manufacturer prices, manufacturing costs, shipments, and industry financial information as inputs. The GRIM estimates the effects of regulatory conditions caused by changes in costs, investments, and associated margins. The GRIM spreadsheet uses several inputs to arrive at a series of annual cash flows, beginning with the base year of the analysis, 2010, and continuing to 2044. The model calculates the INPV by summing the stream of annual discounted cash flows during this period.

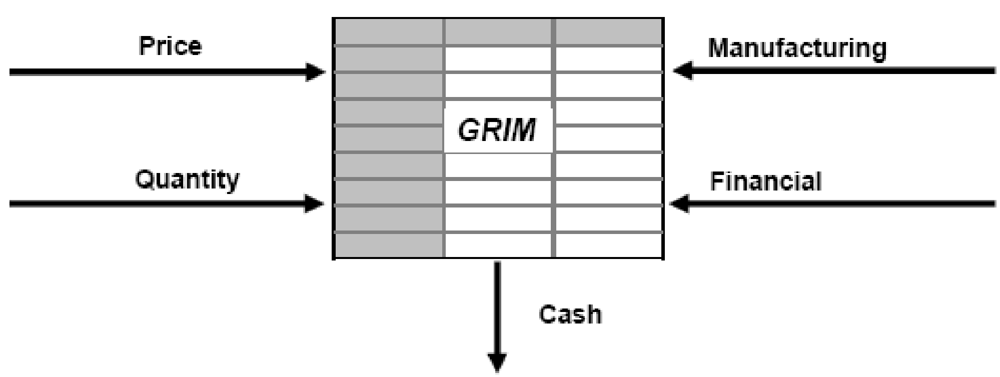


Figure 12.4.1 Using the GRIM to Calculate Cash Flow

The GRIM projected cash flows using standard accounting principles. The model compared changes in INPV between the baseline equipment information (the base-case scenario) and different TSLs (the standards-case scenario). The difference in INPV between the base case and the standards case(s) represents the estimated financial impact of the new energy conservation standard on manufacturers. Appendix 12B provides more technical details and user information for the GRIM.

12.4.2 Sources of GRIM Inputs

The GRIM used several different sources for data inputs to determine cash flows for the industry, including corporate annual reports, company profiles, credit ratings, Census data, the shipments model, the engineering analysis, and manufacturer interviews.

12.4.2.1 Corporate Annual Reports

Corporate annual reports to the SEC (SEC 10-Ks) provided many of the financial inputs to the GRIM.[1] These reports exist for publicly held companies and are freely available to the public. The SEC 10-Ks provide consistent financial data for the consolidated corporation but do not provide detailed financial information for the company's SEM lines. Some SEC 10-Ks are therefore more relevant than others to the SEM industry analysis, depending on the prominence that business has in the company's overall operations. In determining financial parameters for the industry, DOE weighted corporate financial information contained in the SEC 10-Ks by each company's market share in the SEM industry to arrive at industry-weighted averages. DOE used corporate annual reports to derive the following GRIM inputs:

- tax rate
- working capital
- SG&A expenses
- research and development (R&D) expenses
- depreciation
- capital expenditures
- net property, plant, and equipment (PPE)

DOE also used information from company SEC 10-K reports to calibrate the GRIM's operating profit margin against the industry-weighted average.

12.4.2.2 Standard and Poor Credit Ratings

S&P provides independent credit ratings, research, and financial information. DOE relied on S&P reports to determine the industry's average cost of debt for the cost of capital calculation.

12.4.2.3 Shipments Model

The GRIM used shipment projections derived from DOE's shipments model in the national impact analysis. Chapter 10 of the TSD is exclusively dedicated to describing the methodology and analytical model DOE used to forecast shipments.

12.4.2.4 Engineering Analysis

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 equipment class. Based on these simulated designs and manufacturer and component supplier data, DOE calculated manufacturing costs and selling prices associated with each efficiency level.

12.4.2.5 Manufacturer Interviews

Key topics discussed during the interviews and reflected in the GRIM include

- Capital conversion costs (one-time investments in property, plant, and equipment);
- Equipment conversion costs (one-time investments in research, equipment development, testing, and marketing);
- The portion of the conversion capital expenditures that companies use to replace stranded assets;
- Equipment cost structure (the portion of manufacturer production costs related to materials, labor, overhead, and depreciation costs);
- Projected total shipment and shipment distribution mix;
- Estimated profit margins characteristic of the industry; and
- Engineering analysis information.

12.4.3 Financial Parameters

For the preliminary analysis, DOE developed financial estimates of the SEM industry by examining several major SEM manufacturers' financial information from annual reports and SEC 10-K reports. Each company DOE analyzed is a subsidiary of a more diversified parent company that manufactures equipment other than SEM. Because the SEC 10-K reports did not provide financial information at the subsidiary level, the financial parameters DOE calculated represented averages of the parent companies applied over the entire range of their equipment offerings; these parameters did not necessarily represent the SEM industry alone.

DOE presented these values to manufacturers during the interviews for comment. While most manufacturers were unable to provide estimates for the SEM industry, they were able to provide their own financial parameters. Using these values, DOE calibrated its original estimates to develop financial parameters that it considers representative of the SEM industry. An aggregation of the MIA interview responses yielded the market-share-weighted financial parameters shown in Table 12.4.1. These aggregated values were the financial parameter inputs DOE used in the GRIM analysis for the notice of proposed rulemaking (NOPR) and subsequent final rule.

Table 12.4.1 GRIM Financial Parameters

Parameter	Industry Weighted Average (%)
Tax Rate ***(% of Taxable Income)***	32.0
Working Capital ***(% of Revenues)***	16.0
SG&A ***(% of Revenues)***	18.4
R&D ***(% of Revenues)***	2.1
Depreciation ***(% of Revenues)***	3.0
Capital Expenditures ***(% of Revenues)***	3.2
Net Property, Plant, and Equipment ***(% of Revenues)***	18.4

12.4.4 Corporate Discount Rate

DOE used the weighted-average cost of capital (WACC) for the industry as the discount rate to calculate the INPV. Because a company's assets are financed by a combination of debt and equity, the industry WACC is the total cost of debt and equity weighted by the composite companies' respective proportions of debt and equity in the capital structure of the industry. DOE made its initial estimate of the WACC for the SEM industry using publicly available information of the four companies used to derive the financial parameters. As described below, DOE revised its estimate of the discount rate after independently researching the industry WACC.

DOE made its initial estimate of the SEM WACC using the following formula:

WACC = After-Tax Cost of Debt x (Debt Ratio) + Cost of Equity x (Equity Ratio)

The cost of equity is the rate of return that equity investors (including, potentially, the company) expect to earn on a company's stock. These expectations are reflected in the market price of the company's stock. The capital asset pricing model (CAPM) provides one widely used means to estimate the cost of equity. According to the CAPM, the cost of equity (expected return) is:

Cost of Equity = Riskless Rate of Return + β x Risk Premium

where:

Riskless rate of return is the rate of return on a "safe" benchmark investment, typically considered the short-term Treasury Bill (T-Bill) yield.

Risk premium is the difference between the expected return on stocks and the riskless rate.

Beta (β) is the correlation between the movement in the price of the stock and that of the broader market. In this case, Beta equals one if the stock is perfectly correlated with the S&P 500 market index. A Beta lower than one means the stock is less volatile than the market index.

DOE initially determined that the industry average cost of equity for the SEM industry is 16.3 percent, as calculated in Table 12.4.2.

Table 12.4.2 Cost of Equity Calculation

Parameter	Industry-Weighted Average (%)
(1) Average Beta	1.17
(2) Yield on 10 Year T-Bill (1991-2008)	5.52
(3) Market Risk Premium (1926-1999)	9.20
Cost of Equity (2)+((1)*(3))	16.3
Equity/Total Capital	64.9

Bond ratings are a tool to measure default risk and arrive at a cost of debt. Each bond rating is associated with a particular spread. One way of estimating a company's cost of debt is to treat it as a spread (usually expressed in basis points) over the risk-free rate. DOE used this method to calculate the cost of debt for all four manufacturers. S&P had bond ratings for most manufacturers, so DOE used these ratings to estimate the manufacturers' cost of debt by adding the relevant spread to the risk-free rate.

In practice, investors use a variety of different maturity Treasury bonds to estimate the risk-free rate. DOE used a long-term Treasury bond return (10-year bond return) because it captures long-term inflation expectations and is less volatile than short-term rates. The risk free rate is estimated to be approximately six percent, which is the average 10-year Treasury bond return over the period of 1991 to 2008.

For the cost of debt, S&P's Credit Services provided the average spread of corporate bonds for all of the public manufacturers. To this, DOE added the industry-weighted average spread to the average T-Bill yield over the same period. Since proceeds from debt issuance are tax deductible, DOE adjusted the gross cost of debt by the industry average tax rate to determine the net cost of debt for the industry. Table 12.4.3 presents the derivation of the cost of debt. Also shown is the capital structure of the industry, i.e. the debt ratio (debt/total capital).

Table 12.4.3 Cost of Debt Calculation

Parameter	Industry-Weighted Average (%)
S&P Bond Rating	--
(1) Yield on 10 year T-Bill (1991-2008)	5.52
(2) Gross Cost of Debt	8.0
(3) Tax Rate	32.0
Net Cost of Debt (2)x((1)-(3))	5.44
Debt/Total Capital	35.1

Using the publicly available information above, DOE initially estimated the SEM industry's WACC to be approximately 12.5 percent. Subtracting an inflation rate of 2.82 percent between 1991 and 2008, the inflation adjusted WACC was 9.68 percent.

12.4.5 Trial Standard Levels

DOE developed eight TSLs for polyphase motors and eight TSLs for CSIR and CSCR motors that include combinations of energy efficiency levels representing comparable stringency for SEM equipment classes. Table 12.4.4, Table 12.4.5, and Table 12.4.6 present the efficiency levels DOE used in the GRIM for three representative motors. Chapter 10 of the TSD discusses in further detail all TSLs for each equipment class in further detail.

Table 12.4.4 Baseline Efficiency Levels and Trial Standard Levels for Polyphase 1 HP, 4 Pole Small Electric Motor

Motor Category	Trial Standard Levels for SEM Product classes Analyzed (%)								
	Baseline	1	2	3	4	4B	5	6	7
Polyphase Motor Category	74.00	76.12	77.69	79.39	80.07	82.58	84.42	85.35	86.97

Table 12.4.5 Baseline Efficiency Levels and Trial Standard Levels for Capacitor-Start, Induction-Run ½ HP, 4 Pole Small Electric Motor

Motor Category	Trial Standard Levels for SEM Product classes Analyzed (%)								
	Baseline	1	2	3	4	5	6	7	8
Capacitor-Start, Induction-Run Motor Category	59.00	71.53	71.53	72.71	73.98	73.98	78.38	78.38	78.38

Table 12.4.6 Baseline Efficiency Levels and Trial Standard Levels for Capacitor-Start, Capacitor-Run ¾ HP, 4 Pole Small Electric Motor

Motor Category	Trial Standard Levels for SEM Product classes Analyzed (%)								
	Baseline	1	2	3	4	5	6	7	8
Capacitor-Start, Capacitor-Run Motor Category	72.00	80.04	82.15	82.15	83.21	82.15	88.37	82.15	87.13

12.4.6 Shipments

The GRIM estimated yearly revenues using the reference shipment forecasts and average efficiency levels from the shipments model used for the NIA (chapter 10 of this TSD). The shipment analysis is a key driver of manufacturer finances because changes in the efficiency mix at the various trial standard levels are tied to shipments. Further explanation of assumptions and calculations of total shipments can be found in chapter 10 of this TSD. Total shipments forecasted in the shipment analysis for all efficiency levels in 2015 are shown in Table 12.4.7 and discussed below.

Table 12.4.7 Base Case Total Industry Shipments by Motor Type for 2015 (Reference Shipments)

Motor Category	Estimated Total Industry Shipments *(Number of Units)*
Polyphase Small Electric Motor	**831,627**
Capacitor-Start, Induction-Run Small Electric Motor	**3,437,392**
Capacitor-Start, Capacitor-Run Small Electric Motor	**180,915**

DOE assumed a roll-up of efficiency distribution in the standards year followed by a gradual improvement in efficiency, which mimics the growth in efficiency observed in historical data (parallel growth trend). Under the parallel growth trend, the equipment mix moves to higher efficiency levels until the maximum efficiency level is reached. In its engineering analysis, DOE analyzed one representative combination of horsepower (hp) and number of poles for each SEM motor category (*e.g*. Polyphase, CSIR, or CSCR) and extrapolated the results to other horsepowers, and number of poles. The shipments distribution by TSL estimated in the NES for these equipment classes in 2015 for these three representative motors is found in Table 12.4.8, Table 12.4.9, and Table 12.4.10.

Table 12.4.8 Distribution of Shipments in the Base Case for Polyphase 1 HP, 4 Pole Small Electric Motor

TSL (%)	Baseline (74.00)	TSL 1 (76.12)	TSL 2 (77.69)	TSL 3 (79.39)	TSL 4 (80.07)	TSL 4B (82.58)	TSL 5 (84.42)	TSL 6 (85.35)	TSL 7 (86.97)
Polyphase	54.0%	6.0%	13.0%	7.0%	12.0%	5.0%	3.0%	0.0%	0.0%

Table 12.4.9 Distribution of Shipments in the Base Case for Capacitor-Start, Induction-Run ½ HP, 4 Pole Small Electric Motor

TSL (%)	Baseline (59.00)	TSL 1 (71.53)	TSL 2 (71.53)	TSL 3 (72.71)	TSL 4 (73.98)	TSL 5 (73.98)	TSL 6 (78.38)	TSL 7 (78.38)	TSL 8 (78.38)
CSIR	40.0%	2.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 12.4.10 Distribution of Shipments in the Base Case for Capacitor-Start, Capacitor-Run ¾ HP, 4 Pole Small Electric Motor

TSL (%)	Baseline (72.00)	TSL 1 (80.04)	TSL 2 (82.15)	TSL 3 (82.15)	TSL 4 (83.21)	TSL 5 (82.15)	TSL 6 (88.37)	TSL 7 (82.15)	TSL 8 (87.13)
CSCR	37.0%	4.0%	11.0%	11.0%	11.0%	11.0%	0.0%	11.0%	0.0%

12.4.7 Production Costs

For the engineering analysis, DOE examined three specific equipment classes at each analyzed efficiency level and created a bill of materials to determine the manufacturing production costs (MPCs) of these three equipment classes. For each equipment class and efficiency level, DOE analyzed the production costs for motor designs used in space constrained and non-space constrained applications. The production costs varied between space constrained and non-space constrained designs by number of laminations, grade of steel used, rotor design, and other design pathways that are fully described in the engineering analysis (chapter 5). In addition, DOE consulted an industry expert to determine total labor hours required per motor, as well as associated overhead. By applying a markup to the MPCs, DOE calculates the manufacturer selling prices (MSPs) that are used in subsequent analysis such as the life-cycle cost (LCC) analysis.

In the engineering analysis, DOE analyzes both space constrained and non-space constrained motor designs for the representative motors to derive the manufacturer selling prices (MSPs) for each efficiency level. Using a scaling formula, DOE determined the MSPs for all equipment classes. For more discussion on the scaling, see the LCC analysis in chapter 8 of the TSD. In the GRIM, DOE uses weighted average MSPs of each equipment class at each efficiency level to first calculate weighted average MPCs. By dividing the MSPs calculated in the engineering analysis and the scaled MSPs from the LCC analysis by the manufacturer markup, DOE calculated the MPCs for all equipment classes at each efficiency level. For the MIA, DOE then applies different sets of markup scenarios to MPCs to determine pricing strategies used by manufacturers.

For polyphase motors, shipment distributions between space constrained and non-space constrained motors were estimated to not vary with higher efficiency requirements. Space constrained polyphase motor MPCs were given a 20-percent weight while non-space constrained polyphase motors MPCs were given 80-percent. For single phase motors (CSIR and CSCR) shipments, distributions between space constrained and non-space constrained motors were estimated to vary with each TSL analyzed. At each TSL, weighted MPCs were calculated using the same shipment distributions used in the NIA between space constrained and non-space constrained single phase motors.

The GRIM included the proportion of costs devoted to labor, materials, depreciation, and overhead that make up the weighted MPC of the equipment. DOE used the same breakdown used for the engineering analysis, except depreciation is broken out of overhead. See chapter 5 of the TSD for more information on the cost breakdown. Table 12.4.11, Table 12.4.12, and Table 12.4.13 provide the production cost assumptions, including the weighted MPCs, at the various TSLs used in the GRIM for the equipment classes analyzed in the engineering analysis.

Table 12.4.11 Production Cost Breakdown for Polyphase 1 HP, 4 Pole Small Electric Motor (2009$)

TSL	Efficiency (%)	Labor	Material	Overhead	Depreciation	MPC	MSP
Baseline	74.00	$12.90	$40.01	$6.59	$2.67	$62.17	$90.33
TSL 1	76.12	$13.73	$42.56	$7.01	$2.84	$66.14	$96.09
TSL 2	77.69	$14.17	$43.92	$7.24	$2.93	$68.25	$99.16
TSL 3	79.39	$14.96	$46.38	$7.64	$3.09	$72.08	$104.72
TSL 4	80.07	$15.52	$48.13	$7.93	$3.21	$74.80	$108.67
TSL 4B	82.58	$17.60	$54.55	$8.99	$3.64	$84.77	$123.16
TSL 5	84.42	$22.17	$68.75	$11.33	$4.58	$106.84	$155.22
TSL 6	85.35	$25.75	$79.84	$13.15	$5.32	$124.07	$180.26
TSL 7	86.97	$80.43	$249.37	$41.09	$16.63	$387.51	$563.00

*Dollar values rounded to the nearest cent

Table 12.4.12 Production Cost Breakdown for Capacitor-Start, Induction-Run ½ HP, 4 Pole Small Electric Motor (2009$)

TSL	Efficiency (%)	Labor	Material	Overhead	Depreciation	MPC	MSP
Baseline	59.00	$12.19	$41.25	$6.66	$2.69	$62.80	$91.24
TSL 1	71.53	$14.49	$49.04	$7.91	$3.20	$74.65	$106.99
TSL 2	71.53	$14.49	$49.04	$7.91	$3.20	$74.65	$106.99
TSL 3	72.71	$15.74	$53.27	$8.60	$3.48	$81.09	$118.00
TSL 4	73.98	$19.00	$64.30	$10.38	$4.20	$97.87	$132.22
TSL 5	73.98	$19.00	$64.30	$10.38	$4.20	$97.87	$132.22
TSL 6	78.38	$48.26	$163.32	$26.36	$10.67	$248.61	$361.19
TSL 7	78.38	$20.21	$68.39	$11.04	$4.47	$104.10	$151.25
TSL 8	78.38	$20.21	$68.39	$11.04	$4.47	$104.10	$151.25

*Dollar values rounded to the nearest cent

Table 12.4.13 Production Cost Breakdown for Capacitor-Start, Capacitor-Run ¾ HP, 4 Pole Small Electric Motor (2009$)

TSL	Efficiency (%)	Labor	Material	Overhead	Depreciation	MPC	MSP
Baseline	72.00	$12.26	$53.18	$8.15	$3.30	$76.90	$111.72
TSL 1	80.04	$14.42	$62.52	$9.58	$3.88	$90.40	$131.34
TSL 2	82.15	$15.03	$65.20	$10.00	$4.05	$94.28	$136.97
TSL 3	82.15	$15.03	$65.20	$10.00	$4.05	$94.28	$136.97
TSL 4	83.21	$15.75	$68.31	$10.47	$4.24	$98.77	$143.49
TSL 5	82.15	$15.03	$65.20	$10.00	$4.05	$94.28	$136.97
TSL 6	88.37	$67.66	$293.45	$44.99	$18.21	$424.31	$616.45
TSL 7	82.15	$15.04	$65.23	$10.00	$4.05	$94.31	$137.02
TSL 8	87.13	$20.90	$90.63	$13.89	$5.62	$131.05	$190.39

*Dollar values rounded to the nearest cent

12.4.8 Conversion Costs

New energy conservation standards typically cause manufacturers to incur one-time conversion costs to bring their production facilities and equipment designs in compliance with the new regulation. For the MIA, DOE classified these one-time conversion costs into three major groups. Equipment conversion costs are one-time investments in research, development, testing, and marketing focused on making equipment 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 equipment designs can be fabricated and assembled under the new regulation. Stranded assets are equipment or tooling that become obsolete as a result of new regulation. During interviews, DOE asked manufacturers to discuss the impacts of new energy conservation standard on their current assets. In general, manufacturers reported that although some redesigns could potentially make some tooling inapplicable for covered SEMs, this tooling would still be applicable to other types of motors that the manufacturer currently produces and not merely scrapped.

12.4.8.1 Capital Conversion Costs

To calculate the industry-wide capital conversion costs, DOE used a combination of estimates provided by manufacturers and an estimated tooling cost at each incremental efficiency level for a typical manufacturer. As part of the tooling cost estimates, DOE examined the specific tooling requirements necessary for a typical manufacturer at each TSL for both space constrained and non-space constrained motor designs. For many design options analyzed, this leads to capital conversion costs that are additive across space constrained and non-space constrained motors.

Because DOE did not receive specific feedback from all manufacturers, DOE estimated the total capital conversion cost for a typical manufacturer based on the engineering designs developed for the analysis, DOE's estimated tooling cost for each separate design at each efficiency level, and information provided by industry experts. DOE used these sources to estimate the required tooling costs for each of the three representative motor designs at each TSL analyzed. For each of these designs, DOE estimated the tooling costs for: (1) rotor redesigns to use copper (if applicable); (2) grade of steel including the use of exotic steels; (3) increases in stack length; (4) necessary rewiring; (5) replacement of end rings; and (6) total number of laminations and the required increases in stack length over baseline designs. For rotor redesigns to use copper, DOE estimated the costs to purchase new presses, new end rings, and additional tooling. For changes to the grade of steel, DOE estimated the costs for punch press dyes. For increases in stack length, DOE estimated the costs of switching more production equipment to accommodate a higher volume of larger sized SEM. For necessary rewiring, DOE estimates the cost of crimp tools. For replacement of end rings, DOE estimated the tooling changes for different dimensional changes to the end rings. For increases in laminations, DOE estimated the purchase of presses and tooling for winding machinery. Table 12.4.17, Table 12.4.17, and Table 12.4.17 show the estimated total tooling cost at each TSL for a typical manufacturer.

Table 12.4.14 Polyphase Weighted Total Capital Conversion Costs for Typical Manufacturer by TSL

TSL	Tooling Cost Estimate by Motor Category	
	Design Changes	**Total Capital Conversion Cost for Typical Manufacturer**
Baseline	-	$ 0
TSL 1	Small lamination increase, change in end ring	$119,300
TSL 2	Small lamination increase, change in end ring	$213,100
TSL 3	Small lamination increase, change in end ring	$244,300
TSL 4	20% lamination increase, change in end ring	$286,000
TSL 4B	46% lamination increase, change in end ring	$619,300
TSL 5	Steel grade change, 115% lamination increase, change in end ring, crimp tooling	$1,864,600
TSL 6	Copper rotor, steel grade change, 114% lamination increase, change in end ring, crimp tooling	$3,030,600
TSL 7	Copper rotor, premium electrical steel change, 400% lamination increase, change in end ring, crimp tooling	$8,329,500

* Estimates rounded to the nearest hundred

Table 12.4.15 Capacitor-Start, Induction-Run Weighted Total Capital Conversion Costs for Typical Manufacturer by TSL

TSL	Tooling Cost Estimate by Motor Category	
	Design Changes	Total Capital Conversion Cost for Typical Manufacturer
Baseline	-	$ 0
TSL 1	61% lamination increase, change in end ring, crimp tooling	$783,400
TSL 2	61% lamination increase, change in end ring, crimp tooling	$783,400
TSL 3	Copper rotor, 122% lamination increase, change in end ring, crimp tooling, stack length change	$2,731,300
TSL 4	Copper rotor, steel grade change, 139% lamination increase, change in end ring, crimp tooling, stack length change	$3,339,600
TSL 5	Copper rotor, steel grade change, 139% lamination increase, change in end ring, crimp tooling, stack length change	$3,339,600
TSL 6	Copper rotor, premium electrical steel, 456% lamination increase, change in end ring, crimp tooling, stack length change	$9,023,900
TSL 7	Copper rotor, change in end ring, crimp tooling, stack length change	$1,185,500
TSL 8	Copper rotor, change in end ring, crimp tooling, stack length change	$1,185,500

* Estimates rounded to the nearest hundred

Table 12.4.16 Capacitor-Start, Capacitor-Run Weighted Total Capital Conversion Costs for Typical Manufacturer by TSL

TSL	Tooling Cost Estimate by Motor Category	
	Design Changes	Total Capital Conversion Cost for Typical Manufacturer
Baseline	-	$ 0
TSL 1	37% laminations increase, crimp tooling	$459,800
TSL 2	53% laminations increase, change in end ring, crimp tooling, stack length change	$716,200
TSL 3	53% laminations increase, change in end ring, crimp tooling, stack length change	$716,200
TSL 4	Copper rotor, 50% laminations increase, change in end ring, crimp tooling, stack length change	$1,810,500
TSL 5	53% laminations increase, change in end ring, crimp tooling, stack length change	$716,200
TSL 6	Cooper rotor, premium electrical steel, 400% laminations increase, change in end ring, crimp tooling, stack length change	$8,329,500
TSL 7	Laminations capacity increase, change in end ring, crimp tooling, stack length change	$ 3,627,700
TSL 8	Laminations capacity increase, copper rotor, steel grade change, 115% laminations increase, change in end ring, crimp tooling, stack length change	$ 6,350,500

* Estimates rounded to the nearest hundred

In addition to estimating the total tooling cost per typical manufacturer, DOE asked manufacturers during interviews to estimate the capital conversion costs they would incur due to new energy conservation standards. Not all manufacturers were able to provide estimates for each TSL. However, DOE used the costs manufacturers provided along with input from industry experts to calibrate final conversion cost figures. For manufacturers that did not provide estimates, DOE used its typical manufacturer estimate for the tooling costs for that manufacturer. DOE weighed manufacturer responses and its estimate of the conversion costs for a typical manufacturer based on their respective market shares to develop estimates for the capital conversion costs for the entire SEM industry at each TSL. Table 12.4.17 summarizes the industry-wide capital conversion estimates used for the cash flow analysis.

Table 12.4.17 Industry-Wide Capital Conversion Costs by Trial Standard Level (2009$ millions)

TSL	Total Capital Conversion Cost by Motor Category (2009$ millions)	TSL	Total Capital Conversion Cost by Motor Category (2009$ millions)	
	Polyphase		CSIR	CSCR
Baseline	$ 0	**Baseline**	$ 0	$ 0
TSL 1	$ 0.37	**TSL 1**	$ 8.00	$ 1.41
TSL 2	$ 0.65	**TSL 2**	$ 8.00	$ 2.49
TSL 3	$ 0.75	**TSL 3**	$ 13.98	$ 2.49
TSL 4	$ 0.88	**TSL 4**	$ 15.85	$ 5.85
TSL 4B	$ 1.90	**TSL 5**	$ 15.85	$ 2.49
TSL 5	$ 7.08	**TSL 6**	$ 45.67	$ 36.23
TSL 6	$ 10.66	**TSL 7**	$ 9.23	$ 11.43
TSL 7	$37.29	**TSL 8**	$ 9.23	$ 19.79

12.4.8.2 Equipment Conversion Costs

Equipment conversion costs include R&D, certification and testing, marketing, and other costs required to bring more efficient equipment onto the market. DOE estimated total equipment conversion for a typical manufacturer using the cost of engineering time and product development resources for each of the three representative motor design at each incremental efficiency level. DOE estimated the engineering hours necessary for each design by assigning each a cost based on the complexity of the required redesigns. The engineering times required to use copper and premium electrical steels in motor designs were given additional weight due to the lack of experience using the material within the industry.

In addition to estimating the total equipment conversion cost per typical manufacturer, DOE asked manufacturers during interviews to estimate the equipment conversion costs they would incur due to new energy conservation standards. Not all manufacturers were able to provide estimates for each TSL. DOE used the costs manufacturers provided in conjunction with input from industry experts to calibrate its final equipment conversion costs. For manufacturers that did not provide estimates, the estimated typical manufacturer equipment conversion costs were used. DOE weighed manufacturer responses based on their respective market shares to develop estimates for the equipment conversion costs of the entire SEM industry at each TSL.

Table 12.4.18 summarizes the total equipment conversion estimates for the industry each motor category.

Table 12.4.18 Industry-Wide Equipment Conversion Costs by Trial Standard Level (2009$ millions)

TSL	Total Equipment Conversion Cost by Motor Category (2009$ millions)	TSL	Total Equipment Conversion Cost by Motor Category (2009$ millions)	
	Polyphase		CSIR	CSCR
Baseline	$ 0	**Baseline**	$ 0	$ 0
TSL 1	$ 1.92	**TSL 1**	$ 15.87	$ 0.84
TSL 2	$ 1.92	**TSL 2**	$ 15.87	$ 0.84
TSL 3	$ 1.92	**TSL 3**	$ 24.05	$ 0.84
TSL 4	$ 3.84	**TSL 4**	$ 24.05	$ 1.27
TSL 4B	$ 3.84	**TSL 5**	$ 24.05	$ 0.84
TSL 5	$ 3.84	**TSL 6**	$ 31.99	$ 1.68
TSL 6	$ 5.82	**TSL 7**	$ 24.05	$ 0.84
TSL 7	$7.74	**TSL 8**	$ 24.05	$ 1.27

12.4.9 Markup Scenarios

To understand how baseline and more-efficient equipment are differentiated, DOE reviewed manufacturer catalogs and utilized information gathered from manufacturers. To estimate the manufacturer price of the equipment sold, DOE applied markups to the production costs. For the analysis, DOE considered different markup scenarios based on manufacturer input for SEMs. Scenarios were used to bound the range of expected equipment prices following new energy conservation standards. For each equipment class, DOE used the markup scenarios that best characterized the prevailing markup conditions and described the range of market responses manufacturers expect as a result of new energy conservation standards.

After discussions with manufacturers and market research, DOE modeled two markup scenarios: The preservation-of-return-on-invested-capital scenario and the preservation-of-operating profit scenario.

12.4.9.1 Preservation-of-Return-on-Invested-Capital Scenario

Under the preservation-of-return-on-invested-capital scenario, DOE applied a markup at each TSL that sets manufacturers return on invested capital in the standards case to the same level as in the base case. Return on invested capital is the ratio of net operating profits (after taxes) to invested capital. As invested capital increases, net operating profits proportionately increase.

During interviews, manufacturers expressed a range of opinions on how selling prices would be impacted by new energy conservation standards. While some manufacturers stated it has been difficult passing along any increase in material or component costs on to customers, others stated that that these cost increases have had a minimal affect on their margins. Due to the uncertainty in how market prices will response to standards, DOE assumes that this scenario represents a high bound to manufacturer selling prices after a new energy conservation standard.

Table 12.4.19 Preservation-of-Return-on-Invested-Capital Markup for Polyphase Small Electric Motors

Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 4B	TSL 5	TSL 6	TSL 7
1.453	1.452	1.452	1.448	1.446	1.442	1.446	1.446	1.413

Table 12.4.20 Preservation-of-Return-on-Invested-Capital Markup for all Capicitor-Start Motors

Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
1.453	1.454	1.456	1.456	1.447	1.444	1.421	1.468	1.447

12.4.9.2 Preservation-of-Operating Profit Scenario

Operating profit is defined as earnings before interest and taxes. The implicit assumption behind this markup scenario is that the industry can maintain its operating profit (in absolute dollars) after the standard. The industry would do so by passing through its increased costs to customers without increasing its operating profits in absolute dollars. DOE implemented this scenario in the GRIM by setting the markups for each TSL to yield approximately the same operating profit in the standards cases the year after the effective date (2016) as is yielded in the base case. For this scenario, the financial metrics of return on sales (percent) and return on invested capital (ROIC) decline with increasing TSL, indicating reduced industry profitability. DOE assumes that this scenario represents a low bound to manufacturer selling prices after a new energy conservation standard. The markups under this scenario are summarized in Table 12.4.21 and Table 12.4.22 for the representative motors.

Table 12.4.21 Preservation-of-Operating Profit Markup for Polyphase Small Electric Motors

Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 4B	TSL 5	TSL 6	TSL 7
1.453	1.443	1.440	1.433	1.430	1.413	1.384	1.368	1.298

Table 12.4.22 Preservation-of-Operating Profit Markup for all Capacitor-Start Motors

Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8
1.453	1.429	1.429	1.417	1.395	1.396	1.321	1.416	1.385

12.5 INDUSTRY FINANCIAL IMPACTS

Using the inputs and scenarios described in the previous sections, the GRIM estimated financial impacts on the SEM industry due to new energy conservation standards. The main results of the MIA are also reported in this section and consist of two key financial metrics: INPV and annual cash flows. During interviews, the majority of manufacturers generally agreed with the assumed markup of 1.45. With that figure fixed, the GRIM was calibrated to produce the same EBIT by adjusting the amounts for R&D and SG&A expenses.

12.5.1 Impacts on Industry Net Present Value

In the MIA, DOE compared the INPV of the base case (no new energy conservation standards) to that of each TSL. The difference in INPV is an estimate of the economic impacts that implementing that particular TSL would have on the entire industry. For the SEM industry, DOE examined two markup scenarios as described in the markup section above. Table 12.5.1 and Table 12.5.2 provide the INPV estimates for the SEM industry for polyphase motors under the different scenarios, while Table 12.5.3 and Table 12.5.4 provide the INPV estimates for the SEM industry for capacitor start motors under the different scenarios. The INPV figures are calculated separately for polyphase motors and capacitor start motors. The two capacitor start motor categories are combined for this analysis as they can potentially be used interchangeably for many functions.

Table 12.5.1 Change in Industry Net Present Value for Polyphase SEMs (Preservation of Return on Invested Capital Markup Scenario)

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

Table 12.5.2 Change in Industry Net Present Value for Polyphase SEMs (Preservation of Operating Profit Markup Scenario)

	Units	Base Case	Trial Standard Level							
			1	**2**	**3**	**4**	**4B**	**5**	**6**	**7**
INPV	2009$ millions	70	68	68	67	66	64	58	52	0
Change in INPV	2009$ millions	-	(1.49)	(1.86)	(2.26)	(3.58)	(5.43)	(11.80)	(17.51)	(69.47)
	%	-	(2.15)	(2.67)	(3.25)	(5.15)	(7.80)	(16.96)	(25.16)	(99.85)
Equipment Conversion Costs	2009$ millions	-	1.9	1.9	1.9	3.8	3.8	3.8	5.8	7.7
Capital Conversion Costs	2009$ millions	-	0.4	0.7	0.7	0.9	1.9	7.1	10.7	37.3
Total Investment Required	2009$ millions	-	2.3	2.6	2.7	4.7	5.7	10.9	16.5	45.0

Table 12.5.3 Change in Industry Net Present Value for Capacitor-Start SEMs (Preservation of Return on Invested Capital Markup Scenario)

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

Table 12.5.4 Change in Industry Net Present Value for Capacitor-Start SEMs (Preservation of Operating Profit Markup Scenario)

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

12.5.2 Impacts on Annual Cash Flow

While INPV is useful for evaluating the long-term effects of new energy conservation standards, short-term changes in cash flow are also important indicators of the industry's financial situation. For example, a large investment over a period of one or two years could strain the industry's access to capital. Consequently, the sharp drop in financial performance could cause investors to flee, even though recovery may be possible. Thus, a short-term disturbance can have long-term effects that the INPV cannot capture. To get an idea of the behavior of annual net cash flows, DOE presents the annual net or free cash flows from 2008 through 2044 for the different TSL levels. Table 12.5.5 and Table 12.5.6 present the annual net cash flows for the base case and each of the eight polyphase motor TSLs, while Table 12.5.7 and Table 12.5.8 present the annual net cash flows for the base case and each of the eight CSIR and CSCR TSLs for the SEM industry assuming the different markups scenarios.

Table 12.5.5 Annual Industry Net Cash Flows for Polyphase Motors (Preservation-of-Return-on-Invested-Capital Markup Scenario)

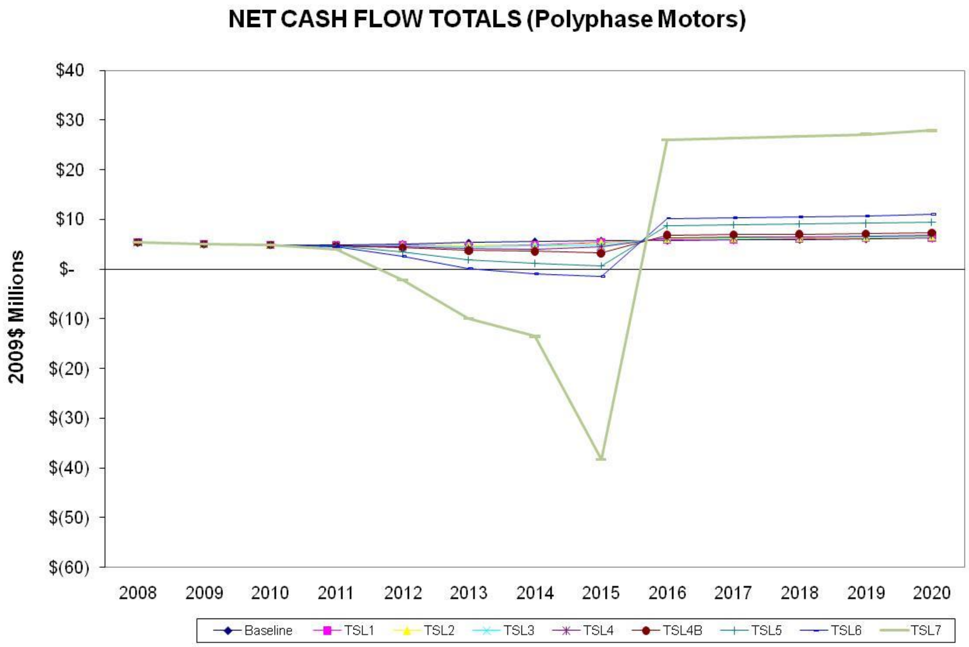
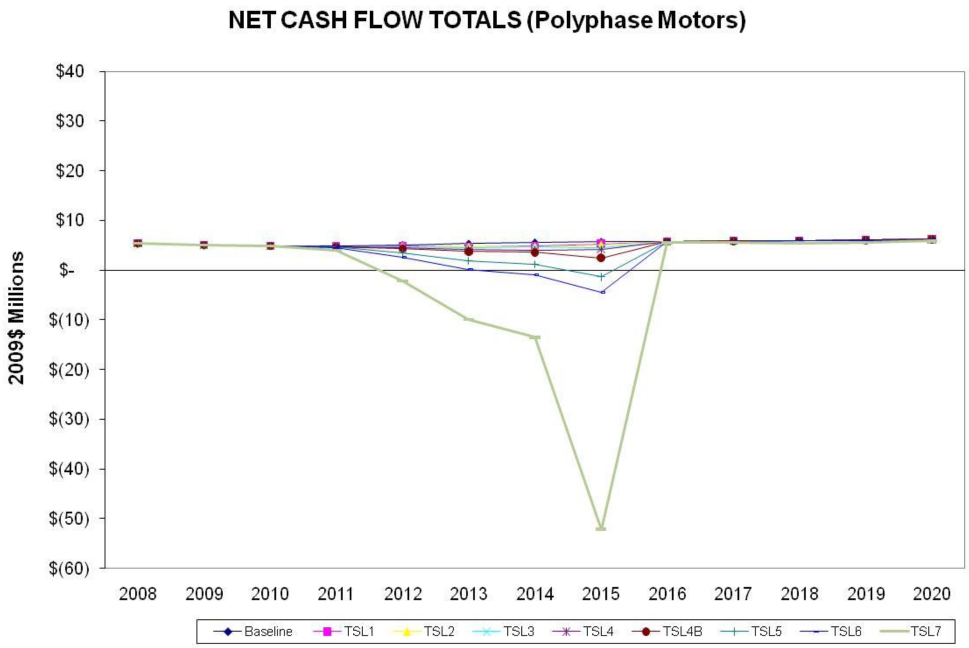


Table 12.5.6 Annual Industry Net Cash Flows for Polyphase Motors (Preservation-of-Operating Profit Markup Scenario)



Prior to the effective date of the amended energy conservation standard for polyphase motors, cash flows are driven by the level of capital investments and equipment conversion costs and the proportion of these investments spent every year. After the standard announcement date, industry cash flows begin to decline as companies use their financial resources to prepare for the new standard. The more stringent the energy conservation standard, the greater the impact on industry cash flows in the years running up to the effective date, as capital expenditures and equipment development costs depress cash flows from operations. Free cash flow begins to improve during the year the new energy conservation standard becomes effective. In this year, manufacturers write down the part of the value of existing tooling, equipment, and intellectual property whose value is impacted by the new efficiency standard. This one time write down acts as a tax shield that increases the cash flow from operations for this one year only. In the years following the standard, the impact on cash flow depends on the operating revenue.

Higher polyphase TSLs have a positive impact on cash flows relative to the base case under the preservation of return on invested capital markup scenario because manufacturers are able to pass along some costs to customers. Under this scenario, free cash flow is restored to baseline level or greater for all TSLs the year the standard becomes effective. Prior to 2015, higher TSLs have a greater cash outlay on the industry's cash position because the investment in new equipment, however, after 2015 the industry is able to obtain higher prices improve revenue brought in by standards compliant equipment and increase operating cash flows. Under this scenario, the higher the TSL, the higher industry cash flows will be.

Unlike the preservation of return on invested capital markup scenario, the preservation of operating profit markup scenario indicates higher polyphase TSLs will have a negative impact on free cash flow relative to the base case prior to the standards year of 2015. In this scenario, higher TSLs squeeze the gross margin percentages as higher incremental price increases of standards compliant equipment lead to a greater proportion of those costs not being recouped, eroding operating cash flow.

Table 12.5.7 Annual Industry Net Cash Flows for Capacitor Start Motors (Preservation-of-Return-on-Invested-Capital Markup Scenario)

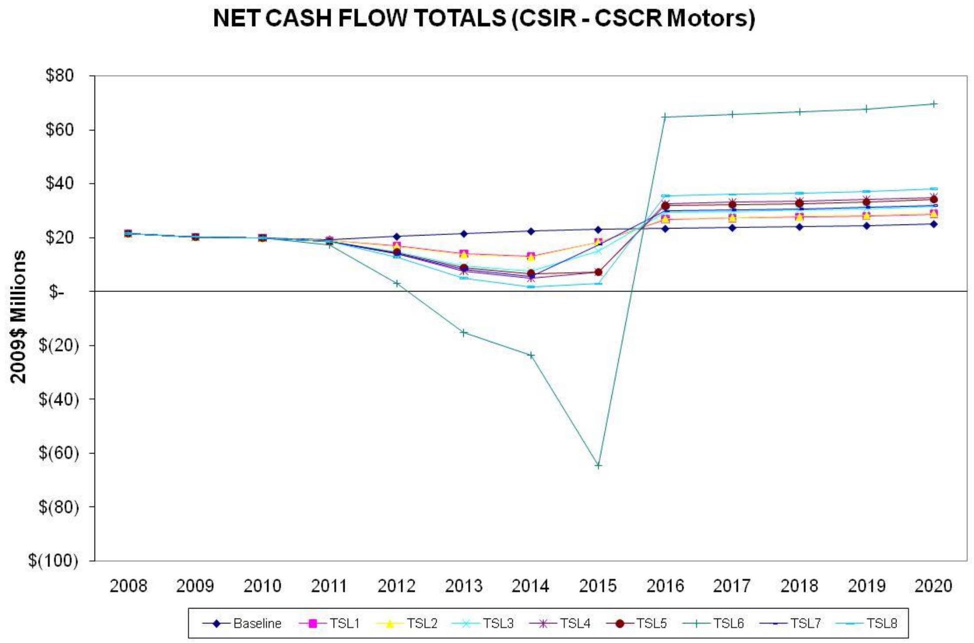
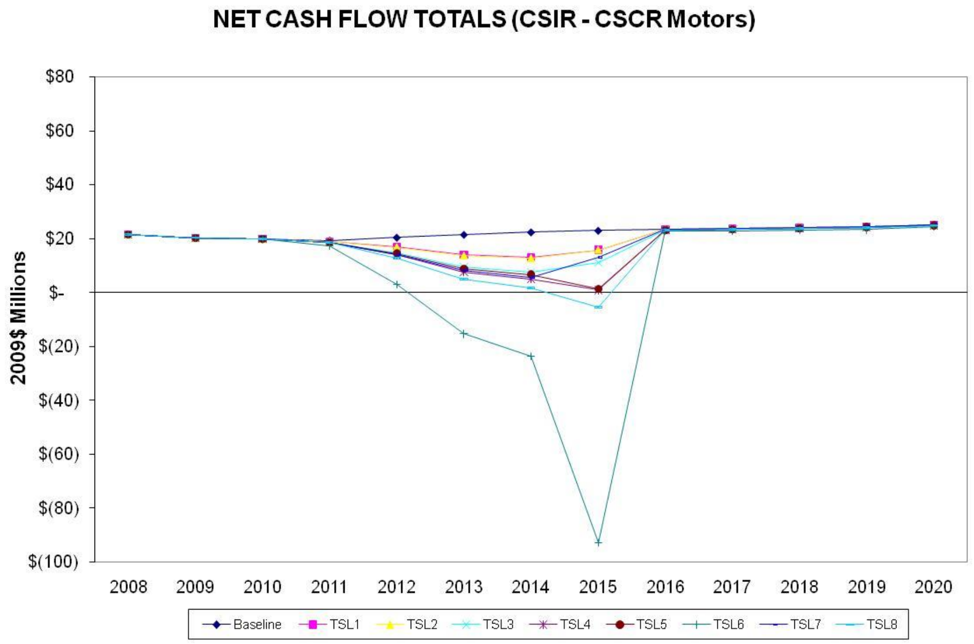


Table 12.5.8 Annual Industry Net Cash Flows for Capacitor Start Motors (Preservation-of-Operating Profit Markup Scenario)



Prior to the effective date of the amended energy conservation standard for capacitor start motors, cash flows are driven by the level of capital investments and equipment conversion costs and the proportion of these investments spent every year. After the standard announcement date, industry cash flows begin to decline as companies use their financial resources to prepare for the new standard. The more stringent the energy conservation standard, the greater the impact on industry cash flows in the years running up to the effective date, as capital expenditures and equipment development costs depress cash flows from operations. Free cash flow begins to improve during the year the new energy conservation standard becomes effective. In this year, manufacturers write down the part of the value of existing tooling, equipment, and intellectual property whose value is impacted by the new efficiency standard. This one time write down acts as a tax shield that increases the cash flow from operations for this one year only. In the years following the standard, the impact on cash flow depends on the operating revenue.

Higher capacitor start TSLs have a positive impact on cash flows relative to the base case under the preservation of return on invested capital markup scenario because manufacturers are able to pass along some costs to customers. Under this scenario, free cash flow is restored to baseline level or greater for all TSLs the year the standard becomes effective. Prior to 2015, higher TSLs have a greater cash outlay on the industry's cash position because the investment in new equipment, however, after 2015 the industry is able to obtain higher prices improve revenue brought in by standards compliant equipment and increase operating cash flows. Under this scenario, the higher the TSL, the higher industry cash flows will be.

Unlike the preservation of return on invested capital markup scenario, the preservation of operating profit markup scenario indicates higher TSLs will have a negative impact on free cash flow relative to the base case prior to the standards year of 2015. In this scenario, higher TSLs squeeze the gross margin percentages as higher incremental price increases of standards compliant equipment lead to a greater proportion of those costs not being recouped, eroding operating cash flow.

12.6 OTHER IMPACTS

12.6.1 Employment

To quantitatively assess the impacts of energy conservation standards on SEM manufacturing employment, DOE used the SEM GRIM to estimate the domestic labor expenditures and number of employees. Higher TSLs should not alter employment at the plant level. During interviews with manufacturers, DOE learned that many facilities produced many other products other than SEMs. DOE's figures assume that even if some manufacturers existed the market, these employees would still be retained.

DOE used statistical data from the U.S. Census Bureau's 2007 Economic Census (2007 EC), the results of the product price determination, and interviews with manufacturers to estimate the inputs necessary to calculate industry-wide labor expenditures and employment levels. DOE multiplied the labor percentage of COGS by the total annual COGS for the industry to calculate the total labor expenditure. DOE estimates that approximately 60 percent of SEMs are manufactured and sold in the U.S. DOE multiplied the total annual labor expenditures in the SEM GRIM by the percentage of U.S. production for domestic consumption to calculate domestic labor expenditures for SEM production labor. The domestic annual labor expenditures in the SEM GRIM were converted to a domestic production employment level by dividing domestic production labor expenditures by the annual payment per production worker (production worker hours times the labor rate found in the 2007 EC). The number of non-production employees was calculated by multiplying the number of production workers by the ratio of non-production workers to production workers calculated using the employment data in the 2007 EC.

The SEM GRIM calculates that the SEM industry's domestic labor expenditure for production labor in 2012 is approximately $33.7 million. Domestic labor expenditures on production labor is calculated by multiplying total COGS in 2012 times the production labor percentage of COGS times the percentage of U.S production. Using the $17.21 wage rate and 1,955 production hours per year per employee found in the 2007 EC, the SEM GRIM estimates that there are approximately 1,001 U.S. production workers in the SEM industry. In addition, DOE estimates that there are approximately 391 non-production employees in the U.S. support SEM production.[b] Direct employment levels are not expected to change due to the increased labor content of more efficient motors, and because the overall scale of the facility does not change with higher efficacy levels.

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. The employment impacts also do not account for the possible relocation of domestic jobs to lower-labor-cost countries because the potential relocation of U.S. jobs is uncertain and highly speculative.

12.6.2 Production Capacity

New energy conservation standards will not significantly affect the production capacity of small electric motor manufacturers. For manufacturers, any necessary redesign will not change the fundamental assembly of the products. Most manufacturers reported that current production equipment has the ability to produce motors designed to reach efficiency level 4 with only minor modifications needed. Therefore, in the long-term there should be no capacity constraints. Manufacturers indicated that producing more efficient small electric motors would

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[b] As defined in the 2006 Annual Survey of Manufacturers, production workers number include "workers (up through the line-supervisor level) engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping (but not delivering), maintenance, repair, janitorial and guard services, product development, auxiliary production for plant's own use (e.g., power plant), recordkeeping, and other services closely associated with these production operations at the establishment covered by the report. Employees above the working-supervisor level are excluded from this item." Non-production workers are defined as "employees of the manufacturing establishment including those engaged in factory supervision above the line-supervisor level. It includes sales (including driver-salespersons), sales delivery (highway truck drivers and their helpers), advertising, credit, collection, installation and servicing of own products, clerical and routine office functions, executive, purchasing, financing, legal, personnel (including cafeteria, medical, etc.), professional, and technical employees. Also included are employees on the payroll of the manufacturing establishment engaged in the construction of major additions or alterations utilized as a separate work force."

not be technically difficult and that they would not need to build new facilities to accommodate the manufacturing of a more efficient motor.

However, short-term capacity could be negatively affected if manufacturers significantly increase the number of laminations for each motor. This increase would likely necessitate the purchase of new stamping tooling and could create a bottleneck until the new tooling is purchased. Most manufacturers indicated that this bottleneck would be at least partially offset by current excess capacity. The real risk is that standards could cause manufacturers to eliminate some motor categories, and reduce overall production.

12.6.3 Exports

SEM exports comprise a small fraction of SEM sales for most manufacturers. A minority of manufactures sell more internationally than domestically, but these companies typically import SEMs from overseas. Manufacturers interviewed estimate that exports account for 10 to15 percent of total sales. The majority of exports are sold to Mexico and Asian countries.

Most manufacturers interviewed stated that they do not expect much change to their export strategies following standards. Regardless of standards, some manufacturers indicated that they expect an increase in exports going forward. Once the U.S. standard takes effect, SEM manufacturers would still be able to produce and export units that do not meet DOE's efficiency standard, since the standard only applies to equipment for use in the United States.

Manufacturers informed DOE that a large percent of the domestic market is imported. In turn, the manufacturers were concerned about the enforcement of energy conservation standards if legislation is enacted.

12.6.4 Cumulative Regulatory Burden

While any one regulation may not impose a significant burden on manufacturers, the combined effects of several 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 the cumulative regulatory burden analysis, DOE describes other significant equipment-specific regulations that could affect SEM manufactures or their parent company that will take effect three years before or three years after the effective date of the new energy conservation standards for the covered equipment.[c]

Companies that produce a wider range of regulated equipment may be faced with more capital and equipment development expenditures than their competitors. Regulatory burdens can prompt companies to exit the market or reduce their equipment offerings, possibly reducing competition. Smaller companies may be especially affected since they have lower sales volumes

[c] The effective date of new energy conservation standards for this rulemaking for SEMs is five years from the date of publication of the final rule (approximately February 2015).

over which to amortize the costs of meeting new regulations. A proposed standard is not economically justified if it contributes to an unacceptable level of cumulative regulatory burden.

In addition to the energy conservation regulations on SEMs, several other Federal regulations and pending regulations apply to this equipment and other equipment produced by the same manufacturers. DOE recognizes that each regulation can significantly impact manufacturers' financial operations. The following sections provide a qualitative discussion of some of these regulations and standards.

12.6.4.1 Federal Regulations on SEMs and Other Equipment Produced by the Same Manufacturers

Besides the energy conservation regulations on SEMs, several other Federal regulations and pending regulations apply to other equipment produced by the same manufacturers. DOE recognizes that each regulation can significantly impact manufacturers' financial operations. Multiple regulations affecting the same manufacturer can quickly strain manufacturers' profits and possibly cause an exit from the market. Table 12.6.1 lists the Federal regulations that could also affect manufacturers of the SEM industry in the three years leading up to and the three years preceding the effective date of the new energy conservation standards for this equipment. It must be noted that the amount of cumulative burden on any particular firm is extremely variable since the product scope of each company is different. Table 12.6.1 also provides the timetables for these regulations.

Table 12.6.1 Other DOE Actions Affecting the SEM Industry

Regulation	**Approximate Effective Date***	**Number of Impacted Companies from the MTA**	**Estimated Total Conversion Costs****
Power Supplies	2013*	1	N/A†
Water Heaters	2015*	1	N/A†

*The dates listed are an approximation. The exact dates are pending final DOE action

** Total conversion costs include both capital and equipment conversion costs.

† For energy conservation standards for ongoing rulemakings that are awaiting DOE final action, DOE does not have finalized estimated total industry conversion costs.

Additional investments necessary to meet these potential standards could have significant impacts on manufacturers of the covered equipment. However, DOE has limited data on the importance of these other regulated products for manufacturers of SEMs. Differences in market shares and manufacturing processes of other regulated products for each manufacture could cause varying degrees of burdens on these manufactures. Therefore, DOE only estimated the cost of compliance to meet other energy conservation standards for regulated products if DOE had published a final rule.

12.6.4.2 Restriction of Hazardous Substances Directive

The Restriction of Hazardous Substance Directive[2] (RoHS) will have some global impact on manufacturing of electrical and electronic equipment. Under the directive, all manufacturers are banned from placing on the European Union market new electrical and electronic equipment containing more than agreed levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl, and polybrominated diphenyl ether flame retardants. Though not all manufacturers export SEMs to the European Union, manufacturers stated this directive could potentially impact their business. Although there is no Federal regulation on RoHS, California has passed SB 20: Electronic Waste Recycling Act of 2003. Under this law, California limits the amount of hazardous substances included in the RoHS directive that can be sold in California. However, manufacturers do not anticipate RoHS will significantly affect the SEM industry as a whole.

12.6.4.3 Registration, Evaluation and Authorization of Chemical substances

Registration, Evaluation and Authorization of Chemical substances (REACH), is a European Community Regulation enacted on June 1, 2007 REACH requires manufacturers and importers demonstrate that they have identified and managed risks linked to the substances they manufacture and market. Companies are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency (ECHA). The Regulation also calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified. One manufacturer mentioned concern that new energy conservation standards would require added cost and time burdens with respect to REACH compliance.

12.6.4.4 Trade Group Regulations

The National Electrical Manufacturers Association (NEMA) and the International Electrotechnical Commission (ICS) both have optional standards that have impacted how manufacturers have designed SEMs. NEMA established a level of "premium" motors that achieve certain efficiency levels depending on product class. The IEC specified electrical (IEC 34) and mechanical (IEC 72) specifications in motors. If new regulations are enacted, this could impact both NEMA and IEC SEM designs.

12.6.4.5 Other Regulations

Some manufacturers expressed their opinion that the Canadian Standards Association (CSA) will likely adopt DOE's efficiency levels following the issuance of the final rule in 2010.

12.7 CONCLUSIONS

The following section summarizes the different impacts for the two scenarios DOE believes are most likely to capture the range of impacts on SEM manufacturers as a result of new energy conservation standards. DOE also notes that while these two scenarios bound the range of most plausible impacts on manufacturers, there potentially could be circumstances which cause manufacturers to experience impacts outside of this range.

To assess the higher end of the range of potential impacts on the SEM industry, DOE considered a scenario in which the industry return on invested capital in the base case is preserved in the standards case (*i.e.*, the markup is adjusted at each TSL). Thus, a manufacturer is able to pass on any additional costs due to standards at the same level as they have historically and maintain the ratio between net operating profits after taxes (NOPAT) and working capital.

To assess the lower end of the range of potential impacts for the SEM industry, DOE considered the scenario reflecting the preservation of operating profit markup. Besides the impact of shipments on the INPV, this case assumed that the industry can maintain its operating profit (EBIT) after the standard effective date. The industry would do so by passing through its increased costs to customers without passing through R&D and SG&A in the year standards become effective.

Polyphase Small Electric Motors

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

DOE estimated the impacts in INPV at TSL 2 to range from $0.34 million to -$1.86 million, or a change in INPV of 0.49 percent to 2.67 percent. At this level, industry cash flow decreases by approximately 15.6 percent, to $4.71 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 2 represents an efficiency increase of 4 percent over the baseline for polyphase motors. Similar to TSL 1, at TSL 2 manufacturers stated that their existing motor designs allow for simple modifications that would entail only minor capital and equipment conversion costs. A possible modification analyzed in the engineering analysis increases the number of laminations by approximately 15 percent from the baseline within both space-constrained and non 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 $0.98 million to -$2.26 million, or a change in INPV of 1.41 percent to -3.25 percent. At this level, industry cash flow decreases by approximately 16.4 percent, to $4.67 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 3 represents an efficiency increase of 6 percent over the baseline for polyphase motors. Similar to TSL 1 and TSL 2, at TSL 3 manufacturers stated that their existing motor designs would still allow for simple modifications that would not require significant capital and equipment conversion costs. In the engineering analysis, standards compliant motors that meet the efficiency requirements at TSL 3 have 17-percent increase in the number of laminations compared to the baseline design within both space-constrained and non 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 $0.57 million to -$3.58 million, or a change in INPV of 0.82 percent to -5.15 percent. At this level, industry cash flow decreases by approximately 27.7 percent, to $4.03 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 4 represents an efficiency increase of 7 percent over the baseline for polyphase motors. Most manufacturers that were interviewed are able to reach this level without significant redesigns. At TSL 4, a possible design pathway for manufacturers could be to increase the number of laminations by approximately 20 percent over the baseline designs within space-constrained and non space-constrained motors.

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

At TSL 5, DOE estimated the impacts in INPV to range from $12.62 million to -$11.80 million, or a change in INPV of 18.15 percent to -16.96 percent. At this level industry cash flow decreases by approximately 77.7 percent, to $1.24 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 5 represents an efficiency increase of 10-percent over the baseline for polyphase motors. TSL 5 is equivalent to the current NEMA premium level that manufacturers produce for medium-sized electric motors. Although some manufacturers reported having existing small electric motors that reach TSL 5, the designs necessary are more complex than their cost optimized designs at lower TSLs. A possible redesign for non space-constrained motors would include adding up to 49 percent more laminations relative to the baseline motor design and improving the grade of steel. For space-constrained motors, redesigns could require up to 114 percent more laminations of a thinner and higher grade of steel. Manufacturers are concerned that redesigns at TSL 5 could increase the size of the motors if they do not currently have motors that reach the NEMA premium efficiency levels. A shift to larger motors could be detrimental to sales due to the inability of OEMs to use standards- compliant motors as direct replacements in some applications. According to manufacturers, at TSL 5, the industry would incur significantly higher capital and equipment conversion costs in comparison to the lower efficiency levels analyzed. DOE estimates that the capital and equipment conversion costs required to make the redesigns at TSL 5 would be approximately four times the amount required to meet TSL 1. At TSL 5 manufacturers would also be required to shift their entire production of baseline motors to higher priced and higher efficiency motors, making their current cost-optimized designs obsolete. These higher production costs could have a greater impact on the industry value if operating profit does not increase. Manufacturers indicated that setting energy conservation standards at TSL 5 could cause some manufacturers to consider exiting the small electric motor market because of the lack of resources, potentially unjustifiable investments for a small segment of their business, and the possibility of lower revenues if OEMs will not accept large motors.

At TSL 6, DOE estimated the impacts in INPV to range from $18.54 million to -$17.51 million, or a change in INPV of 26.65 percent to -25.16 percent. At this level industry cash flow decreases by approximately 117.2 percent, to -$0.96 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 6 represents an efficiency increase of 12-percent over the baseline for polyphase motors. Currently, no small electric motors are rated above the equivalent to the NEMA premium standard (TSL 5). Possible redesigns for space-constrained motors at TSL 6 include the use of copper rotors and a 114-percent increase in the number of laminations of a thinner and higher grade of steel. These changes would cause manufacturers to incur significant capital and equipment conversion costs to redesign their space-constrained motors due to the lack of experience in using copper. According to manufacturers, copper tooling is significantly costlier and not currently used by any manufacturers for the production of small electric motors. If copper rotor designs are required, manufacturers with in-house die-casting capabilities will need completely new machinery to process copper. Manufacturers that outsource rotor production would pay higher prices for their rotor designs. In both cases, TSL 6 results in significant equipment conversion costs to modify current manufacturing processes in addition to redesigning motors to use copper in the applications of general purpose small electric motors. Largely due to the significant changes to space-constrained motors, DOE estimates that at TSL 6 manufacturers would incur close to seven times the total conversion costs required at TSL 1 (a total of approximately $16.5 million). However, for non spac-constrained motors, manufacturers are able to redesign their existing motors without the use of copper rotors by using twice the number of laminations that are contained in the baseline design. Therefore, for non space-constrained motors the impacts at TSL 6 are significantly less because manufacturers can maintain existing manufacturing processes without the potentially significant changes associated with copper rotors. At TSL 6 the impacts for non space-constrained motors are mainly due to higher motor costs and the possible decrease in profitability if manufacturers are unable to fully pass through their higher production costs.

At TSL 7, DOE estimated the impacts in INPV to range from $95.27 million to -$69.47 million, or a change in INPV of 136.95 percent to -99.85 percent. At this level industry cash flow decreases by approximately 342.4 percent, to -$13.52 million, compared to the base-case value of $5.58 million in the year leading up to the energy conservation standards. TSL 7 represents an efficiency increase of 14-percent over the baseline for polyphase motors. Currently, the market does not have any motors that reach TSL 7. At TSL 7, space-constrained motor designs may require the use of copper rotors and premium electrical steels, such as the Hiperco steel used in DOE's design. There is some uncertainty about the magnitude of the impacts on the industry of using Hiperco steel. Manufacturers were unsure about the required conversion costs to reach TSL 7 because of the unproven properties and applicability of the technology in the general purpose motors covered by this rulemaking. Significant R&D for both manufacturing processes and motor redesigns would be necessary to understand the applications of premium steels to general purpose small electric motors. According to manufacturers, requiring this technology could cause some competitors to exit the small electric motor market. If manufacturers' concerns of having to use both copper rotors and new steels materialize, manufacturers could be significantly impacted. For non space-constrained motors, DOE estimates that manufacturers would require the use of copper rotors but not premium steels. If manufacturers are required to redesign non-spaced constrained motors with copper, the total conversion costs for the industry increases greatly because all motors require substantially different production equipment. Finally, the production costs of motors that meet TSL 7 could be up to 18 times higher than the production costs of baseline motors. The cost to manufacture standards-compliant motors could have a significant impact on the industry if operating profit does not increase with production costs.

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

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

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

At TSL 3, DOE estimated the impacts in INPV to range from $16.27 million to -$32.42 million, or a change in INPV of 5.83 percent to -11.62 percent. At this level, industry cash flow decreases by approximately 66.5 percent, to $7.51 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 3 represents an efficiency increase of 23 percent over the baseline for CSIR motors and 13 percent over the baseline for CSCR motors. At TSL 3, space-constrained CSIR motors could require redesigns that use copper rotors. Using copper rotors for space-constrained CSIR motors could cause manufacturers to incur approximately $41.4 million in capital and equipment conversion costs, largely to purchase the equipment necessary to produce these redesigned motors. As with polyphase motors, manufacturers reported that copper rotor tooling is significantly costlier than traditional aluminum rotor tooling and not currently used by the industry for the production of small electric motors. Similarly, in-house die-casting capabilities would need completely new machinery to process copper and the alternative of outsourcing rotor production would greatly increase material costs. For non space-constrained CSIR motors, manufacturers could redesign motors by increasing the number of laminations without the use of copper rotors, resulting in significantly smaller impacts. At TSL 3, the impacts for non space-constrained motors are mainly due to higher motor material costs and a possible decline in profit margins. TSL 3 represents what manufacturers would consider a NEMA Premium equivalent efficiency level for CSCR motors. The required efficiencies for space-constrained CSCR motors could be met by manufacturers by increasing the number of laminations by 15 percent and using higher steel grades. The required efficiencies for non-spaced constrained CSCR motors could be met by increasing the number of laminations by 53 percent. Because the redesigns for CSCR motors are less substantial, the impacts at TSL 3 are driven largely by the required CSIR efficiencies.

At TSL 4, DOE estimated the impacts in INPV to range from $32.15 million to -$43.15 million, or a change in INPV of 11.52 percent to -15.46 percent. At this level, industry cash flow decreases by approximately 77.5 percent, to $5.02 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 4 represents an efficiency increase of 27 percent over the baseline for CSIR motors and 15 percent over the baseline for CSCR motors. TSL 4 currently represents a NEMA premium equivalent level for CSIR motors. Possible redesigns for both CSIR and CSCR motors to meet TSL 4 involve both increasing the number of laminations as well as using higher grades of steel. For space-constrained CSIR motors, redesigns could require the use of copper rotors. Because of these redesigns, standards-compliant motors at TSL 4 have significantly higher costs than manufacturers' baseline motors. These changes increase the engineering and capital resources that must be employed, especially for CSCR motors. The negative impacts at TSL 4 are driven by the conversion costs that potentially require some single-phase motors to use copper rotors, and the higher production costs of standards-compliant motors.

At TSL 5, DOE estimated the impacts in INPV to range from $28.48 million to -$40.09 million, or a change in INPV of 10.20 percent to -14.37 percent. At this level, industry cash flow decreases by approximately 70.2 percent, to $6.66 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 5 represents an efficiency increase of 27 percent over the baseline for CSIR motors and 13 percent over the baseline for CSCR motors. TSL 5 represents NEMA premium equivalent efficiency levels for both CSIR and CSCR motors. At TSL 5, space-constrained CSIR motors could require the use of copper rotors. The required efficiencies for non space-constrained CSIR motors could be met by manufacturers by increasing the number of laminations by 82 percent and using a higher grade of steel. The required efficiencies for space-constrained CSCR motors could be met by manufacturers by increasing the number of laminations by 15 percent and using higher steel grades. The required efficiencies for non-spaced constrained CSCR motors could be met by increasing the number of laminations by 53 percent. Although manufacturers reported that meeting TSL 5 is feasible, the production costs of motors at TSL 5 increase substantially and require approximately $43.2 million in total capital and equipment conversion costs. The negative impacts at TSL 5 are driven by these conversion costs that potentially require some CSIR motors to use copper rotors, and the impacts on profitability if the higher production costs of standards-compliant motors cannot be fully passed through to customers.

At TSL 6, DOE estimated the impacts in INPV to range from $186.60 million to -$152.05 million, or a change in INPV of 66.87 percent to -54.49 percent. At this level, industry cash flow decreases by approximately 205.8 percent, to -$22.67 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 6 represents an efficiency increase of 33 percent over the baseline for CSIR motors and 23 percent over the baseline for CSCR motors. Currently, the market does not have any CSIR and CSCR motors that reach TSL 6. TSL 6 represents the max-tech level for both CSIR and CSCR motors. In addition to the possibility of using copper rotors for both CSIR and CSCR motors, at TSL 6, space-constrained motor designs could require premium steels, such as Hiperco. There is uncertainty about the impact of Hiperco steel on the industry, primarily due to uncertainty about capital conversion costs required to use a new type of steel. Significant R&D in manufacturing processes would be necessary to understand the applications of these premium steels in general purpose small electric motors. Because all space-constrained motors could require copper rotors and premium steels and all non-spaced constrained motors could require copper rotors, the capital conversion costs are a significant driver of INPV at TSL 6. Finally, the production costs of motors that meet TSL 6 can be as high as 13 times the production cost of baseline motors, which impact profitability if the higher production costs cannot be fully passed through to OEMs. Manufacturers indicated that the potentially large impacts on the industry at TSL 6 could force some manufacturers to exit the small electric motor market because of the lack of resources and what could be an unjustifiable investment for a small segment of their total business.

At TSL 7, DOE estimated the impacts in INPV to range from $18.40 million to -$34.05 million, or a change in INPV of 6.59 percent to -12.20 percent. At this level, industry cash flow decreases by approximately 74.7 percent, to $5.66 million, compared to the base-case value of $22.38 million in the year leading up to the energy conservation standards. TSL 7 represents an efficiency increase of 33 percent over the baseline for CSIR motors and 13 percent over the baseline for CSCR motors. TSL 7 corresponds to the NEMA premium equivalent efficiency for CSCR motors. The required efficiencies for space-constrained CSCR motors could be met by manufacturers by increasing the number of laminations by 15 percent and using higher steel grades. The required efficiencies for non space-constrained CSCR motors could be met by increasing the number of laminations by 53 percent. Consequently, the industry is not severely impacted by the CSCR efficiency requirements at TSL 7 because these design changes could be met with relatively minor changes to baseline designs. However, there are no CSIR motors currently on the market that reach TSL 7 (the max-tech level for CSIR). At TSL 7 space-constrained CSIR redesigns could require the use of both copper rotors and premium steels while non space-constrained CSIR motors could require only copper rotors. Manufacturers continue to have the same concerns about copper rotors and premium steels for CSIR motors as with other efficiency levels that may require these technologies. The impacts on INPV from CSIR motors are mainly associated with estimated shipments of non-space constrained CSIR motors and how investments exclude premium steels in motor redesigns. The INPV impacts for all single-phase motors at TSL 7 are less severe than at TSL 6 due to a change in balance of shipments between CSIR and CSCR motors. At TSL 7, the possible high cost of CSIR motors would likely cause customers to migrate to CSCR motors. In its analysis, DOE assumed that manufacturers would not invest in all the alternative technologies for CSIR motors in light of the expected migration to CSCR motors. At TSL 7, the industry is impacted (though to a lesser extent than at TSL 6) by the high conversion costs for CSIR motors, for which manufacturers must invest even though these are a small portion of total shipments after standards. However, because the total volume of single-phase motors does not decline with the shift from CSIR to CSCR motors, the higher revenues from standards-compliant CSCR motors mitigate redesign costs for CSIR motors.

At TSL 8, DOE estimated the impacts in INPV to range from $46.35 million to -$52.58 million, or a change in INPV of 13.07 percent to -16.17 percent. At this level, industry cash flow decreases by approximately 92.1 percent, to $1.77 million, compared to the base-case value of $22.38 million in the year leading up to the compliance date for the energy conservation standards. TSL 8 represents an efficiency increase of 33 percent over the baseline for CSIR motors and 20 percent over the baseline for CSCR motors. As with TSL 7, CSIR motors are at the max-tech level at TSL 8. However, the impacts on INPV are worse at TSL 7 because the efficiency requirements for CSCR motors increase. At TSL 8, both space-constrained and non space-constrained CSCR motors could require the use of copper, which increases the total conversion costs for the industry. Manufacturers continue to share the same concerns about the copper and premium steel investments for CSCR and CSIR motors as at TSL 6 and TSL 7. Like TSL 7, TSL 8 causes a migration of CSIR motors to CSCR motors. DOE assumed that manufacturers would fully incur the required conversion costs for CSCR, but partially for CSIR motors, due to the low market share of CSIR motors after the energy conservation standards must be met. After these standards apply, the shift to CSCR motors increases total industry revenue and helps to mitigate impacts related to capital conversion costs necessary for CSIR motors to use alternative technologies.

REFERENCES

[1] Securities and Exchange Commission, *Annual 10-K Reports*, Various Years, Washington D.C., www.sec.gov.

[2] Further information about RoHS can be found at http://eur-lex.europa.eu/LexUriServ/site/en/oj/2003/l_037/l_03720030213en00190023.pdf.