CHAPTER 9. SHIPMENTS ANALYSIS

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CHAPTER 9. SHIPMENTS ANALYSIS

9.1 INTRODUCTION

The U.S. Department of Energy (DOE) analyzes shipments of affected equipment as a part of its rulemakings about new or amended energy efficiency standards for equipment that impact national energy use. Estimates of shipments are a necessary input to calculating national energy savings (NES) and net present value (NPV) of the investment in more efficient equipment; both of these calculations are required to analyze the impact of proposed new or amended energy efficiency standards. Shipments also are a necessary input to the manufacturer impact analysis (MIA), which DOE conducts to prepare its notice of proposed rulemaking (NOPR). The MIA estimates the impact of potential efficiency standards on manufacturers of the affected equipment, in this case electric motors, and assesses the direct impact of such standards on employment and manufacturing capacity. This chapter describes the method DOE used to project annual shipments for electric motors under base- and standards-case efficiency levels and the results obtained.

DOE developed a shipments model to predict shipments of electric motors covered in this analysis. The core of the shipments analysis is a model that DOE developed to simulate how future purchases are incorporated into an in-service stock of aging motors that are gradually replaced. DOE's motors shipments projections are based on forecasts of economic growth and do not incorporate a distinction within shipments between replacements and purchases for new applications.

To formulate its total shipments estimates, DOE began with shipments data from a market research report[1], input from interested parties, and responses to the Request for Information (RFI) published in the Federal Register (76 FR 17577 (March 30, 2011)). Based on a database of motor field data[2], U.S. Census Bureau's Current Industrial Reports[3,4], and stakeholder input, DOE then developed a distribution of shipments across each of the three equipment class group (NEMA Design A and B, NEMA Design C, and fire pump motors). Within each category, motor shipments were split into several horsepower ratings, rotation speeds (corresponding to 2-pole, 4-pole, 6-pole, and 8-pole motors), and two enclosure types (open or enclosed) to arrive at shipments at the equipment class level.

The shipments model is prepared as a Microsoft Excel spreadsheet that is accessible on the Internet (http://www.eere.energy.gov/buildings/appliance_standards/). Appendix 10-A discusses how to access the shipments model and other related spreadsheets and provides basic instructions for using them. The rest of this chapter explains the shipments model in more detail. Section 9.2 provides a summary of the data DOE used to develop estimates of the shipments of covered electric motors by equipment class and for each sector and applications. Section 9.3 describes the methodology that underlies development of the model and presents the shipments projection.

9.2 TOTAL SHIPMENTS

Based on a market research report[1] and stakeholder input and responses to the RFI, annual shipments of covered motors were estimated to total 4.56 million units in 2011.

DOE drew upon two data sources to develop a distribution of the total shipments across the 510 equipment classes: input from interested parties, and data from extensive field measurements collected by the Washington State University Extension Energy Program (WSU), Applied Proactive Technologies and the New York State Energy Research and Development Authority (NYSERDA) 2 ("WSU/NYSERDA database").

9.2.1 Distribution across Equipment Class Groups

DOE derived the distribution by equipment class group from the WSU/NYSERDA database (Table 9.2.1).

Table 9.2.1 Share of Motors by Equipment Class Group in Percent

NEMA Design A and B	NEMA Design C	Fire Pump
99.68	0.20	0.12

9.2.2 Distribution across Horsepower

Shipments were first distributed by horsepower range, based on U.S. Census Bureau's Current Industrial Reports3,4 and input from interested parties (Table 9.2.2).

Table 9.2.2 Share of Motors by Horsepower Range

Range *hp*	2011 Shipments (*1,000*)	Percentage of Total (*%*)
1 – 5	2,668	58.5%
6 – 20	1,368	30.0%
21 – 50	342	7.5%
51 – 100	114	2.5%
101 – 200	46	1.0%
201 – 500	23	0.5%
Total	4,560	100.0%

DOE then split shipments by individual horsepower rating, based on the distribution observed in the WSU/NYSERDA database (Table 9.2.3).

Table 9.2.3 Share of Motors by Horsepower Rating

Horsepower rating *hp*	Percentage of Total (%)
1	6.2%
1.5	5.6%
2	10.2%
3	14.5%
5	22.1%
7.5	9.1%
10	8.2%
15	8.1%
20	4.5%
25	2.1%
30	2.0%
40	2.1%
50	1.3%
60	0.8%
75	0.9%
100	0.8%
125	0.4%
150	0.4%
200	0.3%
250	0.3%
300	0.1%
350	0.04%
400	0.1%
450	0.02%
500	0.03%

9.2.3 Distribution across Pole Configurations and Enclosures

DOE derived the distribution by pole configuration and enclosure from the WSU/NYSERDA database (Table 9.2.4).

Table 9.2.4 Share of Motors by Pole Configuration and Enclosure (All Equipment Class Groups)

Enclosure	Open				Enclosed			
Range *hp*	2 poles	4 poles	6 poles	8 poles	2 poles	4 poles	6 poles	8 poles
1 – 5	0.7%	8.1%	1.1%	0.1%	5.0%	19.6%	2.6%	1.4%
6 – 20	1.0%	6.2%	0.6%	0.1%	6.6%	17.0%	1.5%	0.2%
21 – 50	0.3%	2.3%	0.2%	0.1%	2.7%	8.1%	1.6%	0.1%
51 – 100	0.1%	0.9%	0.4%	0.1%	0.7%	4.1%	1.0%	0.1%
101 – 200	0.0%	0.4%	0.1%	0.1%	0.2%	2.3%	1.0%	0.2%
201 – 500	0.1%	0.1%	0.1%	0.1%	0.1%	0.4%	0.1%	0.1%

DOE then combined the distribution by horsepower and the share of motors by pole and enclosure configuration to estimate the shipment distribution per equipment class.

9.2.4 Distribution across Equipment Classes, Sectors and Applications

DOE used the data presented in Table 9.2.1, Table 9.2.2, Table 9.2.3, and Table 9.2.4 to produce market shares for each of the 510 equipment classes. Further, DOE developed a model of the applications and sectors for which motors covered in this analysis are used. These distributions are presented in chapter 7, Energy Use Characterization.

9.3 SHIPMENTS PROJECTION

9.3.1 Shipments Model

DOE projected shipments of covered motors throughout the 30-year analysis period, which stretches from 2015 (the effective date of the standard) to 2044. DOE projects total shipments using a model driven by forecasted economic growth. DOE assumed that motors sales are driven by economic growth and machinery production growth for equipment including motors.

Based on historical data for the period 1993-2011 on U.S. shipments provided by the U.S. Census Bureau[3,5]and NEMA[6,7] and private fixed investment data from the Bureau of Economic Analysis's (BEA)[8,9], DOE assumes that annual shipments growth rate correlate to the annual growth rate of private fixed investment in selected equipment and structures[10,a] including motors (Figure 9.3.1).

[a] Heating, ventilation, and air conditioning (HVAC) equipment which incorporates motors is typically included in "structures" and not in equipment. Based on RSMeans, DOE estimates that 9 percent of investments in structures are related to HVAC equipment.

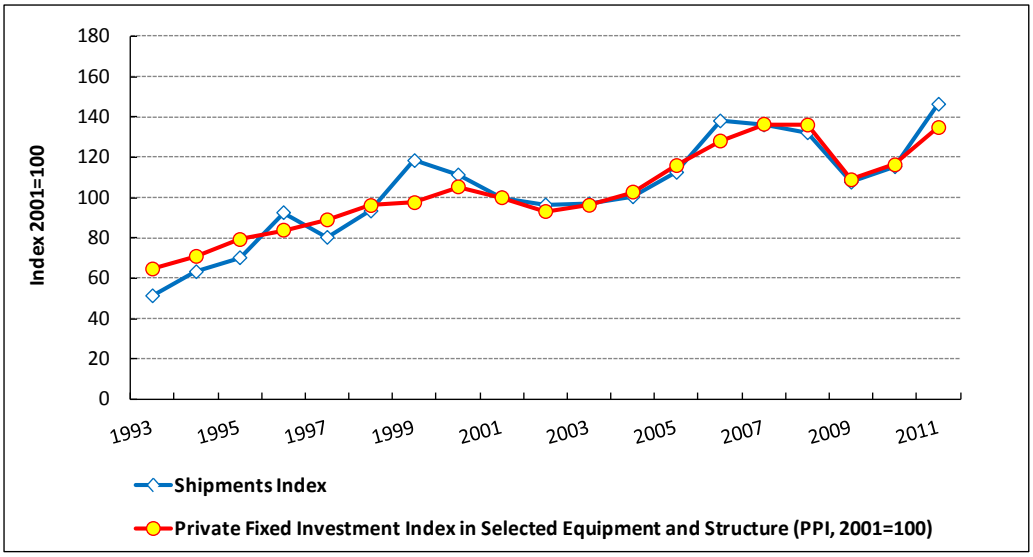

Figure 9.3.1 Shipments Index vs. Private Fixed Investment Index in Selected Equipment and Structure

DOE developed a relationship between shipments and private fixed investment in equipment and structures including motors (indexed to 2001). The relation, derived from a linear regression (R^2=0.91), is expressed by the following equation:

$$Shipments_{index}(y) = 1.15126 \cdot FixInvest_{index}(y) - 15.17265 \text{Shipments}_{\text{index}}(\text{y}) = 1.15126 \cdot \text{FixInvest}_{\text{index}}(\text{y})\text{-}15.17265 \quad \text{[Equation 1, Step 0]}$$

Where:

$Shipments_{index}$ (y) is the shipments index based in 2001 in year *y*, and
$FixInvest_{index}$ (y) is the private fixed investment index based in 2001 for selected equipment and structure including motors in year *y*.

DOE projects private fixed investment in selected equipment and structure from 2015 through 2035 based on the real "gross domestic product" (GDP) growth from the Energy Information Administration Annual Energy Outlook for 2011 (*AEO2011*) for the period 2015–2035. DOE then extrapolated the GDP growth trend from 2035 to 2044. The steps for the calculation are:

1) Based on historical data from the BEA, DOE projected private fixed investment in equipment and structure including motors as a share of total private fixed investment in equipment and structure for 2015 to 2044.
2) For 2015 to 2035, DOE used total private fixed investment in equipment and structures data (private domestic investment data) from *AEO2011* to project private fixed investment in equipment and structure including motors.

3) From 2035 to 2044, DOE used *AEO 2011* data to estimate a trend for private domestic investment as a share of GDP using a linear regression (R^2>0.99). DOE then projected the GDP for 2035 to 2044 using a quadratic regression based on *AEO 2011* data (R^2>0.99). Using the GDP projection, DOE projected *private domestic investment* and estimated private fixed investment in equipment and structure including motors.
4) DOE used the data on projected private fixed investment in equipment and structure including motors and Equation 1 to estimate shipments growth over the analysis period (2015–2044).

Following the same methodology, DOE estimated shipments projections for the Reference Economic Growth Case, the High Economic Growth Case, and Low Economic Growth Case available in *AEO 2011*.

9.3.2 Shipments in Standards Cases

Sales of electric motors may be sensitive to increases in the installed cost that may result from efficiency standards. Increased motor prices could affect the repair versus replace decision that the user makes and could lead to increasing the longevity of less efficient motors and decreased shipments. However, DOE did not find sufficient data to quantitatively estimate the impact of increased efficiency levels on shipments and therefore used a price elasticity equal to zero as a default.

9.3.3 Shipments Data

Figure 9.3.2 shows the annual shipments for each scenario case between 2015 and 2044.

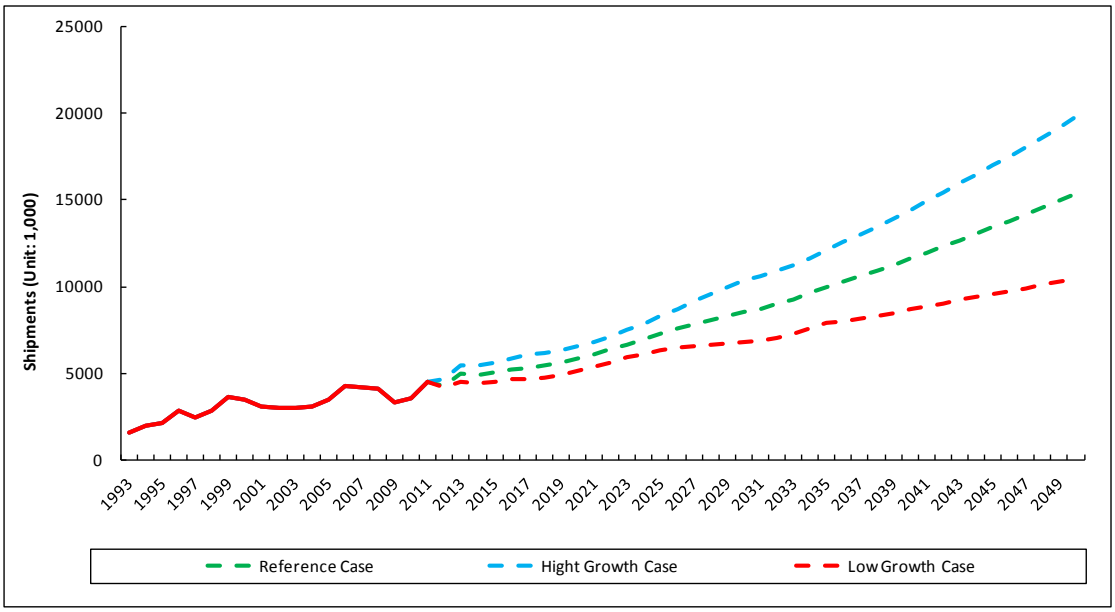

Figure 9.3.2 Shipments Projection by Scenario Case

Table 9.3.1 shows the annual and cumulative shipments for each equipment class grouping for Reference Case

Table 9.3.1 Annual and Cumulative Shipments Projection

Equipment Class Grouping	Annual Shipments *thousand units*				
	2015	**2025**	**2035**	**2044**	**Cumulative 2015–2044**
NEMA Designs A & B	5,072	7,254	9,958	13,005	256,846
NEMA Design C	10	15	20	26	515
Fire Pump	6	9	12	16	309
Total*	5,089	7,278	9,990	13,047	257,671

*Total may not sum up because of rounding.

There are two major assumptions inherent in the shipments model:

1) The relative market shares of the different equipment classes are constant over time.
2) U.S. production, imports, exports, and therefore shipments (i.e. apparent consumption) have the same growth rate as described by the shipments index provided by NEMA[6,7] (see section 9.3.1).

REFERENCES

[1] IMS Research (February 2012), The *World Market for Low Voltage Motors, 2012 Edition*, Austin.

[2] Database of motor nameplate and field measurements compiled by the Washington State University Extension Energy Program (WSU) and Applied Proactive Technologies (APT) under contract with the New York State Energy Research and Development Authority (NYSERDA). 2011.

[3] U.S. Census Bureau (November 2004), *Motors and Generators – 2003.MA335H(03)-1*. http://www.census.gov/manufacturing/cir/historical_data/discontinued/ma335h/index.html

[4] U.S. Census Bureau (August 2003), *Motors and Generators – 2002.MA335H(02)-1*. at http://www.census.gov/manufacturing/cir/historical_data/discontinued/ma335h/ma335h02.xls

[5] U.S. Census Bureau, Current Industrial Report: Manufacturing Profiles, 1994-1998.

[6] NEMA (2007), *Motor Shipments Slip in Third Quarter of 2007*, NEMA News, on 05 Dec 2007.

[7] NEMA (2011*), Motors Shipments on the Upswing in First Half of 2011*, NEMA News, on 18 Aug 2011.

[8] Bureau of Economic Analysis (March 01, 2012), Private *Fixed Investment in Equipment and Software by Type*. http://www.bea.gov/iTable/iTable.cfm?ReqID=12&step=1

[9] Bureau of Economic Analysis (March 01, 2012), Private *Fixed Investment in Structures by Type*. http://www.bea.gov/iTable/iTable.cfm?ReqID=12&step=1

[10] RSMeans (2011), *RSMeans Facilities Construction Cost Data 201*, Norwell.