United States Industrial Electric Motor Systems Market Opportunities Assessment
December 2002

This document was originally published by the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) in December 1998. As of fiscal year 2000, DOE's Motor Challenge Program was integrated into BestPractices, a broad initiative within EERE.

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OFFICE OF INDUSTRIAL TECHNOLOGIES

MOTOR CHALLENGE

United States Industrial Electric Motor Systems Market Opportunities Assessment

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY
U.S. DEPARTMENT OF ENERGY

United States Industrial Electric Motor Systems Market Opportunities Assessment

PREPARED FOR
THE U.S. DEPARTMENT OF ENERGY'S
OFFICE OF INDUSTRIAL TECHNOLOGIES AND
OAK RIDGE NATIONAL LABORATORY
(OPERATED BY LOCKHEED MARTIN ENERGY RESEARCH, INC.)

BY XENERGY, INC.,
BURLINGTON, MASSACHUSETTS

DECEMBER 1998

ACKNOWLEDGEMENTS

We would like to thank Paul Scheihing of the U.S. Department of Energy's Office of Industrial Technologies and Mitch Olszewski of Oak Ridge National Laboratory for their guidance and support throughout this project.

The following individuals provided technical review and suggestions at various points in the development of this report:

Lawrence Ambs, University of Massachusetts–Amherst
Aimee McKane, Lawrence Berkeley National Laboratory
R. Neal Elliot, American Council for an Energy-Efficient Economy
Dwight French, Energy Information Administration, U.S. Department of Energy
Bruce Meberg, Easton Consultants
Gunnar Hovstadius, ITT Flygt
Steve Wilson, PACO Pumps
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Amory Lovins, Rocky Mountain Institute

We thank these individuals for their time and insights. XENERGY is, of course, responsible for the report and any errors it might contain.

Finally, we wish to thank the management and staff of the 265 industrial establishments who allowed us to conduct inventories of their facilities, provided escorts for our field engineers, and discussed their motor system purchase and management practices with them. Without their active cooperation, this report could not have been completed.

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Executive Summary

PROJECT OBJECTIVES

This is the *Final Report of the United States Industrial Electric Motor System Market Opportunities Assessment.* The Market Assessment is one component of the United States Department of Energy's (DOE's) Motor Challenge Program. Motor Challenge is an industry/government partnership designed to help industry capture significant energy and cost savings by increasing the efficiency of motor systems. DOE's primary strategy is to support plant managers in applying a systems approach to specifying, purchasing, and managing electric motors and related machines so as to minimize the electricity needed to achieve production goals. This Market Assessment is intended to serve as a blue print for the implementation of the Motor Challenge strategy.

The objectives of the Market Assessment are to:

- Develop a detailed profile of the current stock of motor-driven equipment in U.S. industrial facilities;
- Characterize and estimate the magnitude of opportunities to improve the energy efficiency of industrial motor systems;
- Develop a profile of current motor system purchase and maintenance practices;
- Develop and implement a procedure to update the detailed motor profile on a regular basis using readily available market information; and,
- Develop methods to estimate the energy savings and market effects attributable to the Motor Challenge Program.

In addition to serving DOE's program planning and evaluation needs, the Market Assessment is designed to be of value to manufacturers, distributors, engineers, and others in the supply channels for motor systems. It provides a detailed and highly differentiated portrait of their end-use markets. For factory managers, this study presents information they can use to identify motor system energy savings opportunities in their own facilities, and to benchmark their current motor system purchase and management procedures against concepts of best practice.

The Market Assessment was carried out by XENERGY Inc. under a subcontract with Oak Ridge National Laboratory (Lockheed Martin Energy Systems). The project was initiated in the autumn of 1995. Field data collection was carried out during most of calendar 1997. Many individuals and organizations contributed to this study. We would particularly like to thank the facilities managers and staff who permitted us to conduct inventories of their motor systems and the representatives of industry, government, and academic organizations who volunteered their time to review the study and its reports at various stages of development.

OVERVIEW OF FINDINGS

Magnitude of industrial motor system energy use and potential energy savings.
In 1994, electric motor-driven systems used in industrial processes consumed 679 billion kWh—23 percent of all electricity sold in the United States. These machines make up by far the largest single category of electricity end use in the American economy. Based on detailed analysis of the motor systems inventory, we estimate that industrial motor energy use could be reduced by 11 to 18 percent if facilities managers undertook *all cost-effective applications of mature proven*

efficiency technologies and practices. That is, implementation of all well-established motor system energy efficiency measures and practices that meet reasonable investment criteria will yield annual energy savings of 75 to 122 billion kWh, with a value of $3.6–$5.8 billion at current industrial energy prices.[1] Many kinds of motor system efficiency improvements yield benefits in addition to energy cost reductions. These include improved control over production processes, reduction in waste materials, and improved environmental compliance.

Of course, this full potential cannot be captured all at once. That would require expenditures of $11–$17 billion, roughly 10 percent of total new capital expenditures by all manufacturers in 1994. While the opportunities for energy savings and other benefits associated with investments in improved motor systems are enormous, so too are the demands on capital and management resources in industrial organizations. Moreover, we identified many barriers which have prevented industrial facilities managers from capturing more than a small percentage of the potential benefits of motor system efficiency. These are described on page 4.

On average, the manufacturing sector could reduce industrial motor energy use by 11% to 18% using mature, proven efficiency technologies and practices. This Greenville Tube production facility reduced its annual energy use by 34% and saved $77,266 annually through improving the efficiency of its tube drawing bench.

Categories and relative size of motor system energy savings opportunities.
There are two basic categories of motor system energy efficiency measures:

- **Motor efficiency upgrades** which improve the energy efficiency of the motor driving a particular machine or group of machines; and,
- **System efficiency measures** which improve the efficiency of a machine or group of machines as a whole. System efficiency can be improved by reducing the overall load on the motor through improved process or system design, improving the match between component size and load requirements, use of speed control instead of throttling or bypass mechanisms, and better maintenance, to name just a few of the engineering strategies available.

We estimate that motor efficiency upgrades can achieve potential savings of about 19.8 billion kWh per year. Improved methods of rewinding failed motors can contribute an additional 4.8 billion kWh. Energy savings from system efficiency improvements are potentially much larger: 37 to 79 billion kWh per year. Most motor efficiency upgrades can be achieved fairly easily by selecting the most efficient available motor for the application at hand. System efficiency measures, on the other hand, often require a significant amount of effort on the part of industrial end-users and their vendors to identify, design, implement, and maintain.

Progress to date: motor efficiency upgrades.
The Market Assessment Inventory (MAI) found that motors which meet federal efficiency standards which took effect in October 1997 account for 9.1 percent of the motors currently in use in manufacturing facilities. Such motors have been available for two decades. Between 1993 and 1996, they constituted about 18 percent of all motors sold in the 1–200 horsepower range

1 We applied a guideline of a 3-year simple payback when questioning engineers and market experts regarding the applicability of common motor system efficiency measures. Average industrial energy price: $0.048 per kWh. (EIA 1997)

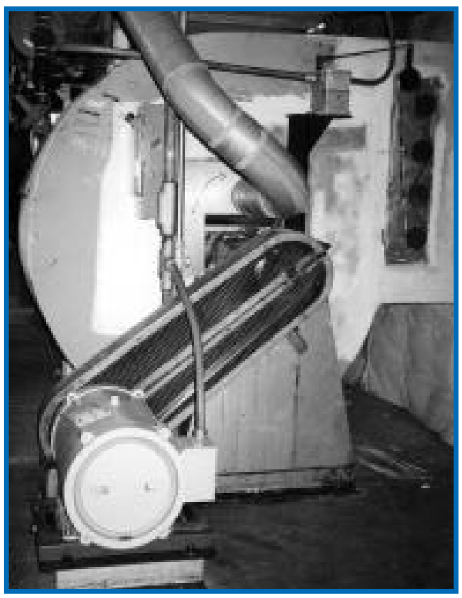
covered by the efficiency standard.[2] In aggregate, efficient motors currently in place are saving industrial facilities 3.3 billion kWh per year, compared to motors of average efficiency sold previous to the promulgation of federal efficiency standards.

Replacement of general purpose AC induction motors currently in use with motors that meet federal efficiency standards will yield energy savings of 13.0 billion kWh per year. Replacement with the most efficient motors currently available will yield an additional 6.8 billion kWh in annual savings. Given patterns of new motor purchase and rewinding of failed motors documented here, it will take 15 to 20 years for current population 1–200 horsepower motors to be 80 percent replaced. The challenge for government and utility efficiency programs is to assist in accelerating the pace of replacement.

Progress to date: system efficiency measures.

The remaining 37 to 79 billion kWh in annual savings will be realized one project or plant at a time through the efforts of facilities managers, engineering and maintenance staff, designers, distributors, and manufacturers. A small number of companies, primarily multinational corporations in industries with high concentrations of motor system energy use, have enacted aggressive programs to identify and capture system improvement opportunities and to monitor and maintain these systems on an ongoing basis. These companies have been amply rewarded for their efforts. The Motor Challenge Program has documented over a dozen major projects that have yielded average system-level energy savings of 33 percent, and some as high as 60 percent. Within the manufacturing sector as a whole, installations of adjustable speed drives now in place yield 3–6 billion kWh in annual savings compared to conventional control mechanisms such as throttle valves and bypass loops. Common improvements to air compressor systems have yielded an estimated 1 billion kWh per year in additional savings.

Using system efficiency measures that included adjustable speed drives and energy-efficient motors on the supply air fan, 3M cut electricity use by 41% in one building and saved over $77,000 per year.



Despite the success of a few companies and the relative maturity of the technologies used to achieve motor systems efficiency, the level of knowledge and adoption of system efficiency measures among facilities managers is very low. Motor systems equipped with adjustable speed drives account for only 4 percent of manufacturing motor system energy, compared to a potential level of application between 18 and 25 percent. We found that only the largest plants had implemented the most common kinds of system improvements in the past 2 years to any great extent, and the pattern of knowledge and implementation, even among the largest companies, was inconsistent. Among all manufacturing facilities, 24 percent reported that they had not taken any of a long list of potential system efficiency measures over the past 2 years.

[2] Standards contained in the Energy Policy Act (EPAct) of 1992 apply to all integral horsepower, general purpose, AC induction motors from 1–200 HP. Such motors constitute 50 to 70 percent of all motors sold in the relevant horsepower classes.

Barriers and solutions.
We and other researchers have found that industrial facilities managers face significant barriers to capturing the financial and operating benefits of motor system energy improvements. Among the most important are the following:

- Low priority of energy efficiency among capital investment and operating objectives. Within manufacturing as a whole, motor system energy costs constitute less than 1 percent of total operating costs. This figure is considerably higher for a small number of energy-intensive industries such as paper and chemicals.
- General lack of awareness among facilities managers, equipment distributors, engineers, and manufacturers' representatives of strategies to achieve motor system efficiency: their costs, management requirements, and benefits.
- Generally low level of staffing for the facilities maintenance function.
- Conflicting incentives for suppliers regarding the promotion of efficient equipment and practices. For example, compressed air distributors have greater incentive to sell additional compressors to customers with increasing load rather than to advise those customers how to control load growth through better maintenance and production planning.

Partnership solutions.
In order to capture the economic and environmental benefits of improved motor system efficiency, all participants in the motor systems markets—end-users, manufacturers, distributors, and designers—must develop new ways of doing business. Realizing the benefits of motor systems upgrades may be a relatively simple matter of adopting specifications for motor purchases and rewinds. To capture system efficiencies, facilities managers and their vendors, and consulting engineers will need to assess operations on a periodic basis to identify the major savings opportunities available in virtually every factory, then work together to design and implement the projects.

Facilities managers, their vendors, and consulting engineers will need to work together to identify and capture major savings opportunities.

No one group of market actors can accomplish this transformation working alone; the barriers of conflicting interests and resource constraints are simply too high. Rather, end-users and suppliers must identify where their business interests in motor systems efficiency coincide and develop ways to work together to realize those interests. The Motor Challenge Program is designed to assist market actors in accomplishing these objectives. Among the program's many achievements to date is the development of the MotorMaster+ motor selection software, which couples an electronic equipment catalog to a sophisticated economic analysis program to help customers select the most cost-effective motor for their needs. Not only has this software program been of direct benefit to end-users, but it has been distributed by motor vendors as a promotional tool for their energy-efficient lines. The Motor Challenge Program, guided by the results of the this Market Assessment and the advice of industry experts, continues to develop new initiatives to transform the market for industrial electric motor systems.

RESEARCH ACTIVITIES

THE MARKET ASSESSMENT INVENTORY

The principal research activity of this project was the Market Assessment Inventory (MAI). During calendar 1997, the assessment team conducted on-site studies of 265 industrial facilities on behalf of the DOE; 254 of these constituted a carefully designed probability-based sample of the entire manufacturing sector. An additional 11 non-manufacturing facilities were inventoried to provide case studies of motor system energy use in such industries as mining, agriculture, and water supply. The inventory was carried out in 20 metropolitan areas nationwide with additional sites in non-metropolitan areas. Figure E-1 shows the locations in which site studies were completed.

Figure E-1: Locations of MAI Activity

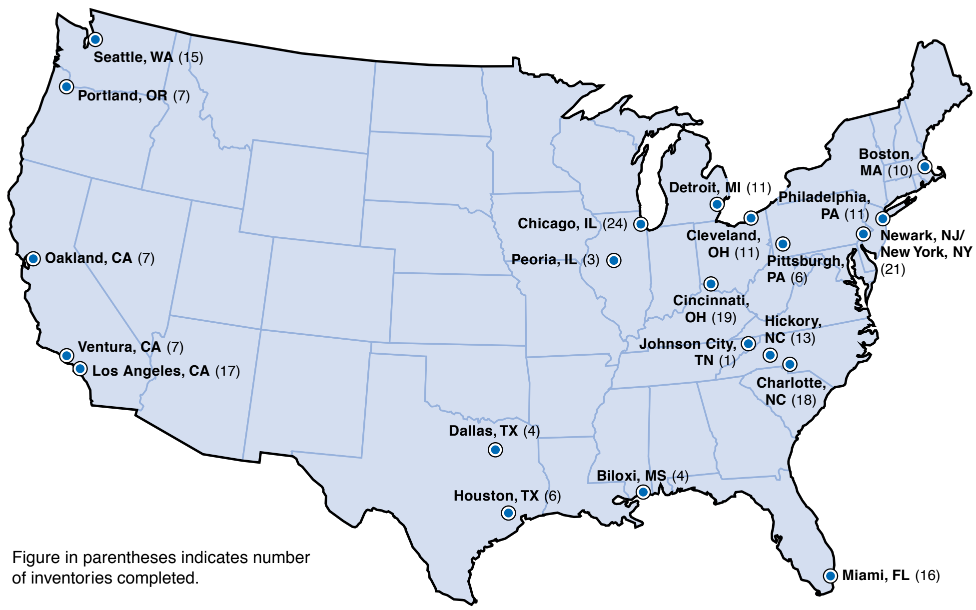


Figure in parentheses indicates number of inventories completed.

The MAI consisted of two parts: the Motor Systems Inventory and the Practices Inventory.

The Motor Systems Inventory.
For the Motor Systems Inventory, trained field engineers, accompanied by a representative of the plant, collected detailed information about every motor-driven system they could observe that was used in a production process. In very large plants, motor systems were sampled to contain the amount of time spent on site with the respondents' personnel. At each plant, the field engineer also worked with plant personnel to take instantaneous load measurements on a sample of motors. These measurements were used to estimate average part loads—a key element in estimates of energy use and potential savings. Through this process, we compiled detailed information on 29,295 motor systems—both the motor itself and the piece of equipment it drove. In addition, we compiled instantaneous load measurements on nearly 2,000 motor systems.

The Practices Inventory.
Achievement of significant increases in motor system efficiency depend to a large extent on the adoption of good design, purchase, and management practices. Equipment on the typical factory floor is constantly updated, reconfigured, and readjusted. Under normal patterns of use,

motors wear out and need to be rebuilt or replaced every 7 to 10 years. Motor systems require continual monitoring and maintenance to run at their design efficiencies. Each decision and action in the daily stream of motor system design, purchase, and maintenance carries with it consequences for energy efficiency and consumption. The Practices Inventory gathered information on the prevalence of actions identified by industry experts as "good practice" in the sample facilities. The Practices Inventory also collected critical information needed to model the change in the motor systems population over time.

Accuracy of inventory results.
The results of any statistically based study such as the MAI are subject to error. Researchers generally identify two basic kinds of errors: sampling error and non-sampling error. In a properly structured study, sampling error can be quantified. We have done so for the most important quantities estimated—motor system energy for the population and key subgroups—using established statistical methods. Non-sampling errors arise due to difficulties in making accurate observations of the population of interest. The effects of these errors cannot be quantified on the basis of the observations themselves. However, they can be described qualitatively. Readers will best be able to understand and apply the results presented below if they understand the sources and sizes of these errors.

- **Sampling error.** Most of the description of the motor system population and energy savings opportunities contained in this report proceeds from estimates of motor system energy used by various groups of motor systems in the population. The assessment team estimated 90-percent confidence intervals for their estimates of total motor system energy in all manufacturing, total motor system energy in each two-digit manufacturing SIC group, and each major application (pumps, fans, air compressors, and other process systems).[3] The 90-percent confidence interval for total manufacturing motor system energy was ± 18 percent. The confidence intervals for total motor system energy in the individual two-digit SIC groups ranged from ± 4 percent (SIC 32: Stone, Clay, and Glass) to ± 81 percent (SIC 33: Primary Metals). The relatively large confidence intervals for Primary Metals and Chemical Products (± 46 percent) reflect the underlying diversity of the facilities found in those industries.

- **Non-sampling error.** The MAI posed many challenges to accurate observation of conditions in sample facilities. These are discussed throughout the report in the context of the specific observations they affected. The assessment team developed and implemented numerous data quality control procedures including: a complete manual review of completed inventories by a trained engineer; automated data quality checks on the raw data once entered; and a final round of "reality checking" on the partially processed data. Anomalous observations were referred back to the data collector or to our contacts at the participating sites for clarification and correction. Despite these precautions, we frequently needed to call on the judgment of site personnel or our field engineers to provide information which could not be directly observed or independently verified. These instances are noted throughout the report.

OTHER RESEARCH

This study supplemented the primary research of the MAI with extensive review of secondary sources and reanalysis of primary data sets including results of industrial facilities audits undertaken by utilities, motor system engineering studies carried out for various utility DSM programs, and the DOE Industrial Assessment Center Program database containing results of over 10,000 energy audits of small manufacturing facilities. The results of this research are reported in the *Interim Report* (XENERGY 1997) of this project. We draw upon these materials throughout this report to place the inventory findings in context.

[3] The 90-percent confidence interval is the range around the sample estimate that has a 90-percent probability of containing the actual population value of the parameter in question—in this case, total motor system energy.

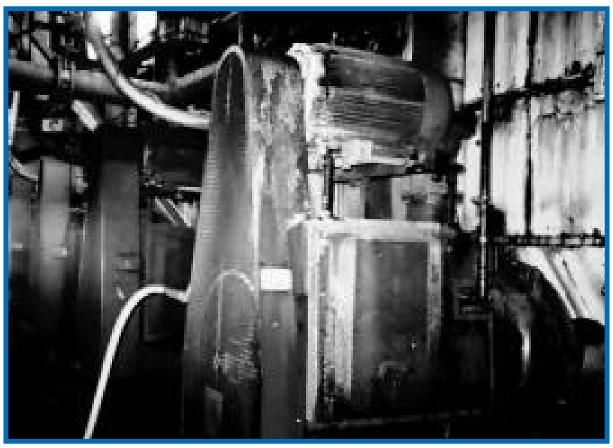
SUMMARY OF KEY FINDINGS

FINDINGS

Improvements in industrial motor system efficiency offer huge opportunities to invest in the enhanced efficiency and profitability of American industry. The key findings from this study concerning the nature and scope of those opportunities are as follows:

- **Industrial motor systems represent the largest single electrical end use in the American economy. In 1994, industrial electric motor systems used in production consumed over 679 billion kWh, or roughly 23 percent of all electricity sold in the United States.** Motors used in industrial space heating, cooling, and ventilation systems used an additional 68 billion kWh, bringing total industrial motor system energy consumption to 747 billion kWh, or 25 percent of all electricity sales. This is roughly equal to *total electric sales to the commercial sector in 1994 (795 billion kWh).*

- **Potential industrial motor system energy savings using mature, proven, cost-effective technologies range from 11 percent to 18 percent of current annual usage or 62 to 104 billion kWh per year, in the manufacturing sector alone. Potential savings in the non-manufacturing industries are estimated at an additional 14 billion kWh.** This is roughly equivalent to potential energy savings in such major commercial end-uses as indoor lighting. (XENERGY 1993) By way of comparison, all utility-sponsored demand-side management programs produced annual energy savings of 62 billion kWh in 1996. (EIA,b) The potential motor system energy savings for all industries translate into reductions in energy costs up to $5.8 billion, which directly increases the bottom line of industrial facilities. Realization of these savings would reduce carbon equivalent emissions by up to 29.5 million metric tons per year.



Improving the performance of this coal slurry pumping system has saved Peabody Holding Company 87,184 kWh per year. In U.S. industry, improvements to fluid systems represent over 60% of the overall industrial motor system energy savings potential.

- **Improvements to the major fluid systems—pumps, fans, and air compressors—represent up to 62 percent of potential savings.** This estimate does not include savings associated with improving the efficiency of the motors driving these systems. The technical aspects of optimizing pump, fan, and air compressor systems are well understood (if not widely implemented).

- **For specific facilities and systems, potential savings far exceed the industry average.** Motor Challenge has documented major cost-effective projects that have reduced energy consumption at the motor system level by an average of 33 percent, and by as much as 59 percent.

- **Motor system energy use and energy savings are highly concentrated by industry and size of plant.** Roughly 3,500 manufacturing facilities (1.5 percent of the total) account for nearly half of all motor system energy use and potential savings in the manufacturing sector.

- **For industries that use significant amounts of motor system energy, the financial impact of motor system energy costs and potential savings are substantial.** Most of the process industries with high levels of motor energy use operate on thin margins—on average 16 percent of operating revenues.[4] Any reductions in operating costs can substantially enhance profitability.

[4] Operating margin here corresponds to the quantity "Income from Operations" as defined in the *Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations.* That is, Net Sales, Receipts, and Operating Revenues less Depreciation and all Operating Costs.

- **The magnitude and patterns of motor system energy use and potential savings vary greatly among industries.** Programs to assist industrial facilities in realizing motor energy savings must take these differences into account.
- **Except in the largest facilities, the level of knowledge and implementation of systematic approaches to motor system energy efficiency is low.** Although the engineering and industrial management community, with the support of Motor Challenge, has elaborated a set of best practices for motor systems design, purchase, and management, few companies are aware of these practices and fewer still have adopted them.
- **Overcoming the barriers to adoption of efficient motor systems purchase and management practices will be difficult.** These barriers include: conflicting priorities for capital investment, long capital replacement cycles, understaffing and under-training of plant maintenance and management functions, and conflicting motivations among equipment suppliers.

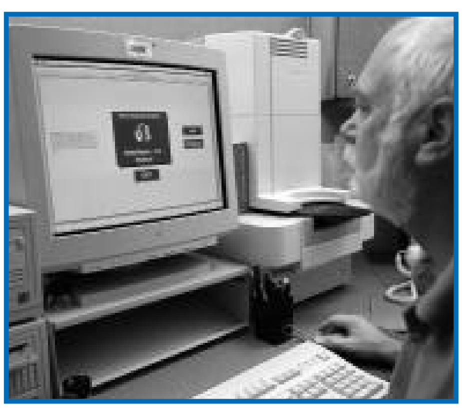
IMPLICATIONS FOR PROGRAM DESIGN

The findings of the Market Assessment provide a number of clear messages for the design of the Motor Challenge Program. These are as follows:

- Focus program resources on those industries and facilities in which the highest levels of energy savings are available. These are: Chemicals, Primary Metals (Steel & Aluminum), Paper and Allied Products, Water Supply and Wastewater, and Mining.
- Focus program resources on equipping manufacturers, designers, distributors, and purchasers of pump, fan, and compressor systems to specify and maintain optimized systems.
- Provide extensive and varied educational opportunities and tools for end-users to learn about and apply knowledge on efficient motors, motor system components, and motor system management.

Over the past 2 years, the Motor Challenge Program has implemented various components which take account of the market intelligence provided by this project. These initiatives include the following:

- **Partnerships with end-user industry organizations.** Motor Challenge is currently developing joint programs with the Technical Association of the Pulp and Paper Industry, the Association of Iron and Steel Engineers, the American Water Works Association, the Water Environment Federation, and the National Mining Association to reach plant engineers and managers in these industries.
- **Partnerships with supplier organizations.** Motor Challenge is pursuing a number of joint programs and initiatives with the industry associations that represent manufacturers and distributors of pump, fan, and compressed air systems. These programs include training for end-users, development of information products and design decision tools, and efficiency test protocols.



Tools like MotorMaster+ 3.0 can help industry capture energy savings opportunities and related cost and productivity benefits.

- **Educational resources.** Motor Challenge offers a broad range of educational products targeted to end-users. These include the MotorMaster+ computerized motor management tool, a technical information hotline, Showcase Demonstration case studies, and a host of other useful publications.

The Motor Challenge Program will continue to refine these offerings to help industry realize the motor energy savings opportunities and related economic benefits identified by the Market Assessment Study.

KEY FINDINGS: SELECTED DETAILS

Industrial motor systems represent the largest single electrical end use in the American economy.

- In 1994, motors systems used for production processes only (not including facility heating and ventilating) consumed 679 billion kWh, or 23 percent of all electricity sold in the United States that year (2,931 billion kWh). If the energy associated with industrial HVAC systems is added, this total comes to 747 billion kWh, or 25 percent of all electric sales.
- Process motor system energy accounts for 63 percent of all electricity used in industry.

Table E-1 shows the distribution of motor system energy use by major industry groups.

Table E-1: Motor System Energy Use by Major Industry Group

Industry Categories	Net Electric Demand* (million kWh)	Motor System Energy (million kWh)	Motor System Energy as % of Total Electricity
Manufacturing	**917,834**	**541,203**	**59%**
Process Industries (SICs 20,21,22,24,26,27,28,29,30,31,32)	590,956	419,587	71%
Metal Production (SIC 33)	152,740	46,093	30%
Non-metals Fabrication (SICs 23,25,36,38,39)	106,107	50,031	47%
Metals Fabrication (SICs 34,35,37)	68,031	25,492	37%
Non-Manufacturing	**167,563**	**137,902**	**82%**
Agricultural Production (SICs 01, 02)	32,970	13,452	41%
Mining (SICs 10, 12,14)	44,027	39,932	90%
Oil and Gas Extraction (SIC 13)	33,038	29,866	90%
Water Supply, Sewage, Irrigation (SICs 494, 4952,4971)	57,528	54,652	95%
Total All Industrial	***1,085,397***	***679,105***	***62.6%***

* 'Net Demand for Electricity' is the sum of purchases, transfers in, and total on-site electricity generation, minus sales and transfers off site. See MECS 1994 Table 12A-B.

Estimates of potential motor system energy savings in the manufacturing sector using mature, proven, cost-effective technologies range from 62 to 104 billion kWh per year, or 11 to 18 percent of current motor system energy use.

Savings estimation methods.
We estimated potential energy savings for motor efficiency upgrades and correction of motor oversizing by applying standard engineering formulae to observations of each motor system inventoried to which the measure would apply. Determining whether system efficiency measures apply to a particular motor system requires more data, time, and professional judgment than could be brought to bear in the course of the inventory. We therefore developed and implemented the following three-step process for estimating potential energy savings from the inventory data:

1. **Estimate total energy usage by major application.** We used the results of the inventory to estimate energy use by major application category: pumps, fans, air compressors, and other process systems.
2. **Compile expert opinion and case studies on measure applicability and savings fractions.** We solicited the opinions of industry experts—primarily consulting engineers, manufacturers' technical staff, and industry association representatives—regarding the percentage of systems to which various measures in the major application categories could be cost-effectively applied. We also solicited their opinions on the average savings these measures could achieve, in terms

of percentage of initial system energy use. We gathered similar information from case studies and other documents. Using this information, we formulated high, low, and midrange estimates of potential savings for each principal measure type within the major motor system application categories.

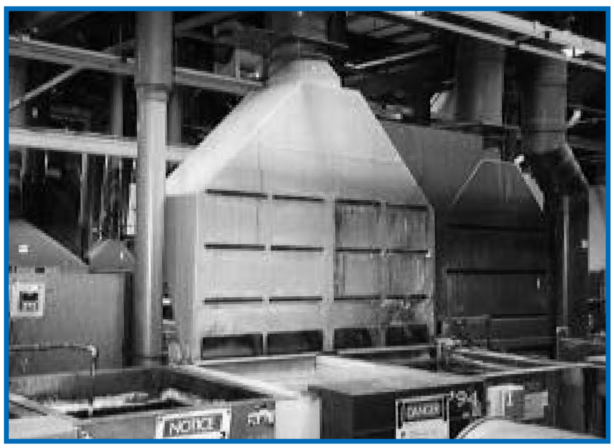
3. **Calculate high, low, and midrange savings estimates.** The savings estimates were calculated by applying the following formula:

$$\textit{Applicability}_{(High,Midrange,Low)} \times \textit{Average Savings Fraction} \times \textit{System Energy.}$$

Because the motor systems grouped under "Other Process Systems" are so diverse, we did not feel it would be appropriate to apply to them the savings estimation process described above. Rather, we applied the method for speed control measures alone. Thus, the potential savings for this category is likely to be somewhat underestimated.

Throughout this analysis, we used a 3-year simple payback as the economic threshold for estimating applicability factors. These savings estimates can be understood as the economic potential for motor system efficiency improvements in existing industrial facilities.

Distribution of potential savings by type of measure.
Table E-2 shows how potential savings are distributed among different kinds of measures and end uses in manufacturing only. Potential efficiency improvements in non-manufacturing facilities add another 14 billion kWh in annual savings. The savings in the major groups of measures are additive. The term "CEE Efficiency Levels" refers to a set of motor efficiency standards proposed by the Consortium for Energy Efficiency, which are somewhat higher than the standards recently promulgated by the federal government. Nearly two-thirds of all potential savings derive from system improvements, such as the substitution of adjustable speed drives for throttling valves or bypass loops in pumping systems or fixing leaks in compressed air systems. Improvements to the major industrial fluid systems—pumps, fans, and air compressors—present between 45 and 62 percent of the total savings opportunities, taking into account low and high estimates.



General Dynamics Armament Systems' (formerly Lockheed Martin Armament Systems') ASD retrofit has resulted in annual savings of more than $68,000, with a 1.5 year payback.

Economic and environmental impacts of potential motor system energy savings in manufacturing.
Potential motor system energy savings carry significant impacts for the national economy and environment.

- Potential savings would reduce greenhouse gas emissions by 15.3 to 26.0 million metric tons of carbon per year.
- These savings are equivalent to removing 3.2 to 5.4 million cars from the road.

- The monetary value of these savings (after accounting for the price effects of self-generation) is $3.0 to $5.0 billion per year.
- In addition to energy savings, these improvements will yield a number of other economic benefits, including increased control over manufacturing processes and higher levels of quality control.

Table E-2: Summary of Motor Energy Savings Opportunities by Measure in Manufacturing Facilities

Measure	Potential Energy Savings GWh/Year Low**	Potential Energy Savings GWh/Year Midrange**	Potential Energy Savings GWh/Year High**	Midrange Savings as Percent of Total Motor System GWh	Midrange Savings as Percent of System-Specific GWh
Motor Efficiency Upgrades*					
Upgrade all integral AC motors to EPAct Levels***		13,043		2.3%	
Upgrade all integral AC motors to CEE Levels***		6,756		1.2%	
Improve Rewind Practices		4,778		0.8%	
Total Motor Efficiency Upgrades		24,577		4.3%	
Systems Level Efficiency Measures					
Correct motor oversizing	6,786	6,786	6,786	1.2%	
Pump Systems: System Efficiency Improvements	8,975	13,698	19,106	2.4%	9.6%
Pump Systems: Speed Controls	6,421	14,982	19,263	2.6%	10.5%
Pump Systems: Total	15,396	28,681	38,369	5.0%	20.1%
Fan Systems: System Efficiency Improvements	1,378	2,755	3,897	0.5%	3.5%
Fan Systems: Speed Controls	787	1,575	2,362	0.3%	2.0%
Fan Systems: Total	2,165	4,330	6,259	0.8%	5.5%
Compressed Air Systems: System Eff. Improvements	8,559	13,248	16,343	2.3%	14.6%
Compressed Air Systems: Speed Controls	1,366	2,276	3,642	0.4%	2.5%
Compressed Air Systems: Total	9,924	15,524	19,985	2.7%	17.1%
Specialized Systems: Total	2,630	5,259	7,889	0.9%	2.0%
Total System Improvements	36,901	60,579	79,288	10.5%	
Total Potential Savings	***61,478***	***85,157***	***103,865***	***14.8%***	

* Potential savings for Motor Efficiency Upgrades calculated directly by applying engineering formulas to Inventory data.
** High, Medium, and Low savings estimates for system efficiency improvements reflect the range of expert opinion on potential savings.
*** Includes savings from upgrades of motors over 200 HP not covered by EPAct standards.

For specific facilities and systems, potential savings far exceed the industry average. Motor Challenge has documented major cost-effective projects that have reduced energy consumption by an average of 33 percent, and by as much as 59 percent at the system level.

Table E-3 summarizes the results of 13 motor systems efficiency projects supported and documented by Motor Challenge as part of its Showcase Demonstration component. Most of these projects involved assessment of and adjustments to fluid systems such as pumps, fans, and compressors, often accompanied by the addition of adjustable speed drives (ASDs) for speed control.

- These projects achieved energy savings of 38.6 million kWh per year at an average payback of 1.5 years.
- The high system-level savings are not atypical of these kinds of projects. There are many case studies of similar kinds of projects in the literature, and savings of this magnitude are reported by industry experts.

Table E-3: Summary of Motor Challenge Showcase Demonstration Projects

Company	Type of Plant	Energy Savings kWh/Year	Savings as % of Initial Sys. Energy	Annual Cost Savings	Payback on Investment (Years)
General Dynamics	Metal fabrication	451,778	38%	$68,000	1.5
3M Company	Laboratory facility	10,821,000	6%	$823,000	1.9
Peabody Coal	Coal processing	103,826	20%	$6,230	2.5
Stroh Brewery	Beer brewing	473,000	52%	$19,000	0.1
City of Milford	Municipal sewage	36,096	17%	$2,960	5.4
Louisiana-Pacific	Strand board	2,431,800	50%	$85,100	1.0
City of Trumbull	Sewage pumping	31,875	44%	$2,614	4.6
Nisshinbo California	Textiles	1,600,000	59%	$100,954	1.3
Greenville Tube	Stainless steel tubing	148,847	34%	$77,266	0.5
Alumax	Primary aluminum	3,350,000	12%	$103,736	0.0
OXY-USA	Oil field pumping	54,312	12%	$5,362	0.5
City of Long Beach	Waste incineration	3,661,200	34%	$329,508	0.8
Bethlehem Steel	Basic oxygen furnace steel mill	15,500,000	50%	$542,600	2.1
Total/Average		***38,663,734***	***33%***	***$2,166,330***	***1.5***

Motor Challenge Showcase Demonstration site, Nisshinbo California, Inc., improved their ventilation system energy efficiency by 59%, cutting costs by over $100,000 per year.

Motor system energy use and energy savings are highly concentrated by industry and size of plant.

- As Table E-4 shows, the top 10 motor system energy consuming four-digit SIC groups account for nearly half of all manufacturing motor system energy use and half of all potential motor system energy savings. These groups include only 3,583 facilities, or 1.5 percent of all manufacturing plants.
- The largest 780 plants in the above groups account for over one-third of all manufacturing motor energy use. These plants are owned by roughly 500 separate companies.

Table E-4: Concentration of Motor Energy Use in Manufacturing

SIC Code	Industry Categories	Motor System Use (million kWh)	Percent of Total Manufacturing Motor System kWh	Motor System Savings (million kWh)	Number of Establishments
2621	Paper Mills	55,777	10.3%	5,711	310
2911	Petroleum Refining	40,805	7.5%	6,138	247
2819	Industrial Inorganic Chemicals, nec.*	37,232	6.9%	4,361	568
2631	Paperboard Mills	27,007	5.0%	2,765	219
3312	Blast Furnaces and Steel Mills	25,323	4.7%	2,742	284
2869	Industrial Organic Chemicals, nec.*	28,721	5.3%	3,364	631
2813	Industrial Gases	21,733	4.0%	2,545	623
2821	Plastics Materials and Resins	13,667	2.5%	1,601	456
3241	Cement, Hydraulic	9,147	1.7%	1,081	190
2611	Pulp Mills	6,402	1.2%	656	55
	Total of Top 10	265,814	49.1%	30,964	3,583
	Total: All Manufacturing	***541,203***		***62,350***	***246,950***

Sources: MECS 1994, Census of Manufactures 1992.
*nec. denotes "not elsewhere classified".

For industries that use significant amounts of motor system energy, the financial impact of motor system energy costs and potential savings are substantial.

Table E-5 displays motor system energy use and potential savings per establishment in the 10 four-digit SIC groups with the highest annual motor energy consumption. In all these industries, the annual cost of motor system energy in a typical plant exceeds $1 million; in steel mills it is $6 million. Potential savings at the typical plant are also very large, ranging from $90,000 per year in the Industrial Organic Chemicals sector to nearly $1 million per year in petroleum refineries.

The right-hand column of Table E-5 shows potential energy savings as a percentage of operating margin. These figures suggest the potential impact of motor energy savings on the bottom line. The process industries listed in Table E-5 operate on very thin margins, that is: the difference between revenues from sales and variable costs including labor, materials, and selling costs. In 1996, operating margins for the 10 groups listed below ranged from 10 to 24 percent, and clustered around 16 percent. Thus, even relatively small increases in operating margin can have a significant impact on profitability.

A typical integrated steel mill spends about $6 million annually on motor system energy. One company—LTV Steel—is reducing its costs by improving this contact water system through the use of technologies such as ASDs and high efficiency pumps.

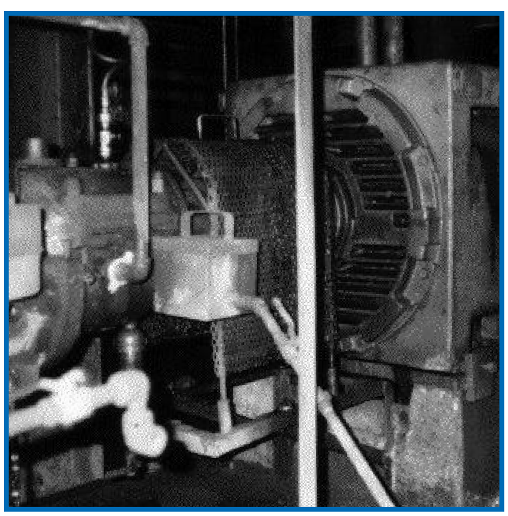


Table E-5: Financial Impact of Motor Energy Consumption and Savings: Selected Industries

Industry Groups	Motor System Costs/Estab.	Motor Energy Costs/Total Operating Costs	Savings per Estab. per Yr.	Savings as % of Operating Margin
Paper Mills	$4.6 mm	6.5%	$659,000	5.0%
Petroleum Refining	$5.6 mm	1.4%	$946,000	1.0%
Industrial Inorganic Chemicals, nec.	$1.6 mm	10.4%	$283,000	6.0%
Paperboard Mills	$3.0 mm	6.4%	$492,000	5.0%
Blast Furnaces and Steel Mills	$6.0 mm	2.1%	$358,000	2.0%
Industrial Organic Chemicals, nec.	$1.3 mm	1.0%	$91,000	1.0%
Industrial Gases	$1.1 mm	21.7%	$116,000	13.0%
Plastics Materials and Resins	$1.5 mm	1.5%	$121,000	1.0%
Cement, Hydraulic	$2.2 mm	9.6%	$219,000	4.0%
Pulp Mills	$1.7 mm	6.7%	$483,000	5.0%

Sources: MECS 1994, Bureau of Economic Analysis 1997, Census of Manufactures 1993.

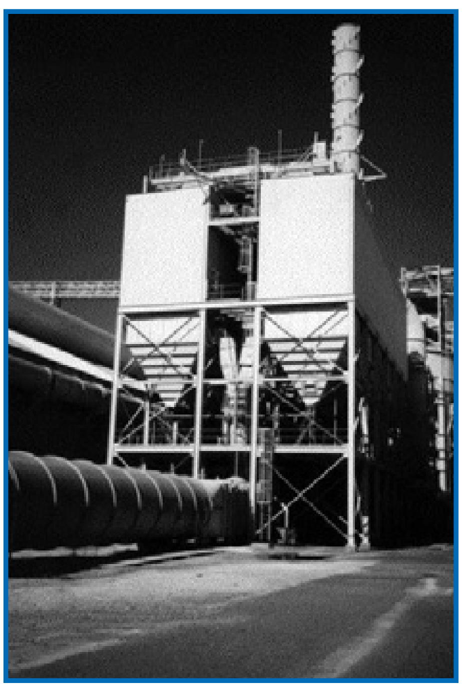
The magnitude and patterns of motor system energy use and potential savings vary greatly among industries.

In developing motor systems efficiency strategies for individual plants or industries, it will be important to take these differences into account and to target sectors and measures with particularly high savings potential.

Patterns of motor energy use.

Each major industry group has a unique distribution of total motor system energy by application and motor size. Figure E-2 shows these distributions for the Paper and Allied Products (SIC 26) and Primary Metals (SIC 33) industries. Much of the motor system energy in the paper industry is concentrated in mid- and large-sized pumps, as well as in pulping equipment and paper machines which are driven, in part, by very large horsepower motors. In the metals industries, a great deal of motor system energy is concentrated in large fans which serve major combustion processes. Other concentrations of motor energy are in large air compressors and materials processing machines.

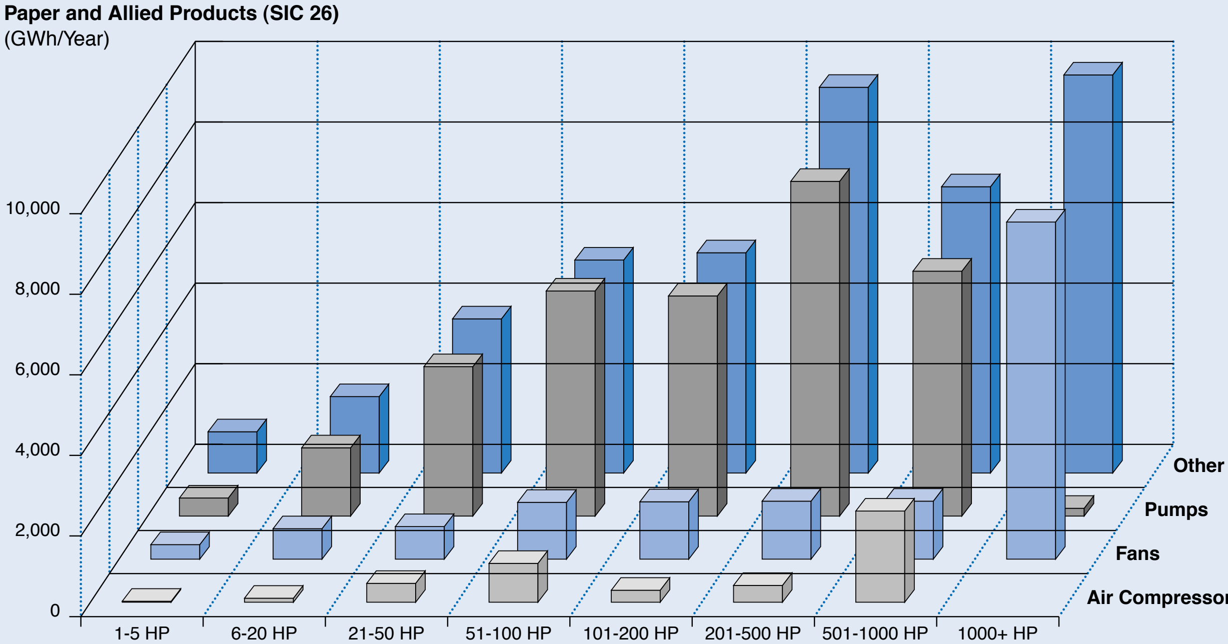
In Primary Metals, the largest savings are in large fan and air compressor systems. At Alcoa's Mount Holly aluminum production facility, the company managed to save more than $100,000 simply by shutting off one fan in each dust collection system.



Patterns of potential savings.

Figure E-3 shows that potential savings opportunities cluster in the application/horsepower groups with the greatest amounts of energy. Most of the savings in the paper industry are concentrated in improvements to pump systems. In Primary Metals, the largest savings can be found in large fan and air compressor systems. Savings in pump systems are also substantial in the lower horsepower ranges. The concentration of many of the savings opportunities in systems driven by large motors suggests that their implementation will require considerable planning and capital outlay.

Figure E-2: Motor System Energy Usage by Application and Motor Horsepower



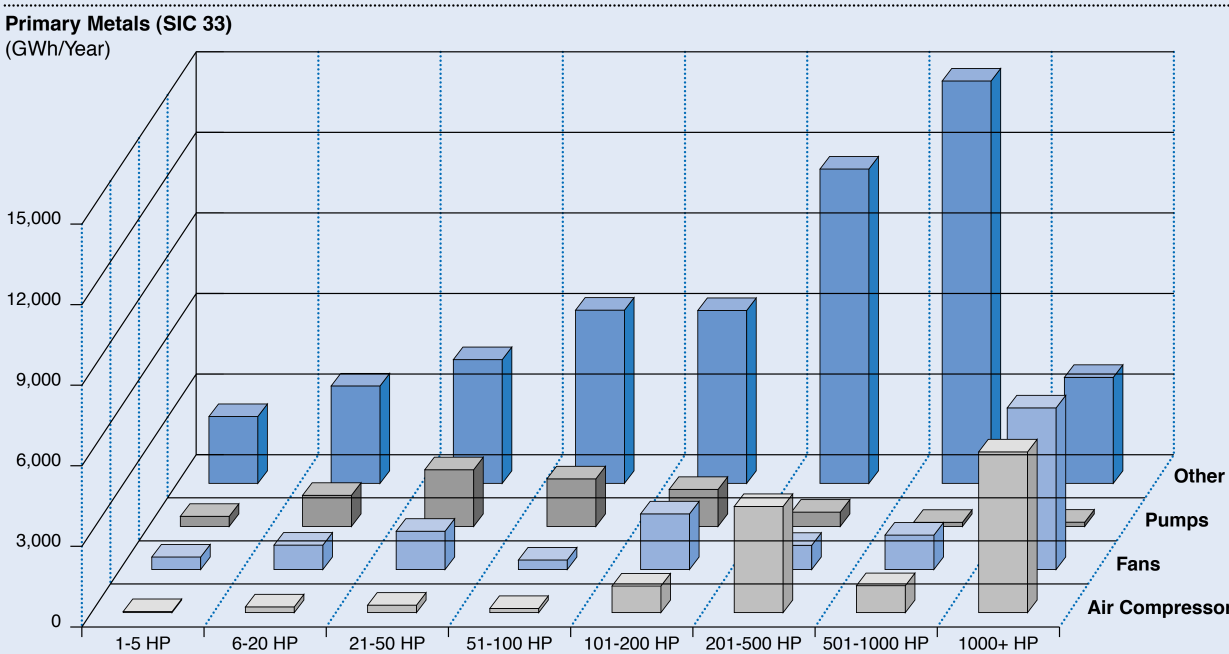
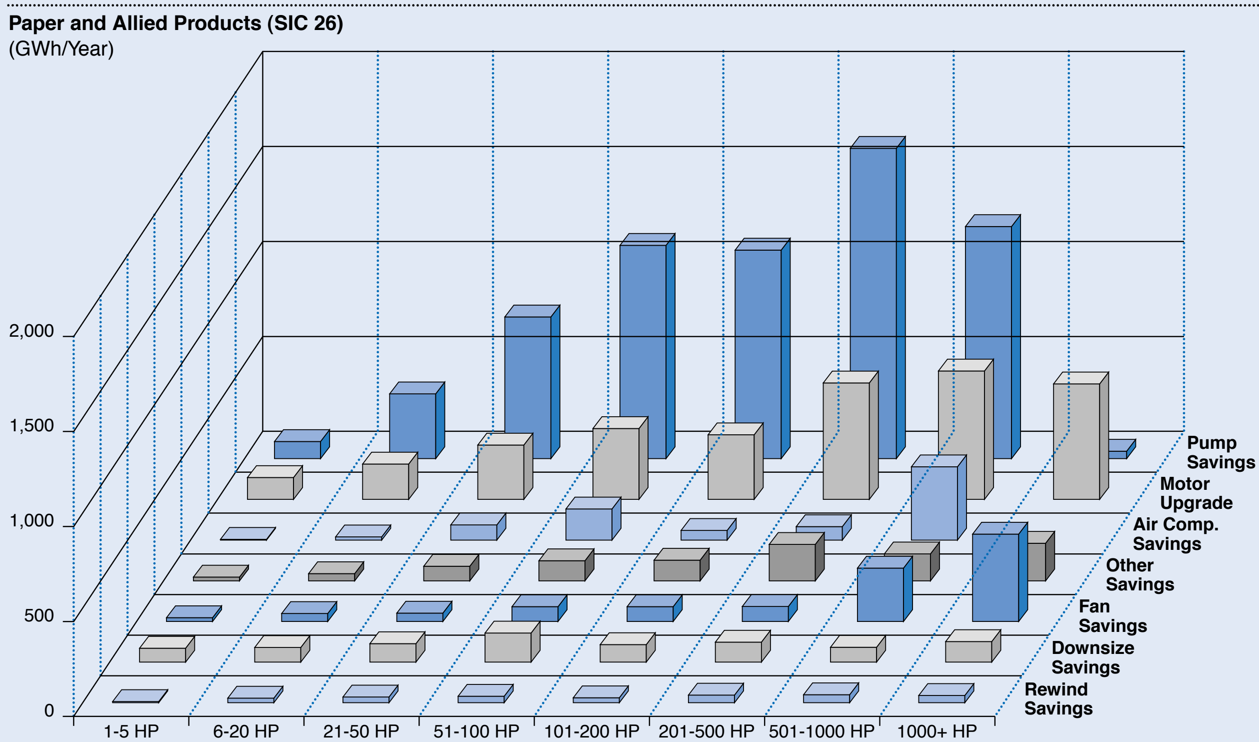
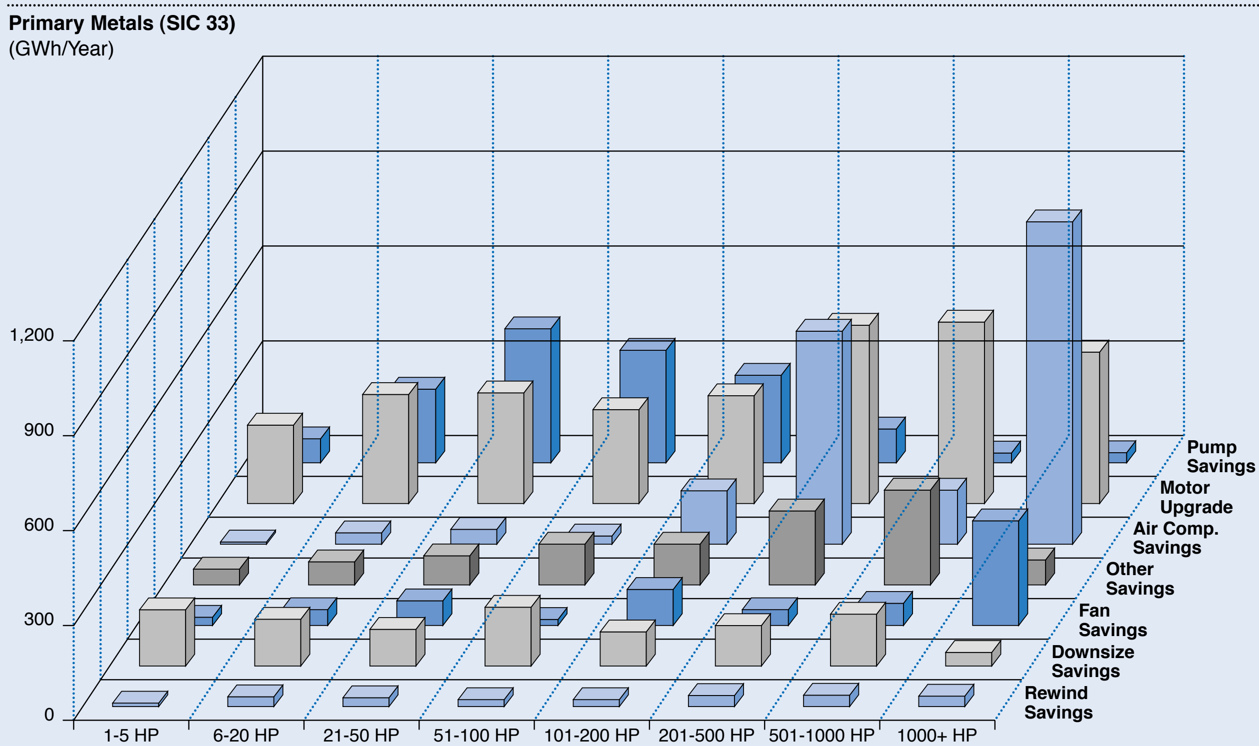


Figure E-3: Distribution of Potential Energy Savings by Application and Motor Size





Patterns of potential savings across industries.
Table E-6 shows potential motor system energy savings by application for each two-digit SIC group. The numbers printed in blue indicate measure groups with particularly high concentrations of potential savings. These 22 SIC/measure groups (out of 126) account for 69 percent of all potential savings.

Table E-6: Potential Systems-Level Motor Energy Savings by Manufacturing SIC and Application

SIC	Industry Category	Estimated Savings (GWh/Year)								As % of Total Energy
		Fan System	Pump System	Compressed Air Systems	Other Proc. Systems	Motor Upgrade	Motor Downsizing	Replace vs. Rewind	All Systems	
20	Food and Kindred Products	157	1,250	494	517	1,376	585	295	4,674	12.4%
21	Tobacco Products									
22	Textile Mill Products	170	593	408	166	743	305	121	2,506	15.0%
23	Apparel & Other Textile Products	1	0	68	15	47	22	8	162	13.9%
24	Lumber and Wood Products	153	243	324	341	432	336	184	2,013	8.8%
25	Furniture and Fixtures	87	5	78	33	173	68	26	471	12.7%
26	Paper and Allied Products	1,082	6,293	773	881	3,197	845	870	13,942	14.0%
27	Printing and Publishing	52	17	74	90	305	153	39	731	12.3%
28	Chemicals and Allied Products	942	7,556	6,813	994	4,219	1,409	1,255	23,188	16.1%
29	Petroleum and Coal Products	271	6,159	1,352	169	1,736	459	453	10,599	20.4%
30	Rubber and Misc. Plastics Products	113	1,851	813	411	1,498	435	303	5,424	14.8%
31	Leather and Leather Products	27	0	0	0	22	6	3	58	11.8%
32	Stone, Clay, and Glass Products	31	18	96	20	117	45	14	343	15.4%
33	Primary Metal Industries	738	1,537	2,150	1,085	3,199	983	749	10,441	11.9%
34	Fabricated Metal Products	34	181	303	80	298	195	46	1,137	15.6%
35	Industrial Machinery and Equipment	28	195	200	94	368	208	44	1,138	15.4%
36	Electronic and Other Electric Equipment	18	1,554	513	43	609	222	93	3,053	23.1%
37	Transportation Equipment	353	1,109	941	242	1,195	340	235	4,415	14.9%
38	Instruments and Related Products	71	119	123	78	263	169	39	862	13.3%
39	Misc. Manufacturing Industries									
	All Industry Groups	***4,330***	***28,681***	***15,524***	***5,259***	***19,799***	***6,786***	***4,778***	***85,157***	***14.8%***

Saturation of the most common motor system efficiency technologies—energy-efficient motors and adjustable speed drives—is relatively low.

- **Energy-efficient motors.** The inventory found that motors meeting EPAct standards accounted for 9.1 percent of all motors currently in use, with the highest concentration (25.5 percent) in the 101–200 horsepower range. EPAct compliant motors use 18.7 percent of total motor system energy in manufacturing.
- **Adjustable speed drives.** The inventory found that 9 percent of all observed motor systems, accounting for 4 percent of all motor system energy were equipped with adjustable speed drives. Over 90 percent of the ASD-equipped motor systems were of 20 horsepower or less. In this size range, it is more likely that the ASD was installed primarily to increase control over the production process rather than to save energy. Based on the application of engineering screening criteria for the application of ASDs, we estimate that motors representing 18 to 25 percent of total manufacturing motor system energy could be cost-effectively equipped with ASDs.

Over 40 percent of motors are operating at less than 40 percent part load. Substantial energy savings can be gained by better matching the size of the motor to the load.

Based on instantaneous load measurements of nearly 2,000 motors operating under reportedly normal conditions, we found that 44 percent were operating at part loads below their efficient operating range. We calculated energy savings associated with resizing these motors to better match load at 1.2 percent of total motor system energy. For pump, fan, and other fluid systems, low part loads may indicate that the entire system is operating at far below its optimal efficiency.

Except in the largest facilities, the level of knowledge and implementation of systematic approaches to motor system energy efficiency is low.

ELEMENTS OF BEST PRACTICE

Over the past 5 years, industrial engineers and plant managers have begun to evolve and articulate a systematic approach to achieving energy efficiency in motor systems. The development of this "systems approach" has been supported by Motor Challenge, as well as by dozens of efforts led by electric utilities, trade and professional organizations, and government agencies in the U.S. and Canada. The systems approach, as it now stands, consists of three elements:

- System performance optimization;
- Selection of efficient components; and
- Operation and maintenance.

Table E-7 provides examples of each of these elements in the context of pumping systems, along with the range of savings associated with each kind of efficiency measure. Similar tables for other kinds of fluid systems are found in Section 2 of this report.

Table E-7: Energy Saving Opportunities in Pump Systems

Equipment Group/Efficiency Measure	Range of Savings (Percent of System Energy)
Process System Design	
Reduce Overall System Requirements	
• Equalize flow over production cycle using holding tanks.	10%–20%: depends on variation in flow.
• Eliminate bypass loops and other unnecessary flows.	10%–20%: depends on initial system design.
• Increase piping diameter to reduce friction.	5%–20%: depends on initial system design.
• Reduce "safety margins" in design system capacity.	5%–10%
• Reduce system effects due to piping bends.	
Match Pump Size to Load	
• Install parallel systems for highly variable loads.	10%-30%: depends on initial system design.
Reduce or Control Pump Speed	
• Reduce speed for fixed loads: trim impeller, lower gear ratios.	5%–40%: depends on initial system design.
• Replace throttling valves with speed controls to meet variable loads.	5%–50%: depends on initial system design.
Component Purchase	
• Replace typical pump with most efficient model.	1%–2%
• Replace belt drives with direct coupling.	About 1%
• Replace typical motor with most efficient model.	1%–3%
Operation and Maintenance	
• Replace worn impellers, especially in caustic or semi-solid applications.	1%–5%

FINDINGS ON CURRENT MOTOR SYSTEMS DESIGN, PURCHASE, AND MAINTENANCE PRACTICES

The following paragraphs summarize key findings on customers' awareness and implementation of the elements of best practice discussed above. Percentages reflect weighting of Practices Inventory results to the population.

- **Most motor purchase decisions are made at the plant level.** Even among multi-site organizations, 91 percent reported that all motor purchase decisions were made at the plant level.

- **Awareness of the availability of energy-efficient motors and understanding of their performance advantages is low.** Only 19 percent of respondents reported being aware of "premium efficiency" motors, the common marketing designation for motors that met EPAct standards prior to their promulgation in October 1997.

  Only 4 percent of customers reported that they understood the efficiency ratings associated with the premium or high-efficiency designations; 38 percent reported being somewhat aware of these relationships. These results likely reflect the inconsistency of product designations that existed prior to the promulgation of the EPAct standards, as well as generally low levels of product knowledge.

Motor purchase decisions are typically made at the plant level.

- **Only 22 percent of customers surveyed reported that they had purchased any efficient motors in the past year.** Among all customers surveyed, the average reported percentage of efficient motors purchased in the past year was 12 percent. According to the Bureau of the Census *Current Industrial Reports,* efficient motors constituted 15 percent of all 1–200 horsepower units shipped domestically in 1996. Thus we believe that customer reporting on this topic was fairly accurate.

- **Customers most often use the size of the failed motor being replaced as a key factor in selecting the size of the new motor. Twenty-nine percent use the size of the failed motor as the *only* factor in the sizing decision. This practice can lead to persistent oversizing of motors, which leads to inefficient operations.**

- **Only 11 percent of customers interviewed reported having written specifications for motor purchases; only two-thirds of these customers included efficiency in their specifications.** Consistent with other findings, larger plants tended to use written specifications more often than smaller ones.

- **Reducing capital costs is the most important consideration driving customers' decision whether to rewind or replace failed motors.** Only 12 percent of customers reported that they considered the lower energy operating costs of new motors in the rewind versus replace decisions. Very few customers report providing specifications to rewind contractors. If improperly done, rewinding reduces the efficiency of motors from 1 to 2 percent.

- **Except among the very largest facilities, the frequency with which system-level improvements are undertaken is very low.** Customers were asked whether they had implemented a list of specific system-level improvements for pump, fan, and compressed air systems over the past 2 years. Except for fixing leaks in compressed air systems, none of the measures were mentioned by more than 8 percent of the respondents. Larger facilities reported making such improvements more frequently.

See Table E-8 for a summary of these results.

Table E-8: Reported System Measures Undertaken During the 2 Years Prior to the Inventory

	Size Categories[5]					
	Large	Med/Large	Medium	Sm/Med	Small	*Total*
Fan Systems						
Retrofitted with ASDs	20%	7%	1%	0%	1%	***1%***
Retrofitted with inlet guide vanes	9%	1%	0%	0%	3%	***2%***
Checked components with large pressure drops	3%	1%	10%	0%	3%	***3%***
No fan systems in facility	0%	29%	24%	18%	43%	***38%***
No improvements	67%	49%	45%	80%	33%	***40%***
Pump Systems						
Substituted speed controls for throttling	22%	8%	11%	1%	0%	***1%***
Used parallel pumps to respond to variations in load	14%	4%	2%	0%	3%	***2%***
Reduced pump size to fit load	0%	5%	7%	11%	3%	***4%***
Increased pipe diameter to reduce friction	5%	6%	6%	11%	1%	***3%***
No pump systems in facility	13%	28%	24%	17%	40%	***35%***
No improvements	45%	57%	42%	52%	34%	***38%***
Compressed Air Systems						
Replaced 1-stage rotary screw units with more efficient models	7%	16%	29%	2%	4%	***6%***
Used parallel compressors to respond to variations in load	23%	12%	10%	13%	7%	***8%***
Reconfigured piping and filters to reduce pressure drops	14%	24%	5%	13%	1%	***5%***
Added multi-unit controls to reduce part load consumption	23%	10%	6%	0%	4%	***4%***
Reduced size of compressors to better match load	10%	6%	1%	2%	1%	***1%***
Fixed leaks	42%	40%	34%	36%	15%	***20%***
No compressed air systems in facility	0%	3%	0%	1%	10%	***8%***
No improvements	39%	44%	37%	62%	52%	***52%***
No Reported Improvements	30%	27%	14%	45%	21%	***24%***

[5] The size categories are based on sample stratification cut points. All establishments in each two-digit SIC group were initially allocated to Large, Medium, and Small size strata, with roughly one-third of all establishments in the SIC group in each size stratum. The cut points between Large, Medium, and Small varied by SIC group. In some regions, we needed to combine adjacent groups to provide a sufficiently large sample frame. Thus, Large and Medium/Large are not mutually exclusive size designations. Likewise for Small and Medium/Small.

ORGANIZATION OF THE REPORT

The remainder of this report is organized as follows:

- **Section 1: The U.S. Industrial Motor Systems Inventory.** This section presents the results of the Inventory, focusing on the distribution of manufacturing motor systems and energy by industry, horsepower, application, efficiency, hours of use, and part load. This section also contains case studies of motor system energy use in non-manufacturing industries.
- **Section 2: Motor System Energy Savings Opportunities.** This section presents detailed estimates of motor system energy savings by type of measure, industry, application, and horsepower size. We also provide extensive documentation of the methods used to develop these estimates.
- **Section 3: Motor Systems Purchase and Maintenance Practices.** This section presents the results of the Practices Inventory in detail, along with related information from the literature.
- **Appendix A: Profiles of Key Industrial Sectors** contains short profiles of five key motor system energy-using sectors covering industry structure and conditions, general energy use patterns, and technical energy savings opportunities specific to the industry. Appendix A also includes summaries of inventories performed at non-manufacturing industrial sites.
- **Appendix B: Standard Tables** contains detailed tables of motor inventory and savings information for each two-digit manufacturing SIC group.
- **Appendix C: Methodology** contains detailed technical descriptions of the sampling approach and variance calculations. It also contains copies of data collection forms.
- **Appendix D: Stock Adjustment Model** contains a description of the model used to forecast the size and overall efficiency of the manufacturing motor inventory. It also contains the inputs, assumptions, and results of the forecast through the year 2002.

Section 1: The U.S. Industrial Motor Systems Inventory

This section presents the methods and key results of the inventory study. We begin with a brief description of the sampling and data collection methods we used to develop the inventory database.[1] The section continues with a comparison of the methods used in this study to methods used in other characterizations of the industrial motor systems population and energy use. This comparison clarifies the most appropriate uses of this and other studies, as well as limitations on their interpretation. We conclude with the findings from the inventory itself.

RESEARCH METHODS

OBJECTIVES

Overall, the objectives of the MAI were to:

- **Characterize motor systems and the energy they use for all major manufacturing groups (SICs 20–39) and selected non-manufacturing industries.** In particular, estimate the distribution of the population on key attributes that affect energy consumption and potential savings: horsepower, type of motor, application, part load, hours of application, and nominal efficiency.
- **Characterize the extent to which energy savings opportunities are present in the motor systems inventory and estimate potential energy savings associated with those opportunities—again for each major industry group.**
- **Characterize the procedures that facilities managers use to purchase, manage, and maintain motor systems, as well as their awareness, knowledge, and adoption of specific measures to reduce motor system energy use.**

To our knowledge, the *U.S. Industrial Electric Motor Systems Market Opportunities Assessment* is the only study ever undertaken with the specific objective of characterizing the population of motor systems in manufacturing for any geographic area—much less for the country as a whole—using direct observations of a representative sample of facilities.[2]

We faced two key methodological challenges in achieving the study's objectives. These were:

- Develop a sampling approach which would enable us to characterize the highly diverse population of manufacturing plants based on a relatively small number of observations.
- Develop an on-site data collection protocol which would enable us to collect detailed information on every motor system within a factory (or a large sample of motors in big plants) without overburdening the participating companies.

The paragraphs below describe how we addressed these challenges. We conclude this section with a brief description of how the inventory was actually conducted, the disposition of the sample, and some of the practical difficulties we encountered.

1 For a more technical description of survey methods, see Appendix C: Methodology, which contains detailed descriptions of our sampling approach, sample disposition, and variance calculations. Appendix C also contains copies of all data collection forms and field descriptions.

2 A number of utilities have undertaken audits of representative samples of industrial facilities in their service territories that have included inventories of electric motors. For descriptions and results of these studies, see the *Interim Report* of this project.

SAMPLING APPROACH

SCOPE: DEFINITION OF STUDY POPULATION

Industries covered.
Initially, DOE specified the scope of the study to include all manufacturing industries (SICs 20–39) as well as selected non-manufacturing industries: mining, agriculture, water supply, irrigation, wastewater treatment, and oil and gas extraction. Early in the project, we determined that it would be possible to complete roughly 300 site inventories of sufficient detail to meet the project's analytical objectives, given the budget and schedule. We further determined it would not be feasible to characterize all of the manufacturing and non-manufacturing facilities in the population on the basis of a sample of 300. We decided, in consultation with DOE, to allocate as much of the sample to the manufacturing industries as would be necessary to develop reasonably precise estimates of their characteristics. The remaining sample would be allocated to the non-manufacturing industries, with the resulting observations to be treated essentially as case studies. Ultimately, 30 sample slots were set aside for non-manufacturing sites.

The sampling plan described below pertains to *manufacturing facilities only*. However, we used the same data collection protocol for all sites.

Motor system applications covered.
All motor systems associated with production activities were included in the universe. Motors associated with boilers and compressors which provided process heat and cooling were included in the inventory. Motors associated solely with plant heating and ventilating equipment were not.

Motor sizes covered.
Only systems driven by integral horsepower motors (1 HP or greater) were included in the inventory.

SAMPLE DESIGN: GENERAL APPROACH

The general strategy for the sample allocation was to select sites with probability proportional to size. That is, the chance that a particular site would be selected into the sample was proportional to its size. Larger sites have a higher chance of being in the sample, and smaller sites have a lower chance. Thus, for any subset of the population, the investment in data collection for that subset and the amount of information collected is roughly proportional to the size of the subset. Those groups that account for the most motor system energy consumption, and the most site-to-site variability, have the best information collected and tend to be the most accurately characterized; those that account for the least consumption have the least information and are least accurately characterized.

SAMPLE FRAME

We used the *iMarket MarketPlace* Dun & Bradstreet database as the sample frame—that is, the list of all industrial facilities that constituted the population for the study. The MarketPlace database contains records from all establishments identified through Dun & Bradstreet's credit rating service. The number and distribution of establishments by SIC code in this database are fairly similar to those found by the Census of Manufacturers for companies with 20 or more employees.

The MarketPlace database identifies several key pieces of information for each facility, including: primary SIC code; sales volume; employment; geographic location using the Bureau of the Census metropolitan statistical areas (MSAs); contact information; and whether manufacturing is actually conducted at the site.[3]

MEASURE OF SIZE

We used facility employment as recorded in Dun & Bradstreet as the basis for characterizing sites by size. However, motor system energy use per employee differs greatly among SIC groups. As Table 1-1 shows, annual motor system energy use per employee ranges from 3,593 kWh in Apparel and Other Textile Products (SIC 23) to 402,434 in Petroleum and Coal Products (SIC 29). To develop a meaningful measure of size for allocating the sample, we needed to translate the employment for each site into a preliminary estimate of motor energy use. To do so, we used an estimated motor energy use per employee specific to each SIC developed from the results of the 1991 Manufacturing Energy Consumption Survey (MECS)[4], a national survey of manufacturing energy use and related information sponsored by the Energy Information Administration (EIA). These factors were applied to site-level employment data from the Dun & Bradstreet database to estimate the motor system energy consumption of sites or groups of sites for use in sampling.

Table 1-1: Motor System Energy Use per Employee in Manufacturing

SIC Number	Industry Description	Motor System kWh per Year per Employee
20	Food and Kindred Products	31,229
21	Tobacco Products	29,323
22	Textile Mill Products	36,267
23	Apparel and Other Textile Products	3,593
24	Lumber and Wood Products	21,095
25	Furniture and Fixtures	7,111
26	Paper and Allied Products	157,448
27	Printing and Publishing	5,657
28	Chemicals and Allied Products	164,464
29	Petroleum and Coal Products	402,434
30	Rubber and Miscellaneous Plastics Products	25,456
31	Leather and Leather Products	6,623
32	Stone, Clay, and Glass Products	42,894
33	Primary Metal Industries	66,996
34	Fabricated Metal Products	11,939
35	Industrial Machinery and Equipment	7,589
36	Electronic and Other Electric Equipment	7,453
37	Transportation Equipment	11,787
38	Instruments and Related Products	5,822
39	Miscellaneous Manufacturing Industries	5,887
	Manufacturing Average	***31,233***

Source: MECS, 1994, Energy Information Administration (EIA).

3 Metropolitan Statistical Areas (MSAs) are geographic subdivisions established by the Bureau of the Census to organize data collection. In most states, they correspond to the larger cities and counties in which they are located. In the Northeast, where political subdivisions are more irregular, MSAs may contain more than one county or portions of counties, as well as their central city.

4 Results of the 1994 MECS were not available at the time the sample was developed.

FURTHER REFINEMENTS TO SAMPLE FRAME

In our initial work on the sample, we made a number of refinements to limit the sample frame so that it matched the objectives and resources of the project. We defined our frame as all Dun & Bradstreet listings in the target SIC groups that had manufacturing activity present at the site. The target SIC groups were the 20 manufacturing two-digit SIC groups, SIC codes 20 through 39. We further restricted our frame to the top 174 (out of 324) MSAs in terms of estimated motor system energy use.

The 174 MSAs included in the sampling frame accounted for 91.7 percent of the estimated manufacturing motor energy use for all MSAs and 72.1 percent of the estimated manufacturing motor energy use for the entire U.S. The second percentage is lower because not all manufacturing facilities are located in MSAs. For example, many pulp and paper mills and primary metal factories are located in rural areas near the natural resources that supply them. We developed a separate process to select a sample of facilities that are located outside MSAs.

SAMPLE STRATIFICATION

The total sample was stratified on three variables:

- **Geographic location.** Geographic stratification was required to ensure that the sample was geographically dispersed for a good representation across the country. Geographic clustering was required to contain field costs.
- **Industry type (SIC).** The sample was stratified by two-digit SIC to ensure a minimum coverage of each manufacturing SIC. In addition, under the probability-proportional-to-size approach, different SICs were sampled at a higher rate because of their greater motor energy use.
- **Size of facility.** The sample was stratified by size as the basis for the sampling with probability in proportion to size. For the main sample, each SIC group was divided into large, medium, and small size strata based on the distribution of total employment among all the establishments in the SIC. The general approach was to split each SIC into three size groups, each accounting for about one-third of the total employment. The break points for the three size strata were therefore defined differently for each SIC.

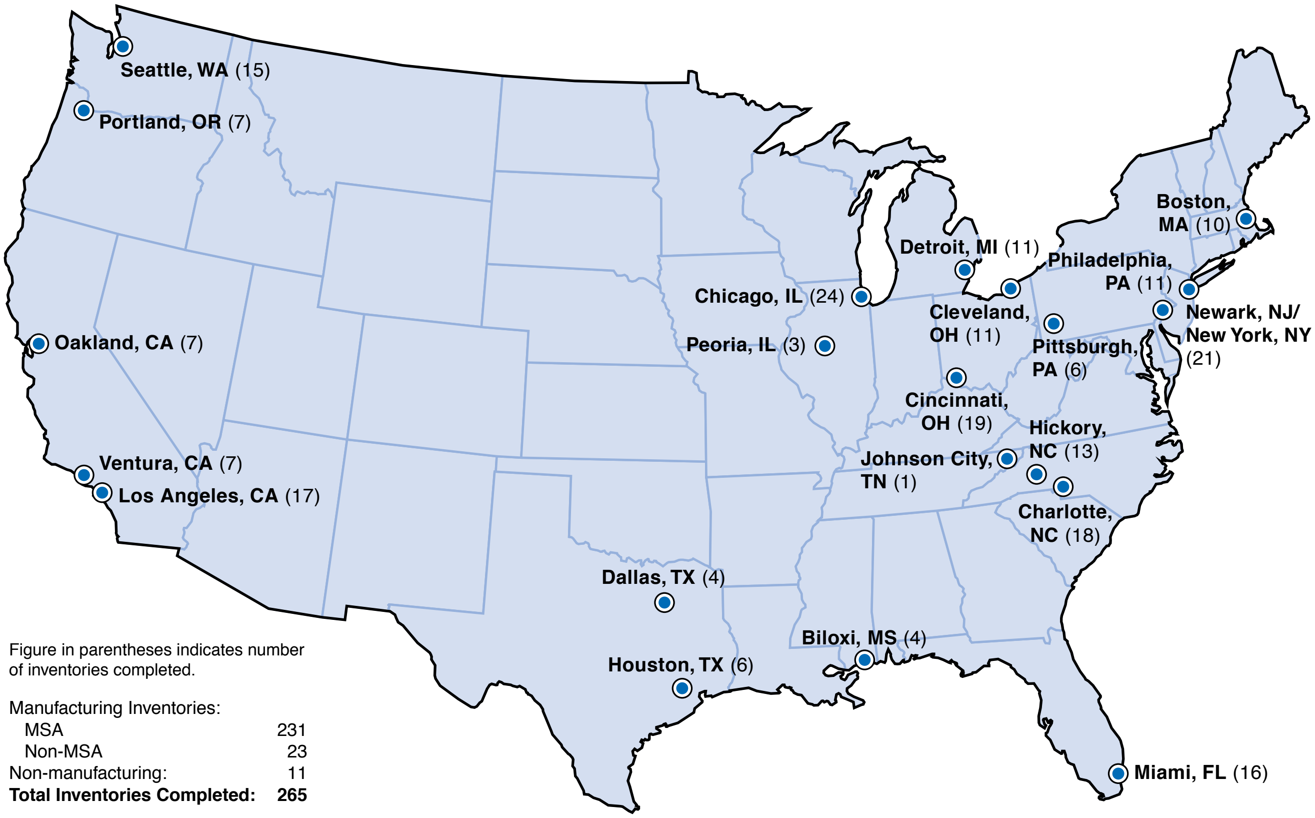
SAMPLE ALLOCATION AND SELECTION

The sample was designed to cover all manufacturing SICs, all regions of the country, and all sizes of operations. To control field costs, it was necessary to limit the data collection to approximately 20 geographic areas. To cover all these factors and use the sample resources efficiently, sample design and selection proceeded through the following stages:

- Allocation of the overall manufacturing sample to sites within and outside MSAs.
- Allocation of the manufacturing samples to geographic areas (Primary Sampling Units or PSUs).
- Allocation of the PSU samples to cells defined by SIC code and size.
- Random selection of sites that fell into the selected sample cells defined by PSU, SIC, and size.

At each stage the selection of PSUs and sample cells and the allocation of the final sample to the sample cells were accomplished using methods based on probability proportional to size. See Appendix C for more detail on the sample design and allocation procedures. Figure 1-1 shows the distribution of completed inventories by PSU. Table 1-2 shows the distribution of the

Figure 1-1: Locations of Completed Inventories (PSU)



completed inventories by SIC and size category. In interpreting Table 1-2, readers should keep in mind the following concerning size categories:

- For purposes of the initial sample development, there were only three size categories: Small, Medium, and Large. The break points between these three categories were set individually for each two-digit manufacturing group. The criterion in setting the break point was to allocate roughly equal portions of total estimated motor system energy (from MECS) to each of the strata. This is a typical procedure used to minimize the variance of estimates and to simplify variance calculations.
- The Small/Medium and Medium/Large categories represent combinations of the two strata rather than a unique group that falls in between the two. For some SIC/PSU combinations, it was necessary to combine size categories in order to have enough facilities to provide the requisite number of completed inventories, after taking sample attrition and refusals into account.

The two right-hand columns of Table 1-2 present a comparison of the distribution of the manufacturing sample to the manufacturing SIC groups versus the distribution of motor system energy to SIC groups provided in MECS. These distributions resemble each other quite closely.

Table 1-2: Distribution of Completed Inventories by SIC and Size

SIC Group	Size Strata*						% of Completed Inventories	% of Total MECS Motor Energy
	S	S/M	M	M/L	L	Total		
20 Food	2	2	0	12	2	18	7.1%	8.8%
21 Tobacco						0	0.0%	0.2%
22 Textile	4	1	2	3	2	12	4.7%	3.9%
23 Apparel	2	0	0	2	0	4	1.6%	0.6%
24 Lumber	3	2	1	4	2	12	4.7%	2.9%
25 Furniture	1	0	1	2	1	5	2.0%	0.7%
26 Paper	14	2	6	14	3	39	15.4%	18.4%
27 Printing	3	0	0	3	0	6	2.4%	1.6%
28 Chemicals	8	5	6	26	5	50	19.7%	25.0%
29 Petroleum	6	11	0	6	1	24	9.4%	7.9%
30 Rubber	8	0	4	4	4	20	7.9%	4.8%
31 Leather	1	0	0	0	0	1	0.4%	0.1%
32 Stone	2	0	0	4	0	6	2.4%	4.1%
33 Metal	8	4	0	11	0	23	9.1%	8.5%
34 Fabricated Metal	3	0	5	2	0	10	3.9%	3.3%
35 Machinery	3	0	2	1	0	6	2.4%	2.8%
36 Electric	1	0	2	2	0	5	2.0%	2.1%
37 Transportation	2	1	0	2	2	7	2.8%	3.2%
38 Instruments	2	2	0	2	0	6	2.4%	0.9%
39 Miscellaneous						0	0.0%	0.4%
Total Manufacturing	***73***	***30***	***29***	***100***	***22***	***254***		
Non-manufacturing Inventories								
02 Agriculture						2		
12 Metal Mining						1		
13 Oil & Gas Extraction						1		
14 Mineral Mining						2		
49 Water & Wastewater						5		
Total Non-manufacturing						***11***		
Total Inventories						***265***		

*The Large and Medium strata were combined in some region/SIC groups to form the Large/Medium stratum. The same procedure was used in regard to the Small/Medium stratum. See pp. 1-6 and App. C for more on this topic.

DATA COLLECTION METHODS

Once a site was selected into the sample, data collection proceeded in the following stages:

- **Recruitment and collection of pre-contact data.** Trained schedulers initiated contact with the selected facility over the phone. The first objective of the call was to determine whether the site was eligible to be included in the inventory. To be eligible, the site needed to meet the following criteria: (1) use integral horsepower motors in its production facilities; and (2) be correctly classified as to two-digit SIC by Dun & Bradstreet. Once we determined that these criteria were met, we went on to solicit the facility's participation in the inventory and gather information to facilitate scheduling.

To encourage participation, we offered facilities a report of the motor inventory, a copy of the MotorMaster+ software, and an electronic data base of the motor inventory entered into that software. We also provided a MotorMaster+ report that identified specific motors that can be cost-effectively upgraded to a higher efficiency.

Each audit was carried out by one field engineer who had participated in extensive classroom and field training. The field engineers required an escort in the facility. Based on experience with similar surveys, we determined that three days was the maximum plant staff would agree to have us on site. The data collection protocol was designed so that it could be completed in three days, even in large sites.

Initial interview and Practices Inventory. The field engineer's first task upon arriving on site was to complete the Practices Inventory with the principal contact. This was generally the maintenance manager, plant engineer, or, in smaller facilities, the owner. Table 1-3 shows the topics covered and the analyses supported by the Practices Inventory.

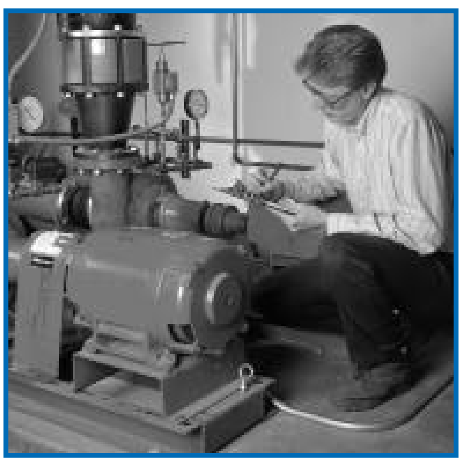
Table 1-3: Topics Covered and Analyses Supported by the Practices Inventory

Topics Covered	Analyses Supported
• Inventory adjustment variables: rates of failure; rewinding and repair; replacement; scrappage and second-hand sales. • Factors affecting the rewind/replace decision. • Criteria applied for selecting energy-efficient motors. • Use and nature of specifications in motor purchase and rewind situations. • Description of maintenance practices. • Purchasing and maintenance practices for generic equipment: pumps, fans, compressors.	• Estimate prevalence of "best practices" in motor purchasing and maintenance. • Identify opportunities to save energy by providing information and education. • Establish baseline practices for use in analysis of Motor Challenge effects. • Estimate parameters for a stock adjustment model to translate data on motor shipments into changes in inventory.

At this stage, the field engineer also collected information on a variety of other topics including: facility electric use; identification of key processes; identification of production departments; and a rough allocation of total facility motor energy use to the different departments.

Motor Inventory. After the initial interview and Practices Inventory, the field engineer made a quick walkthrough inspection of the facility accompanied by an escort. The objectives of the walkthrough were to confirm the rough allocation of motor energy to the departments and to map out a strategy for accomplishing the data collection as quickly as possible. For large sites which could not be fully inventoried in three days (over 300 motor systems), there was a second objective. This was to work out the application of prescribed methods for sampling motors within the site. This method is described in Appendix C. During the walkthrough, the field engineer also collected data at the department level—primarily hours of operation.

For this inventory, field engineers collected data on motor systems in 254 manufacturing plants.


Jeff Uhrlaub, Uhrlaub Photography

Once the field engineer determined the best general approach to the site, he collected information on all motor systems in the plant, or within the sampled areas. Table 1-4 shows the individual pieces of inventory data which were collected at the site, department, and individual motor system levels. For purposes of data collection, the motor system consisted of the motor itself, controls on the immediate motor circuit, the drive train, and speed controls.

Instantaneous load measurements. Once the inventory was completed, the field engineer took instantaneous load measurements on a sample of 12 operating motors within the plant. The measurements were made using the two-wattmeter method. The method used to select the sample of motor systems to be metered is described in Appendix C.

SAMPLING WITHIN SITES

Sampling the inventory in large sites.
Based on field tests of the data collection methods, we determined that a field engineer could inventory a maximum of 300 motor systems during a 3-day visit. We knew that many of the sample facilities would have more than 300 motors. Some would have thousands. To address this situation, we developed a procedure to select a representative sample of motors in the large sites. The challenge in these cases was that, in all but one or two exceptional factories that kept complete motor inventories, we had no list of motors to start from. Thus, our sampling approach proceeded in the following steps:

- Divide the facility into logically grouped areas, using the experience of the escort as a guide.
- Estimate the percentage of total motor energy accounted for by each logical division, again relying on site personnel. This factor was used in weighting the results.
- Select areas of the plant for inclusion in the inventory using random procedures.
- Complete full motor system inventories of the selected areas.

Of the 254 manufacturing sites inventoried, 86, or 33.8 percent used this sampling approach to complete the motor systems inventory.

Table 1-4: Overview of Field Data Collection for the Inventory

Level of Observation/Type of Data
Facility Level Observations • Number of employees • Total electric consumption and costs • List of principal industrial processes in the plant • Size of the plant and production areas
Department Level Observations • Operating schedules • Estimated percentage of total plant motor energy (where internal sampling was needed)
Motor System Level: Component Data • Component type: e.g., pump, fan, air compressor, refrigeration compressor, etc. • Process: e.g., grinding, gas separation, process heat, etc. • Component age • Load modulation type: e.g., throttle valve, ASD, inlet vane, outlet damper, mechanical clutch • Mechanical drive type: e.g., shaft, flat belt, V-belt, roller chain, etc. • Manufacturer • Escort's assessment of whether the load is fluctuating or constant • Diversity: i.e., percentage of department operating hours the motor is on, per escort
Motor Data • Size (HP or KW converted to HP) • NEMA design: A, B, C, D, E, DC motor; synchronous motor; or other special purpose • Motor age • Synchronous speed • Enclosure type • Voltage rating and "wired for" voltage • Manufacturer • Nameplate speed • Nameplate amps • Nameplate power factor • Nameplate efficiency

Selection of motors for load measurement.
We selected motors for load measurement by making random selections from the list of motors inventoried. The quotas for size categories were developed based on information on the allocation of motor energy developed for the larger sampling effort. The quotas were as follows: in 1–19 horsepower, it was three motors; in 20–29 horsepower, it was four motors; and in 100+ horsepower, it was five motors. If there were fewer motors in the higher HP categories than the quota required, the remaining samples were allocated to the next lowest size category. Thus, if a plant had only two motors of 100 horsepower or more, the allocation would be: 1–19 HP: three motors; 20–99 HP: seven motors; 100+ HP: two motors.

INVENTORY ADMINISTRATION AND RESPONSE

We tested the data collection protocol at a number of sites in the late summer and autumn of 1996. Based on this work, we refined the data collection protocol and solicitation system substantially. Field engineers were recruited and trained in November and December of 1996, and field work began in earnest in January 1997. It took approximately 10 months to complete the data collection.

Convincing facility owners and managers to allow us to conduct the inventory at their plants proved to be the most difficult part of the inventory. We recruited participants essentially through “cold calling.” The process of identifying the appropriate decision maker and gaining their permission took an average of four to six telephone calls and fax communications.

Table 1-5 shows the results of our sample recruitment efforts. We attempted to contact nearly 4,500 facilities listed in the Dun & Bradstreet database. We determined that 8.4 percent of these facilities did not exist, and we were unable to establish contact with a similar number. Among those we were able to contact, nearly half refused to take part in the inventory. Another sizable portion deferred their decision for so long that their sample cell was closed before they replied. These can be interpreted as polite refusals. We also determined that roughly one-quarter of the facilities we attempted to contact fell out of the scope of the study. Among the typical reasons for disqualification: there were no integral horsepower motors on site; no manufacturing activities were conducted at the site; Dun & Bradstreet had misclassified the site in terms of SIC or size. The information gained from the screening calls was used in developing the results of the inventory. For more on this topic, see Appendix C.

We obtained initial permission to undertake the inventory from 277, or 6.3 percent of those contacted. Twenty-three of these customers later declined to be inventoried. We had similar success in lining up non-manufacturing sites. Larger facilities were more likely than others to participate in the inventory. Among companies in the Large and Medium/Large strata, participation rates averaged 17 percent, versus the 6 percent for the inventory as a whole. This pattern is not surprising for a number of reasons. First, larger facilities had more to gain from products we offered in exchange for their cooperation, since they had more motor systems on site. Second, larger facilities generally had more personnel to assign to escorting the field engineer and taking load measurement readings. Many smaller companies did not have electricians on staff. The understaffing of the maintenance function, which we observed throughout the sample, was particularly pronounced for smaller companies. Once the field engineers were on site, however, they enjoyed a very high level of cooperation and response from their hosts.

Table 1-5: Disposition of Manufacturing Sample

Disposition	Number	% of Sites Attempted
Complete	254	5.7%
Canceled	23	0.5%
Does not Exist	375	8.4%
Refused/Not Interested	1,730	38.7%
Not Qualified	1,057	23.7%
Not Contacted	378	8.5%
Decision Pending when Quota Filled	651	14.6%
Total	***4,468***	***100.0%***

THE MARKET ASSESSMENT INVENTORY IN THE CONTEXT OF PREVIOUS STUDIES: APPROPRIATE APPLICATIONS AND CAVEATS

Over the past decade, analysts of the market for industrial motor systems have relied primarily on two sets of sources to characterize the inventory. The first is the Manufacturing Energy Consumption Survey (MECS), a triennial survey of over 15,000 manufacturing establishments designed to estimate the amount of different kinds of energy used at very fine levels of industry and geographic aggregation. The second is a series of market research studies based on a combination of expert industry opinion, shipment data, and a variety of secondary sources. The earliest of these studies was conducted by Arthur D. Little for DOE in 1977 and revised in 1980. Succeeding studies in this vein have essentially been updates of the Arthur D. Little work. Readers wishing to get the maximum value from these sources, as well as from the MAI, should be acquainted with their strengths and limitations. In this section, we briefly describe the MECS and the market research studies, and compare their outputs and appropriate applications with those of this study.

THE MANUFACTURING ENERGY CONSUMPTION SURVEY (MECS)

MECS is a survey of roughly 15,000 industrial facilities drawn from the Census of Manufactures sample frame. MECS is conducted every 3 years. The most recent survey for which results are now available was completed in 1994.

MECS is designed and analyzed by the Energy Information Agency and administered by the Bureau of the Census. The survey's principal objective is to estimate consumption of various forms of energy by the population of facilities in all manufacturing industries (SICs 20–39). Respondents to the survey compile energy bills and report total consumption of electricity and other fuels for the calendar year preceding the survey. When combined with information on the facility such as value of shipments, value added, and employment, the fuel consumption data provide much useful information on energy use in individual industries, as well as ratios by which meaningful comparisons can be made between industries.

The survey's sampling methods are rigorous, and it enjoys the benefit of access to the Census of Manufacturers' sample frame and sampling apparatus. Moreover, the survey has enjoyed extremely high levels of customers response—90 percent in the most recent rounds. These procedures and response levels ensure the representativeness of the results.

Perhaps most important for this project, MECS estimates the proportion of total electricity used by motor systems in industrial processes by industry for all two-digit SICs, and selected three and four-digit SICs. This allocation is based on the respondent's estimate of the allocation of total electric consumption among end uses. The process related end-use categories to which respondents may allocate electricity usage are: Process Heating, Process Cooling and Refrigeration, Machine Drive, Electro-Chemical Processes, and Other Process Uses. The sum of electricity in the Machine Drive and Process Cooling and Refrigeration categories corresponds to the energy the MAI was designed to estimate.[5]

Generally, an individual familiar with plant operations answers the questions concerning the allocation of energy to end uses.[6] However, the survey form itself offers no guidance on how to make this allocation, beyond providing a few examples of the kinds of end uses included in the larger categories. At no point in the survey are the end-use allocations corroborated by any kind of field observation.

Strengths of the MECS estimates.
The strengths of MECS as a source on motor system energy can be summarized as follows:

- It is based on a large, representative sample and enjoys high response rates.
- MECS obtains accurate information on the total amount of electricity used at the site level. This effectively prevents wild overestimates of motor system energy and provides an intuitive check on the reasonableness of the end-use allocations.
- The MECS sample is sufficiently large to provide reasonably precise estimates of energy use for important four-digit SIC groups. This is particularly important in such industries as Chemicals (SIC 28) and Primary Metals (SIC 33). For example, Industrial Inorganic Chemical Plants (SIC 2819) and Industrial Gas Producers (SIC 2813) each use more motor system energy than many two-digit industrial groups. However, their patterns of electricity and motor system energy use are quite different.

Limitations of the MECS estimates.
While the MECS results serve as an excellent point of departure for detailed analyses of the motor system population and energy use, they have the following limitations.

- Given that the electric end-use allocations are not corroborated by other kinds of observations, their accuracy can be questioned. This is particularly the case for industries dominated by large facilities that use huge amounts of electricity: Pulp and Paper, Primary Metals, certain chemical subindustries.
- MECS does not provide any detail of the distribution of the motor system population by size, application, operating hours, part load, or other characteristics that can be used to assess energy savings opportunities.

THE MARKET ASSESSMENT INVENTORY: COMPARISON TO MECS

Comparison of motor system energy estimates.
The primary purpose of MECS is to estimate total energy use by energy source for all subdivisions of manufacturing. Secondarily it produces an estimate of electric use in motor systems, among other end uses. The primary purpose of the MAI was to characterize the population of manufacturing motor systems in great detail. As a byproduct, we produced estimates of motor energy use for all but the two smallest two-digit manufacturing groups, and for the manufacturing sector as a whole.

5 There is likely to be some motor system energy in other categories including “Process Heating” and “Other”. The survey form provides the following end uses as examples of end uses to be included under “Process Heating”: kilns, furnaces, ovens. This suggests that most respondents would generally think of uses in which electricity is used directly to produce heat, rather than to drive ancillary equipment, such as induced draft fans or boiler water pumps, which could also be covered under machine drive.

6 Communication with Dwight French, Director of the Energy Consumption Division of EIA.

Although the scale, time period covered, and basic methodological approach of the two surveys are different, it is nonetheless important to compare the motor system energy estimates they developed. If the MAI's estimates of motor system energy at the two-digit SIC level differed greatly from that of MECS, then we would suspect that there was something wrong with the sampling plan or data collection protocol. As Table 1-6 shows, the motor system energy estimates generated by the two surveys are generally very close, within 6 percent for the manufacturing sector as a whole. We would expect the MAI estimates to be somewhat higher than the MECS estimates for a number of reasons.

- According to Energy Information Administration statistics on industrial electric consumption and updates of the Annual Census of Manufacturers, electric use in the manufacturing sector increased from 1994 to 1996 by approximately 1.4 percent.
- The MAI is likely to pick up some equipment whose electric consumption is classified under other categories in the MECS.

Table 1-6: Comparison of MAI and MECS 1994 Estimates of Motor System Energy by Two-Digit SIC Group

		Motor Energy (GWh/Year)		Survey Estimate as
SIC	Industry Description	MECS 94	MAI	% of MECS Estimate
20	Food and Kindred Products	47,374	37,797	80%
21	Tobacco Products	909	–	–
22	Textile Mill Products	20,890	16,750	80%
23	Apparel and Other Textile Products	3,108	1,168	38%
24	Lumber and Wood Products	15,589	22,946	147%
25	Furniture and Fixtures	3,662	3,694	101%
26	Paper and Allied Products	99,350	99,594	100%
27	Printing and Publishing	8,570	5,961	70%
28	Chemicals and Allied Products	135,518	144,362	107%
29	Petroleum and Coal Products	42,658	51,938	122%
30	Rubber and Miscellaneous Plastics Products	25,914	36,610	141%
31	Leather and Leather Products	510	491	96%
32	Stone, Clay, and Glass Products	22,305	2,231	10%
33	Primary Metal Industries	46,093	87,935	191%
34	Fabricated Metal Products	17,706	7,296	41%
35	Industrial Machinery and Equipment	15,034	7,378	49%
36	Electronic and Other Electric Equipment	11,605	13,243	114%
37	Transportation Equipment	17,291	29,549	171%
38	Instruments and Related Products	4,780	6,487	136%
39	Miscellaneous Manufacturing Industries	2,337	-	-
		541,203	***575,428***	***106%***

At the two-digit SIC level, the divergence between the MAI and MECS results is more pronounced. This is to be expected given the relatively small size of the MAI samples at the two-digit level. Among the five of six major process industries which use huge amounts of motor system energy (Food, Textiles, Paper, Chemicals, Petroleum, and Primary Metals), the difference between the MAI and the MECS energy estimates was 22 percent or less. The one exception was in Primary Metals where the MAI estimate was 91 percent higher than the MECS estimate. A number of factors may have influenced this result. First, as discussed above, Primary Metals facilities use large amounts of electricity in a variety of processes, including motor systems and process heat. Small but consistent misallocations of energy among these end uses by participants in the MECS could lead that survey to underestimate motor system electricity. The 1994 MECS estimates SIC 33 motor system energy at 30 percent of total electricity (purchased and net on-site generation). The MAI estimate would come in at 57 percent of total electricity. Second, as in most large industries, there is a great deal of variation in the nature and intensity of motor energy use within subdivisions. With only 23 sites in the sample, it was difficult to account for all of this variation, and the kinds of factories that fell into the sample may have had unusually high proportions of motor system energy consumption. Similarly, the low level of motor system energy use found in SIC 32 may have been due to the small sample (six sites) and the nature of the processes at those sites.

Use of MECS versus MAI estimates.
Throughout this report, we will be making reference to the 1994 MECS estimates of motor system energy use and using various indicators of energy intensity and cost based on those estimates. We have attempted to be as consistent as possible in our choice between MECS motor system estimates and the estimates generated by the MAI. Table 1-7 displays uses to which the different estimates are put, as well as our criteria for each decision.

Table 1-7: Application of MECS and MAI Results

Application	Rationale
MAI Applications	
• Detailed distributions of motor system population and energy use by HP, application, and other attributes.	• Only the MAI collects information on motor attributes. • Each motor system observation contains sufficient information to estimate its annual energy consumption.
• Estimates of motor system energy savings.	• The methods used to estimate energy savings directly incorporate observations on individual motor systems, including the efficiency of the motor, the application of the motor system, and detailed attributes of the system including control mechanisms, hours of use, motor size, and type.
MECS Applications	
• Estimates of motor system energy use at the four-digit SIC level.	• The MAI sample was designed to yield representative results only at the two-digit SIC level for manufacturing industries.
• Development of indices of motor system energy intensity and costs, e.g., motor system energy per employee or motor system energy costs as a percentage of operating costs for various industries.	• Estimates of the component statistics for these indices generally come from Census surveys which make use of the same sampling frame and procedures, that is, the Census of Manufactures and the Annual Survey of Manufactures.

PRECISION OF MAI ESTIMATES

Most of the description of the motor system population and energy savings opportunities contained in this report proceeds from estimates of motor system energy used by various groups of motor systems in the population. We estimated 90-percent confidence intervals for our estimates of total motor system energy in all manufacturing, total motor system energy in each two-digit manufacturing SIC group, and each major application (pumps, fans, air compressors, and other machines).

Table 1-8 shows the 90-percent confidence interval for the MAI estimate of motor system energy for the relevant two-digit SIC group and for manufacturing as a whole.[7] The 90-percent confidence interval for total manufacturing motor system energy was ± 18 percent. The confidence intervals for total motor system energy in the individual two-digit SIC groups ranged from ± 4 percent in Stone, Clay, and Glass (SIC 32) to ± 81 percent in Primary Metals (SIC 33). The broadest confidence intervals are for Primary Metals, SIC 33 (± 81 percent) and Chemicals

[7] The 90-percent confidence interval can be interpreted as follows: There is a 90-percent probability that the actual total motor system energy consumption is within "X" percent of the estimate based on sample observations.

SIC 28 (± 46 percent). The high variance in these groups reflects the extreme diversity of motor usage in the chemical and steel industries. For example, motor system energy use per employee in Industrial Gases (SIC 2811) is over 3 million kWh per year, versus 270,000 kWh per year in Plastic Materials and Resins (SIC 2821).

Given the relatively small size of the MAI sample, the precision of these estimates is high. However, the further the results of the inventory are disaggregated, the less precise the estimates of population attributes become. Readers should keep this in mind in interpreting the inventory results presented below.

Table 1-8: Precision of Motor System Energy Estimates by Two-Digit SIC Group

SIC	Industry Description	MAI Estimate of Motor System Energy Use (GWh/Year)	90% Confidence Interval
20	Food and Kindred Products	37,797	±16%
21	Tobacco Products	–	–
22	Textile Mill Products	16,750	±22%
23	Apparel and Other Textile Products	1,168	±10%
24	Lumber and Wood Products	22,946	±27%
25	Furniture and Fixtures	3,694	±18%
26	Paper and Allied Products	99,594	±28%
27	Printing and Publishing	5,961	±22%
28	Chemicals and Allied Products	144,362	±46%
29	Petroleum and Coal Products	51,938	±13%
30	Rubber and Miscellaneous Plastics Products	36,610	±10%
31	Leather and Leather Products	491	
32	Stone, Clay, and Glass Products	2,231	±4%
33	Primary Metal Industries	87,935	±81%
34	Fabricated Metal Products	7,296	±16%
35	Industrial Machinery and Equipment	7,378	±14%
36	Electronic and Other Electric Equipment	13,243	±9%
37	Transportation Equipment	29,549	±38%
38	Instruments and Related Products	6,487	±12%
39	Miscellaneous Manufacturing Industries	-	-
	Total Manufacturing	***575,428***	***±18%***

OVERVIEW OF MOTOR SYSTEM ENERGY USE IN INDUSTRY

In this section, we provide a general overview of the scale of motor energy consumption and costs in industry.

SCALE OF MOTOR SYSTEM ENERGY USE

According to the results of the MAI, there are roughly 12.4 million electric motors of more than 1 horsepower in service in U.S. manufacturing plants. Based on a combination of survey results, previous government surveys, and secondary literature, we estimate that there are an additional 2.5 million integral horsepower motors in use in the non-manufacturing industries covered by this study. Table 1-9 shows the distribution of motor system energy between manufacturing and non-manufacturing industries, and among major subdivisions within those categories.

Table 1-9: Motor System Energy Use by Major Industry Group, 1994

Industry Categories	Net Electric Demand* (GWh/Year)	Motor System Energy (GWh/Year)	Motor System Energy as % of Total Electricity
Manufacturing	**917,834**	**541,203**	**59%**
Process Industries (SICs 20,21,22,24,26,27,28,29,30,31,32)	590,956	419,587	71%
Metal Production (SIC 33)	152,740	46,093	30%
Non-metals Fabrication (SICs 23,25,36,38,39)	106,107	50,031	47%
Metals Fabrication (SICs 34,35,37)	68,031	25,492	37%
Non-manufacturing	**167,563**	**137,902**	**82%**
Agricultural Production (SICs 01, 02)	32,970	13,452	41%
Mining (SICs 10, 12,14)	44,027	39,932	90%
Oil and Gas Extraction (SIC 13)	33,038	29,866	90%
Water Supply, Sewage, Irrigation (SICs 494, 4952,4971)	57,528	54,652	95%
Total All Industrial	***1,085,397***	***679,105***	***62.6%***

* Net electric demand is the total of purchased kWh plus kWh generated on site less kWh sold to off-site users.
Sources: MECS 1994, Department of Agriculture 1992, Census of Mineral Industries 1992, Burton Environmental et al. 1993.

Industrial motor system energy in the context of national electric usage.
In 1994, motors systems used for production processes only (not including facility heating and ventilating) consumed 679 billion kWh, or 23 percent of all electricity sold in the United States that year (2,931 billion kWh). If the energy associated with industrial HVAC systems is added, this total comes to 747 billion kWh, or 25 percent of all electric sales.

Motor system energy use in the context of industrial energy usage.
Process motor system energy accounts for 63 percent of all electricity used in industry; 59 percent of all electricity used in manufacturing. Motor system energy accounts for 8.5 percent of all manufacturing energy consumption from all sources, or 22 percent, if losses in the conversion of thermal to electrical energy and transmission are taken into account.

Concentration of motor system energy by industry.
Motor system energy usage is highly concentrated by industry. Table 1-10 shows that the top 10 two-digit industries (after consolidating mining into one group) account for 75 percent of all motor system energy use in industry.

Table 1-10: Motor System Energy Use by Top 10 Two-Digit Industrial Groups

SIC	Industry Group	Motor Systems Energy (GWh/Year)	Percent of Total Industrial Motor System Energy
28	Chemicals and Allied Products	135,518	20%
26	Paper and Allied Products	99,350	15%
20	Food and Kindred Products	47,374	7%
33	Primary Metal Industries	46,093	7%
29	Petroleum and Coal Products	42,658	6%
10,12,14	Mining	39,932	6%
494	Water Supply	26,885	4%
13	Oil and Gas Extraction	26,836	4%
30	Rubber and Misc. Plastics	25,914	4%
22	Textile Mill Products	20,890	3%
	Subtotal	***511,450***	***75%***
	Total (All Industrial)	679,105	

Concentration of motor system energy use in manufacturing.
The concentration of motor system energy in manufacturing is even more pronounced than it is in industry as a whole. Table 1-11 shows the 10 four-digit SIC groups with the highest estimated motor system energy use. These 10 SIC groups account for nearly half of all manufacturing motor system energy use (and a commensurate share of potential savings). These groups include only 3,583 facilities, or 1.5 percent of all manufacturing plants. The largest 780 plants in these groups account for over one-third of all manufacturing motor energy use. These plants are owned by roughly 500 separate companies.

Table 1-11: Concentration of Motor Energy Use in Manufacturing

SIC	Industry Categories	Motor System Energy Use (mm kWh/Yr)	% of Total Manufacturing Motor System Energy
2621	Paper Mills	55,777	10.3%
2911	Petroleum Refining	40,805	7.5%
2819	Industrial Inorganic Chemicals, nec.	37,232	6.9%
2631	Paperboard Mills	27,007	5.0%
3312	Blast Furnaces and Steel Mills	25,323	4.7%
2869	Industrial Organic Chemicals, nec.	28,721	5.3%
2813	Industrial Gases	21,733	4.0%
2821	Plastics Materials and Resins	13,667	2.5%
3241	Cement, Hydraulic	9,147	1.7%
2611	Pulp Mills	6,402	1.2%
	Total of Top 10	***265,814***	***49.1%***
	Total: All Manufacturing	***541,203***	

Sources: MECS 1994, Census of Manufactures 1992.

Motor system energy costs in the context of total operating costs.
In 1994, manufacturing facilities spent $23.4 billion for motor system energy. The non-manufacturing industries covered in this study spent an additional $6.6 billion. Despite these large numbers, motor system energy costs constituted only 0.7 percent of total operating costs for all manufacturing industries. At the two-digit level, motor system energy costs amounted to more than 1 percent of total energy costs for six groups: Paper; Chemicals; Textiles; Lumber and Wood Products; Stone, Clay and Glass Products; and Primary Metals. Only in Paper and Allied Products did motor system energy costs exceed 2 percent of operating costs. The low ratio of motor system energy costs to total operating costs may help explain the scant attention motor system efficiency has received from most industrial establishments.

Don Meadows, TAPPI Journal

Paper mills like this one could save an average of $659,000 a year through motor system efficiency.

As with energy, motor system costs are highly concentrated in a small number of industries. Table 1-12 displays motor system energy use and potential savings per establishment in the 10 four-digit SIC groups with the highest annual motor energy consumption. In all these industries, the annual cost of motor system energy in a typical plant exceeds $1 million; in steel mills it is $6 million. Potential savings at the typical plant are also very large, ranging from $90,000 per year in the Industrial Organic Chemicals sector to nearly $1 million per year in petroleum refineries.

Table 1-12: Financial Impact of Motor Energy Consumption and Savings: Selected Industries

Industry Groups	Motor System Costs/Estab.	Motor Energy Costs/Total Operating Costs	Savings per Estab. per Yr.	Savings as % of Operating Margin
Paper Mills	$4.6 mm	6.5%	$659,000	5%
Petroleum Refining	$5.6 mm	1.4%	$946,000	1%
Industrial Inorganic Chemicals, nec.	$1.6 mm	10.4%	$283,000	6%
Paperboard Mills	$3.0 mm	6.4%	$492,000	5%
Blast Furnaces and Steel Mills	$6.0 mm	2.1%	$358,000	2%
Industrial Organic Chemicals, nec.	$1.3 mm	1.0%	$91,000	1%
Industrial Gases	$1.1 mm	21.7%	$116,000	13%
Plastics Materials and Resins	$1.5 mm	1.5%	$121,000	1%
Cement, Hydraulic	$2.2 mm	9.6%	$219,000	4%
Pulp Mills	$1.7 mm	6.7%	$483,000	5%

Sources: MECS 1994, Bureau of Economic Analysis 1997, Census of Manufactures 1993, Savings Analysis in Section 2.

DETAILED INVENTORY FINDINGS: MANUFACTURING INDUSTRIES

In this section we present detailed findings on the manufacturing motor systems inventory, concentrating on the distribution of motors and motor system energy by the following characteristics:

- Motor size: Horsepower or kW;
- Application and process;
- Hours of operation;
- Part load;
- Efficiency; and,
- Saturation of adjustable speed drives.

The presentation in this section focuses at the national level. In most cases, we disaggregate our findings by SIC group for the five largest motor system using SIC categories. These account for 36 percent of the motors and 73 percent of the motor system energy in manufacturing. Appendix B contains complete detailed tables of inventory characteristics for all two-digit manufacturing groups except Tobacco Products and Miscellaneous.

Estimation of motor system energy.
We estimated the annual energy use of every motor system inventoried for this project. The energy estimate was based on the standard engineering formula.

$$\text{Annual Energy} = \frac{\text{horsepower} \times 0.746 \times \text{operating hours} \times \text{motor loading}}{\text{efficiency}}$$

The value of the parameters in the energy equation for each motor system was established as follows:

- Horsepower: Nameplate horsepower observed or information from escort.
- Constant to convert HP to kW: 0.746.
- Hours of operation: Reported hours of operation for the department in which the motor system is located multiplied by the diversity factor for the individual motor system provided by the escort or machine operator.
- Part load: Average measured part load for the application category of the sampled motor system: pump, fan, air compressor, or other.[8] These figures were developed from instantaneous load measurements taken as part of the inventory.
- Nominal efficiency: Nameplate efficiency observed. If no efficiency was observed on the nameplate, the MotorMaster+ default efficiency for the horsepower class was used.[9]

DISTRIBUTION BY HORSEPOWER SIZE

Motor systems in the 1–5 horsepower range account for 59 percent of the motors in the entire manufacturing inventory. However, they account for only 5 percent of the energy use. Motors over 200 horsepower account for only one percent of the inventory, but use 45 percent of the energy. Table 1-13 shows the distribution of the motor population by horsepower class for selected SIC groups and for manufacturing as a whole. Table 1-14 shows the distribution of motor energy by the same categories.

Table 1-13: Distribution of Motor Population by Horsepower Size: Manufacturing Number of Units in Service

Motor Horsepower	28 Chem	26 Paper	33 Metals	29 Petrol.	20 Food	Other	*All SICs Percent*	*All SICs Number*
1–5	42.4%	52.2%	55.0%	32.0%	65.8%	63.9%	***58.8%***	***7,306,080***
6–20	30.0%	22.3%	26.1%	38.6%	22.6%	25.6%	***26.4%***	***3,288,035***
21–50	14.5%	13.0%	10.7%	18.9%	6.2%	7.2%	***9.1%***	***1,129,527***
51–100	5.9%	6.3%	3.5%	6.2%	2.4%	1.9%	***2.9%***	***363,940***
101–200	4.1%	3.1%	2.1%	2.8%	1.8%	1.2%	***1.8%***	***220,908***
201–500	2.2%	2.0%	1.7%	1.0%	0.9%	0.2%	***0.7%***	***86,836***
501–1000	0.6%	0.9%	0.7%	0.3%	0.4%	0.0%	***0.2%***	***28,047***
1000+	0.4%	0.3%	0.3%	0.2%	0.0%	0.0%	***0.1%***	***10,958***
All Sizes	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	***100.0%***	***12,434,330***

Table 1-14: Distribution of Motor System Energy by Horsepower Size: Manufacturing

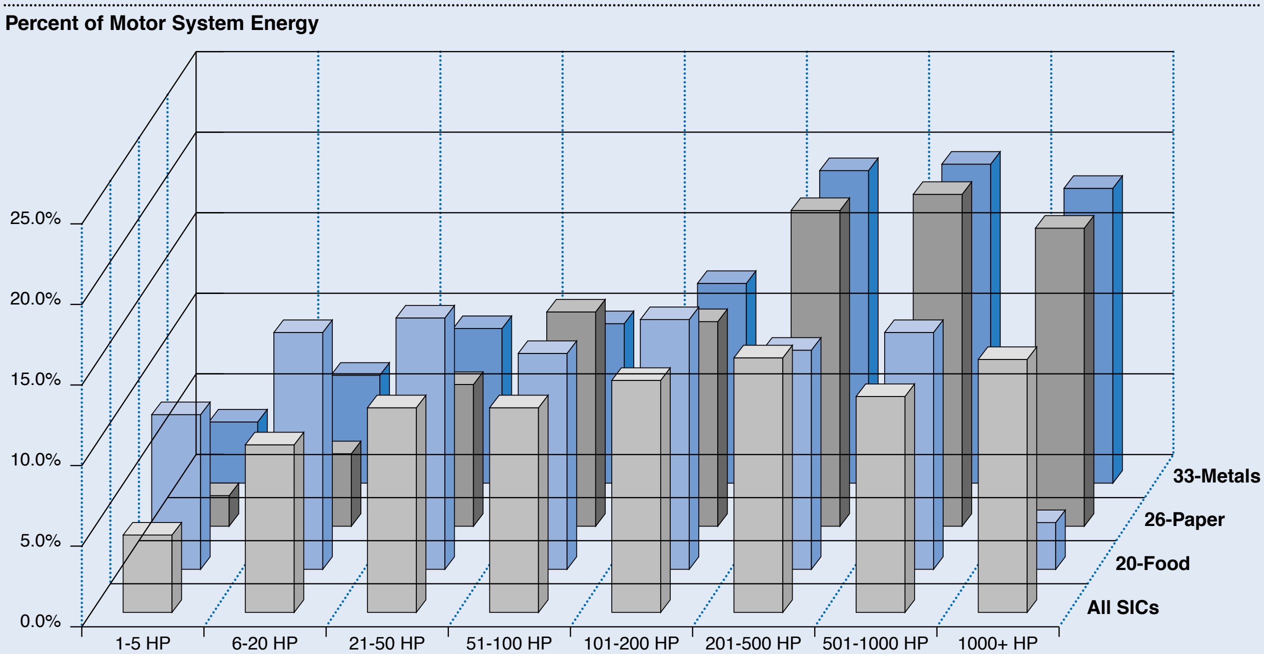
Motor Horsepower	28 Chem	26 Paper	33 Metals	29 Petrol.	20 Food	Other	*All SICs Percent*	*All SICs Number*
1–5	1.6%	1.9%	3.8%	1.0%	9.6%	10.4%	***4.8%***	***27,807***
6–20	6.4%	4.5%	6.7%	5.9%	14.7%	20.7%	***10.4%***	***60,122***
21–50	9.1%	8.8%	9.6%	12.4%	15.6%	19.8%	***12.7%***	***73,111***
51–100	9.3%	13.3%	9.9%	12.2%	13.4%	17.0%	***12.7%***	***72,924***
101–200	14.3%	12.7%	12.4%	13.9%	15.5%	16.9%	***14.4%***	***83,099***
201–500	18.1%	19.6%	19.4%	16.1%	13.6%	9.4%	***15.8%***	***90,819***
501–1000	13.7%	20.6%	19.8%	11.0%	14.7%	5.3%	***13.4%***	***77,238***
1000+	27.5%	18.5%	18.3%	27.4%	2.9%	0.5%	***15.7%***	***90,307***
All Sizes	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	***100.0%***	***575,428***

8 Part load is defined as the ratio of the instantaneous output from a piece of equipment to the equipment's rated load. Most motors, pumps, fans, and air compressors operate most efficiently at part loads that are within 15 to 20 percent of their rated loads.

9 MotorMaster+ is a software program developed by Washington State University that supports electric motor selection decisions. It contains a current database of electric motors offered by most major manufacturers, as well as a set of default assumptions concerning the nominal efficiency of motors currently in use. These assumptions are reviewed and revised periodically by experts in the field.

Figure 1-2 illustrates the differences between industries in distribution of motor system energy by horsepower class. In manufacturing as a whole, the distribution of motor system energy across horsepower classes above the 1–5 range is fairly even. In Paper and Primary Metals, which have high levels of motor system energy use per establishment (9 GWh/Year and 18 GWh/Year, respectively), the distribution of motor system energy is concentrated in the higher horsepower ranges, especially in Metals. These large motors are generally driving very large machines or fluid systems that provide heat or compressed air to the entire facility. Food Processing, on the other hand, has a relatively low level of motor energy use per establishment (3 GWh/Year). Its motor energy use is concentrated in the 1–20 and 51–100 horsepower ranges. Many of these are systems that provide service to the entire facility. However, food processing plants are generally smaller than paper or metals facilities.

Figure 1-2: Distribution of Motor Energy by Horsepower—All Manufacturing and Selected SIC Groups



HOURS OF OPERATION

The high concentration of motor system energy in the larger horsepower ranges can be explained to some extent by the distribution of motor systems by hours of operation. As Table 1-15 shows, annual hours of operation increase fairly consistently with motor size, particularly in the process industries. This reflects the use of large motors to provide facility-level services such as compressed air or pumping of finished products. In Paper and Chemicals for example, motors systems in the 1000+ horsepower range were reported to operate more or less continuously. (There are 8,760 hours in a year.) On average, motor systems in the 501–1000 horsepower range were reported to be operating 80 percent of the time.

Table 1-15: Annual Motor System Operating Hours by Horsepower Size: Manufacturing

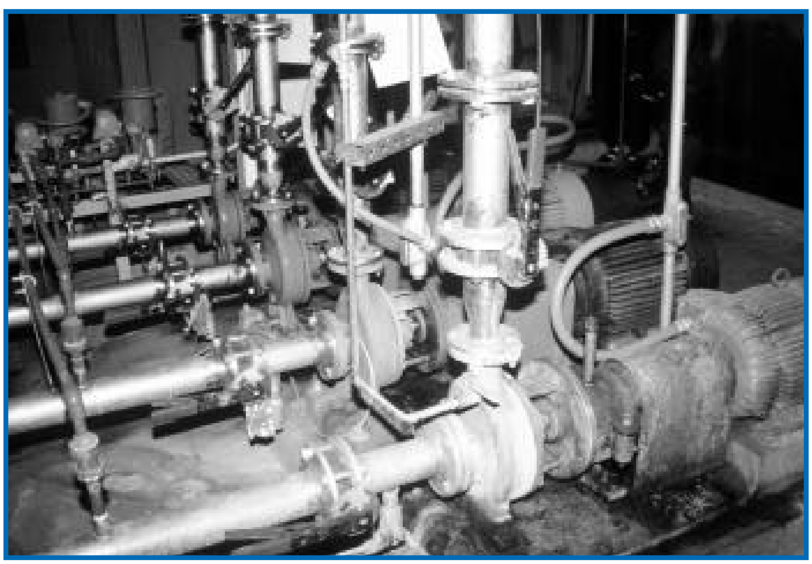
Motor Horsepower	28 Chem	26 Paper	33 Metals	29 Petrol.	20 Food	Other	All SICs Number
1–5	4,082	3,997	4,377	1,582	3,829	2,283	2,745
6–20	4,910	4,634	4,140	1,944	3,949	3,043	3,391
21–50	4,873	5,481	4,854	3,025	4,927	3,530	4,067
51–100	5,853	6,741	6,698	3,763	5,524	4,732	5,329
101–200	5,868	6,669	7,362	4,170	5,055	4,174	5,200
201–500	6,474	6,975	7,114	5,611	3,711	5,396	6,132
501–1000	7,495	7,255	7,750	5,934	5,260	8,157	7,186
1000+	7,693	8,294	7,198	6,859	6,240	2,601	7,436
All Sizes	6,333	6,748	6,465	4,332	4,584	3,678	5,083

DISTRIBUTION BY APPLICATION

Previous studies have identified the major fluid systems—pumps, fans, and compressors of various types—as the applications that account for the greatest portion of motor system energy. One frequently cited study based on various marketing research sources estimated that 49 percent of total manufacturing motor system energy was used by pumps, fans, and compressors. (RDC 1991) The results of the MAI place this figure at 61 percent. The heavy concentration of motor system energy in fluid systems is an important finding because methods to improve the efficiency of such systems are fairly well understood *and* because virtually every industry uses these systems. They are particularly heavily concentrated in the process industries.

Tables 1-16 and 1-17 show the distribution of the motor population and motor system energy use by application for selected SIC groups. As we previously saw in the motor size distributions, the differences between industries is pronounced. Pumps account for 59 percent of total motor system energy in the petroleum industry, versus 25 percent for all manufacturing. In Primary Metals, 47 percent of motor system energy is consumed by material handling equipment versus 12 percent in manufacturing as a whole. Compressed air systems account for 28 percent of motor system energy in Chemicals, versus 16 percent in all manufacturing facilities. Figure 1-3 illustrates these differences.

Pumps account for 25% of total motor system energy in all manufacturing. The Heileman Division of Stroh Brewery Company showed how a pump optimization project at its Lacrosse facility cut the cooling system's energy use by half.



Energy Center of Wisconsin

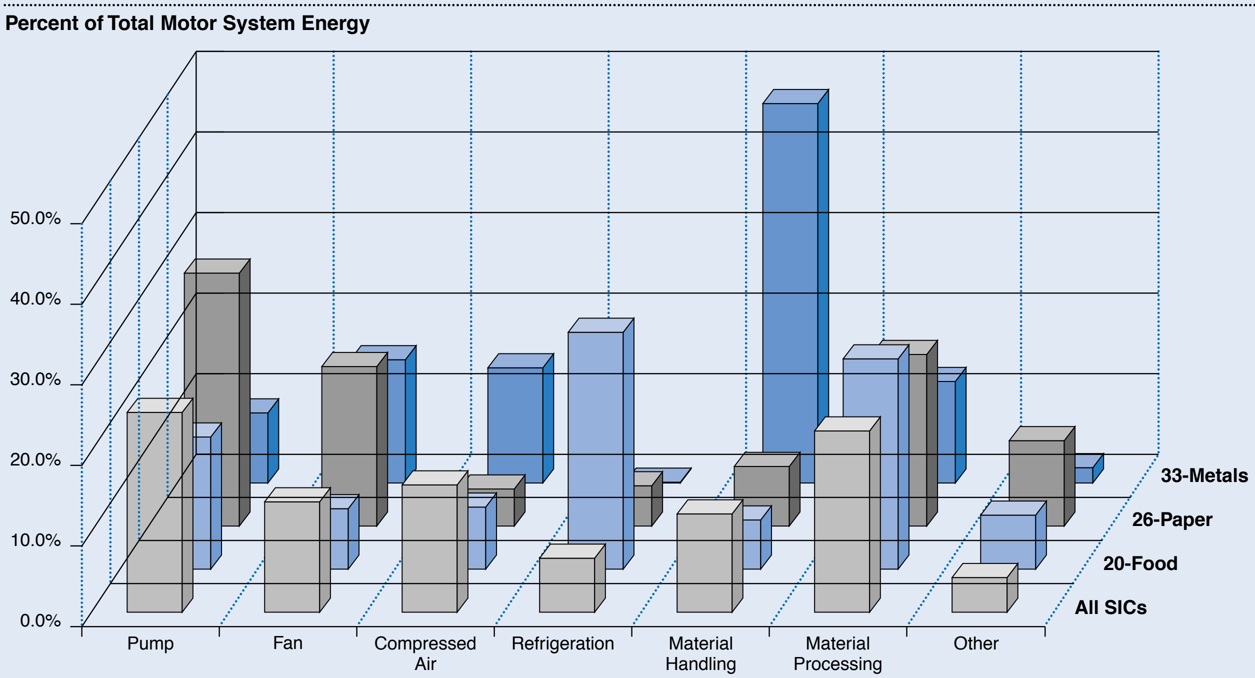
Table 1-16: Distribution of Motor Population by Application

Motor Horsepower	28 Chem	26 Paper	33 Metals	29 Petrol.	20 Food	Other	*All SICs Percent*
Pump	42.2%	22.3%	17.9%	43.3%	22.7%	13.9%	***19.7%***
Fan	10.4%	13.4%	14.1%	10.7%	12.9%	10.6%	***11.2%***
Compressed Air	4.1%	3.3%	6.0%	3.2%	3.8%	5.6%	***5.1%***
Refrigeration	1.8%	0.4%	0.3%	0.6%	2.1%	0.6%	**0.8%**
Subtotal: Fluid Systems	58.5%	39.4%	38.4%	57.8%	41.5%	30.7%	***36.8%***
Material Handling	5.1%	24.6%	34.9%	12.4%	23.9%	15.0%	***16.8%***
Material Process	33.7%	29.3%	20.3%	28.1%	31.1%	50.0%	***42.2%***
Other	2.6%	6.8%	6.4%	1.8%	3.4%	4.3%	***4.2%***
Subtotal: Other Systems	41.5%	60.6%	61.6%	42.2%	58.5%	69.3%	***63.2%***
All Applications	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	***100.0%***

Table 1-17: Distribution of Motor System Energy Use by Application

Motor Horsepower	28 Chem	26 Paper	33 Metals	29 Petrol.	20 Food	Other	*All SICs Percent*
Pump	26.0%	31.4%	8.7%	59.0%	16.4%	19.0%	***24.8%***
Fan	11.9%	19.8%	15.3%	9.5%	7.5%	13.5%	***13.7%***
Compressed Air	27.7%	4.6%	14.3%	15.3%	7.7%	15.0%	***15.8%***
Refrigeration	7.7%	5.0%	0.1%	0.7%	29.4%	7.1%	***6.7%***
Subtotal: Fluid Systems	73.3%	60.7%	38.4%	84.4%	61.1%	54.6%	***61.0%***
Material Handling	1.4%	7.4%	47.1%	2.6%	6.1%	10.3%	***12.2%***
Material Process	23.6%	21.3%	12.6%	11.1%	26.1%	31.0%	***22.5%***
Other	1.8%	10.6%	1.9%	1.9%	6.7%	4.1%	***4.3%***
Subtotal: Other Systems	26.7%	39.3%	61.6%	15.6%	38.9%	45.4%	***39.0%***
All Applications	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	***100.0%***

Figure 1-3: Distribution of Motor Energy by Application—All Manufacturing and Selected SIC Groups

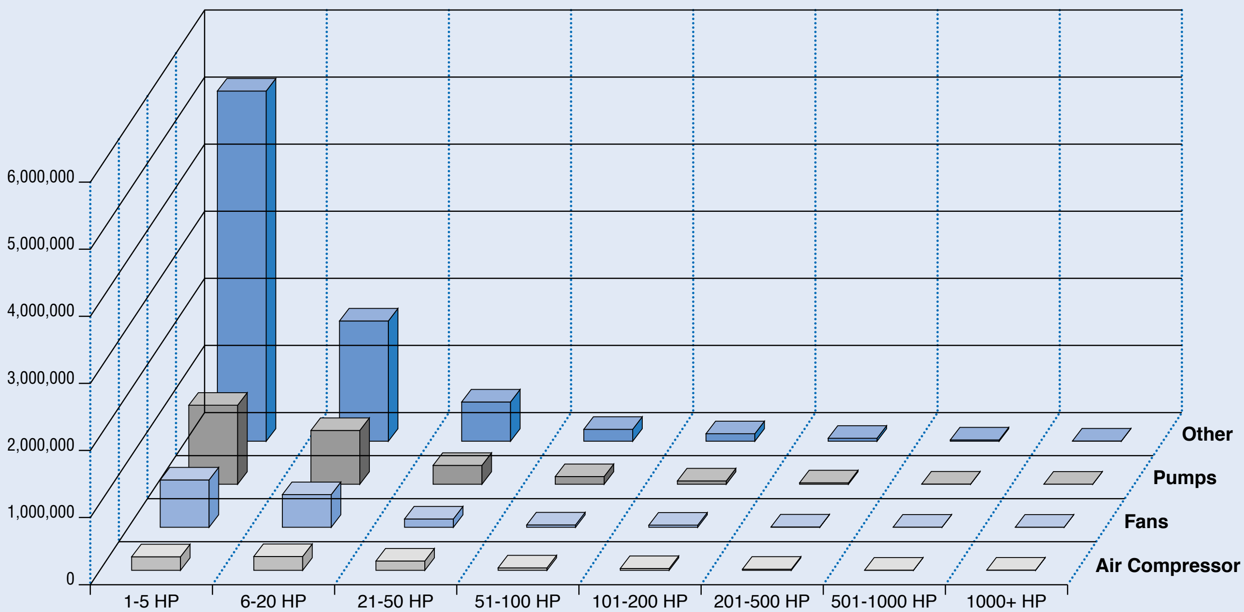


DISTRIBUTION OF MOTOR SYSTEM POPULATION AND ENERGY BY SIZE AND APPLICATION

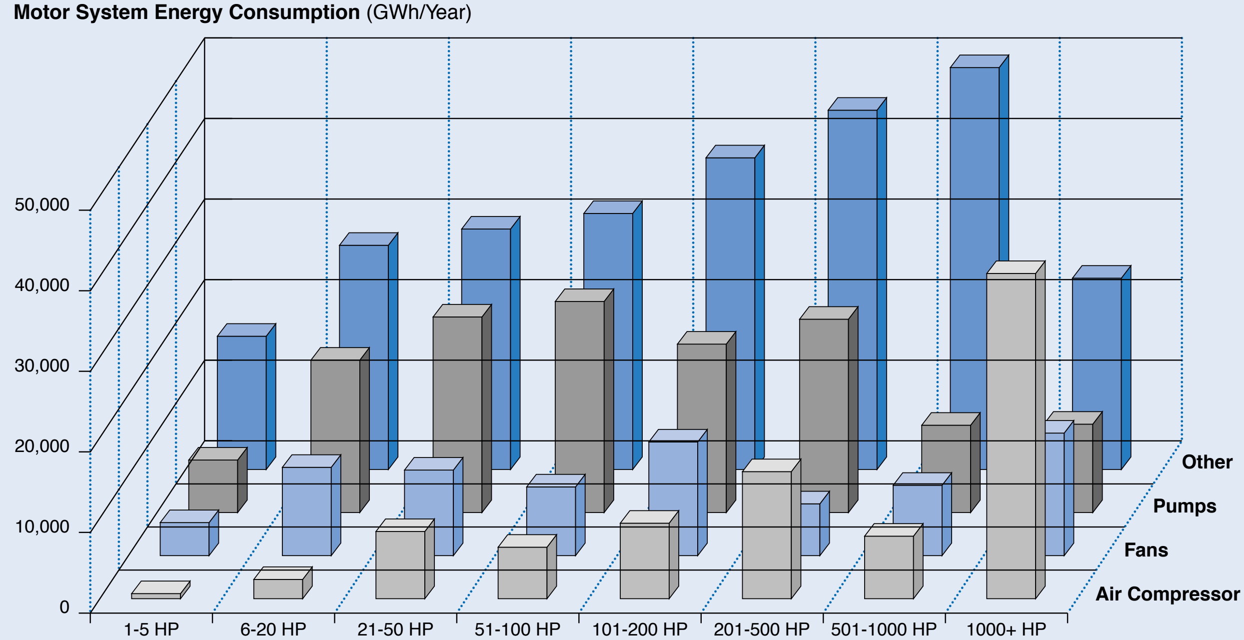
The overall layout of the motor population in terms of units and energy, as well as the differences between industries become clearer when motor system energy is disaggregated by motor size *and* application. Figure 1-4 shows the distribution of motors and motor system energy by size and application. The striking aspect of this chart is the extreme concentration of the motor population in relatively small, non-fluid applications.

Figure 1-4: Distribution of Motor Population and Energy Use by Horsepower Class and Application

Motor Population (Number of motors)



Motor System Energy Consumption (GWh/Year)



Motor system energy is considerably more evenly distributed among size and application categories than the population. As discussed above, total motor system energy is fairly evenly distributed among the horsepower size categories from 6 to 20 HP and above. At the application level, motor system energy for non-fluid systems is distributed fairly evenly by horsepower, and accounts for about 40 percent of all motor system energy use. Among the fluid system categories, compressed air system energy is concentrated in the highest motor HP range—1,000 horsepower and above. Pumping system energy, by contrast, is spread fairly evenly among the HP categories from 6 to 200 HP.

DISTRIBUTION OF MOTOR SYSTEMS AND ENERGY BY PART LOAD

It is widely observed by persons familiar with industrial motor systems operation that a significant portion of motors operate for extended periods below the efficient range of part loads. Below 40 percent part load, the efficiency of motors drops off precipitously. If a motor system runs consistently below 40 percent, considerable energy savings can be achieved by reducing the size of the motor. (E-Source 1993) Prior to the MAI, several studies had been undertaken to assess the extent of motor oversizing. All of these use instantaneous load measurements on small, unrepresentative samples of motors. (Gordon et al. 1994, Kotiuga et al. 1995) Such evidence as these studies provide suggests that a large portion of industrial motors—perhaps 20–40 percent generally operate at low part loads.

The inventory database contains instantaneous load measurements for 1,991 motors. These measurements were taken at 221 of the inventoried sites. While we attempted to take measurements at all of the sites, this was not possible in all cases. At some factories, processes were shut down for maintenance or retooling; at others the electrician was not available to connect the meters.

The field engineers selected motors for measurement from the completed inventory list using random methods. The selection method was structured so that the probability of selection increased with motor size (a proxy for motor system energy use). Prior to taking load measurements, the field engineers consulted with the escort to verify that the motor was operating under load and in "typical conditions."

The distribution of the load measurements are shown in Tables 1-18 and 1-19. These distributions are properly weighted to reflect the representation in the population of the sample facilities and the sample motor systems within those facilities. Of the 1,991 motors measured, 44 percent were loaded at less than 40 percent. Table 1-18 displays the loading by motor application and shows that the proportion of motors under loaded (less than 40% of full load) does vary by the motor application. Of the three fluid applications analyzed, air compressors are most consistently fully loaded with only 15 percent underloaded. Thirty percent of the fan systems measured and 39 percent of the pump systems measured were underloaded. "Other" motor systems—those that generally did not involve a fluid process—had the highest proportion of underloaded motors: 55 percent.

When pump and fan systems are significantly underloaded, it is likely that the system as a whole is operating far from its best (i.e. most efficient) operating point.[10] The high percentage of underloaded motors in pump and fan systems suggest that significant savings are available in these systems through adjustments to the system and downsizing of the drive motors.

The Motor System and Practices Inventory did not collect data which might shed light on the reasons for the pronounced differences between applications in percentage of underloaded motors. A number of studies note that conventional engineering practice has supported

10 The operating point is defined by the combination of static pressure, flow, and input power at which the pump is operating. The further actual operating conditions depart from the design point or best efficiency point, the lower the operating efficiency of the pump.

oversizing of pumps to accommodate potential large fluctuations in flow, thereby avoiding overflows and the damage they can cause. (Easton Consultants 1996, BPA 1992) However, we are not aware of sizing conventions that would lead to the large difference between fan and compressed air systems in the percentage of underloaded motors. Also, the higher loading of air compressors does not necessarily indicate greater system efficiency. Some of the load may consist of leaks and bypasses which do no productive work. Finally, the very high percentage of underloaded motors driving "other" machines is striking. It may reflect the diversity of the work these machines do and the lack of widely applicable sizing conventions.

Table 1-18: Distribution of Motors by Part Load and Application

Part Load (Percentage of Full Load)	Application				
	Air Compressor	Fan	Other	Pump	All
< 40%	15%	30%	55%	39%	44%
40 to 120%	84%	69%	43%	56%	53%
> 120%	1%	1%	2%	4%	2%

As Table 1-19 shows, the distribution of part loads does not vary significantly or consistently with the size of the motor.

Table 1-19: Loading by Horsepower

Part Load (Percentage of Full Load)	Horsepower Category					
	1 to 5 HP	6 to 20 HP	21 to 50 HP	51 to 100 HP	101 to 200 HP	200+ HP
< 40%	42%	48%	39%	45%	24%	40%
40 to 120%	54%	51%	60%	54%	75%	58%
> 120%	4%	1%	1%	0%	1%	2%

Care should be taken interpreting these data on motor loading. First, these are one-time instantaneous load measurements taken on systems where load may vary substantially on an hourly or seasonal basis. While our escorts reported that the measurements were made under typical operating conditions, we could not independently verify these reports. In addition, the readings are subject to some measurement error. The auditors were well trained in the use of the meters and the proper method of connecting a motor for measurement. However, in practice, the connection of leads and current transducers appropriate to current flow is substantially more difficult on the factory floor than it is under test conditions.

SATURATION OF EPACT-COMPLIANT MOTORS[11]

As of October 1997, all integral horsepower, polyphase, general purpose, low voltage AC induction motors from 1 to 200 horsepower sold in the U.S. must meet minimum efficiency standards. These standards, promulgated by the Energy Policy Act of 1992 (EPAct), are based on the National Electrical Manufacturers Association (NEMA) MG-1 Table 12-10. The minimum efficiency standard increases with horsepower category. The standards do not cover so-called Definite and Special Purpose motors,[12] nor do they cover integral horsepower motors over 200 horsepower. The motors covered by the standards account for 50–70 percent of all integral horsepower motors sold and 23–32 percent of annual energy consumed by integral horsepower motors.

11 In this report, the term "saturation" denotes the percentage of efficient equipment installed in the population. "Penetration" denotes the percentage of efficient equipment in the current stream of annual sales or shipments.

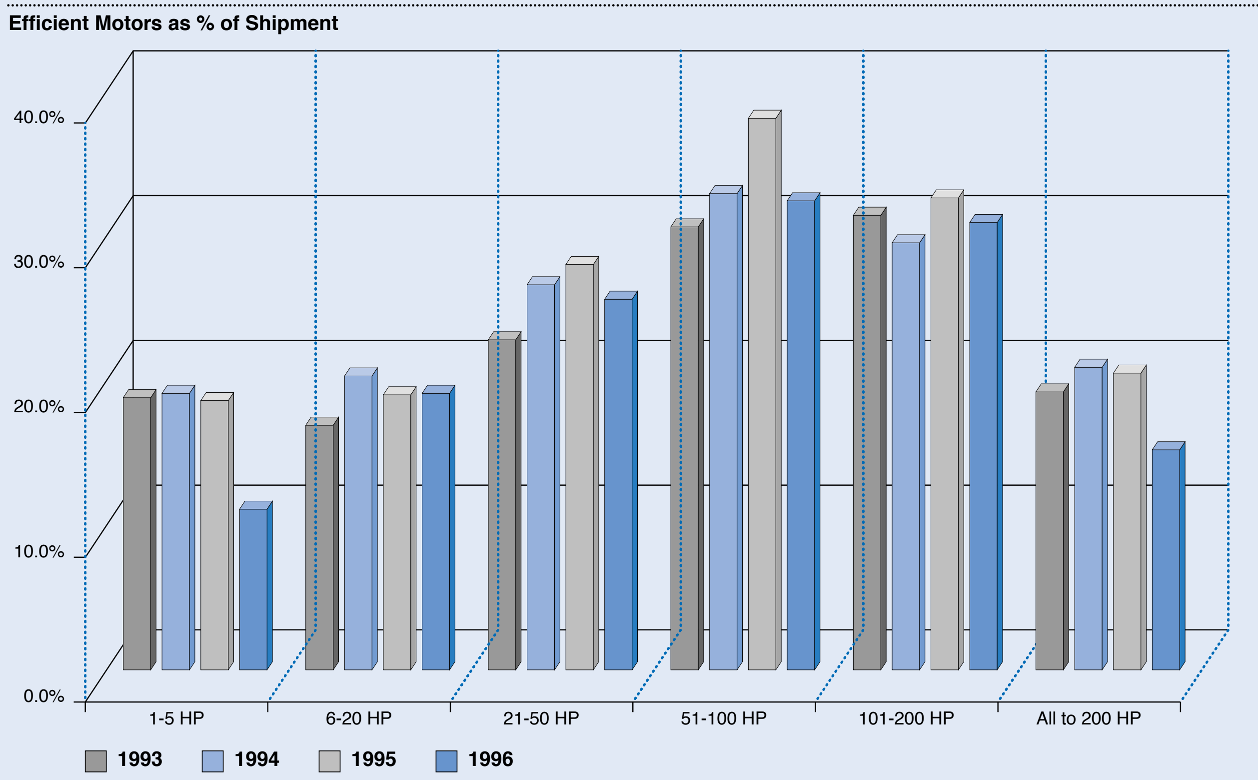
12 "Definite purpose" motors are defined by EPAct as motors that are designed in standard ratings and construction but cannot be used in most general purpose applications. "Special purpose" motors have special mechanical or operating characteristics designed for a specific application.

EFFICIENCY OF MOTORS SHIPPED

The Bureau of the Census has been tracking motor shipments and value of shipments by NEMA (now federal) efficiency designation since 1993. Most recent available figures run through 1996. Figure 1-5 shows the percentage of annual integral horsepower motor shipments represented by motors that met the NEMA (now EPAct) standards by year and by horsepower category. The following trends can be discerned.

- During the years 1993–1995, the market penetration of efficient motors held fairly steady around 20 percent, with the highest penetration in the 51–100 HP category.
- In 1996, the penetration of efficient motors declined to 15 percent. From 1995 to 1996, shipments of EPAct motors declined from 340,451 to 335,570. Shipments of standard efficiency motors increased 42% from 1.32 to 1.87 million units. Most of this increase came in the 1–5 horsepower range. The percentage of efficient motors dropped in all horsepower categories covered by EPAct, except for 6–20 HP, where the penetration of efficient motors held even.
- During the period 1993–1996, 1.2 million motors meeting the current EPAct standards were shipped by domestic manufacturers.

Figure 1-5: Efficient Motor Penetration



SATURATION OF ENERGY-EFFICIENT MOTORS

The inventory captured efficiency information for each motor observed. If the nominal efficiency of the motor appeared on the nameplate, it was entered on the data collection instrument. If no efficiency information was provided on the nameplate, we used a default value taken from the standard efficiencies listed in MotorMaster+ motor system management software.

The saturation of efficient motors is shown in Table 1-20. These results reflect the cumulative effects of the shipments of efficient motors. Overall, the inventory results show that about 1.1 million motors, or 9 percent of the population, meet or exceed the EPAct standards. The highest saturations are in Chemicals (SIC 28) and Paper (SIC 26), process industries with high levels of motor system energy consumption. Among the large motor system energy-using sectors, Primary Metals (SIC 33) has the lowest saturation of efficient motors.

The saturation of efficient motors is consistently greater for larger motors, with over 25 percent of motors of 101 to 200 HP meeting the EPAct standards. There are no standards for motors greater than 200 HP. However we estimated the saturation of energy-efficient motors over 200 HP by applying the EPAct efficiency standard for 200 HP motors. Using this benchmark, the saturation of efficient motors drops off for motors greater than 500 HP.

Table 1-20: Saturation of Efficient Motors by Horsepower Size: Manufacturing

Motor Horsepower	28 Chem	26 Paper	33 Metals	29 Petrol.	20 Food	Other	*All SICs Percent*	*All SICs Number*
1–5	7.8%	12.0%	2.1%	4.7%	6.6%	7.5%	*7.2%*	*523,735*
6–20	15.1%	17.3%	2.0%	8.3%	12.4%	10.3%	*10.4%*	*340,437*
21–50	21.6%	21.9%	4.3%	11.8%	13.2%	7.8%	*11.3%*	*127,111*
51–100	27.9%	27.2%	8.4%	2.1%	28.3%	15.3%	*17.1%*	*62,234*
101–200	32.7%	17.0%	0.1%	7.0%	7.4%	37.6%	*25.5%*	*56,247*
201–500	19.8%	4.2%	0.0%	19.6%	5.2%	48.4%	*17.7%*	*15,346*
501–1000	1.3%	0.0%	0.0%	0.0%	0.0%	9.5%	*1.3%*	*352*
1000+	4.5%	0.0%	9.6%	0.6%	0.0%	0.0%	*3.9%*	*425*
All Sizes	14.4%	15.3%	2.5%	7.5%	8.8%	8.9%	*9.1%*	*1,125,887*

SATURATION OF ADJUSTABLE SPEED DRIVES

Adjustable speed drives (ASDs), also referred to as variable speed drives, variable frequency drives, and adjustable frequency drives offer two major benefits to industrial end-users.

- **Enhanced process control.** ASDs allow factory managers to increase their control over production processes, thereby increasing consistency and quality.

By installing an ASD to the induced draft fans on this Basic Oxygen Furnace, Bethlehem Steel saved more than $600,000, showing the substantial savings that can be achieved through ASD applications.

- **Energy savings.** ASDs can be used to match the speed of an AC motor to the requirements of a fluctuating load, such as a pump that must move volumes of fluid that change in the course of a production shift. For centrifugal loads, which include many pumps and fans, power requirements are roughly proportional to the cube of the fluid velocity, which is proportional to motor speed over a wide range of operating conditions. Thus, the energy (and financial) penalty of running a pump or fan faster than necessary to accomplish the work at hand is severe. Conversely, the savings available through matching motor speed to system requirements can be very high.

Not all motor systems with fluctuating loads offer opportunities for cost effective capture of energy savings through the application of ASDs. In analyzing the saturation of ASDs for the purposes of this report, it is useful to understand the factors that favor cost effective applications. Generally speaking, these factors include:

- **Horsepower**. Generally, the higher the horsepower, the more likely the cost-effective application of ASDs.
- **Operating hours.** Generally, ASDs will be cost effective only on motor systems used 2,000 hours per year or more.
- **Nature of load.** Centrifugal loads, such as pumps and fans, offer the best potential savings. Reciprocating machines offer fewer opportunities.
- **Load fluctuation.** Loads that vary over time by 30 percent of full load offer the best opportunities for cost effective application.
- **Circulating pumps versus systems with static head.** In pumping, ASDs are applicable primarily to circulating systems as opposed to systems with significant static head. In the latter situations, slowing the pump may actually lead to higher energy use under certain conditions, as well as to severe maintenance problems.

CURRENT SATURATION OF ASDS

Table 1-21 shows the distribution of motor systems with ASDs by horsepower class. Currently, the saturation of ASDs is fairly low: 9 percent of motor systems which represent 4 percent of total motor system energy. The saturation of ASDs, both in terms of units and energy is highest in the smallest horsepower classes. In these cases, ASDs are likely to be used primarily to enhance control over production processes rather than to save energy.

Table 1-21: Saturation of Motor Systems with AC Adjustable Speed Drives by Horsepower Class

	Motor Systems with ASDs		Energy in Systems with ASDs	
Horsepower Class	Number	% of Total	GWh/Year	% of Total
1–5	767,807	11%	3,753	13%
6–20	254,862	8%	4,431	7%
21–50	46,126	4%	2,545	3%
51–100	13,536	4%	2,888	4%
101–200	11,661	5%	2,955	4%
201–500	1,873	2%	1,421	2%
501–1000	820	3%	3,127	4%
1000+	644	6%	4,203	5%
All Motor Systems	***1,097,328***	***9%***	***25,325***	***4%***

Table 1-22 shows the distribution of motor systems with ASDs by application. Over 80 percent of ASDs currently in use are installed in "other systems." Motor system optimization studies conducted by Motor Challenge and consortia of U.S. and Canadian utilities have found that the largest energy savings for ASDs are present in fluid systems—pumps, fans, and compressors. Saturation of ASDs on pump and compressed air systems is particularly low, at present.

Table 1-22: Saturation of Motor Systems with ASDs by Application

	Motor Systems with ASDs		Energy in Systems with ASDs	
Application	Number	% of Total	GWh/Year	% of Total
Pump	77,510	3.2%	4,205	2.9%
Fan	101,204	7.3%	6,564	8.3%
Compressed Air	11,044	1.7%	3,354	3.7%
Other	907,570	11.4%	11,202	4.3%
All Applications	***1,097,328***	***8.8%***	***25,325***	***4.4%***

THE POTENTIAL MARKET FOR ASDS

We have used information collected in the inventory to develop an estimate of the size of the potential for cost-effective applications of ASDs in manufacturing motor systems of 1 HP or greater. We developed and applied a number of screening factors to identify motor systems in the inventory that would likely be good candidates for cost-effective retrofit with an ASD. These screening factors were developed in consultation with engineers familiar with field analyses of ASD applications and from review of ASD screening tools, such as ASD Master. (EPRI, 1996)

Engineers generally use a number of screening factors to assess whether installation of an ASD on an existing motor system will be cost-effective in terms of energy savings. Table 1-23 shows these factors along with relevant indicators developed from the inventory and our assessment of the reliability of the information from which the indicators are developed.

Table 1-23: ASD Applicability Criteria

Characteristic	Screening Factor for ASD Applicability	Indicators from the Inventory
1. Induction Motors	• Only AC motors can use an ASD (more specifically an adjustable frequency drive).	• Reliable observations of motor type for each motor system inventoried.
2. Horsepower	• <15 HP the payback is usually too long. • 15 to 30 HP are good candidates. • >30 HP usually excellent candidates for ASDs.	• Reliable observations of HP for each motor system inventoried.
3. Operating Hours	• Relatively high operating hours (> 2000 per year).	• Based on escorts' reports. Not directly observed. Medium confidence.
4. Type of Load	• Centrifugal load rather than a static load or constant volume displacement.	• Can be inferred in most cases from basic system description. All pumps and fans are classified as centrifugal loads.
5. Load Fluctuation	• Load variability greater than 30%, e.g., a load that varies from 60% to 90%.	• Obtained assessment from escort on whether load fluctuates for each system. No information on degree of fluctuation. Questionable confidence in accuracy.
6. Percentage of Time at Reduced Load	• The loading on a motor may vary a great deal but if the variation occurs for only a short period of time and it is running most of the time at a constant load, a drive is usually not justified.	• Not observed. Would require continuous load measurements.
7. Existing Load Modulation Equipment	• Throttle Valve: excellent applicability of ASDs. • Outlet Damper: good applicability of ASDs. • Inlet Vane: depends on the type of control. Iris type is better to retrofit with ASD than the parallel box type. • Multi Speed Motor: with a throttle valve it is also indicated. • Eddy Current Clutch: applicability fair but it may not pay back. • Adjustable Speed Gearbox: direct load measurements needed. • None: direct load measurements needed.	• Observed load modulation mechanisms for each inventoried system. • Reliability of observations questionable due to difficulties in finding and identifying control mechanisms in some cases.

We classified motor systems that met the first four conditions listed in Table 1-24 *and* were not currently equipped with ASDs as likely candidates for retrofit with an ASD. This subset is likely to be somewhat larger than the actual population of cost-effective applications because it does not take into account the final three screens. However, data on whether loads on individual machines fluctuated were of questionable reliability, and it was not possible under the constraints of the project to gather information on the degree of load fluctuation. Similar problems affected the observations of existing (non-ASD) load controls. We thus decided to proceed using screening variables in which we had a medium to high degree of confidence in identifying the potential market.

Table 1-24 displays the result of the first cut estimation of the remaining potential for cost-effective applications of ASDs to reduce energy use. The numbers to the right of the "Total" column represent the number of motor systems (top half of the table) and motor system energy (bottom half of the table) that met the four threshold criteria for successful ASD applications. These are: the system is driven by an AC motor, 21 HP or greater, for more than 2,000 hours per year, and currently is not equipped with an ASD. Roughly 7 percent (about 839,000 units) of the current population of integral horsepower motors meet these criteria. They represent 70 percent of total motor system energy. Motor systems that meet the further screening criterion of centrifugal loads (areas printed in blue) account for 3 percent of all units and 29 percent of total motor system energy.

Table 1-24: Distribution of Motor Systems with Good Potential for ASD Application

		AC Motor Systems with No ASD, 2000+ Hours over 20 HP				
HP Category	**Total**	**All Applications**	**Fans**	**Pumps**	**Air Comp.**	**Other**
Units						
1–5	7,306,080					
6–20	3,288,035					
21–50	1,129,527	500,058	73,969	135,654	91,807	198,629
51–100	363,940	176,662	17,509	56,745	24,621	77,787
101–200	220,908	104,406	18,417	17,269	18,122	50,598
201–500	86,836	41,897	1,958	8,526	11,916	19,496
501–1000	28,047	10,426	1,224	1,046	1,208	6,947
1000+	10,958	5,294	425	1,063	2,360	1,446
Total	***12,434,330***	***838,744***	***113,502***	***220,304***	***150,034***	***354,904***
Energy: GWh/Year						
1–5	27,807					
6–20	60,122					
21–50	73,111	60,331	9,807	22,433	7,321	20,770
51–100	72,924	61,044	8,020	23,616	5,752	23,656
101–200	83,099	68,559	13,331	18,693	9,035	27,500
201–500	90,819	72,041	6,103	22,860	15,624	27,454
501–1000	77,238	59,200	8,536	8,951	5,500	36,214
1000+	90,307	82,521	11,149	10,972	40,233	20,168
Total	***575,428***	***403,696***	***56,945***	***107,524***	***83,465***	***155,762***

Numbers printed in blue represent centrifugal loads.

The final step in assessing the magnitude of potential applications of ASDs is to gather and apply evidence regarding the effects of the final screens for load fluctuation. As discussed above, the patterns of response to items about load fluctuation in individual systems appeared questionable, especially when disaggregated to horsepower and end-use categories. For the population of motors as a whole, we found that 26 percent of the motor systems representing 19 percent of total motor system energy had fluctuating loads. Applying these factors to the results in the table above, the remaining "prime market" for ASDs as energy saving devices would total about 220,000 units which consume 78,000 GWh per year, or 14 percent of total motor system energy. This last estimate is consistent with expert opinion on the applicability of ASDs, as discussed in Section 2.

Section 2: Opportunities for Energy Savings

This section presents the methods by which potential motor system energy savings were calculated and summarizes the estimates. We begin with an overview of estimation methods and results. We then present a detailed description of the methods used on a measure-by-measure basis. The section concludes with a detailed description of the results of the energy savings estimates.

OVERVIEW OF SAVINGS ESTIMATION METHODS AND RESULTS

Estimates of potential energy savings available in a given population of facilities generally distinguish between a number of conceptual approaches. These can be summarized as follows.

- **Technical potential** denotes energy savings that can be achieved by applying proven energy efficiency technologies to all available opportunities for their use in the population, regardless of the relationship between implementation costs and savings.
- **Economic potential** denotes energy savings that can be achieved through a subset of the technically feasible efficiency improvements that meet specified economic criteria. These criteria are often expressed as simple payback (the ratio of estimated annual energy cost savings to the capital costs of the measure) or as financial metrics, such as return on investment or internal rate of return. These latter measures take the full range of the measure's operating costs and benefits into effect, as well as the measure's predicted useful life. The financial metrics also take into account the cost of capital. This supports comparison of the performance of investments in energy efficiency to the performance of other potential uses of capital.
- **Market potential** denotes the energy savings that can be achieved by a subset of economically cost-effective measures which analysts believe the market can deliver during the time horizon of the analysis. Supply-side constraints on the achievement of economic potential include lack of awareness of energy efficiency measures and design practices among engineers and conflicting economic incentives for manufacturers or distributors who are principally interested in equipment sales. On the demand side, constraints arise from the competing priorities for capital expenditures and plant maintenance resources.

The energy savings estimates presented in this report are best characterized as the economic potential for energy savings through the retrofit of the inventory of manufacturing facilities as they were operated at the time of the study (1997). In reviewing the energy savings analysis, the reader should keep the following in mind.

- **Financial criteria.** We applied the criterion of a 3-year payback to the energy efficiency measures included in the potential savings calculations. For simple motor replacements, we implemented this criterion using cost and savings information available in the MotorMaster+ software. For more complex measures involving improvements to whole systems, we relied on the judgment of consulting engineers and other experts to estimate what portion of the relevant load could be retrofitted with a given measure with a 3-year payback.

There is extensive literature on the shortcomings of simple payback as an investment decision criterion.[1] However, a number of studies have shown that commercial and industrial customers rarely apply more formal financial criteria to investments in energy efficiency.[2] The 3-year time period was chosen as a mid point in the range of financial performance that industry observers believed that industrial enterprises would find acceptable.

- **Total population versus facility-level estimates.** The energy savings estimates presented below represent totals for the entire population of industrial facilities. They take into account the extent to which measures have already been implemented and limitations on the use of measures for specific applications which may affect some but not all facilities in an industry. The energy savings opportunities in a given plant or system (in terms of percentage of total motor system energy use) may be much larger than the corresponding percentage for the population. The Showcase Demonstration projects supported by Motor Challenge achieved documented system-level savings of 6 to 59 percent of initial energy use, with an average savings of 33 percent.
- **Savings in retrofit versus new applications.** The energy savings estimates presented below do not include estimates of savings that could be achieved by applying best design practices (versus current standard practices) to the design of new systems. In such situations, the costs of implementing best practices are far less than they are in operating plants, which leads to far better financial returns on incremental investments in energy-efficient design in new versus retrofit applications.

CATEGORIES OF MOTOR SYSTEM EFFICIENCY MEASURES

For purposes of this study we defined two categories of motor system efficiency measures:

- **Motor efficiency upgrades,** which improve the energy efficiency of the motor driving a particular machine or group of machines.
- **System efficiency measures,** which improve the efficiency of a machine or group of machines as a whole. System efficiency can be improved by reducing the overall load on the motor through improved process or system design, improving the match between component size and load requirements, use of speed control instead of throttling or bypass mechanisms, and better maintenance to name just a few of the engineering strategies available.

The assessment identified individual measures for which energy savings were to be estimated through review of secondary literature and interviews with engineers, motor system manufacturers, and other industry observers. Table 2-1 presents definitions and descriptions of the measures covered by this study.

The descriptions for system efficiency measures represent general types of energy efficiency strategies. These descriptions were further refined for each major application category: pump systems, fan systems, compressed air systems, and other process systems. These more detailed measure descriptions are discussed on pages 57 to 62.

1 See, for example, Fuller, Sieglinde K. and Petersen, Stephen R. 1995. *Life-Cycle Costing Manual for the Federal Energy Management Program.* Washington, D.C., U.S. Department of Commerce, National Institute of Standards and Technology, Chapter 1.

2 In a recent study, the assessment team found that only 11 percent of commercial customers applied any kind of financial analysis to the selection of lighting equipment. (XENERGY 1998)

Table 2-1: Motor System Efficiency Measure Descriptions

Measure Category/Measure Name	**Measure Description**
Motor Efficiency Upgrade	
Efficient replacement	Replace motor currently in use with higher efficiency motor. Savings estimated for upgrades to two different standards: EPAct and CEE.
Improve rewinding practices	Follow rewinding protocols adopted by the Electrical Apparatus Service Association (EASA). Avoid rewind practices known to contribute to efficiency degradation such as the use of high temperatures to soften wire.
System Efficiency Measures	
Reduce system load requirements	This category encompasses a wide range of strategies such as widening pipe diameters to reduce resistance, straightening ducts, leveling process flows over time to reduce peak loads, and eliminating unnecessary by-passes. These strategies share a common result in reducing and/or leveling loads on motors, which open up opportunities for use of smaller or fewer motors in the system. Case studies of these kinds of projects report reductions of 5 percent to 60 percent of system energy.
Reduce or control motor speed	Reduction of speed to match load or use of ASDs to match speed to fluctuating loads can save a great deal of system energy due to the exponential relationship between shaft speed and energy. Case studies of ASD installations or mechanical speed reductions to replace throttling controls have found system savings in the range of 30 percent to 80 percent.
Match component size to load	Frequently motor systems are sized to accommodate the peak load expected for the system, with little or no allowance for the operation of the process at partial load. Various schemes can be used to serve part load while saving energy. These include staging of equipment, automatic shutdown, parallel systems, and downsizing. Estimated savings from these kinds of projects range from 5 percent to 30 percent.
Upgrade component efficiency	For most types of turbomachinery, relatively small savings are available by upgrading the inherent efficiency of components such as pumps, compressors, and auxiliaries. Analysts suggest that available savings range from 2 percent to 10 percent of system energy.
Maintenance	For some kinds of systems, in particular air compressors, conscientious maintenance can yield significant system savings due to plugging leaks and maintaining system balances. Savings from these measures can range from 2 percent to 30 percent of system energy.
Motor downsizing	This measure reduces the size of the motor to better match load within the motor's efficient operating range. It is included in System Efficiency Measures because it involves the balancing of system components with load rather than upgrading the efficiency of the motor itself.

SAVINGS ESTIMATION METHODS

Motor efficiency upgrades.
The assessment team estimated potential energy savings for motor efficiency upgrades by applying the savings formulas and input assumptions contained in the MotorMaster+ motor selection software to descriptive data on each motor system inventoried.

System efficiency measures.
Determining whether system efficiency measures apply to a particular motor system requires more data, time, and professional judgment than could be brought to bear in the course of the inventory. We therefore developed and implemented the following three-step process for estimating potential energy savings from the inventory data:

1. **Estimate total energy usage by major application.** We used the results of the inventory to estimate energy use by major application category: pumps, fans, air compressors, and other process systems.
2. **Compile expert opinion and case studies on measure applicability and savings fractions.** The assessment team solicited the opinions of industry experts—primarily consulting engineers, manufacturers' technical staff, and industry association representatives—regarding the percentage of systems to which various measures in the major application categories could be cost-

effectively applied. We also solicited their opinion on the average savings these measures could achieve, in terms of percentage of initial system energy use. We gathered similar information from case studies and other documents. Using this information, we formulated high, low, and midrange estimates of potential savings for each principal measure type within the major motor system application categories.

3. **Calculate high, low, and midrange savings estimates.** The savings estimates were calculated by applying the following formula:

$$\textit{Applicability}_{(High,Midrange,Low)} \times \textit{Average Savings Fraction} \times \textit{System Energy.}$$

To estimate the potential savings from motor downsizing, we first estimated the savings available from downsizing the motors operating at less than 40 percent part load in the subsample of motors for which load measurements were made. We then projected these results to the population using the weighting procedures established through the site and motor sampling process.

Distribution of potential savings by type of measure.
Table 2-2 shows how potential savings are distributed among different kinds of measures and end uses in manufacturing only. Potential motor system energy savings in the manufacturing sector total between 61 billion and 104 billion kWh per year, with a midrange estimate of 85 billion kWh per year. The savings in the major groups of measures are additive. Potential efficiency improvements in non-manufacturing facilities are estimated to add another 14 billion kWh in annual savings. These savings are not shown in Table 2-2.

Table 2-2: Summary of Motor Energy Savings Opportunities by Measure in Manufacturing Facilities

	Potential Energy Savings GWh/Year			Midrange Savings as Percent of	
Measure	Low**	Midrange**	High**	Total Motor System GWh	System-Specific GWh
Motor Efficiency Upgrades*					
Upgrade all integral AC motors to EPAct Levels***		13,043		2.3%	
Upgrade all integral AC motors to CEE Levels***		6,756		1.2%	
Improve Rewind Practices		4,778		0.8%	
Total Motor Efficiency Upgrades		24,577		4.3%	
Systems Level Efficiency Measures					
Correct motor oversizing	6,786	6,786	6,786	1.2%	
Pump Systems: System Efficiency Improvements	8,975	13,698	19,106	2.4%	9.6%
Pump Systems: Speed Controls	6,421	14,982	19,263	2.6%	10.5%
Pump Systems: Total	15,396	28,681	38,369	5.0%	20.1%
Fan Systems: System Efficiency Improvements	1,378	2,755	3,897	0.5%	3.5%
Fan Systems: Speed Controls	787	1,575	2,362	0.3%	2.0%
Fan Systems: Total	2,165	4,330	6,259	0.8%	5.5%
Compressed Air Systems: System Eff. Improvements	8,559	13,248	16,343	2.3%	14.6%
Compressed Air Systems: Speed Controls	1,366	2,276	3,642	0.4%	2.5%
Compressed Air Systems: Total	9,924	15,524	19,985	2.7%	17.1%
Specialized systems: Total	2,630	5,259	7,889	0.9%	2.0%
Total System Improvements	36,901	60,579	79,288	10.5%	
Total Potential Savings	***61,478***	***85,157***	***103,865***	***14.8%***	

* Potential savings for Motor Efficiency Upgrades calculated directly by applying engineering formulas to Inventory data.
** High, Medium, and Low savings estimates for system efficiency improvements reflect the range of expert opinion on potential savings.
***Includes savings from upgrades of motors over 200 HP not covered by EPAct standards.

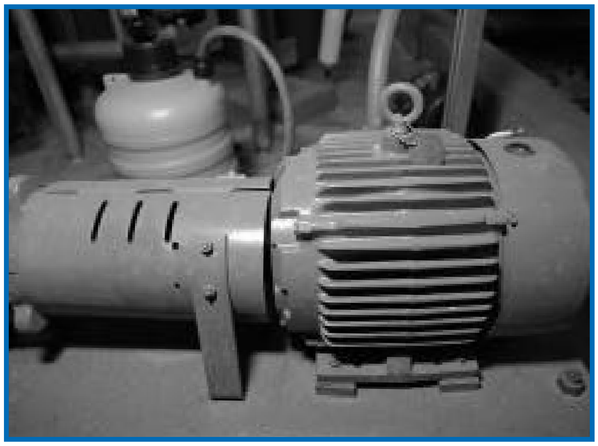
Nearly two-thirds of all potential savings derive from system efficiency measures, such as the substitution of adjustable speed drives for throttling valves or bypass loops in pumping systems or fixing leaks in compressed air systems. The specific system efficiency measures for which savings were estimated differ for each major application category. For convenience of presentation, the specific measures have been collapsed into two categories: System Efficiency Improvements and Speed Control. Detailed descriptions of these measures appear below. Savings attributable to the major industrial fluid systems—pumps, fans, and air compressors—present between 45 and 62 percent of the total savings opportunities, taking into account low and high estimates.

DETAILED ENERGY SAVINGS ESTIMATION METHODS

SYSTEM EFFICIENCY MEASURES

For each of the major fluid processes—pumps, fans and air compressors—we developed estimates of the percentage of load to which individual measures were applicable and the expected savings from the measures. As discussed above, we compiled lists of specific measures applicable to each fluid process from secondary literature and interviews with industrial engineers. We then developed preliminary estimates of applicability and savings fraction from the literature and case studies. The preliminary estimates were then circulated to groups of individuals expert in particular applications and technologies. We revised the preliminary estimates based on comments from the expert reviewers. The tables of assumptions below summarize the results of this process.

Pump system energy efficiency can be improved by 20%, on average, across U.S. industry with a variety of system efficiency measures.



PUMP SYSTEMS

The pump system savings have been developed based on information from several sources. Descriptions of the types of system improvements applicable to pumps for each measure category are contained in Table 2-3.

Table 2-3: Assumptions on Pump System Efficiency Measures

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Reduce Overall System Requirements	
Equalize flow over production cycle using holding tanks.	Easton Consultants[3] report suggests savings are in the 10–20 percent range.
Eliminate bypass loops and other unnecessary flows.	Easton report suggests savings are in the 10–20 percent range.
Increase piping diameter to reduce friction.	The retrofit of increasing pipe diameter has been done in 9 percent of facilities according to the practices survey. This is an expensive measure but the Easton report suggests savings are in the 5–20 percent range. This is corroborated by specialists in the pulp and paper industry.[4]
Reduce "safety margins" in design system capacity.	This measure is applicable to all pumps. Easton report suggest savings are in the 5–10 percent range.

(Table continues on next page)

[3] Easton Consultants, *Strategies to Promote Energy-Efficient Motor Systems in North America's OEM Markets.* Stamford, Connecticut. Easton Consultants, Inc. 1995.

[4] Personal communications with R. Giese.

Table 2-3: ***Continued***

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Match Pump Size to Load	
Install parallel systems for highly variable loads.	According to the practices survey 5 percent of facilities have implemented parallel pumps. Easton report suggest savings are in the 10–50 percent range. Other experts[5] report that the “best practice” for variable loads is to install a larger pump with speed control to obtain similar savings.
Reduce pump size to better fit load.	According to the practices survey 5 percent of facilities have implemented smaller pumps. Easton report, supported by other experts, suggests that pumps are routinely 15–25 percent oversized.[6]
Reduce or control pump speed	
Reduce speed for fixed loads: trim impeller, lower gear ratios.	According to the inventory data, 82 percent of pumps have load modulation recorded as “none.” Performance optimization studies cite savings as high as 75 percent in the food processing, paper and petrochemical industries.
Replace throttling valves with speed controls to meet variable loads.	According to the inventory data, 6 percent of pumps have load modulation recorded as “throttle valve,” which seems low according to industry experts. Case studies of ASD installations show savings in the range of 30 to 80 percent.[7] This measure applies to circulating pump systems, not systems with static heads.
Improve Pump Components	
Replace typical pump with most efficient model, or one with an efficient operating point better suited to the process flows.	According to the inventory data, 16 percent of pumps are greater than 20 years old, many of which can be replaced with more efficient models that better match the process operating point. According to industry experts, the problem is not necessarily the age of the pump but the fact that the process may have changed over time and that the operating point does not match the best efficiency point of the pump. Easton report notes pump efficiency may degrade 10–25 percent before replacement. Newer pumps are 2–5 percent more efficient. ACEEE[8] cites savings in the 2–10 percent range.
Replace belt drives with direct coupling.	According to the inventory data, 4 percent of pumps have drive type as V-belt, many of which can be replaced with direct couplings. Savings are on the order of 1 percent
Operation and Maintenance	
Replace worn impellers, especially in caustic or semi-solid applications. Inspect and repair bearings, lip seals, packings and other mechanical seals.	According to the Hydraulic Institute[9], pump efficiency degrades from 1 to 6 points for impellers less than maximum diameter and with increased wear ring clearances. Pumps less than 15 HP are particularly sensitive to reductions in pump efficiency due to mechanical losses.

Based on the information summarized in Table 2-3, we developed estimates of the applicability and savings fractions for pump system efficiency measures. These are shown in Table 2-4. This table and the corresponding tables for fan and air compressor efficiency measures have been reviewed by a panel of engineers and industry experts. They represent our best estimates of savings potential for pump, fan, and compressed air systems. Note that the greatest savings for pump systems relate to controlling pump speed. This is consistent with expert opinion that circulating pumps are generally good candidates for ASDs.

5 Personal communication with Robert W. Bailey at Planergy, Richmond, CA, October 30, 1997.

6 Personal communication with Gunnar Hovstadius, ITT Flygt, Trumbull, CT.

7 Unpublished data, Wisconsin Performance Optimization Service Program.

8 Elliot, R. Neal. *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector.* Washington, D.C. ACEEE 1994.

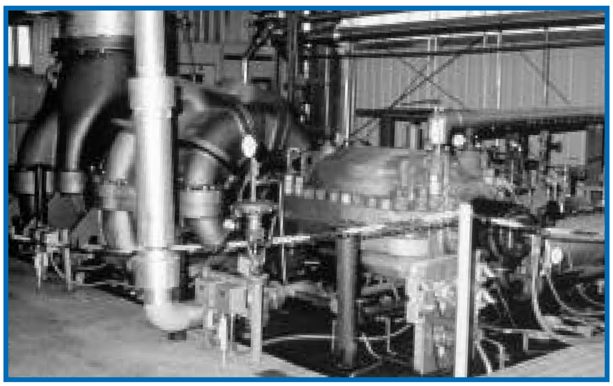
9 Hydraulic Institute. *Efficiency Prediction Method for Centrifugal Pumps.* Parsippany, NJ. 1994.

Table 2-4: Pump System Improvement Applicability and Savings

Measure	Applicability			Savings Fraction	Net Savings
	Low	Midrange	High		
Reduce Overall System Requirements	40%	50%	65%	10%	5.0%
Match Pump Size to Load	10%	20%	30%	20%	4.0%
Reduce or Control Pump Speed	15%	35%	45%	30%	10.5%
Improve Pump Components	5%	10%	15%	5%	0.5%
Operation and Maintenance	2%	5%	7%	2%	0.1%
Overall Savings					***20.1%***

COMPRESSED AIR SYSTEMS

The air compressor system savings have been developed based on information from several sources. These include the *Improving Compressed Air System Performance Sourcebook* developed by the Compressed Air Challenge initiative and published by the Motor Challenge Program, as well as numerous engineering texts and case studies. The types of system improvements applicable to air compressors for each measure category are described in Table 2-5. While the measures mentioned are not applicable to all situations, they serve as a guide to make generalized estimates of the relative applicability of measures and the savings associated with them.



Compressed air systems like this one can be improved by 17%, on average, and will save U.S. industry up to $1 billion per year.

Table 2-5: Compressed Air System Efficiency Measures

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Reduce Overall System Requirements	
Reduce overall system pressure through better system design and better ancillary components (filters and dryers).	According to the practices survey 15 percent of facilities have reconfigured piping and filters in their compressor systems. Easton report estimates savings in the range of 4–6 percent.
Reduce system demand by eliminating poor applications of compressed air.	The misapplication of compressed air for uses such as blowing, cooling, cleaning or to move parts, etc. is a wasteful practice. Compressed air can be replaced with blowers, fans or electric motors with substantial energy savings. Industry experts estimate that discontinuing these practices as well as shutting off air flow to equipment not in use can save as much as 20 percent.
Segment system and provide satellite or booster compressors or storage when remote locations have special requirements such as higher pressures, cleaner air, or short term high volumes.	While decentralizing compressors does not always save energy, some facilities with large compressors serving all departments in a relatively large area (in terms of floorspace) may benefit from segmenting the system. ACEEE report cites a case study in a Ford plant in which savings of 80 percent were achieved but industry experts[10] point out that this is not typical and savings are closer to about 5 percent.
Improve supply conditions; use outside air.	Assume half of all compressors use room air for supply. Easton report estimates savings for this measure in the range of 4–6 percent. Industry experts note that this measure may increase O&M.

(Table continued next page)

10 The authors grateful acknowledge the contributions of the following individuals in preparing this table: Lawrence Ambs, University of Massachusetts; Aimee McKane, Lawrence Berkeley National Laboratory; Dean Smith, Plant Air Engineering; Robert Bailey, Planergy; Chris Beals, David MacCulloch, and Mac Mottley.

Table 2-5 ***Continued***

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Match Compressor Size to Load	
Size compressors for efficient trimming.	Stage compressors so that the base load is supplied by compressors running at design load with a trim compressor (reciprocating or rotary screw type) to supply the variable load. Industry experts estimate savings of 5 percent.
Compressor Control	
Install standard part load controls which include automation and storage.	This can be applied to most compressors. ACEEE cites savings in the 3–7 percent range.
Install microprocessor controls on compressor system.	These controls tighten the deadband from 10 psi to 2 psi. Savings in the 2–4 percent range.
Use parallel compressors and install multi-unit controls to reduce compressor part loading.	According to the practices survey 14 percent of facilities indicated using parallel compressors and 7 percent of facilities indicated the installation of multi-unit controls. Unloading controls were recommended for 6 of 7 case studies using AIRMaster[11], with savings ranging from 3 to 33 percent. Performance optimization studies calculate savings in the range of 11–16 percent. Easton study cites savings of 10–15 percent. Industry experts point out that these savings can only be achieved in facilities having several compressors, not just two or three.
Install ASDs for rotary compressors.	The inventory data indicates that 97 percent of compressors do not have ASDs. Easton estimates the proportion of rotary compressors is 72 percent. Industry experts point out that the opportunities may not be as large as these saturations suggest because there are often better methods to manage the load (sizing and trimming). For rotary compressors with variable loads ASDs offer better part load efficiency than inlet valve modulation. Savings are on the order of 10 percent according to industry experts.
Improve Compressor Components	
Replace older single stage reciprocating compressors and symmetrical screw compressors with more efficient model.	According to the inventory data, 6 percent of compressors are greater than 20 years old. Easton report cites a 10–20 percent efficiency variation across compressor types. Industry experts note that some of the older equipment, such as double acting reciprocating compressors, are very efficient.
Operation and Maintenance	
Reduce leaks by instituting an ongoing program of system maintenance on regulators, quick connect fittings, tubing, pipes and other points of connection.	According to the practices survey 38 percent of facilities indicated they had fixed leaks in the past 2 years. Easton report estimates savings in the range of 15–25 percent. ACEEE report states leaks are 15 percent of compressor load. All 7 case studies using AIRMaster recommend reducing leaks with estimated savings ranging from 2.7 to 59 percent.
Improve maintenance on compressor: e.g., valves for reciprocating compressors and intercoolers for centrifugal compressors.	Industry experts estimate savings in the range of 2–5 percent.
Change compressor filters and point of use filters regularly to reduce pressure drops.	Easton report cites that improved ancillary equipment saves 4–6 percent. Industry experts estimate that replacing point of use filters saves 3 percent and compressor filters 1–2 percent.

Using information contained in Table 2-5, we estimated the applicability and savings fractions of compressed air system efficiency measures. These are shown in Table 2-6. The greatest savings opportunity for compressors, representing half of the potential is to reduce the overall system requirements.

[11] Bonneville Power Administration, Case Studies: Compressed Air System Audits Using AIRMaster, January 1997.

Table 2-6: Compressed Air System Improvement Applicability and Savings

Measure	Applicability: Low	Applicability: Midrange	Applicability: High	Savings Fraction	Net Savings
Reduce Overall System Requirements	20%	30%	40%	20%	6.0%
Match Compressor Size to Load	5%	10%	15%	3%	0.3%
Compressor Control	15%	25%	40%	10%	2.5%
Improve Compressor Components	5%	15%	20%	5%	0.8%
Operation and Maintenance	50%	75%	85%	10%	7.5%
Overall Savings					***17.1%***

FAN SYSTEMS

This Louisiana Pacific low-cost fan optimization project achieved electrical cost savings of $85,000. Fan system improvements yield net savings of 5.5%.

The fan system savings have been developed based on information from several sources. The types of system improvements applicable to fans for each measure category are described in Table 2-7.

Table 2-7: Fans System Efficiency Measures

Measure	Sources and Method to Determine Applicable Load and Savings Fraction
Reduce Overall System Requirements	
Reduce "system effect" through better inlet and outlet design.	Easton report states that reducing system effect can reduce energy consumption by 25 percent.
Reduce fan oversizing.	Easton report states that cost pressures limit oversizing, but that reducing oversizing can reduce consumption by 1–5 percent. Industry experts[12] indicate that most have some degree of oversizing. It is often easier to control speed or use a slower speed motor than to replace fan with smaller size.
Reduce or control fan speed	
Replace inlet or outlet dampers and variable inlet vane with electronic speed controls to meet variable loads.	According to industry experts, there are about 10 times more fans with inlet damper than outlet damper, both of which allow some adjustment in flow. Performance optimization studies estimate savings in the range of 14–49 percent when retrofitting with an ASD. Higher savings are achieved with outlet damper but there are fewer applications.
Improve Fan Components	
Replace Standard V-Belt with Cogged V-Belt.	According to the inventory data, half of fans have "V-belt" drive type. According to Easton report, 2/3 of V-belts are standard and can be upgraded to cog belts. Standard V-belt efficiency ranges from 90–97 percent while cogged V-belt efficiencies are 94–98 percent.
Replace fan with more efficient model.	According to the Easton report, although fan efficiencies vary significantly across impeller types, there are limited opportunities to trade up to more efficient models.
Operation and Maintenance	
Improve O&M practices: • Tighten belts • Clean fans • Change filters regularly	These practices can be applied to all fans with savings ranging from 2 to 5 percent.

[12] The authors acknowledge the contributions of Robert W. Bailey of Planergy in preparing this table.

The values used in the analysis for the applicability and savings fractions for fan systems are shown in Table 2-8.

Table 2-8: Fan System Improvement Applicability and Savings

Measure	Applicability			Savings Fraction	Net Savings
	Low	Midrange	High		
Reduce Overall System Requirements	5%	15%	25%	10%	1.5%
Reduce or Control Fan Speed	5%	10%	15%	20%	2.0%
Improve Fan Components	15%	20%	25%	5%	1.0%
Operation and Maintenance	25%	50%	60%	2%	1.0%
Overall Savings					***5.5%***

OTHER PROCESS SYSTEMS

Because the motor systems grouped under "Other Process Systems" are so diverse, we did not feel it would be appropriate to apply to them the savings estimation process described above. Rather, we applied the method for speed control measures alone, which are widely applicable to many kinds of motor systems. We selected an applicability factors ranging from 5 to 15 percent, which reflect the range indicated by our analysis of the potential market for ASDs presented in Section 1. Because we were not able identify and analyze all the applicable measures for other process systems, the potential savings for this category is likely to be somewhat underestimated.

MOTOR DOWNSIZING

Instantaneous load measurements were taken for a sample of up to 12 motors at each site. The results of these measurements are discussed and shown on pages 45-46. In general, the operating efficiency of a motor decreases significantly at part loads less than 40 percent. Motors that are consistently under loaded can be replaced with smaller motors. The smaller motor will run closer to its higher full load efficiency and as a result will consume less energy. Using the load measurement data, we estimated the potential savings from motor downsizing for the population as a whole.

The savings from downsizing are based on the difference in operating efficiency of motors in specific horsepower categories at 25 percent load and 75 percent part load. (For purposes of this estimate, we assume that oversized motors are running at an average of 25 percent part load and that the properly sized motors will run at 75 percent part load.) The savings fractions are calculated based on information contained in the MotorMaster+ software on the operating efficiency of standard motors at 25 percent part load and a smaller "downsized" motor at 75 percent part load. These efficiencies are shown in Table 2-9.

The difference in efficiency ("Savings Fraction" in Table 2-9) is multiplied by the energy consumption of the portion of motors operating below 40 percent part load in each horsepower category to obtain an estimate of potential annual energy savings. This is a simplification for several reasons. First the energy consumption for the baseline is calculated using the full load efficiency and average loading on the motor. Secondly, the savings fraction is based on the average part load efficiencies of motors in the same size category; however, the difference in efficiency at 25 and 75 percent part load of particular sized motors within a category varies greatly, especially for motors less than 10 horsepower. Nevertheless, the estimated savings will be a good indicator of the magnitude of downsizing savings relative to other measures.

Table 2-9: Part Load Efficiencies for Downsizing

Motor Size Category (HP)	Average Efficiency at 75% Load	Average Efficiency at 25% Load	Savings Fraction (%)
1–5	77.7%	64.7%	16.8%
6- 20	84.5%	81.7%	3.2%
21- 50	88.3%	86.8%	1.7%
51- 100	89.9%	87.9%	2.2%
101- 200	91.6%	89.1%	2.7%
201- 500	92.3%	90.3%	2.2%
501- 1000	92.3%	90.3%	2.2%
1000+	92.3%	90.3%	2.2%

Source: MotorMaster+.

MOTOR EFFICIENCY UPGRADES

EFFICIENT REPLACEMENT

As of October 1997, all integral horsepower, polyphase, general purpose, low voltage AC induction motors from 1 to 200 horsepower sold in the United States will have to meet minimum efficiency standards. These standards, promulgated by the EPAct, are based on the NEMA MG-1 Table 12-10. The minimum efficiency standard increases with horsepower category. The minimum EPAct standards leave room for improvement in motor efficiency and offer the opportunity for energy savings. As Figure 2-1 shows, some so-called “premium efficiency” motors currently on the market are more efficient than the minimum standard, particularly in the lower horsepower ranges.

Replacing standard efficiency, general purpose, three-phase, AC induction motors in use with EPAct energy efficiency rated motors could save U.S. industry over $500 million annually, and could reduce motor system energy consumption by 2.3%, on average.

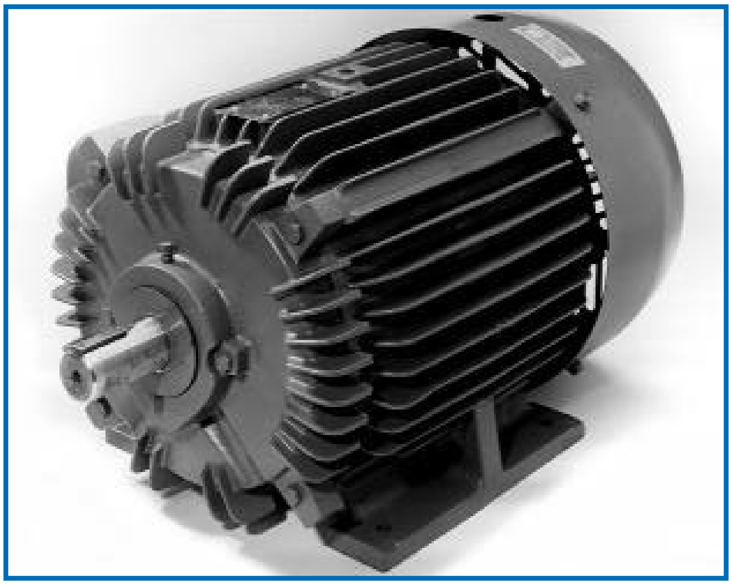
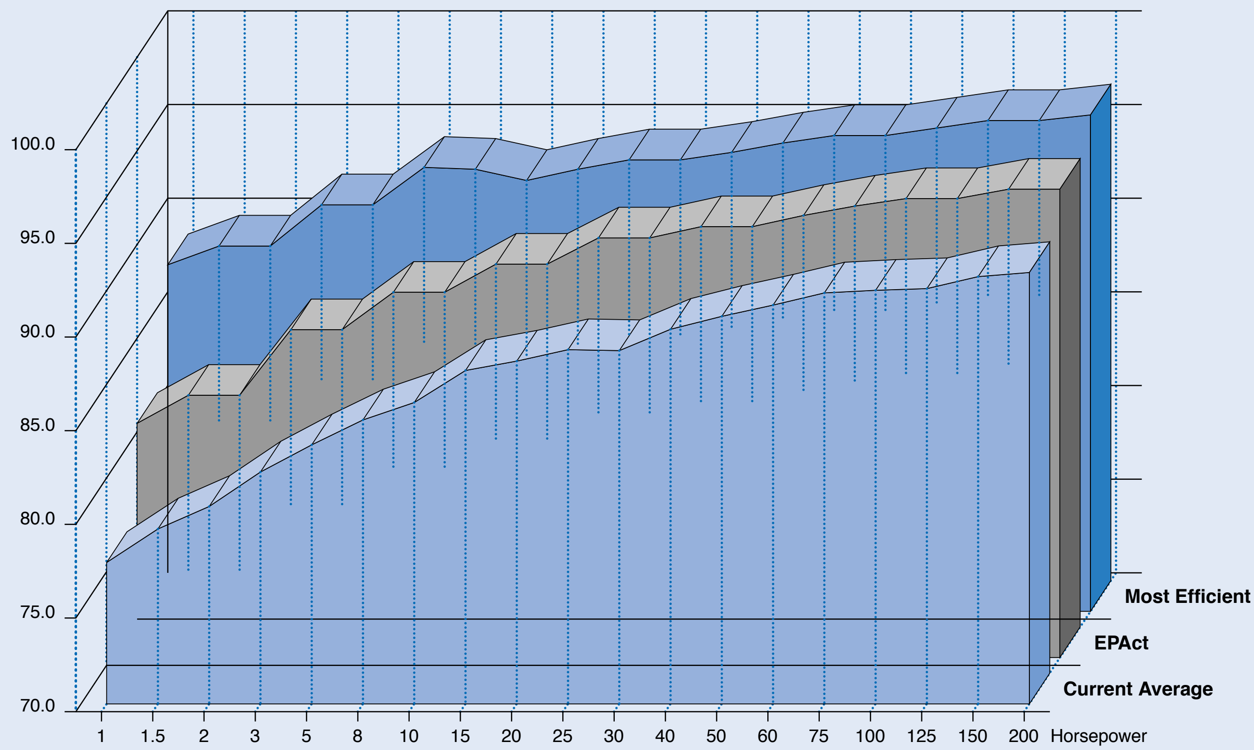


Figure 2-1: Comparison of Nominal Motor Efficiencies by Horsepower



The energy savings from replacing existing motors with their high efficiency equivalent are calculated based on energy consumption of the current motor compared to consumption of a motor meeting the efficiency requirements of EPAct, or alternatively, a higher efficiency standard advanced by the Consortium for Energy Efficiency (CEE). Energy savings are calculated by taking the difference in energy consumption of the baseline motor and the energy consumption of the high efficiency equivalent motor. The equation to calculate savings is:

$$\textit{Energy Savings} = \textit{Annual Energy}_{base} - \textit{Annual Energy}_{higheff.}$$

where $\textit{Annual Energy}_{base}$ refers to the energy consumption of existing baseline motor and $\textit{Annual Energy}_{higheff.}$ refers to the energy consumption of the equivalent high efficiency motor. The equation for annual energy is as follows:

$$\textit{Annual Energy} = \frac{\textit{horsepower} \times 0.746 \times \textit{operating hours} \times \textit{motor loading}}{\textit{efficiency}}$$

The value of the efficiency parameter is the only parameter that changes in calculating the baseline and high efficiency motor consumption. The baseline efficiency used in the equation is taken from the nameplate reading gathered in the survey. Where the nameplate efficiency is missing or otherwise inaccessible, a default efficiency is used, taken from the standard efficiencies listed in MotorMaster+ motor energy system management software. The default, EPAct standard, and CEE standard efficiencies used in the calculation for 1800 rpm motors are shown in Table 2-10.

IMPROVED REWINDING PRACTICES

The motor practices survey results indicate that 79 percent of the sites rewind some of their motors upon failure. The efficiency of a rewound motor is often poorer than the efficiency of the motor when new. Many studies have been performed to measure the effect of rewinding on motor efficiency.[13] Generally the studies involve taking performance measurements on a small number of motors before and after rewinding. In some cases, the rewinds have been performed "blind" by commercial shops using their standard practices. In others, specific technical protocols were covered. The results of the studies vary widely, with average degradation in efficiency after the rewinds ranging from 0 to 2.5 efficiency percentage points. Generally, researchers have found that use of low burn-out temperatures to remove old windings and careful attention to the original winding pattern can minimize efficiency degradation. However, the measured effects of these procedures have not been consistent. We should also note that operating efficiency testing procedures have a resolution of 0.2 efficiency percentage points.

If improperly done, rewinding can reduce the efficiency of motors 1% to 2%.

Given these findings, we assigned a savings fraction of 1.0 percent (0.9 percent difference in efficiency degradation between best practice and conventional rewinds divided by 90 percent initial efficiency). The annual energy savings from using best rewinding practices was then calculated using the following equation for the motors in each horsepower category of the inventory:

$$Energy\ Savings = Annual\ Energy_{base} \times Fraction\ Failed_{year} \times Proportion\ Rewind \times Savings\ Fraction.$$

Table 2-10: Motor Efficiencies Used in Savings Calculations

Horsepower Range	Default	EPAct	CEE
Up to 1 HP	77.55	82.5	86.5
>1 to 1.5	79.34	84.0	86.5
>1.5 to 2	80.54	84.0	86.5
>2 to 3	82.38	87.5	89.5
>3 to 5	83.83	87.5	89.5
>5 to 7.5	85.16	89.5	91.7
>7.5 to 10	86.09	89.5	91.7
>10 to 15	87.80	91.0	92.4
>15 to 20	88.30	91.0	93.0
>20 to 25	88.91	92.4	93.6
>25 to 30	88.86	92.4	93.6
>30 to 40	90.00	93.0	94.1
>40 to 50	90.69	93.0	94.5
>50 to 60	91.29	93.6	95.0
>60 to 75	91.94	94.1	95.4
>75 to 100	92.08	94.5	95.4
>100 to 125	92.17	94.5	95.4
>125 to 150	92.81	95.0	95.8
>150 to 200	93.03	95.0	96.2

[13] See Howe et al. (1993) Drivepower Technology Atlas, E-Source, Boulder, CO, Section 10 for a summary of these studies.

The sources for the parameters in this equation are as follows:

- *Annual Energy$_{base}$* is developed through the inventory data. See Section 1.
- *Fraction Failed* is estimated by dividing average lifetime operating hours for motors in the horsepower category (Seton, Johnson & Odell, 1987) by the average annual hours of operation for motors in the horsepower category (see Table 1-16).
- *Proportion Rewound* is estimated from the results of the Practices Inventory.
- *Savings Fraction* is set to 1.0 percent. See discussion above.

Table 2-11 contains the key input and results of the savings fraction estimates for improved rewinding practices. The savings estimate for all other measures discussed in this section assume that the measure will be implemented for all applicable systems in the population. In the case of improved rewinding practices, it is more "realistic" to characterize the measure as applying to the fraction of motors that fails in a year, even though, over a number of years, it will apply to all motors that are rewound. To characterize the magnitude of potential savings from improved rewinding practices on the same basis as the other measures, we have also calculated the savings associated with going through a full "rewind cycle" for all motors in the inventory. Full cycle savings range from 0.20 to 0.91 percent of total motor system energy consumption, depending on horsepower category. They increase with horsepower size because the percentage of motors rewound increases with size.

Table 2-11: Savings Fractions for Improved Rewinding Practices

HP Category	Mean Lifetime Operating Hrs	Mean Annual Operating Hrs	% of Units Failed/Year	% of Failed Units Rewound	Full Cycle Savings % of Total Energy	Savings/Year % of Total Energy
1-5	40,000	2,745	7%	20%	0.20%	0.01%
6-20	40,000	3,391	8%	61%	0.61%	0.05%
21-50	40,000	4,067	10%	81%	0.81%	0.08%
51-100	40,000	5,329	13%	90%	0.90%	0.12%
101-200	40,000	5,200	13%	91%	0.91%	0.12%
201-500	40,000	6,132	15%	91%	0.91%	0.14%
501 -1000	40,000	7,186	18%	91%	0.91%	0.16%
1001+	40,000	7,436	19%	91%	0.91%	0.17%

ENERGY SAVINGS RESULTS

Table 2-12 summarizes total potential motor system energy savings by measure category and horsepower range. In the detailed tables on the following page, we include only the midrange estimates for savings from system efficiency measures. The greatest savings potential lies with the system savings measures, specifically in compressed air and pump systems. System improvements account for 71 percent of total potential motor system energy savings. System efficiency measures related to pumps fans and compressors account for 57 percent of total potential savings. The next largest opportunity for savings is for motor efficiency upgrades with motor downsizing and improved rewinding practices having the smallest savings potential. On an aggregate basis, energy savings opportunities are distributed fairly evenly across the horsepower size ranges. We should note, however, that the higher horsepower ranges contain many fewer motor systems than the lower ranges, and that the savings and required investment per system are correspondingly higher in the larger horsepower categories. Details of the savings estimates for each measure are described on the following pages.

Table 2-12: Overall Motor System Savings

Size Category (HP)	System Efficiency Measure Savings (GWh/Year): Fan Systems	Pump Systems	Compressed Air Systems	Other Process Sys.	Downsize Motors	Motor Eff. Upgrades: Efficient Replacement	Rewinds Improved
1–5	226	1,312	107	331	1,973	1,824	56
6–20	603	3,804	409	557	953	2,972	367
21–50	584	4,882	1,422	597	459	2,767	592
51–100	470	5,268	1,090	636	753	2,213	656
101–200	776	4,204	1,599	774	559	2,105	756
201–500	354	4,825	2,690	892	749	2,617	826
501–1000	480	2,181	1,324	998	575	2,618	703
1000+	837	2,205	6,884	475	765	2,683	822
All Motors	***4,330***	***28,681***	***15,524***	***5,259***	***6,786***	***19,799***	***4,778***

SAVINGS FROM SYSTEM EFFICIENCY MEASURES

Table 2-13 shows estimates of energy savings from system efficiency measures by SIC. The key conclusions that can be drawn from this table are as follows.

- In the manufacturing sector, potential motor system energy savings from measures average 14.8 percent. They range from 8.8 percent in Lumber and Wood Products (SIC 24) to 23.1 percent in Electronic and Other Electric Equipment (SIC 36). Other SIC groups with high potential system efficiency are Petroleum (SIC 29), Chemicals (SIC 28), and Paper and Allied Products (SIC 26).
- The numbers in blue show the SIC/System Type combinations in which potential system savings are heavily concentrated. These 22 (out of 126) groups account for 69 percent of all potential savings identified through this study.

Table 2-13: Potential Energy Savings from System Efficiency Measures by SIC

SIC	Industry Category	Estimated Savings (GWh/Year): Fan System	Pump System	Compressed Air Systems	Other Proc. Systems	Motor Upgrade	Motor Downsizing	Replace vs. Rewind	All Systems	As % of Total Energy
20	Food and Kindred Products	157	1,250	494	517	1,376	585	295	4,674	12.4%
21	Tobacco Products									
22	Textile Mill Products	170	593	408	166	743	305	121	2,506	15.0%
23	Apparel & Other Textile Products	1	0	68	15	47	22	8	162	13.9%
24	Lumber and Wood Products	153	243	324	341	432	336	184	2,013	8.8%
25	Furniture and Fixtures	87	5	78	33	173	68	26	471	12.7%
26	Paper and Allied Products	1,082	6,293	773	881	3,197	845	870	13,942	14.0%
27	Printing and Publishing	52	17	74	90	305	153	39	731	12.3%
28	Chemicals and Allied Products	942	7,556	6,813	994	4,219	1,409	1,255	23,188	16.1%
29	Petroleum and Coal Products	271	6,159	1,352	169	1,736	459	453	10,599	20.4%
30	Rubber and Misc. Plastics Products	113	1,851	813	411	1,498	435	303	5,424	14.8%
31	Leather and Leather Products	27	0	0	0	22	6	3	58	11.8%
32	Stone, Clay, and Glass Products	31	18	96	20	117	45	14	343	15.4%
33	Primary Metal Industries	738	1,537	2,150	1,085	3,199	983	749	10,441	11.9%
34	Fabricated Metal Products	34	181	303	80	298	195	46	1,137	15.6%
35	Industrial Machinery and Equipment	28	195	200	94	368	208	44	1,138	15.4%
36	Electronic and Other Electric Equipment	18	1,554	513	43	609	222	93	3,053	23.1%
37	Transportation Equipment	353	1,109	941	242	1,195	340	235	4,415	14.9%
38	Instruments and Related Products	71	119	123	78	263	169	39	862	13.3%
39	Misc. Manufacturing Industries									
	All Industry Groups	***4,330***	***28,681***	***15,524***	***5,259***	***19,799***	***6,786***	***4,778***	***85,157***	***14.8%***

Numbers printed in blue show SIC/system types with greatest potential for systems savings.

MOTOR DOWNSIZING

Table 2-14 shows our estimates of potential savings associated with better matching of motors to the load they drive. On the whole the savings are greatest for the smaller motors, especially in pumps and other applications. Air compressors have the lowest savings potential because we found that relatively few of the motors that drove air compressors were underloaded.

Table 2-14: Savings from Motor Downsizing

	Potential Motor System Energy Savings (% of Energy)				
Size Category (HP)	Fan Systems	Pump Systems	Compressed Air Systems	Other Process	Total
1–5	7.6%	6.3%	0.3%	7.5%	7.1%
6–20	0.5%	1.6%	0.6%	2.1%	1.6%
21–50	0.5%	0.2%	0.1%	1.1%	0.6%
51–100	0.7%	0.8%	0.2%	1.5%	1.0%
101–200	0.1%	0.3%	0.3%	1.1%	0.7%
201–500	0.0%	0.9%	1.2%	0.8%	0.8%
501–1000	0.0%	0.9%	1.2%	0.8%	0.7%
1000+	0.0%	0.9%	1.2%	0.8%	0.8%
All Motor Sizes	***0.6%***	***1.0%***	***0.9%***	***1.5%***	***1.2%***

MOTOR EFFICIENCY UPGRADES

EFFICIENT REPLACEMENT

Estimates of savings available from upgrading the efficiency of motors currently in place at the point of replacement are shown in Tables 2-15 and 2-16. These tables display motor system energy savings attributable to efficient replacement by horsepower category and SIC group respectively. As discussed on pages 63 and 64, neither the EPAct nor the CEE standard applies to motors over 200 horsepower. However, we estimated energy savings in horsepower ranges above 200 by applying the relevant efficiencies for 200 horsepower motors to observations of nominal efficiency for motors currently in place.

Tables 2-15 through 2-17 support the following findings in regard to potential energy savings from efficient replacement.

Overview

- For all manufacturing SICs, motor system efficiency savings associated with upgrading the efficiency of all motors currently in use to EPAct standards total 13.1 billion kWh per year. This is 18 percent of the total midrange potential savings estimate, and 2.3 percent of total manufacturing motor system energy consumption.
- Upgrading the efficiency of all motors in use to the higher CEE standards yields an additional 6.7 billion kWh per year. This would bring total savings from efficient replacement to 19.8 billion kWh, which is equivalent to 23.2 percent of the total midrange potential savings estimate and 3.4 percent of total manufacturing motor system energy use.

Distribution of Savings by Horsepower Category

- In terms of GWh per year, potential energy savings from efficient replacement is distributed fairly evenly among the horsepower categories. The lower horsepower categories show higher percentage savings than the larger motors. This is the result of the larger difference in (pre-1997) standard efficiencies and EPAct-compliant efficiencies in the smaller horsepower ranges described on pages 63 and 64.

Distribution of Savings by SIC Group

- For individual two-digit SIC groups, potential motor system energy savings from efficient replacements range from 1.9 percent of total motor system energy to 2.9 percent for EPAct level upgrades; 2.9 to 4.1 percent for CEE level upgrades.
- The difference in savings potential among the SICs is related to the representation of smaller motors in the population. Thus, for example, the Plastics industry shows a substantially higher level of potential savings than Chemicals or Paper.

Table 2-15: Savings from Motor Efficiency Upgrades by HP

	Savings from Upgrading to EPAct Standards		Savings from Upgrading to CEE Standards	
Size Category (HP)	GWh/Year	% of Total Energy Use	GWh/Year	% of Total Energy Use
1–5	1,221	4.4%	1,824	6.6%
6–20	1,925	3.2%	2,972	4.9%
21–50	1,971	2.7%	2,767	3.8%
51–100	1,487	2.0%	2,213	3.0%
101–200	1,438	1.7%	2,105	2.5%
201–500	1,625	1.8%	2,617	2.9%
501–1000	1,689	2.2%	2,618	3.4%
1000+	1,688	1.9%	2,683	3.0%
All Motor Sizes	***13,043***	***2.3%***	***19,799***	***3.4%***

Table 2-16: Savings from Motor Efficiency Upgrades by SIC

	Savings from Upgrading to EPAct Standards		Savings from Upgrading to CEE Standards	
Industry	GWh/Year	% of Total Energy Use	GWh/Year	% of Total Energy Use
28 Chemicals	2,720	1.9%	4,219	2.9%
26 Paper	2,078	2.1%	3,197	3.2%
33 Metals	2,104	2.4%	3,199	3.6%
29 Petroleum	1,137	2.2%	1,736	3.3%
20 Food	904	2.4%	1,376	3.6%
30 Plastics	1,053	2.9%	1,498	4.1%
Other	3,048	2.6%	4,573	3.9%
All Industry Groups	***13,043***	***2.3%***	***19,799***	***3.4%***

IMPROVED REWINDING PRACTICES

Table 2-17 shows estimates of energy savings associated with improved rewinding practices. We calculated both the annual and "full cycle" savings by applying the appropriate savings fractions shown in Table 2-11 to total annual motor system energy in each of the horsepower categories. Full cycle savings amount to 4.8 billion kWh per year. Annual savings are 0.4 billion kWh per year. The rewind cycles vary considerably by motor size. At average annual hours of operation, motors under 20 horsepower fail within 11 to 15 years; motors over 100 horsepower fail once in 5 to 8 years.

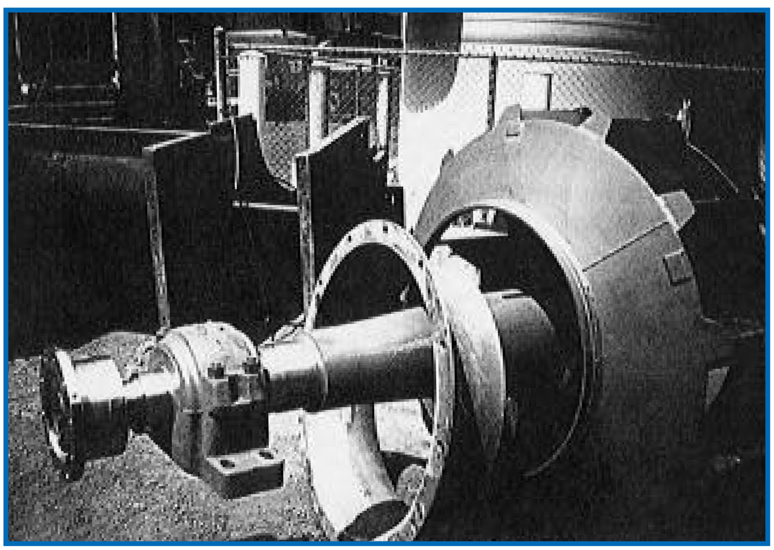
Table 2-17: Replace vs. Rewind Savings

Size Category (HP)	Motor System Energy (GWh/Year)	Annual Savings (GWh/Year)	Full Cycle Savings (GWh/Year)
1–5	27,776	29	56
6–20	60,122	70	367
21–50	73,111	65	592
51–100	72,924	44	656
101–200	83,099	39	756
201–500	90,819	51	826
501–1000	77,238	51	703
1000+	90,307	61	822
All Motor Sizes	***575,428***	***410***	***4,778***

PATTERNS OF POTENTIAL SAVINGS IN INDIVIDUAL INDUSTRIES

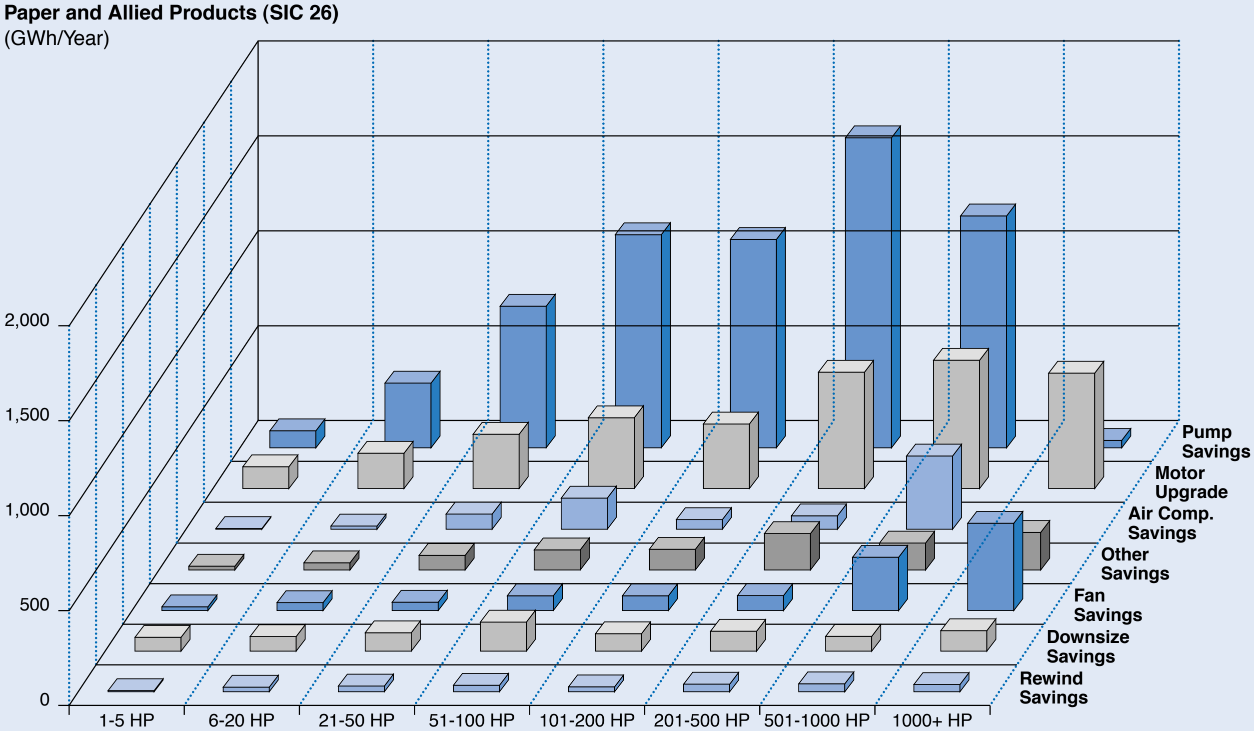
Just as patterns of motor system energy use vary significantly between different industries, so too do patterns of potential energy savings. Figure 2-2 shows the distribution of potential energy savings from major measure groups for facilities in the Paper and Allied Products (SIC 26) and Primary Metals (SIC 33) industries. Figure 2-2 that potential savings opportunities cluster in the application/horsepower groups with the greatest amounts of energy. Most of the savings in the paper industry are concentrated in improvements to pump systems. In Primary Metals, the largest savings can be found in large fan and air compressor systems. Savings in pump systems are also substantial in the lower horsepower ranges. The concentration of many of the savings opportunities in systems driven by large motors suggests that their implementation will require considerable planning and capital outlay. Appendix A contains similar charts for other industries with intensive motor energy use. Facilities managers and equipment vendors alike can use these figures as a guide for exploring motor system energy savings opportunities in their facilities.

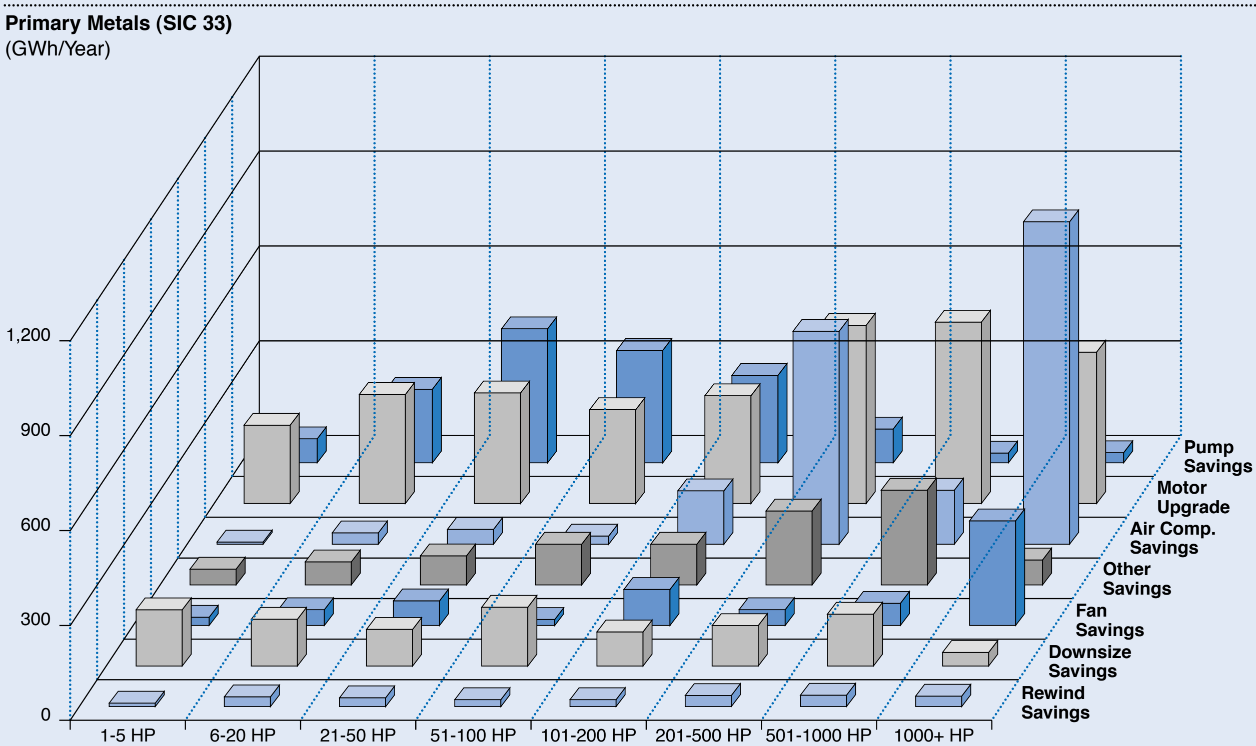
A steel producer optimized its fume collection system by tipping a fan impeller. Fan optimization projects result in large savings in the Primary Metals industry.



Flowcare Engineering, Inc.

Figure 2-2: Distribution of Potential Energy Savings by Application and Motor Size





Section 3: Motor System Purchase and Management Practices

This section presents key results of the motor systems Practices Inventory. Achievement of significant increases in motor system efficiency depend to a large extent on the adoption of good design, purchase, and management practices. Motor systems require continual monitoring and maintenance to run at their design efficiency. Each decision and action in the daily stream of motor system design, purchase, and maintenance carries with it consequences for energy efficiency and consumption. The Practices Inventory gathered information on the prevalence in the sample facilities of actions identified by industry experts as "good practice."

Through the Practices Inventory, we sought information on a number of other issues central to the design and marketing of the Motor Challenge Program. These included:

- Which individuals within an industrial organization make various motor system purchase and management decisions?
- What criteria do these individuals apply to motor system purchase and management decisions?
- To what extent are facilities managers and staff aware of the elements of good motor system purchasing and management practice?
- What barriers inhibit facilities managers and engineering staff from implementing elements of good practice?

Due to time constraints on site and the extreme complexity of the Motor Systems Inventory, we chose to keep the Practices Inventory brief. We therefore did not have time to explore the full range of "market barriers" which affect the implementation of motor system efficiency measures or the structural and operating issues which affect decisions regarding allocation of capital expenditures to various strategic objectives. On the other hand, the results of the Practices Inventory do support a number of clear conclusions about the challenges of reaching decision makers in industrial organizations and of changing their motor systems purchasing and management practices. These can be summarized as follows:

- Most purchase and maintenance decisions that affect motor systems efficiency are made at the plant level, even in large companies with national multi-facility operations.
- Few facilities managers have implemented more than one or two elements of good motor systems purchasing and maintenance practices. Many had implemented none.
- Lack of information concerning the nature of motor system efficiency measures—their benefits, costs, and implementation procedures—constitutes a principal barrier to their adoption.
- While we did not explicitly question respondents concerning allocation of resources to motor system efficiency, the field engineers noted repeatedly the limited resources available for motor system monitoring and maintenance. The priority for facilities management and maintenance staff was to ensure continuity and consistency of mechanical operations. It was very difficult for facilities management staff to break away from their jobs long enough to answer a few questions or to provide escorts for the field engineers. There was clearly little slack in their schedule for the additional tasks required for active motor systems management—at least without considerable guidance concerning the most worthwhile allocation of resources. These informal observations have been confirmed by many engineers and utility program staff who provide services to industrial customers.

The results of the survey highlighted the need for Motor Challenge and similar programs to:

- Increase the visibility and credibility of information on the potential benefits of motor system efficiency measures.
- Facilitate the implementation of such measures by end-users and vendors in the market.

The paragraphs below present detailed findings from the Practices Inventory. All percentages reflect the effects of weighting the responses from individual sample facilities for their representation in the population.

MOTOR PURCHASE DECISION-MAKING

LOCUS OF DECISION-MAKING

The results of the inventory clearly show that decisions regarding motor purchases are made at the plant versus the corporate level. First, as Table 3-1 shows, 77 percent of all manufacturing plants are sole locations for their respective companies. Ninety percent of sole locations are in the small and small/medium size categories. A higher percentage of large plants are branches of big companies.

Table 3-1: Branch/Sole Locations by Facility Size

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Sole Location	46%	55%	71%	71%	80%	**77%**
Branch or Subsidiary	54%	45%	29%	29%	10%	**16%**
No Answer	0%	0%	0%	0%	9%	**7%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

Even in plants that are subsidiaries of larger companies, motor purchase decisions are made at the factory level. Table 3-2 shows results only for factories which were identified as branch facilities or subsidiaries of larger organizations. Overall, 91 percent of facilities personnel in multi-plant companies reported that motor purchase decisions are made at the plant level. The percentage was even higher for larger facilities.

Table 3-2: Location of Motor Purchasing Decisions for Facilities with Multiple Locations

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Decision made at plant	96%	92%	100%	88%	91%	**91%**
Decision made at HQ	0%	6%	0%	9%	5%	**5%**
Decision depends on purchase	4%	2%	0%	2%	5%	**4%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

The individual responsible for motor purchasing decisions varies by the size of company, as can be seen in Table 3-3. In larger companies, the maintenance manager is primarily responsible for motor purchase decisions. Whereas in smaller companies, the majority of motor purchasing decisions are made by the president or CEO.

Table 3-3: Position of Inventory Respondent (Person Who Makes Motor Purchase Decisions)

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Plant Manager	0%	17%	0%	12%	14%	**13%**
Maintenance Manager	41%	43%	72%	5%	3%	**9%**
Purchasing Manager	0%	0%	0%	20%	0%	**2%**
Plant Engineer	16%	8%	12%	2%	4%	**5%**
Chief Electrician	23%	4%	4%	1%	0%	**1%**
President or General Manager	0%	0%	4%	35%	47%	**40%**
Other	20%	24%	8%	25%	31%	**29%**
(blank)	0%	4%	0%	0%	0%	**1%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

MOTOR PURCHASING PRACTICES

AWARENESS OF ENERGY-EFFICIENT MOTORS

Overall, awareness of energy-efficient electric motors among the facilities personnel surveyed was relatively low. Excepting large companies, a very small percentage of motor purchasers reported being aware of premium efficiency motors. As Table 3-4 shows, only 19 percent of all respondents were aware of premium-level efficient motors.

Table 3-4: Percent of Motor Purchasers Reporting Awareness of Premium Efficiency Motors by Facility Size

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Aware	97%	42%	35%	38%	12%	**19%**
Not Aware	3%	58%	65%	62%	72%	**69%**
No Answer	0%	0%	0%	0%	16%	**12%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

With the exception of companies in the Chemical and Allied Products industry, awareness of premium efficiency motors was higher in industries with higher amounts of electric motor use. These include Pulp and Paper, Petroleum, Rubber, and the Primary Metals industries.

Awareness of energy-efficient electric motors is generally low, except with the large users of electric motor systems, such as petroleum refineries.

Table 3-5: Percent of Motor Purchasers Reporting Awareness of Premium Efficiency Motors by SIC

	SIC Categories							
	Food	Paper	Chemical	Petroleum	Rubber	Metals	Other	Total
Aware	35%	66%	31%	69%	73%	78%	8%	**19%**
Not Aware	21%	30%	69%	31%	27%	22%	78%	**69%**
No Answer	44%	3%	0%	0%	0%	0%	14%	**12%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

Overall, only 4 percent of respondents reported they were aware of the efficiency ratings associated with the "High or Premium" designation. An additional 38 percent reported they were somewhat aware of the efficiency implications of the designation. Representatives of larger companies tended to be more versed in this area than those of smaller companies.

Table 3-6: Percent of Motor Purchasers Reporting Awareness of Efficiency Ratings Associated with "High" or "Premium" Designation

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Yes	45%	10%	12%	3%	2%	**4%**
Somewhat	53%	55%	71%	62%	30%	**38%**
No	2%	35%	16%	34%	51%	**46%**
No Answer	0%	0%	0%	0%	16%	**12%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

Some care needs to be taken in interpreting the results of the Practices Inventory with regard to awareness of energy-efficient motors. During the time the survey was underway, motor dealers did not always use a consistent system of nomenclature for motors which met the efficiency standards promulgated by NEMA. Some companies referred to such motors as "high efficiency", others as "premium efficiency", and still others as "energy efficient." (The NEMA nomenclature for motors that met its standards was "energy efficient.") Moreover, some manufacturers labeled motors which did not meet NEMA standards as energy efficient. We tried to clarify the motors we were referring to through the wording of items in the questionnaire, but any confusion that respondents faced in answering these questions may have reflected inconsistencies in nomenclature in the market.

PURCHASES OF ENERGY-EFFICIENT MOTORS

Twenty-two percent of customers reported that they had purchased efficient motors over the 2 years prior to the Inventory. These purchasers were concentrated in larger company size categories and were in more motor-intensive industries. Table 3-7 shows that larger companies generally bought a higher percentage of efficient motors during the past 2 years. The pattern is not consistent in small to medium companies.

Table 3-7: Percent of Customers Who Bought Efficient Motors Over the Past 2 Years—Average Percentage of New Motors that are Efficient by Facility Size

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
All motors energy efficient	9%	6%	3%	13%	4%	**5%**
Some motors energy efficient	77%	31%	15%	5%	17%	**17%**
No motors energy efficient	14%	50%	82%	79%	68%	**68%**
No Answer	0%	13%	0%	3%	12%	**10%**
Average % Energy Efficient	***29%***	***18%***	***6%***	***15%***	***11%***	***12%***

Purchase of efficient motors also varies considerably by SIC, even among large motor system energy users. Some of this variation may be due to the use of very large (over 200 HP) motors in certain industries such as chemicals and metals. These large motors are not covered by EPAct standards. However, a high proportion of respondents in the Petroleum industry (61 percent) reported that all motors purchased over the past 2 years had been energy efficient. The Petroleum industry is characterized by a high saturation of large motors.

Table 3-8: Percent of Customers Who Bought Efficient Motors Over the Past 2 Years— Average Percentage of New Motors that are Efficient by SIC

	SIC Categories							
	Food	Paper	Chemical	Petroleum	Rubber	Metals	Other	Total
All motors energy efficient	47%	20%	13%	61%	1%	1%	2%	**5%**
Some motors energy efficient	32%	24%	22%	5%	29%	34%	14%	**17%**
No motors energy efficient	14%	49%	53%	30%	70%	64%	72%	**68%**
No Answer	8%	7%	12%	3%	0%	0%	12%	**10%**
Average % Efficient	***58%***	***28%***	***23%***	***65%***	***4%***	***4%***	***9%***	***12%***

The overall findings on market penetration of energy-efficient motors are consistent with U.S. Census shipment figures. Over the past 3 years, the market penetration of efficient motors in the type and horsepower categories covered by the federal standards has averaged around 18 percent. In 1996, however, this percentage fell to 15 percent. The average percentage of energy-efficient motors purchased by respondents over the 2 years prior to the Inventory was 12 percent.

RESTRICTION IN REPLACING MOTORS IN OEM EQUIPMENT

Some motor system market observers have hypothesized that customers were inhibited from buying energy-efficient motors by restrictions on motor replacements made by machine manufacturers (OEMs). For example, for some kinds of specialized machines, only motors with particular frame sizes, physical configuration, or operating characteristics would work. Alternatively, warranties would be voided if replacement motors were supplied by unauthorized manufacturers.

We questioned the Practices Inventory respondents on these points. Table 3-9 summarizes their answers. We found that OEM restrictions on purchase of replacement motors affected roughly 60 percent of the companies represented. However, only 18 percent of the respondents mentioned that replacement motors were not available in premium efficiency models. We conclude, therefore, that OEM practices constituted a barrier to the purchase of energy-efficient motors prior to the promulgation of federal efficiency standards. However, this barrier appeared to affect a minority of manufacturers. Federal standards cover integral horsepower general purpose motors, including those packaged into other machines.

Table 3-9: OEM Restrictions on Equipment with Installed Motors

Restriction*	Percent Reporting
Replacement motors available only through OEM	22%
Replacement motors available only through one manufacturer	14%
Replacement with motors from unauthorized vendors voids warranty	7%
Replacement motors not available in premium efficiency models	18%
Other problems	10%
Not applicable to motors in facility	6%
No problems reported	33%

*Customers could name more than one restriction.

USE OF PURCHASE GUIDES

Some observers of industrial equipment markets hypothesize that customers are inhibited from purchasing efficient motors because they rely primarily on vendors to make selections of the appropriate motors for various applications. They further hypothesized that, until recently, vendors faced disincentives to stocking efficient motors due to their higher costs. To assess this hypothesis, we asked end-users about the sources of information they used in selecting new and replacement motors. We were particularly interested in finding out whether customers used compilations of product information to support independent judgments on motor selection. We found that only one one-quarter of customers are aware of any publications or tools whatsoever for guiding purchase of new and replacement motors. The percentage is significantly higher only among the very largest customers. See Table 3-10.

Table 3-10: Percentage of Customers Aware of Tools for Selecting New or Replacement Motors

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Yes	71%	33%	23%	37%	22%	**25%**
No	29%	66%	77%	63%	59%	**61%**
No Answer	0%	1%	0%	0%	19%	**14%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

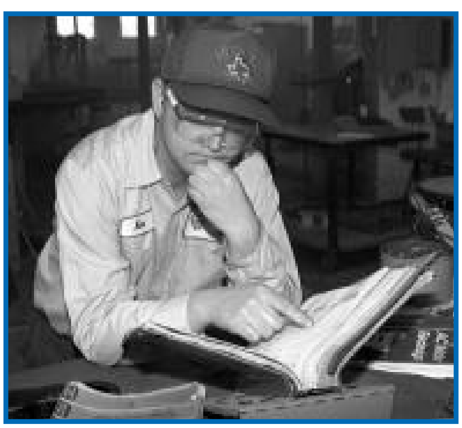
The most frequently used references for motor selection were manufacturers' catalogs. Only 5 percent of customers reported using these sources regularly. The corresponding figure for large customers was 17 percent. See Table 3-11. While nearly one-half of the large customers interviewed reported being aware of the MotorMaster+ software, which provides extensive support for motor selection and inventory management, only one reported having actually used it.

Table 3-11: Awareness and Usage of Manufacturers' Catalogs for Motor Selection

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Not aware	1%	3%	0%	4%	2%	**2%**
Have heard of	0%	7%	1%	0%	16%	**13%**
Have used it	53%	10%	3%	23%	3%	**6%**
Use it regularly	17%	6%	17%	13%	2%	**5%**
No answer	29%	74%	79%	59%	77%	**75%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

MOTOR PURCHASE POLICIES

Adopting standard policies and specifications for purchasing efficient motors will help in replacement situations where quick action is needed to avoid downtime.



The Motor Challenge Program and similar utility-sponsored efforts encourage customers to adopt standard policies and specifications for purchasing efficient motors. This can be particularly important for ensuring the purchase of efficient models in replacement situations where quick action is needed to keep production up and running. Overall, only 3 percent of customers reported that their companies had adopted a policy regarding the efficiency of new motors purchased. As Table 3-12 shows, virtually all of these are among the largest customers.

Table 3-12: Prevalence of Motor Purchase Policies

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Have efficiency policy	20%	9%	5%	13%	1%	**3%**
No policy	80%	80%	75%	85%	67%	**70%**
No answer	0%	11%	19%	2%	32%	**26%**
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

Only 11 percent of the companies that participated in the Inventory reported having had written specifications for motor purchases. Only two-thirds of these companies reported including efficiency in their specifications. Items included in those specifications are shown in Table 3-13.

Table 3-13: Company Purchasing Specifications

Specification	Percent Reporting
Temperature rise/Insulation class	11%
Maximum starting current	8%
Minimum stall time	5%
Power factor range	5%
Efficiency and test standard	7%
Load inertia	3%
Expected number of starts	7%
Suitability to facility operating environment	9%
Ease of reparability	4%

MOTOR SIZING PRACTICES

Instantaneous load measurements conducted as part of the Motor Systems Inventory found that over 40 percent of motors in use were operating at less than 40 percent part load. These findings suggested that the practice of oversizing motors was widespread. Customers' responses to criteria used to select the size of replacement motors was consistent with these findings. Inventory respondents reported using the size of the motor being replaced most often as the criterion for selecting the size of new motors. This practice would tend to perpetuate any oversizing in the selection of the original motor.

Table 3-14 shows the pattern of response to questions concerning the methods used to determine the size of replacement motors. Respondents could report using more than one method. Using the size of the motor replaced was by far the most frequently reported sizing method. Eighty-six percent of customers reported using it all or most of the time. By contrast, 44 percent of customers reported using equipment manufacturers' specifications as a guide to sizing all or most of the time. Moreover, 29 percent of customers used the size of replaced motor as their only sizing criterion. These customers are mostly in the small- and medium-size ranges.

Table 3-14: Frequency of Criteria for Selecting Motor Size

	Always	Most of the time	Some of the time	Never	No Answer	Total
Select the same size as the motor being replaced.	55%	31%	4%	0%	11%	100%
Use motor in inventory closest in size to motor being replaced.	5%	10%	20%	41%	24%	100%
Select motor size based on load measurements or estimates.	7%	3%	12%	55%	23%	100%
Select motor size based on production equip. specifications.	24%	20%	8%	25%	23%	100%

REWINDING PRACTICES

There are two major energy saving opportunities associated with rewind practices. The first is to encourage customers to replace failed motors with more efficient models rather than rewind them. The second is to ensure that customers specify and rewind shops use best practices so that degradation of efficiency is minimized. The Practices Inventory contained an extensive series of questions on the proportion of motors that customers rewound, the criteria applied to the rewind/replace decision, and the use of written rewind specifications. The responses to these items are detailed below.

PERCENTAGE OF MOTORS REWOUND

Respondents were asked to report on the percentage of motors they rewind in each horsepower category. The results from these questions are shown in Table 3-15. Not surprisingly, the percentage of motors rewound upon failure increases with size. This is largely because the difference in cost between purchasing a replacement motor and rewinding the failed unit increases with size.

Table 3-15 shows a number of unexpected results. First, a large percentage of customers report rewinding failed motors in the 1–5 horsepower category. Several studies of the rewind industry have found that it is less expensive, even on the basis of first costs alone, to replace motors in this size category than it is to rewind them.[1] One possible explanation of this finding is that the smaller motors rewound are special purpose items which are difficult and costly to replace. Second, small facilities report that they rewind smaller motors more frequently than large ones. This finding likely reflects the fact that there are very few motors above 50 horsepower in small facilities.

Table 3-15: Percentage of Motors Rewound By Horsepower Category and Facility Size

	Large	Med/Large	Medium	Sm/Med	Small	Total
1–5 HP	19%	20%	16%	19%	23%	**20%**
6–20 HP	62%	62%	55%	50%	68%	**61%**
21–50 HP	84%	80%	83%	79%	79%	**81%**
51–100 HP	90%	90%	86%	87%	94%	**90%**
101–200 HP	***94%***	***89%***	***93%***	***85%***	***97%***	***91%***

Respondents to the Practices Inventory reported that they rewound a given motor three times, on average. Larger motors tend to be rewound more often than smaller ones.

FACTORS CONSIDERED IN REWIND DECISION

Respondents to the Practices Survey were asked to indicate whether they took various considerations into account in their replace versus rewind decisions. Table 3-16 summarizes the answers to this series of items.

[1] One recent study of the practices of rewind shops placed the “break-even point” at 10–12 horsepower. (Douglass et al., 1995) However, it should be noted that the price relationship between replacement purchases and rewinds fluctuates with price changes in the motors market and the costs of materials and labor in the motor service business.

Table 3-16: Factors Considered in Rewind Decision*

	Large	Med/Large	Medium	Sm/Med	Small	Total
Capital cost of rewound motor vs. cost of new motor	91%	80%	55%	43%	63%	**62%**
Installation cost of rewound motor vs. installation cost of new motor	2%	17%	0%	17%	2%	**5%**
Cost of electricity used by rewound motor vs. electric cost of new motor	6%	11%	8%	31%	10%	**12%**
Reliability of rewound motor vs. reliability of new motor	4%	20%	11%	6%	19%	**17%**

*Respondents could name more than one factor.

The results shown in Table 3-16 clearly show that the replace/rewind decision is driven by considerations of first costs. Sixty-two percent of respondents reported that they considered the capital cost of the rewind versus the cost of the new motor in making their decision. By contrast, only 12 percent considered the relative energy costs of the two options and 17 percent took the reliability of rewound versus new motors into account. Larger customers appeared to put a larger weight on capital costs than smaller customers. This may reflect the fact that larger customers tend to have larger motors, for which the differential costs of rewinding and replacing are larger.

PUMP, FAN, AND COMPRESSOR SYSTEM EFFICIENCY PRACTICES

Customers were asked whether they had undertaken any of a long list of system efficiency measures over the past 2 years. They were not asked how often they carried out the measures or whether they constituted a regular practice. Compressed air systems appeared to have received the most attention, with 20 percent of all respondents reporting that they fixed leaks and 6 percent reporting that they replaced single stage rotary screw compressors with more efficient models. Except among the very largest customers, pump and fan systems were virtually ignored.

As would be expected, large facilities made the most system efficiency improvements. Measures which they implemented with some frequency included:

- Retrofit of fan systems with ASDs: 20 percent;
- Retrofit of duct systems with inlet guide vanes: 9 percent;
- Substitution of ASDs for throttling valves in pump systems: 22 percent;
- Installation of parallel pumps to respond to load variations: 14 percent;
- Use of parallel compressors to respond to load variations: 23 percent;
- Reconfigured piping and filters to reduce pressure drops in compressed air systems: 14 percent;
- Added multi-unit controls to reduce part load consumption in compressed air systems: 23 percent;
- Reduce the size of compressors to better match load: 10 percent; and,
- Fixed leaks in compressed air systems: 42 percent.

Table 3-17: Reported System Measures Undertaken During the 2 Years Prior to the Inventory

	Size Categories					
	Large	Med/Large	Medium	Sm/Med	Small	Total
Fan Systems						
Retrofitted with ASDs	20%	7%	1%	0%	1%	**1%**
Retrofitted with inlet guide vanes	9%	1%	0%	0%	3%	**2%**
Checked components with large pressure drops	3%	1%	10%	0%	3%	**3%**
No fan systems in facility	0%	29%	24%	18%	43%	**38%**
No improvements	67%	49%	45%	80%	33%	**40%**
Pump Systems						
Substituted speed controls for throttling	22%	8%	11%	1%	0%	**1%**
Used parallel pumps to respond to variations in load	14%	4%	2%	0%	3%	**2%**
Reduced pump size to fit load	0%	5%	7%	11%	3%	**4%**
Increased pipe diameter to reduce friction	5%	6%	6%	11%	1%	**3%**
No pump systems in facility	13%	28%	24%	17%	40%	**35%**
No improvements	45%	57%	42%	52%	34%	**38%**
Compressed Air Systems						
Replaced 1-stage rotary screw units with more efficient models	7%	16%	29%	2%	4%	**6%**
Used parallel compressors to respond to variations in load	23%	12%	10%	13%	7%	**8%**
Reconfigured piping and filters to reduce pressure drops	14%	24%	5%	13%	1%	**5%**
Added multi-unit controls to reduce part load consumption	23%	10%	6%	0%	4%	**4%**
Reduce size of compressors to better match load	10%	6%	1%	2%	1%	**1%**
Fixed leaks	42%	40%	34%	36%	15%	**20%**
No compressed air systems in facility	0%	3%	0%	1%	10%	**8%**
No improvements	39%	44%	37%	62%	52%	**52%**
No Reported Improvements	30%	27%	14%	45%	21%	**24%**

Table 3-17 also shows that a large proportion of customers had not taken any of the common systems related measures over the 2 years prior to the inventory. Specifically:

- 40 percent of customers had undertaken none of the listed fan system measures;
- 38 percent had undertaken none of the listed pump system measures;
- 52 percent had undertaken none of the listed compressed air system measures; and,
- 24 percent had undertaken none of the systems measures at all.

These results do not include customers who reported that they had none of the various kinds of motor systems in their facilities.

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Appendix A: Profiles of Selected Industries

UNITED STATES
INDUSTRIAL MOTOR SYSTEMS
MARKET OPPORTUNITIES
ASSESSMENT

A PROFILES OF SELECTED INDUSTRIES

A.1 INTRODUCTION

Appendix A contains brief profiles of the five largest manufacturing industries in terms of total motor electric use and costs. The industries covered are:

- Food and Kindred Products
- Paper and Allied Products
- Chemicals and Allied Products
- Petroleum and Coal Products
- Primary Metals Industries

The profiles contain brief industry and energy information, as well as information on motor inventories and savings potentials gathered from the survey. Documented case studies of energy efficiency improvements are presented where available.

Additionally, Appendix A contains survey results from four non-manufacturing industries. These results present useful information gathered from the survey, but are not representative of the industries covered. Data were gathered from 11 surveys covering the following industries:

- Agriculture
- Mining
- Oil and Gas Extraction
- Water Supply

A.2 SIC 20: FOOD AND KINDRED PRODUCTS

A.2.1 Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Establishments: 1994	14,698	12,348	6
Value of Shipments: 1996	$461 Bil.	$186 Bil.	2
Number of Employees: 1996	1,517	866	3
Capital Intensity: Value of Fixed Assets/Employee	$124,274	$147,800	6
Capital Spending: 1996	$9.3 Bil.	$5.6 Bil	5

Key Investment Decision Factors

- The Food and Kindred Products industry is extremely competitive due to the large number of firms and the relatively slow growth rate in demand.
- This industry has historically low profit margins, which significantly impacts investment decisions.
- Much available investment supports new product development.

A.2.2 Energy Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Energy Costs ($ million/Year)	$5,752	$3,237	4
Per establishment ($,000)	$390	$260	8
As a percent of operating costs	1.3%	1.9%	11
Net Electricity Demand (GWh/Year)	64,877	45,892	4
Electric Costs ($ million)	$3,367	2,028	4
Percent of total energy costs	59%	63%	16
Percent of net electricity demand self-generated	8%	10%	4
Motor System Electric Use (GWh/Year)	47,374	27,060	3
As a percent of total electric use	73%	59%	3
Motor System Electric Costs ($ million/Year)	$2,459	$1,172	3
Per establishment ($,000)	$170	$90	7
As a percent of operating costs	.6%	0.7%	10

Energy Overview

- Food and kindred industries rank high on indices of the economic impact of energy costs and on the impacts of motor system use: fourth in total energy costs and in net electric demand, third in total motor systems electric use and motor system electric cost, and tenth in motor system energy costs as a percent of operating costs.
- The primary industry uses of energy are for food preservation, packaging, and storage.
- Wet corn milling is the most energy intensive subgroup of SIC 20, consuming 15 percent of total sector energy.

A.2.3 Motor Systems Inventory and Energy Use Details

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Integral HP Motors (Survey Estimate) 000s	992	622	4
Percent of motors that meet EPAct standards	8.8%	9.1%	7
Percent of motors with ASDs	21.0%	8.8%	2
Total Motor Systems Energy (Survey Estimate) GWh/Yr	37,797	28,771	5
Percent of energy under ASD control	9.8%	4.4%	3
Average part load	61%	62%	9
Percent of energy in fluid systems	61%	61%	6
Percent of energy in pump systems	16.4%	24.8%	8
Percent of energy in fan systems	7.5%	13.7%	14
Percent of energy in compressed air systems	7.7%	15.8%	15
Percent of energy in refrigeration systems	29.4%	6.7%	1
Percent of energy in motors > 200 HP	31.2%	44.9%	6
Percent of energy in DC motors	0.31%	9.71%	14

Motor Systems Inventory Overview

- The bulk of electricity is consumed by motor drives for material processing, refrigeration and freezing.
- The penetration of ASD motors is very high in SIC 20, although they control a disproportionately small amount of the electricity consumed by the sector.

Figure A-1
Distribution of Motor System Energy for SIC 20 by HP and Application

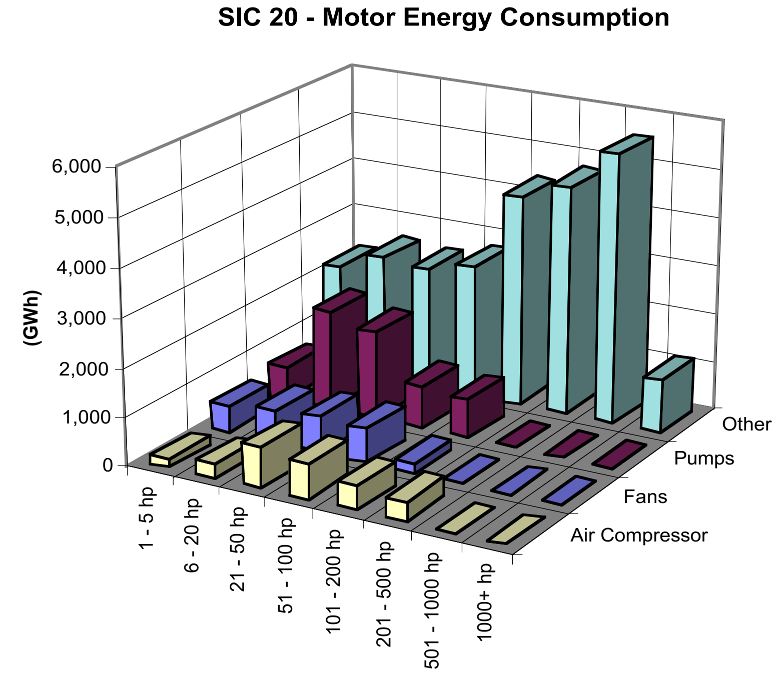
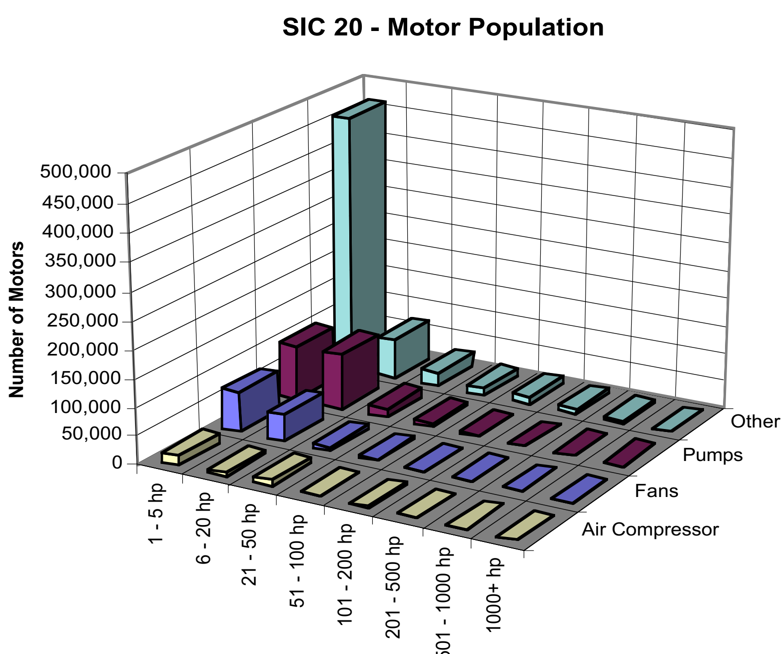


Figure A-2
Distribution of Motor Population SIC 20 by HP and Application



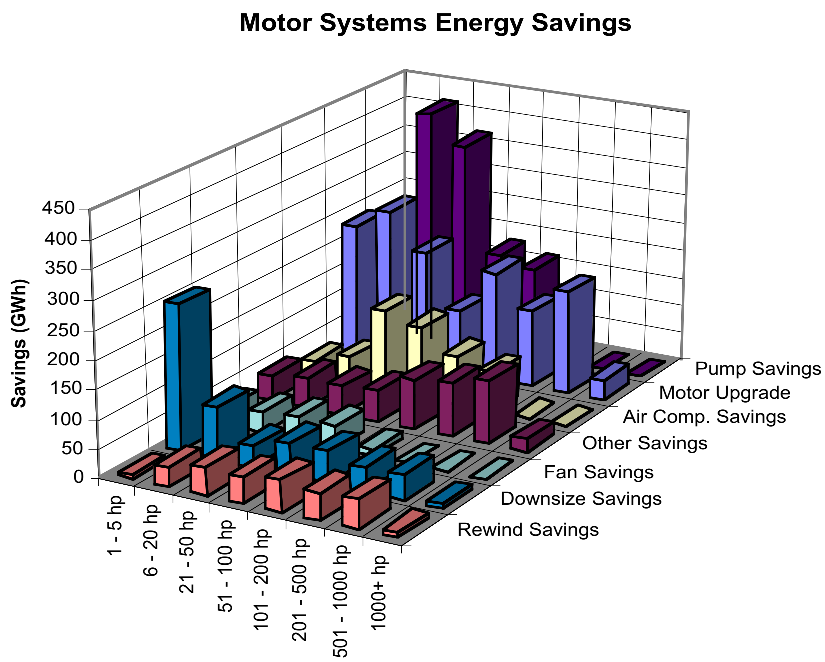
A.2.4 Motor System Savings Opportunities: Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Potential Motor System Savings (GWh/Year)	4,674	4,258	6
As a percent of motor energy use	12.4%	14.8%	14
Value of Motor Systems Savings ($ million/Year)	187	170	6
As a percent of operating income	0.4%	1.2%	10
Savings by Measure Type/Application (GWh/Year)			
Motor Efficiency Upgrades/EPAct levels	904	652	6
Motor Efficiency Upgrades/CEE levels + Large HP	1,376	990	6
Rewind improvements	295	239	6
Motor downsizing	585	339	4
Systems improvements: pumps	1,250	1,434	7
Systems improvements: fans	157	217	7
Systems improvements: air compressors	494	776	8
Systems Improvements: other systems	517	263	4

Motor Systems Energy Savings Overview

- Motor savings in SIC 20 is concentrated in improving smaller sized pumps and correctly sizing and upgrading motors.
- Although the impact of motor savings on operating income is relatively less in SIC 20, the improved profitability of efficiency improvements can represent a large competitive advantage in this industry.

Figure A-3
SIC 20: Distribution of Potential Motor Systems Energy Savings by Application and Motor Horsepower Class



A.2.5 Motor Systems Savings: Context and Selected Cases

Although the food sector consumes large aggregate amounts of electricity, this sector has received less energy R&D attention than other more energy intensive industries. However, there are numerous opportunities for large amounts of electricity savings from improved efficiency.

R&D efforts in the food industry are focused on other issues such as improving freshness, preservation, and safety. Collaborative R&D efforts have been limited. The overriding concern governing new investments is the assurance of product quality.

Table A-1 summarizes case studies of motor systems improvements in Food and Kindred Products industry facilities that produced documented energy savings.

Table A-1
Documented Systems-Level Savings from Projects in Food and Kindred Products Facilities

Measure Description	Annual Savings (MWh)	Simple Payback
Install adjustable speed drives and direct feedback control on vacuum pump motors.	142.5 (150 kWh/cow-year)	NA
Replace 150 hp motor with 75 hp motor and trim impeller.	490	Less than 1 Month
Retrofit fan with 250 hp ASD.	308.8	1.77 years.

Source: EPRI, DOE Motor Challenge Showcase Demonstration Project Summaries.

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A.3 SIC 26: PAPER AND ALLIED PRODUCTS

A.3.1 Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Establishments: 1994	5,582	12,348	
Value of Shipments: 1996	$461.3 Bil.	$186 Bil.	10
Number of Employees: 1996	630,600	866	13
Capital Intensity: Value of Fixed Assets/Employee	$243,502	$147,800	3
Capital Spending: 1996	8.4 Bil.	$5.6 Bil	6

Key Investment Decision Factors

- The 1990s have been a tumultuous decade for the paper industry. Prices, sales and profits have fluctuated widely and are currently on a downward trend. Sales declined 2.3 percent during 1997 compared to a 7.9 percent increase for all manufacturing industries. Return to stockholder equity was 3.9 percent compared to manufacturing average of 10.3 percent.
- Given the huge size, complexity, and high degree of integration among processes in pulp and paper mills, capital replacement cycles tend to be long, and few major changes are made to production facilities in the interim periods.

A.3.2 Energy Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Energy Costs ($ million/Year)	$7,587	$3,237	3
Per establishment ($,000)	$1,360	$260	3
As a percent of operating costs	5.4%	1.9%	3
Net Electricity Demand (GWh/Year)	121,835	45,892	3
Electric Costs ($ million)	$4,403	2,028	3
Percent of total energy costs	58%	63%	16
Percent of net electricity demand self-generated	39%	10%	1
Motor System Electric Use (GWh/Year)	99,350	27,060	2
As a percent of total electric use	82%	59%	1
Motor System Electric Costs ($ million/Year)	$3,590	$1,172	2
Per establishment ($,000)	$640	$90	2
As a percent of operating costs	2.6%	0.7%	1

Energy Overview

- The Paper and Allied Products industries rank very high on indices of the economic impact of motor system energy costs: first in motor system energy costs as a percent of operating costs; second (to Petroleum, SIC 29) in motor system energy costs per establishment; first in motor system energy use as a percent of total electric costs.
- Pulp and paper plants generate nearly half the electricity they use by burning byproducts of their processes. This reduces the average cost of electricity and reduces, to some extent, the economic benefits of projects to effect reductions in electric use and demand, compared to other industries.
- Three sub-industries: pulp mills, paper mills, and paperboard mills account for over 86 percent of the electrical energy used in SIC 26.

A.3.3 Motor Systems Inventory and Energy Use Details

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Integral HP Motors (Survey Estimate) 000s	652	622	10
Percent of motors that meet EPAct standards	15.3%	9.1%	4
Percent of motors with ASDs	5.5%	8.8%	7
Total Motor Systems Energy (Survey Estimate) GWh/Yr	99,594	28,771	2
Percent of energy under ASD control	4.8%	4.4%	6
Average part load	64%	62%	5
Percent of energy in fluid systems	61%	61%	7
Percent of energy in pump systems	31.4%	24.8%	3
Percent of energy in fan systems	19.8%	13.7%	6
Percent of energy in compressed air systems	4.6%	15.8%	17
Percent of energy in refrigeration systems	5.0%	6.7%	6
Percent of energy in motors > 200 HP	58.8%	44.9%	2
Percent of energy in DC motors	9.5%	9.71%	5

Motor Systems Inventory Overview

- A large percentage of motors in the pulp and paper industry are special purpose, designed to handle wide variations in speed and load.
- The saturation of EPAct compliant motors is relatively high in SIC 26; the saturation of ASDs is relatively low.
- As Figure A-4 shows, motor system energy in SIC 26 is concentrated in mid-size to large pump systems, large fan systems, and large motors which drive paper machines.

Figure A-4
Distribution of Motor System Energy by HP and Application

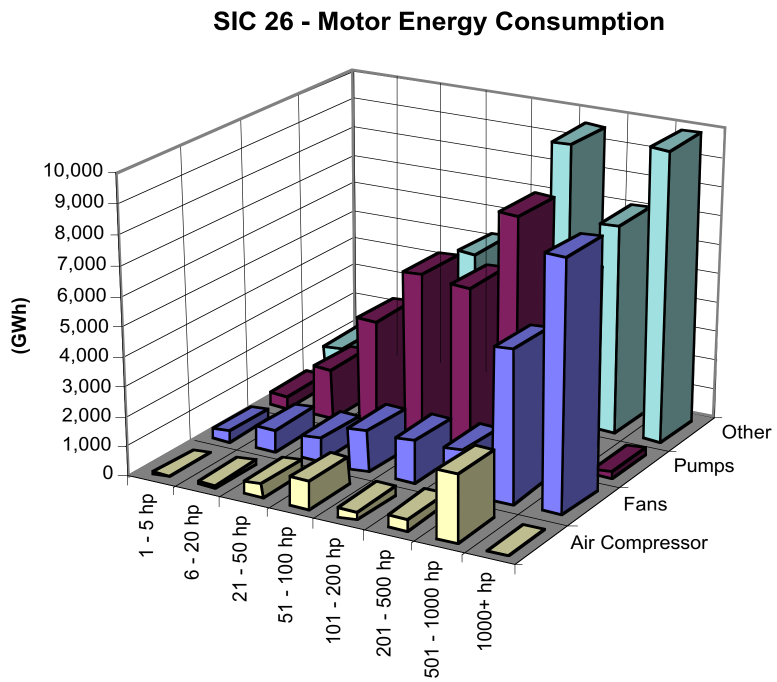
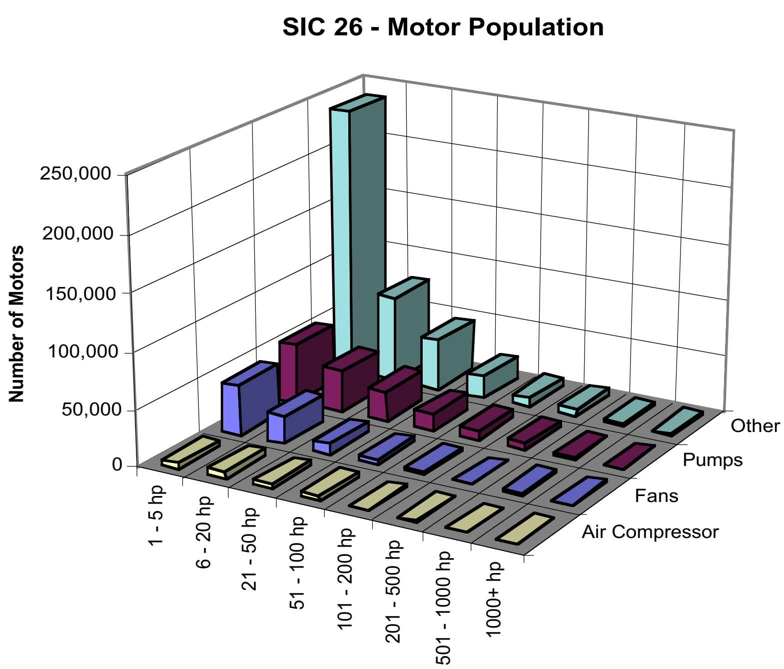


Figure A-5
Distribution of Motor Population by HP and Application



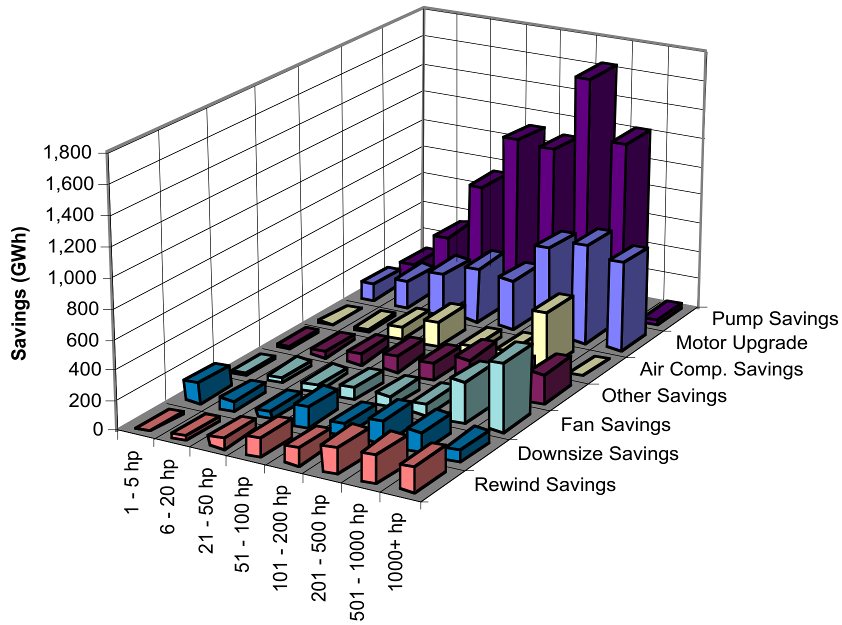
A.3.4 Motor System Savings Opportunities: Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Potential Motor System Savings (GWh/Year)	13,942	4,258	2
As a percent of motor energy use	14.0%	14.8%	10
Value of Motor Systems Savings ($ million/Year)	558	170	2
As a percent of operating income	3.8%	1.2%	2
Savings by Measure Type/Application (GWh/Year)			
Motor Efficiency Upgrades/EPAct levels	2,078	652	3
Motor Efficiency Upgrades/CEE levels + Large HP	3,197	990	3
Rewind improvements	870	239	2
Motor downsizing	845	339	3
Systems improvements: pumps	6,293	1,434	2
Systems improvements: fans	1,082	217	1
Systems improvements: air compressors	773	776	6
Systems Improvements: other systems	881	263	3

Motor Systems Energy Savings Overview

- Industry observers report that the greatest opportunities for motor systems savings lie in pump systems, particularly substituting speed control for throttling and by-pass valve control mechanisms. This observation is confirmed by the inventory findings. See Figure A-6.
- Savings from motor efficiency upgrades (as a percent of total motor systems energy) are relatively low due to the high percentage of total energy associated with larger motors.
- SIC 26 ranks very high among manufacturing industries in terms of the overall value of potential motor system energy savings and potential energy savings as a percent of operating income.

Figure A-6
SIC 26: Distribution of Potential Motor Systems Energy Savings by Application and Motor Horsepower Class



A.3.5 Motor Systems Savings: Context and Selected Cases

Energy use in the pulp and paper industry has been studied extensively over the past decade.[1] The trends identified in this work include the following:

- Primary energy use per air-dry metric tonne of energy decreased by 17 percent between 1972 and 1993. (Nilsson et al. 1995)
- This decrease in energy use has been driven by a number of technological changes, including accelerated adoption of thermal integration processes, increased use of bio-mass-based cogeneration, and substitution of electric motor energy for thermal energy in the pulping process. (Herzog and Tester 1990)
- Despite these advances, the U.S. paper industry remains considerably more energy intensive than its European and Asian competitors.
- Enormous opportunities are available to increase the efficiency of motor systems, particularly pumps and paper machines, through the use of ASDs, as well as other system improvements. (Giese 1998)

[1] See Nilsson et al. (1995), Giese et al. (1991), and Herzog and Tester (1990) for general overviews.

Table A-2 summarizes a number of case reports of motor systems improvements in pulp and paper mills that produced documented energy savings. These results suggest the magnitude of systems-level savings available in SIC 26.

Table A-2
Documented Systems-Level Savings from Projects in Pulp and Paper Mills

Measure Description	Connected HP	Annual Savings (kWh)	Annual Savings as % of pre-retrofit system energy
Install ASD on boiler feedwater pump	150	142,321	26%
Install ASD on boiler forced draft fan	25	3,488	70%
Install ASD on whitewater pump, downsize motor	50	133,579	69%
Replacement of two older refiners with combined 450 connected HP with one refiner @ 400 HP.	450	1,280,429	62%

Source: Englander et al. 1996.

A.4 SIC 28: CHEMICALS AND ALLIED PRODUCTS

A.4.1 Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Establishments: 1994	9,565	12,348	11
Value of Shipments: 1996	$367 Bil.	$186 Bil.	4
Number of Employees: 1996	824	866	9
Capital Intensity: Value of Fixed Assets/Employee	$353,055	$147,800	2
Capital Spending: 1996	$16.9 Bil.	$5.6 Bil	1

Key Investment Decision Factors

- The U.S. Chemicals industry is the world leader, and is an extremely complex and diverse industry.
- Research by firms is highly proprietary, and seldom shared.
- The U.S. Chemicals industry has devoted a significant portion of capital spending on pollution abatement, primarily related to Clear Air Act compliance.

A.4.2 Energy Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Energy Costs ($ million/Year)	$11,483	$3,237	1
Per establishment ($,000)	$1,200	$260	4
As a percent of operating costs	3.3%	1.9%	5
Net Electricity Demand (GWh/Year)	199,284	45,892	1
Electric Costs ($ million)	$6,463	2,028	1
Percent of total energy costs	56%	63%	18
Percent of net electricity demand self-generated	13%	10%	3
Motor System Electric Use (GWh/Year)	135,518	27,060	1
As a percent of total electric use	68.0%	59%	5
Motor System Electric Costs ($ million/Year)	$4,395	$1,172	1
Per establishment ($,000)	$460	$90	3
As a percent of operating costs	1.2%	0.7%	5

Energy Overview

- The chemical industry ranks among the top of all manufacturing industries in terms of the economic impact of energy costs: first in total energy costs, first in net electricity demand, first in motor system electric use, and fifth in motor system costs as a percentage of operating costs.
- Three SIC 28 subgroups: industrial inorganic chemicals, industrial organic chemicals, and plastic materials and synthetics (SIC 281, 282, & 286) consume over 84 percent of total sector electricity use.
- The majority of motor electricity use in chemical industries is by pumps and compressors to overcome friction in piping systems.

A.4.3 Motor Systems Inventory and Energy Use Details

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Integral HP Motors (Survey Estimate) 000s	1,049	622	2
Percent of motors that meet EPAct standards	14.4%	9.1%	5
Percent of motors with ASDs	12.5%	8.8%	5
Total Motor Systems Energy (Survey Estimate) GWh/Yr	144,362	28,771	1
Percent of energy under ASD control	2.3%	4.4%	8
Average part load	65%	62%	4
Percent of energy in fluid systems	73%	61%	5
Percent of energy in pump systems	26.0%	24.8%	4
Percent of energy in fan systems	11.9%	13.7%	11
Percent of energy in compressed air systems	27.7%	15.8%	2
Percent of energy in refrigeration systems	7.7%	6.7%	5
Percent of energy in motors > 200 HP	59.3%	44.9%	1
Percent of energy in DC motors	3.8%	9.71%	8

Motor Systems Inventory Overview

- The saturation of EPAct compliant motors is very high in SIC 28, while the use of motors with ASDs is relatively low.
- As Figure A-7 shows, motor energy use is highest in large compressed air systems.

Figure A-7
Distribution of Motor System Energy for SIC 28 by HP and Application

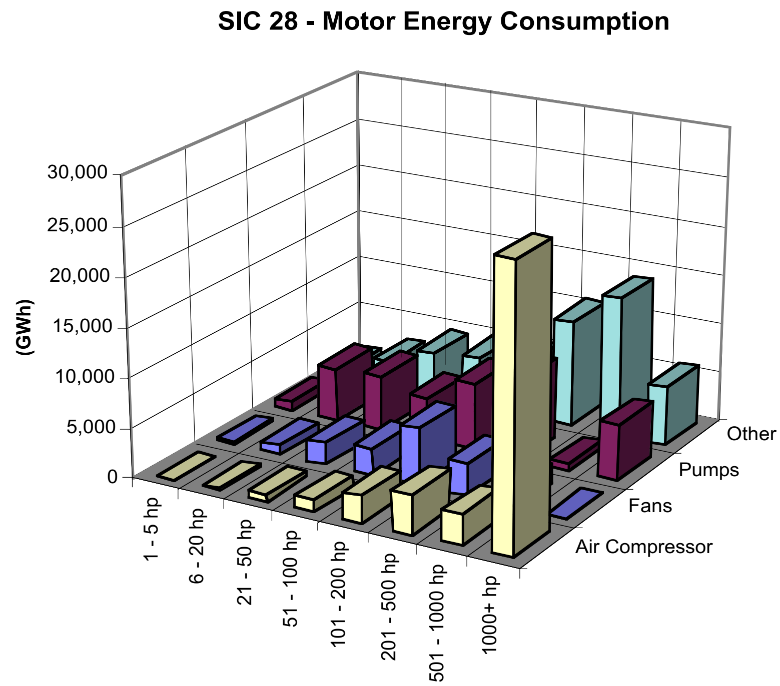
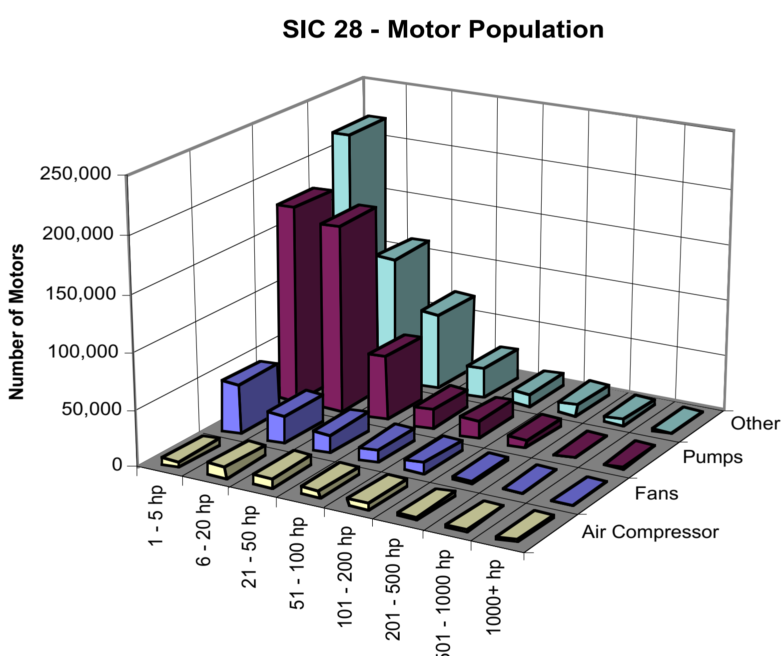


Figure A-8
Distribution of Motor Population by HP and Application



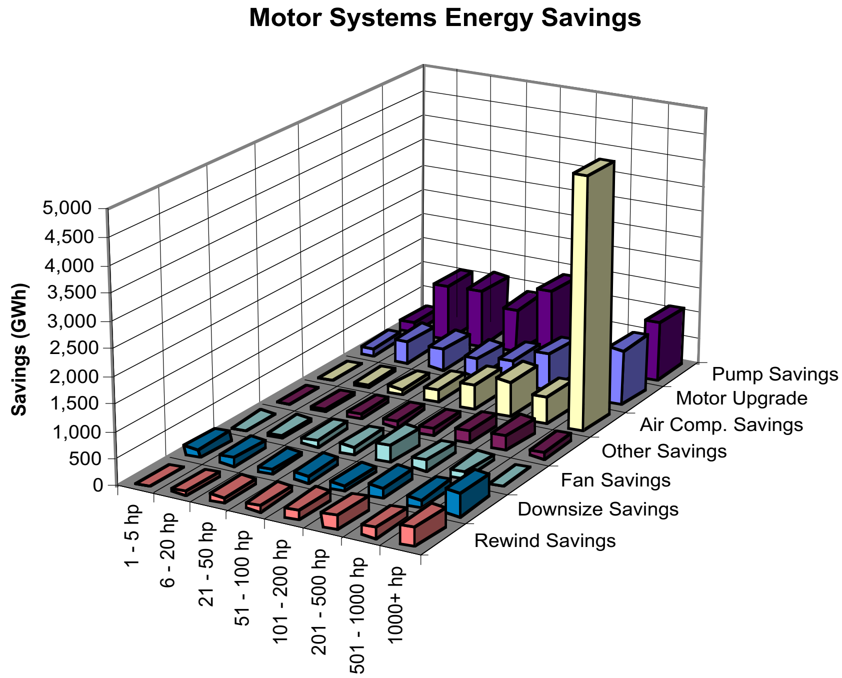
A.4.4 Motor System Savings Opportunities: Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Potential Motor System Savings (GWh/Year)	23,188	4,258	1
As a percent of motor energy use	16.1%	14.8%	3
Value of Motor Systems Savings ($ million/Year)	928	170	1
As a percent of operating income	2.0%	1.2%	5
Savings by Measure Type/Application (GWh/Year)			
Motor Efficiency Upgrades/EPAct levels	2,720	652	1
Motor Efficiency Upgrades/CEE levels + Large HP	4,219	990	1
Rewind improvements	1,255	239	1
Motor downsizing	1,409	339	1
Systems improvements: pumps	7,556	1,434	1
Systems improvements: fans	942	217	2
Systems improvements: air compressors	6,813	776	1
Systems Improvements: other systems	994	263	2

Motor Systems Energy Savings Overview

- As Figure A-9 shows, the greatest potential for energy savings in SIC 28 is in pumps and compressor systems due to the high use of pumps and the high energy consumption of compressors.
- SIC 28 ranks extremely high in the potential dollar savings that can be realized by improving motor efficiency.

Figure A-9
SIC 28: Distribution of Potential Motor Systems Energy Savings by Application and Motor Horsepower Class



A.4.5 Motor Systems Savings: Context and Selected Cases

Significant amounts of energy use in the chemicals industry can be saved through the use of high efficiency motors.

Table A-3 presents a number of documented case reports of motor systems improvements in the chemicals industry. They are indicative of the types of savings opportunities available in SIC 28.

Table A-3
Documented Systems-Level Savings from Projects in Chemical and Allied Product Facilities

Measure Description	Annual Savings (MWh)	Simple Payback
Install 3 energy-efficient motors and 1 VFD.	NA	Less than one year
Install energy-efficient 50 HP motor and 1 VFD.	NA	1.9 years
Install VFD and energy-efficient motors.	190	1.4 years

Source: DOE Motor Challenge Showcase Demonstration Project Summaries.

References:

EPRI, "Potential for the Increased Efficiency in Motors in the Chemical and Processing Industries," EPRI TR-106655, August 1996.

A.5 SIC 29: PETROLEUM AND COAL PRODUCTS

A.5.1 Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Establishments: 1994	1,971	12,348	18
Value of Shipments: 1996	$174 Bil.	$186 Bil.	9
Number of Employees: 1996	106	866	18
Capital Intensity: Value of Fixed Assets/Employee	2,991,689	$147,800	1
Capital Spending: 1996	$4.8 Bil	$5.6 Bil	11

Key Investment Decision Factors

- Petroleum and Coal Products industries are extremely capital-intensive.
- The U.S. refining industry (SIC 291) is the third largest in the world, accounting for 21 percent of global refining capacity.
- Increases in environmental costs combined with declining quality of crude oil imports led to increased investment requirements per unit of refined product.

A.5.2 Energy Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Energy Costs ($ million/Year)	$4,422	$3,237	5
Per establishment ($,000)	$2,240	$260	1
As a percent of operating costs	1.5%	1.9%	10
Net Electricity Demand (GWh/Year)	49,990	45,892	5
Electric Costs ($ million)	1,946	2,028	10
Percent of total energy costs	44%	63%	20
Percent of net electricity demand self-generated	23%	10%	2
Motor System Electric Use (GWh/Year)	42,658	27,060	5
As a percent of total electric use	85.3%	59%	1
Motor System Electric Costs ($ million/Year)	$1,660	$1,172	4
Per establishment ($,000)	$840	$90	1
As a percent of operating costs	.6%	0.7%	9

Energy Overview

- Petroleum and Coal Products industries rank very high on indices of the economic impact of energy costs, particularly in terms of electric motor use per establishment: first in energy costs per establishment, first in motor systems electric use as a percentage of total electric use, and first in motor system energy costs per establishment.
- Over 84 percent of total sector electrical consumption was by SIC subgroup 291: Petroleum Refining, which uses over 44300 BTU/$ value of shipments.[2]

[2] T. Kaarsberg & T. Foust, "External Research and Energy Efficiency in the Process Industries," ACEEE Summer Study on Energy Efficiency in Industry, 1997.

A.5.3 Motor Systems Inventory and Energy Use Details

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Integral HP Motors (Survey Estimate) 000s	834	622	6
Percent of motors that meet EPAct standards	7.5%	9.1%	8
Percent of motors with ASDs	4.8%	8.8%	9
Total Motor Systems Energy (Survey Estimate) GWh/Yr	51,938	28,771	4
Percent of energy under ASD control	0.8%	4.4%	13
Average part load	59%	62%	11
Percent of energy in fluid systems	84%	61%	3
Percent of energy in pump systems	59.0%	24.8%	1
Percent of energy in fan systems	9.5%	13.7%	12
Percent of energy in compressed air systems	15.3%	15.8%	8
Percent of energy in refrigeration systems	0.7%	6.7%	9
Percent of energy in motors > 200 HP	54.6%	44.9%	4
Percent of energy in DC motors	0.26%	9.71%	15

Motor System Inventory Overview

- The largest use of energy in SIC 29 used to drive pumping systems.
- This sector has a higher reliance on large (> 200) hp motors.
- The penetration rates for EPAct compliant and ASD motors are moderate, but the amount of energy used by motors with ASDs is low.

Figure A-10
Distribution of Motor System Energy for SIC 29 by HP and Application

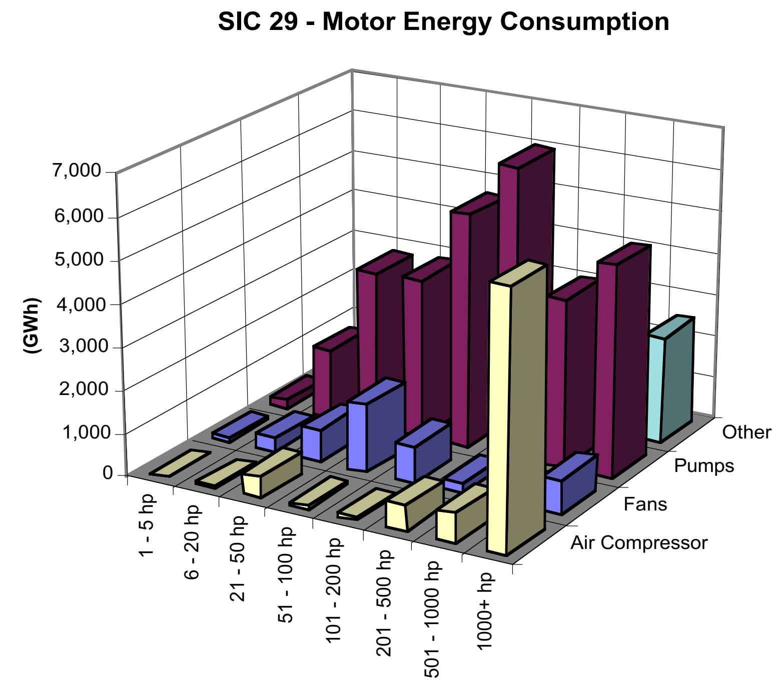
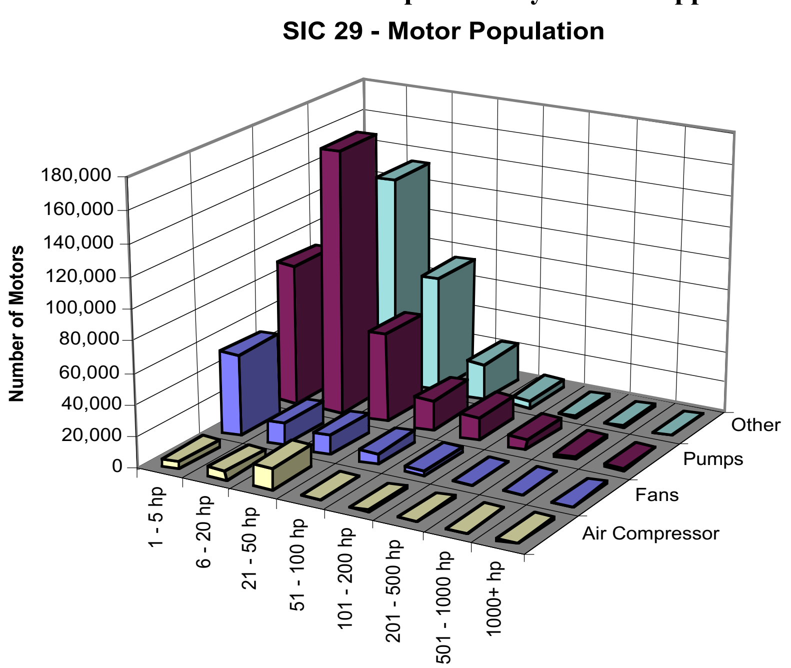


Figure A-11
Distribution of Motor Population by HP and Application



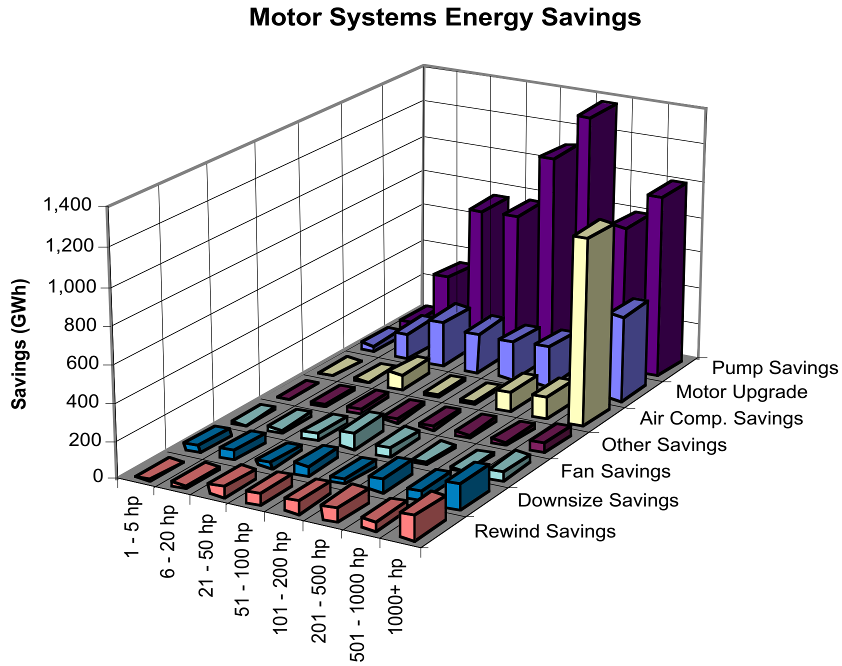
A.5.4 Motor System Savings Opportunities: Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Potential Motor System Savings (GWh/Year)	10,599	4,258	3
As a percent of motor energy use	20.4%	14.8%	2
Value of Motor Systems Savings ($ million/Year)	424	170	3
As a percent of operating income	1.8%	1.2%	6
Savings by Measure Type/Application (GWh/Year)			
Motor Efficiency Upgrades/EPAct levels	1,137	652	4
Motor Efficiency Upgrades/CEE levels + Large HP	1,736	990	4
Rewind improvements	453	239	4
Motor downsizing	459	339	5
Systems improvements: pumps	6,159	1,434	3
Systems improvements: fans	271	217	5
Systems improvements: air compressors	1,352	776	3
Systems Improvements: other systems	169	263	8

Motor Systems Energy Savings Overview

- The largest amount of motor savings is in improving the efficiency of pump systems.
- Improvements to larger motors can yield significant savings for SIC 29, as is shown in Figure A-12.
- There exists large potential electricity and cost savings in this sector.

Figure A-12
SIC 29: Distribution of Potential Motor Systems Energy Savings by Application and Motor Horsepower Class



A.5.5 Motor Systems Savings: Context and Selected Cases

Energy use in SIC 29 is concentrated in the refining subsector. Over 60 percent of the energy in refineries is obtained from burning gaseous fuels in refinery heaters.[3]

Significant savings have and can be realized by utilizing the best available technologies.

Table A-4 presents documented case reports of motor systems improvements in Petroleum and Coal Products facilities.

[3] T. Kaarsberg & T. Foust, "External Research and Energy Efficiency in the Process Industries," *ACEEE Summer Study on Energy Efficiency in Industry*, 1997.

Table A-4
Documented Systems-Level Savings from Projects in Petroleum and Coal Products Facilities

Measure Description	Annual Savings (MWh)	Simple Payback
Install VFDs and efficient motors.	NA	3.7 years
Motor downsizing and electronic modifications.	54.3	6.5 months
Install new pump with ASD.	141	1.15 years[4]

Source: DOE Motor Challenge Showcase Demonstration Project Summaries, Case Study, EPRI Innovators.

[4] Includes non-energy benefits.

A.6 SIC 33: PRIMARY METALS

A.6.1 Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Establishments: 1994	5,171	12,348	16
Value of Shipments: 1996	$178 Bil.	$186 Bil.	8
Number of Employees: 1996	688	866	12
Capital Intensity: Value of Fixed Assets/Employee	$141,792	$147,800	5
Capital Spending: 1996	$6.3 Bil.	$5.6 Bil	7

Key Investment Decision Factors

- The Primary Metals industry is a mature industry with very high pressure from international competition on U.S. companies to reduce costs.
- The U.S. Iron and Steel industry subgroups have made significant improvements in the past decade, and are now one of the lowest-cost producers in the world.
- The industry continues to direct R&D spending on developing new technologies to reduce costs.

A.6.2 Energy Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Energy Costs ($ million/Year)	$8,381	$3,237	2
Per establishment ($,000)	$1,620	$260	2
As a percent of operating costs	6.4%	1.9%	1
Net Electricity Demand (GWh/Year)	152,740	45,892	2
Electric Costs ($ million)	5,196	2,028	2
Percent of total energy costs	62%	63%	14
Percent of net electricity demand self-generated	4%	10%	5
Motor System Electric Use (GWh/Year)	46,093	27,060	4
As a percent of total electric use	30%	59%	20
Motor System Electric Costs ($ million/Year)	$1,568	$1,172	5
Per establishment ($,000)	$300	$90	5
As a percent of operating costs	1.2%	0.7%	7

Energy Overview

- The Primary Metals industries rank very high on indices of the economic impact of energy costs: first in energy costs as a percent of operating costs, fourth in total motor systems electric use, and seventh in motor system energy costs as a percent of operating costs.
- The majority of sector energy is consumed by two industry subgroups: Blast Furnaces and Steel Mills (SIC 3312) and Primary Aluminum Production (SIC 3334).

A.6.3 Motor Systems Inventory and Energy Use Details

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Number of Integral HP Motors (Survey Estimate) 000s	1,001	622	3
Percent of motors that meet EPAct standards	2.5%	9.1%	11
Percent of motors with ASDs	3.5%	8.8%	10
Total Motor Systems Energy (Survey Estimate) GWh/Yr	87,935	28,771	3
Percent of energy under ASD control	6.0%	4.4%	5
Average part load	57%	62%	16
Percent of energy in fluid systems	38%	61%	15
Percent of energy in pump systems	8.7%	24.8%	12
Percent of energy in fan systems	15.3%	13.7%	9
Percent of energy in compressed air systems	14.3%	15.8%	9
Percent of energy in refrigeration systems	0.1%	6.7%	12
Percent of energy in motors > 200 HP	57.6%	44.9%	3
Percent of energy in DC motors	31.6%	9.71%	2

Motor Systems Inventory Overview

- The penetration rates of EPAct compliant and ASD motors are relatively low.
- The use of motors greater than 200 HP is very high.
- The use of DC motors is very high in SIC 33.

Figure A-13
Distribution of Motor System Energy by HP and Application

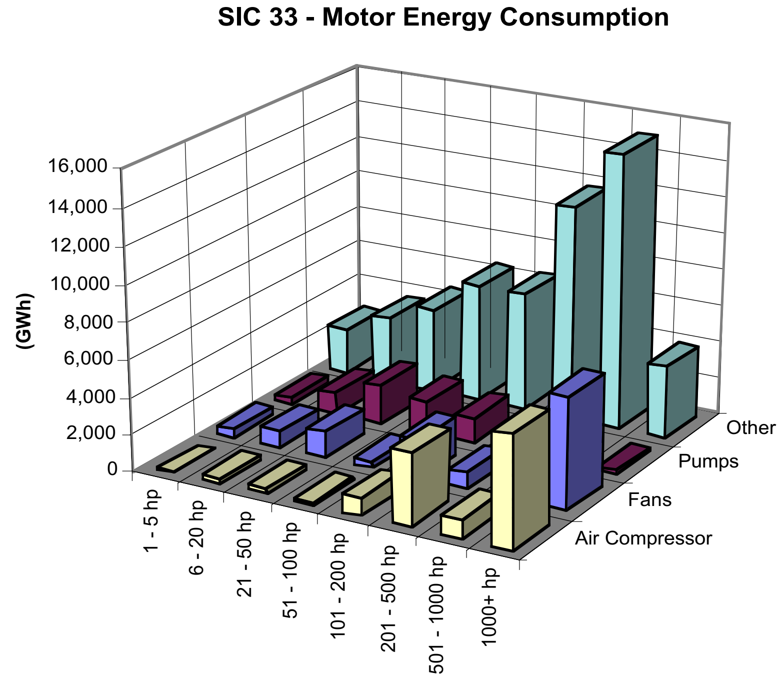
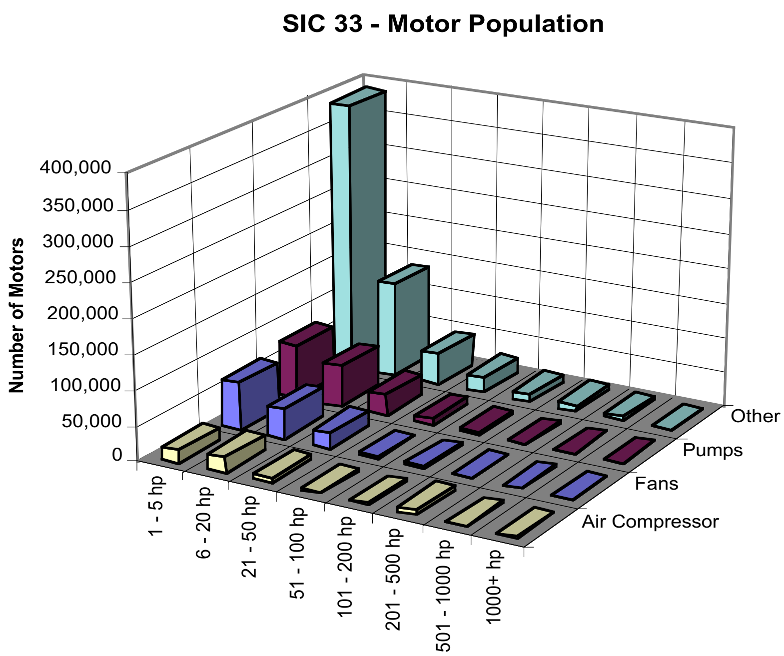


Figure A-14
Distribution of Motor Population by HP and Application



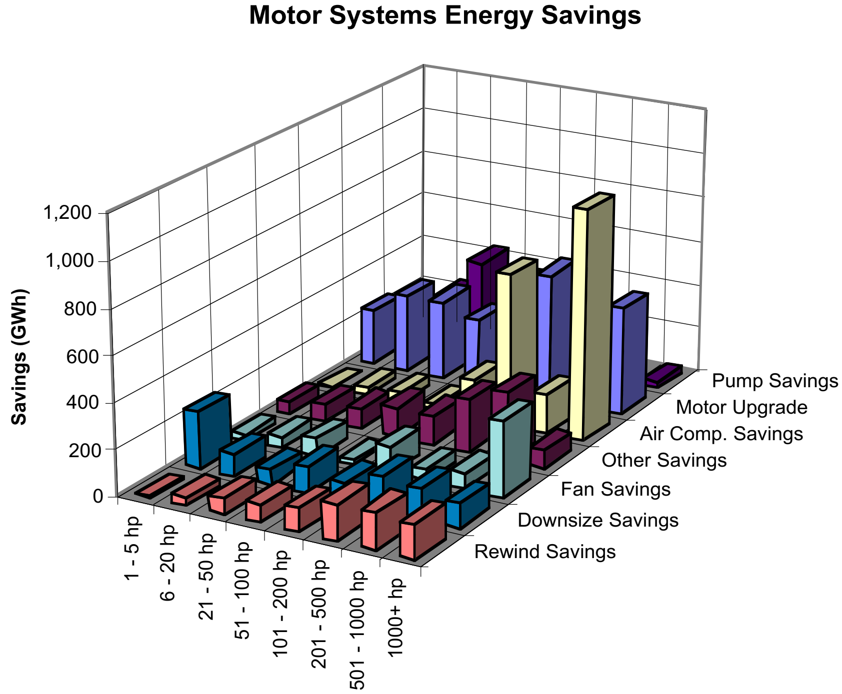
A.6.4 Motor System Savings Opportunities: Industry Overview

		Manufacturing Average	Rank Among 2-digit Manu. SICs
Total Potential Motor System Savings (GWh/Year)	10,441	4,258	4
As a percent of motor energy use	11.9%	14.8%	16
Value of Motor Systems Savings ($ million/Year)	418	170	4
As a percent of operating income	5.1%	1.2%	1
Savings by Measure Type/Application (GWh/Year)			
Motor Efficiency Upgrades/EPAct levels	2,104	652	2
Motor Efficiency Upgrades/CEE levels + Large HP	3,199	990	2
Rewind improvements	749	239	3
Motor downsizing	983	339	2
Systems improvements: pumps	1,537	1,434	6
Systems improvements: fans	738	217	3
Systems improvements: air compressors	2,150	776	2
Systems Improvements: other systems	1,085	263	1

Motor Systems Energy Savings Overview

- Electricity savings from efficient motors can yield the highest percentage of operating cost savings for SIC 33.
- The largest amount of savings can be realized from upgrading motors to EPAct and CEE efficiency levels.

Figure A-15
SIC 33: Distribution of Potential Motor Systems Energy Savings by Application and Motor Horsepower Class



A.6.5 Motor Systems Savings: Context and Selected Cases

Energy use in the Primary Metals industry has been studied extensively due to the high degree of energy intensity.[5] The iron and steel industries alone consume approximately 8 percent of total manufacturing energy consumption. Significant savings have and can be realized by utilizing the best available technologies.

- U.S. steel energy intensity has decreased 17 percent, 11 percent is due to efficiency improvements. (Worrell and Moore)
- Despite the improvements in the 1980's, the potential of U.S. improvements in energy efficiency is higher than in other OECD countries. (Worrell and Moore)

Table A-5 summarizes a number of case reports of motor systems improvements in Primary Metals facilities that produced documented energy savings. These results are indicative of the large amount of cost-effective, systems-level savings available in SIC 33.

[5] See Worrell and Moore (1996).

Table A-5
Documented Systems-Level Savings from Projects in Primary Metals Facilities

Measure Description	Annual Savings (MWh)	Simple Payback
Install variable frequency drive and other equipment modifications to induced draft fans.	15,500	2.3 years
Install variable inlet vane controls on fans in pot line dust collection systems.	3,346	immediate
Install energy efficient motor with vector control.	149	5 months
Install variable frequency drives in ventilation system.	443	1.5 years

Source: DOE Motor Challenge Showcase Demonstration Case Studies.

A.7 SELECTED NON-MANUFACTURING INDUSTRIES

The following section presents data collected from surveys of 11 non-manufacturing facilities, grouped by industry. The data does not provide a representative sample of the selected industries.

Information is presented for the following industries:

- Agriculture
- Mining
- Oil and Gas Extraction
- Water

A.7.1 SICs 01 and 02: Agriculture

The agricultural production sectors include dairy and animal farms. Most motor use is for irrigation, water pumping, and material handling and processing.

The following data was gathered from surveying two SIC 01 and 02 facilities:

Table A-6

SICs 01 and 02: Motor Energy Uses by HP

Size Category	Fan Energy (MWh)	Pump Energy (MWh)	Air Compressor (MWh)	Other Energy (MWh)	Total Energy (MWh)
1 - 5 hp		1		11	12
6 - 20 hp				34	34
21 - 50 hp				140	140
51 - 100 hp					0
101 - 200 hp					0
201 - 500 hp					0
501 – 1000 hp					0
1000+ hp					0
All Motor Sizes	0	1	0	185	186
% of total energy	0.0%	0.6%	0.0%	99.4%	

Table A-7

SICs 01 and 02: Percent Energy by HP

Size Category	Fan Energy	Pump Energy	Air Compressor	Other Energy	Percent of Total Energy
1 – 5 hp		1%		6%	7%
6 – 20 hp				18%	18%
21 - 50 hp				75%	75%
51 - 100 hp					
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes		1%		99%	100%

Table A-8

SICs 01 and 02: Motor Inventory

Size Category	Number of Motors				
	Fans	Pumps	Air Compressor	Other	Total
1 – 5 hp		1		10	11
6 – 20 hp				4	4
21 - 50 hp				4	4
51 - 100 hp					0
101 - 200 hp					0
201 - 500 hp					0
501 - 1000 hp					0
1000+ hp					0
All Motor Sizes	0	1	0	18	19

Table A-9

SICs 01 and 02: Motor Savings

Size Category	System Efficiency Measure Savings (MWH/Year)					Motor Eff. Upgrades			
	Fan Systems	Pump Systems	Comp. Air Systems	Other Process Sys.	Downsize Motors	Efficient Replace-ment	Improved Rewinds	Total Savings (MWh)	Total Savings (%)
1 - 5 hp	0	0	0	0	1	1	0	3	20.6%
6 - 20 hp	0	0	0	1	1	2	0	4	11.6%
21 - 50 hp	0	0	0	3	2	7	1	12	8.9%
51 - 100 hp	0	0	0	0	0	0	0	0	
101 - 200 hp	0	0	0	0	0	0	0	0	
201 - 500 hp	0	0	0	0	0	0	0	0	
501 - 1000 hp	0	0	0	0	0	0	0	0	
1000+ hp	0	0	0	0	0	0	0	0	
All Motor Sizes	0	0	0	4	3	10	1	19	10.2%

A.7.2 SICs 10, 11, 12, and 14: Mining

The mining industries are primarily engaged in the mining of metal ores and industrial minerals. Major energy end uses include drilling, pumping, and material handling and processing.

The following data was gathered from surveys of four mining establishments.

Table A-10

SICs 10, 11, 12, and 14: Motor Energy Uses by HP

Size Category	Fan Energy (MWh)	Pump Energy (MWh)	Air Compressor (MWh)	Other Energy (MWh)	Total Energy (MWh)
1 - 5 hp	43	79	6	608	737
6 - 20 hp	198	174	10	3,951	4,333
21 - 50 hp	775	1,845		5,046	7,666
51 - 100 hp	302	1,913	2,367	6,941	11,523
101 - 200 hp	1,470	625	605	5,838	8,538
201 - 500 hp	2,557	8,877		18,929	30,363
501 - 1000 hp	25	2,591		2,026	4,641
1000+ hp					0
All Motor Sizes	5,369	16,105	2,988	43,339	67,801
% of total energy	7.9%	23.8%	4.4%	63.9%	

Table A-11

SICs 10, 11, 12, and 14: Percent of Energy by HP

Size Category	Fan Energy	Pump Energy	Compressor	Other Energy	Total Energy
1 - 5 hp	0.1%	0.1%	0.0%	0.9%	1.1%
6 - 20 hp	0.3%	0.3%	0.0%	5.8%	6.4%
21 - 50 hp	1.1%	2.7%	0.0%	7.4%	11.3%
51 - 100 hp	0.4%	2.8%	3.5%	10.2%	17.0%
101 - 200 hp	2.2%	0.9%	0.9%	8.6%	12.6%
201 - 500 hp	3.8%	13.1%	0.0%	27.9%	44.8%
501 - 1000 hp	0.0%	3.8%	0.0%	3.0%	6.8%
1000+ hp	0.0%	0.0%	0.0%	0.0%	0.0%
All Motor Sizes	7.9%	23.8%	4.4%	63.9%	100.0%

Table A-12

SICs 10, 11, 12, and 14: Motor Inventory

Size Category	Number of Motors				
	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	6	27	2	80	115
6 - 20 hp	15	12	2	134	164
21 - 50 hp	12	27		105	144
51 - 100 hp	4	20	13	59	97
101 - 200 hp	4	4	2	24	33
201 - 500 hp	4	12		37	52
501 - 1000 hp	1	2		2	5
1000+ hp					0
All Motor Sizes	*46*	*103*	*18*	*442*	*609*

Table A-13

SICs 10, 11, 12, and 14: Motor Savings

Size Category	System Efficiency Measure Savings (MWH/Year)					Motor Eff. Upgrades			
	Fan Systems	Pump Systems	Comp. Air Systems	Other Process Sys.	Downsize Motors	Efficient Replace-ment	Improved Rewinds	Total Savings (MWh)	Total Savings (%)
1 - 5 hp	2	16	1	12	54	43	1	130	17.6%
6 - 20 hp	11	35	2	79	88	216	26	457	10.5%
21 - 50 hp	43	371	0	101	65	334	62	976	12.7%
51 - 100 hp	17	385	404	139	125	299	104	1,472	12.8%
101 - 200 hp	81	126	103	117	73	240	78	817	9.6%
201 - 500 hp	141	1,784	0	379	226	1,001	276	3,806	12.5%
501 - 1000 hp	1	521	0	41	39	153	42	797	17.2%
1000+ hp	0	0	0	0	0	0	0	0	
All Motor Sizes	295	3,237	509	867	670	2,286	590	8,455	12.5%

A.7.3 SIC 13: Oil and Gas Extraction

This industry includes businesses engaged in the production of crude petroleum and natural gas. The primary uses of electricity are drilling and pumping.

The following information was gathered from surveying a SIC 13 facility.

Table A-14

SIC 13: Energy by HP

Size Category	Fan Energy (MWh)	Pump Energy (MWh)	Air Compressor (MWh)	Other Energy (MWh)	Total Energy (MWh)
1 - 5 hp		88,049	1		88,050
6 - 20 hp		337,365			337,365
21 - 50 hp		281,588			281,588
51 - 100 hp					0
101 - 200 hp		68,688			68,688
201 - 500 hp		103,032			103,032
501 – 1000 hp		322,834			322,834
1000+ hp					0
All Motor Sizes	0	1,201,556	1	0	1,201,557
% of total energy	0.0%	100.0%	0.0%	0.0%	

Table A-15

SIC 13: Percent Energy by HP

Size Category	Fan Energy	Pump Energy	Compressor	Other Energy	Percent of Total Energy
1 – 5 hp		7.3%	0.0%		7.3%
6 – 20 hp		28.1%			28.1%
21 - 50 hp		23.4%			23.4%
51 - 100 hp		0.0%			0.0%
101 - 200 hp		5.7%			5.7%
201 - 500 hp		8.6%			8.6%
501 - 1000 hp		26.9%			26.9%
1000+ hp		0.0%			0.0%
All Motor Sizes		100.0%	0.0%		100.0%

Table A-16

SIC 13: Motor Inventory

Size Category	Fans	Pumps	Air Compressor	Other	Total
	Number of Motors				
1 – 5 hp		2,852	1		2,853
6 – 20 hp		4,904			4,904
21 - 50 hp		1,300			1,300
51 - 100 hp					
101 - 200 hp		60			60
201 - 500 hp		80			80
501 - 1000 hp		200			200
1000+ hp					
All Motor Sizes	0	*9,396*	1	0	*9,397*

Table A-17

SIC 13: Motor Savings

Size Category	System Efficiency Measure Savings (MWH/Year)				Motor Eff. Upgrades				
	Fan Systems	Pump Systems	Comp. Air Systems	Other Process Sys.	Downsize Motors	Efficient Replace-ment	Improved Rewinds	Total Savings (MWh)	Total Savings (%)
1 - 5 hp	0	17,698	0	0	5,590	5,641	176	29,105	33.1%
6 - 20 hp	0	67,810	0	0	5,253	19,793	2,058	94,914	28.1%
21 - 50 hp	0	56,599	0	0	603	12,563	2,281	72,045	25.6%
51 - 100 hp	0	0	0	0	0	0	0	0	
101 - 200 hp	0	13,806	0	0	227	2,263	625	16,922	24.6%
201 - 500 hp	0	20,709	0	0	926	3,395	938	25,969	25.2%
501 - 1000 hp	0	64,890	0	0	2,903	10,638	2,938	81,368	25.2%
1000+ hp	0	0	0	0	0	0	0	0	
All Motor Sizes	0	241,513	0	0	15,503	54,293	9,015	320,324	26.7%

A.7.4 SIC 49: Water Supply/Irrigation

The primary function of this industry is the transport of water. Electricity is the largest energy source used by this industry, primarily for pumping.

The following information was gathered from surveying 4 SIC 49 facilities.

Table A-18

SIC 49: Energy by HP

Size Category	Fan Energy (MWh)	Pump Energy (MWh)	Compressor (MWh)	Other Energy (MWh)	Total Energy (MWh)
1 – 5 hp		1,059	0	839	1,898
6 - 20 hp	319	2,537	67	991	3,914
21 - 50 hp	271	12,062		585	12,918
51 - 100 hp		23,258	790	4,179	28,227
101 - 200 hp	1,993	7,478		787	10,258
201 - 500 hp	13,255	32,141		8,163	53,558
501 - 1000 hp		22,800			22,800
1000+ hp			86,594		86,594
All Motor Sizes	15,838	101,334	87,451	15,548	220,171
% of total energy	7.2%	46.0%	39.7%	7.1%	

Table A-19

SIC 49: Percent Energy by HP

Size Category	Fan Energy	Pump Energy	Air Compressor Energy	Other Energy	Percent of Total Energy
1 – 5 hp	0.0%	0.5%	0.0%	0.4%	0.9%
6 – 20 hp	0.1%	1.2%	0.0%	0.5%	1.8%
21 - 50 hp	0.1%	5.5%	0.0%	0.3%	5.9%
51 - 100 hp	0.0%	10.6%	0.4%	1.9%	12.8%
101 - 200 hp	0.9%	3.4%	0.0%	0.4%	4.7%
201 - 500 hp	6.0%	14.6%	0.0%	3.7%	24.3%
501 - 1000 hp	0.0%	10.4%	0.0%	0.0%	10.4%
1000+ hp	0.0%	0.0%	39.3%	0.0%	39.3%
All Motor Sizes	7.2%	46.0%	39.7%	7.1%	100.0%

Table A-20

SIC 49: Motor Inventory

	Number of Motors				
Size Category	**Fans**	**Pumps**	**Air Compressor**	**Other**	**Total**
1 – 5 hp		73	1	83	157
6 – 20 hp	7	57	1	18	84
21 - 50 hp	4	183		5	192
51 - 100 hp		138	3	13	154
101 - 200 hp	3	25		4	32
201 - 500 hp	6	52		9	68
501 - 1000 hp		24			24
1000+ hp			11		11
All Motor Sizes	*20*	*553*	*16*	*133*	*722*

Table A-21

SIC 49: Motor Savings

	System Efficiency Measure Savings (MWH/Year)					Motor Eff. Upgrades			
Size Category	**Fan Systems**	**Pump Systems**	**Comp. Air Systems**	**Other Process Sys.**	**Downsize Motors**	**Efficient Replace-ment**	**Improved Rewinds**	**Total Savings (MWh)**	**Total Savings (%)**
1 - 5 hp	0	213	0	17	131	117	4	481	25.3%
6 - 20 hp	18	510	11	20	63	109	24	754	19.3%
21 - 50 hp	15	2,425	0	12	34	544	105	3,134	24.3%
51 - 100 hp	0	4,675	135	84	246	971	254	6,365	22.5%
101 - 200 hp	110	1,503	0	16	37	303	93	2,061	20.1%
201 - 500 hp	729	6,460	0	163	352	1,295	487	9,487	17.7%
501 - 1000 hp	0	4,583	0	0	205	751	207	5,747	25.2%
1000+ hp	0	0	14,764	0	1,036	2,853	788	19,441	22.5%
All Motor Sizes	871	20,368	14,910	311	2,102	6,944	1,963	47,470	21.6%

Appendix B: Standard Tables of Inventory Results by Manufacturing SIC Group

UNITED STATES
INDUSTRIAL MOTOR SYSTEMS
MARKET OPPORTUNITIES
ASSESSMENT

B

Standard Tables Of Inventory Results By Manufacturing SIC Group

Appendix B contains uniform sets of tables of key inventory results for each manufacturing SIC except Tobacco Products (SIC 21) and Miscellaneous Manufacturing (SIC 39), for which no inventories were conducted. It also contains a set of tables for overall manufacturing facilities.

The tables included in each set are as follows:

- Motor System Energy Use by Application and Horsepower
- Number of Motors by Application and Horsepower
- Average Hours of Operation by Application and Horsepower

- Motor System Energy with ASD Control
- Motor Systems with ASD Control
- Motor System Energy with Fluctuating Load
- Motor Systems with Fluctuating Load

- Motor System Energy Use for NEMA Design B Motors
- Number of NEMA Design B Motors
- Motor System Energy Use for Other Induction Motors
- Number of Other Induction Motors
- Motor System Energy Use for DC Motors
- Number of DC Motors

- Saturation of EPAct — Compliant Motors
- Potential Motor Upgrade Savings by Horsepower
- Potential Motor Upgrade Savings by Horsepower: EPAct Standards
- Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards
- Potential Motor System Savings

SIC 20-39 - Overall Manufacturing

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	4,107	6,529	630	16,540	27,807
6 - 20 hp	10,964	18,926	2,397	27,836	60,122
21 - 50 hp	10,626	24,288	8,341	29,857	73,111
51 - 100 hp	8,539	26,208	6,393	31,785	72,924
101 - 200 hp	14,113	20,914	9,377	38,696	83,099
201 - 500 hp	6,435	24,004	15,774	44,605	90,819
501 - 1000 hp	8,734	10,849	7,763	49,891	77,238
1000+ hp	15,210	10,972	40,375	23,751	90,307
All Motor Sizes	*78,727*	*142,690*	*91,050*	*262,961*	*575,428*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	706,013	1,178,117	201,620	5,220,331	7,306,080
6 - 20 hp	487,160	802,061	205,865	1,792,949	3,288,035
21 - 50 hp	124,147	281,409	138,743	585,229	1,129,527
51 - 100 hp	35,300	114,856	36,450	177,334	363,940
101 - 200 hp	32,127	49,913	27,288	111,580	220,908
201 - 500 hp	5,217	21,261	16,275	44,082	86,836
501 - 1000 hp	2,413	3,586	2,642	19,405	28,047
1000+ hp	1,787	1,795	3,848	3,528	10,958
All Motor Sizes	*1,394,163*	*2,452,998*	*632,731*	*7,954,438*	*12,434,330*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	4,550	3,380	1,257	2,435	2,745
6 - 20 hp	4,316	4,121	2,131	2,939	3,391
21 - 50 hp	5,101	4,889	3,528	3,488	4,067
51 - 100 hp	6,151	5,667	4,520	5,079	5,329
101 - 200 hp	5,964	5,126	4,685	5,137	5,200
201 - 500 hp	7,044	5,968	6,148	6,102	6,132
501 - 1000 hp	8,013	6,829	6,156	7,328	7,186
1000+ hp	8,167	6,955	7,485	7,173	7,436
All Motor Sizes	*5,988*	*5,211*	*5,476*	*4,692*	*5,083*

SIC 20-39 - Overall Manufacturing

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*6,564*	8.3%	*4,205*	2.9%	*3,354*	3.7%	*11,202*	4.3%	*25,325*	4.4%

Motor Systems with ASD Control

B-1

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*101,204*	7.3%	*77,510*	3.2%	*11,044*	1.7%	*907,570*	11.4%	*1,097,328*	8.8%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*7,296*	9.3%	*13,568*	9.5%	*28,352*	31.1%	*62,005*	23.6%	*111,221*	19.3%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*59,980*	4.3%	*298,610*	12.2%	*162,280*	25.6%	*2,668,345*	33.5%	*3,189,215*	25.6%

SIC 20-39 - Overall Manufacturing

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	3,801	92.6%	5,515	84.5%	513	81.4%	11,415	69.0%
6 - 20 hp	9,571	87.3%	16,243	85.8%	2,050	85.5%	19,697	70.8%
21 - 50 hp	8,805	82.9%	20,735	85.4%	6,684	80.1%	19,341	64.8%
51 - 100 hp	7,577	88.7%	19,928	76.0%	5,926	92.7%	22,862	71.9%
101 - 200 hp	12,991	92.0%	18,204	87.0%	8,123	86.6%	25,535	66.0%
201 - 500 hp	3,569	55.5%	14,475	60.3%	11,673	74.0%	19,974	44.8%
501 - 1000 hp	4,104	47.0%	6,078	56.0%	2,429	31.3%	26,285	52.7%
1000+ hp	2,386	15.7%	2,035	18.6%	14,504	35.9%	9,188	38.7%
All Motor Sizes	*52,803*	67.1%	*103,213*	72.3%	*51,903*	57.0%	*154,296*	58.7%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	619,872	87.8%	853,681	72.5%	168,158	83.4%	3,714,478	71.2%
6 - 20 hp	419,226	86.1%	679,539	84.7%	161,823	78.6%	1,276,548	71.2%
21 - 50 hp	104,949	84.5%	240,631	85.5%	104,175	75.1%	367,375	62.8%
51 - 100 hp	29,252	82.9%	88,405	77.0%	32,410	88.9%	132,280	74.6%
101 - 200 hp	30,065	93.6%	41,961	84.1%	24,455	89.6%	85,105	76.3%
201 - 500 hp	3,047	58.4%	14,508	68.2%	12,720	78.2%	26,218	59.5%
501 - 1000 hp	1,497	62.1%	2,160	60.2%	873	33.0%	10,840	55.9%
1000+ hp	429	24.0%	415	23.1%	1,843	47.9%	1,915	54.3%
All Motor Sizes	*1,208,337*	86.7%	*1,921,298*	78.3%	*506,458*	80.0%	*5,614,760*	70.6%

SIC 20-39 - Overall Manufacturing

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	5	0.1%	3	0.0%			142	0.9%
6 - 20 hp	392	3.6%	54	0.3%	2	0.1%	347	1.2%
21 - 50 hp	126	1.2%	184	0.8%	122	1.5%	632	2.1%
51 - 100 hp	137	1.6%	2,128	8.1%	4	0.1%	250	0.8%
101 - 200 hp	308	2.2%	637	3.0%	106	1.1%	1,138	2.9%
201 - 500 hp	110	1.7%	177	0.7%			3,640	8.2%
501 - 1000 hp	206	2.4%	68	0.6%	176	2.3%		
1000+ hp	1,305	8.6%			1,792	4.4%		
All Motor Sizes	*2,590*	3.3%	*3,251*	2.3%	*2,202*	2.4%	*6,149*	2.3%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	1,242	0.2%	1,737	0.1%			27,094	0.5%
6 - 20 hp	9,081	1.9%	1,743	0.2%	595	0.3%	23,006	1.3%
21 - 50 hp	1,907	1.5%	1,676	0.6%	632	0.5%	8,967	1.5%
51 - 100 hp	500	1.4%	8,289	7.2%	10	0.0%	1,392	0.8%
101 - 200 hp	750	2.3%	2,178	4.4%	168	0.6%	1,604	1.4%
201 - 500 hp	189	3.6%	285	1.3%			3,615	8.2%
501 - 1000 hp	95	3.9%	20	0.6%	95	3.6%		
1000+ hp	189	10.6%			180	4.7%		
All Motor Sizes	*13,954*	1.0%	*15,928*	0.6%	*1,679*	0.3%	*65,678*	0.8%

SIC 20-39 - Overall Manufacturing

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	1	0.0%	14	0.2%	9	1.5%	1,297	7.8%
6 - 20 hp	24	0.2%	50	0.3%			3,332	12.0%
21 - 50 hp					35	0.4%	4,623	15.5%
51 - 100 hp			227	0.9%			6,419	20.2%
101 - 200 hp			776	3.7%			8,845	22.9%
201 - 500 hp	115	1.8%					13,920	31.2%
501 - 1000 hp			316	2.9%			12,546	25.1%
1000+ hp							3,328	14.0%
All Motor Sizes	*139*	0.2%	*1,384*	1.0%	*44*	0.0%	*54,311*	20.7%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	286	0.0%	6,002	0.5%	415	0.2%	290,751	5.6%
6 - 20 hp	1,918	0.4%	3,839	0.5%			192,356	10.7%
21 - 50 hp					862	0.6%	88,710	15.2%
51 - 100 hp			565	0.5%			28,419	16.0%
101 - 200 hp			909	1.8%			17,217	15.4%
201 - 500 hp	113	2.2%					9,726	22.1%
501 - 1000 hp			82	2.3%			4,997	25.8%
1000+ hp							555	15.7%
All Motor Sizes	*2,317*	0.2%	*11,397*	0.5%	*1,277*	0.2%	*632,730*	8.0%

SIC 20-39 - Overall Manufacturing

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	89,185	13%	89,099	8%	21,858	11%	323,593	6%	523,735	7%
6 - 20 hp	46,645	10%	95,287	12%	7,067	3%	191,438	11%	340,437	10%
21 - 50 hp	13,836	11%	47,859	17%	10,967	8%	54,448	9%	127,111	11%
51 - 100 hp	6,933	20%	20,117	18%	1,974	5%	33,210	19%	62,234	17%
101 - 200 hp	9,031	28%	7,883	16%	7,900	29%	31,433	28%	56,247	25%
201 - 500 hp	185	4%	4,085	19%	1,031	6%	10,044	23%	15,346	18%
501 - 1000 hp					85	3%	267	1%	352	1%
1000+ hp			12	1%	414	11%			425	4%
All Motor Sizes	*165,816*	12%	*264,342*	11%	*51,296*	8%	*644,433*	8%	*1,125,887*	9%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	27,807	4.8%	1,220	4.4%	1,824	6.6%
6 - 20 hp	60,122	10.4%	1,925	3.2%	2,972	4.9%
21 - 50 hp	73,111	12.7%	1,971	2.7%	2,767	3.8%
51 - 100 hp	72,924	12.7%	1,487	2.0%	2,213	3.0%
101 - 200 hp	83,099	14.4%	1,438	1.7%	2,105	2.5%
201 - 500 hp	90,819	15.8%	1,625	1.8%	2,617	2.9%
501 - 1000 hp	77,238	13.4%	1,689	2.2%	2,618	3.4%
1000+ hp	90,307	15.7%	1,688	1.9%	2,683	3.0%
All Motor Sizes	*575,428*		*13,043*	2.3%	*19,799*	3.4%

SIC 20-39 - Overall Manufacturing

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	159	3.9%	281	4.3%	25	4.0%	755	4.6%	1,220	4.4%
6 - 20 hp	364	3.3%	574	3.0%	102	4.3%	884	3.2%	1,925	3.2%
21 - 50 hp	301	2.8%	602	2.5%	231	2.8%	836	2.8%	1,971	2.7%
51 - 100 hp	171	2.0%	536	2.0%	144	2.2%	636	2.0%	1,487	2.0%
101 - 200 hp	214	1.5%	360	1.7%	161	1.7%	702	1.8%	1,438	1.7%
201 - 500 hp	114	1.8%	420	1.7%	303	1.9%	788	1.8%	1,625	1.8%
501 - 1000 hp	181	2.1%	225	2.1%	155	2.0%	1,128	2.3%	1,689	2.2%
1000+ hp	315	2.1%	226	2.1%	654	1.6%	493	2.1%	1,688	1.9%
All Motor Sizes	*1,820*	2.3%	*3,224*	2.3%	*1,776*	2.0%	*6,223*	2.4%	*13,043*	2.3%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	244	5.9%	413	6.3%	38	6.1%	1,128	6.8%	1,824	6.6%
6 - 20 hp	553	5.0%	901	4.8%	148	6.2%	1,370	4.9%	2,972	4.9%
21 - 50 hp	415	3.9%	857	3.5%	330	4.0%	1,166	3.9%	2,767	3.8%
51 - 100 hp	254	3.0%	807	3.1%	212	3.3%	940	3.0%	2,213	3.0%
101 - 200 hp	326	2.3%	533	2.5%	234	2.5%	1,013	2.6%	2,105	2.5%
201 - 500 hp	190	3.0%	678	2.8%	482	3.1%	1,267	2.8%	2,617	2.9%
501 - 1000 hp	288	3.3%	358	3.3%	246	3.2%	1,726	3.5%	2,618	3.4%
1000+ hp	501	3.3%	359	3.3%	1,040	2.6%	783	3.3%	2,683	3.0%
All Motor Sizes	*2,771*	3.5%	*4,904*	3.4%	*2,730*	3.0%	*9,393*	3.6%	*19,799*	3.4%

SIC 20-39 - Overall Manufacturing

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
	Potential Motor System Savings					
1 - 5 hp	226	1,312	107	331	1,977	7.1%
6 - 20 hp	603	3,804	409	557	5,372	8.9%
21 - 50 hp	584	4,882	1,422	597	7,486	10.2%
51 - 100 hp	470	5,268	1,090	636	7,463	10.2%
101 - 200 hp	776	4,204	1,599	774	7,352	8.8%
201 - 500 hp	354	4,825	2,690	892	8,760	9.6%
501 - 1000 hp	480	2,181	1,324	998	4,983	6.5%
1000+ hp	837	2,205	6,884	475	10,401	11.5%
All Motor Sizes	4,330	28,681	15,524	5,259	53,794	9.3%

SIC 20 - Food and Kindred Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	563	689	158	2,222	3,633
6 - 20 hp	662	2,051	270	2,580	5,562
21 - 50 hp	734	1,813	837	2,514	5,898
51 - 100 hp	705	870	732	2,753	5,061
101 - 200 hp	184	795	495	4,375	5,848
201 - 500 hp			405	4,728	5,134
501 - 1000 hp				5,560	5,560
1000+ hp				1,100	1,100
All Motor Sizes	*2,848*	*6,218*	*2,898*	*25,833*	*37,797*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	72,246	98,129	17,541	464,641	652,557
6 - 20 hp	46,772	100,085	5,097	71,966	223,920
21 - 50 hp	6,902	17,346	10,642	26,184	61,075
51 - 100 hp	2,153	6,698	2,603	12,335	23,790
101 - 200 hp	294	2,712	1,226	13,849	18,080
201 - 500 hp			627	7,851	8,478
501 - 1000 hp				3,879	3,879
1000+ hp				451	451
All Motor Sizes	*128,367*	*224,972*	*37,735*	*601,157*	*992,231*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	5,983	3,696	5,902	3,465	3,829
6 - 20 hp	2,214	3,712	5,867	5,046	3,949
21 - 50 hp	6,378	5,820	3,462	4,754	4,927
51 - 100 hp	7,848	4,873	5,543	5,340	5,524
101 - 200 hp	6,178	6,292	5,355	4,816	5,055
201 - 500 hp			5,400	3,614	3,711
501 - 1000 hp				5,260	5,260
1000+ hp				6,240	6,240
All Motor Sizes	*4,537*	*4,588*	*4,718*	*4,574*	*4,584*

SIC 20 - Food and Kindred Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*86*	3.0%	*211*	3.4%	*474*	16.4%	*2,924*	11.3%	*3,695*	9.8%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*12,303*	9.6%	*7,300*	3.2%	*4,560*	12.1%	*184,139*	30.6%	*208,302*	21.0%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*7*	0.2%	*296*	4.8%	*1,055*	36.4%	*9,396*	36.4%	*10,754*	28.5%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*251*	0.2%	*8,730*	3.9%	*7,168*	19.0%	*229,680*	38.2%	*245,829*	24.8%

SIC 20 - Food and Kindred Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	502	89.1%	663	96.2%	112	71.0%	1,807	81.3%
6 - 20 hp	658	99.4%	2,022	98.6%	215	79.7%	2,480	96.1%
21 - 50 hp	718	97.8%	1,640	90.5%	672	80.3%	1,361	54.1%
51 - 100 hp	705	100.0%	870	100.0%	665	90.8%	2,670	97.0%
101 - 200 hp	184	100.0%	795	100.0%	391	78.9%	4,341	99.2%
201 - 500 hp					405	100.0%	4,117	87.1%
501 - 1000 hp							4,925	88.6%
1000+ hp							1,100	100.0%
All Motor Sizes	*2,767*	97.1%	*5,990*	96.3%	*2,461*	84.9%	*22,802*	88.3%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	62,857	87.0%	88,885	90.6%	15,072	85.9%	397,583	85.6%
6 - 20 hp	46,696	99.8%	98,398	98.3%	4,087	80.2%	66,140	91.9%
21 - 50 hp	6,750	97.8%	15,444	89.0%	5,628	52.9%	18,831	71.9%
51 - 100 hp	2,153	100.0%	6,698	100.0%	2,172	83.4%	11,722	95.0%
101 - 200 hp	294	100.0%	2,712	100.0%	1,092	89.0%	13,720	99.1%
201 - 500 hp					627	100.0%	7,272	92.6%
501 - 1000 hp							3,586	92.4%
1000+ hp							451	100.0%
All Motor Sizes	*118,749*	92.5%	*212,138*	94.3%	*28,678*	76.0%	*519,306*	86.4%

SIC 20 - Food and Kindred Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							0	0.0%
6 - 20 hp	4	0.6%					3	0.1%
21 - 50 hp							341	13.6%
51 - 100 hp								
101 - 200 hp							28	0.6%
201 - 500 hp							316	6.7%
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*4*	0.1%					*688*	2.7%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							76	0.0%
6 - 20 hp	76	0.2%					646	0.9%
21 - 50 hp							2,280	8.7%
51 - 100 hp								
101 - 200 hp							52	0.4%
201 - 500 hp							286	3.6%
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*76*	0.1%					*3,340*	0.6%

SIC 20 - Food and Kindred Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							19	0.8%
6 - 20 hp							32	1.2%
21 - 50 hp								
51 - 100 hp							67	2.4%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*117*	0.5%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							3,015	0.6%
6 - 20 hp							447	0.6%
21 - 50 hp								
51 - 100 hp							451	3.7%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*3,913*	0.7%

SIC 20 - Food and Kindred Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	20,465	28%	13,908	14%	207	1%	8,188	2%	42,768	7%
6 - 20 hp	5,962	13%	14,965	15%			6,801	9%	27,728	12%
21 - 50 hp	1,422	21%	1,934	11%	2,549	24%	2,152	8%	8,057	13%
51 - 100 hp	2,050	95%	104	2%			4,573	37%	6,727	28%
101 - 200 hp			293	11%			1,042	8%	1,334	7%
201 - 500 hp							440	6%	440	5%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*29,898*	23%	*31,203*	14%	*2,756*	7%	*23,196*	4%	*87,053*	9%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	3,633	9.6%	154	4.2%	234	6.4%
6 - 20 hp	5,562	14.7%	176	3.2%	272	4.9%
21 - 50 hp	5,898	15.6%	145	2.5%	207	3.5%
51 - 100 hp	5,061	13.4%	75	1.5%	113	2.2%
101 - 200 hp	5,848	15.5%	136	2.3%	193	3.3%
201 - 500 hp	5,134	13.6%	79	1.5%	137	2.7%
501 - 1000 hp	5,560	14.7%	115	2.1%	183	3.3%
1000+ hp	1,100	2.9%	23	2.1%	36	3.3%
All Motor Sizes	*37,797*		*904*	2.4%	*1,376*	3.6%

SIC 20 - Food and Kindred Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	16	2.9%	24	3.5%	7	4.2%	107	4.8%	154	4.2%
6 - 20 hp	19	2.9%	64	3.1%	13	4.7%	80	3.1%	176	3.2%
21 - 50 hp	18	2.5%	48	2.7%	11	1.4%	66	2.6%	145	2.5%
51 - 100 hp	0	0.1%	21	2.4%	15	2.0%	39	1.4%	75	1.5%
101 - 200 hp	1	0.5%	15	1.9%	8	1.7%	112	2.6%	136	2.3%
201 - 500 hp					8	1.9%	71	1.5%	79	1.5%
501 - 1000 hp							115	2.1%	115	2.1%
1000+ hp							23	2.1%	23	2.1%
All Motor Sizes	*55*	1.9%	*173*	2.8%	*62*	2.1%	*614*	2.4%	*904*	2.4%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	25	4.4%	37	5.4%	11	7.0%	161	7.3%	234	6.4%
6 - 20 hp	31	4.7%	100	4.9%	18	6.7%	123	4.8%	272	4.9%
21 - 50 hp	26	3.6%	67	3.7%	16	1.9%	98	3.9%	207	3.5%
51 - 100 hp	1	0.1%	31	3.6%	23	3.1%	59	2.1%	113	2.2%
101 - 200 hp	3	1.8%	21	2.7%	13	2.7%	155	3.5%	193	3.3%
201 - 500 hp					13	3.1%	124	2.6%	137	2.7%
501 - 1000 hp							183	3.3%	183	3.3%
1000+ hp							36	3.3%	36	3.3%
All Motor Sizes	*86*	3.0%	*256*	4.1%	*94*	3.3%	*940*	3.6%	*1,376*	3.6%

SIC 20 - Food and Kindred Products

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
	Potential Motor System Savings					
1 - 5 hp	31	139	27	44	241	6.6%
6 - 20 hp	36	412	46	52	546	9.8%
21 - 50 hp	40	364	143	50	598	10.1%
51 - 100 hp	39	175	125	55	394	7.8%
101 - 200 hp	10	160	84	88	342	5.8%
201 - 500 hp			69	95	164	3.2%
501 - 1000 hp				111	111	2.0%
1000+ hp				22	22	2.0%
All Motor Sizes	157	1,250	494	517	2,417	6.4%

SIC 22 - Textile Mill Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	150	126	27	1,720	2,024
6 - 20 hp	757	482	273	3,278	4,790
21 - 50 hp	647	668	17	1,152	2,484
51 - 100 hp	812	901	650	628	2,991
101 - 200 hp	329	373	864	1,536	3,101
201 - 500 hp	399	399	437		1,236
501 - 1000 hp			123		123
1000+ hp					
All Motor Sizes	*3,095*	*2,949*	*2,392*	*8,314*	*16,750*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	57,401	14,493	10,499	250,523	332,917
6 - 20 hp	31,187	20,462	14,950	135,136	201,735
21 - 50 hp	10,840	13,671	2,338	24,982	51,832
51 - 100 hp	2,993	3,616	3,741	5,510	15,860
101 - 200 hp	636	1,123	1,966	4,377	8,102
201 - 500 hp	373	373	670		1,416
501 - 1000 hp			76		76
1000+ hp					
All Motor Sizes	*103,431*	*53,738*	*34,241*	*420,528*	*611,937*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	2,905	4,362	813	4,445	4,039
6 - 20 hp	3,959	2,804	2,509	4,311	3,887
21 - 50 hp	4,274	3,085	512	3,182	3,252
51 - 100 hp	6,510	5,796	4,281	4,313	5,178
101 - 200 hp	6,311	4,637	6,142	4,193	4,850
201 - 500 hp	6,854	6,854	5,162		6,142
501 - 1000 hp			6,000		6,000
1000+ hp					
All Motor Sizes	*4,916*	*4,145*	*4,169*	*4,113*	*4,256*

SIC 22 - Textile Mill Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*349*	11.3%	*1,452*	49.2%	*0*	0.0%	*843*	10.1%	*2,644*	15.8%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*5,412*	5.2%	*18,116*	33.7%	*14*	0.0%	*61,043*	14.5%	*84,584*	13.8%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*778*	25.1%	*2,120*	71.9%	*1,938*	81.0%	*2,073*	24.9%	*6,907*	41.2%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*15,018*	14.5%	*30,095*	56.0%	*8,111*	23.7%	*168,848*	40.2%	*222,072*	36.3%

SIC 22 - Textile Mill Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	141	93.5%	80	63.4%	6	23.8%	533	31.0%
6 - 20 hp	299	39.5%	407	84.5%	194	71.3%	1,611	49.1%
21 - 50 hp	537	83.0%	430	64.3%	17	98.0%	857	74.4%
51 - 100 hp	478	58.8%	704	78.1%	520	80.0%	521	82.8%
101 - 200 hp	229	69.6%	373	100.0%	864	100.0%	200	13.0%
201 - 500 hp	233	58.3%	166	41.7%	422	96.4%		
501 - 1000 hp					123	100.0%		
1000+ hp								
All Motor Sizes	*1,916*	61.9%	*2,160*	73.2%	*2,146*	89.7%	*3,722*	44.8%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	56,506	98.4%	10,381	71.6%	8,425	80.2%	94,120	37.6%
6 - 20 hp	14,009	44.9%	18,932	92.5%	12,391	82.9%	68,141	50.4%
21 - 50 hp	6,394	59.0%	8,993	65.8%	1,059	45.3%	12,150	48.6%
51 - 100 hp	1,873	62.6%	2,720	75.2%	2,462	65.8%	4,885	88.7%
101 - 200 hp	449	70.7%	1,123	100.0%	1,966	100.0%	1,279	29.2%
201 - 500 hp	187	50.0%	187	50.0%	656	98.0%		
501 - 1000 hp					76	100.0%		
1000+ hp								
All Motor Sizes	*79,418*	76.8%	*42,336*	78.8%	*27,037*	79.0%	*180,576*	42.9%

SIC 22 - Textile Mill Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp								
21 - 50 hp							1	0.1%
51 - 100 hp								
101 - 200 hp							1,004	65.4%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*1,005*	12.1%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp								
21 - 50 hp							114	0.5%
51 - 100 hp								
101 - 200 hp							1,343	30.7%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*1,457*	0.3%

SIC 22 - Textile Mill Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							398	23.1%
6 - 20 hp			41	8.6%			561	17.1%
21 - 50 hp							59	5.1%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes			*41*	1.4%			*1,017*	12.2%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							58,594	23.4%
6 - 20 hp			895	4.4%			20,426	15.1%
21 - 50 hp							662	2.7%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes			*895*	1.7%			*79,682*	18.9%

SIC 22 - Textile Mill Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	21	0%	249	2%			985	0%	1,254	0%
6 - 20 hp	357	1%	1,458	7%	313	2%	1,953	1%	4,081	2%
21 - 50 hp	530	5%	1,272	9%			777	3%	2,579	5%
51 - 100 hp	41	1%	127	4%			27	0%	196	1%
101 - 200 hp					1,279	65%			1,279	16%
201 - 500 hp					187	28%			187	13%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*949*	1%	*3,106*	6%	*1,778*	5%	*3,742*	1%	*9,575*	2%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	2,024	12.1%	98	4.9%	147	7.3%
6 - 20 hp	4,790	28.6%	182	3.8%	274	5.7%
21 - 50 hp	2,484	14.8%	74	3.0%	101	4.1%
51 - 100 hp	2,991	17.9%	68	2.3%	106	3.6%
101 - 200 hp	3,101	18.5%	49	1.6%	75	2.4%
201 - 500 hp	1,236	7.4%	22	1.8%	34	2.8%
501 - 1000 hp	123	0.7%	3	2.1%	4	3.3%
1000+ hp						
All Motor Sizes	*16,750*		*497*	3.0%	*743*	4.4%

SIC 22 - Textile Mill Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	8	5.3%	6	4.9%	1	4.4%	83	4.8%	98	4.9%
6 - 20 hp	31	4.0%	15	3.1%	12	4.5%	125	3.8%	182	3.8%
21 - 50 hp	20	3.2%	16	2.5%	0	1.6%	37	3.2%	74	3.0%
51 - 100 hp	19	2.3%	19	2.1%	15	2.3%	16	2.5%	68	2.3%
101 - 200 hp	7	2.2%	4	1.1%	4	0.5%	33	2.2%	49	1.6%
201 - 500 hp	8	2.1%	8	2.1%	5	1.2%			22	1.8%
501 - 1000 hp					3	2.1%			3	2.1%
1000+ hp										
All Motor Sizes	*93*	3.0%	*69*	2.3%	*41*	1.7%	*294*	3.5%	*497*	3.0%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	12	8.2%	9	7.1%	2	6.5%	124	7.2%	147	7.3%
6 - 20 hp	44	5.8%	22	4.6%	17	6.2%	192	5.8%	274	5.7%
21 - 50 hp	28	4.3%	23	3.5%	0	2.9%	50	4.3%	101	4.1%
51 - 100 hp	29	3.5%	30	3.3%	23	3.5%	25	4.0%	106	3.6%
101 - 200 hp	11	3.2%	8	2.1%	7	0.8%	50	3.2%	75	2.4%
201 - 500 hp	13	3.3%	13	3.3%	8	1.8%			34	2.8%
501 - 1000 hp					4	3.3%			4	3.3%
1000+ hp										
All Motor Sizes	*136*	4.4%	*105*	3.6%	*61*	2.6%	*440*	5.3%	*743*	4.4%

SIC 22 - Textile Mill Products

	Potential Motor System Savings					
Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	8	25	5	34	73	3.6%
6 - 20 hp	42	97	46	66	251	5.2%
21 - 50 hp	36	134	3	23	196	7.9%
51 - 100 hp	45	181	111	13	349	11.7%
101 - 200 hp	18	75	147	31	271	8.7%
201 - 500 hp	22	80	75		177	14.3%
501 - 1000 hp			21		21	17.1%
1000+ hp						
All Motor Sizes	170	593	408	166	1,337	8.0%

SIC 23 - Apparel and Other Textile Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp				195	195
6 - 20 hp	23		17	15	55
21 - 50 hp			381	347	728
51 - 100 hp				190	190
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*23*		*398*	*747*	*1,168*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp				60,054	60,054
6 - 20 hp	1,633		10,911	816	13,360
21 - 50 hp			4,898	4,898	9,796
51 - 100 hp				1,633	1,633
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*1,633*		*15,809*	*67,401*	*84,842*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp				2,124	2,124
6 - 20 hp	2,880		306	2,880	806
21 - 50 hp			2,947	2,880	2,915
51 - 100 hp				2,880	2,880
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*2,880*		*2,164*	*2,635*	*2,457*

SIC 23 - Apparel and Other Textile Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*		*0*	0.0%	*0*	0.0%		

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*		*0*	0.0%	*0*	0.0%		

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*		*0*	0.0%	*234*	31.3%	*234*	20.0%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*		*0*	0.0%	*4,082*	6.1%	*4,082*	4.8%

SIC 23 - Apparel and Other Textile Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							15	7.6%
6 - 20 hp								
21 - 50 hp					324	85.0%		
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes					*324*	81.5%	*15*	2.0%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							4,082	6.8%
6 - 20 hp								
21 - 50 hp					3,265	66.7%		
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes					*3,265*	20.7%	*4,082*	6.1%

SIC 23 - Apparel and Other Textile Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

SIC 23 - Apparel and Other Textile Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							79	40.6%
6 - 20 hp	23	100.0%						
21 - 50 hp								
51 - 100 hp							104	54.9%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*23*	100.0%					*183*	24.6%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							21,225	35.3%
6 - 20 hp	1,633	100.0%						
21 - 50 hp								
51 - 100 hp							816	50.0%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*1,633*	100.0%					*22,041*	32.7%

SIC 23 - Apparel and Other Textile Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp										
6 - 20 hp										
21 - 50 hp					1,633	33%			1,633	17%
51 - 100 hp										
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes					*1,633*	10%			*1,633*	2%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	195	16.7%	10	4.9%	14	7.2%
6 - 20 hp	55	4.7%	3	5.0%	4	7.2%
21 - 50 hp	728	62.3%	16	2.2%	22	3.1%
51 - 100 hp	190	16.3%	5	2.4%	7	3.8%
101 - 200 hp						
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*1,168*		*33*	2.8%	*47*	4.1%

SIC 23 - Apparel and Other Textile Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp							10	4.9%	10	4.9%
6 - 20 hp	1	4.8%			1	6.1%	1	3.8%	3	5.0%
21 - 50 hp					6	1.7%	10	2.9%	16	2.2%
51 - 100 hp							5	2.4%	5	2.4%
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*1*	4.8%			*7*	1.9%	*25*	3.3%	*33*	2.8%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp							14	7.2%	14	7.2%
6 - 20 hp	2	7.1%			1	8.4%	1	6.1%	4	7.2%
21 - 50 hp					8	2.2%	14	4.0%	22	3.1%
51 - 100 hp							7	3.8%	7	3.8%
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*2*	7.1%			*10*	2.5%	*36*	4.8%	*47*	4.1%

SIC 23 - Apparel and Other Textile Products

	Potential Motor System Savings					
Size Category	**Fan Savings (GWh/Yr)**	**Pump Savings (GWh/Yr)**	**Air Compressor Savings (GWh/Yr)**	**Other Savings (GWh/Yr)**	**Total Savings (GWh/Yr)**	**Total Savings (%)**
1 - 5 hp				4	4	2.0%
6 - 20 hp	1		3	0	4	8.1%
21 - 50 hp			65	7	72	9.9%
51 - 100 hp				4	4	2.0%
101 - 200 hp						
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	1		68	15	84	7.2%

SIC 24 - Lumber and Wood Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	117	40	12	1,173	1,342
6 - 20 hp	675	397	277	2,498	3,847
21 - 50 hp	802	361	331	2,073	3,566
51 - 100 hp	378	364	462	3,542	4,746
101 - 200 hp	814	46	819	5,459	7,138
201 - 500 hp				2,305	2,305
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*2,787*	*1,209*	*1,901*	*17,049*	*22,946*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	27,525	9,087	3,636	445,535	485,783
6 - 20 hp	43,311	18,230	18,976	256,147	336,664
21 - 50 hp	10,381	7,843	9,030	50,102	77,356
51 - 100 hp	1,718	4,356	1,995	27,900	35,969
101 - 200 hp	3,448	153	4,117	27,249	34,967
201 - 500 hp				7,232	7,232
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*86,383*	*39,669*	*37,755*	*814,164*	*977,971*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	2,646	3,285	2,229	1,774	1,857
6 - 20 hp	4,141	3,293	2,567	1,943	2,294
21 - 50 hp	4,331	2,485	1,816	2,399	2,591
51 - 100 hp	4,933	2,496	5,997	3,474	3,598
101 - 200 hp	2,862	4,160	2,611	2,806	2,794
201 - 500 hp				2,509	2,509
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*3,698*	*2,778*	*2,769*	*2,547*	*2,678*

SIC 24 - Lumber and Wood Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*83*	3.0%	*27*	2.3%	*48*	2.5%	*211*	1.2%	*369*	1.6%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*7,124*	8.2%	*4,749*	12.0%	*3,562*	9.4%	*84,296*	10.4%	*99,731*	10.2%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*727*	26.1%	*382*	31.6%	*691*	36.4%	*5,399*	31.7%	*7,199*	31.4%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*7,778*	9.0%	*6,633*	16.7%	*10,896*	28.9%	*329,836*	40.5%	*355,142*	36.3%

SIC 24 - Lumber and Wood Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	103	88.1%	40	100.0%	12	100.0%	1,040	88.7%
6 - 20 hp	646	95.7%	397	100.0%	277	100.0%	2,159	86.4%
21 - 50 hp	657	81.9%	361	100.0%	132	39.8%	1,822	87.9%
51 - 100 hp	378	100.0%	364	100.0%	462	100.0%	3,276	92.5%
101 - 200 hp	814	100.0%	46	100.0%	819	100.0%	5,368	98.3%
201 - 500 hp							2,305	100.0%
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*2,598*	93.2%	*1,209*	100.0%	*1,702*	89.5%	*15,969*	93.7%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	20,029	72.8%	9,087	100.0%	3,636	100.0%	308,576	69.3%
6 - 20 hp	36,205	83.6%	18,230	100.0%	18,976	100.0%	200,940	78.4%
21 - 50 hp	9,808	94.5%	7,843	100.0%	5,548	61.4%	44,893	89.6%
51 - 100 hp	1,718	100.0%	4,356	100.0%	1,995	100.0%	26,114	93.6%
101 - 200 hp	3,448	100.0%	153	100.0%	4,117	100.0%	26,704	98.0%
201 - 500 hp							7,232	100.0%
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*71,208*	82.4%	*39,669*	100.0%	*34,272*	90.8%	*614,458*	75.5%

SIC 24 - Lumber and Wood Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							32	2.8%
6 - 20 hp							125	5.0%
21 - 50 hp								
51 - 100 hp							18	0.5%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*175*	1.0%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							5,821	1.3%
6 - 20 hp							6,518	2.5%
21 - 50 hp								
51 - 100 hp							153	0.5%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*12,492*	1.5%

SIC 24 - Lumber and Wood Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							0	0.0%
6 - 20 hp							10	0.4%
21 - 50 hp							121	5.8%
51 - 100 hp							248	7.0%
101 - 200 hp							91	1.7%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*470*	2.8%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							153	0.0%
6 - 20 hp							1,242	0.5%
21 - 50 hp							2,178	4.3%
51 - 100 hp							1,634	5.9%
101 - 200 hp							545	2.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*5,751*	0.7%

SIC 24 - Lumber and Wood Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	12,553	46%	3,812	42%			109,311	25%	125,676	26%
6 - 20 hp	25,049	58%	10,891	60%	2,276	12%	96,567	38%	134,783	40%
21 - 50 hp	1,662	16%	7,079	90%	545	6%	13,766	27%	23,052	30%
51 - 100 hp			4,356	100%			16,336	59%	20,692	58%
101 - 200 hp	2,723	79%			3,812	93%	23,415	86%	29,950	86%
201 - 500 hp							7,079	98%	7,079	98%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*41,987*	49%	*26,138*	66%	*6,633*	18%	*266,475*	33%	*341,233*	35%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,342	5.9%	36	2.7%	54	4.1%
6 - 20 hp	3,847	16.8%	78	2.0%	119	3.1%
21 - 50 hp	3,566	15.5%	67	1.9%	96	2.7%
51 - 100 hp	4,746	20.7%	66	1.4%	101	2.1%
101 - 200 hp	7,138	31.1%	39	0.5%	58	0.8%
201 - 500 hp	2,305	10.0%	3	0.1%	4	0.2%
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*22,946*		*289*	1.3%	*432*	1.9%

SIC 24 - Lumber and Wood Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	2	1.8%	0	1.2%	1	7.9%	32	2.8%	36	2.7%
6 - 20 hp	7	1.1%	6	1.4%	13	4.6%	52	2.1%	78	2.0%
21 - 50 hp	20	2.5%	2	0.5%	7	2.1%	38	1.8%	67	1.9%
51 - 100 hp	9	2.3%			11	2.4%	46	1.3%	66	1.4%
101 - 200 hp	3	0.4%	2	5.3%	2	0.3%	31	0.6%	39	0.5%
201 - 500 hp							3	0.1%	3	0.1%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*42*	1.5%	*10*	0.9%	*34*	1.8%	*203*	1.2%	*289*	1.3%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	3	2.6%	1	1.9%	1	10.3%	49	4.2%	54	4.1%
6 - 20 hp	12	1.7%	8	2.1%	17	6.2%	81	3.3%	119	3.1%
21 - 50 hp	29	3.6%	2	0.7%	11	3.3%	54	2.6%	96	2.7%
51 - 100 hp	14	3.6%			17	3.7%	70	2.0%	101	2.1%
101 - 200 hp	5	0.6%	3	6.1%	3	0.3%	48	0.9%	58	0.8%
201 - 500 hp							4	0.2%	4	0.2%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*62*	2.2%	*14*	1.2%	*50*	2.6%	*306*	1.8%	*432*	1.9%

SIC 24 - Lumber and Wood Products

Potential Motor System Savings

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	6	8	2	23	40	3.0%
6 - 20 hp	37	80	47	50	214	5.6%
21 - 50 hp	44	73	57	41	215	6.0%
51 - 100 hp	21	73	79	71	244	5.1%
101 - 200 hp	45	9	140	109	303	4.2%
201 - 500 hp				46	46	2.0%
501 - 1000 hp						
1000+ hp						
All Motor Sizes	153	243	324	341	1,061	4.6%

SIC 25 - Furniture and Fixtures

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	59	20	1	503	583
6 - 20 hp	161	2		559	722
21 - 50 hp	357	3	159	409	928
51 - 100 hp	176	3	95	69	344
101 - 200 hp	824		205	88	1,117
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*1,578*	*27*	*460*	*1,628*	*3,694*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	16,939	9,861	2,009	212,681	241,489
6 - 20 hp	10,618	952		51,580	63,149
21 - 50 hp	6,876	1,072	2,741	15,751	26,440
51 - 100 hp	2,144	1,871	1,741	1,568	7,324
101 - 200 hp	4,090		1,170	1,072	6,332
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*40,667*	*13,755*	*7,661*	*282,652*	*344,735*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	2,246	1,401	160	1,867	1,841
6 - 20 hp	3,693	450		2,080	2,281
21 - 50 hp	2,743	260	2,361	2,033	2,269
51 - 100 hp	2,406	23	1,776	1,806	1,232
101 - 200 hp	3,601		3,024	1,392	3,103
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*3,142*	*192*	*2,356*	*1,936*	*2,197*

SIC 25 - Furniture and Fixtures

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*5*	0.3%	*5*	0.1%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*2,024*	0.7%	*2,024*	0.6%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*7*	25.8%	*280*	60.9%	*463*	28.4%	*750*	20.3%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*4,551*	33.1%	*4,442*	58.0%	*55,123*	19.5%	*64,116*	18.6%

SIC 25 - Furniture and Fixtures

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	59	100.0%	18	90.2%	1	59.2%	394	78.3%
6 - 20 hp	144	89.0%	2	83.4%			370	66.2%
21 - 50 hp	169	47.2%	3	100.0%	159	100.0%	214	52.2%
51 - 100 hp	91	51.7%	3	100.0%	58	60.8%	69	100.0%
101 - 200 hp	824	100.0%			146	71.4%	45	51.1%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*1,287*	81.5%	*25*	91.6%	*364*	79.1%	*1,091*	67.0%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	16,939	100.0%	8,252	83.7%	139	6.9%	153,871	72.3%
6 - 20 hp	9,957	93.8%	416	43.7%			30,423	59.0%
21 - 50 hp	3,933	57.2%	1,072	100.0%	2,741	100.0%	5,493	34.9%
51 - 100 hp	1,072	50.0%	1,871	100.0%	669	38.4%	1,568	100.0%
101 - 200 hp	4,090	100.0%			634	54.2%	536	50.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*35,991*	88.5%	*11,611*	84.4%	*4,182*	54.6%	*191,891*	67.9%

SIC 25 - Furniture and Fixtures

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							0	0.1%
6 - 20 hp								
21 - 50 hp	118	33.2%						
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*118*	7.5%					*0*	0.0%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							536	0.3%
6 - 20 hp								
21 - 50 hp	1,871	27.2%						
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*1,871*	4.6%					*536*	0.2%

SIC 25 - Furniture and Fixtures

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							51	10.2%
6 - 20 hp							39	6.9%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*90*	5.5%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							9,305	4.4%
6 - 20 hp							1,786	3.5%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*11,091*	3.9%

SIC 25 - Furniture and Fixtures

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp							714	0%	714	0%
6 - 20 hp										
21 - 50 hp	536	8%							536	2%
51 - 100 hp	536	25%							536	7%
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*1,072*	3%					*714*	0%	*1,786*	1%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	583	15.8%	31	5.3%	45	7.7%
6 - 20 hp	722	19.5%	27	3.8%	42	5.9%
21 - 50 hp	928	25.1%	35	3.7%	46	5.0%
51 - 100 hp	344	9.3%	7	2.1%	11	3.1%
101 - 200 hp	1,117	30.2%	19	1.7%	28	2.5%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*3,694*		*119*	3.2%	*173*	4.7%

SIC 25 - Furniture and Fixtures

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	3	5.1%	1	4.8%	0	4.2%	27	5.4%	31	5.3%
6 - 20 hp	6	3.9%	0	3.7%			21	3.8%	27	3.8%
21 - 50 hp	8	2.3%	0	3.8%	5	3.1%	21	5.2%	35	3.7%
51 - 100 hp	4	2.1%	0	2.6%	2	1.8%	2	2.6%	7	2.1%
101 - 200 hp	11	1.4%			5	2.5%	2	2.3%	19	1.7%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*33*	2.1%	*1*	4.4%	*12*	2.6%	*73*	4.5%	*119*	3.2%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	4	7.4%	1	7.2%	0	6.3%	39	7.8%	45	7.7%
6 - 20 hp	10	6.1%	0	5.3%			33	5.8%	42	5.9%
21 - 50 hp	12	3.5%	0	5.0%	7	4.6%	26	6.4%	46	5.0%
51 - 100 hp	5	2.8%	0	3.5%	3	3.1%	3	3.9%	11	3.1%
101 - 200 hp	18	2.2%			7	3.4%	3	3.3%	28	2.5%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*50*	3.2%	*2*	6.5%	*17*	3.7%	*104*	6.4%	*173*	4.7%

SIC 25 - Furniture and Fixtures

Potential Motor System Savings

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	3	4	0	10	18	3.0%
6 - 20 hp	9	0		11	20	2.8%
21 - 50 hp	20	1	27	8	55	6.0%
51 - 100 hp	10	1	16	1	28	8.1%
101 - 200 hp	45		35	2	82	7.3%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	87	5	78	33	203	5.5%

SIC 26 - Paper and Allied Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	360	449	24	1,024	1,857
6 - 20 hp	756	1,695	99	1,897	4,447
21 - 50 hp	809	3,710	468	3,827	8,814
51 - 100 hp	1,410	5,588	964	5,288	13,250
101 - 200 hp	1,424	5,465	297	5,468	12,654
201 - 500 hp	1,439	8,130	417	9,576	19,562
501 - 1000 hp	5,114	6,080	2,263	7,107	20,564
1000+ hp	8,369	193		9,883	18,445
All Motor Sizes	*19,681*	*31,309*	*4,533*	*44,071*	*99,594*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	44,081	52,572	5,149	238,360	340,162
6 - 20 hp	25,539	37,014	6,284	76,294	145,132
21 - 50 hp	8,793	26,602	4,456	44,795	84,646
51 - 100 hp	3,718	14,400	3,751	19,467	41,335
101 - 200 hp	2,855	8,076	754	8,465	20,151
201 - 500 hp	554	5,327	362	6,769	13,012
501 - 1000 hp	1,112	1,599	455	2,481	5,646
1000+ hp	776	29		1,261	2,066
All Motor Sizes	*87,428*	*145,619*	*21,211*	*397,892*	*652,149*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	5,399	4,725	2,809	3,478	3,997
6 - 20 hp	5,529	5,644	2,321	3,953	4,634
21 - 50 hp	4,725	6,725	4,813	4,857	5,481
51 - 100 hp	8,245	7,242	5,569	6,222	6,741
101 - 200 hp	5,587	6,698	5,540	7,074	6,669
201 - 500 hp	8,736	6,463	8,176	7,196	6,975
501 - 1000 hp	8,164	7,867	8,736	6,042	7,255
1000+ hp	8,736	8,736		7,945	8,294
All Motor Sizes	*7,719*	*6,825*	*6,613*	*6,354*	*6,748*

SIC 26 - Paper and Allied Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*139*	0.7%	*797*	2.5%	*2,452*	54.1%	*1,416*	3.2%	*4,805*	4.8%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*2,125*	2.4%	*6,087*	4.2%	*1,593*	7.5%	*26,113*	6.6%	*35,918*	5.5%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*2,945*	15.0%	*2,246*	7.2%	*3,375*	74.4%	*12,444*	28.2%	*21,010*	21.1%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*5,087*	5.8%	*17,857*	12.3%	*9,736*	45.9%	*99,739*	25.1%	*132,419*	20.3%

SIC 26 - Paper and Allied Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	330	91.7%	411	91.5%	16	67.9%	699	68.3%
6 - 20 hp	714	94.4%	1,532	90.4%	93	93.6%	1,338	70.5%
21 - 50 hp	634	78.4%	3,621	97.6%	381	81.5%	2,169	56.7%
51 - 100 hp	1,342	95.2%	5,165	92.4%	823	85.4%	2,894	54.7%
101 - 200 hp	937	65.8%	4,011	73.4%	74	25.0%	2,896	53.0%
201 - 500 hp	146	10.1%	1,933	23.8%	339	81.2%	4,882	51.0%
501 - 1000 hp	888	17.4%	2,472	40.7%			1,366	19.2%
1000+ hp	257	3.1%	193	100.0%			1,791	18.1%
All Motor Sizes	*5,248*	26.7%	*19,338*	61.8%	*1,727*	38.1%	*18,035*	40.9%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	37,662	85.4%	43,702	83.1%	3,946	76.6%	159,931	67.1%
6 - 20 hp	22,475	88.0%	34,146	92.3%	5,579	88.8%	45,208	59.3%
21 - 50 hp	6,885	78.3%	25,245	94.9%	3,507	78.7%	18,834	42.0%
51 - 100 hp	3,419	92.0%	13,295	92.3%	3,274	87.3%	8,403	43.2%
101 - 200 hp	2,401	84.1%	5,724	70.9%	392	51.9%	4,187	49.5%
201 - 500 hp	100	18.0%	2,331	43.8%	251	69.4%	4,077	60.2%
501 - 1000 hp	364	32.7%	661	41.4%			429	17.3%
1000+ hp	29	3.7%	29	100.0%			335	26.6%
All Motor Sizes	*73,334*	83.9%	*125,134*	85.9%	*16,948*	79.9%	*241,403*	60.7%

SIC 26 - Paper and Allied Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	1	0.2%					11	1.0%
6 - 20 hp			11	0.7%	2	2.2%	12	0.6%
21 - 50 hp							26	0.7%
51 - 100 hp			393	7.0%				
101 - 200 hp			235	4.3%	106	35.6%	65	1.2%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*1*	0.0%	*639*	2.0%	*108*	2.4%	*113*	0.3%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	334	0.8%					3,963	1.7%
6 - 20 hp			595	1.6%	595	9.5%	1,883	2.5%
21 - 50 hp							180	0.4%
51 - 100 hp			909	6.3%				
101 - 200 hp			909	11.3%	168	22.3%	84	1.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*334*	0.4%	*2,413*	1.7%	*763*	3.6%	*6,109*	1.5%

SIC 26 - Paper and Allied Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	1	0.2%	0	0.1%			213	20.8%
6 - 20 hp	1	0.1%					370	19.5%
21 - 50 hp							1,289	33.7%
51 - 100 hp							1,555	29.4%
101 - 200 hp			776	14.2%			1,330	24.3%
201 - 500 hp							1,431	14.9%
501 - 1000 hp			116	1.9%			2,079	29.2%
1000+ hp							258	2.6%
All Motor Sizes	*1*	0.0%	*892*	2.8%			*8,523*	19.3%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	286	0.6%	209	0.4%			37,599	15.8%
6 - 20 hp	286	1.1%					18,470	24.2%
21 - 50 hp							21,555	48.1%
51 - 100 hp							8,746	44.9%
101 - 200 hp			909	11.3%			3,052	36.1%
201 - 500 hp							933	13.8%
501 - 1000 hp			29	1.8%			778	31.4%
1000+ hp							54	4.2%
All Motor Sizes	*571*	0.7%	*1,147*	0.8%			*91,188*	22.9%

SIC 26 - Paper and Allied Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	3,377	8%	4,903	9%	504	10%	32,118	13%	40,901	12%
6 - 20 hp	1,692	7%	7,958	22%	619	10%	14,809	19%	25,079	17%
21 - 50 hp	1,545	18%	9,132	34%			7,823	17%	18,501	22%
51 - 100 hp	1,331	36%	4,178	29%	610	16%	5,125	26%	11,244	27%
101 - 200 hp	585	20%	1,782	22%			1,052	12%	3,419	17%
201 - 500 hp	71	13%	125	2%	37	10%	312	5%	546	4%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*8,602*	10%	*28,077*	19%	*1,769*	8%	*61,239*	15%	*99,687*	15%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,857	1.9%	77	4.1%	115	6.2%
6 - 20 hp	4,447	4.5%	122	2.7%	186	4.2%
21 - 50 hp	8,814	8.8%	201	2.3%	286	3.3%
51 - 100 hp	13,250	13.3%	254	1.9%	373	2.8%
101 - 200 hp	12,654	12.7%	235	1.9%	340	2.7%
201 - 500 hp	19,562	19.6%	382	2.0%	613	3.1%
501 - 1000 hp	20,564	20.6%	425	2.1%	676	3.3%
1000+ hp	18,445	18.5%	382	2.1%	608	3.3%
All Motor Sizes	*99,594*		*2,078*	2.1%	*3,197*	3.2%

SIC 26 - Paper and Allied Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	14	4.0%	21	4.6%	1	4.3%	40	3.9%	77	4.1%
6 - 20 hp	25	3.4%	44	2.6%	3	3.0%	49	2.6%	122	2.7%
21 - 50 hp	20	2.5%	80	2.2%	12	2.5%	90	2.3%	201	2.3%
51 - 100 hp	29	2.0%	111	2.0%	19	2.0%	94	1.8%	254	1.9%
101 - 200 hp	28	1.9%	92	1.7%	6	2.1%	109	2.0%	235	1.9%
201 - 500 hp	28	1.9%	162	2.0%	8	1.8%	184	1.9%	382	2.0%
501 - 1000 hp	106	2.1%	126	2.1%	47	2.1%	146	2.1%	425	2.1%
1000+ hp	174	2.1%	4	2.1%			205	2.1%	382	2.1%
All Motor Sizes	*424*	2.2%	*641*	2.0%	*96*	2.1%	*917*	2.1%	*2,078*	2.1%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	22	6.1%	30	6.8%	2	6.3%	61	6.0%	115	6.2%
6 - 20 hp	38	5.1%	69	4.1%	4	4.4%	74	3.9%	186	4.2%
21 - 50 hp	28	3.5%	114	3.1%	18	3.9%	126	3.3%	286	3.3%
51 - 100 hp	41	2.9%	161	2.9%	29	3.0%	142	2.7%	373	2.8%
101 - 200 hp	38	2.7%	132	2.4%	9	3.1%	161	2.9%	340	2.7%
201 - 500 hp	44	3.1%	260	3.2%	12	2.9%	297	3.1%	613	3.1%
501 - 1000 hp	169	3.3%	200	3.3%	75	3.3%	233	3.3%	676	3.3%
1000+ hp	276	3.3%	6	3.3%			326	3.3%	608	3.3%
All Motor Sizes	*657*	3.3%	*972*	3.1%	*149*	3.3%	*1,419*	3.2%	*3,197*	3.2%

SIC 26 - Paper and Allied Products

Potential Motor System Savings

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	20	90	4	20	135	7.3%
6 - 20 hp	42	341	17	38	437	9.8%
21 - 50 hp	44	746	80	77	946	10.7%
51 - 100 hp	78	1,123	164	106	1,471	11.1%
101 - 200 hp	78	1,098	51	109	1,337	10.6%
201 - 500 hp	79	1,634	71	192	1,976	10.1%
501 - 1000 hp	281	1,222	386	142	2,031	9.9%
1000+ hp	460	39		198	697	3.8%
All Motor Sizes	1,082	6,293	773	881	9,030	9.1%

SIC 27 - Printing and Publishing

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	320	43		848	1,210
6 - 20 hp	225	41	16	1,190	1,472
21 - 50 hp	408		421	1,168	1,997
51 - 100 hp				1,282	1,282
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*953*	*84*	*437*	*4,487*	*5,961*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	16,676	2,713	29,806	226,048	275,244
6 - 20 hp	6,750	2,868	10,553	138,692	158,863
21 - 50 hp	4,500		4,500	36,602	45,602
51 - 100 hp				3,640	3,640
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*27,925*	*5,581*	*44,859*	*404,983*	*483,348*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	8,241	6,832		2,465	2,782
6 - 20 hp	5,357	1,151	566	2,490	2,519
21 - 50 hp	4,748		4,200	2,958	3,437
51 - 100 hp				6,709	6,709
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*5,715*	*1,995*	*2,495*	*3,188*	*3,327*

SIC 27 - Printing and Publishing

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*201*	4.5%	*201*	3.4%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*89,419*	22.1%	*89,419*	18.5%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*34*	0.7%	*34*	0.6%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*39,742*	88.6%	*30,062*	7.4%	*69,804*	14.4%

SIC 27 - Printing and Publishing

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	319	99.6%	39	92.4%			505	59.6%
6 - 20 hp	225	100.0%	41	100.0%	16	100.0%	275	23.1%
21 - 50 hp	408	100.0%			421	100.0%	228	19.5%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*952*	99.9%	*80*	96.2%	*437*	100.0%	*1,008*	22.5%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	16,213	97.2%	2,250	82.9%	19,871	66.7%	131,532	58.2%
6 - 20 hp	6,750	100.0%	2,868	100.0%	10,553	100.0%	57,818	41.7%
21 - 50 hp	4,500	100.0%			4,500	100.0%	4,016	11.0%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*27,462*	98.3%	*5,118*	91.7%	*34,924*	77.9%	*193,366*	47.7%

SIC 27 - Printing and Publishing

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

SIC 27 - Printing and Publishing

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							156	18.3%
6 - 20 hp							915	76.9%
21 - 50 hp							887	76.0%
51 - 100 hp							1,282	100.0%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*3,239*	72.2%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							32,587	14.4%
6 - 20 hp							80,874	58.3%
21 - 50 hp							31,660	86.5%
51 - 100 hp							3,640	100.0%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*148,760*	36.7%

SIC 27 - Printing and Publishing

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp					9,935	33%	74,505	33%	84,440	31%
6 - 20 hp										
21 - 50 hp										
51 - 100 hp										
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes					*9,935*	22%	*74,505*	18%	*84,440*	17%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,210	20.3%	49	4.0%	74	6.1%
6 - 20 hp	1,472	24.7%	59	4.0%	91	6.2%
21 - 50 hp	1,997	33.5%	71	3.5%	95	4.8%
51 - 100 hp	1,282	21.5%	33	2.6%	45	3.5%
101 - 200 hp						
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*5,961*		*211*	3.5%	*305*	5.1%

SIC 27 - Printing and Publishing

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	13	4.0%	2	5.6%			33	3.9%	49	4.0%
6 - 20 hp	12	5.2%	2	4.6%	0	1.6%	46	3.8%	59	4.0%
21 - 50 hp	15	3.6%			12	2.9%	44	3.8%	71	3.5%
51 - 100 hp							33	2.6%	33	2.6%
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*39*	4.1%	*4*	5.1%	*12*	2.8%	*156*	3.5%	*211*	3.5%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	20	6.3%	3	7.7%			50	5.9%	74	6.1%
6 - 20 hp	17	7.5%	3	6.4%	1	3.1%	71	6.0%	91	6.2%
21 - 50 hp	20	4.8%			17	4.1%	58	5.0%	95	4.8%
51 - 100 hp							45	3.5%	45	3.5%
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*57*	5.9%	*6*	7.1%	*18*	4.0%	*225*	5.0%	*305*	5.1%

SIC 27 - Printing and Publishing

	Potential Motor System Savings					
Size Category	**Fan Savings (GWh/Yr)**	**Pump Savings (GWh/Yr)**	**Air Compressor Savings (GWh/Yr)**	**Other Savings (GWh/Yr)**	**Total Savings (GWh/Yr)**	**Total Savings (%)**
1 - 5 hp	18	9		17	43	3.6%
6 - 20 hp	12	8	3	24	47	3.2%
21 - 50 hp	22		72	23	118	5.9%
51 - 100 hp				26	26	2.0%
101 - 200 hp						
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	52	17	74	90	233	3.9%

SIC 28 - Chemicals and Allied Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	272	988	30	1,079	2,369
6 - 20 hp	948	5,421	160	2,733	9,262
21 - 50 hp	2,225	5,625	625	4,661	13,136
51 - 100 hp	2,678	4,354	1,280	5,075	13,387
101 - 200 hp	5,764	6,758	2,742	5,323	20,587
201 - 500 hp	3,299	8,134	3,956	10,747	26,136
501 - 1000 hp	1,949	652	3,107	14,075	19,783
1000+ hp		5,658	28,059	5,984	39,701
All Motor Sizes	*17,135*	*37,591*	*39,960*	*49,676*	*144,362*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	44,350	176,206	5,326	218,982	444,864
6 - 20 hp	25,021	167,120	9,481	112,607	314,230
21 - 50 hp	16,690	56,946	8,833	69,254	151,722
51 - 100 hp	10,653	17,709	7,256	26,191	61,809
101 - 200 hp	8,873	15,913	6,229	11,474	42,488
201 - 500 hp	2,792	7,830	2,884	9,563	23,070
501 - 1000 hp	657	255	1,012	4,831	6,755
1000+ hp		769	2,113	926	3,807
All Motor Sizes	*109,036*	*442,748*	*43,133*	*453,829*	*1,048,747*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	5,105	3,683	3,684	4,304	4,082
6 - 20 hp	6,128	5,220	2,692	4,314	4,910
21 - 50 hp	6,981	5,163	4,767	4,030	4,873
51 - 100 hp	6,587	6,049	4,653	5,729	5,853
101 - 200 hp	7,635	4,699	5,284	6,685	5,868
201 - 500 hp	6,508	5,803	6,115	7,253	6,474
501 - 1000 hp	8,400	6,410	6,456	7,715	7,495
1000+ hp		8,346	7,552	7,796	7,693
All Motor Sizes	*7,060*	*5,581*	*6,847*	*6,372*	*6,333*

SIC 28 - Chemicals and Allied Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*176*	1.0%	*1,332*	3.5%	*142*	0.4%	*1,669*	3.4%	*3,319*	2.3%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*1,581*	1.5%	*5,131*	1.2%	*12*	0.0%	*124,597*	27.5%	*131,322*	12.5%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*1,843*	10.8%	*1,855*	4.9%	*12,542*	31.4%	*14,074*	28.3%	*30,315*	21.0%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*5,847*	5.4%	*35,920*	8.1%	*9,932*	23.0%	*213,089*	47.0%	*264,788*	25.2%

SIC 28 - Chemicals and Allied Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	179	65.7%	781	79.0%	30	99.4%	446	41.3%
6 - 20 hp	864	91.2%	4,235	78.1%	94	58.4%	2,164	79.2%
21 - 50 hp	1,697	76.3%	4,715	83.8%	546	87.3%	3,634	78.0%
51 - 100 hp	2,337	87.3%	2,393	54.9%	1,202	93.9%	4,822	95.0%
101 - 200 hp	5,764	100.0%	6,758	100.0%	2,681	97.8%	3,937	74.0%
201 - 500 hp	2,388	72.4%	7,498	92.2%	3,284	83.0%	5,107	47.5%
501 - 1000 hp	1,949	100.0%	381	58.3%	2,274	73.2%	4,812	34.2%
1000+ hp					5,176	18.4%	5,984	100.0%
All Motor Sizes	*15,179*	88.6%	*26,760*	71.2%	*15,286*	38.3%	*30,906*	62.2%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	28,092	63.3%	119,929	68.1%	5,303	99.6%	77,379	35.3%
6 - 20 hp	21,503	85.9%	136,940	81.9%	6,003	63.3%	94,469	83.9%
21 - 50 hp	13,760	82.4%	49,482	86.9%	8,229	93.2%	54,875	79.2%
51 - 100 hp	9,374	88.0%	10,663	60.2%	6,801	93.7%	23,386	89.3%
101 - 200 hp	8,873	100.0%	15,913	100.0%	6,068	97.4%	8,296	72.3%
201 - 500 hp	1,894	67.8%	6,983	89.2%	2,092	72.5%	5,088	53.2%
501 - 1000 hp	657	100.0%	184	72.1%	785	77.6%	1,799	37.2%
1000+ hp					563	26.7%	926	100.0%
All Motor Sizes	*84,152*	77.2%	*340,094*	76.8%	*35,845*	83.1%	*266,217*	58.7%

SIC 28 - Chemicals and Allied Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							50	4.6%
6 - 20 hp			0	0.0%			12	0.5%
21 - 50 hp	8	0.4%	35	0.6%			4	0.1%
51 - 100 hp	130	4.9%	1,603	36.8%				
101 - 200 hp							22	0.4%
201 - 500 hp							3,089	28.7%
501 - 1000 hp								
1000+ hp					1,278	4.6%		
All Motor Sizes	*138*	0.8%	*1,639*	4.4%	*1,278*	3.2%	*3,177*	6.4%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							2,923	1.3%
6 - 20 hp			63	0.0%			739	0.7%
21 - 50 hp	36	0.2%	175	0.3%			122	0.2%
51 - 100 hp	485	4.6%	6,026	34.0%				
101 - 200 hp							63	0.5%
201 - 500 hp							2,951	30.9%
501 - 1000 hp								
1000+ hp					85	4.0%		
All Motor Sizes	*521*	0.5%	*6,264*	1.4%	*85*	0.2%	*6,797*	1.5%

SIC 28 - Chemicals and Allied Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp			5	0.5%			12	1.1%
6 - 20 hp			1	0.0%			116	4.2%
21 - 50 hp							257	5.5%
51 - 100 hp			227	5.2%			153	3.0%
101 - 200 hp							484	9.1%
201 - 500 hp							954	8.9%
501 - 1000 hp			200	30.7%			3,060	21.7%
1000+ hp								
All Motor Sizes			*433*	1.2%			*5,035*	10.1%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp			1,283	0.7%			2,170	1.0%
6 - 20 hp			36	0.0%			2,308	2.0%
21 - 50 hp							3,053	4.4%
51 - 100 hp			565	3.2%			1,012	3.9%
101 - 200 hp							1,402	12.2%
201 - 500 hp							771	8.1%
501 - 1000 hp			53	20.9%			1,216	25.2%
1000+ hp								
All Motor Sizes			*1,937*	0.4%			*11,931*	2.6%

SIC 28 - Chemicals and Allied Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	1,752	4%	17,567	10%	675	13%	14,549	7%	34,543	8%
6 - 20 hp	8,372	33%	24,798	15%	844	9%	13,463	12%	47,477	15%
21 - 50 hp	5,659	34%	16,878	30%	809	9%	9,439	14%	32,786	22%
51 - 100 hp	1,972	19%	8,230	46%	947	13%	6,111	23%	17,260	28%
101 - 200 hp	2,564	29%	4,423	28%	1,329	21%	5,568	49%	13,884	33%
201 - 500 hp	41	1%	2,497	32%	32	1%	2,008	21%	4,578	20%
501 - 1000 hp					85	8%			85	1%
1000+ hp					170	8%			170	4%
All Motor Sizes	*20,360*	19%	*74,394*	17%	*4,891*	11%	*51,138*	11%	*150,783*	14%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	2,369	1.6%	101	4.3%	150	6.3%
6 - 20 hp	9,262	6.4%	268	2.9%	422	4.6%
21 - 50 hp	13,136	9.1%	287	2.2%	413	3.1%
51 - 100 hp	13,387	9.3%	243	1.8%	350	2.6%
101 - 200 hp	20,587	14.3%	310	1.5%	463	2.2%
201 - 500 hp	26,136	18.1%	435	1.7%	710	2.7%
501 - 1000 hp	19,783	13.7%	404	2.0%	642	3.2%
1000+ hp	39,701	27.5%	673	1.7%	1,070	2.7%
All Motor Sizes	*144,362*		*2,720*	1.9%	*4,219*	2.9%

SIC 28 - Chemicals and Allied Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	14	5.1%	41	4.1%	1	3.8%	45	4.2%	101	4.3%
6 - 20 hp	23	2.4%	161	3.0%	5	3.3%	79	2.9%	268	2.9%
21 - 50 hp	34	1.5%	120	2.1%	20	3.3%	113	2.4%	287	2.2%
51 - 100 hp	57	2.1%	58	1.3%	32	2.5%	96	1.9%	243	1.8%
101 - 200 hp	88	1.5%	94	1.4%	68	2.5%	61	1.2%	310	1.5%
201 - 500 hp	51	1.5%	129	1.6%	81	2.0%	175	1.6%	435	1.7%
501 - 1000 hp	40	2.1%	14	2.1%	58	1.9%	292	2.1%	404	2.0%
1000+ hp			117	2.1%	432	1.5%	124	2.1%	673	1.7%
All Motor Sizes	*306*	1.8%	*733*	1.9%	*697*	1.7%	*985*	2.0%	*2,720*	1.9%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	20	7.4%	60	6.0%	2	5.8%	68	6.3%	150	6.3%
6 - 20 hp	34	3.6%	256	4.7%	8	4.9%	123	4.5%	422	4.6%
21 - 50 hp	51	2.3%	172	3.1%	28	4.5%	161	3.5%	413	3.1%
51 - 100 hp	84	3.1%	89	2.0%	42	3.3%	136	2.7%	350	2.6%
101 - 200 hp	135	2.3%	148	2.2%	90	3.3%	90	1.7%	463	2.2%
201 - 500 hp	91	2.7%	213	2.6%	129	3.3%	278	2.6%	710	2.7%
501 - 1000 hp	64	3.3%	21	3.3%	93	3.0%	464	3.3%	642	3.2%
1000+ hp			186	3.3%	686	2.4%	197	3.3%	1,070	2.7%
All Motor Sizes	*479*	2.8%	*1,146*	3.0%	*1,077*	2.7%	*1,517*	3.1%	*4,219*	2.9%

SIC 28 - Chemicals and Allied Products

Potential Motor System Savings

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	15	199	5	22	240	10.1%
6 - 20 hp	52	1,090	27	55	1,224	13.2%
21 - 50 hp	122	1,131	107	93	1,453	11.1%
51 - 100 hp	147	875	218	101	1,342	10.0%
101 - 200 hp	317	1,358	467	106	2,249	10.9%
201 - 500 hp	181	1,635	675	215	2,706	10.4%
501 - 1000 hp	107	131	530	281	1,050	5.3%
1000+ hp		1,137	4,784	120	6,041	15.2%
All Motor Sizes	942	7,556	6,813	994	16,305	11.3%

SIC 29 - Petroleum and Coal Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	99	194	1	243	536
6 - 20 hp	336	1,670	32	1,009	3,047
21 - 50 hp	778	3,747	510	1,410	6,445
51 - 100 hp	1,610	3,778	79	886	6,353
101 - 200 hp	859	5,521	61	765	7,207
201 - 500 hp	230	6,808	613	713	8,364
501 - 1000 hp	192	3,963	685	893	5,732
1000+ hp	821	4,961	5,949	2,523	14,254
All Motor Sizes	*4,924*	*30,643*	*7,930*	*8,441*	*51,938*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	52,198	90,864	4,903	118,536	266,501
6 - 20 hp	14,068	169,100	5,079	133,604	321,852
21 - 50 hp	12,289	56,937	13,794	74,796	157,816
51 - 100 hp	7,197	19,733	1,094	23,272	51,296
101 - 200 hp	2,893	14,958	269	5,482	23,603
201 - 500 hp	178	6,955	447	939	8,519
501 - 1000 hp	58	1,675	199	393	2,324
1000+ hp	96	971	628	167	1,861
All Motor Sizes	*88,976*	*361,192*	*26,414*	*357,190*	*833,772*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	1,745	1,404	136	1,767	1,582
6 - 20 hp	4,031	2,112	1,565	1,499	1,944
21 - 50 hp	5,014	3,914	3,070	1,655	3,025
51 - 100 hp	5,936	4,429	2,680	1,657	3,763
101 - 200 hp	3,517	4,647	2,256	2,847	4,170
201 - 500 hp	7,838	5,501	7,989	4,852	5,611
501 - 1000 hp	8,736	5,720	8,529	5,222	5,934
1000+ hp	8,254	5,850	7,729	6,989	6,859
All Motor Sizes	*5,123*	*4,570*	*6,737*	*2,684*	*4,332*

SIC 29 - Petroleum and Coal Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*2*	0.0%	*363*	1.2%	*0*	0.0%	*48*	0.6%	*412*	0.8%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*205*	0.2%	*29,558*	8.2%	*0*	0.0%	*9,844*	2.8%	*39,608*	4.8%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*334*	6.8%	*410*	1.3%	*1,663*	21.0%	*2,388*	28.3%	*4,795*	9.2%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*6,507*	7.3%	*35,456*	9.8%	*3,140*	11.9%	*210,483*	58.9%	*255,587*	30.7%

SIC 29 - Petroleum and Coal Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	75	76.0%	169	87.3%	1	100.0%	114	46.9%
6 - 20 hp	265	78.9%	1,427	85.4%	28	87.7%	660	65.4%
21 - 50 hp	769	98.8%	3,520	94.0%	303	59.4%	1,181	83.8%
51 - 100 hp	1,554	96.5%	3,289	87.1%	75	95.2%	757	85.5%
101 - 200 hp	653	76.0%	4,554	82.5%	37	60.8%	598	78.2%
201 - 500 hp	125	54.2%	4,399	64.6%	64	10.4%	515	72.2%
501 - 1000 hp	192	100.0%	3,139	79.2%	32	4.6%	503	56.4%
1000+ hp	821	100.0%	1,683	33.9%	3,858	64.9%		
All Motor Sizes	*4,453*	90.4%	*22,181*	72.4%	*4,398*	55.5%	*4,330*	51.3%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	42,794	82.0%	59,589	65.6%	4,903	100.0%	66,033	55.7%
6 - 20 hp	9,105	64.7%	127,432	75.4%	4,941	97.3%	98,905	74.0%
21 - 50 hp	12,099	98.5%	53,643	94.2%	4,946	35.9%	58,522	78.2%
51 - 100 hp	6,673	92.7%	16,811	85.2%	1,084	99.1%	20,981	90.2%
101 - 200 hp	2,226	76.9%	11,808	78.9%	47	17.6%	4,133	75.4%
201 - 500 hp	102	57.4%	4,293	61.7%	59	13.2%	802	85.4%
501 - 1000 hp	58	100.0%	1,278	76.3%	12	5.8%	287	72.9%
1000+ hp	96	100.0%	359	36.9%	307	49.0%		
All Motor Sizes	*73,153*	82.2%	*275,213*	76.2%	*16,300*	61.7%	*249,662*	69.9%

SIC 29 - Petroleum and Coal Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	2	2.4%						
6 - 20 hp			0	0.0%			9	0.9%
21 - 50 hp			9	0.3%			0	0.0%
51 - 100 hp	6	0.4%	122	3.2%	4	4.8%	30	3.4%
101 - 200 hp	35	4.0%	277	5.0%				
201 - 500 hp			122	1.8%				
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*43*	0.9%	*530*	1.7%	*4*	0.0%	*40*	0.5%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	509	1.0%						
6 - 20 hp			24	0.0%			1,296	1.0%
21 - 50 hp			96	0.2%			190	0.3%
51 - 100 hp	15	0.2%	1,299	6.6%	10	0.9%	698	3.0%
101 - 200 hp	56	1.9%	912	6.1%				
201 - 500 hp			222	3.2%				
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*580*	0.7%	*2,552*	0.7%	*10*	0.0%	*2,184*	0.6%

SIC 29 - Petroleum and Coal Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp			0	0.1%			27	11.2%
6 - 20 hp			8	0.5%			98	9.7%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes			*8*	0.0%			*125*	1.5%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp			4,164	4.6%			8,804	7.4%
6 - 20 hp			714	0.4%			4,203	3.1%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes			*4,878*	1.4%			*13,006*	3.6%

SIC 29 - Petroleum and Coal Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp			9,351	10%			3,234	3%	12,584	5%
6 - 20 hp	606	4%	18,577	11%	222	4%	7,160	5%	26,565	8%
21 - 50 hp	278	2%	3,504	6%	440	3%	14,400	19%	18,623	12%
51 - 100 hp	278	4%	183	1%			602	3%	1,064	2%
101 - 200 hp	440	15%	1,220	8%					1,660	7%
201 - 500 hp			1,463	21%			205	22%	1,668	20%
501 - 1000 hp										
1000+ hp			12	1%					12	1%
All Motor Sizes	*1,603*	2%	*34,310*	9%	*662*	3%	*25,601*	7%	*62,176*	7%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	536	1.0%	25	4.7%	37	6.8%
6 - 20 hp	3,047	5.9%	96	3.1%	145	4.7%
21 - 50 hp	6,445	12.4%	174	2.7%	248	3.8%
51 - 100 hp	6,353	12.2%	147	2.3%	221	3.5%
101 - 200 hp	7,207	13.9%	143	2.0%	209	2.9%
201 - 500 hp	8,364	16.1%	140	1.7%	222	2.7%
501 - 1000 hp	5,732	11.0%	119	2.1%	189	3.3%
1000+ hp	14,254	27.4%	294	2.1%	467	3.3%
All Motor Sizes	*51,938*		*1,137*	2.2%	*1,736*	3.3%

SIC 29 - Petroleum and Coal Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	5	5.5%	8	4.1%	0	7.4%	12	4.8%	25	4.7%
6 - 20 hp	11	3.3%	48	2.9%	1	2.7%	35	3.5%	96	3.1%
21 - 50 hp	29	3.7%	91	2.4%	16	3.1%	38	2.7%	174	2.7%
51 - 100 hp	37	2.3%	91	2.4%	2	2.3%	17	1.9%	147	2.3%
101 - 200 hp	15	1.8%	111	2.0%	1	2.1%	16	2.0%	143	2.0%
201 - 500 hp	5	2.1%	110	1.6%	13	2.1%	12	1.7%	140	1.7%
501 - 1000 hp	4	2.1%	82	2.1%	14	2.1%	19	2.1%	119	2.1%
1000+ hp	17	2.1%	101	2.0%	123	2.1%	52	2.1%	294	2.1%
All Motor Sizes	*124*	2.5%	*642*	2.1%	*170*	2.1%	*201*	2.4%	*1,137*	2.2%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	8	7.8%	12	6.1%	0	9.5%	17	7.0%	37	6.8%
6 - 20 hp	17	5.1%	72	4.3%	1	4.4%	54	5.4%	145	4.7%
21 - 50 hp	38	4.9%	135	3.6%	23	4.4%	52	3.7%	248	3.8%
51 - 100 hp	57	3.5%	133	3.5%	3	3.6%	28	3.2%	221	3.5%
101 - 200 hp	24	2.8%	160	2.9%	2	3.3%	22	2.9%	209	2.9%
201 - 500 hp	8	3.3%	174	2.6%	20	3.3%	20	2.8%	222	2.7%
501 - 1000 hp	6	3.3%	131	3.3%	23	3.3%	29	3.3%	189	3.3%
1000+ hp	27	3.3%	161	3.2%	196	3.3%	83	3.3%	467	3.3%
All Motor Sizes	*185*	3.8%	*978*	3.2%	*268*	3.4%	*306*	3.6%	*1,736*	3.3%

SIC 29 - Petroleum and Coal Products

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
	Potential Motor System Savings					
1 - 5 hp	5	39	0	5	49	9.2%
6 - 20 hp	18	336	5	20	380	12.5%
21 - 50 hp	43	753	87	28	911	14.1%
51 - 100 hp	89	759	14	18	879	13.8%
101 - 200 hp	47	1,110	10	15	1,183	16.4%
201 - 500 hp	13	1,368	104	14	1,500	17.9%
501 - 1000 hp	11	796	117	18	942	16.4%
1000+ hp	45	997	1,014	50	2,107	14.8%
All Motor Sizes	271	6,159	1,352	169	7,951	15.3%

SIC 30 - Rubber and Miscellaneous Plastics Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	309	281	62	706	1,358
6 - 20 hp	682	1,262	482	1,627	4,052
21 - 50 hp	313	2,621	523	3,627	7,084
51 - 100 hp	62	4,710	779	4,049	9,600
101 - 200 hp	580	336	1,305	6,629	8,850
201 - 500 hp	115		1,616	1,672	3,403
501 - 1000 hp				1,948	1,948
1000+ hp				313	313
All Motor Sizes	*2,061*	*9,211*	*4,767*	*20,572*	*36,610*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	38,373	43,510	7,949	180,159	269,992
6 - 20 hp	18,651	52,171	16,504	59,109	146,435
21 - 50 hp	5,075	22,065	7,882	42,667	77,688
51 - 100 hp	287	21,466	3,510	14,822	40,086
101 - 200 hp	1,262	862	2,732	14,652	19,508
201 - 500 hp	113		2,009	1,193	3,315
501 - 1000 hp				612	612
1000+ hp				202	202
All Motor Sizes	*63,762*	*140,074*	*40,585*	*313,417*	*557,838*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	5,947	4,190	3,589	2,992	3,649
6 - 20 hp	6,735	3,692	4,197	4,678	4,475
21 - 50 hp	4,777	5,999	4,674	5,062	5,323
51 - 100 hp	7,357	5,971	5,665	6,377	6,116
101 - 200 hp	7,813	7,238	6,770	6,001	6,241
201 - 500 hp	5,242		6,523	6,051	6,232
501 - 1000 hp				7,971	7,971
1000+ hp				3,744	3,744
All Motor Sizes	*6,374*	*5,479*	*5,799*	*5,645*	*5,658*

SIC 30 - Rubber and Miscellaneous Plastics Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*59*	2.8%	*0*	0.0%	*0*	0.0%	*239*	1.2%	*298*	0.8%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*1,333*	2.1%	*0*	0.0%	*0*	0.0%	*12,538*	4.0%	*13,871*	2.5%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*73*	3.6%	*1*	0.0%	*2,766*	58.0%	*3,589*	17.4%	*6,429*	17.6%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*1,446*	2.3%	*862*	0.6%	*10,741*	26.5%	*62,046*	19.8%	*75,095*	13.5%

SIC 30 - Rubber and Miscellaneous Plastics Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	302	97.6%	256	91.0%	57	91.8%	512	72.5%
6 - 20 hp	677	99.4%	1,161	92.0%	482	100.0%	967	59.5%
21 - 50 hp	298	95.2%	2,581	98.5%	441	84.4%	2,044	56.3%
51 - 100 hp	62	100.0%	4,626	98.2%	779	100.0%	1,629	40.2%
101 - 200 hp	580	100.0%	336	100.0%	1,305	100.0%	2,848	43.0%
201 - 500 hp					1,616	100.0%	192	11.5%
501 - 1000 hp							1,778	91.3%
1000+ hp							313	100.0%
All Motor Sizes	*1,920*	93.1%	*8,960*	97.3%	*4,680*	98.2%	*10,283*	50.0%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	35,385	92.2%	39,018	89.7%	6,438	81.0%	121,977	67.7%
6 - 20 hp	18,493	99.2%	48,211	92.4%	16,504	100.0%	38,118	64.5%
21 - 50 hp	3,351	66.0%	21,374	96.9%	5,806	73.7%	24,495	57.4%
51 - 100 hp	287	100.0%	21,232	98.9%	3,510	100.0%	6,895	46.5%
101 - 200 hp	1,262	100.0%	862	100.0%	2,732	100.0%	8,212	56.0%
201 - 500 hp					2,009	100.0%	113	9.5%
501 - 1000 hp							533	87.1%
1000+ hp							202	100.0%
All Motor Sizes	*58,778*	92.2%	*130,697*	93.3%	*36,997*	91.2%	*200,546*	64.0%

SIC 30 - Rubber and Miscellaneous Plastics Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp								
21 - 50 hp							84	2.3%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*84*	0.4%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp								
21 - 50 hp							862	2.0%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*862*	0.3%

SIC 30 - Rubber and Miscellaneous Plastics Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp			1	0.5%			115	16.3%
6 - 20 hp							176	10.8%
21 - 50 hp					35	6.7%	805	22.2%
51 - 100 hp							1,673	41.3%
101 - 200 hp							3,248	49.0%
201 - 500 hp	115	100.0%					730	43.7%
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*115*	5.6%	*1*	0.0%	*35*	0.7%	*6,747*	32.8%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp			79	0.2%			32,845	18.2%
6 - 20 hp							3,917	6.6%
21 - 50 hp					862	10.9%	6,996	16.4%
51 - 100 hp							5,680	38.3%
101 - 200 hp							5,579	38.1%
201 - 500 hp	113	100.0%					653	54.7%
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*113*	0.2%	*79*	0.1%	*862*	2.1%	*55,671*	17.8%

SIC 30 - Rubber and Miscellaneous Plastics Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	4,258	11%	2,498	6%	1,914	24%	8,140	5%	16,811	6%
6 - 20 hp	1,350	7%	1,827	4%	1,979	12%	5,449	9%	10,605	7%
21 - 50 hp	493	10%	347	2%	767	10%	967	2%	2,574	3%
51 - 100 hp			468	2%	102	3%	102	1%	672	2%
101 - 200 hp	400	32%			102	4%	357	2%	858	4%
201 - 500 hp					357	18%			357	11%
501 - 1000 hp							267	44%	267	44%
1000+ hp										
All Motor Sizes	*6,501*	10%	*5,141*	4%	*5,221*	13%	*15,280*	5%	*32,143*	6%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,358	3.7%	64	4.7%	96	7.0%
6 - 20 hp	4,052	11.1%	139	3.4%	214	5.3%
21 - 50 hp	7,084	19.4%	232	3.3%	317	4.5%
51 - 100 hp	9,600	26.2%	222	2.3%	337	3.5%
101 - 200 hp	8,850	24.2%	187	2.1%	268	3.0%
201 - 500 hp	3,403	9.3%	67	2.0%	107	3.1%
501 - 1000 hp	1,948	5.3%	136	7.0%	148	7.6%
1000+ hp	313	0.9%	7	2.1%	10	3.3%
All Motor Sizes	*36,610*		*1,053*	2.9%	*1,498*	4.1%

SIC 30 - Rubber and Miscellaneous Plastics Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	14	4.4%	12	4.4%	2	4.0%	35	5.0%	64	4.7%
6 - 20 hp	24	3.5%	47	3.7%	15	3.1%	53	3.3%	139	3.4%
21 - 50 hp	10	3.1%	93	3.6%	18	3.4%	111	3.1%	232	3.3%
51 - 100 hp	1	2.1%	110	2.3%	14	1.8%	97	2.4%	222	2.3%
101 - 200 hp	3	0.5%	8	2.5%	29	2.2%	147	2.2%	187	2.1%
201 - 500 hp	2	2.1%			30	1.9%	35	2.1%	67	2.0%
501 - 1000 hp							136	7.0%	136	7.0%
1000+ hp							7	2.1%	7	2.1%
All Motor Sizes	*54*	2.6%	*271*	2.9%	*108*	2.3%	*620*	3.0%	*1,053*	2.9%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	21	6.6%	19	6.8%	4	5.9%	52	7.4%	96	7.0%
6 - 20 hp	37	5.4%	71	5.6%	24	4.9%	82	5.1%	214	5.3%
21 - 50 hp	13	4.2%	127	4.8%	23	4.4%	154	4.2%	317	4.5%
51 - 100 hp	2	3.4%	169	3.6%	23	2.9%	143	3.5%	337	3.5%
101 - 200 hp	6	1.1%	11	3.4%	43	3.3%	208	3.1%	268	3.0%
201 - 500 hp	4	3.3%			48	3.0%	55	3.3%	107	3.1%
501 - 1000 hp							148	7.6%	148	7.6%
1000+ hp							10	3.3%	10	3.3%
All Motor Sizes	*82*	4.0%	*397*	4.3%	*164*	3.4%	*854*	4.1%	*1,498*	4.1%

SIC 30 - Rubber and Miscellaneous Plastics Products

Potential Motor System Savings

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	17	56	11	14	98	7.2%
6 - 20 hp	37	254	82	33	406	10.0%
21 - 50 hp	17	527	89	73	706	10.0%
51 - 100 hp	3	947	133	81	1,164	12.1%
101 - 200 hp	32	68	223	133	455	5.1%
201 - 500 hp	6		276	33	315	9.3%
501 - 1000 hp				39	39	2.0%
1000+ hp				6	6	2.0%
All Motor Sizes	113	1,851	813	411	3,189	8.7%

SIC 31 - Leather and Leather Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	41	1		6	48
6 - 20 hp	442				442
21 - 50 hp			1		1
51 - 100 hp					
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*483*	*1*	*1*	*6*	*491*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	6,683	6,683		20,048	33,414
6 - 20 hp	18,378				18,378
21 - 50 hp			1,671		1,671
51 - 100 hp					
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*25,061*	*6,683*	*1,671*	*20,048*	*53,463*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	3,819	212		313	1,330
6 - 20 hp	2,635				2,635
21 - 50 hp			42		42
51 - 100 hp					
101 - 200 hp					
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*2,706*	*212*	*42*	*313*	*2,098*

SIC 31 - Leather and Leather Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*0*	0.0%		

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*0*	0.0%		

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*1*	100.0%	*6*	100.0%	*8*	1.6%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*1,671*	100.0%	*20,048*	100.0%	*21,719*	40.6%

SIC 31 - Leather and Leather Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	41	100.0%	1	100.0%			3	44.8%
6 - 20 hp	442	100.0%						
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*483*	100.0%	*1*	100.0%			*3*	44.8%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	6,683	100.0%	6,683	100.0%			10,024	50.0%
6 - 20 hp	18,378	100.0%						
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*25,061*	100.0%	*6,683*	100.0%			*10,024*	50.0%

SIC 31 - Leather and Leather Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

SIC 31 - Leather and Leather Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes								

SIC 31 - Leather and Leather Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp										
6 - 20 hp										
21 - 50 hp										
51 - 100 hp										
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes										

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	48	9.8%	2	4.5%	4	7.4%
6 - 20 hp	442	89.9%	12	2.7%	19	4.3%
21 - 50 hp	1	0.3%	0	3.8%	0	5.0%
51 - 100 hp						
101 - 200 hp						
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*491*		*14*	2.9%	*22*	4.6%

SIC 31 - Leather and Leather Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	2	4.4%	0	1.2%			0	5.4%	2	4.5%
6 - 20 hp	12	2.7%							12	2.7%
21 - 50 hp					0	3.8%			0	3.8%
51 - 100 hp										
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*14*	2.9%	*0*	1.2%	*0*	3.8%	*0*	5.4%	*14*	2.9%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	3	7.2%	0	5.8%			1	9.3%	4	7.4%
6 - 20 hp	19	4.3%							19	4.3%
21 - 50 hp					0	5.0%			0	5.0%
51 - 100 hp										
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*22*	4.5%	*0*	5.8%	*0*	5.0%	*1*	9.3%	*22*	4.6%

SIC 31 - Leather and Leather Products

	Potential Motor System Savings					
Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	2	0		0	3	5.4%
6 - 20 hp	24				24	5.5%
21 - 50 hp			0		0	17.1%
51 - 100 hp						
101 - 200 hp						
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	27	0	0	0	27	5.5%

SIC 32 - Stone, Clay, and Glass Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	80	39		263	382
6 - 20 hp	367	51	69	332	819
21 - 50 hp	125		190	408	723
51 - 100 hp			5		5
101 - 200 hp			302		302
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*572*	*90*	*566*	*1,004*	*2,231*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	21,507	11,400		86,447	119,354
6 - 20 hp	22,112	7,204	10,918	28,176	68,410
21 - 50 hp	3,239		4,836	7,218	15,293
51 - 100 hp			1,612		1,612
101 - 200 hp			813		813
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*46,858*	*18,604*	*18,180*	*121,840*	*205,482*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	2,989	2,833		2,106	2,309
6 - 20 hp	4,249	1,446	1,234	2,053	2,413
21 - 50 hp	2,145		2,412	3,373	2,802
51 - 100 hp			113		113
101 - 200 hp			8,400		8,400
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*3,336*	*1,836*	*2,671*	*2,461*	*2,656*

SIC 32 - Stone, Clay, and Glass Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*0*	0.0%		

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*0*	0.0%		

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*4*	0.6%	*21*	23.9%	*520*	91.9%	*483*	48.1%	*1,028*	46.1%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*3,447*	7.4%	*5,088*	27.3%	*11,538*	63.5%	*50,599*	41.5%	*70,672*	34.4%

SIC 32 - Stone, Clay, and Glass Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	80	100.0%	32	82.0%			170	64.6%
6 - 20 hp	367	100.0%	14	27.1%	69	100.0%	257	77.5%
21 - 50 hp	125	100.0%			190	100.0%	183	44.8%
51 - 100 hp					5	100.0%		
101 - 200 hp					302	100.0%		
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*572*	100.0%	*46*	50.9%	*566*	100.0%	*610*	60.8%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	21,507	100.0%	7,939	69.6%			59,558	68.9%
6 - 20 hp	22,112	100.0%	5,232	72.6%	10,918	100.0%	23,463	83.3%
21 - 50 hp	3,239	100.0%			4,836	100.0%	1,627	22.5%
51 - 100 hp					1,612	100.0%		
101 - 200 hp					813	100.0%		
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*46,858*	100.0%	*13,171*	70.8%	*18,180*	100.0%	*84,648*	69.5%

SIC 32 - Stone, Clay, and Glass Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							0	0.1%
6 - 20 hp								
21 - 50 hp							19	4.7%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*19*	1.9%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							3,195	3.7%
6 - 20 hp								
21 - 50 hp							799	11.1%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*3,993*	3.3%

SIC 32 - Stone, Clay, and Glass Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							4	1.5%
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*4*	0.4%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							799	0.9%
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*799*	0.7%

SIC 32 - Stone, Clay, and Glass Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp							6,507	8%	6,507	5%
6 - 20 hp	799	4%			813	7%	2,440	9%	4,052	6%
21 - 50 hp										
51 - 100 hp										
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*799*	2%			*813*	4%	*8,948*	7%	*10,560*	5%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	382	17.1%	14	3.8%	23	6.1%
6 - 20 hp	819	36.7%	36	4.4%	50	6.2%
21 - 50 hp	723	32.4%	29	4.0%	37	5.2%
51 - 100 hp	5	0.2%	0	3.4%	0	4.8%
101 - 200 hp	302	13.5%	3	1.0%	6	1.9%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*2,231*		*82*	3.7%	*117*	5.3%

SIC 32 - Stone, Clay, and Glass Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	2	2.8%	2	4.0%			11	4.0%	14	3.8%
6 - 20 hp	22	5.9%	2	3.3%	3	4.1%	9	2.8%	36	4.4%
21 - 50 hp	5	4.1%			8	4.1%	16	3.9%	29	4.0%
51 - 100 hp					0	3.4%			0	3.4%
101 - 200 hp					3	1.0%			3	1.0%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*29*	5.1%	*3*	3.6%	*14*	2.4%	*36*	3.6%	*82*	3.7%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	4	5.4%	3	6.5%			17	6.3%	23	6.1%
6 - 20 hp	29	7.8%	3	5.5%	4	5.9%	15	4.5%	50	6.2%
21 - 50 hp	7	5.5%			10	5.3%	20	5.0%	37	5.2%
51 - 100 hp					0	4.8%			0	4.8%
101 - 200 hp					6	1.9%			6	1.9%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*40*	6.9%	*5*	5.9%	*20*	3.6%	*52*	5.2%	*117*	5.3%

SIC 32 - Stone, Clay, and Glass Products

	Potential Motor System Savings					
Size Category	**Fan Savings (GWh/Yr)**	**Pump Savings (GWh/Yr)**	**Air Compressor Savings (GWh/Yr)**	**Other Savings (GWh/Yr)**	**Total Savings (GWh/Yr)**	**Total Savings (%)**
1 - 5 hp	4	8		5	17	4.6%
6 - 20 hp	20	10	12	7	49	6.0%
21 - 50 hp	7		32	8	47	6.6%
51 - 100 hp			1		1	17.1%
101 - 200 hp			51		51	17.1%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	31	18	96	20	166	7.4%

SIC 33 - Primary Metal Industries

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	465	377	38	2,490	3,370
6 - 20 hp	908	1,159	212	3,628	5,906
21 - 50 hp	1,425	2,112	276	4,609	8,422
51 - 100 hp	354	1,772	154	6,451	8,731
101 - 200 hp	2,072	1,380	989	6,438	10,879
201 - 500 hp	901	533	3,952	11,706	17,092
501 - 1000 hp	1,281	154	1,003	14,985	17,423
1000+ hp	6,019	159	5,984	3,948	16,111
All Motor Sizes	*13,424*	*7,646*	*12,609*	*54,256*	*87,935*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	67,282	76,390	18,508	388,208	550,389
6 - 20 hp	42,946	59,360	22,197	136,759	261,262
21 - 50 hp	22,317	30,006	8,131	46,239	106,693
51 - 100 hp	1,894	8,811	1,520	23,149	35,374
101 - 200 hp	4,171	3,731	1,938	11,263	21,103
201 - 500 hp	1,133	777	6,589	8,496	16,995
501 - 1000 hp	513	58	568	5,501	6,639
1000+ hp	915	27	1,067	520	2,529
All Motor Sizes	*141,171*	*179,160*	*60,519*	*620,135*	*1,000,985*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	4,485	3,346	683	5,003	4,377
6 - 20 hp	3,654	3,822	2,208	4,657	4,140
21 - 50 hp	3,737	4,011	2,464	6,445	4,854
51 - 100 hp	4,801	5,610	2,402	7,591	6,698
101 - 200 hp	7,064	5,649	6,970	8,066	7,362
201 - 500 hp	7,502	7,993	5,402	7,888	7,114
501 - 1000 hp	6,946	7,267	3,161	8,685	7,750
1000+ hp	7,479	5,436	8,250	5,817	7,198
All Motor Sizes	*6,075*	*4,720*	*5,618*	*7,207*	*6,465*

SIC 33 - Primary Metal Industries

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*4,280*	31.9%	*11*	0.1%	*0*	0.0%	*951*	1.8%	*5,241*	6.0%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*1,311*	0.9%	*1,357*	0.8%	*0*	0.0%	*31,907*	5.1%	*34,574*	3.5%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*2*	0.0%	*354*	4.6%	*1,058*	8.4%	*5,475*	10.1%	*6,889*	7.8%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*245*	0.2%	*28,202*	15.7%	*10,267*	17.0%	*138,072*	22.3%	*176,786*	17.7%

SIC 33 - Primary Metal Industries

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	435	93.5%	272	72.2%	11	27.7%	2,182	87.6%
6 - 20 hp	768	84.6%	1,030	88.9%	212	100.0%	2,770	76.3%
21 - 50 hp	1,297	91.0%	1,967	93.1%	276	100.0%	3,302	71.6%
51 - 100 hp	354	100.0%	1,762	99.5%	154	100.0%	5,019	77.8%
101 - 200 hp	1,742	84.1%	1,275	92.4%	861	87.0%	2,726	42.3%
201 - 500 hp	625	69.4%	478	89.7%	2,379	60.2%	352	3.0%
501 - 1000 hp	1,075	83.9%	86	55.8%			7,577	50.6%
1000+ hp	1,308	21.7%	159	100.0%	5,470	91.4%		
All Motor Sizes	*7,604*	56.6%	*7,030*	91.9%	*9,364*	74.3%	*23,929*	44.1%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	45,259	67.3%	44,050	57.7%	5,191	28.0%	270,536	69.7%
6 - 20 hp	28,922	67.3%	43,875	73.9%	22,197	100.0%	100,936	73.8%
21 - 50 hp	21,557	96.6%	27,135	90.4%	8,131	100.0%	29,706	64.2%
51 - 100 hp	1,894	100.0%	8,756	99.4%	1,520	100.0%	17,201	74.3%
101 - 200 hp	3,418	82.0%	3,447	92.4%	1,539	79.4%	4,561	40.5%
201 - 500 hp	691	61.0%	714	91.9%	5,360	81.3%	496	5.8%
501 - 1000 hp	418	81.5%	37	64.9%			2,499	45.4%
1000+ hp	305	33.3%	27	100.0%	973	91.1%		
All Motor Sizes	*102,465*	72.6%	*128,042*	71.5%	*44,911*	74.2%	*425,933*	68.7%

SIC 33 - Primary Metal Industries

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	2	0.5%					0	0.0%
6 - 20 hp			13	1.1%			166	4.6%
21 - 50 hp							56	1.2%
51 - 100 hp			9	0.5%			202	3.1%
101 - 200 hp	274	13.2%	104	7.6%			20	0.3%
201 - 500 hp	110	12.3%	55	10.3%			235	2.0%
501 - 1000 hp	206	16.1%	68	44.2%	176	17.6%		
1000+ hp	1,305	21.7%			514	8.6%		
All Motor Sizes	*1,898*	14.1%	*250*	3.3%	*690*	5.5%	*678*	1.2%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	400	0.6%					63	0.0%
6 - 20 hp			360	0.6%			8,941	6.5%
21 - 50 hp							478	1.0%
51 - 100 hp			55	0.6%			541	2.3%
101 - 200 hp	694	16.6%	284	7.6%			63	0.6%
201 - 500 hp	189	16.7%	63	8.1%			379	4.5%
501 - 1000 hp	95	18.5%	20	35.1%	95	16.7%		
1000+ hp	189	20.7%			95	8.9%		
All Motor Sizes	*1,567*	1.1%	*782*	0.4%	*189*	0.3%	*10,465*	1.7%

SIC 33 - Primary Metal Industries

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp			7	1.9%	9	24.4%	154	6.2%
6 - 20 hp							462	12.7%
21 - 50 hp							947	20.5%
51 - 100 hp							1,207	18.7%
101 - 200 hp							3,693	57.4%
201 - 500 hp							10,805	92.3%
501 - 1000 hp							7,408	49.4%
1000+ hp							3,070	77.7%
All Motor Sizes			*7*	0.1%	*9*	0.1%	*27,745*	51.1%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp			267	0.3%	415	2.2%	36,856	9.5%
6 - 20 hp							18,828	13.8%
21 - 50 hp							10,395	22.5%
51 - 100 hp							5,149	22.2%
101 - 200 hp							6,639	58.9%
201 - 500 hp							7,370	86.7%
501 - 1000 hp							3,002	54.6%
1000+ hp							501	96.5%
All Motor Sizes			*267*	0.1%	*415*	0.7%	*88,740*	14.3%

SIC 33 - Primary Metal Industries

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	715	1%	1,591	2%	540	3%	8,947	2%	11,793	2%
6 - 20 hp	658	2%	3,551	6%			1,050	1%	5,259	2%
21 - 50 hp	723	3%	1,810	6%			2,067	4%	4,600	4%
51 - 100 hp	652	34%	2,325	26%					2,977	8%
101 - 200 hp			19	1%					19	0%
201 - 500 hp										
501 - 1000 hp										
1000+ hp					243	23%			243	10%
All Motor Sizes	*2,748*	2%	*9,296*	5%	*783*	1%	*12,064*	2%	*24,891*	2%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	3,370	3.8%	168	5.0%	248	7.4%
6 - 20 hp	5,906	6.7%	229	3.9%	345	5.8%
21 - 50 hp	8,422	9.6%	248	2.9%	350	4.2%
51 - 100 hp	8,731	9.9%	206	2.4%	297	3.4%
101 - 200 hp	10,879	12.4%	234	2.2%	341	3.1%
201 - 500 hp	17,092	19.4%	355	2.1%	564	3.3%
501 - 1000 hp	17,423	19.8%	361	2.1%	574	3.3%
1000+ hp	16,111	18.3%	301	1.9%	479	3.0%
All Motor Sizes	*87,935*		*2,104*	2.4%	*3,199*	3.6%

SIC 33 - Primary Metal Industries

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	21	4.5%	18	4.8%	2	4.8%	128	5.1%	168	5.0%
6 - 20 hp	35	3.9%	44	3.8%	19	9.0%	130	3.6%	229	3.9%
21 - 50 hp	42	2.9%	64	3.0%	6	2.3%	136	3.0%	248	2.9%
51 - 100 hp	7	1.9%	35	2.0%	4	2.5%	160	2.5%	206	2.4%
101 - 200 hp	38	1.8%	30	2.2%	22	2.2%	145	2.2%	234	2.2%
201 - 500 hp	20	2.2%	11	2.1%	82	2.1%	243	2.1%	355	2.1%
501 - 1000 hp	27	2.1%	3	2.1%	21	2.1%	311	2.1%	361	2.1%
1000+ hp	125	2.1%	3	2.1%	91	1.5%	82	2.1%	301	1.9%
All Motor Sizes	*314*	2.3%	*210*	2.7%	*247*	2.0%	*1,334*	2.5%	*2,104*	2.4%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	32	6.8%	27	7.1%	3	6.8%	187	7.5%	248	7.4%
6 - 20 hp	54	5.9%	65	5.6%	23	11.0%	203	5.6%	345	5.8%
21 - 50 hp	59	4.2%	90	4.2%	10	3.6%	192	4.2%	350	4.2%
51 - 100 hp	10	2.7%	52	2.9%	5	3.5%	230	3.6%	297	3.4%
101 - 200 hp	59	2.8%	44	3.2%	32	3.2%	207	3.2%	341	3.1%
201 - 500 hp	31	3.4%	18	3.3%	130	3.3%	386	3.3%	564	3.3%
501 - 1000 hp	42	3.3%	5	3.3%	33	3.3%	494	3.3%	574	3.3%
1000+ hp	198	3.3%	5	3.3%	145	2.4%	130	3.3%	479	3.0%
All Motor Sizes	*484*	3.6%	*305*	4.0%	*382*	3.0%	*2,028*	3.7%	*3,199*	3.6%

SIC 33 - Primary Metal Industries

	Potential Motor System Savings					
Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	26	76	7	50	158	4.7%
6 - 20 hp	50	233	36	73	392	6.6%
21 - 50 hp	78	424	47	92	642	7.6%
51 - 100 hp	19	356	26	129	531	6.1%
101 - 200 hp	114	277	169	129	689	6.3%
201 - 500 hp	50	107	674	234	1,065	6.2%
501 - 1000 hp	70	31	171	300	572	3.3%
1000+ hp	331	32	1,020	79	1,462	9.1%
All Motor Sizes	738	1,537	2,150	1,085	5,510	6.3%

SIC 34 - Fabricated Metal Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	418	561	58	831	1,868
6 - 20 hp	78	184	46	1,306	1,614
21 - 50 hp	115	158	640	1,034	1,947
51 - 100 hp			302	497	799
101 - 200 hp			85	337	423
201 - 500 hp			645		645
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*611*	*903*	*1,777*	*4,005*	*7,296*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	118,897	184,201	37,341	281,489	621,929
6 - 20 hp	5,618	9,478	6,102	116,018	137,216
21 - 50 hp	702	1,330	12,685	31,175	45,892
51 - 100 hp			4,446	4,642	9,088
101 - 200 hp			1,969	3,526	5,496
201 - 500 hp			316		316
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*125,217*	*195,010*	*62,859*	*436,850*	*819,936*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	3,672	1,345	541	1,926	1,746
6 - 20 hp	2,890	3,554	1,289	2,019	2,121
21 - 50 hp	6,656	6,656	4,134	2,410	3,116
51 - 100 hp			2,231	5,677	3,584
101 - 200 hp			607	3,744	1,831
201 - 500 hp			6,656		6,656
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*3,863*	*1,833*	*2,647*	*2,377*	*2,427*

SIC 34 - Fabricated Metal Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*94*	2.4%	*94*	1.3%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*12,521*	2.9%	*12,521*	1.5%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*63*	3.6%	*976*	24.4%	*1,040*	14.2%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*2,674*	4.3%	*105,476*	24.1%	*108,150*	13.2%

SIC 34 - Fabricated Metal Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	404	96.6%	291	51.8%	58	100.0%	767	92.4%
6 - 20 hp	78	100.0%	184	100.0%	46	100.0%	1,250	95.7%
21 - 50 hp	115	100.0%	158	100.0%	200	31.2%	834	80.6%
51 - 100 hp					292	96.8%	380	76.5%
101 - 200 hp					63	73.6%	337	100.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*597*	97.6%	*633*	70.1%	*659*	37.1%	*3,568*	89.1%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	114,673	96.4%	88,058	47.8%	37,341	100.0%	241,936	85.9%
6 - 20 hp	5,618	100.0%	9,478	100.0%	6,102	100.0%	112,138	96.7%
21 - 50 hp	702	100.0%	1,330	100.0%	7,828	61.7%	28,515	91.5%
51 - 100 hp					4,130	92.9%	3,786	81.6%
101 - 200 hp					1,653	84.0%	3,526	100.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*120,993*	96.6%	*98,867*	50.7%	*57,054*	90.8%	*389,901*	89.3%

SIC 34 - Fabricated Metal Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							2	0.3%
6 - 20 hp							4	0.3%
21 - 50 hp					122	19.0%	55	5.3%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes					*122*	6.8%	*61*	1.5%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							632	0.2%
6 - 20 hp							705	0.6%
21 - 50 hp					632	5.0%	316	1.0%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes					*632*	1.0%	*1,653*	0.4%

SIC 34 - Fabricated Metal Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							19	2.3%
6 - 20 hp							13	1.0%
21 - 50 hp							75	7.2%
51 - 100 hp							117	23.5%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*223*	5.6%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							9,289	3.3%
6 - 20 hp							1,561	1.3%
21 - 50 hp							1,712	5.5%
51 - 100 hp							856	18.4%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*13,419*	3.1%

SIC 34 - Fabricated Metal Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	37,263	31%	2,033	1%			23,366	8%	62,662	10%
6 - 20 hp			1,681	18%			12,037	10%	13,718	10%
21 - 50 hp	702	100%	1,330	100%	4,224	33%	1,996	6%	8,253	18%
51 - 100 hp					316	7%	333	7%	649	7%
101 - 200 hp					316	16%			316	6%
201 - 500 hp					316	100%			316	100%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*37,965*	30%	*5,044*	3%	*5,172*	8%	*37,731*	9%	*85,913*	10%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,868	25.6%	85	4.6%	122	6.5%
6 - 20 hp	1,614	22.1%	45	2.8%	69	4.2%
21 - 50 hp	1,947	26.7%	50	2.6%	69	3.5%
51 - 100 hp	799	11.0%	17	2.1%	26	3.3%
101 - 200 hp	423	5.8%	9	2.2%	13	3.0%
201 - 500 hp	645	8.8%				
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*7,296*		*206*	2.8%	*298*	4.1%

SIC 34 - Fabricated Metal Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	14	3.3%	31	5.5%	3	5.6%	37	4.5%	85	4.6%
6 - 20 hp	2	2.8%	3	1.8%	1	2.4%	38	2.9%	45	2.8%
21 - 50 hp					15	2.4%	34	3.3%	50	2.6%
51 - 100 hp					7	2.4%	10	1.9%	17	2.1%
101 - 200 hp					2	1.8%	8	2.3%	9	2.2%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*16*	2.6%	*34*	3.8%	*29*	1.6%	*128*	3.2%	*206*	2.8%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	20	4.9%	43	7.6%	5	8.1%	54	6.5%	122	6.5%
6 - 20 hp	4	4.9%	5	2.9%	2	4.8%	57	4.4%	69	4.2%
21 - 50 hp					24	3.7%	45	4.3%	69	3.5%
51 - 100 hp					11	3.6%	15	3.0%	26	3.3%
101 - 200 hp					2	2.5%	11	3.1%	13	3.0%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*24*	4.0%	*48*	5.3%	*44*	2.5%	*182*	4.5%	*298*	4.1%

SIC 34 - Fabricated Metal Products

	Potential Motor System Savings					
Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	23	113	10	17	162	8.7%
6 - 20 hp	4	37	8	26	75	4.7%
21 - 50 hp	6	32	109	21	168	8.6%
51 - 100 hp			51	10	61	7.7%
101 - 200 hp			15	7	21	5.0%
201 - 500 hp			110		110	17.1%
501 - 1000 hp						
1000+ hp						
All Motor Sizes	34	181	303	80	598	8.2%

SIC 35 - Industrial Machinery and Equipment

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	189	217	96	1,621	2,121
6 - 20 hp	327	212	380	1,260	2,179
21 - 50 hp		540	232	458	1,229
51 - 100 hp				74	74
101 - 200 hp			465	1,310	1,775
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*515*	*968*	*1,172*	*4,722*	*7,378*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	27,687	59,833	38,574	1,468,676	1,594,769
6 - 20 hp	45,939	31,294	61,051	254,355	392,639
21 - 50 hp		20,602	4,389	46,219	71,210
51 - 100 hp				4,319	4,319
101 - 200 hp			1,062	5,311	6,373
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*73,626*	*111,729*	*105,076*	*1,778,880*	*2,069,310*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	4,822	2,961	754	929	1,069
6 - 20 hp	1,378	1,376	1,217	977	1,093
21 - 50 hp		1,983	3,612	986	1,535
51 - 100 hp				505	505
101 - 200 hp			7,200	4,562	5,047
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*1,865*	*1,939*	*2,065*	*1,201*	*1,398*

SIC 35 - Industrial Machinery and Equipment

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*605*	12.8%	*605*	8.2%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*52,047*	2.9%	*52,047*	2.5%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*209*	21.6%	*0*	0.0%	*2,367*	50.1%	*2,576*	34.9%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*36,114*	32.3%	*0*	0.0%	*635,211*	35.7%	*671,325*	32.4%

SIC 35 - Industrial Machinery and Equipment

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	171	90.9%	123	57.0%	96	100.0%	985	60.8%
6 - 20 hp	310	94.7%	183	86.5%	316	83.1%	688	54.6%
21 - 50 hp			510	94.4%	232	100.0%	422	92.2%
51 - 100 hp							74	100.0%
101 - 200 hp					465	100.0%	1,310	100.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*481*	93.3%	*816*	84.3%	*1,108*	94.5%	*3,479*	73.7%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	22,376	80.8%	34,340	57.4%	38,574	100.0%	1,247,526	84.9%
6 - 20 hp	44,877	97.7%	24,851	79.4%	36,379	59.6%	202,638	79.7%
21 - 50 hp			17,416	84.5%	4,389	100.0%	44,025	95.3%
51 - 100 hp							4,319	100.0%
101 - 200 hp					1,062	100.0%	5,311	100.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*67,252*	91.3%	*76,607*	68.6%	*80,404*	76.5%	*1,503,819*	84.5%

SIC 35 - Industrial Machinery and Equipment

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp							16	1.3%
21 - 50 hp							36	7.8%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*52*	1.1%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp							2,194	0.9%
21 - 50 hp							2,194	4.7%
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*4,389*	0.2%

SIC 35 - Industrial Machinery and Equipment

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							8	0.5%
6 - 20 hp							35	2.8%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*43*	0.9%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							5,381	0.4%
6 - 20 hp			2,194	7.0%			4,389	1.7%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes			*2,194*	2.0%			*9,770*	0.5%

SIC 35 - Industrial Machinery and Equipment

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	1,062	4%					2,194	0%	3,257	0%
6 - 20 hp							1,062	0%	1,062	0%
21 - 50 hp							1,062	2%	1,062	1%
51 - 100 hp										
101 - 200 hp					1,062	100%			1,062	17%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*1,062*	1%			*1,062*	1%	*4,319*	0%	*6,443*	0%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	2,121	28.8%	101	4.8%	154	7.3%
6 - 20 hp	2,179	29.5%	84	3.9%	129	5.9%
21 - 50 hp	1,229	16.7%	37	3.0%	52	4.2%
51 - 100 hp	74	1.0%	2	2.4%	3	3.8%
101 - 200 hp	1,775	24.1%	19	1.0%	31	1.7%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*7,378*		*243*	3.3%	*368*	5.0%

SIC 35 - Industrial Machinery and Equipment

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	6	3.2%	9	4.1%	4	4.2%	82	5.1%	101	4.8%
6 - 20 hp	14	4.2%	10	4.9%	14	3.8%	46	3.7%	84	3.9%
21 - 50 hp			17	3.2%	8	3.4%	12	2.7%	37	3.0%
51 - 100 hp							2	2.4%	2	2.4%
101 - 200 hp							19	1.4%	19	1.0%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*20*	3.8%	*37*	3.8%	*26*	2.2%	*161*	3.4%	*243*	3.3%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	11	5.7%	14	6.6%	6	6.3%	123	7.6%	154	7.3%
6 - 20 hp	20	6.1%	14	6.6%	23	6.1%	72	5.7%	129	5.9%
21 - 50 hp			24	4.4%	11	4.6%	17	3.8%	52	4.2%
51 - 100 hp							3	3.8%	3	3.8%
101 - 200 hp							31	2.3%	31	1.7%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*31*	5.9%	*52*	5.4%	*40*	3.4%	*246*	5.2%	*368*	5.0%

SIC 35 - Industrial Machinery and Equipment

	Potential Motor System Savings					
Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	10	44	16	32	103	4.8%
6 - 20 hp	18	43	65	25	151	6.9%
21 - 50 hp		109	39	9	157	12.8%
51 - 100 hp				1	1	2.0%
101 - 200 hp			79	26	106	5.9%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	28	195	200	94	517	7.0%

SIC 36 - Electronic and Other Electric Equipment

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	227	1,400	26	285	1,938
6 - 20 hp	82	1,421		1,632	3,136
21 - 50 hp	25	1,810	1,635	251	3,722
51 - 100 hp		3,101	715		3,815
101 - 200 hp			631		631
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*335*	*7,732*	*3,008*	*2,168*	*13,243*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	32,241	136,441	3,737	50,082	222,501
6 - 20 hp	6,757	41,288		39,743	87,788
21 - 50 hp	759	16,155	14,273	2,978	34,165
51 - 100 hp		14,048	2,163		16,212
101 - 200 hp			702		702
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*39,756*	*207,934*	*20,875*	*92,803*	*361,369*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	3,326	5,585	4,878	3,732	4,838
6 - 20 hp	2,691	5,613		4,913	5,090
21 - 50 hp	2,160	7,200	5,495	6,069	6,181
51 - 100 hp		6,437	7,036		6,541
101 - 200 hp			8,400		8,400
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*3,026*	*6,251*	*6,270*	*4,819*	*5,815*

SIC 36 - Electronic and Other Electric Equipment

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*0*	0.0%		

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*0*	0.0%	*0*	0.0%	*0*	0.0%		

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*4,563*	59.0%	*749*	24.9%	*796*	36.7%	*6,108*	46.1%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*30,204*	14.5%	*4,496*	21.5%	*36,806*	39.7%	*71,506*	19.8%

SIC 36 - Electronic and Other Electric Equipment

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	227	100.0%	1,301	93.0%	17	66.0%	185	64.9%
6 - 20 hp	82	100.0%	806	56.7%			1,086	66.5%
21 - 50 hp	25	100.0%	154	8.5%	1,635	100.0%	199	79.2%
51 - 100 hp					715	100.0%		
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*335*	100.0%	*2,261*	29.2%	*2,367*	78.7%	*1,470*	67.8%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	32,241	100.0%	129,417	94.9%	3,035	81.2%	28,308	56.5%
6 - 20 hp	6,757	100.0%	30,752	74.5%			24,290	61.1%
21 - 50 hp	759	100.0%	1,405	8.7%	14,273	100.0%	2,276	76.4%
51 - 100 hp					2,163	100.0%		
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*39,756*	100.0%	*161,575*	*77.7%*	*19,471*	93.3%	*54,873*	59.1%

SIC 36 - Electronic and Other Electric Equipment

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp			30	2.1%				
21 - 50 hp			140	7.7%				
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes			*169*	2.2%				

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp			702	1.7%				
21 - 50 hp			1,405	8.7%				
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes			*2,107*	1.0%				

SIC 36 - Electronic and Other Electric Equipment

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp								
6 - 20 hp							4	0.2%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*4*	0.2%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp								
6 - 20 hp							702	1.8%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*702*	0.8%

SIC 36 - Electronic and Other Electric Equipment

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	759	2%							759	0%
6 - 20 hp							3,681	9%	3,681	4%
21 - 50 hp			4,214	26%					4,214	12%
51 - 100 hp										
101 - 200 hp										
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*759*	2%	*4,214*	2%			*3,681*	4%	*8,654*	2%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,938	14.6%	93	4.8%	139	7.2%
6 - 20 hp	3,136	23.7%	106	3.4%	167	5.3%
21 - 50 hp	3,722	28.1%	99	2.7%	144	3.9%
51 - 100 hp	3,815	28.8%	91	2.4%	142	3.7%
101 - 200 hp	631	4.8%	9	1.5%	17	2.7%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*13,243*		*398*	3.0%	*609*	4.6%

SIC 36 - Electronic and Other Electric Equipment

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	10	4.4%	67	4.8%	2	6.0%	14	5.0%	93	4.8%
6 - 20 hp	4	4.8%	50	3.5%			52	3.2%	106	3.4%
21 - 50 hp	1	3.8%	34	1.9%	54	3.3%	9	3.8%	99	2.7%
51 - 100 hp			71	2.3%	20	2.8%			91	2.4%
101 - 200 hp					9	1.5%			9	1.5%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*15*	4.5%	*223*	2.9%	*85*	2.8%	*76*	3.5%	*398*	3.0%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	15	6.6%	100	7.2%	2	8.3%	22	7.6%	139	7.2%
6 - 20 hp	6	7.1%	80	5.6%			81	5.0%	167	5.3%
21 - 50 hp	1	5.0%	53	2.9%	78	4.7%	13	5.0%	144	3.9%
51 - 100 hp			115	3.7%	27	3.8%			142	3.7%
101 - 200 hp					17	2.7%			17	2.7%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*22*	6.6%	*348*	4.5%	*124*	4.1%	*115*	5.3%	*609*	4.6%

SIC 36 - Electronic and Other Electric Equipment

Potential Motor System Savings

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	12	281	4	6	304	15.7%
6 - 20 hp	5	286		33	323	10.3%
21 - 50 hp	1	364	279	5	649	17.4%
51 - 100 hp		623	122		745	19.5%
101 - 200 hp			108		108	17.1%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	18	1,554	513	43	2,129	16.1%

SIC 37 - Transportation Equipment

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	236	512	15	547	1,310
6 - 20 hp	2,903	2,877	63	586	6,428
21 - 50 hp	1,860	1,121	470	1,448	4,899
51 - 100 hp	353	767	160	1,001	2,280
101 - 200 hp	811	240	115	39	1,205
201 - 500 hp	52		3,733	3,157	6,942
501 - 1000 hp	199		582	5,323	6,103
1000+ hp			382		382
All Motor Sizes	*6,412*	*5,517*	*5,519*	*12,101*	*29,549*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	23,984	107,388	1,448	194,022	326,843
6 - 20 hp	83,393	77,351	7,313	45,583	213,640
21 - 50 hp	14,709	10,832	15,486	48,644	89,672
51 - 100 hp	2,543	2,147	869	8,887	14,446
101 - 200 hp	1,285	2,386	2,338	219	6,229
201 - 500 hp	73		2,371	2,040	4,484
501 - 1000 hp	73		333	1,709	2,114
1000+ hp			40		40
All Motor Sizes	*126,061*	*200,104*	*30,198*	*301,104*	*657,467*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	7,550	3,129	6,669	2,302	3,013
6 - 20 hp	6,856	7,147	1,717	1,967	5,540
21 - 50 hp	7,927	6,393	2,175	2,087	3,712
51 - 100 hp	3,806	7,688	4,493	3,410	4,373
101 - 200 hp	8,486	1,862	847	1,986	3,171
201 - 500 hp	4,202		6,726	8,697	7,462
501 - 1000 hp	7,862		5,667	8,736	8,279
1000+ hp			2,080		2,080
All Motor Sizes	*7,008*	*5,687*	*4,353*	*4,812*	*5,214*

SIC 37 - Transportation Equipment

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*294*	4.6%	*12*	0.2%	*238*	4.3%	*88*	0.7%	*632*	2.1%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*4,851*	3.8%	*5,212*	2.6%	*1,303*	4.3%	*21,079*	7.0%	*32,445*	4.9%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*584*	9.1%	*1,089*	19.7%	*1,027*	18.6%	*1,089*	9.0%	*3,788*	12.8%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*14,354*	11.4%	*26,564*	13.3%	*19,643*	65.0%	*135,367*	45.0%	*195,928*	29.8%

SIC 37 - Transportation Equipment

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	233	98.6%	492	96.1%	14	97.1%	428	78.3%
6 - 20 hp	2,399	82.6%	2,801	97.4%	7	11.0%	418	71.3%
21 - 50 hp	1,352	72.7%	1,076	96.0%	132	28.1%	840	58.0%
51 - 100 hp	275	78.1%	752	98.1%	160	100.0%	751	75.0%
101 - 200 hp	811	100.0%	56	23.4%	115	100.0%		
201 - 500 hp	52	100.0%			3,165	84.8%	2,503	79.3%
501 - 1000 hp							5,323	100.0%
1000+ hp								
All Motor Sizes	*5,121*	79.9%	*5,178*	93.9%	*3,592*	65.1%	*10,263*	84.8%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	22,715	94.7%	96,091	89.5%	1,242	85.8%	109,569	56.5%
6 - 20 hp	68,903	82.6%	71,694	92.7%	6,743	92.2%	17,125	37.6%
21 - 50 hp	11,138	75.7%	10,247	94.6%	11,331	73.2%	14,478	29.8%
51 - 100 hp	789	31.0%	2,001	93.2%	869	100.0%	3,023	34.0%
101 - 200 hp	1,285	100.0%	219	9.2%	2,338	100.0%		
201 - 500 hp	73	100.0%			1,666	70.3%	1,139	55.8%
501 - 1000 hp							1,709	100.0%
1000+ hp								
All Motor Sizes	*104,903*	83.2%	*180,253*	90.1%	*24,190*	80.1%	*147,043*	48.8%

SIC 37 - Transportation Equipment

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp			3	0.5%			16	2.9%
6 - 20 hp	388	13.4%					0	0.1%
21 - 50 hp							10	0.7%
51 - 100 hp								
101 - 200 hp			21	8.6%				
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*388*	6.0%	*23*	0.4%			*26*	0.2%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp			1,737	1.6%			1,801	0.9%
6 - 20 hp	9,005	10.8%					83	0.2%
21 - 50 hp							1,434	2.9%
51 - 100 hp								
101 - 200 hp			73	3.1%				
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*9,005*	7.1%	*1,811*	0.9%			*3,317*	1.1%

SIC 37 - Transportation Equipment

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							41	7.5%
6 - 20 hp							8	1.3%
21 - 50 hp							184	12.7%
51 - 100 hp							14	1.4%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*248*	2.0%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							29,737	15.3%
6 - 20 hp							869	1.9%
21 - 50 hp							10,498	21.6%
51 - 100 hp							434	4.9%
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*41,538*	13.8%

SIC 37 - Transportation Equipment

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp			854	1%			6,583	3%	7,437	2%
6 - 20 hp	1,801	2%	1,497	2%			716	2%	4,014	2%
21 - 50 hp	285	2%	358	3%					643	1%
51 - 100 hp	73	3%	146	7%					219	2%
101 - 200 hp			146	6%					146	2%
201 - 500 hp	73	100%			103	4%			176	4%
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*2,232*	2%	*3,001*	1%	*103*	0%	*7,299*	2%	*12,635*	2%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,310	4.4%	62	4.7%	91	7.0%
6 - 20 hp	6,428	21.8%	194	3.0%	314	4.9%
21 - 50 hp	4,899	16.6%	171	3.5%	234	4.8%
51 - 100 hp	2,280	7.7%	51	2.2%	80	3.5%
101 - 200 hp	1,205	4.1%	26	2.2%	37	3.1%
201 - 500 hp	6,942	23.5%	142	2.0%	226	3.2%
501 - 1000 hp	6,103	20.7%	127	2.1%	201	3.3%
1000+ hp	382	1.3%	8	2.1%	13	3.3%
All Motor Sizes	*29,549*		*780*	2.6%	*1,195*	4.0%

SIC 37 - Transportation Equipment

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	7	2.9%	28	5.5%	1	4.2%	26	4.8%	62	4.7%
6 - 20 hp	95	3.3%	77	2.7%	2	3.1%	20	3.4%	194	3.0%
21 - 50 hp	80	4.3%	35	3.1%	13	2.8%	43	3.0%	171	3.5%
51 - 100 hp	8	2.3%	19	2.5%	3	1.9%	21	2.1%	51	2.2%
101 - 200 hp	20	2.5%	4	1.5%	2	1.6%	1	2.1%	26	2.2%
201 - 500 hp					76	2.0%	65	2.1%	142	2.0%
501 - 1000 hp	4	2.1%			12	2.1%	110	2.1%	127	2.1%
1000+ hp					8	2.1%			8	2.1%
All Motor Sizes	*214*	3.3%	*163*	3.0%	*117*	2.1%	*286*	2.4%	*780*	2.6%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	12	5.2%	39	7.6%	1	6.9%	39	7.1%	91	7.0%
6 - 20 hp	147	5.1%	133	4.6%	3	5.2%	30	5.1%	314	4.9%
21 - 50 hp	101	5.4%	50	4.4%	20	4.3%	63	4.3%	234	4.8%
51 - 100 hp	12	3.5%	28	3.7%	5	3.2%	35	3.5%	80	3.5%
101 - 200 hp	27	3.4%	5	2.2%	3	2.5%	1	3.3%	37	3.1%
201 - 500 hp					122	3.3%	104	3.3%	226	3.2%
501 - 1000 hp	7	3.3%			19	3.3%	175	3.3%	201	3.3%
1000+ hp					13	3.3%			13	3.3%
All Motor Sizes	*307*	4.8%	*256*	4.6%	*186*	3.4%	*447*	3.7%	*1,195*	4.0%

SIC 37 - Transportation Equipment

Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
		Potential Motor System Savings				
1 - 5 hp	13	103	2	11	129	9.9%
6 - 20 hp	160	578	11	12	760	11.8%
21 - 50 hp	102	225	80	29	437	8.9%
51 - 100 hp	19	154	27	20	221	9.7%
101 - 200 hp	45	48	20	1	113	9.4%
201 - 500 hp	3		636	63	702	10.1%
501 - 1000 hp	11		99	106	217	3.5%
1000+ hp			65		65	17.1%
All Motor Sizes	353	1,109	941	242	2,645	8.9%

SIC 38 - Instruments and Related Products

Motor System Energy Use by Application and Horsepower

Size Category	Fan Energy (GWh/Yr)	Pump Energy (GWh/Yr)	Air Compressor (GWh/Yr)	Other Energy (GWh/Yr)	Total Energy (GWh/Yr)
1 - 5 hp	200	592	81	786	1,660
6 - 20 hp	634	1	2	1,706	2,343
21 - 50 hp	4		623	461	1,087
51 - 100 hp			16		16
101 - 200 hp	453			928	1,381
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*1,291*	*594*	*721*	*3,881*	*6,487*

Number of Motors by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	37,943	98,344	15,193	315,839	467,319
6 - 20 hp	38,467	8,083	449	136,363	183,363
21 - 50 hp	75		8,158	12,723	20,957
51 - 100 hp			150		150
101 - 200 hp	2,320			4,640	6,960
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*78,805*	*106,427*	*23,950*	*469,566*	*678,748*

Average Hours of Operation by Application and Horsepower

Size Category	Fans	Pumps	Air Compressor	Other	Total
1 - 5 hp	8,003	7,509	1,851	2,266	3,355
6 - 20 hp	6,543	40	283	3,280	3,554
21 - 50 hp	2,081		4,185	4,100	4,134
51 - 100 hp			2,389		2,389
101 - 200 hp	8,400			8,400	8,400
201 - 500 hp					
501 - 1000 hp					
1000+ hp					
All Motor Sizes	*7,263*	*5,127*	*3,526*	*3,561*	*4,085*

SIC 38 - Instruments and Related Products

Motor System Energy with ASD Control

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*1,097*	85.0%	*0*	0.0%	*0*	0.0%	*1,909*	49.2%	*3,006*	46.3%

Motor Systems with ASD Control

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*64,959*	82.4%	*0*	0.0%	*0*	0.0%	*196,004*	41.7%	*260,963*	38.4%

Motor System Energy with Fluctuating Load

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
All Motor Sizes	*0*	0.0%	*15*	2.5%	*622*	86.4%	*720*	18.5%	*1,357*	20.9%

Motor Systems with Fluctuating Load

Motors with Fluctuating Load

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
All Motor Sizes	*0*	0.0%	*32,334*	30.4%	*8,083*	33.8%	*143,777*	30.6%	*184,194*	27.1%

SIC 38 - Instruments and Related Products

Motor System Energy Use for NEMA Design B Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp	200	100.0%	545	92.0%	81	99.9%	630	80.2%
6 - 20 hp	634	100.0%	1	100.0%	2	100.0%	1,204	70.6%
21 - 50 hp	4	100.0%			623	100.0%	51	11.1%
51 - 100 hp					16	100.0%		
101 - 200 hp	453	100.0%					928	100.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*1,291*	100.0%	*547*	92.0%	*721*	100.0%	*2,814*	72.5%

Number of NEMA Design B Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp	37,943	100.0%	66,010	67.1%	15,043	99.0%	231,936	73.4%
6 - 20 hp	38,467	100.0%	8,083	100.0%	449	100.0%	95,796	70.3%
21 - 50 hp	75	100.0%			8,158	100.0%	4,640	36.5%
51 - 100 hp					150	100.0%		
101 - 200 hp	2,320	100.0%					4,640	100.0%
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes	*78,805*	100.0%	*74,093*	69.6%	*23,801*	99.4%	*337,012*	71.8%

SIC 38 - Instruments and Related Products

Motor System Energy Use for Other Induction Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							30	3.8%
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*30*	0.8%

Number of Other Induction Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							8,083	2.6%
6 - 20 hp								
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*8,083*	1.7%

SIC 38 - Instruments and Related Products

Motor System Energy Use for DC Motors

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy
1 - 5 hp							1	0.1%
6 - 20 hp							496	29.1%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*497*	12.8%

Number of DC Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors
1 - 5 hp							2,395	0.8%
6 - 20 hp							32,334	23.7%
21 - 50 hp								
51 - 100 hp								
101 - 200 hp								
201 - 500 hp								
501 - 1000 hp								
1000+ hp								
All Motor Sizes							*34,729*	7.4%

SIC 38 - Instruments and Related Products

Saturation of EPACT -- Compliant Motors

Size Category	Fan Motors	% of Total Fan Motors	Pump Motors	% of Total Pump Motors	Air Compressor Motors	% of Total Air Comp. Motors	Other Motors	% of Total Other Motors	All Systems Motors	% of Total All Systems Motors
1 - 5 hp	6,960	18%	32,334	33%	8,083	53%	24,250	8%	71,628	15%
6 - 20 hp			8,083	100%			24,250	18%	32,334	18%
21 - 50 hp										
51 - 100 hp										
101 - 200 hp	2,320	100%							2,320	33%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*9,280*	12%	*40,417*	38%	*8,083*	34%	*48,501*	10%	*106,282*	16%

Potential Motor Upgrade Savings by Horsepower

Size Category	Motor Drive Energy (GWh/Yr)	% of Total Drive Energy	EPACT Savings (GWh/Yr)	EPACT Savings (%)	CEE Savings (GWh/Yr)	CEE Savings (%)
1 - 5 hp	1,660	25.6%	51	3.1%	76	4.6%
6 - 20 hp	2,343	36.1%	69	2.9%	111	4.7%
21 - 50 hp	1,087	16.8%	36	3.3%	49	4.5%
51 - 100 hp	16	0.2%	0	1.0%	0	1.9%
101 - 200 hp	1,381	21.3%	20	1.4%	27	2.0%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	*6,487*		*176*	2.7%	*263*	4.1%

SIC 38 - Instruments and Related Products

Potential Motor Upgrade Savings by Horsepower: EPACT Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	8	4.0%	10	1.7%	0	0.4%	33	4.2%	51	3.1%
6 - 20 hp	20	3.2%			0	4.6%	49	2.9%	69	2.9%
21 - 50 hp	0	1.4%			19	3.0%	17	3.7%	36	3.3%
51 - 100 hp					0	1.0%			0	1.0%
101 - 200 hp							20	2.1%	20	1.4%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*28*	2.2%	*10*	1.7%	*19*	2.7%	*118*	3.0%	*176*	2.7%

Potential Motor Upgrade Savings by Horsepower: Proposed CEE Standards

Size Category	Fan (GWh/Yr)	% of Total Fan Energy	Pump (GWh/Yr)	% of Total Pump Energy	Air Compressor (GWh/Yr)	% of Total Air Comp. Energy	Other (GWh/Yr)	% of Total Other Energy	All Systems (GWh/Yr)	% of Total All Systems Energy
1 - 5 hp	12	5.9%	14	2.4%	1	0.6%	50	6.3%	76	4.6%
6 - 20 hp	34	5.4%			0	6.1%	77	4.5%	111	4.7%
21 - 50 hp	0	3.0%			26	4.1%	23	4.9%	49	4.5%
51 - 100 hp					0	1.9%			0	1.9%
101 - 200 hp							27	2.9%	27	2.0%
201 - 500 hp										
501 - 1000 hp										
1000+ hp										
All Motor Sizes	*46*	3.6%	*14*	2.4%	*27*	3.7%	*176*	4.5%	*263*	4.1%

SIC 38 - Instruments and Related Products

	Potential Motor System Savings					
Size Category	Fan Savings (GWh/Yr)	Pump Savings (GWh/Yr)	Air Compressor Savings (GWh/Yr)	Other Savings (GWh/Yr)	Total Savings (GWh/Yr)	Total Savings (%)
1 - 5 hp	11	119	14	16	160	9.6%
6 - 20 hp	35	0	0	34	70	3.0%
21 - 50 hp	0		106	9	116	10.6%
51 - 100 hp			3		3	17.1%
101 - 200 hp	25			19	43	3.1%
201 - 500 hp						
501 - 1000 hp						
1000+ hp						
All Motor Sizes	71	119	123	78	391	6.0%

Appendix C: Methodology

C METHODOLOGY

This appendix presents an overview of the key sampling and data collection methods used in the Baseline Survey. The first section summarizes the objectives and methods of the sample design and sample selection. The second section describes the estimation formulas based on this sample design. The third section provides further detail on data collection. The final section contains copies of the various data collection forms and materials.

C.1 SAMPLING

C.1.1 Objectives

As discussed in Section 1, the scope of this study encompasses all manufacturing industries as well as selected non-manufacturing industries that have high levels of motor drive electric use. Overall, the objectives of the market assessment survey were to:

- ***Characterize motor systems and the energy they use for all major manufacturing groups (SICs 20–39) and selected non-manufacturing industries.*** In particular, estimate the distribution of the population on key attributes that affect energy consumption and potential savings: horsepower, type of motor, application, part load, hours of application, and nominal efficiency.
- ***Characterize the extent to which energy savings opportunities are present in the motor systems inventory and estimate potential energy savings associated with those opportunities – again for each major industry group.***
- Characterize the procedures that facilities managers use to purchase, manage, and maintain motor systems, as well as their awareness, knowledge, and adoption of specific measures to reduce motor systems energy use.

To our knowledge, the U.S. Industrial Electric Motor Systems Market Opportunities Assessment is the only study ever undertaken with the specific objective of characterizing the population of motor systems in manufacturing for any geographic area—much less for the country as a whole—using direct observations of a representative sample of facilities.[1]

The challenge was in designing a sampling approach for selecting representative manufacturing sites for estimating motor energy consumption and other parameters of interest related to motor

[1] A number of utilities have undertaken audits of representative samples of industrial facilities in their service territories that have included inventories of electric motors. For descriptions and results of these studies, see *Interim Report* of this project.

use. We faced two key methodological challenges in achieving the study's objectives. These were:

1. Develop a sampling approach that would enable us to characterize the highly diverse population of manufacturing plants based on a relatively small number of observations.
2. Develop an on-site data collection protocol that would enable us to collect detailed information on every motor system within a factory (or a large sample of motors in big plants) without overburdening the participating companies.

Below we describe how we addressed these challenges.

C.1.2 Sampling Approach

Scope: Definition of Study Population

Industries covered. Initially, the Department of Energy (DOE) specified the scope of the study to include all manufacturing industries (SICs 20–39) as well as selected non-manufacturing industries: mining, agriculture, water supply, irrigation, wastewater treatment, and oil and gas extraction. Early in the project, we determined that it would be possible to complete roughly 300 site surveys of sufficient detail to meet the project's analytical objectives, given the budget and schedule. We further determined it would not be feasible to characterize all of the manufacturing and non-manufacturing facilities in the population on the basis of a sample of 300. We decided, in consultation with DOE, to allocate as much of the sample to the manufacturing industries as would be necessary to develop reasonably precise estimates of their characteristics. The remaining sample would be allocated to the non-manufacturing industries, with the resulting observations to be treated essentially as case studies. Ultimately, 30 sample slots were set aside for non-manufacturing sites.

Motor system applications covered. All motor systems associated with production activities were included in the universe. Motors associated with boilers and compressors that provided process heating and cooling were included in the survey. Motors associated with plant heating and ventilating equipment were not.

Motor sizes covered. Only systems driven by integral horsepower motors (1 HP or greater) were included in the survey.

Sample Design: General Approach

Manufacturing sites were selected for this study using a probability sampling procedure. The sample was designed to ensure as high accuracy as possible for the estimate of total manufacturing motor energy consumption in the U.S., subject to the constraint of a total sample size of approximately 270 audited sites. Even with this relatively small number of sites to represent the entire range of manufacturing activity, XENERGY determined it was possible to develop estimates that could be projected to the population with calculable error bands, rather than simply having a collection of case studies.

The general strategy for the sample allocation was to select sites with probability proportional to size. That is, the chance that a particular site would be selected into the sample was proportional to its size. Larger sites have a higher chance of being in the sample, and smaller sites have a lower chance. Thus, for any subset of the population, the investment in data collection for that subset and the amount of information collected is roughly proportional to the size of the subset. Those groups that account for the most motor system energy consumption, and the most site-to-site variability, have the best information collected and tend to be the most accurately characterized, and those that account for the least consumption have the least information and are least accurately characterized.

Sample Frame

We used the Dun & Bradstreet iMarket MarketPlace database as the sample frame—that is, the list of all industrial facilities that constituted the population for the study. The MarketPlace database contains records from all establishments identified through Dun & Bradstreet's credit rating service. The number and distribution of establishments by SIC code in this database are fairly similar to those found by the Census of Manufacturers for companies with 20 or more employees.

The MarketPlace database identifies several key pieces of information for each facility, including: primary SIC code, sales volume, employment, geographic location (using the Bureau of the Census metropolitan statistical areas (MSAs), contact information, and whether manufacturing is actually conducted at the site.[2]

Measure of Size

To select sites with probability proportional to size, it is necessary to have a measure of size that is known for each site. For this selection strategy to be effective, the measure of size should be related to the quantity of greatest interest from the study, motor energy use. The ideal case would be if we knew the motor energy consumption for each site in advance. However, as is typically the case for designing samples, the ideal design variable is a key quantity to be determined from the study and is not known in advance. We therefore use as a measure of size a quantity that is known in advance for each site, and is expected to be closely correlated with motor energy use.

[2] Metropolitan Statistical Areas are geographic subdivisions established by the Bureau of the Census to organize data collection. In most states, they correspond to the larger cities and the counties in which they are located. In the Northeast, where political subdivisions are more irregular, MSAs may contain more than one county or portions of counties as well as their central city.

We used facility employment as recorded in Dun & Bradstreet as the basis for characterizing sites by size. However, motor system energy use per employee differs greatly among SIC groups. To develop a meaningful measure of size for allocating the sample, we needed to translate the employment for each site into a preliminary estimate of motor energy use. To do so, we used an estimate of motor energy use per employee specific to each SIC developed from the results of the 1991 Manufacturing Energy Consumption Survey (MECS).[3] For each SIC group, MECS provides the total electricity use for machine drive (i.e., motor energy). MECS also provides total electricity use and electricity use per employee. Thus, we calculated the MECS-based scaling factor for each SIC *s* as

$$UM_s = (EM_s/ET_s)*UE_s$$

where

UM_s = calculated motor energy use per employee for SIC *s*
EM_s = electricity for machine drive for SIC *s*, from MECS
ET_s = total electricity use for SIC *s*, from MECS
UE_s = electricity use per employee for SIC *s*, from MECS.

The motor use per employee UM_s was calculated at the national level. These factors were applied to site-level employment data from the Dun & Bradstreet database to estimate the motor system energy consumption of sites or groups of sites for use in sampling.

Further Refinements to Sample Frame

In our initial work on the sample, we made a number of refinements to limit the sample frame so that it matched the objectives and resources of the project. We defined our frame as all Dun & Bradstreet listings in the target SIC groups that had manufacturing activity present at the site. The target SIC groups were the 20 manufacturing two-digit SIC groups, SIC codes 20–39. We further restricted our frame to the top 174 (out of 324) metropolitan statistical areas (MSAs) in terms of estimated motor system energy use.

The 174 MSAs included in the sampling frame accounted for 91.7 percent of the estimated manufacturing motor energy use for all MSAs and 72.1 percent of the estimated manufacturing motor energy use for the entire U.S. The second percentage is lower because not all manufacturing facilities are located in MSAs. For example, many pulp and paper mills and primary metal factories are located in rural areas near the natural resources that supply them. We developed a separate process to select a sample of facilities that are located outside MSAs. With the supplemental non-MSA sample, the universe covered by this study includes 91.4 percent of estimated manufacturing motor energy in the U.S.

[3] Results of the 1994 MECS were not available at the time the sample was developed.

Sample Stratification

The total sample was stratified on three variables:

- ***Geographic Location.*** Geographic stratification was required to ensure that the sample was geographically dispersed for a good representation across the country. Geographic clustering was required to contain field costs.
- ***Industry Type (SIC).*** The sample was stratified by a two-digit SIC to ensure a minimum coverage of each manufacturing SIC. In addition, under the probability-proportional-to-size approach, different SICs were sampled at a higher rate because of their greater motor energy use.
- ***Size of Facility.*** The sample was stratified by size as the basis for the sampling with probability in proportion to size. For the main sample, each SIC group was divided into large-, medium-, and small-size strata based on the distribution of total employment among all the establishments in the SIC. The general approach was to split each SIC into three size groups each accounting for about one-third of the total employment. The break points for the three-size strata were therefore defined differently for each SIC.

Stratification based on the above variables led to a three-stage approach for the sampling, as discussed in the next section.

Sample Allocation and Selection

The sample was designed to cover all manufacturing SICs, all regions of the country, and all sizes of operations. The first dimension of the sampling was the allocation of sample points to SIC groups.

The next was the allocation of the overall manufacturing sample within each SIC to sites within and outside MSAs. After these allocations were made, at the national level, three successive stages of sampling were used to select individual sites within the MSA sample. To control field costs, it was necessary to limit the data collection to approximately 20 geographic areas. The first stage of the MSA sample was selection of these areas.

Because of the limited total sample size, it was not possible to sample from all 20 SIC groups of interest in all 20 geographic areas and all three-size categories. Thus, the next MSA sampling stage was the selection of sampling cells defined by SIC group and size stratum within each selected area. The final selection was of sites to be visited within the selected cells.

Only a small number of visits were allocated to the non-MSA sample. For this portion of the sample, geographic clustering was not attempted. In addition, the stratification by size was limited to two categories, large and small.

The overall sequence of allocation steps, therefore, was as follows:

Total Manufacturing Sample
1. Allocation to SIC groups.
2. Allocation of each SIC's sample between MSA and non-MSA.

MSA Manufacturing Sample Selection
1. Selection of primary sampling units (PSU), i.e., geographic areas.
2. Selection of SIC-size cells within each selected PSU.
3. Selection of sites within each selected PSU-SIC-size cell.

Non-MSA Manufacturing Sample Selection
1. Selection of sites within each SIC-size cell.

Non-Manufacturing Sample
1. Selection of sites within each targeted SIC.

At each stage the allocations and selections were accomplished using methods based on probability-proportional-to-size. Each of these dimensions and stages is described below.

Overall Allocation Steps 1 and 2 for Manufacturing SICs: Allocation to SIC Groups and MSA/non-MSA

The main sample for this study was the statistical sample of manufacturing sites in MSAs indicated above. Additional sample points were set aside for non-manufacturing SICs and for manufacturing SICs outside MSAs.

Among these three sample components, 30 sites were set aside for non-manufacturing and 22 for non-MSA manufacturing. The remaining 248 of the total target of 300 were designated for the main MSA manufacturing sample.

Within these overall bounds, the first allocation step was the allocation of sample points to SIC groups. This allocation was systematic for the manufacturing SICs and judgmental for the non-manufacturing SICs, as described below.

Non-Manufacturing SICs

To cover the non-manufacturing SICs as noted, we set aside an allocation of 30 sample points. Given the expense of on-site data collection, it was not possible to visit a sufficient number of sites to characterize both manufacturing and non-manufacturing SICs with statistically estimated precision. We allocated sites among the non-manufacturing SICs based on judgments informed by the following factors:

- ***Diversity (versus uniformity) of end uses within SICs.*** For example, industry-specific literature suggests that pumping accounts for up to 90 percent of all electricity consumed in the water supply and irrigation industries. Motor applications in mining are much more diverse. We allocated a greater number of sites to industries with more diverse motor applications.
- ***Availability of industry studies.*** Energy use has been studied on a consistent, national basis for a few non-manufacturing industries, notably wastewater and water supply. (EPRI 1988) We allocated a greater number of sites to industries for which previous documentation was relatively sparse.

Non-MSA Manufacturing Sample

We set aside an allocation of an additional 22 points to be used for supplemental sampling of manufacturing SICs that have substantial activity outside the designated MSA frame for the main sample. We anticipated that the types of activity taking place in non-MSA sites will be different from that in MSA sites for those industries where the non-MSA activity is likely to be closer to raw materials. These industries include Food, Lumber, Paper, Chemicals, and Metal. We therefore set aside some sample allocation for non-MSA sites for these five industries. For the other industries, we have less concern that the non-MSA activity needs to be represented, either because it is unlikely to differ greatly from the MSA activity, or because its contribution to the total is small. Therefore, samples for these SICs were restricted to the MSA sample. For this sample, costs per completed visit tend to be lower because of geographic clustering.

Main Sample: MSA Manufacturing

The set-aside allocations left a total of 248 sites to be allocated systematically in the main sample design. These sites were allocated to two-digit SIC groups in proportion to the estimated motor energy use, subject to requiring a minimum of four sites for each group. That is, we first assigned four sites to each SIC group. We then allocated the remaining sites to SICs in proportion to the SIC's estimated motor energy consumption. We also anticipated that we would have to oversample to account for likely nonresponse in cells with small numbers of sites. Hence, instead of allocating sample to 248 sites, we allocated sample to 281 sites, with the expectation of not being able to fill every cell. Thus, the allocation to each SIC was given by

$$n_{SIC} = 4 + n_A \times \frac{motorenergy_{SIC}}{\sum_{SIC=20 to 39} motorenergy_{SIC}}$$

where

n_A = 201 is the number of points to allocate after assigning four per SIC with a total target of 281.

Summary of SIC Allocations

Table C-1 summarizes the sample sizes targeted and achieved in the main MSA and supplemental non-MSA and non-manufacturing samples by SIC.

Table C-1
Sample Allocation by SIC

SIC Category	Allocation MSA*	Allocation non-MSA	Allocation Total	Achieved MSA*	Achieved non-MSA	Achieved Total
20 Food	14	4	18	14	4	18
21 Tobacco	4		4			
22 Textile	10		10	12		12
23 Apparel	5		5	4		4
24 Lumber	8	4	12	8	4	12
25 Furniture	5		5	5		5
26 Paper	38	5	43	34	5	39
27 Printing	7		7	6		6
28 Chemicals	67	5	72	45	5	50
29 Petroleum	28		28	24		24
30 Rubber	10		10	20		20
31 Leather	4		4	1		1
32 Stone	11		11	6		6
33 Metal	20	4	24	18	5	23
34 Fabricated Metal	10		10	10		10
35 Machinery	10		10	6		6
36 Electric	9		9	5		5
37 Transportation	10		10	7		7
38 Instruments	6		6	6		6
39 Miscellaneous	5		5			
Subtotal Manufacturing	*281*	*22*	*303*	*231*	*23*	*254*
02 Agriculture			4			2
12 Metal Mining			4			1
13 Oil & Gas Extraction			5			1
14 Mineral Mining			7			2
49 Water & Wastewater			10			5
Total Non-Manufacturing			30			11
Total Surveys			***333***			***265***

* Main Sample

Main Sample Selection Step 1: Selection of Geographic Areas—Primary Sampling Units (PSUs)

For the main sample, controlling field costs required that the data collection be conducted within geographically contained clusters. We began by defining geographically contiguous clusters within which field work could be done economically. These clusters are called Primary Sampling Units (PSUs) because they are the unit at which the first stage of random sample selection occurs. Each PSU was an MSA or group of contiguous MSAs.

For each PSU, we had an estimate of total motor energy use, obtained by applying the scaling factors UM to the Dun & Bradstreet employment totals for each SIC within the PSU. PSUs were selected for sampling with probability roughly proportional to the estimate of total motor energy use. We wanted to have a total of approximately 20 selected PSUs. Selection with probability proportional to motor energy use meant that we should have one selected PSU for every 5 percent of total motor energy use.

We began by sorting all the PSUs by estimated motor energy use. There were 10 PSUs that each had at least 1.75 percent of the total. Each of these was automatically selected into the sample (selected with certainty). Together, the 10 PSUs selected with certainty accounted for a total of 36 percent of the estimated motor energy use in the manufacturing SICs in MSAs.

Our schedulers found that, for some cells, it was impossible to meet the quota, or even get any sites scheduled, even with extensive callbacks to all eligible sites. This problem was anticipated, so we deliberately selected a larger sample than we wanted to fill to allow for some unfilled and underfilled cells. However, it appears that the overall response rates are lower than our projections, with the result that the number of unfilled and underfilled cells is higher.

We divided the remainder of the PSUs into groups of decreasing size per PSU with each group accounting for about 10 percent of the total motor energy use. Within each of these groups, two PSUs were selected at random. This procedure gave each PSU a chance of being included in the sample roughly proportional to the average motor energy consumption for the PSUs in its group. PSUs with high total motor energy use were in selection groups with only a few others, and had a higher chance of being included in the sample. PSUs with low total motor energy use were in a selection group with a large number of other PSUs, and had a small chance of being selected for the sample.

Table **C-2** shows the PSUs in which the survey was conducted, along with the number of SIC-size cells in each PSU and the number of sites targeted to be surveyed. The number of sites (310) is slightly higher than found in Table C-1 (303) as the PSU allocation methodology randomly selected cells in order to closely match the SIC targets. The second and third stages of sampling were designed in such a way that the expected target number of sites was about 14 for each PSU. However, the actual number targeted for each PSU was random. For this reason, the targeted number of sites ranges from 4 to 25 across the PSUs.

Table C-2
Allocation of Sample to Geographic Areas (PSUs)

	Allocation		Achieved	
PSU	**Cells**	**Sites**	**Cells**	**Sites**
Biloxi, MS	7	15	4	4
Boston, MA*	5	10	6	10
Charlotte, NC	10	20	9	18
Chicago, IL*	11	23	13	24
Cincinnati, OH	9	21	9	19
Cleveland, OH*	3	5	7	11
Dallas, TX*	2	4	3	4
Detroit, MI*	3	6	6	11
Hickory, NC	7	16	8	13
Houston, TX*	4	15	3	6
Johnson City, TN	1	1	1	1
Los Angeles, CA*	8	17	10	17
Miami, Fl	12	25	11	16
Newark, NJ-New York, NY*	7	19	9	21
Oakland, CA*	5	10	4	7
Peoria, IL	3	7	3	3
Philadelphia, PA*	6	12	6	11
Pittsburgh, PA	5	10	4	6
Portland, OR	5	12	5	7
Seattle, WA	8	17	10	15
Ventura, CA	11	23	4	7
non-MSA		22	10	23
Total Manufacturing	*132*	*310*	*145*	*254*
Non-Manufacturing		*30*		*11*
Total		***340***		***265***

* Selected with certainty.

Main Sample Selection Step 2: Selection of Cells Defined by SIC Group and Size

Within each PSU, we wanted to allocate sample points across SICs and size categories, with sampling probability proportional to estimated motor energy use. However, if we had wanted to allocate some sample points to each cell defined by SIC group (20), PSU (20), and size (3), we would have needed a minimum of 1,200 sample points just to allow one for each cell.

The next stage of sampling was therefore to select SIC-size cells within each selected PSU. For each cell, a random determination was made of whether or not the cell would be included in the sample. The random inclusion probability for each cell was set so that its overall chance of being in the sample was proportional to its fraction of the SIC's total motor energy use. This overall chance took into account both the chance that the PSU would be selected for the sample and the chance that the cell would be selected if the PSU had been. The cell selection probabilities were also set so that the total expected number of sites selected for each SIC would match the target allocations.

Main Sample Selection Step 3: Selection of Sites Within Cells

For each selected cell, a minimum of two sites were allocated to the sample. Some of the larger cells had higher numbers of sites allocated. The total number of sites allocated to each cell was set in combination with the cell-selection probabilities so that the expected number of sites selected for each SIC would match the target allocations.

Implementing the Main Sample Selection

In all cases the SIC allocation gives a target number for each SIC. Consider a particular SIC. We need to distribute the SIC's target number among the SIC's PSU-size cells. The algorithm below does this by assigning a probability p_{2h} and number n_h to each PSU-size cell h in the SIC; p_{2h} is the probability that cell h is chosen in the second sampling stage and n_h is the number of sites to sample from that cell if it is chosen. (p_{2h} has a subscript "2" to indicate that it is a second stage selection probability. Once we select cell h, we still need to sample n_h of its sites.)

Let H be the number of cells in the SIC. For h=1,2,...,H let N_h be the total number of sites in cell h and let M_h be the total measure of size for cell h. Also let n^* be the target number of sites to sample for the SIC. The algorithm allocates n^* among cells in proportion to size (number of employees). Cells whose initial allocation is big enough get included for sure; others get included with a probability less than one such that the expected number equals the theoretical allocation.

- **step 0.** Sort the cells in decreasing order by M_h so that $M_1 \geq M_2 \geq \ldots \geq M_H$. Also set $M = \sum_h M_h$ so that initially M is the total measure of size for the SIC.
- **loop**. Repeat for h=1,2,...,H.
- **step 1.** Set $n'_h = n^* M_h / M$.
- **step 2.** Set $p_{1h} = \min(1, n'_h / B_h)$ where B_h is the smaller of 2 or N_h.
- **step 3.** Set $n_h = \min\left(\frac{n'_h}{p_{1h}}, N_h\right)$.
- **step 4.** If p_{1h}=1

  Decrease M by M_h, and
  Decrease n^* by n_h.

To select a sample from the SIC we generated H random values $u_1, u_2, \ldots, u_H$ uniformly distributed between 0 and 1 and picked a particular cell h only if $u_H \leq p_{2h}$. For each chosen cell h, we then listed the sites it contained in a random order and instructed the schedulers to contact sites starting at the top of the list until they received n_h.

For allocations within a given SIC, the measure of size used is number of employees. Allocations across SICs require translation of number of employees into estimated motor energy use. Within an SIC, however, the translation factors would be a constant, so this step is unnecessary.

Implementing the non-MSA Manufacturing Sample Selection

Our sample design called for four or five sites to be selected in non-MSA locations for each of five SIC groups. To enhance the overall analysis, the non-MSA portion was drawn using a statistical sample. To minimize costs, the sampling frame was limited geographically, but was not clustered as the MSA sample was. The frame was restricted to the continental U.S. (Alaska and Hawaii were excluded) and excluded the smallest sites in each SIC.

The sampling was implemented by a combination of simple random samples provided by Dun & Bradstreet. Using the following steps separately for each SIC to allocate sample to size strata gave a probability-proportional-to-size sample from those draws:

1. Define the universe as all non-MSA sites with employment greater than a cut-off c, where c is one of Dun & Bradstreet's employment boundaries, such that about 90 percent of the non-MSA employment is above c.
2. Split the universe into two size strata, Large and Small, along a Dun & Bradstreet employment boundary such that each stratum has about half the total employment in the universe. (For SICs where the target sample size is five, aim for 60 percent and three sample points in the Large stratum, 40 percent and two points in the Small stratum.)
3. Split each of the two strata into substrata h along the finest Dun & Bradstreet employment boundaries available. In each substratum h, determine the average employment m_h as

   $$m_h = M_h / N_h$$

   where M_h and N_h, respectively, are the employment total and number of sites for the substratum.
4. Set the selection probability p_h for each site in stratum h as

   $$p_h = m_h / M$$

   where M is the total employment for the universe.
5. Request a random sample from Dun & Bradstreet in each substratum h of size

$n_h = 100\ N_h\ p_h = 100\ M_h/M.$

6. After receiving the Dun & Bradstreet sample, randomize it across all substrata within each size stratum (Large and Small), and set quotas of size two or three for each stratum. Work through the randomized lists to fill the quotas.

In field work such as this, we expected about a 20 percent recruitment rate. That is, about 20 percent of the sites contacted were expected to agree to a visit within the time frame of the field work in that location. For this reason, it was necessary to designate about a five-to-one oversample for the recruiters to work with. Once the cell was selected and its sample allocation determined, all the sites in the cell were listed in randomized order. Recruiters then worked through the list in order until the target allocation was met.

Oversampling and Substitution

Our first cut at defining sampling cells involved the following steps:

- For purposes of the initial sample development, there were only three size categories: Small, Medium, and Large. The break points between these three categories were set individually for each two-digit manufacturing group. The criterion in setting the break point was to allocate roughly equal portions of total estimated motor system energy (from MECS) to each of the strata. This is a typical procedure used to minimize the variance of estimates and to simplify variance calculations.
- Within each selected PSU, we defined cells by SIC and size stratum. For some SIC/PSU combinations, it was necessary to combine size categories in order to have enough facilities to provide the requisite number of completed surveys after taking sample attrition and refusals into account.

Within a PSU, cells were then selected randomly for inclusion in the sample with probability proportional to estimated motor energy use. Estimated motor energy use was just a multiple of employment with a different multiplier used for each SIC. For PSUs that were selected at random, rather than included with certainty, all the cell selection probabilities were increased by the inverse of the PSU selection probability. This adjustment preserves the overall selection probability proportional to size (employment) for each site. The adjustment also keeps the number of sites to be completed in each PSU approximately the same across large and small PSUs.

A disadvantage of this procedure is that it increases the likelihood that cells with very few sites will be selected. Even within the certainty PSUs, there are some cells with only one or two sites. However, the number of such cells is increased when we go to some of the smaller noncertainty PSUs.

With a single site in a cell, we cannot be sure of having the cell in the sample at all, since any one site may or may not be able to be scheduled. Likewise, any time the allocation is equal to the total cell count, we are likely to fall short of the allocation. In fact, we anticipate a response rate on the order of 15 to 20 percent. Thus, we would only expect to get about one out of five of the single-site cells. Even in the cells where the number of sites is three or four times the allocation, we can expect to fall somewhat short of the allocations.

Recognizing this problem, we defined larger cells in order to increase the available sample. The disadvantage of increasing the cell size is that the larger sites are no longer designated as the preferred sites for completion. The advantage is that the larger cell defines the natural "substitution" group, while allowing for straightforward estimation. We simply regard response or nonresponse as one more random selection step. Thus, we can regard the completed sample within each cell as the result of a random draw from the total population in the cell.

To increase the cell sizes, we set a rule that if the number of sites in a cell was fewer than five times the cell's conditional allocation, that cell must be merged with the next smaller cell in the same PSU and SIC. However, for those cells that were conditional certainty cells based on the original stratification, we changed boundaries individually. Rather than simply merging these cells with the next smaller, we moved the lower boundary down until we had a reasonable oversample within the cell, but without making the range of sizes within the cell too large.

Cells Still Too Small

In some cases these judgment-based boundaries resulted in cells that still had less than the desired five to one ratio of population to sample allocation. Our reasoning was that it would be better to get fewer of the large sites, but be fairly sure of getting some, than to have a cell so diffuse that we may get no large sites in the sample.

Dealing with Too-Small Cells: Do the Best We Can and Live with It

We, therefore, still have the question of what to do when we are unable to fill the quota in a given cell. Our strategy is simply to get as many completes as possible in these "tight" cells and not attempt to make any substitutes. Again, we effectively allow the nonresponse to serve as another part of the random selection process. This strategy will leave us with some cells short of their quotas and even some completely empty cells. To balance the expected shortfall in meeting quotas, we pull an oversample such that the expected total sample size will equal the target.

Oversample Needed to Compensate Expected Shortfall

We estimated the likely shortfall, and corresponding oversample required, by looking at an initial sample drawn with a target allocation total of 270. In this sample, there were 30 cells with less than a five-to-one ratio of population to sample quota. These cells contained a total of 191 sites.

We expected to be trying virtually every site in these cells to get as close as possible to filling the quotas. Thus, the total expected number of completes in these cells was the response rate times the number of cells. Since we plan to make extra efforts to fill the tight cells, we assumed that the response rate for these will be at the upper end of our anticipated range, or 20 percent.

The expected number of completes would be 239 when the target allocation was 270. We, therefore, compute the target number required to give an expectation of 248 completes. Thus, we selected the three-stage sample for a total target sample size of 280. Starting from a total quota of 280, this would give an expected total completed sample of 248, which was our goal.

However, the total of the cell quotas resulting from the three-stage selection process is random, not exactly controlled. In the selected sample with a target total of 280, the total selected quota was 288. Thus, with the expected shortfall of 32, we anticipated a total sample of 256 from the three-stage MSA sample. Because recruiting was somewhat more difficult than anticipated, the actual number of site visits completed for the main sample was somewhat smaller, as indicated in Table **C-2**.

C.1.3 Data Collection Methods

Once a site was selected into the sample, data collection for the Baseline Inventory proceeded in a number of stages. These are summarized in Table C-3.

Table C-3
Overview of Field Data Collection for the Baseline Survey

Stage	Facility Description/ Process Inventory	Motor Inventory	Motor Measurements (Site Subsampled)
1. Precontact	Confirm SIC Confirm motors > 1 HP Obtain number of employees and facility. SF Request energy bills.		
2. Initial Site Interview	Confirm processes Identify on-site process experts Complete Practices Survey Output of key processes	Estimate number of motors Hours of operation at process level	
3. Detailed Site Inspection		HP and type Nameplate Load type Operating schedule	Instantaneous load using amps and speed. Used to calculate energy and op. efficiency.

- ***Stage 1: Precontact – Facility Description/Process Inventory.*** Trained schedulers initiated contact with the selected facility over the phone. The first objective of the call was to determine whether the site was eligible to be included in the survey. To be eligible, the site needed to meet the following criteria: use integral horsepower motors in its production facilities, and be correctly classified as a two-digit SIC by Dun & Bradstreet. Once we determined that these criteria were met, we asked for employment, square footage, and energy consumption and went on to solicit the facility's participation in the survey and gather information to facilitate scheduling.

  To encourage participation, we offered facilities a report of the motor inventory, a copy of the MotorMaster+ software, and an electronic database of the motor inventory entered into that software. We also provided a MotorMaster+ report that identified specific motors that can be cost-effectively upgraded to a higher efficiency.

  Each audit was carried out by one field engineer who had participated in extensive classroom and field training. Because the field engineers required an escort in the facility, 3 days was the maximum we believed plant staff would agree to have us on site. The data collection protocol was designed so that it could be completed in three days, even in large sites.

- ***Stage 2: Initial Site Interview – Facility Description/Process Inventory.*** The field engineer's first task upon arriving on site was to complete the Practices Survey with the principal contact. This was generally the maintenance manager, plant engineer, or, in smaller facilities, the owner. Table C-4 shows the topics covered and the analyses supported by the Practices Survey.

Table C-4
Topics Covered and Analyses Supported by the Practices Survey

Topics Covered	Analyses Supported
• Inventory adjustment variables: rates of failure, rewinding and repair, replacement, scrappage, and second-hand sales • Factors affecting the rewind/replace decision • Criteria applied for selecting premium efficiency motors • Use and nature of specifications in motor purchase and rewind situations • Description of maintenance practices • Purchasing and maintenance practices for generic equipment: pumps, fans, compressors	• Estimate prevalence of "best practices" in motor purchasing and maintenance • Identify opportunities to save energy by providing information and education • Establish baseline practices for use in analysis of Motor Challenge effects • Estimate parameters for a stock adjustment model to translate data on motor shipments into changes in inventory

At this stage, the field engineer also collected information on a variety of other topics including: facility electric use, identification of key processes, identification of production departments, and a rough allocation of total facility motor energy use to the different departments.

- ***Stage 2: Initial Site Interview – Motor Inventory.*** After the initial interview and Practices Survey, the field engineer made a quick walkthrough inspection of the facility accompanied by an escort. The objectives of the walkthrough were to confirm the rough allocation of motor energy to the departments and to map out a strategy for accomplishing the data collection as quickly as possible. For large sites, which could not be fully inventoried in 3 days (over 300 motor systems), there was a second objective. This was to work out the application of prescribed methods for sampling motors within the site. This method is described in the next subsection. During the walkthrough, the field engineer also collected data at the department level, primarily hours of operation.

  Once the field engineer determined the best general approach to the site, he collected on all motor systems in the plant, or within the sampled areas. Table C-5 shows the individual pieces of inventory data that were collected at facility, department, and individual motor system levels. For purposes of data collection, the motor system consisted of the motor itself, controls on the immediate motor circuit, the drive train, and speed controls.

- ***Stage 3: Detailed Site Inspection – Motor Inventory.*** Once the general approach to the site was determined, the field engineer collected data on all motor systems in the plant or within the sampled areas. The specific data collected for each motor are shown in Table C-6.

Table C-5
Overview of Field Data Collection for the Inventory Survey

Level of Observation / Type of Data
Facility Level Observations • Number of employees • Total electric consumption and costs • List of principal industrial processes in the plant • Size of the plant and production areas ***Department Level Observations*** • Operating schedules • Estimated percentage of total plant motor energy (where internal sampling was needed)
Motor System Level: Component Data • Component type: e.g., pump, fan, air compressor, refrigeration compressor, etc. • Process: e.g., grinding, gas separation, process heat, etc. • Component Age • Load Modulation Type: e.g., throttle valve, ASD, inlet vane, outlet damper, mechanical clutch • Mechanical Drive Type: e.g., shaft, flat belt, V-belt, roller chain, etc. • Manufacturer • Escort's assessment of whether the load is fluctuating or constant • Diversity: i.e., percentage of department operating hours the motor is on, per escort
Motor Data • Size (HP or kW converted to HP) • NEMA design: A, B, C, D, E, DC motor; synchronous motor; other special purpose • Motor age • Synchronous speed • Enclosure type • Voltage rating and "wired for" voltage • Manufacturer • Nameplate speed • Nameplate amps • Nameplate power factor • Nameplate efficiency

Table C-6
Variables Collected for Motor Systems

NEMA Design	Load Control (e.g., ASD or Throttle)	Age of Motor/Component
Manufacturer	Mechanical Drive Type	Enclosure
Hours of Operation	Application Process	Voltage Rating
Load: Constant or Fluctuating	Component Type (pump, fan, etc.)	Speed
Nominal Efficiency	OEM Packaged vs. Separate Motor	Amps/ Power Factor

- ***Stage 3: Detailed Site Inspection – Motor Measurements.*** After the inventory was completed, the field engineer took instantaneous load measurements on a sample of twelve operating motors within the plant. The measurements were made using the two-wattmeter method. The method used to select the sample of motor systems to be metered is described in the next subsection.

C.1.4 Sampling within Sites

Sampling the inventory in large sites. Based on field tests of the data collection methods, we determined that a field engineer could inventory a maximum of 300 motor systems during a 3-day visit. We knew that many of the sample facilities would have more than 300 motors. Some would have thousands. To address this situation, we developed a sub-sampling procedure which was based on our experience in surveying factories for energy efficiency program evaluations. The basic problem was that, in all but exceptional factories that kept complete motor inventories, we would have no list of motors to start from. Thus, our sampling approach proceeded in the following steps:

- Divide the facility into logically grouped areas, using the experience of the escort as a guide.
- Estimate the percentage of total motor energy accounted for by each logical division, again relying on site personnel. This factor was used in weighting the results.
- Select areas for inclusion in the survey using random procedures.
- Complete full inventories on the selected areas.

Of the 254 manufacturing sites surveyed, 86, or 33.8 percent used a within-site sample of motor systems.

Selection of motors for load measurement. We selected motors for load measurement by making random selections from the list of motors inventoried. The quotas for size categories were developed based on information on the allocation of motor energy developed for the larger sampling effort. The quotas are shown in Table C-7. If there were fewer motors in the higher HP categories than the quota required, the remaining samples were allocated to the next lowest size category. For example, if a plant had only two motors of 100 horsepower or more, the allocation would be as indicated in the final column of Table C-7.

Table C-7
Site Monitoring Quotas by Motor Size

Horsepower	Number Monitored		
	Quota	If Too Few ≥ 100 HP	Example with 2 motors ≥ 100 HP
1-19	3	3	3
20-99	4	$9\text{-}N_{100}$	7
100+	5	N_{100}	2

C.1.5 Survey Administration and Response

We tested the data collection protocol at a number of sites in the late summer and autumn of 1996. Based on this work, we refined the data collection protocol and solicitation system substantially. Field engineers were recruited and trained in November and December of 1996, and field work began in earnest in January 1997. It took approximately 10 months to complete the data collection.

Convincing facility owners and managers to allow us to conduct the survey at their plants proved to be the most difficult part of the survey. We recruited survey participants essentially through "cold calling." The process of identifying the appropriate decision-maker and gaining their permission took an average of four to six combined telephone calls and fax communications at each recruited site.

Table C-8 shows the results of our sample recruitment efforts for the manufacturing sample (MSA plus non-MSA sites). We attempted to contact nearly 4,500 facilities listed in the Dun & Bradstreet database. We determined that 8.4 percent of these facilities did not exist, and were unable to establish contact with a roughly similar number. Among those we were able to contact, nearly half refused to take part in the survey. Another sizable portion deferred their decision for so long that their sample cell was closed before they replied. These can be interpreted as polite refusals. We also determined that roughly one quarter of the facilities we attempted to contact fell out of the scope of the study. Among the typical reasons for disqualification: there were no integral horsepower motors on site; no manufacturing activities were conducted at the site; and Dun & Bradstreet had misclassified the site in terms of SIC or size. The information gained from the screening calls was used in analyzing the results of the survey. For more on this topic, see Section C.3.

We obtained initial permission to undertake the survey from 277, or 6.3 percent, of those manufacturing sites contacted. Twenty-three of these customers later declined to be surveyed. We had similar success in lining up non-manufacturing sites. Larger facilities were more likely than others to participate in the survey. Among companies in the Large and Medium/Large strata, participation rates averaged 17 percent, versus 6 percent for the survey as a whole. This pattern is not surprising for a number of reasons. First, larger facilities had more to gain from products we offered in exchange for their cooperation, since they had more motor systems on site. Second, larger facilities generally had more personnel to assign to escorting the field engineer and taking load measurement readings. Many smaller companies did not have electricians on staff. The understaffing of the maintenance function, which we observed throughout the sample, was particularly pronounced for smaller companies. Once the field engineers were on site, however, they enjoyed a very high level of cooperation and response from their hosts.

Table C-8
Disposition of Manufacturing Sample

Disposition	Number	% of Sites Attempted
Complete	254	5.7%
Canceled	23	0.5%
Does Not Exist	375	8.4%
Refused/Not Interested	1,730	38.7%
Not Qualified	1,057	23.7%
Not Contacted	378	8.5%
Decision Pending when Quota Filled	651	14.6%
Total	4,468	100.0%

C.2 ESTIMATING POPULATION CHARACTERISTICS FROM THE SITE DATA

The objective in designing a sampling plan is to enhance our ability to make informed inferences pertaining to an entire population frame based on data collected from the sampled portion. The underlying basis of sampling principles is that we can devise a strategy to collect data from a small portion or sample of a population frame that will be statistically representative of the whole population. What do all these calculations tell us about the population? The formulas used to develop population estimates from the sample data are given below.

Form of the Estimators

We begin with basic notation.

Notation

With three-stage sampling, we have selection of PSUs (MSAs) at a different stage from selection of SIC-PSU-size cells. We use the indices *ks* to indicate the PSU *k* and size stratum *s*. The numbering of the sampling stages is 1 (PSU selection); 2 (cell selection within PSUs); and 3 (site selection within cells). In addition, we explicitly recognize that the first-stage selection of PSUs is by simple random sample (SRS) within PSU selection groups *L*. We assume that the estimation is within an SIC, and suppress the SIC subscripts.

- *Target Variables*

x_j = value of x for site j
X = population total of x_j across all sites j in the frame
X_k = population total of x_j across all sites j in PSU k, k= 1,...K
X_{ks} = population total of x_j across all sites j in size stratum s in PSU k, s = 1,2,3
$X_{\bullet L}$ = simple average of population totals X_k across all PSUs k in PSU selection group L
$\bar{x}_{ks}$ = sample average of x_j in cell ks

- *Population sizes*

N_k = number of sites in population for PSU k
N_{ks} = number of sites in population for PSU k, size stratum s
N_{1L} = number of PSUs in the frame for PSU selection group L

- *Sample sizes*

n_k = achieved total sample size for PSU k
n_{ks} = achieved sample size for PSU k, size stratum s
n_{1L} = number of PSUs selected by SRS from group L

- *Selection probabilities*

p_{1k} = first-stage selection probability for PSU k (i.e., the probability that PSU k is selected)
p_{2ks} = second-stage selection probability for cell ks (i.e., the probability that size stratum s is selected, given that PSU k is selected)
p_{3j} = third-stage (conditional) selection probability for site j (i.e., the probability that site j is selected, given that the PSU k and size stratum s that contain the site are selected)
p_j = unconditional selection probability for site j in PSU k, size stratum s

- *Sample inclusion indicators*

δ_{1k} = 0/1 dummy variable indicating that PSU k is included in the sample.

δ_{2ks} = 0/1 dummy variable indicating that PSU-size cell ks is included in the sample, assuming PSU k is included.

δ_{3j} = 0/1 dummy variable indicating that site j in PSU-size cell ks is included in the sample, assuming that cell ks is included.

δ_{j} = 0/1 dummy variable indicating that site j in PSU-size cell ks is included in the sample, unconditionally.

MSA Manufacturing Sample: Stratified Mean-per-Unit Estimate of a Total

The starting point for the estimation is the simple mean-per-unit estimate for a stratified sample. Adjustments to this estimator are described further below.

The probability that the jth unit is included in the sample is

$$p_j = p_{1k}p_{2ks}p_{3j}$$

where

$p_{3j} = n_{ks}/N_{ks}$ is the probability of selecting unit j once cell ks containing unit j is chosen.

If δ_j is the 0/1 variable indicating that the jth unit—either an individual or a cell—is included in the sample, then the estimate of the SIC total is

$$\hat{X} = \sum_j \delta_j x_j / p_j$$

$$= \sum_k \frac{\delta_{1k}}{p_{1k}} \sum_s \frac{\delta_{2ks}}{p_{2ks}} \sum_j \frac{\delta_{3j} x_j}{(n_{ks} / N_{ks})}$$

$$= \sum_k \frac{\delta_{1k}}{p_{1k}} \sum_s \frac{\delta_{2ks}}{p_{2ks}} N_{ks} \bar{x}_{ks}$$

$$= \sum_k \frac{\delta_{1k}}{p_{1k}} \sum_s \frac{\delta_{2ks}}{p_{2ks}} \hat{X}_{ks}$$

$$= \sum_k \frac{\delta_{1k}}{p_{1k}} \hat{X}_k .$$

The summations above are all over the entire population of sites j, size strata s, and PSUs k. In addition, the formula, as presented here, shows that the overall population total X can be viewed either as the sum of cell-level totals X_{ks} or as the sum of PSU-level totals X_k.

Note that the estimated cell total $\hat{X}_{ks}$ is simply the cell population size times the estimated mean. Since selection within the final-stage cells is by simple random sample, the estimated cell mean is the simple mean of the x_j for the sampled sites. That is,

$$\hat{X}_{ks} = N_{ks}\bar{x}_{ks} = N_{ks}\left(\sum_j \delta_j x_j\right)/ n_{ks}$$

Non-MSA Sample

For the non-MSA portion of the sample, we followed the sampling procedures described in Section C.1. Within each stratum defined by SIC group and size, the total *X* is estimated from any single sample point $x_{(d)}$ from draw *d* as

$$\hat{X}^{(d)} = x_j / p_j$$

where p_j is the selection probability determined at step four for the non-MSA sample implementation procedure described above. For the total sample of size *n* (with *n* = 2 or 3 within each stratum), the total *X* is estimated by the average of the separate estimates

$$\hat{X} = (1/n)\sum_{d=1}^{n} \hat{X}^{(d)}$$
$$= \sum_{d=1}^{n} x_{(d)} / \left(np_{(d)}\right)$$

where $x_{(d)}$ denotes the observed value of *y* for the single site selected at draw *d* and $p_{(d)}$ is the associated selection probability. The selection probability $p_{(d)}$ used in this formula is the pps probability

$$p_{(d)} = m_h/M$$

where m_h is the estimated measure of size for the site and *M* is the total Dun & Bradstreet employment for the stratum. The estimated measure of size m_h is the average employment in the Dun & Bradstreet size range for the stratum.

Adjusting for Ineligible Sites

- *Main Sample*

In the course of the field work, schedulers/recruiters found that many of our listed sites are actually non-manufacturing. The possibility of ineligible sites in our lists created a problem for the estimation procedures. These procedures require that we be able to estimate the cell totals of employment M_{ks} and motor energy use Y_{ks} from the cell sample means. We therefore need to know the size of the eligible population in each cell.

Each estimated PSU total $\hat{X}_k$ is a weighted combination of independent cell totals $\hat{X}_{ks}$. The variance terms S_{LX} defined below are variances across a PSU selection group L of PSU totals X_k. Thus, the estimation formulas all depend on our ability to estimate the cell-level totals X_{ks} and their variances. Moreover, changing the way we compute these terms does not change anything about the rest of the estimation formulas, provided we maintain the original procedures for selecting PSUs and cells.

Our approach is therefore to adjust for ineligibles separately within each cell. Because the estimates and inclusion δ_{2ks} for each cell are independent, we can consider each cell separately. That is, we will develop a formula that is applied at the cell level. For ease of notation, we omit the cell subscripts *ks*.

- *Framework*

Within each cell, we regard the selection of the visited sample as part of a nested sampling process. First, a large sample is screened to determine the eligibility of each site in the sample. We refer to this large sample as the contact sample A, with sample size n_A. (Sites that are called, but for which eligibility cannot be determined are excluded from consideration.)

Once eligibility is determined for each site in the contact sample, we select a subsample B of size n_B to visit. Only eligible sites may be included in the visited subsample. We assume that the contacted sample A is effectively drawn by simple random sample from the universe of all sites in the frame, and the visited sample B is effectively drawn by simple random sample from the set of eligible contacted sites.

- *Notation*

I = index denoting in-scope sites
O = index denoting out-of-scope sites
A = index denoting the contacted sample
B = index denoting the visited subsample
N_g = number of in-scope sites in the population in the group indicated by index g
n_A = number of sites in the contacted sample
n_{IA} = number of in-scope sites in the contacted sample
n_{OA} = number of out-of-scope sites in the contacted sample
n_{IB} = number of (in-scope) sites in the visited sample
M_g = total Dun & Bradstreet employment for sites in the group indicated by index g
$\bar{m}_g$ = mean Dun & Bradstreet employment for sites in the group indicated by index g
Y_g = total manufacturing motor energy use for sites in the group indicated by index g
$\bar{y}_g$ = mean motor energy use for sites in the group indicated by index g
I_j = 0/1 indicator variable indicating site j is in-scope.

- *Stratified Ratio Estimator*

Our general approach is to treat eligibility as a stratification variable and construct the total motor energy use for eligible sites as a stratified ratio estimator. Because we do not know the population sizes of the two strata (in-scope and out-of-scope), we use the larger contact sample to estimate these sizes. For this estimate, we use a simple ratio estimator. The in-scope total employment is estimated by

$$\hat{M}_I = (M_{IA} / M_A) M \; .$$

Note that

$$M_{IA} + M_{OA} = M_A$$
$$\hat{M}_1 + \hat{M}_O = M \; .$$

We then compute the stratified ratio estimate of Y as

$$\hat{Y}_{RS} = \frac{\hat{M}_I (\overline{y}_{IB} / \overline{m}_{IB}) + \hat{M}_O (\overline{y}_{OB} / \overline{m}_{OB})}{\hat{M}_I + \hat{M}_O} M$$
$$= M(M_{IA} / M_a)(\overline{y}_{IB} / \overline{m}_{IB}) \; .$$

Thus, we have an estimate of total in-scope employment based on the contact sample, combined with the ratio of motor energy use to in-scope employment from the visited sample.

- *Non-MSA Manufacturing Sample*

The point estimation formula would be appropriate if all sites counted in the Dun & Bradstreet employment total M were in scope for our study. However, many sites are not in scope. Accordingly, the total M for each size stratum is adjusted by our estimate of the proportion of employment that is in scope in that stratum.

$$R_I = M_{IA}/M_A$$

where

M_{IA} = total Dun & Bradstreet employment for contacted in-scope sites in the size stratum
M_A = total Dun & Bradstreet employment for contacted sites in the stratum.

Thus, with adjustment for ineligibles, the estimated total for the stratum becomes

$$\hat{Y} = (1/n)\Sigma_{d=1}^{n} y_{(d)} / \left(m_{h(d)} / (R_I M)\right)$$
$$= R_I (1/n)\Sigma_{d=1}^{n} y_{(d)} / \left(m_{h(d)} / M\right)$$
$$= R_I \hat{Y}_0 .$$

That is, within each stratum, the out-of-scope adjustment R_I can be applied after the initial computation of the total $\hat{Y}_0$. The adjustment R_I does not have to be included with each stand-alone estimate of the total.

Final Estimates—Combined Ratio Estimator

The final estimator used for this analysis is a combined ratio estimator. If information is available on the relationship between the variable being measured, and some other variable, which is known for the entire population, an estimator can be constructed that relies this relationship. Estimators of this type include separate and combined ratio estimators, regression estimators, and model-based estimators.

Within a stratified sample design two alternative forms of the ratio estimate are available. The "separate" ratio estimate is the product of the ratio of the two variables' means and the known quantity at the stratum level. The "combined" ratio estimate applies the known quantity to the ratio of the estimated means at the total level, that is, across all strata. The combined estimate of the ratio is given by

$$\hat{R} = \hat{Y} / \hat{M}$$

where $\hat{Y}$ and $\hat{M}$ are each estimated by the mean-per-unit formula as shown above. For our application, the particular ratio of interest is for

Y = total motor energy use
M = total employment.

Our final estimate of total motor energy use is then given by the combined ratio-based estimator

$$\hat{Y}_R = \hat{R}M$$

where M is the known employment total from Dun & Bradstreet.

By constructing the ratio of motor energy to employment for the sample and applying this ratio to the known employment of the original population, we improve the estimates for the population. Because the two variables are highly correlated, the precision of the ratio-estimated parameters is better than the precision of the mean-per-unit parameter estimates.

Weights

The original approach, which was the basis for the sample design, was to extrapolate the estimated motor energy to the population using a mean-per-unit estimator. This is the simplest estimator of a population total, given a sample of observed data. With the mean-per-unit approach, the sampled data can be extrapolated to the population by applying sample weights to the results, where the sample weight for units selected from stratum *h* or cell *ks* is the inverse of the probability of having been drawn in that stratum or cell:

$$weight_{MSA} = \frac{\delta_{1k}}{p_{1k}} \frac{\delta_{2ks}}{p_{2ks}} \frac{N_{ks}}{n_{ks}}$$

$$weight_{nonMSA} = \frac{1}{n_h} \frac{M}{m_h}.$$

Based on the adjustments for ineligibles and the combined ratio, the weights developed for extrapolating site data to the population are

$$adjusted\ weight_{MSA} = \frac{M}{\hat{M}} \times \frac{M_{IA}}{M_A} \times \frac{\delta_{1k}}{p_{1k}} \frac{\delta_{2ks}}{p_{2ks}} \frac{M_{ks}}{m_{ksIB}} \frac{1}{n_{IB}}$$

$$adjusted\ weight_{nonMSA} = \frac{M}{\hat{M}} \times \frac{M_{IA}}{M_A} \times \frac{1}{n_h} \frac{M}{m_h}.$$

Variance of the Estimators

The relative precision of the population estimates, for a randomly drawn sample, is governed by proven statistical principles based on the number of points sampled, the variability of the data, the estimation formulas, and the required confidence interval.

MSA Manufacturing Sample

For the main sample, the variance of the estimator X derives from three sources of variation, corresponding to the three stages of sampling: PSUs (Stage 1); PSU-size cells with selected PSUs (Stage 2); and sites within selected cells (Stage 3).

Within-PSU Variance

First consider the within-PSU variance. For a selected PSU k, the variance of the estimated PSU total $\hat{X}_k$ is given by

$$V\left[\hat{X}_k\right] = \sum_s \frac{(1-p_{2ks})}{p_{2ks}} \hat{X}_{ks}^2 + \sum_s \frac{V\left[\hat{X}_{ks}\right]}{p_{2ks}}.$$

The same derivation applied to the total $\hat{X}$, viewed as the sum of estimates over PSU-totals for selected PSUs, gives

$$V\left[\hat{X}\right] = \sum_k \frac{(1-p_{1k})}{p_{2ks}} \hat{X}_k^2 + \sum_k \frac{V\left[\hat{X}_k\right]}{p_{1k}}.$$

In the above equations, the standard variance formula for the mean or total based on a simple random sample gives the within-cell variance as

$$V\left[\hat{X}_{ks}\right] = \frac{N_{ks}^2}{n_{ks}(n_{ks}-1)}\left(1-\frac{n_{ks}}{N_{ks}}\right)\sum_j (x_j - \bar{x}_{ks})^2 .$$

Incorporating Between-PSU Variance

The above formulas were presented for the variance of the stratified estimator under the assumption that the selections of all the PSUs k as well as all the cells within PSUs were independent. However, in our sampling procedure, the selection of PSUs is by simple random sample within a group of PSUs. Thus, the PSU selections are not mutually independent. We therefore need to modify the variance formula.

The variance computation is substantially simplified if the selections of PSUs are all independent. A simple random sample does not achieve this independence, because knowing that certain PSUs are included changes the probabilities that certain other PSUs are included. Allow each unit an independent chance to be included or not. The final PSU sample size is random. For example, PSU k is in the sample if a random number drawn from the uniform distribution on [0,1] is less than or equal to the desired selection probability p_{1k}. With this method, it is easy to control the selection probabilities, and in fact these probabilities can be proportional to the PSU measure of size or vary in other ways across PSUs. However, the actual PSU sample size is random.

To get the unconditional variance, we have to add the between-PSU contribution to variance. To do this, we make the not entirely correct assumption that the samples in different PSUs are independent. Note that only the noncertainty PSU ($p_{1k} < 1$) will contribute to this variance. Note also that the between-PSU variance contribution will be large if the PSU total X_k is large.

Each selected PSU k is drawn from a size group L of PSUs by simple random sampling. That is, the selection probability for PSU k drawn from PSU group L is

$$p_{1k} = n_{IL}/N_{IL}$$

where n_{IL} is the number of PSUs selected from PSU group L in the first-stage selection, and N_{IL} is the number of PSUs in the group. Thus, the estimate of X can be written as

$$E(\hat{X}|\delta_1) = \Sigma_L N_{1L} \bar{X}_L$$

where $\bar{X}_L$ denotes the average of PSU totals X_k over the sample (designated by δ_1) drawn from group L. Since the selections in the different groups L are independent, the variance of the sum is the sum of the variances. Combining the two components of variance, we have

$$V[\hat{X}] = \Sigma_L N_{1L}^2 (1 - \int_{1L}) S_{LX}^2 / n_{1L} + \Sigma_k (1/p_{1k}) V(\hat{X}_k)$$
$$= \Sigma_L N_{1L}^2 (1 - \int_{1L}) S_{LX}^2 / n_{1L} + \Sigma_k (1/p_{1k}) \left[\sum_s \frac{(1-p_{2ks})}{p_{2ks}} X_{ks}^2 + \sum_s \frac{V[\hat{X}_{ks}]}{p_{2ks}} \right]$$

where

$$S_{LX}^2 = \Sigma_{k\varepsilon L} (X_k - X_{\bullet L})^2 / (N_{1L} - 1)$$
$$X_{\bullet L} = \frac{1}{N_{1L}} \Sigma_{k\varepsilon L} X_k$$
$$\int_{1L} = n_{1L} / N_{1L} \ .$$

This equation gives us the variance for the ratio estimator by substituting $\hat{U}_{ks} = \hat{Y}_{ks} - RX_{ks}$ for $\hat{X}_{ks}$. Then

$$V(\hat{Y}_R) = V[\hat{U}] = \Sigma_L N\Sigma_{1L}^2 (1 - \int_{1L}) S_{LU}^2 / n_{1L} + \Sigma_k (1/p_{1k}) V(\hat{U}_k)$$
$$= \Sigma_L N\Sigma_{1L}^2 (1 - \int_{1L}) S_{LU}^2 / n_{1L} + \Sigma_k (1/p_{1k}) \left[\sum_s \frac{(1-p_{2ks})}{p_{2ks}} U_{ks}^2 + \sum_s \frac{V[\hat{U}_{ks}]}{p_{2ks}} \right].$$

Note that for the certainty PSUs, $\hat{S}_{LX}^2$ is zero, and only the terms in $\hat{V}[\hat{X}_k]$ contribute to the variance.

Non-MSA Sample

Since $\hat{X}_0$ is the mean of n independent estimates, its variance is estimated by

$$\hat{V}\left[\hat{X}_0\right] = \frac{1}{n}\frac{1}{(n-1)}\Sigma_{d=1}^{n}(\hat{X}^{(d)} - \hat{X}_0)^2 \ .$$

Now, actually the n estimates $\hat{X}^{(d)}$ are not all independent, since we are sampling without replacement. Since we are only selecting two or three out of the whole country, the difference in variance between sampling with and without replacement is minimal. The effect of this approximation is a slight overstatement of variance. Because we have unequal selection probabilities, a simple finite population correction of the form (*1-n/N*) probably would not be a correct adjustment for sampling with replacement. Therefore we leave the variance estimate unadjusted.

Adjusting for Ineligible Sites

The following equations describe the adjustment to the variance equations to address the size of the eligible population in each cell. Given the stratified ratio estimate of Y_{RS} described above, the approximate variance of this total is given by

$$\hat{V}[\hat{Y}_{RS}] \cong (N / n_A - 1)\{(\hat{N}_I - 1)\hat{S}^2_{IB} + \left(\frac{\hat{N}_I \hat{N}_O}{N}\right)\bar{y}^2_{IB}\} + \hat{N}^2_I (1 - n_{IB} / n_{IA})\tilde{S}^2_{IB} / n_{IB}$$

where

$$\hat{S}^2_{IB} = \frac{1}{n_{IB} - 1}\sum_{j \varepsilon IB}(y_j - \bar{y}_{IB})^2$$

$$\tilde{S}^2_{IB} = \frac{1}{n_{IB} - 1}\sum_{j \varepsilon IB}(y_j - \hat{R}_{IB} m_h)^2$$

$$\hat{R}_{IB} = \bar{y}_{IB} / \bar{m}_{IB}$$

$$\hat{N}_1 = (n_{IA} / n_A)N$$

$$\hat{N}_O = (n_{OA} / n_A)N = N - \hat{N}_I \ .$$

Non-MSA

We can approximate the variance of the adjusted total by

$$\mathrm{Re}lVar[\hat{Y}] \cong \mathrm{Re}lVar[R_I] + \mathrm{Re}lVar[\hat{Y}_0]$$

$$V[\hat{Y}] = \hat{Y}^2 \operatorname{Re} lVar[\hat{Y}]$$
$$\cong \{\operatorname{Re} lVar[R_I] + \operatorname{Re} lVar[\hat{Y}_0]\}$$
$$= \hat{Y}_0^2 V[R_I] + R_I^2 V[\hat{Y}_0] \,.$$

The second term in the final expression is the variance estimate that would be obtained from the variance formula without ineligible adjustment, if the adjusted stratum total $R_I M$ were substituted for M. For the first term, we need to calculate $Var(R_I)$. The adjustment factor R_I is a simple ratio estimator of the form, thus, a standard variance approximation formula for a ratio estimator gives

$$V[R_I] = \frac{1}{n_A} \frac{1}{(n_A - 1)} \Sigma_{d=1}^{n_A} \left(v_{(d)} - R_I x_{(d)}\right)^2 / \left(\frac{M_A}{n_A}\right)^2$$

where

v_c = $x_{(d)}$ if site d is in scope
0 otherwise.

C.3 Description of the Survey Database

The data collected at each site consists of five separate survey forms. These are:

- Motor Practices Survey
- General Information
- Department Information
- Motor Data
- Measurement Data

The motor Practices Survey is filled out by the person at the facility responsible for motor purchase and maintenance decisions at the site. The results of the motor Practices Survey are discussed in Section 3 of the report. The other four survey forms are fill out by the auditor and contain the motor inventory data for analyzing the motor usage at each site.

The data from each form is data input into a separate database. The content of the databases is shown in Table C-9 through Table C-12. The common link between the databases is the facility ID. The hierarchy of the data collection follows the order that the databases are listed above. There is one general information record for each site. A site most often has more than one department record. The departments are selected based on the logical operating divisions of the plant with further consideration of the operating hours and size of the department. Areas of the plant that have different operating hours from the rest of the plant are assigned different departments. Likewise areas of the plant that have a large number of similar motors in which a sample of motors is inventoried is also assigned its own department. The department database has the operating hours for the department and subsampling in formation for the larger departments in which the census of motors is not taken.

The motor data form contains the detailed data for each motor. In addition to the facility ID, it is linked to the department record by the department ID. This link is important in order to calculate the operating hours of the motor. The measurement database contains the instantaneous load measurements. It is linked to the motor record by the process ID and the component ID.

The raw data from the survey forms was data input to flat files. These files were read into Statistical Analysis System (SAS) databases and analyzed using SAS software.

Table C-9
General Information

Field Name	Description
sidfac	Facility ID
idbatch	Batch ID
unitid	Unit ID
auditor	Auditor
company	Company
name	Facility name
address1	Address 1
address2	Address 2
city	City
state	State
zip	ZIP
contact1	Contact 1 name
tel1	Contact 1 Telephone
contact2	Contact 2 name
tel2	Contact 2 Telephone
SIC	SIC Code
outvol	Output Volume
outunit	Output Units
kwh	Annual kWh

Table C-10
Department Information

Field Name	Description
sidfac	Facility ID
siddpt	Department ID
deptdesc	Department Description
shiftw	Average Shifts per Weekday
shiftsa	Average Shifts per Saturday
shiftsu	Average Shifts per Sunday
weeks	Weeks per Year
pcthpkwh	Percentage of Facility HP or Energy
subdiv	Subsampling Subdivision
pctdpthp	Percentage of Department HP
subdesc	Subdivision Description

Table C-11
Motor Data

Field Name	Description
sidfac	Facility ID
package	Package Name
prctype	Process Type
bbox	Black Box
siddpt	Department ID
sidprc	Process ID
sidinv	Component / Motor ID
componnt	Component Name
compcat	Component Category
qty	Quantity of Same Components
compage	Component Age
diversty	Load Diversity
loadmod	Load Modulation Type
drvtype	Mechanical Drive Type
loadflux	Load Fluctuation While on
bbmfg	Black Box Manufacturer
bbmodel	Black Box Model Number
bbkw	Black Box kW
dcpower	DC Power Supply
loadmeas	Motor Load Measured
hp	Motor Horsepower
kw	Motor kW
hprange	Motor Horsepower Range
nema	NEMA Design
motage	Motor Age
rpmsync	Motor Synchronized Speed
encl	Enclosure Type
voltrate	Voltage Rating
phase	Circuit Phase
wired	Wired for Voltage
mtrmfg	Motor Manufacturer
mfgname	Other Motor Manufacturer Name
rpmname	Nameplate Speed
ampsname	Nameplate Amps
pfname	Nameplate Power Factor
effname	Nameplate Efficiency

Table C-12
Measurement Data

Field Name	Description
sidfac	Facility ID
package	Package Name
sidprc	Process ID
sidinv	Component / Motor ID
loaddiv	Load Diversity
sizefac	Component Size Factor
outqty	Output Quantity
outunit	Output Units
measload	Loading During Measurement
m1volt	Measurement 1 Volts
m1amps	Measurement 1 Amperage
m1kw	Measurement 1 Kilowatts
m1pf	Measurement 1 Power Factor
m2volt	Measurement 2 Volts
m2amps	Measurement 2 Amperage
m2kw	Measurement 2 Kilowatts
m2pf	Measurement 2 Power Factor

C.4 DETAILS OF CALCULATIONS

C.4.1 Energy Calculation

The most important calculation done on the data is the estimate of energy consumption for each motor. This is important for two reasons. First, energy consumption forms the baseline against which energy efficiency opportunities can be measured. Secondly, energy consumption allows comparison to secondary information sources. While the focus of the data collection may have been on the inventory of motors and their characteristics such as size, type, process, age, NEMA design, control, speed, etc., accurate estimates of energy consumption are essential to be able to compare these results to other industrial surveys.

Annual motor energy consumption is calculated with the following formula:

$$Annual\,Energy = \frac{horsepower \times 0.746 \times operatinghours \times motorloading}{efficiency}.$$

The value of the parameters in the energy equation for each motor system was established as follows:

- Horsepower: Nameplate horsepower observed or information from escort.
- Constant to convert HP to kW: 0.746.
- Hours of operation: Departmental hours of operation multiplied by the diversity factor for the individual motor system provided by the escort or machine operator.
- Part load: Average part load for application of the motor system for all motor systems with part load measurements.
- Nominal efficiency: Nameplate efficiency observed. If no efficiency was observed on the nameplate, the MotorMaster+ default efficiency for the horsepower class was used.

In some instances horsepower is not collected for a particular motor and must be estimated. In that case the auditor has two options available. The first is that he can enter motor kW instead. From kW the motor horsepower is calculated using the following formula:

$$Horsepower = \frac{kW}{0.746}$$

The second option is that the auditor can estimate the range of horsepower size based on information from the escort. The midpoint of the range is selected as the estimated horsepower for the motor.

C.4.2 Savings Calculation

See Section 2, pages 57-66, for details of the calculations for estimating potential motor system energy savings.

SURVEY FORMS

Industrial Motor-driven Systems Data Collection Instrument

Batch Number: 1a ___ ___ Survey Number: ___ ___ ___ ___ ___ ___ ___ ___

General Facility Information

Pre-Contact Information

Primary Sampling Unit I.D. # 2 ___ ___ ___ Auditor ID: 3 ___ ___ ___6

Company Name 4

Facility
Name 5
Address1 6
Address2 6a
City 7
State 8 ___ ___ ZIP 9 ___ ___ ___ ___ ___

Primary Contact
Name 10
Phone # 11 ___ ___ ___ -- ___ ___ ___ -- ___ ___ ___ ___ x ___ ___ ___ ___

Other contact
Name 12
Phone # 13 ___ ___ ___ -- ___ ___ ___ -- ___ ___ ___ ___ x ___ ___ ___ ___

Facility SIC (4 or 6 digit) 14 ___ ___ ___ ___ -- ___ ___
SIC Text Description: ____________________

On-Site Data:

Output volume of facility 15 ___ ___ ___ , ___ ___ ___ , ___ ___ ___

Output units 16

Annual KWh 16a ___ ___ ___ , ___ ___ ___ , ___ ___ ___

Facility Notes: 17 ____________________

"Don't know" or "Not available": Enter 0000 for numeric fields, 99 for text fields.

Survey Number: 1______ ___ ___ ___ ___ ___ ___

Department Data

Subsampling

Dept. ID #	Department Name / Description	Average 8-hr Shifts / Day: Wk Day	Sat	Sun	Wks / Year	% of Facility HP or Energy	Subdiv # (27)	% Dept. HP (28)
1 (20)	21	22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
2		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
3		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
4		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
5		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
6		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
7		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
8		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
9		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
10		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
11		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			
12		22___ . ___	23___ . ___	24___ . ___	25___ ___	26___ ___ ___	___ ___ ___	___ ___ ___
Notes					29: Subdiv. Description			

Package / Component / Motor Data

Survey Number: ___ ___ ___ ___ ___ ___ ___ ___ p

Package Name: 30 **(BB)** Package Process Type #: 31 ___ ___ ___ **(BB)**

Is Package "Black Box"? 32 ___ Y/N (If yes, then answer only "BB" questions)

Dept. ID Number: 33 ___ **(BB)** >>> Pkg. ID # 34 ___ ___ ___ **(BB)** >>> Component/Motor ID #: 35 ___ ___ ___ **(BB)**

Component Name: 36 Component Category: 37 ___ ___

Motor-driven Component Data kW / Load Measured? (Y/N)70 ___ ***Motor Nameplate Data***

Qty of Same Components: 50 ___ ___ **(BB)**

Component Age (Yrs): 51 **(BB)**

< 5 5 - 10 11 - 20 >20

% Diversity: 52 ___ ___ ___ **(BB)**

Load Modulation Type: 53 ___ ___

Drive Type: 54 ___ ___

Load fluctuates while on: 55 Y N

Component/Pkg. Manuf. 56 ______________ **(BB Only)**

If other data not avail: Mdl# 57 ______________ **(BB Only)**

Nameplate. kW: 58 ___ ___ ___ . ___ **(BB Only)**

DC Power Supply: 60 ___

Motor/Component Notes 59

Size (HP): 71 ___ ___ , ___ ___ ___ . ___ NEMA Design 73 ___

or, Size (kW): 72 ___ ___ , ___ ___ ___ . ___ or, Range72a ___

Motor Age : 74 < 5 5 - 10 11 - 20 >20 Years

Synch. Spd.: 75 ___ ___ ___ ___ Encl. Type: 76 ___

Voltage Rating: 77 ___ ___ Phase: 1 3 77a

"Wired-for" Voltage: 78 ___ ___ ___ ___

Mtr. Manufact.: 79 ___ ___ Other Name 79A ___________

Full Load Nameplate Data

Speed 80 ___ ___ ___ ___ PF 82 ___ ___ . ___ %

Amps 81 ___ ___ ___ . ___ Effic. 83 ___ ___ . ___ %

Package Name: 30 **(BB)** Package Process Type #: 31 ___ ___ ___ **(BB)**

Is Package "Black Box"? 32 ___ Y/N (If yes, then answer only "BB" questions)

Dept. ID Number: 33 ___ **(BB)** >>> Pkg. ID # 34 ___ ___ ___ **(BB)** >>> Component/Motor ID #: 35 ___ ___ ___ **(BB)**

Component Name: 36 Component Category: 37 ___ ___

Motor-driven Component Data kW / Load Measured? (Y/N)70 ___ ***Motor Nameplate Data***

Qty of Same Components: 50 ___ ___ **(BB)**

Component Age (Yrs): 51 **(BB)**

< 5 5 - 10 11 - 20 >20

% Diversity: 52 ___ ___ ___ **(BB)**

Load Modulation Type: 53 ___ ___

Drive Type: 54 ___ ___

Load fluctuates while on: 55 Y N

Component/Pkg. Manuf. 56 ______________ **(BB Only)**

If other data not avail: Mdl# 57 ______________ **(BB Only)**

Nameplate. kW: 58 ___ ___ ___ . ___ **(BB Only)**

DC Power Supply: 60 ___

Motor/Component Notes 59

Size (HP): 71 ___ ___ , ___ ___ ___ . ___ NEMA Design 73 ___

or, Size (kW): 72 ___ ___ , ___ ___ ___ . ___ or, Range72a ___

Motor Age : 74 < 5 5 - 10 11 - 20 >20 Years

Synch. Spd.: 75 ___ ___ ___ ___ Encl. Type: 76 ___

Voltage Rating: 77 ___ ___ Phase: 1 3 77a

"Wired-for" Voltage: 78 ___ ___ ___ ___

Mtr. Manufact.: 79 ___ ___ Other Name 79A ___________

Full Load Nameplate Data

Speed 80 ___ ___ ___ ___ PF 82 ___ ___ . ___ %

Amps 81 ___ ___ ___ . ___ Effic. 83 ___ ___ . ___ %

Component Category/Type
1) AirComp, Centrif
2) AirComp, Scrw/Recip
3) Pump, Centrifugal
4) Pump, Pos. Displcmnt
5) Fan, Centriifugal
6) Fan, Axial Propeller
7) Fan, Other Axial Flow
8) Blower
9) Vacuum pump
10) Dust Collector
11) Refrig Comp, recip
12) Refrig Comp, centrif
13) Refrig Comp, screw
14) Other Mater'l Handle
15) Other Material Proc.
16) Other -explain in notes

Mech'l Drive Types
1) Coupling (shaft)
2) Flat belt
3) V-Belt
4) Synch. / cog Belt
5) Roller chain
6) Silent chain
7) Gear box
8) Adj. Sheave
9) Other

Load Modulation
1) Throttle Vlv, Air
2) Throttle Vlv, Liquid
3) Inlet vane, air flow
4) Outlet damper, air
6) AFD, air flow
7) AFD, liquid flow
8) Staging
9) Multi-spd Motor
10) Mech'l Drive
11) Eddy Current Clutch
12) AFD other
13) Adj. Speed Gearbox
14) Mult. w/AFD
15) Mult. w/o AFD
18) Other 19) None

Manufacturers
1) AO Smith
2) Baldor
3) Brook Hansen
4) Dayton/Grainger
5) G.E.
6) Leeson
7) Lincoln
8) MagneTek /Century /Louis Allis
9) Marathon
10) Reliance
11) Siemens
12) Sterling
13) Tatung
14) Teco
15) Toshiba6
16) US Motors/6 /Emerson6 /Leroy Somer6
17) WEG Elec. Motors6
18) Westinghouse
19) Other

Voltage Ratings
1) 110/120
2) 200 3) 230
4) 208-230
5) 208-230/460
6) 230/460
7) 460
8) 575
9) 2300
10) 4000
11) 220/440

Enclosure
0) ODP
1) TEFC
2) EXP
3) Non-Vented

NEMA Design
A) Design A
B) Design B
C) Design C
D) Design D
E) Design E
X) DC Motor
Y) Synchronous
N) None/Other

DC Power Supply
1) SCR/ Solid State
2)M-G Set6
3) Mercury Arc Rectifier

Estimated Horse Power Ranges A) 1-5 B) 6-20 C) 21-50 D) 51-100 E) 100-200 F) >200

Default Codes: Numeric Fields: Missing/Inaccessible: 000.0, Text Fields: "Don't know" = 99, "Missing" = 97

Subsample Data

Survey Number: ___ ___ ___ ___ ___ ___ ___ ___

Package Name: 30

Pkg. ID # 34 ___ ___ ___ Component/Motor ID Number: 35 ___ ___ ___

Component Load Diversity: 90 ___ ___ ___
(Percent of time loaded)

Est. component loading during meas.: High 1 Med. 2 Low 3 Circle One (94)

Component Size Factor: 91 ___ . ___

Measured Data (Two Wattmeter method for 3 phase)

	Meas. 1	**Meas. 2**
Meas. Volts	95 ___ ___ ___ ___ . ___	99 ___ ___ ___ ___ . ___
Meas Amps	96 ___ ___ ___ . ___ ___	100 ___ ___ ___ . ___ ___
Meas kW	97 ___ ___ ___ ___ . ___ ___	101 ___ ___ ___ ___ . ___ ___

Optional:

Output Quantity: 92 ___ ___ , ___ ___ ___ . ___

Output Units: 93 ____________

Notes: ____

Package Name: 30

Pkg. ID # 34 ___ ___ ___ Component/Motor ID Number: 35 ___ ___ ___

Component Load Diversity: 90 ___ ___ ___
(Percent of time loaded)

Est. component loading during meas.: High 1 Med. 2 Low 3 Circle One (94)

Component Size Factor: 91 ___ . ___

Measured Data (Two Wattmeter method for 3 phase)

	Meas. 1	**Meas. 2**
Meas. Volts	95 ___ ___ ___ ___ . ___	99 ___ ___ ___ ___ . ___
Meas Amps	96 ___ ___ ___ . ___ ___	100 ___ ___ ___ . ___ ___
Meas kW	97 ___ ___ ___ ___ . ___ ___	101 ___ ___ ___ ___ . ___ ___

Optional:

Output Quantity: 92 ___ ___ , ___ ___ ___ . ___

Output Units: 93 ____________

Notes: ____

Package Name: 30

Pkg. ID # 34 ___ ___ ___ Component/Motor ID Number: 35 ___ ___ ___

Component Load Diversity: 90 ___ ___ ___
(Percent of time loaded)

Est. component loading during meas.: High 1 Med. 2 Low 3 Circle One (94)

Component Size Factor: 91 ___ . ___

Measured Data (Two Wattmeter method for 3 phase)

	Meas. 1	**Meas. 2**
Meas. Volts	95 ___ ___ ___ ___ . ___	99 ___ ___ ___ ___ . ___
Meas Amps	96 ___ ___ ___ . ___ ___	100 ___ ___ ___ . ___ ___
Meas kW	97 ___ ___ ___ ___ . ___ ___	101 ___ ___ ___ ___ . ___ ___

Optional:

Output Quantity: 92 ___ ___ , ___ ___ ___ . ___

Output Units: 93 ____________

Notes: ____

Default Codes: Numeric Fields: Missing/Inaccessible: 000.0, Text Fields: "Don't know" = 99, "Missing" = 97

Data Field Descriptions

Mapping Notes

Mapping Notes describe requirements of MotorMaster+ (MM+) software database. The following MSAccess/VB tables are MM+ tables: Company, Departments, Facilities, Processes, Inventory. Tables with postfix "A", like InventoryA, are additional XENERGY tables. "A" tables are related one-to-one to MM+ tables, except for Inventory and InventoryA tables. See note on Qty field.

Fields are described as **Table.Field**, like **Facilities.idfac.**

(M) means field is mandatory.
"Not mapped" means field is not saved in MM+ table.
"Not data entered" means data entry of the field is not required.

General Facility Fields

Data on this page is collected, in part during the recruitment and scheduling process, and, in part during the initial on-site interview with the primary contact. All pre-contact data provided during the recruitment and scheduling process will be verified on site.

The numbers preceding each data field description correspond to the numbering of the input fields in the Industrial Motor-driven Systems Data Collection Instrument.

1a. Batch Number **FacilitiesA.batch** **(1 or 2digit integer)**
Data entry batch identifier

1. Survey Number (M) **Facilities.idfac** **(8 digit integer)**
An identifier number unique to each survey. This and all other data collection forms with data from this facility will have the survey number entered in the top right corner. The first two digits are the SIC, the next two are the region/PSU, the fifth digit is the strata, and the last three digits are an increment within the sample quota.
Mapping Note: idfac doesn't change within a survey. The same value is used for all record types.

2. Primary sampling unit ID #: (M) **Company.cmpname** **(1 or 2 digit integer)/ER: 1-21**
Identifies which of the 20 primary sampling units (PSU's) or survey regions the surveyed facility is located. The survey regions consist of one or more Standard Metropolitan Statistical Areas.

3. Auditor ID (M) **FacilitiesA.auditor** **(1-3 digit integer)**
Auditor's identification number assigned by XENERGY.

4. Company Name (M) **FacilitiesA.cmpname** **(CMAX255)**
The name of the company that owns the facility.

5. Facility Name (M) **Facilities.address1** **(CMAX32)**

6. Address (M) **Facilities.address2** **(CMAX32)**

7. City (M) **Facilities.city** **(CMAX20)**

8. State (M) Facilities.state (Two text characters)
Two digit state abbreviation

9. Zip (M) Facilities.zip (5 digit integer)

10. Primary contact name (M) Facilities.contact (CMAX32)
Auditor's primary contact at the facility.

11. Primary contact phone# (M) Facilities.phone (14 digit integer)
Record area code and extension. If no extension, then enter 000.

12-13. Other Contact name FacilitiesA.othcontact (CMAX255)
Additional contact such as electrician or other key source of help or information at facility.

13. Other Contact phone FacilitiesA.othphone (14 digit integer)
Record area code and extension. If no extension, then enter 000.

14. Facility SIC (M) FacilitiesA.SIC (SIC is 4 or 6 digit integer)
Primary four- or six-digit SIC code for the company's activities at this facility. Associated SIC text description is generated from D&B data for the facility. Text description is not mapped.

15. Output volume of facility (M) FacilitiesA.volume (up to a 9 digit integer)
Annual production in dollars or quantity of items produced

16. Output units (M) FacilitiesA.units (CMAX255)
Dollars, component description -- see previous item.

17. Facility Notes Not mapped/Not data entered

Process Line / Facility Department Information Page

1. Survey Number (M) Departments.idfac (8 digit integer)
Associates data on this page with other data for the facility.
Mapping Note: idfac doesn't change within a survey. If value here differs from value on a first page, it's an error. This is a page from another survey.

20. Department ID number (M) Departments.iddpt (1 - 3 digit integer)
Each process line or department identified at the facility will have a unique identifier number.

21. Department Name (M) Departments.dptname (CMAX32)
Group process equipment into departments or process lines that will make sense to the facility manager.

22-24. Daily Shifts (M) **DepartmentsA.ShiftsWkd, ShiftsSat, ShiftsSun (2 digits in form of x.x)/ER≤3.0**

The average number of shifts that this process operates for each of the following day types: Weekdays, Saturdays, and Sundays.

25. Operating Weeks per Year (M) **DepartmentsA.opwksY** **(1 or 2 digits)ER≤52**

The number of operating weeks considered in the shift data above.

Mapping Notes:
DepartmentsA.tothrs (M)= opwksY*(ShftsWkd*5+ShftsSat+ShftsSun)*8
Processes.tothrs (M)= same as above. This field is mandatory.
MM+ requires Operating Schedule section of Processes table fields to be compatible with tothrs field so let's calculate estimated values:
Shifthours3W(M) =MAX(0,(ShiftsWkd*8-16))
Shifthours2W(M) =MAX(0,(ShiftsWkd*8-Shifthours3W-8)
Shifthours1W(M) =MAX(0,(ShiftsWkd*8-Shifthours3W-Shifthours2W)

Shifthours3E(M) = MAX(0,(ShiftsSat*8- 16))+
MAX(0,(ShiftsSun*8-16))
Shifthours2E(M) = MAX(0,(ShiftsSat*8-Shifthours3E-8)+
MAX(0,(ShiftsSun*8-Shifthours3E-8)
Shifthours1E(M) = MAX(0,(ShiftsSat*8-Shifthours3E-Shifthours2E)+
MAX(0,(ShiftsSun*8-Shifthours3E-Shifthours2E)
opdaysW(M) =260
opdaysE(M) = (tothrs -(Shifthours1W+ Shifthours2W+ Shifthours3W)* opdaysW) / (Shifthours1E+ Shifthours2E+ Shifthours3E)
totdays(M) = opdaysW+ opdaysE

Process/Department Notes **Not data entered**

Space for additional comments on the process such as output capacity, operating details, name of process expert, etc.

26. % of Facility HP or Energy **DepartmentsA.prfacHP (integer) ER 1-100**

27. % of Dept HP 0 to 10 **DepartmentsA.prdpHP10 (integer) ER 1-100**

28. % of Dept HP 12.5 to 50 **DepartmentsA.prdpHP12 (integer) ER 1-100**

29. % of Dept HP over 50 **DepartmentsA.prdpHP50 (integer) ER 1-100**

Package / Motor-Driven Component / Motor Nameplate Data Page

These fields are where the primary inventory data are collected for each motor-driven component and for the associated motor or motors. If the package identified on the Process Hierarchy Information page is considered a "black box" (i.e,. data regarding individual motors and motor-driven components is inaccessible), then fields labeled "BB" should be populated based on information about the package. Several fields on this page are populated using standard codes from look-up tables at the bottom of the form.

1. Survey Number (M) **Processes.idfac, Inventory.idfac** **(8 digit integer)**
Associates data on this page with other data for the facility.
Mapping Note: idfac doesn't change within a survey. If value here differs from value on a first page, it is an error. This is a page from another survey.

Process Hierarchy Data

30. Package Name (M) **Processes.prcname** **(CMAX32)**
The name of the process equipment package using terminology that is familiar to facility staff.

31. Package Process Type: **ProcessesA.prctype (1 or 2 digit integer)**
A code number describing the application of the package in general terms. Selected from the standard process type list.
Mapping Note: check against the list provided.

32. Is Package a "Black Box"? (M) InventoryA.BB **(Character)/ER:Y or N**
If data regarding individual motors and motor-driven components within the package are inaccessible, then "Y" is circled. If "Y" is circled, the auditor collects operation and nameplate data for the complete package.

33. Department ID Number: (M) **Process.iddpt, Inventory.iddpt** **(1 - 3 digit integer)**
This letter associates the motor-driven component or "black box" data with the appropriate facility department or process line.

34. Parent Package ID # (M) **Processes.idprc, Inventory.idprc** **(1 - 3 digit integer)**
This number associates the motor-driven component or "black box" data with the appropriate package which is a constituent of the department or process line. This number is unique for a given package or group of same packages for this facility regardless of department.

35. Component/Motor ID# (M) **Inventory.idinv** **(1 - 3 digit integer)**
For each package, motor-driven components are numbered from 1to *n*. This number defaults to the Parent Package ID # if the package is a black box.

36. Component Name: **Inventory.description** **(CMAX40)**
A name identifying the motor driven component within the package. This description / name may include an ID number associated with a facility equipment list.

37. Component Category (M) **InventoryA.CompCat** **(1 or 2 digit integer)/ER: 1 - 20**
The applicable component category or type selected from the key at the bottom of the form. This category/type will be used to aggregate motor data by application and to associate motor end uses to other parameters such as SIC.
Mapping Note: Assign Inventory.Idloadtype =99 (OTHER).

Motor-Driven Component Data

50. Qty (M) InventoryA.BBqty (1 or 2 digit integer)
The quantity of identical motor-driven components in the package. For the "BB" case, the number of identical packages identified in the process.

Mapping Notes: if Qty > 1 then multiple Inventory entries created for one InventoryA entry. Unique idinv assigned to each entry. Othewise entries are similar. Number of entries is Qty.
Idinv = XXXYYYZZ where:
XXX is Pkg. ID (34);
YYY is Component/Motor ID (35);
ZZ = 00 if Qty = 1, n if Qty>1; n is order number of new entry, 1<=n<=Qty.
If Qty >1 then InventoryA.idinv = XXXYYY01.

51. Component Age (M) InventoryA.Bbage (integer)/ER 1,5,10,20)
The approximate range of time in years since the component was installed. Circle the correct age range.
Mapping Notes:
use following codes:
<5 ...1
5-10 ...5
10-20 ...10
>20 ...20

52. Percent diversity (M) InventoryA.diversity (1 - 3 digit integer)/ER:1-100)
Operating diversity may be used to refine the estimate of operating hours for the component as compared to the operating hours previously recorded for the facility department. The diversity for one component of a package may be more or less than that for other components. For example, if the facility staff indicate that the component cycles on and off such that its actual operating hours are one half of the estimated department operating hours, 50% would be entered. If the component is running whenever the department is running, then the operating diversity is 100%.

Mapping note: Assign Inventory.tothrs = diversity/100 * DepartmentsA.tothrs (use DepartmentsA record with same iddpt).

53. Load Modulation Type InventoryA.loadModul (1 or 2 digit integer)/ER: 1 - 15
The system, if any, used to control the output from the motor-driven component. Type code is selected from the key at the bottom of the page.

Mapping note: this is related to “ASD present” of MM+. Not mapped to MM+ othewise motor is excluded from MM+ calculations.

54. Drive Type Inventory.iddrivetype (1 digit integer)/ ER: 1-9
The applicable mechanical drive type, such as v-belt, coupling, etc., selected from the key at the bottom of the form.

55. Load Fluctuation InventoryA.loadFluct (Character)/ER:YorN
If the load fluctuates while the component is operating, then "Y" is selected for this field.

Mapping note: this is related to "Load characteristics" of MM+. Not mapped to MM+ otherwise motor is excluded from MM+ calculations.

56. Manufacturer InventoryA.BBmanuf (CMAX255)
In some cases, very little data may be available for the component or black box. If this is the case, the auditor will record manufacturer name if there is the possibility of collecting missing information in the future, based on the manufacturer and model.

57. Model Number Inventory.Model (CMAX 20)
See above discussion re: "Manufacturer".

58. Nameplate kW InventoryA.BBnplKW (4 digit in form of xxx.x)/ER: 0 - 999.9
If the package is a "black box" the total connected motor driven load is estimated from the nameplate. Known or estimated non-motor loads, such as electric resistance heat, are subtracted from the total for the machine.

59. Motor/Component Notes Not mapped/Not data entered

Motor Nameplate Data

70. kW / Load Measure? InventoryA.KWloadMeas (Character)/ER:YorN
The auditor checks the box if the motor has been included in the kW / load measurement subsample.
Mapping Note: If 70. kW / Load Measure? is "Y" then 90, 91, 94-101 are mandatory.

71. Size (HP) Inventory.HP (6 digit in form of xxxxx.x)/ER: 0 - 50,000

Nameplate horsepower.

72. KW InventoryA.KW (6 digit in form of xxxxx.x)/ER: 0 - 50,000
If HP not available, enter kW.

Mapping Notes:
If 32. Is Package a "Black Box"? (InventoryA.BB) is "N" then Inventory.HP is mandatory. One of HP or KW must be specified. If no HP specified then assign an estimate based on KW:

Inventory.HP = KW * 0.88/0.746

73. NEMA Design Inventory.NEMA_Design (Character)/ER: A, B, C, D, E, X, Y, N
The relevant NEMA code if it is a synchronous motor, otherwise DC or synchronous. These data are entered as a code from the lookup key at the bottom of the page.

74. Installation Age (M) **InventoryA.insage** **(integer)/ ER:1,5,10,20**
The approximate age range of the motor in years. Circle correct range.
Mapping Notes:
use following codes:
<5 ...1
5-10 ...5
10-20 ...10
>20 ...20
Assign Inventory.installyear = 1996 - insage - 2

75. Synchronous Speed (M) **Inventory.RPM_Sync** **(4 digit integer)/ ER: 1200, 1800, 3600**
The nominal speed of the motor, such as 1200, 1800 or 3600.

76. Enclosure Type (M) **Inventory.Encl** **(1 digit integer)/ ER: 0 - 3**
Numerical code from Enclosure key at the bottom of the form.

77. Voltage Rating (M) **Inventory.voltage_rating** **(1 or 2 digit integer)/ ER: 2 -11**
The nominal voltage(s) that the motor may be operated at. Enter correct code form Voltage Rating table on bottom of form.

78. "Wired-for" Voltage **Inventory.Voltage** **(1 - 4 digit integer) ER: 0 - 4000**
The nominal voltage actually connected to the motor.

79. Mtr. Manufact: **Inventory.idmnf,** **(2 digit integer)**
The motor manufacturer.
Mapping Notes:
Valid codes are: 1 through 18, 99. A code of 99 must be mapped as -99 (that's minus 99).

79A. Other Name: **InventoryA.OthName,** **(CMAX 20)**
If 79. Mtr. Manufact: is 99 then this field must be filled in.

80-83. Full Load Nameplate Ddata
Collected if available from the nameplate.

8**0. Speed** **Inventory.RPM_FL,** **(4 digit integer)/ ER: 1200, 1800, 3600**

82. PF **Inventory.PF_FL,** **(3 digit in form of xx.x)**

81. Amps **Inventory.AMPS_FL** **(4 digit in form of xxx.x)**

83.Effic. **Inventory.Eff_FL** **(3 digit in form of xx.x)**

Subsample Data Page

Data entered on subsample data pages includes measured data as well as data used to qualitatively determine the extent to which the motor-driven component or package is oversized.

1. Survey Number **InventoryA.idfac** **(8 digit integer)**
Associates data on this page with other data for the facility.

30. Package Name **InventoryA.prcname** **(CMAX32)**
The name of the process equipment package using terminology that is familiar to facility staff.

34. Parent Package ID # **InventoryA.idprc** **(1 - 3 digit integer)**
This number associates the motor-driven component or "black box" data with the appropriate package, which is a constituent of the department or process line. This number is unique for a given package or group of same packages for this facility, regardless of department.

35. Component/Motor ID# **InventoryA.idinv** **(1 - 3 digit integer)**
For each package, motor-driven components are numbered from one to *n*. This number defaults to the Parent Package ID # if the package is a black box.

Component Sizing and Operation

90. Component Load Diversity **InventoryA.LoadDiv** **(1 -3 digit integer)/ ER: 0-100**
If the load cycles on and off, a qualitative estimate of the amount of time (out of the total operating time) that the component is loaded.
Mapping Note: mandatory if 70. kW/Load Measure? is "Y".

91. Component Oversize Factor **InventoryA.SizeFctr** **(2 digit in form of x.x)**
A qualitative estimate of the extent to which the motor-driven component is oversized for the task it performs. This factor can be determined by discussing several operation characteristics of the equipment with facility staff. Determinants of oversizing may include one or more of the following depending on the type of component:

- Ratio of flow capacity to throttled flow for centrifugal systems.
- Ratio of output capacity to required capacity for batch systems.
- Ratio of operating time to time available.

Mapping Note: mandatory if 70. kW / Load Measure? is "Y".

92. Output Quantity InventoryA.outQty (6 digit in form of xxxxx.x)
The number of units of output capacity of the component. This is an optional field to be used if data is relevant to estimate of oversizing.
93. Output units InventoryA.outUnits (CMAX255)
Description of units of output (gpm, cfm, # widgets, etc.).

94. Est. Component loading during meas.:
InventoryA.CompLoad 1-High, 2-Med, 3-Low (1 digit).

Measured Data

The primary objective of collecting measured data is to evaluate the load on the motor and a percentage of its full power output capacity. As recognized in the design of Motor Master +, load measure, various levels of measurement accuracy may be possible. In most cases, it will be physically possible to connect power measurement probes to the supply circuit. In some cases, it may not be possible to connect a current transducer (CT) to any of the wires. The measurement protocol consists of the following:

kW measurement (using voltage and current probes from a kW / PF meter).

Power for DC motors will be measured at the AC supply/controller for the motor.

95, 99. Measured voltage Inventory.Voltage_ab, .Voltage_bc (5 digits in form of xxxx.x)
Measured voltage at each phase of the circuit
Mapping Notes:
Mandatory if 70. kW / Load Measured? is "Y"

96, 100. Measured amperage Inventory.amps_a, .amps_b (5 digits in form of xxx.xx)

Current measurement for each phase of the circuit.
Mapping Notes:
Mandatory if 70. kW / Load Measured? is "Y"

97, 101. Measured kW InventoryA.M1KW, M2KW (6 digits in form of xxxx.xx) xxxx.xx)
Power measurement for each phase of the circuit. Not applicable to DC motor data.

Mapping Note:
Mandatory if 70. kW / Load Measured? is "Y"
Inventory.kwdraw = M1KW + M2KW
Inventory.PF_Meas = kwdraw / (SQRT(3) * (Voltage_ab* amps_a + Voltage_bc* amps_b)/2/1000)
where:
SQRT(3) = 1.7321 is the square root of 3.

MOTOR SYSTEMS PRACTICES QUESTIONNAIRE

INDUSTRIAL ELECTRIC MOTOR SYSTEMS
MARKET OPPORTUNITIES ASSESSMENT

Introduction: Thank you for taking time to answer this questionnaire. You are taking part in a national study of industrial motor systems sponsored by the U.S. Department of Energy. The objective of the study is to develop accurate information about the kinds of motor-driven equipment in use in the nation's industrial facilities, the ways in which this stock of equipment changes over time, and the market forces driving those changes.

PLEASE FOLLOW THESE GENERAL INSTRUCTIONS IN COMPLETING THE QUESTIONNAIRE.

1. **Questions appear in boldface type.**
2. THROUGHOUT THE QUESTIONNAIRE, INSTRUCTIONS ARE GIVEN IN CAPITAL LETTERS.
3. To indicate your answer, check the numbered boxes next to the response items.
4. Please note and follow the instructions on whether you should choose only one of the responses (CHECK ONE ONLY) or choose all that apply to your situation (CHECK ALL THAT APPLY).
5. If none of the responses listed apply to your facility, please write in a short answer next to the question. In some cases, we provide a response item labeled ☐ Other (Specify) _________ in which you may write in answers.
6. If you do not know the answer to a question, check the appropriate box, or write the number "99" next to the question.
7. Depending on your motor purchase and maintenance practices, not all questions will apply to you and your facility. For example, if your company operates in one facility only, questions about decision-making for multiple plants will not apply. "Skip Patterns" are indicated throughout by indentations and lines.
8. **Place survey number on all pages of this questionnaire**.

If you have any questions about this questionnaire or the study, please call Glenn Reed or Mitchell Rosenberg at XENERGY Inc., 3 Burlington Woods, Burlington, MA 01803, 1-888-756-7563.

IDENTIFICATION

Name of Company:		
Street Address:		
City:	State:	ZIP:
Telephone: ( )	Fax : ( )	
Contact Name:	Contact Title:	

A. FACILITY INFORMATION

First, we'd like to get some basic information about you and your firm.

A.1.a. What is your title or position? (CHECK ONE ONLY.)

1. ☐ Plant Manager
2. ☐ Maintenance Manager
3. ☐ Purchasing Manager
4. ☐ Plant Engineer
5. ☐ Chief Electrician
6. ☐ President or General Manager
7. ☐ Other (PLEASE SPECIFY.)

____

____

A.1.b. How long have you been with the firm?

____
(ENTER NUMBER OF YEARS. ENTER 0 IF LESS THAN ONE YEAR.)

A.1.c. And how long have you been in your current position?

____
(ENTER NUMBER OF YEARS. ENTER 0 IF LESS THAN ONE YEAR.)

A.2. How many total workers (full-time equivalents) are employed at this facility? PLEASE BE SURE TO INCLUDE ALL CLERICAL WORKERS AS WELL AS PRODUCTION WORKERS, SUPERVISORY PERSONNEL AND MANAGERS.

__________________ (ENTER NUMBER OF WORKERS.)

A.3.a. Which utility company provides power to this facility?

______________________________ (ENTER NAME OF UTILITY COMPANY.)

A.3.b. Can you tell me approximately how much this facility spends on electricity every year?

__________________ (ENTER DOLLARS SPENT. ENTER 99 FOR DON'T KNOW.)

A.3.c. Is a summary of your recent electric bills for a recent year readily available?

1. ☐ Yes
2. ☐ No

IF YES: May we have a copy of this summary to attach to this survey?

1. ☐ Copy Attached: __________________ INTERVIEWER: ENTER VERIFIED AMOUNT
2. ☐ Copy not available

Enter kWh consumption for past 12 months on the General Facility Information Sheet.

A.4. Please examine this list of motor-driven processes. SHOW RESPONDENT THE PROCESS LIST. Which of the processes listed occur in this facility? (ENTER THE NUMBERS OF THE PROCESSES ON THE LIST IN THE SPACES BELOW.)

______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ Other:____________________
______________________ Other:____________________

A.5.a. How large is the production area of this facility (in square feet)?

______________________ square feet (ENTER NUMBER OF SQUARE FEET.)

A.5.b. About what percentage of the facility area is used for industrial processes (versus office and other non-production uses)?

______________________ percent

A.6. Is this facility the sole production facility for your firm, or is it a subsidiary or branch of a larger company?

1. ☐ Sole production facility/single location (PLEASE SKIP TO Q. B.1.)
2. ☐ Subsidiary or branch (GO TO Q. A.6.b.)

A.6.b. Where are decisions regarding the purchase of motors made?

1. ☐ Here (PLEASE SKIP TO Q. B.1.)
2. ☐ Headquarters/Central office (PLEASE SKIP TO Q. B.1.)
3. ☐ Depends (GO TO Q. A.6.c.)

A.6.c. (IF DEPENDS) What criteria determine where decisions regarding motors are made?

1. ☐ Motor size
2. ☐ Level of expenditure
3. ☐ Other (PLEASE SPECIFY.) ___________________

B. REPLACEMENT PATTERNS. As you know, we're interested in your company's practices regarding the selection and use of motors. This next section is intended to give us some basic facts about your inventory and stock adjustment procedures.

B.1. Approximately how many motors of one horsepower or more are currently in use in production equipment in this facility? (PLEASE DO NOT INCLUDE MOTORS USED IN ELEVATORS OR SPACE CONDITIONING (HVAC) EQUIPMENT.)

______________________ (ENTER NUMBER OF MOTORS.)

B.2 In the past 12 months, approximately what percentage of these motors were removed from service <u>due to failure</u>?

______________________ (ENTER PERCENT OF MOTORS IN USE.)

B.3. Considering all the motors that were removed from service due to failure last year, approximately what percentage were ... (ENTER PERCENTAGES IN TABLE. PERCENTAGES SHOULD TOTAL 100.)

	Percent of Failed Motors
B.3.a. rewound or repaired and returned immediately to service	
B.3.b. rewound or repaired and returned to inventory	
B.3.c. scrapped	
B.3.d. sold	
B.3.e. placed in inventory as is	
B.3.f. Other (Specify)	

B.4. In the past 12 months, what percentage of the motors in use in your facility were removed prior to failure?

____________________(ENTER PERCENT OF MOTORS IN USE.)

IF B.4>0%, ASK B.5. IF B.4 = 0%, SKIP TO B.6.

B.5. Now, considering motors that are removed from service prior to failure, approximately what percentage are ... (ENTER PERCENTAGES IN TABLE.)

	Percent of Motors Removed from Service Prior to Failure
B.5.a. reconditioned and returned immediately to service	
B.5.b. reconditioned and returned to inventory	
B.5.c. placed in inventory as is	
B.5.d. scrapped	
B.5.e sold	
B.5.f Other (Specify) ________________	

B.6. Do you keep motors in inventory at this facility?

1. ☐ Yes (GO TO Q. B.6. b.)
2. ☐ No (PLEASE SKIP TO Q. C.1.)

B.6.b. How big is your motor inventory? That is, approximately what percentage of the motors currently in use could be replaced by the motors in inventory?

________________________ (ENTER PERCENT OF MOTORS IN USE.)

C. THE REWIND/REPLACE DECISION. Now we'd like to find out a bit more about your decisions to replace or rewind failed motors.

C.1. Do you ever rewind failed motors rather than purchasing new ones to replace them?

1. ☐ Yes
2. ☐ No (PLEASE SKIP TO Q. D.1.)

C.2. Which of the following criteria do you use to decide whether to repair or rewind a failed motor versus replacing that motor? PLEASE CHECK ALL THAT APPLY.

C.2.a Horsepower

1. ☐ Yes (PLEASE GO TO C.2.b.)
2. ☐ No (PLEASE SKIP TO C.2.c.)

C.2.b. Within the following horsepower categories, what percentage of failed motors do you typically rewind?

Horsepower Category	Percent Rewound
1 - 5 hp	
6 - 20hp	
21 - 50 hp	
50 - 100 hp	
101 - 200 hp	

C.2.c How about type of motor?

1. ☐ Yes (PLEASE GO TO C.2.d.)
2. ☐ No (PLEASE SKIP TO C.3.)

C.2.d **What kinds of motors do you typically rewind *more frequently* than standard A/C polyphase (squirrel cage) motors?** (CHECK ALL THAT APPLY.)

1. ☐ Definite or Special Purpose Motors
2. ☐ Motors with non-standard physical dimensions
3. ☐ Motors which do not have "T" frames
4. ☐ Synchronous AC motors
5. ☐ DC Motors

C.3.a. Do you use the cost of rewinding versus replacement as a criterion for deciding which of those courses of action to take?

1. ☐ No (PLEASE SKIP TO Q. C.4.)
2. ☐ Yes (GO TO Q. C.3.b.)

C.3.b. In your decisions on motor rewinds, which of the following cost factors or criteria do you typically consider? PLEASE CHECK ALL THAT APPLY

1. ☐ Capital cost of the rewound motor versus the cost of a new motor
2. ☐ Installation cost of the rewound motor versus the installation cost of a new motor
3. ☐ Costs of electricity used by the rewound motor versus electric costs for the new motor
4. ☐ Reliability of the rewound motor versus reliability of the new one
5. ☐ Other (PLEASE SPECIFY.) ____

C.4. On average, how many times do you typically rewind a motor?

______________(ENTER NUMBER OF TIMES A MOTOR IS TYPICALLY REWOUND.)

C.5.a. Do you provide specifications to your motor rewinder?

1. ☐ Yes (GO TO Q. C.5.b.)
2. ☐ No (PLEASE SKIP TO Q. D.1.)

C.5.b Which of the following are covered in your specifications? (PLEASE CHECK ALL THAT APPLY.)

1. ☐ Turn-around time
2. ☐ Burn-out temperatures
3. ☐ Wire quality
4. ☐ Core loss testing
5. ☐ Coatings and insulation
6. ☐ Pre- and post-rewind efficiency testing
7. ☐ Post-rewind operational testing
8. ☐ Other (PLEASE SPECIFY.) ____

D. MOTOR PURCHASING PRACTICES. The following section is concerned with your electric motor purchasing procedures.

Some standard squirrel cage motors are classified as "High Efficiency Motors," meaning that that they meet efficiency test standards established by the National Electrical Manufacturers Association and adopted by the US government. So-called "Premium Efficiency Motors" exceed these standards.

D.1.a. Have you heard of high efficiency electric motors?

1. ☐ Yes
2. ☐ No

D.1.b. Have you heard of premium efficiency electric motors?

1. ☐ Yes
2. ☐ No

D.1.c. For the types of motors you typically buy, are you aware of the efficiency ratings that qualify for the "high efficiency" designation?

1. ☐ Yes
2. ☐ Somewhat
3. ☐ No

D.1.d. Approximately what percentage of the motors you have purchased in the past two years would qualify as premium efficiency units?

1. ☐ All (PLEASE SKIP TO Q. D.2.)
2. ☐ None (PLEASE SKIP TO Q. D.2.)
3. ☐ Some, but not all

D.1.e. __________ FILL IN THE APPROXIMATE PERCENTAGE. (GO TO Q. D.1.f.)

D.1.f. Which of the following requirements of the intended application do you use to decide whether to purchase a high efficiency motor versus a standard efficiency motor? (PLEASE CHECK ALL THAT APPLY.)

1. ☐ Load (required horsepower)
2. ☐ Hours of use
3. ☐ Motor quality
4. ☐ Motor reliability
5. ☐ Motor durability
6. ☐ Other (PLEASE SPECIFY.) ____

D.2 I am going to read you a set of procedures used for selecting the size of motors. Please tell me if you use these procedures...

1. **all the time**
2. **most of the time**
3. **some of the time, or**
4. **never**

CODE 1-4 DEPENDING ON THE ANSWER		
D.2.a. Select the same size as the motor being replaced		
D.2.b. Use motor in inventory closest in size to motor being replaced		
D.2.c. Select the size based on measurements or estimates of load		
D.2.d. Select the size according to production equipment manufacturer's specifications		

D.2.e Has your company participated in programs sponsored by electric utilities that provide rebates for the purchase of high or premium efficiency motors?

1. ☐ Yes (ASK D.2.f.)
2. ☐ No (SKIP TO D.3.)

D.2.f. How important would you say these utility programs were in your company's decision to purchase high or premium efficiency motors? Were they...

1. ☐ Very important
2. ☐ Somewhat important
3. ☐ Not important
4. ☐ Don't know

D.3. How frequently do you compare motors available from several manufacturers when purchasing replacements? Would you say it is

1. ☐ All of the time
2. ☐ Most of the time
3. ☐ Some of the time
4. ☐ Rarely
5. ☐ Never
6. ☐ Have competitively bid all motor purchases to one supplier
7. ☐ Don't know

D.4 When you replace motors in equipment that was purchased with motors already installed by the original equipment manufacturer (OEM), do you face any of the following kinds of restrictions in your choice of motors... (PLEASE CHECK ALL THAT APPLY.)

1. ☐ Replacement motors available only through OEM
2. ☐ Replacement motors available only through one manufacturer
3. ☐ Replacement with motors from unauthorized vendors voids warranty
4. ☐ Replacement motors not available in premium efficiency models
5. ☐ Other (PLEASE SPECIFY.) ____
6. ☐ Question not applicable to equipment in my facility
7. ☐ No such problems encountered

D.5. Are you aware of published guides or software tools that are intended to help identify the best motors for new applications or replacements?

1. ☐ No (PLEASE SKIP TO Q. D.7.)
2. ☐ Yes (PLEASE GO TO Q. D.6.)

D.6. For each of the following decision tools, please indicate whether you are not aware of it, have heard of it, have used it, or use it regularly. PLEASE CIRCLE THE NUMBER IN EACH ROW THAT BEST INDICATES YOUR FAMILIARITY WITH EACH TOOL.

Tool	Not Aware	Have Heard Of	Have Used It	Use it Regularly
D.6.a MotorMaster	1 ☐	2 ☐	3 ☐	4 ☐
D.6.b Other Motor Selection Software	1 ☐	2 ☐	3 ☐	4 ☐
D.6.c Manufacturer's Guidebooks	1 ☐	2 ☐	3 ☐	4 ☐
D.6.d Other Specify:	1 ☐	2 ☐	3 ☐	4 ☐

D.7. Has your company formally adopted a policy regarding the efficiency of new or replacement motors?

1. ☐ Yes
2. ☐ No

D.8. Does your company use written specifications when purchasing motors?

1. ☐ No (PLEASE SKIP TO Q. E.1.)
2. ☐ Yes (PLEASE GO TO Q. D.8.a.)
3. ☐ Sometimes (PLEASE GO TO Q. D.8.a.)

D.8.a. Which of the following concerns are addressed in those specifications?
(PLEASE CHECK ALL THAT APPLY.)

1. ☐ Temperature rise/Insulation class
2. ☐ Maximum starting current
3. ☐ Minimum stall time
4. ☐ Power factor range
5. ☐ Efficiency and test standard
6. ☐ Load inertia
7. ☐ Expected number of starts
8. ☐ Suitability to your facility's operating environment
9. ☐ Ease of repairability (Including availability and access to repair specifications)
10 ☐ Other (PLEASE SPECIFY.) ______________________________________

E. MOTOR MAINTENANCE PRACTICES. Now we'd like to get some information about your company's installation and maintenance practices.

E.1. Do you or someone on your staff inspect motors at regular intervals?

1. ☐ No (PLEASE SKIP TO Q. E.3.)
2. ☐ Yes (PLEASE GO TO Q. E.2.)

E.2 What is the typical interval between inspections?

1. ☐ Weekly
2. ☐ Every two weeks
3. ☐ Monthly
5. ☐ Quarterly
6. ☐ Every four to six months
7. ☐ Annually
8. ☐ Other (PLEASE SPECIFY.) _________________

E.3 Please indicate which of the following is included in your preventive maintenance routine. (CHECK ALL THAT APPLY.)

Maintenance Practice	Check if conducted
1. Lubrication	☐
2. Belt tensioning	☐
3. Checking for worn-out parts, discoloration, unusual noise	☐
4. Removal of contamination and surface dust from surfaces, cooling fins, and openings	☐
5. Protection and repair of parts subject to corrosion	☐
6. Thermographic inspection	☐

E.4. Do you or someone on your staff monitor loads and hours of use (or duty factors) for your production motors?

1. ☐ Yes, for all motors
2. ☐ Yes, for some motors
3. ☐ No

E.5. For which motors does your firm maintain inventory records?

1. ☐ Motors currently in use (PLEASE GO TO E.6.)
2. ☐ Motors in stock (PLEASE GO TO E.6.)
3. ☐ No records kept (PLEASE SKIP F.1.)

E.6. How are these records maintained?

1. ☐ Paper-based
2. ☐ Computer-based
3. ☐ Both paper-based and computer-based

F. PUMP, FAN, AND COMPRESSOR PRACTICES.

F.1. In the past two years, have you taken any steps to improve the efficiency of fan-driven systems in your facility?

1. ☐ Retrofitted systems with variable speed drives
2. ☐ Retrofitted systems with inlet guide vanes
3. ☐ Checked systems for components with larger than expected pressure drops
4. ☐ Other (PLEASE SPECIFY.) ____________________________________
5. ☐ No fan-driven systems in facility
6. ☐ No efficiency improvements in last two years

F.2 In the past two years, have you taken any steps to improve the efficiency of pump-driven systems in your facility?

1. ☐ Substituted speed controls for throttling
2. ☐ Used parallel pumps to respond to variations in load
3. ☐ Reduced pump size to better fit load
4. ☐ Increased pipe diameter to reduce friction
5. ☐ Other (PLEASE SPECIFY.) ____________________________________
6. ☐ No pump-driven systems in facility
7. ☐ No efficiency improvements in last two years

F.3 In the past two years, have you taken any steps to improve the efficiency of air compressor systems in your facility?

1. ☐ Substituted two-stage reciprocating or rotary screw compressors for single-stage rotary screw models
2. ☐ Used parallel compressors to respond to variations in load
3. ☐ Reconfigured piping and filters to reduce pressure drops
4. ☐ Added multi-unit controls to reduce part load consumption
5. ☐ Reduced size of compressors to better match load
6. ☐ Fixed leaks
7. ☐ Other (PLEASE SPECIFY.) ____________________________________
8. ☐ No air compressor systems in facility
9. ☐ No efficiency improvements in last two years

THANK YOU VERY MUCH FOR YOUR TIME AND COOPERATION

SUBSAMPLING PROCEDURES

1. PROCEDURES FOR ALLOCATING MOTOR OBSERVATIONS FOR BIG SITES

BACKGROUND. A field engineer can inventory roughly 50 motors or small groups of identical motors per day (including load measurements). The maximum amount of time the project can allocate to inventorying each sampled facility is 3 days. Many sample facilities in the sample will house more than 150 motors. Some of the larger facilities in the sample will have several thousand motors in use. Clearly, in these cases, we will not be able to inventory all of the motors. Use this procedure and the accompanying worksheet to subdivide large facilities into segments and allocate available observations (and time) over the 3-day period you will be on site.

OVERVIEW. The basic steps in this procedure are as follows:

1. Divide the facility into departments based on conversations with the plant manager or respondent and/or walkthrough.

2. Make a rough estimate of the proportion of total motor horsepower accounted for by each department based on conversations with the plant manager and a walkthrough.

3. Allocate 150 observations to the various departments in proportion to the percentage of total motor horsepower they represent.

4. For departments that have more motors than their allocation from the 150, subdivide the motors in the department by location on the shop floor, by line, or by some other logical grouping that contains the rough number of motors allocated to the department.

5. Select the subdivision within each department to be inventoried.

The following paragraphs cover each of these steps in detail:

1. DIVIDE FACILITY INTO DEPARTMENTS.

Use the same procedure as you do in a smaller facility in which all motors will be inventoried. That is, use the plant manager's designation of departments. Some points of which you should be aware during the walkthrough in regard to this:

Make sure the departments don't overlap in terms of space.

Make sure that you understand the boundaries of the departments. Make notes or sketches to clarify any potential points of confusion.

If there are eight or more departments, consolidate them into no more than eight, using your best judgment in grouping them. The best strategy will generally be to consolidate contiguous spaces. NOTE: THIS IS FOR PURPOSES OF SUBSAMPLING ONLY. DO NOT CHANGE THE NOMENCLATURE OF THE DEPARTMENTS FROM WHAT YOU GET FROM THE PLANT MANAGER.

2. ESTIMATE PERCENTAGE OF MOTOR HORSEPOWER ACCOUNTED FOR BY EACH DEPARTMENT.

3. ALLOCATE OBSERVATIONS TO THE DEPARTMENTS.

The basic strategy for this step is to (1) ask the plant manager or other knowledgeable informant to make the allocation and then, (2) confirm the allocation during the walkthrough. No one expects this allocation to be 100% accurate. It should reflect the plant manager's and your feel for the relative size of the departments in terms of motor horsepower.

Instructions for filling out the form set for this process are as follows:

- Enter the names of the departments on the Department Data Sheet in Field 21.
- Enter your estimate of the percentage share of motor horsepower in each department in Field 26.
- Multiply the percentage in Field 26 by 150 to arrive at the target number of motors to be inventoried in each department. Enter this number in Field 27.

4. CREATE SUBDIVISIONS WITHIN DEPARTMENTS.

If the number of motors in a given department is less than or equal to the number of motors in the allocation developed in Steps 2 and 3, inventory all the motors in the department. In most large facilities, however, the number of motors in each department will exceed the allocation developed through Steps 2 and 3. In these cases, a subsample of motors will need to be chosen. Since no listing of motors is available, selecting every nth motor to inventory is not an option. Rather, the approach will be to subdivide the department, and inventory all motors within one subdivision that has been selected at random. The steps in this process are as follows:

Create subdivisions within the department. The first step is to segment the department into subdivisions. Your work for this task will be entered in the Subdivision Worksheet. Keep in mind the following as you divide up the department:

- The subdivisions should reflect some kind of logical grouping, either by location or by virtue of reflecting some aspect of the plant configuration — say one production line or subassembly.

- Each subdivision should contain roughly the number of motors allocated to the department. For example, if the Plating Department of a metals fabricator was allocated 25 motor observations in steps 1 and 2, then each subdivision should have roughly 25 motors in it. (If there is less than twice the number of motors allocated in the department, create at least one logical division that contains the 25 motors and inventory that division.)

- The subdivisions should not overlap. That is, they should have no motors in common.

Record the subdivisions on the Subdivision Worksheet.

You will need to fill out a Subdivision Worksheet for each department you subdivide. Please follow these instructions in filling out the Subdivision Worksheet.

- Enter the facility name, survey number, department name, and department number in the fields provided.

- List the subdivisions in the grid provided, using descriptions that will allow you to go back and find the selected subdivision.

- Enter your best estimate of the percentage of total department motor horsepower accounted for by the subdivision.

5. SELECT THE SUBDIVISION TO BE INVENTORIED.

You will need the random number table to select the subdivision to be inventoried. The random numbers are crossed out after you have used them. Follow the procedures described in Section 3 for selecting a random number. Note that the procedures for selecting a random number are different for populations of 9 or fewer (generally the number of subdivisions) and populations of 10 or greater (generally used to select motors for metering).

Enter the subdivision number, description, and percentage of total department horsepower of the selected subdivision in fields 27, 29, and 28, respectively, on the department data sheet.

2. Selecting Motors within a Site for Metering

The objectives of this procedure are to allocate the 12 meter observations available to each site among the motors in the facility. Start from the listing of all inventoried motors (Package/Component Motor Data Sheets).

Define:

- N_{list} = number of listed components. Multiples of the same component are counted by the number of multiples. So, if there are three of the same kind component (Field 50 = 3), then that component would be counted three times for purposes of subsampling.

- N_{mtr} = number of motors to meter at the site (12).

- N_{rate} = sampling rate.

- N_{start} = listing line number to begin.

Step 1. Divide the total number of listing lines (Nlist) by the total number to be metered.

(N_{mtr} = 12) to get N_{rate}. That is,

$N_{rate} = N_{list}/12$ (rounded to nearest integer).

Step 2. Take a random fraction R_{start} from the random number lists and set the starting point as N_{rate} times that fraction. That is,

$N_{start} = N_{rate} * R_{start}$.

See Section 3 on selecting R_{start}.

Select the motor at listing line # = N_{start}.

Select every N_{rate}^{th} listed motor after Nstart, subject to filling quotas of:

- large: ≥100 HP 5 motors
- medium: 20–99 HP 4 motors
- small: l–l9 HP 3 motors

That is, if the next selected motor (@ listing line #$N_{start} + kN_{rate}$) would exceed a size quota, go to the next selection N_{rate} farther down the list (@ listing line #N_{start} + $(k+l)N_{rate}$). If the end of the list is reached before the quotas are filled, wrap the list around and continue.

If there are fewer than five motors ≥ 100 HP in the facility, select all large motors for metering. N_{mtr} (the number of meters to be selected using the random procedure described below) now becomes (12 - number of large motors). Allocate remaining metering observations from the large category to the medium category. So, for example, if there were two motors over 100 HP, you would meter those two. You would then:

- Set the sampling rate at $N_{rate} = (N_{list} - 2)/10$.
- Set the quota for the medium stratum at 7; the small stratum quota remains at 3.
- Follow the instructions in Step 2 to fill new quotas.

If there are fewer than nine motors in the combined large and medium categories, allocate the remaining metering observations to the small category. Thus for example, if there were only six motors of 20 HP or over, all six would be metered. N_{mtr} now becomes (10 - 6) = 4. The sampling rate is $N_{rate} = (N_{list} - 6)/4$. All motors selected in this manner will come from the low stratum.

Enter selected motors on the Metering Sample Worksheet.

3. Making Selections from a Random Number List

For Selection of 1 in N when N is ≤ 10 (selecting subdivisions)

To choose a random number between l and N (inclusive), go to the next random number on the list and from it take the first digit (reading from the left) that is greater than 0 and less than or equal to N. That is:

1. Take the next random number on the list.
2. Take the first digit from that number.
3. If that digit is 0 or greater than N, or if the selected unit has already been picked in a previous round, go to the next digit. Otherwise that digit is the selection number.
4. Repeat Step 3 until a selection is made that is > 0 and < N.
5. If all digits in the random number are 0 or > N, go to the next random number on the list.
6. Cross out in full each random number that was used.

For example, if the next random number is 8042 and N = 6, the random selection is 4—the first digit in the number that is greater than 0 and less than or equal to 6.

For Selection of 1 in N when N Is (10 (Selecting motors for metering)

To choose a random number between l and N (inclusive):

1. Take the next random number R on the list, expressed as a decimal (e.g., 8042 = 0.8042). Then cross that number off the list.
2. Multiply N by R to get the selection number X = N R.
3. Round ALL fractions up to the next integer. That is:
   0.436 rounds to 1
   0.936 rounds to 1
   8.436 rounds to 9
   8.936 rounds to 9.

This method can also be used when N is ≤ 10, but the other method is probably quicker.

Appendix D: Stock Adjustment Model

UNITED STATES
INDUSTRIAL MOTOR SYSTEMS
MARKET OPPORTUNITIES
ASSESSMENT

D STOCK ADJUSTMENT MODEL

The baseline Motor Systems Inventory and Practices Survey provided a richly detailed portrait of U.S. industrial facilities at one point in time. However, this portrait is subject to constant change as equipment is replaced, production resources are reconfigured, and technology evolves. In order to serve as a reliable tool for assessing the effects of policies and programs on industrial energy use, the baseline will need to be updated periodically. Changes such as implementation of federal product standards in October 1997 affect the potential energy savings achievable through programs and policies that encourage end users to purchase efficient motors. Other important changes include net additions or deletions to the stock of driven equipment in various categories, which in turn affect the amount of motor energy that may be influenced by a program or policy.

In this section, we describe the stock adjustment model that was developed as a method to update the equipment inventory, practices inventory, and associated measures of motor energy use. The intent of developing this model was to create a straightforward stock adjustment approach to update key descriptors of the motor-driven equipment inventory. The approach is meant to facilitate simple stock adjustments, but is not designed for complete stock turnover.

D.1 THE STOCK ADJUSTMENT MODEL

The model was created as an Excel 7.0 workbook consisting of 10 worksheets. The first major step in the stock adjustment model is to adjust for the addition and removal of motors each year. The first worksheet (*trend*) contains motor shipment data and industry production to track trends for developing growth factors. These are intended as a guideline to the user for industry growth rates, but are not directly linked to other tables in the model. Four worksheets (*base year, year 2, year 3, and year 4*) start with the "base" inventory, energy, and efficiency for a given year and keep track of the changes to motor inventory based on efficiency changes and standard practices. Another four of the worksheets (*adjusters1, adjusters2, adjusters3,* and *adjusters4*) allow the user to account for other savings adjustments, such as variable speed drives, that are not due to direct motor change-outs. The final worksheet (*summary*) provides the inventory of motor stock (number of motors) and the associated energy consumption.

In working with the model, the spreadsheet was designed to be fairly user-friendly. Areas that require user inputs are indicated with light gray shading. The inputs in these areas show up in bold blue font. The calculation areas do not require any user input. These areas show up as plain white cells (without shading)—the fonts in these areas are the automatic regular fonts. The motor inventory sheets (as well as the savings adjuster sheets) were designed with identical layouts to expedite going forward from one year to the next. Although some data do not vary by industry group, each table is setup for 20 industry groups and 7 motor size categories. The initial inputs are based on data collected during the on-site surveys.

D.2 METHODOLOGY

There are a number of inputs that are required in order to adjust the base motor stock and energy using the motor stock adjustment model. In general, the inputs account for the addition and removal of motors each year.

- ***Additions to Stock.*** Statistics on additions to the stock are available from the *Census Current Industrial Reports* on domestic shipments of integral horsepower motors (Series MA36H). This series provides estimates of unit shipments and value of shipments by domestic manufacturers to U.S. customers by horsepower category and energy efficient/standard efficiency designation. It also provides estimates of the total number and value of integral horsepower motors exported and imported with no breakdown by horsepower group.
- ***Deletions from Stock.*** Deletions from stock will be estimated by combining information gained from the Practices Survey with inventory data. Specifically, respondents to the Practices Survey are asked:
  - What percentage of motors were removed from service due to failure?
  - What percentage of failed motors are typically rewound, by horsepower category?
  - What percentage of motors were removed from service prior to failure?
  - Among the motors removed from service: what percentage were repaired or rewound and returned to service, returned to inventory, scrapped, sold?
  - How large is the facility's motor inventory in relation to the stock in use on the floor?

D.2.1 Inputs

This section discusses the input tables that need to be filled in to run the model. Each table is discussed below, along with the assumptions that were used to populate the current version of the model.

Base Year, Year 2, Year, 3 and Year 4

- Number of Motors: weighted motor inventory as included in the motors database.
- Average Energy: based on size, operating hours, and efficiency of motor inventory.
- Average Efficiency: nameplate or default data of motor inventory from motor surveys.
- Percent of Motors Rewound Upon Failure: based on responses in motor Practices Survey.
- Percent of Motors Retired Upon Failure: based on responses in motor Practices Survey.
- Industry Growth Rate: based on trends from Annual Survey of Manufacturer.

- Efficiency of New Motors: weighted EPACT standards (weighted CEE standards for *Year 2*, *Year 3* and *Year 4*).
- Efficiency of Rewound Motors: 1-percent decrease from average based on previous studies.

The number of motors, adjusted energy, and average efficiency as calculated in one year are carried onto the following year. For example, the values calculated on *base year* are automatically carried forward onto *Year 2*.

Adjusters1, Adjusters2, Adjusters3, and Adjusters4

- Applicability: Percent Pumps – type from component category of motor survey data.
- Applicability: Percent Fans – type from component category of motor survey data.
- Applicability: Percent Compressors – type from component category of motor surveys.
- Savings Fraction: Pumps – to account for other program savings.
- Savings Fraction: Fans – to account for other program savings.
- Savings Fraction: Compressors – to account for other program savings.
- Program Life: used to determine the percent of applicable motors for overall savings.

The "adjuster" sheets are intended to account for savings resulting from policy and program decisions. The savings assumptions were taken from Table 2-4. The program life was assumed to be 10 years, so that the savings would apply to 10 percent of the motors in any given year.

D.2.2 Equations

The equations for all of the calculations as found on the spreadsheets are given below.

Base Year, Year 2, Year 3, and Year 4

- Number of Purchased Motors (replaced + additions)

$$Purchased\ \ Motors = New\ Inventory - Old\ \ Inventory + Scrapped$$

- Number of Rewound Motors

$$Rewounded\ \ Motors = Old\ \ Inventory \times \%\,Rewound\ Upon\ Failure$$

- Number of Retired Motors

$$Retired\ \ Motors = Old\ \ Inventory \times \%Retired\ Upon\ Failure$$

- Average Energy of New Motors or Rewound Motors

$$New\ Energy_i\ = Old\ \ Energy_i \times \left(1 - \frac{(New\ Efficiency_i\ - Old\ Efficiency_i\ )}{New\ Efficiency_i}\right)$$

- Number of Motors in Year+1

$$New\ Inventory = Old\ \ Inventory \times (1 + \%Growth)$$

- Average Energy - Year+1

$$Energy = (Old - Rewound - Scrapped) \times Old\ \ Energy + Purchased \times Energy_p\ + Rewound \times Energy_w$$

- Average Efficiency - Year+1

$$New\ Efficiency = \frac{Old\ \ Efficiency}{1 - \left(\frac{Old\ \ Energy - New\ Energy}{Old\ \ Energy}\right)}$$

- Adjusted Energy - Year+1

$$Adjusted\ \ Energy\ = Energy \times (1 - Overall\ Savings)$$

Adjusters1, Adjusters2, Adjusters3. and Adjusters4

- Overall Savings - Year+1

$$Overall\ Savings\ = \frac{\sum_{pumps,\ fans,\ compressors}(Applicability \times Savings\ Fraction)}{Program\ Life}$$

D.3 MODEL OUTPUT

A summary of the stock adjustment model results is shown in Table D-1. The table offers a comparison of the expected motor consumption assuming only efficiency upgrades versus the additional savings that are available using an overall approach to system improvements. Under both scenarios, the inventory of motors as well as the annual consumption is increasing every year. The benefits of efficiency upgrades and system improvements can be seen in that the average use per motor is steadily decreasing.

Table D-1
Summary of Adjusted Motor Inventory

	No Policy Savings			Policy Savings: 10-Year Program		
Program Year	Number of Motors	Annual Energy (GWh)	Average Use (kWh/motor)	Number of Motors	Annual Energy (GWh)	Average Use (kWh/motor)
Base Year	12,434,330	575,428	46,277	12,434,330	575,428	46,277
Year 2	12,558,823	581,296	46,286	12,558,823	576,724	45,922
Year 3	12,691,726	586,677	46,225	12,691,726	577,523	45,504
Year 4	12,833,190	592,162	46,143	12,833,190	578,414	45,072
Year 5	12,983,368	597,768	46,041	12,983,368	579,412	44,627

The tables for each of the worksheets based on the scenario assuming a 10-year program encouraging overall system improvements can be found on the following pages:

- Trend
- Base Year
- Adjusters1
- Year 2
- Adjusters2
- Year 3
- Adjusters3
- Year 4
- Adjusters4
- Summary

Year	Number of Motors Bought 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	Number of Efficient Motors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
1996	1,360,287	576,180	168,933	61,530	35,209	22,811	5,505	151,316	110,256	43,202	19,934	10,862		
1995	846,850	571,521	155,130	52,912	32,160	27,363	4,918	157,559	108,758	43,502	20,160	10,472		
1994	764,720	507,336	141,644	50,277	27,839	15,954	4,603	145,811	103,198	37,741	16,556	8,203		
1993	587,776	464,772	130,820	46,735	24,771	14,559	4,418	110,538	78,478	29,786	14,301	7,780		
1992	773,942	443,600	122,720	43,863	24,132	15,909	4,712	104,478	72,935	22,280	13,221	8,106		
1991	889,853	491,711	132,448	39,887	29,705	15,153	4,340	63,979	134,988	39,215	12,624	8,221		
1990	771,539	553,496	126,993	35,179	28,546	15,593	2,109	57,710	125,687	31,784	12,620	7,753		

Year	Percent Annual Growth of Motors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	Percent of Efficient Motors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
1996	160.63%	100.82%	108.90%	116.29%	109.48%	83.36%	111.94%	11.12%	19.14%	25.57%	32.40%	30.85%		
1995	110.74%	112.65%	109.52%	105.24%	115.52%	171.51%	106.84%	18.61%	19.03%	28.04%	38.10%	32.56%		
1994	130.10%	109.16%	108.27%	107.58%	112.39%	109.58%	104.19%	19.07%	20.34%	26.64%	32.93%	29.47%		
1993	75.95%	104.77%	106.60%	106.55%	102.65%	91.51%	93.76%	18.81%	16.89%	22.77%	30.60%	31.41%		
1992	86.97%	90.22%	92.66%	109.97%	81.24%	104.99%	108.57%	13.50%	16.44%	18.16%	30.14%	33.59%		
1991	115.33%	88.84%	104.30%	113.38%	104.06%	97.18%	205.78%	7.19%	27.45%	29.61%	31.65%	27.68%		
1990								7.48%	22.71%	25.03%	35.87%	27.16%		
	113.29%	*101.08%*	*105.04%*	*109.83%*	*104.22%*	*109.69%*	*121.85%*							

Industry Groups	Number of Employees 1995	1994	1993	1992	1987	1982	1977	Percent Annual Change 95/94	94/93	93/92	92/87	87/82	82/77	*average 92-95*
20 Food and Kindred Products	1,651,000	1,635,600	1,643,300	1,622,000	1,557,100	1,596,600	1,622,300	100.94%	99.53%	101.31%	104.17%	97.53%	98.42%	*100.60%*
21 Tobacco Products	47,700	51,400	56,600	59,500	63,500	72,200	68,600	92.80%	90.81%	95.13%	93.70%	87.95%	105.25%	*92.91%*
22 Textile Mill Products	632,700	650,400	635,100	643,700	699,000	750,300	908,600	97.28%	102.41%	98.66%	92.09%	93.16%	82.58%	*99.45%*
23 Apparel and Other Textile Products	991,000	988,500	1,013,300	1,017,300	1,114,000	1,223,800	1,361,800	100.25%	97.55%	99.61%	91.32%	91.03%	89.87%	*99.14%*
24 Lumber and Wood Products	761,500	736,600	701,400	672,800	712,500	598,300	706,900	103.38%	105.02%	104.25%	94.43%	119.09%	84.64%	*104.22%*
25 Furniture and Fixtures	525,500	505,900	492,200	481,700	522,600	446,700	472,600	103.87%	102.78%	102.18%	92.17%	116.99%	94.52%	*102.95%*
26 Paper and Allied Products	677,000	669,500	673,500	676,600	654,600	636,900	666,300	101.12%	99.41%	99.54%	103.36%	102.78%	95.59%	*100.02%*
27 Printing and Publishing	1,628,600	1,583,900	1,575,500	1,572,100	1,578,100	1,340,100	1,131,100	102.82%	100.53%	100.22%	99.62%	117.76%	118.48%	*101.19%*
28 Chemicals and Allied Products	1,090,700	1,074,000	1,095,800	1,102,700	1,028,600	1,079,100	1,061,600	101.55%	98.01%	99.37%	107.20%	95.32%	101.65%	*99.65%*
29 Petroleum and Coal Products	143,600	148,000	156,300	158,400	153,500	227,600	212,100	97.03%	94.69%	98.67%	103.19%	67.44%	107.31%	*96.80%*
30 Rubber and Misc. Plastics Products	1,058,900	1,013,400	972,300	942,200	862,900	713,400	746,500	104.49%	104.23%	103.19%	109.19%	120.96%	95.57%	*103.97%*
31 Leather and Leather Products	90,700	96,500	103,400	105,800	135,700	209,000	253,300	93.99%	93.33%	97.73%	77.97%	64.93%	82.51%	*95.02%*
32 Stone, Clay and Glass Products	530,100	511,000	493,900	496,300	554,400	573,300	654,800	103.74%	103.46%	99.52%	89.52%	96.70%	87.55%	*102.24%*
33 Primary Metal Industries	711,800	687,300	676,700	688,700	730,000	901,600	1,160,400	103.56%	101.57%	98.26%	94.34%	80.97%	77.70%	*101.13%*
34 Fabricated Metal Products	1,509,600	1,449,300	1,410,400	1,400,700	1,501,500	1,511,200	1,605,800	104.16%	102.76%	100.69%	93.29%	99.36%	94.11%	*102.54%*
35 Industrial Machinery and Equipment	2,054,900	1,934,500	1,879,600	1,865,900	2,007,900	2,326,400	2,176,400	106.22%	102.92%	100.73%	92.93%	86.31%	106.89%	*103.29%*
36 Electronic and Other Electric Equip.	1,691,000	1,634,800	1,581,900	1,563,800	1,689,400			103.44%	103.34%	101.16%	92.57%			*102.65%*
37 Transportation Equipment	1,655,100	1,662,800	1,726,000	1,783,100	1,957,300	1,704,300	1,873,600	99.54%	96.34%	96.80%	91.10%	114.84%	90.96%	*97.56%*
38 Instuments and Related Products	877,400	896,200	952,200	969,300	1,042,300			97.90%	94.12%	98.24%	93.00%			*96.75%*
39 Misc. Manufacturing Industries	411,900	397,300	393,400	382,300	386,800	395,800	451,000	103.67%	100.99%	102.90%	98.84%	97.73%	87.76%	*102.52%*

Industry Groups	Base Number of Motors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	652,557	223,920	61,075	23,790	18,080	8,478	4,331
21 Tobacco Products							
22 Textile Mill Products	332,917	201,735	51,832	15,860	8,102	1,416	76
23 Apparel and Other Textile Products	60,054	13,360	9,796	1,633			
24 Lumber and Wood Products	485,783	336,664	77,356	35,969	34,967	7,232	
25 Furniture and Fixtures	241,489	63,149	26,440	7,324	6,332		
26 Paper and Allied Products	340,162	145,132	84,646	41,335	20,151	13,012	7,711
27 Printing and Publishing	275,244	158,863	45,602	3,640			
28 Chemicals and Allied Products	444,864	314,230	151,722	61,809	42,488	23,070	10,563
29 Petroleum and Coal Products	266,501	321,852	157,816	51,296	23,603	8,519	4,185
30 Rubber and Misc. Plastics Products	269,992	146,435	77,688	40,086	19,508	3,315	815
31 Leather and Leather Products	33,414	18,378	1,671				
32 Stone, Clay and Glass Products	119,354	68,410	15,293	1,612	813		
33 Primary Metal Industries	550,389	261,262	106,693	35,374	21,103	16,995	9,169
34 Fabricated Metal Products	621,929	137,216	45,892	9,088	5,496	316	
35 Industrial Machinery and Equipment	1,594,769	392,639	71,210	4,319	6,373		
36 Electronic and Other Electric Equip.	222,501	87,788	34,165	16,212	702		
37 Transportation Equipment	326,843	213,640	89,672	14,446	6,229	4,484	2,154
38 Instuments and Related Products	467,319	183,363	20,957	150	6,960		
39 Misc. Manufacturing Industries							

Industry Groups	Base Average Energy 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,568	24,840	96,574	212,729	323,470	605,525	1,537,901
21 Tobacco Products							
22 Textile Mill Products	6,079	23,746	47,919	188,619	382,727	872,986	1,620,619
23 Apparel and Other Textile Products	3,252	4,084	74,307	116,300			
24 Lumber and Wood Products	2,763	11,428	46,104	131,952	204,147	318,713	
25 Furniture and Fixtures	2,414	11,435	35,094	46,930	176,470		
26 Paper and Allied Products	5,460	30,639	104,127	320,557	627,970	1,503,398	5,058,554
27 Printing and Publishing	4,398	9,264	43,786	352,141			
28 Chemicals and Allied Products	5,326	29,476	86,578	216,594	484,522	1,132,905	5,631,554
29 Petroleum and Coal Products	2,011	9,466	40,837	123,860	305,346	981,820	4,775,241
30 Rubber and Misc. Plastics Products	5,031	27,674	91,188	239,486	453,687	1,026,735	2,775,836
31 Leather and Leather Products	1,448	24,040	767				
32 Stone, Clay and Glass Products	3,203	11,966	47,308	2,866	371,119		
33 Primary Metal Industries	6,123	22,607	78,940	246,814	515,511	1,005,725	3,657,446
34 Fabricated Metal Products	3,004	11,760	42,430	87,932	76,930	2,041,219	
35 Industrial Machinery and Equipment	1,330	5,549	17,263	17,111	278,483		
36 Electronic and Other Electric Equip.	8,710	35,720	108,946	235,343	898,970		
37 Transportation Equipment	4,007	30,087	54,629	157,833	193,468	1,548,091	3,010,632
38 Instuments and Related Products	3,552	12,776	51,885	105,392	198,428		
39 Misc. Manufacturing Industries							

Industry Groups	Base Average Efficiency 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8130	0.8713	0.9013	0.9272	0.9348	0.9375	0.9303
21 Tobacco Products							
22 Textile Mill Products	0.8132	0.8674	0.9049	0.9197	0.9315	0.9296	0.9303
23 Apparel and Other Textile Products	0.8049	0.8510	0.9030	0.9162			
24 Lumber and Wood Products	0.8703	0.9232	0.9226	0.9462	0.9614	0.9703	
25 Furniture and Fixtures	0.8105	0.8643	0.8904	0.9202	0.9305		
26 Paper and Allied Products	0.8168	0.8752	0.9061	0.9288	0.9343	0.9340	0.9305
27 Printing and Publishing	0.8362	0.8612	0.8929	0.9149			
28 Chemicals and Allied Products	0.8197	0.8739	0.9044	0.9241	0.9348	0.9333	0.9324
29 Petroleum and Coal Products	0.8226	0.8738	0.8987	0.9198	0.9299	0.9313	0.9306
30 Rubber and Misc. Plastics Products	0.8162	0.8730	0.8984	0.9190	0.9300	0.9318	0.9091
31 Leather and Leather Products	0.7940	0.8786	0.8891				
32 Stone, Clay and Glass Products	0.8176	0.8564	0.8883	0.9065	0.9360		
33 Primary Metal Industries	0.8133	0.8661	0.8980	0.9219	0.9282	0.9301	0.9307
34 Fabricated Metal Products	0.8401	0.8894	0.9079	0.9256	0.9324	0.9770	
35 Industrial Machinery and Equipment	0.8092	0.8636	0.8954	0.9283	0.9381		
36 Electronic and Other Electric Equip.	0.8162	0.8676	0.9029	0.9157	0.9360		
37 Transportation Equipment	0.8156	0.8726	0.8956	0.9181	0.9299	0.9339	0.9303
38 Instuments and Related Products	0.8274	0.8693	0.9025	0.9330	0.9380		
39 Misc. Manufacturing Industries							

Industry Groups	Percent of Motors Rewound Upon Failure 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	25.69%	48.01%	85.13%	85.89%	83.37%	83.37%	83.37%
21 Tobacco Products							
22 Textile Mill Products	44.44%	95.97%	95.97%	96.40%	96.40%	96.40%	96.40%
23 Apparel and Other Textile Products							
24 Lumber and Wood Products	12.55%	69.85%	65.81%	62.22%	99.65%	99.65%	99.65%
25 Furniture and Fixtures	61.19%	86.51%	95.28%	100.00%	95.28%	95.28%	95.28%
26 Paper and Allied Products	16.98%	66.58%	82.53%	88.35%	90.31%	90.31%	90.31%
27 Printing and Publishing	0.00%	50.00%	100.00%	100.00%	100.00%	100.00%	100.00%
28 Chemicals and Allied Products	4.35%	25.95%	77.46%	91.82%	95.08%	95.08%	95.08%
29 Petroleum and Coal Products	0.00%	7.12%	70.27%	90.15%	90.18%	90.18%	90.18%
30 Rubber and Misc. Plastics Products	27.57%	67.11%	95.82%	95.82%	96.46%	96.46%	96.46%
31 Leather and Leather Products							
32 Stone, Clay and Glass Products	18.80%	83.76%	100.00%	100.00%	100.00%	100.00%	100.00%
33 Primary Metal Industries	11.87%	56.02%	99.89%	95.34%	95.34%	95.34%	95.34%
34 Fabricated Metal Products	40.49%	64.55%	100.00%	100.00%			
35 Industrial Machinery and Equipment	41.52%	97.45%	100.00%	100.00%	100.00%	100.00%	100.00%
36 Electronic and Other Electric Equip.	3.60%	80.57%	80.57%	100.00%	100.00%	100.00%	100.00%
37 Transportation Equipment	7.79%	23.38%	77.16%	90.85%	93.15%	93.15%	93.15%
38 Instuments and Related Products				100.00%	100.00%	100.00%	100.00%
39 Misc. Manufacturing Industries							

Industry Groups	Percent of Motors Retired Upon Failure 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%
21 Tobacco Products							
22 Textile Mill Products	6.69%	6.69%	6.69%	6.69%	6.69%	6.69%	6.69%
23 Apparel and Other Textile Products							
24 Lumber and Wood Products	2.59%	2.59%	2.59%	2.59%	2.59%	2.59%	2.59%
25 Furniture and Fixtures	6.54%	6.54%	6.54%	6.54%	6.54%	6.54%	6.54%
26 Paper and Allied Products	5.23%	5.23%	5.23%	5.23%	5.23%	5.23%	5.23%
27 Printing and Publishing	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%
28 Chemicals and Allied Products	14.52%	14.52%	14.52%	14.52%	14.52%	14.52%	14.52%
29 Petroleum and Coal Products	0.84%	0.84%	0.84%	0.84%	0.84%	0.84%	0.84%
30 Rubber and Misc. Plastics Products	2.96%	2.96%	2.96%	2.96%	2.96%	2.96%	2.96%
31 Leather and Leather Products							
32 Stone, Clay and Glass Products	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%
33 Primary Metal Industries	5.85%	5.85%	5.85%	5.85%	5.85%	5.85%	5.85%
34 Fabricated Metal Products	0.78%	0.78%	0.78%	0.78%	0.78%	0.78%	0.78%
35 Industrial Machinery and Equipment	0.28%	0.28%	0.28%	0.28%	0.28%	0.28%	0.28%
36 Electronic and Other Electric Equip.	3.98%	3.98%	3.98%	3.98%	3.98%	3.98%	3.98%
37 Transportation Equipment	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%
38 Instuments and Related Products	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%
39 Misc. Manufacturing Industries							

Industry Groups	Industry Growth Rate 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%
21 Tobacco Products	-7.09%	-7.09%	-7.09%	-7.09%	-7.09%	-7.09%	-7.09%
22 Textile Mill Products	-0.55%	-0.55%	-0.55%	-0.55%	-0.55%	-0.55%	-0.55%
23 Apparel and Other Textile Products	-0.86%	-0.86%	-0.86%	-0.86%	-0.86%	-0.86%	-0.86%
24 Lumber and Wood Products	4.22%	4.22%	4.22%	4.22%	4.22%	4.22%	4.22%
25 Furniture and Fixtures	2.95%	2.95%	2.95%	2.95%	2.95%	2.95%	2.95%
26 Paper and Allied Products	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
27 Printing and Publishing	1.19%	1.19%	1.19%	1.19%	1.19%	1.19%	1.19%
28 Chemicals and Allied Products	-0.35%	-0.35%	-0.35%	-0.35%	-0.35%	-0.35%	-0.35%
29 Petroleum and Coal Products	-3.20%	-3.20%	-3.20%	-3.20%	-3.20%	-3.20%	-3.20%
30 Rubber and Misc. Plastics Products	3.97%	3.97%	3.97%	3.97%	3.97%	3.97%	3.97%
31 Leather and Leather Products	-4.98%	-4.98%	-4.98%	-4.98%	-4.98%	-4.98%	-4.98%
32 Stone, Clay and Glass Products	2.24%	2.24%	2.24%	2.24%	2.24%	2.24%	2.24%
33 Primary Metal Industries	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%
34 Fabricated Metal Products	2.54%	2.54%	2.54%	2.54%	2.54%	2.54%	2.54%
35 Industrial Machinery and Equipment	3.29%	3.29%	3.29%	3.29%	3.29%	3.29%	3.29%
36 Electronic and Other Electric Equip.	2.65%	2.65%	2.65%	2.65%	2.65%	2.65%	2.65%
37 Transportation Equipment	-2.44%	-2.44%	-2.44%	-2.44%	-2.44%	-2.44%	-2.44%
38 Instuments and Related Products	-3.25%	-3.25%	-3.25%	-3.25%	-3.25%	-3.25%	-3.25%
39 Misc. Manufacturing Industries	2.52%	2.52%	2.52%	2.52%	2.52%	2.52%	2.52%

Number of Purchased Motors (replaced + additions)

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	31,074	10,663	2,909	1,132	861	403	205
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	20,448	12,390	3,183	973	497	87	5
23 Apparel and Other Textile Products	-518	-115	-84	-14	0	0	0
24 Lumber and Wood Products	33,083	22,927	5,268	2,450	2,381	493	0
25 Furniture and Fixtures	22,909	5,991	2,508	694	601	0	0
26 Paper and Allied Products	17,865	7,622	4,445	2,170	1,059	683	405
27 Printing and Publishing	67,071	38,711	11,112	887	0	0	0
28 Chemicals and Allied Products	63,028	44,521	21,496	8,758	6,020	3,268	1,496
29 Petroleum and Coal Products	-6,296	-7,604	-3,729	-1,212	-558	-201	-99
30 Rubber and Misc. Plastics Products	18,720	10,153	5,387	2,780	1,352	229	56
31 Leather and Leather Products	-1,665	-916	-84	0	0	0	0
32 Stone, Clay and Glass Products	4,482	2,568	574	60	31	0	0
33 Primary Metal Industries	38,393	18,225	7,443	2,467	1,473	1,186	639
34 Fabricated Metal Products	20,635	4,553	1,523	301	182	10	0
35 Industrial Machinery and Equipment	57,011	14,037	2,546	154	228	0	0
36 Electronic and Other Electric Equip.	14,748	5,818	2,264	1,074	47	0	0
37 Transportation Equipment	-4,468	-2,921	-1,226	-198	-85	-62	-29
38 Instuments and Related Products	-10,145	-3,981	-455	-3	-151	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Number of Rewound Motors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	167,642	107,504	51,993	20,433	15,074	7,068	3,611
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	147,948	193,605	49,743	15,289	7,810	1,365	73
23 Apparel and Other Textile Products	0	0	0	0	0	0	0
24 Lumber and Wood Products	60,966	235,160	50,908	22,380	34,844	7,206	0
25 Furniture and Fixtures	147,767	54,631	25,192	7,324	6,033	0	0
26 Paper and Allied Products	57,760	96,629	69,858	36,519	18,198	11,751	6,964
27 Printing and Publishing	0	79,431	45,602	3,640	0	0	0
28 Chemicals and Allied Products	19,352	81,543	117,524	56,753	40,398	21,935	10,043
29 Petroleum and Coal Products	0	22,916	110,898	46,243	21,285	7,682	3,774
30 Rubber and Misc. Plastics Products	74,437	98,272	74,441	38,410	18,817	3,197	786
31 Leather and Leather Products	0	0	0	0	0	0	0
32 Stone, Clay and Glass Products	22,438	57,300	15,293	1,612	813	0	0
33 Primary Metal Industries	65,331	146,359	106,576	33,725	20,120	16,203	8,742
34 Fabricated Metal Products	251,819	88,573	45,892	9,088	0	0	0
35 Industrial Machinery and Equipment	662,148	382,627	71,210	4,319	6,373	0	0
36 Electronic and Other Electric Equip.	8,010	70,731	27,527	16,212	702	0	0
37 Transportation Equipment	25,461	49,949	69,191	13,124	5,802	4,177	2,007
38 Instuments and Related Products	0	0	0	150	6,960	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Number of Retired Motors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	27,189	9,330	2,545	991	753	353	180
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	22,277	13,499	3,468	1,061	542	95	5
23 Apparel and Other Textile Products	0	0	0	0	0	0	0
24 Lumber and Wood Products	12,599	8,732	2,006	933	907	188	0
25 Furniture and Fixtures	15,795	4,130	1,729	479	414	0	0
26 Paper and Allied Products	17,788	7,589	4,426	2,161	1,054	680	403
27 Printing and Publishing	63,794	36,820	10,569	844	0	0	0
28 Chemicals and Allied Products	64,600	45,631	22,032	8,976	6,170	3,350	1,534
29 Petroleum and Coal Products	2,240	2,705	1,326	431	198	72	35
30 Rubber and Misc. Plastics Products	8,000	4,339	2,302	1,188	578	98	24
31 Leather and Leather Products	0	0	0	0	0	0	0
32 Stone, Clay and Glass Products	1,810	1,037	232	24	12	0	0
33 Primary Metal Industries	32,176	15,274	6,237	2,068	1,234	994	536
34 Fabricated Metal Products	4,857	1,072	358	71	43	2	0
35 Industrial Machinery and Equipment	4,496	1,107	201	12	18	0	0
36 Electronic and Other Electric Equip.	8,859	3,495	1,360	645	28	0	0
37 Transportation Equipment	3,515	2,297	964	155	67	48	23
38 Instuments and Related Products	5,032	1,974	226	2	75	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Efficiency of New Motors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**0.8528**	**0.9007**	**0.9265**	**0.9419**	**0.9487**	**0.9500**	**0.9500**
21 Tobacco Products							
22 Textile Mill Products	**0.8551**	**0.9012**	**0.9263**	**0.9391**	**0.9490**	**0.9500**	**0.9500**
23 Apparel and Other Textile Products	**0.8506**	**0.8950**	**0.9280**	**0.9385**			
24 Lumber and Wood Products	**0.8592**	**0.8986**	**0.9267**	**0.9415**	**0.9489**	**0.9500**	
25 Furniture and Fixtures	**0.8557**	**0.8998**	**0.9263**	**0.9413**	**0.9489**		
26 Paper and Allied Products	**0.8532**	**0.9016**	**0.9269**	**0.9411**	**0.9479**	**0.9500**	**0.9500**
27 Printing and Publishing	**0.8652**	**0.8994**	**0.9252**	**0.9383**			
28 Chemicals and Allied Products	**0.8574**	**0.9018**	**0.9270**	**0.9406**	**0.9486**	**0.9500**	**0.9500**
29 Petroleum and Coal Products	**0.8607**	**0.9023**	**0.9267**	**0.9404**	**0.9485**	**0.9500**	**0.9500**
30 Rubber and Misc. Plastics Products	**0.8520**	**0.9007**	**0.9273**	**0.9406**	**0.9484**	**0.9500**	**0.9500**
31 Leather and Leather Products	**0.8302**	**0.9032**	**0.9240**				
32 Stone, Clay and Glass Products	**0.8518**	**0.8995**	**0.9260**	**0.9360**	**0.9450**		
33 Primary Metal Industries	**0.8556**	**0.8998**	**0.9261**	**0.9415**	**0.9485**	**0.9500**	**0.9500**
34 Fabricated Metal Products	**0.8522**	**0.9010**	**0.9259**	**0.9397**	**0.9495**	**0.9500**	
35 Industrial Machinery and Equipment	**0.8510**	**0.8993**	**0.9254**	**0.9420**	**0.9467**		
36 Electronic and Other Electric Equip.	**0.8602**	**0.9004**	**0.9255**	**0.9381**	**0.9500**		
37 Transportation Equipment	**0.8571**	**0.9035**	**0.9265**	**0.9387**	**0.9469**	**0.9500**	**0.9500**
38 Instuments and Related Products	**0.8598**	**0.8985**	**0.9290**	**0.9430**	**0.9500**		
39 Misc. Manufacturing Industries							

Efficiency of Rewound Motors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**0.8030**	**0.8613**	**0.8913**	**0.9172**	**0.9248**	**0.9275**	**0.9203**
21 Tobacco Products							
22 Textile Mill Products	**0.8032**	**0.8574**	**0.8949**	**0.9097**	**0.9215**	**0.9196**	**0.9203**
23 Apparel and Other Textile Products	**0.7949**	**0.8410**	**0.8930**	**0.9062**			
24 Lumber and Wood Products	**0.8603**	**0.9132**	**0.9126**	**0.9362**	**0.9514**	**0.9603**	
25 Furniture and Fixtures	**0.8005**	**0.8543**	**0.8804**	**0.9102**	**0.9205**		
26 Paper and Allied Products	**0.8068**	**0.8652**	**0.8961**	**0.9188**	**0.9243**	**0.9240**	**0.9205**
27 Printing and Publishing	**0.8262**	**0.8512**	**0.8829**	**0.9049**			
28 Chemicals and Allied Products	**0.8097**	**0.8639**	**0.8944**	**0.9141**	**0.9248**	**0.9233**	**0.9224**
29 Petroleum and Coal Products	**0.8126**	**0.8638**	**0.8887**	**0.9098**	**0.9199**	**0.9213**	**0.9206**
30 Rubber and Misc. Plastics Products	**0.8062**	**0.8630**	**0.8884**	**0.9090**	**0.9200**	**0.9218**	**0.8991**
31 Leather and Leather Products	**0.7840**	**0.8686**	**0.8791**				
32 Stone, Clay and Glass Products	**0.8076**	**0.8464**	**0.8783**	**0.8965**	**0.9260**		
33 Primary Metal Industries	**0.8033**	**0.8561**	**0.8880**	**0.9119**	**0.9182**	**0.9201**	**0.9207**
34 Fabricated Metal Products	**0.8301**	**0.8794**	**0.8979**	**0.9156**	**0.9224**	**0.9670**	
35 Industrial Machinery and Equipment	**0.7992**	**0.8536**	**0.8854**	**0.9183**	**0.9281**		
36 Electronic and Other Electric Equip.	**0.8062**	**0.8576**	**0.8929**	**0.9057**	**0.9260**		
37 Transportation Equipment	**0.8056**	**0.8626**	**0.8856**	**0.9081**	**0.9199**	**0.9239**	**0.9203**
38 Instuments and Related Products	**0.8174**	**0.8593**	**0.8925**	**0.9230**	**0.9280**		
39 Misc. Manufacturing Industries							

Average Energy of New Motors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,308	24,030	93,947	209,409	318,730	597,557	1,506,010
21 Tobacco Products							
22 Textile Mill Products	5,781	22,856	46,812	184,723	375,669	854,240	1,587,013
23 Apparel and Other Textile Products	3,077	3,883	72,306	113,536			
24 Lumber and Wood Products	2,799	11,741	45,900	132,611	206,836	325,524	
25 Furniture and Fixtures	2,286	10,984	33,734	45,878	173,048		
26 Paper and Allied Products	5,227	29,742	101,790	316,367	618,960	1,478,078	4,954,721
27 Printing and Publishing	4,250	8,871	42,257	343,359			
28 Chemicals and Allied Products	5,092	28,564	84,467	212,794	477,473	1,112,989	5,527,222
29 Petroleum and Coal Products	1,922	9,167	39,604	121,146	299,358	962,494	4,677,725
30 Rubber and Misc. Plastics Products	4,819	26,823	88,346	233,986	444,885	1,007,065	2,656,329
31 Leather and Leather Products	1,385	23,386	738				
32 Stone, Clay and Glass Products	3,074	11,392	45,382	2,776	367,585		
33 Primary Metal Industries	5,820	21,761	76,544	241,676	504,478	984,658	3,583,142
34 Fabricated Metal Products	2,961	11,608	41,605	86,612	75,544	2,099,233	
35 Industrial Machinery and Equipment	1,265	5,328	16,704	16,862	275,953		
36 Electronic and Other Electric Equip.	8,264	34,419	106,286	229,724	885,722		
37 Transportation Equipment	3,813	29,058	52,807	154,370	189,995	1,521,855	2,948,201
38 Instuments and Related Products	3,419	12,361	50,405	104,274	195,921		
39 Misc. Manufacturing Industries							

Average Energy of Rewound Motors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,637	25,129	97,657	215,048	326,968	612,053	1,554,612
21 Tobacco Products							
22 Textile Mill Products	6,154	24,023	48,455	190,693	386,880	882,479	1,638,229
23 Apparel and Other Textile Products	3,293	4,132	75,139	117,583			
24 Lumber and Wood Products	2,795	11,553	46,609	133,362	206,292	322,032	
25 Furniture and Fixtures	2,444	11,569	35,492	47,446	178,387		
26 Paper and Allied Products	5,528	30,993	105,289	324,046	634,764	1,519,668	5,113,508
27 Printing and Publishing	4,451	9,373	44,282	356,033			
28 Chemicals and Allied Products	5,392	29,817	87,546	218,963	489,761	1,145,175	5,692,607
29 Petroleum and Coal Products	2,036	9,576	41,297	125,221	308,665	992,477	4,827,112
30 Rubber and Misc. Plastics Products	5,093	27,995	92,214	242,120	458,618	1,037,874	2,806,709
31 Leather and Leather Products	1,466	24,317	775				
32 Stone, Clay and Glass Products	3,242	12,107	47,846	2,898	375,127		
33 Primary Metal Industries	6,199	22,871	79,829	249,520	521,126	1,016,656	3,697,170
34 Fabricated Metal Products	3,040	11,893	42,903	88,892	77,764	2,062,328	
35 Industrial Machinery and Equipment	1,347	5,614	17,458	17,297	281,483		
36 Electronic and Other Electric Equip.	8,818	36,137	110,166	237,942	908,679		
37 Transportation Equipment	4,057	30,436	55,246	159,572	195,571	1,564,847	3,043,345
38 Instuments and Related Products	3,596	12,925	52,466	106,534	200,566		
39 Misc. Manufacturing Industries							

Industry Groups	Number of Motors - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	656,442	225,253	61,439	23,931	18,188	8,528	4,356
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	331,088	200,626	51,547	15,772	8,057	1,408	76
23 Apparel and Other Textile Products	59,536	13,245	9,712	1,619	0	0	0
24 Lumber and Wood Products	506,267	350,859	80,618	37,486	36,441	7,537	0
25 Furniture and Fixtures	248,603	65,010	27,219	7,539	6,519	0	0
26 Paper and Allied Products	340,239	145,165	84,665	41,344	20,156	13,015	7,713
27 Printing and Publishing	278,521	160,754	46,145	3,683	0	0	0
28 Chemicals and Allied Products	443,292	313,120	151,186	61,591	42,338	22,988	10,525
29 Petroleum and Coal Products	257,965	311,543	152,761	49,653	22,847	8,246	4,051
30 Rubber and Misc. Plastics Products	280,712	152,249	80,773	41,678	20,282	3,446	847
31 Leather and Leather Products	31,749	17,462	1,587	0	0	0	0
32 Stone, Clay and Glass Products	122,026	69,941	15,635	1,648	832	0	0
33 Primary Metal Industries	556,606	264,213	107,899	35,773	21,342	17,187	9,272
34 Fabricated Metal Products	637,707	140,697	47,057	9,318	5,635	324	0
35 Industrial Machinery and Equipment	1,647,284	405,569	73,555	4,461	6,583	0	0
36 Electronic and Other Electric Equip.	228,390	90,111	35,069	16,641	721	0	0
37 Transportation Equipment	318,860	208,422	87,482	14,093	6,077	4,374	2,102
38 Instuments and Related Products	452,142	177,408	20,276	145	6,734	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Average Energy - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,573	24,940	97,366	214,552	326,144	610,559	1,550,251
21 Tobacco Products							
22 Textile Mill Products	6,094	23,958	48,368	190,389	386,317	881,034	1,635,365
23 Apparel and Other Textile Products	3,254	4,085	74,325	116,323			
24 Lumber and Wood Products	2,769	11,532	46,410	132,837	206,374	322,332	
25 Furniture and Fixtures	2,420	11,506	35,337	47,334	177,929		
26 Paper and Allied Products	5,459	30,828	104,963	323,419	633,631	1,516,760	5,102,726
27 Printing and Publishing	4,362	9,223	43,908	353,872			
28 Chemicals and Allied Products	5,296	29,435	87,030	218,237	488,519	1,141,781	5,674,979
29 Petroleum and Coal Products	2,013	9,482	41,201	125,194	308,584	992,219	4,825,956
30 Rubber and Misc. Plastics Products	5,033	27,825	91,944	241,547	457,675	1,035,760	2,796,555
31 Leather and Leather Products	1,451	24,075	768				
32 Stone, Clay and Glass Products	3,205	12,060	47,764	2,894	374,905		
33 Primary Metal Industries	6,111	22,695	79,652	249,011	520,043	1,014,576	3,689,777
34 Fabricated Metal Products	3,017	11,839	42,864	88,826	76,885	2,043,015	
35 Industrial Machinery and Equipment	1,335	5,602	17,433	17,282	281,300		
36 Electronic and Other Electric Equip.	8,685	35,963	109,732	237,512	907,567		
37 Transportation Equipment	4,014	30,185	55,142	159,501	195,525	1,564,464	3,042,738
38 Instuments and Related Products	3,555	12,786	51,918	106,594	200,694		
39 Misc. Manufacturing Industries							

Industry Groups	Average Efficiency - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8122	0.8678	0.8940	0.9193	0.9271	0.9298	0.9229
21 Tobacco Products							
22 Textile Mill Products	0.8111	0.8597	0.8965	0.9112	0.9228	0.9211	0.9219
23 Apparel and Other Textile Products	0.8045	0.8506	0.9028	0.9160			
24 Lumber and Wood Products	0.8684	0.9148	0.9165	0.9399	0.9510	0.9594	
25 Furniture and Fixtures	0.8084	0.8590	0.8843	0.9123	0.9229		
26 Paper and Allied Products	0.8169	0.8698	0.8989	0.9206	0.9260	0.9258	0.9224
27 Printing and Publishing	0.8430	0.8650	0.8904	0.9104			
28 Chemicals and Allied Products	0.8244	0.8751	0.8997	0.9171	0.9272	0.9260	0.9253
29 Petroleum and Coal Products	0.8217	0.8724	0.8908	0.9100	0.9201	0.9215	0.9208
30 Rubber and Misc. Plastics Products	0.8158	0.8683	0.8910	0.9112	0.9219	0.9237	0.9024
31 Leather and Leather Products	0.7922	0.8773	0.8873				
32 Stone, Clay and Glass Products	0.8169	0.8497	0.8798	0.8977	0.9265		
33 Primary Metal Industries	0.8149	0.8627	0.8900	0.9138	0.9201	0.9220	0.9225
34 Fabricated Metal Products	0.8365	0.8834	0.8987	0.9163	0.9329	0.9761	
35 Industrial Machinery and Equipment	0.8065	0.8553	0.8867	0.9191	0.9287		
36 Electronic and Other Electric Equip.	0.8185	0.8617	0.8964	0.9073	0.9271		
37 Transportation Equipment	0.8142	0.8698	0.8873	0.9085	0.9201	0.9241	0.9205
38 Instuments and Related Products	0.8267	0.8687	0.9019	0.9225	0.9274		
39 Misc. Manufacturing Industries							

Industry Groups	Adjusted Energy - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,550	24,677	96,461	212,831	324,755	609,789	1,550,251
21 Tobacco Products							
22 Textile Mill Products	6,080	23,859	48,018	188,553	383,476	867,986	1,607,482
23 Apparel and Other Textile Products	3,254	4,026	73,691	116,323			
24 Lumber and Wood Products	2,767	11,500	46,188	132,353	205,830	322,332	
25 Furniture and Fixtures	2,416	11,492	35,195	46,823	176,736		
26 Paper and Allied Products	5,437	30,617	104,146	320,494	627,628	1,503,205	5,069,081
27 Printing and Publishing	4,352	9,207	43,810	353,872			
28 Chemicals and Allied Products	5,250	29,093	86,234	216,336	483,059	1,130,798	5,633,359
29 Petroleum and Coal Products	1,997	9,377	40,823	124,084	304,385	974,936	4,747,421
30 Rubber and Misc. Plastics Products	5,011	27,552	91,227	238,577	456,013	1,024,864	2,796,555
31 Leather and Leather Products	1,444	23,942	755				
32 Stone, Clay and Glass Products	3,196	11,981	47,450	2,845	368,513		
33 Primary Metal Industries	6,086	22,538	79,007	247,509	516,815	1,006,565	3,674,709
34 Fabricated Metal Products	2,993	11,811	42,634	88,085	76,415	2,008,181	
35 Industrial Machinery and Equipment	1,333	5,575	17,313	17,282	280,501		
36 Electronic and Other Electric Equip.	8,568	35,608	107,894	232,835	892,093		
37 Transportation Equipment	3,986	29,883	54,796	158,706	192,546	1,550,217	3,033,195
38 Instuments and Related Products	3,537	12,759	51,572	104,777	200,326		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Pumps 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	15.04%	44.70%	28.40%	28.16%	15.00%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	4.35%	10.14%	26.38%	22.80%	13.86%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	0.00%	0.00%	0.00%			
24 Lumber and Wood Products	1.87%	5.41%	10.14%	12.11%	0.44%	0.00%	
25 Furniture and Fixtures	4.08%	1.51%	4.05%	25.55%	0.00%		
26 Paper and Allied Products	15.46%	25.50%	31.43%	34.84%	40.08%	40.94%	21.10%
27 Printing and Publishing	0.99%	1.81%	0.00%	0.00%			
28 Chemicals and Allied Products	39.61%	53.18%	37.53%	28.65%	37.45%	33.94%	9.69%
29 Petroleum and Coal Products	34.10%	52.54%	36.08%	38.47%	63.37%	81.64%	63.21%
30 Rubber and Misc. Plastics Products	16.12%	35.63%	28.40%	53.55%	4.42%	0.00%	0.00%
31 Leather and Leather Products	20.00%	0.00%	0.00%				
32 Stone, Clay and Glass Products	9.55%	10.53%	0.00%	0.00%	0.00%		
33 Primary Metal Industries	13.88%	22.72%	28.12%	24.91%	17.68%	4.57%	0.93%
34 Fabricated Metal Products	29.62%	6.91%	2.90%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	3.75%	7.97%	28.93%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	61.32%	47.03%	47.29%	86.65%	0.00%		
37 Transportation Equipment	32.86%	36.21%	12.08%	14.86%	38.30%	0.00%	0.00%
38 Instuments and Related Products	21.04%	4.41%	0.00%	0.00%	0.00%		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Fans 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	11.07%	20.89%	11.30%	9.05%	1.62%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	17.24%	15.46%	20.91%	18.87%	7.85%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	12.22%	0.00%	0.00%			
24 Lumber and Wood Products	5.67%	12.86%	13.42%	4.78%	9.86%	0.00%	
25 Furniture and Fixtures	7.01%	16.81%	26.01%	29.28%	64.59%		
26 Paper and Allied Products	12.96%	17.60%	10.39%	8.99%	14.17%	4.26%	24.48%
27 Printing and Publishing	6.06%	4.25%	9.87%	0.00%			
28 Chemicals and Allied Products	9.97%	7.96%	11.00%	17.24%	20.88%	12.10%	6.22%
29 Petroleum and Coal Products	19.59%	4.37%	7.79%	14.03%	12.26%	2.09%	3.66%
30 Rubber and Misc. Plastics Products	14.21%	12.74%	6.53%	0.72%	6.47%	3.41%	0.00%
31 Leather and Leather Products	20.00%	100.00%	0.00%				
32 Stone, Clay and Glass Products	18.02%	32.32%	21.18%	0.00%	0.00%		
33 Primary Metal Industries	12.22%	16.44%	20.92%	5.35%	19.76%	6.67%	15.57%
34 Fabricated Metal Products	19.12%	4.09%	1.53%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	1.74%	11.70%	0.00%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	14.49%	7.70%	2.22%	0.00%	0.00%		
37 Transportation Equipment	7.34%	39.03%	16.40%	17.61%	20.63%	1.63%	3.39%
38 Instuments and Related Products	8.12%	20.98%	0.36%	0.00%	33.33%		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Compressors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	2.69%	2.28%	17.42%	10.94%	6.78%	7.40%	0.00%
21 Tobacco Products							
22 Textile Mill Products	3.15%	7.41%	4.51%	23.59%	24.27%	47.29%	100.00%
23 Apparel and Other Textile Products	0.00%	81.67%	50.00%	0.00%			
24 Lumber and Wood Products	0.75%	5.64%	11.67%	5.55%	11.77%	0.00%	
25 Furniture and Fixtures	0.83%	0.00%	10.36%	23.77%	18.48%		
26 Paper and Allied Products	1.51%	4.33%	5.26%	9.07%	3.74%	2.78%	5.90%
27 Printing and Publishing	10.83%	6.64%	9.87%	0.00%			
28 Chemicals and Allied Products	1.20%	3.02%	5.82%	11.74%	14.66%	12.50%	29.58%
29 Petroleum and Coal Products	1.84%	1.58%	8.74%	2.13%	1.14%	5.25%	19.75%
30 Rubber and Misc. Plastics Products	2.94%	11.27%	10.15%	8.76%	14.00%	60.60%	0.00%
31 Leather and Leather Products	0.00%	0.00%	100.00%				
32 Stone, Clay and Glass Products	0.00%	15.96%	31.62%	100.00%	100.00%		
33 Primary Metal Industries	3.36%	8.50%	7.62%	4.30%	9.19%	38.77%	17.84%
34 Fabricated Metal Products	6.00%	4.45%	27.64%	48.92%	35.83%	100.00%	
35 Industrial Machinery and Equipment	2.42%	15.55%	6.16%	0.00%	16.67%		
36 Electronic and Other Electric Equip.	1.68%	0.00%	41.78%	13.35%	100.00%		
37 Transportation Equipment	0.44%	3.42%	17.27%	6.01%	37.54%	52.89%	17.30%
38 Instuments and Related Products	3.25%	0.24%	38.93%	100.00%	0.00%		
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Pumps 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
21 Tobacco Products							
22 Textile Mill Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
23 Apparel and Other Textile Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
24 Lumber and Wood Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
25 Furniture and Fixtures	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
26 Paper and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
27 Printing and Publishing	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
28 Chemicals and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
29 Petroleum and Coal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
30 Rubber and Misc. Plastics Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
31 Leather and Leather Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
32 Stone, Clay and Glass Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
33 Primary Metal Industries	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
34 Fabricated Metal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
35 Industrial Machinery and Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
36 Electronic and Other Electric Equip.	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
37 Transportation Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
38 Instuments and Related Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Fans 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
21 Tobacco Products							
22 Textile Mill Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
23 Apparel and Other Textile Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
24 Lumber and Wood Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
25 Furniture and Fixtures	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
26 Paper and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
27 Printing and Publishing	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
28 Chemicals and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
29 Petroleum and Coal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
30 Rubber and Misc. Plastics Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
31 Leather and Leather Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
32 Stone, Clay and Glass Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
33 Primary Metal Industries	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
34 Fabricated Metal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
35 Industrial Machinery and Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
36 Electronic and Other Electric Equip.	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
37 Transportation Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
38 Instuments and Related Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Compressors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
21 Tobacco Products							
22 Textile Mill Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
23 Apparel and Other Textile Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
24 Lumber and Wood Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
25 Furniture and Fixtures	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
26 Paper and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
27 Printing and Publishing	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
28 Chemicals and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
29 Petroleum and Coal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
30 Rubber and Misc. Plastics Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
31 Leather and Leather Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
32 Stone, Clay and Glass Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
33 Primary Metal Industries	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
34 Fabricated Metal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
35 Industrial Machinery and Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
36 Electronic and Other Electric Equip.	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
37 Transportation Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
38 Instuments and Related Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
39 Misc. Manufacturing Industries							

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Industry Groups	Overall Savings - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.41%	1.05%	0.93%	0.80%	0.43%	0.13%	0.00%
21 Tobacco Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22 Textile Mill Products	0.24%	0.42%	0.72%	0.96%	0.74%	1.48%	1.71%
23 Apparel and Other Textile Products	0.00%	1.46%	0.85%	0.00%	0.00%	0.00%	0.00%
24 Lumber and Wood Products	0.08%	0.28%	0.48%	0.36%	0.26%	0.00%	0.00%
25 Furniture and Fixtures	0.13%	0.12%	0.40%	1.08%	0.67%	0.00%	0.00%
26 Paper and Allied Products	0.41%	0.68%	0.78%	0.90%	0.95%	0.89%	0.66%
27 Printing and Publishing	0.24%	0.17%	0.22%	0.00%	0.00%	0.00%	0.00%
28 Chemicals and Allied Products	0.87%	1.16%	0.91%	0.87%	1.12%	0.96%	0.73%
29 Petroleum and Coal Products	0.82%	1.11%	0.92%	0.89%	1.36%	1.74%	1.63%
30 Rubber and Misc. Plastics Products	0.45%	0.98%	0.78%	1.23%	0.36%	1.05%	0.00%
31 Leather and Leather Products	0.51%	0.55%	1.71%	0.00%	0.00%	0.00%	0.00%
32 Stone, Clay and Glass Products	0.29%	0.66%	0.66%	1.71%	1.71%	0.00%	0.00%
33 Primary Metal Industries	0.40%	0.69%	0.81%	0.60%	0.62%	0.79%	0.41%
34 Fabricated Metal Products	0.80%	0.24%	0.54%	0.83%	0.61%	1.71%	0.00%
35 Industrial Machinery and Equipment	0.13%	0.49%	0.69%	0.00%	0.28%	0.00%	0.00%
36 Electronic and Other Electric Equip.	1.34%	0.99%	1.67%	1.97%	1.71%	0.00%	0.00%
37 Transportation Equipment	0.71%	1.00%	0.63%	0.50%	1.52%	0.91%	0.31%
38 Instuments and Related Products	0.52%	0.21%	0.67%	1.71%	0.18%	0.00%	0.00%
39 Misc. Manufacturing Industries	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Industry Groups	Number of Motors - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	656,442	225,253	61,439	23,931	18,188	8,528	4,356
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	331,088	200,626	51,547	15,772	8,057	1,408	76
23 Apparel and Other Textile Products	59,536	13,245	9,712	1,619	0	0	0
24 Lumber and Wood Products	506,267	350,859	80,618	37,486	36,441	7,537	0
25 Furniture and Fixtures	248,603	65,010	27,219	7,539	6,519	0	0
26 Paper and Allied Products	340,239	145,165	84,665	41,344	20,156	13,015	7,713
27 Printing and Publishing	278,521	160,754	46,145	3,683	0	0	0
28 Chemicals and Allied Products	443,292	313,120	151,186	61,591	42,338	22,988	10,525
29 Petroleum and Coal Products	257,965	311,543	152,761	49,653	22,847	8,246	4,051
30 Rubber and Misc. Plastics Products	280,712	152,249	80,773	41,678	20,282	3,446	847
31 Leather and Leather Products	31,749	17,462	1,587	0	0	0	0
32 Stone, Clay and Glass Products	122,026	69,941	15,635	1,648	832	0	0
33 Primary Metal Industries	556,606	264,213	107,899	35,773	21,342	17,187	9,272
34 Fabricated Metal Products	637,707	140,697	47,057	9,318	5,635	324	0
35 Industrial Machinery and Equipment	1,647,284	405,569	73,555	4,461	6,583	0	0
36 Electronic and Other Electric Equip.	228,390	90,111	35,069	16,641	721	0	0
37 Transportation Equipment	318,860	208,422	87,482	14,093	6,077	4,374	2,102
38 Instuments and Related Products	452,142	177,408	20,276	145	6,734	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Average Adjusted Energy - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,550	24,677	96,461	212,831	324,755	609,789	1,550,251
21 Tobacco Products							
22 Textile Mill Products	6,080	23,859	48,018	188,553	383,476	867,986	1,607,482
23 Apparel and Other Textile Products	3,254	4,026	73,691	116,323			
24 Lumber and Wood Products	2,767	11,500	46,188	132,353	205,830	322,332	
25 Furniture and Fixtures	2,416	11,492	35,195	46,823	176,736		
26 Paper and Allied Products	5,437	30,617	104,146	320,494	627,628	1,503,205	5,069,081
27 Printing and Publishing	4,352	9,207	43,810	353,872			
28 Chemicals and Allied Products	5,250	29,093	86,234	216,336	483,059	1,130,798	5,633,359
29 Petroleum and Coal Products	1,997	9,377	40,823	124,084	304,385	974,936	4,747,421
30 Rubber and Misc. Plastics Products	5,011	27,552	91,227	238,577	456,013	1,024,864	2,796,555
31 Leather and Leather Products	1,444	23,942	755				
32 Stone, Clay and Glass Products	3,196	11,981	47,450	2,845	368,513		
33 Primary Metal Industries	6,086	22,538	79,007	247,509	516,815	1,006,565	3,674,709
34 Fabricated Metal Products	2,993	11,811	42,634	88,085	76,415	2,008,181	
35 Industrial Machinery and Equipment	1,333	5,575	17,313	17,282	280,501		
36 Electronic and Other Electric Equip.	8,568	35,608	107,894	232,835	892,093		
37 Transportation Equipment	3,986	29,883	54,796	158,706	192,546	1,550,217	3,033,195
38 Instuments and Related Products	3,537	12,759	51,572	104,777	200,326		
39 Misc. Manufacturing Industries							

Industry Groups	Average Efficiency - Year 2 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8122	0.8678	0.8940	0.9193	0.9271	0.9298	0.9229
21 Tobacco Products							
22 Textile Mill Products	0.8111	0.8597	0.8965	0.9112	0.9228	0.9211	0.9219
23 Apparel and Other Textile Products	0.8045	0.8506	0.9028	0.9160			
24 Lumber and Wood Products	0.8684	0.9148	0.9165	0.9399	0.9510	0.9594	
25 Furniture and Fixtures	0.8084	0.8590	0.8843	0.9123	0.9229		
26 Paper and Allied Products	0.8169	0.8698	0.8989	0.9206	0.9260	0.9258	0.9224
27 Printing and Publishing	0.8430	0.8650	0.8904	0.9104			
28 Chemicals and Allied Products	0.8244	0.8751	0.8997	0.9171	0.9272	0.9260	0.9253
29 Petroleum and Coal Products	0.8217	0.8724	0.8908	0.9100	0.9201	0.9215	0.9208
30 Rubber and Misc. Plastics Products	0.8158	0.8683	0.8910	0.9112	0.9219	0.9237	0.9024
31 Leather and Leather Products	0.7922	0.8773	0.8873				
32 Stone, Clay and Glass Products	0.8169	0.8497	0.8798	0.8977	0.9265		
33 Primary Metal Industries	0.8149	0.8627	0.8900	0.9138	0.9201	0.9220	0.9225
34 Fabricated Metal Products	0.8365	0.8834	0.8987	0.9163	0.9329	0.9761	
35 Industrial Machinery and Equipment	0.8065	0.8553	0.8867	0.9191	0.9287		
36 Electronic and Other Electric Equip.	0.8185	0.8617	0.8964	0.9073	0.9271		
37 Transportation Equipment	0.8142	0.8698	0.8873	0.9085	0.9201	0.9241	0.9205
38 Instuments and Related Products	0.8267	0.8687	0.9019	0.9225	0.9274		
39 Misc. Manufacturing Industries							

Industry Groups	Percent of Motors Rewound Upon Failure 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	25.69%	48.01%	85.13%	85.89%	83.37%	83.37%	83.37%
21 Tobacco Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22 Textile Mill Products	44.44%	95.97%	95.97%	96.40%	96.40%	96.40%	96.40%
23 Apparel and Other Textile Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
24 Lumber and Wood Products	12.55%	69.85%	65.81%	62.22%	99.65%	99.65%	99.65%
25 Furniture and Fixtures	61.19%	86.51%	95.28%	100.00%	95.28%	95.28%	95.28%
26 Paper and Allied Products	16.98%	66.58%	82.53%	88.35%	90.31%	90.31%	90.31%
27 Printing and Publishing	0.00%	50.00%	100.00%	100.00%	100.00%	100.00%	100.00%
28 Chemicals and Allied Products	4.35%	25.95%	77.46%	91.82%	95.08%	95.08%	95.08%
29 Petroleum and Coal Products	0.00%	7.12%	70.27%	90.15%	90.18%	90.18%	90.18%
30 Rubber and Misc. Plastics Products	27.57%	67.11%	95.82%	95.82%	96.46%	96.46%	96.46%
31 Leather and Leather Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32 Stone, Clay and Glass Products	18.80%	83.76%	100.00%	100.00%	100.00%	100.00%	100.00%
33 Primary Metal Industries	11.87%	56.02%	99.89%	95.34%	95.34%	95.34%	95.34%
34 Fabricated Metal Products	40.49%	64.55%	100.00%	100.00%	0.00%	0.00%	0.00%
35 Industrial Machinery and Equipment	41.52%	97.45%	100.00%	100.00%	100.00%	100.00%	100.00%
36 Electronic and Other Electric Equip.	3.60%	80.57%	80.57%	100.00%	100.00%	100.00%	100.00%
37 Transportation Equipment	7.79%	23.38%	77.16%	90.85%	93.15%	93.15%	93.15%
38 Instuments and Related Products	0.00%	0.00%	0.00%	100.00%	100.00%	100.00%	100.00%
39 Misc. Manufacturing Industries	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Industry Groups	Percent of Motors Retired Upon Failure 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%
21 Tobacco Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22 Textile Mill Products	6.69%	6.69%	6.69%	6.69%	6.69%	6.69%	6.69%
23 Apparel and Other Textile Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
24 Lumber and Wood Products	2.59%	2.59%	2.59%	2.59%	2.59%	2.59%	2.59%
25 Furniture and Fixtures	6.54%	6.54%	6.54%	6.54%	6.54%	6.54%	6.54%
26 Paper and Allied Products	5.23%	5.23%	5.23%	5.23%	5.23%	5.23%	5.23%
27 Printing and Publishing	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%
28 Chemicals and Allied Products	14.52%	14.52%	14.52%	14.52%	14.52%	14.52%	14.52%
29 Petroleum and Coal Products	0.84%	0.84%	0.84%	0.84%	0.84%	0.84%	0.84%
30 Rubber and Misc. Plastics Products	2.96%	2.96%	2.96%	2.96%	2.96%	2.96%	2.96%
31 Leather and Leather Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32 Stone, Clay and Glass Products	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%	1.52%
33 Primary Metal Industries	5.85%	5.85%	5.85%	5.85%	5.85%	5.85%	5.85%
34 Fabricated Metal Products	0.78%	0.78%	0.78%	0.78%	0.78%	0.78%	0.78%
35 Industrial Machinery and Equipment	0.28%	0.28%	0.28%	0.28%	0.28%	0.28%	0.28%
36 Electronic and Other Electric Equip.	3.98%	3.98%	3.98%	3.98%	3.98%	3.98%	3.98%
37 Transportation Equipment	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%
38 Instuments and Related Products	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%	1.08%
39 Misc. Manufacturing Industries	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Industry Groups	Industry Growth Rate 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%
21 Tobacco Products	-7.09%	-7.09%	-7.09%	-7.09%	-7.09%	-7.09%	-7.09%
22 Textile Mill Products	-0.55%	-0.55%	-0.55%	-0.55%	-0.55%	-0.55%	-0.55%
23 Apparel and Other Textile Products	-0.86%	-0.86%	-0.86%	-0.86%	-0.86%	-0.86%	-0.86%
24 Lumber and Wood Products	4.22%	4.22%	4.22%	4.22%	4.22%	4.22%	4.22%
25 Furniture and Fixtures	2.95%	2.95%	2.95%	2.95%	2.95%	2.95%	2.95%
26 Paper and Allied Products	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
27 Printing and Publishing	1.19%	1.19%	1.19%	1.19%	1.19%	1.19%	1.19%
28 Chemicals and Allied Products	-0.35%	-0.35%	-0.35%	-0.35%	-0.35%	-0.35%	-0.35%
29 Petroleum and Coal Products	-3.20%	-3.20%	-3.20%	-3.20%	-3.20%	-3.20%	-3.20%
30 Rubber and Misc. Plastics Products	3.97%	3.97%	3.97%	3.97%	3.97%	3.97%	3.97%
31 Leather and Leather Products	-4.98%	-4.98%	-4.98%	-4.98%	-4.98%	-4.98%	-4.98%
32 Stone, Clay and Glass Products	2.24%	2.24%	2.24%	2.24%	2.24%	2.24%	2.24%
33 Primary Metal Industries	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%	1.13%
34 Fabricated Metal Products	2.54%	2.54%	2.54%	2.54%	2.54%	2.54%	2.54%
35 Industrial Machinery and Equipmen	3.29%	3.29%	3.29%	3.29%	3.29%	3.29%	3.29%
36 Electronic and Other Electric Equip.	2.65%	2.65%	2.65%	2.65%	2.65%	2.65%	2.65%
37 Transportation Equipment	-2.44%	-2.44%	-2.44%	-2.44%	-2.44%	-2.44%	-2.44%
38 Instuments and Related Products	-3.25%	-3.25%	-3.25%	-3.25%	-3.25%	-3.25%	-3.25%
39 Misc. Manufacturing Industries	2.52%	2.52%	2.52%	2.52%	2.52%	2.52%	2.52%

	Number of Purchased Motors (replaced + additions)							Number of Rewound Motors							Number of Retired Motors						
Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	31,259	10,726	2,926	1,139	866	406	207	168,640	108,144	52,303	20,554	15,163	7,110	3,632	27,351	9,385	2,560	997	758	355	181
21 Tobacco Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Textile Mill Products	20,336	12,323	3,166	968	495	86	5	147,136	192,541	49,470	15,204	7,767	1,357	73	22,155	13,425	3,449	1,055	539	94	5
23 Apparel and Other Textile Products	-514	-114	-84	-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Lumber and Wood Products	34,477	23,894	5,490	2,553	2,482	513	0	63,537	245,075	53,055	23,324	36,313	7,511	0	13,130	9,100	2,091	972	945	195	0
25 Furniture and Fixtures	23,583	6,167	2,582	715	618	0	0	152,120	56,240	25,934	7,539	6,211	0	0	16,260	4,252	1,780	493	426	0	0
26 Paper and Allied Products	17,869	7,624	4,446	2,171	1,059	684	405	57,773	96,651	69,874	36,527	18,203	11,754	6,966	17,792	7,591	4,427	2,162	1,054	681	403
27 Printing and Publishing	67,869	39,172	11,244	898	0	0	0	0	80,377	46,145	3,683	0	0	0	64,553	37,258	10,695	854	0	0	0
28 Chemicals and Allied Products	62,805	44,362	21,420	8,726	5,998	3,257	1,491	19,283	81,255	117,109	56,553	40,255	21,857	10,007	64,372	45,469	21,954	8,944	6,148	3,338	1,528
29 Petroleum and Coal Products	-6,095	-7,361	-3,609	-1,173	-540	-195	-96	0	22,182	107,345	44,762	20,603	7,436	3,653	2,168	2,618	1,284	417	192	69	34
30 Rubber and Misc. Plastics Products	19,464	10,556	5,600	2,890	1,406	239	59	77,392	102,174	77,397	39,936	19,564	3,324	817	8,318	4,511	2,393	1,235	601	102	25
31 Leather and Leather Products	-1,582	-870	-79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32 Stone, Clay and Glass Products	4,582	2,627	587	62	32	0	0	22,941	58,583	15,635	1,648	832	0	0	1,850	1,061	237	25	13	0	0
33 Primary Metal Industries	38,827	18,430	7,527	2,495	1,489	1,199	647	66,069	148,012	107,780	34,106	20,347	16,386	8,840	32,540	15,446	6,308	2,091	1,248	1,005	542
34 Fabricated Metal Products	21,159	4,669	1,561	309	187	11	0	258,208	90,820	47,057	9,318	0	0	0	4,980	1,099	367	73	44	3	0
35 Industrial Machinery and Equipment	58,888	14,498	2,629	160	236	0	0	683,952	395,227	73,555	4,461	6,583	0	0	4,644	1,143	207	13	19	0	0
36 Electronic and Other Electric Equip.	15,138	5,973	2,324	1,103	48	0	0	8,222	72,602	28,255	16,641	721	0	0	9,094	3,588	1,396	663	29	0	0
37 Transportation Equipment	-4,359	-2,849	-1,196	-192	-83	-60	-28	24,839	48,729	67,501	12,803	5,661	4,074	1,958	3,429	2,241	941	152	65	47	23
38 Instuments and Related Products	-9,815	-3,852	-440	-3	-146	0	0	0	0	0	145	6,734	0	0	4,869	1,910	218	2	73	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Efficiency of New Motors							Efficiency of Rewound Motors						
Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**0.8785**	**0.9204**	**0.9390**	**0.9531**	**0.9595**	**0.9620**	**0.9620**	**0.8022**	**0.8578**	**0.8840**	**0.9093**	**0.9171**	**0.9198**	**0.9129**
21 Tobacco Products														
22 Textile Mill Products	**0.8807**	**0.9212**	**0.9381**	**0.9519**	**0.9590**	**0.9620**	**0.9620**	**0.8011**	**0.8497**	**0.8865**	**0.9012**	**0.9128**	**0.9111**	**0.9119**
23 Apparel and Other Textile Products	**0.8782**	**0.9170**	**0.9400**	**0.9520**				**0.7945**	**0.8406**	**0.8928**	**0.9060**			
24 Lumber and Wood Products	**0.8835**	**0.9192**	**0.9394**	**0.9534**	**0.9583**	**0.9620**		**0.8584**	**0.9048**	**0.9065**	**0.9299**	**0.9410**	**0.9494**	
25 Furniture and Fixtures	**0.8799**	**0.9199**	**0.9383**	**0.9529**	**0.9574**			**0.7984**	**0.8490**	**0.8743**	**0.9023**	**0.9129**		
26 Paper and Allied Products	**0.8794**	**0.9212**	**0.9392**	**0.9531**	**0.9576**	**0.9620**	**0.9620**	**0.8069**	**0.8598**	**0.8889**	**0.9106**	**0.9160**	**0.9158**	**0.9124**
27 Printing and Publishing	**0.8876**	**0.9202**	**0.9372**	**0.9510**				**0.8330**	**0.8550**	**0.8804**	**0.9004**			
28 Chemicals and Allied Products	**0.8816**	**0.9212**	**0.9394**	**0.9527**	**0.9583**	**0.9620**	**0.9620**	**0.8144**	**0.8651**	**0.8897**	**0.9071**	**0.9172**	**0.9160**	**0.9153**
29 Petroleum and Coal Products	**0.8837**	**0.9219**	**0.9391**	**0.9526**	**0.9580**	**0.9620**	**0.9620**	**0.8117**	**0.8624**	**0.8808**	**0.9000**	**0.9101**	**0.9115**	**0.9108**
30 Rubber and Misc. Plastics Products	**0.8785**	**0.9208**	**0.9395**	**0.9528**	**0.9579**	**0.9620**	**0.9620**	**0.8058**	**0.8583**	**0.8810**	**0.9012**	**0.9119**	**0.9137**	**0.8924**
31 Leather and Leather Products	**0.8650**	**0.9208**	**0.9360**					**0.7822**	**0.8673**	**0.8773**				
32 Stone, Clay and Glass Products	**0.8772**	**0.9195**	**0.9379**	**0.9500**	**0.9540**			**0.8069**	**0.8397**	**0.8698**	**0.8877**	**0.9165**		
33 Primary Metal Industries	**0.8809**	**0.9202**	**0.9383**	**0.9530**	**0.9582**	**0.9620**	**0.9620**	**0.8049**	**0.8527**	**0.8800**	**0.9038**	**0.9101**	**0.9120**	**0.9125**
34 Fabricated Metal Products	**0.8778**	**0.9207**	**0.9381**	**0.9523**	**0.9580**	**0.9620**		**0.8265**	**0.8734**	**0.8887**	**0.9063**	**0.9229**	**0.9661**	
35 Industrial Machinery and Equipmen	**0.8776**	**0.9195**	**0.9374**	**0.9527**	**0.9553**			**0.7965**	**0.8453**	**0.8767**	**0.9091**	**0.9187**		
36 Electronic and Other Electric Equip.	**0.8850**	**0.9206**	**0.9382**	**0.9514**	**0.9620**			**0.8085**	**0.8517**	**0.8864**	**0.8973**	**0.9171**		
37 Transportation Equipment	**0.8814**	**0.9224**	**0.9387**	**0.9518**	**0.9559**	**0.9620**	**0.9620**	**0.8042**	**0.8598**	**0.8773**	**0.8985**	**0.9101**	**0.9141**	**0.9105**
38 Instuments and Related Products	**0.8829**	**0.9196**	**0.9415**	**0.9540**	**0.9580**			**0.8167**	**0.8587**	**0.8919**	**0.9125**	**0.9174**		
39 Misc. Manufacturing Industries														

	Average Energy of New Motors							Average Energy of Rewound Motors						
Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,132	23,268	91,834	205,288	313,800	589,359	1,487,224	5,620	24,965	97,552	215,171	328,296	616,419	1,567,233
21 Tobacco Products														
22 Textile Mill Products	5,599	22,266	45,890	180,481	369,017	831,091	1,540,495	6,156	24,140	48,560	190,645	387,677	877,513	1,625,110
23 Apparel and Other Textile Products	2,981	3,734	70,774	111,926				3,295	4,074	74,516	117,607			
24 Lumber and Wood Products	2,720	11,446	45,064	130,479	204,267	321,463		2,799	11,627	46,698	133,776	208,017	325,727	
25 Furniture and Fixtures	2,220	10,731	33,169	44,830	170,362			2,447	11,628	35,598	47,342	178,672		
26 Paper and Allied Products	5,051	28,910	99,675	309,559	606,886	1,446,596	4,860,654	5,505	30,973	105,317	324,013	634,480	1,519,619	5,124,636
27 Printing and Publishing	4,133	8,655	41,623	338,774				4,404	9,315	44,308	357,802			
28 Chemicals and Allied Products	4,909	27,637	82,590	208,262	467,358	1,088,533	5,418,245	5,314	29,429	87,204	218,721	488,326	1,143,142	5,694,908
29 Petroleum and Coal Products	1,857	8,873	38,722	118,534	292,356	933,931	4,544,202	2,021	9,486	41,287	125,462	307,730	985,631	4,799,543
30 Rubber and Misc. Plastics Products	4,653	25,981	86,519	228,150	438,873	984,041	2,623,194	5,073	27,873	92,263	241,224	461,014	1,036,081	2,827,894
31 Leather and Leather Products	1,322	22,812	716					1,462	24,218	764				
32 Stone, Clay and Glass Products	2,976	11,071	44,512	2,688	357,909			3,235	12,123	47,996	2,877	372,534		
33 Primary Metal Industries	5,630	21,131	74,937	237,319	496,272	964,698	3,523,995	6,162	22,802	79,905	250,247	522,494	1,017,602	3,714,977
34 Fabricated Metal Products	2,852	11,333	40,843	84,754	74,417	2,037,702		3,029	11,946	43,113	89,057	77,243	2,028,967	
35 Industrial Machinery and Equipment	1,225	5,186	16,376	16,672	272,692			1,350	5,641	17,510	17,473	283,554		
36 Electronic and Other Electric Equip.	7,925	33,332	103,091	222,052	859,761			8,674	36,026	109,111	235,430	901,820		
37 Transportation Equipment	3,682	28,178	51,794	151,487	185,339	1,489,185	2,902,294	4,035	30,231	55,421	160,473	194,662	1,567,176	3,066,509
38 Instuments and Related Products	3,312	12,052	49,405	101,315	193,929			3,580	12,908	52,151	105,925	202,510		
39 Misc. Manufacturing Industries														

Industry Groups	Number of Motors - Year 3 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	660,350	226,594	61,805	24,073	18,296	8,579	4,382
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	329,269	199,524	51,264	15,685	8,013	1,400	76
23 Apparel and Other Textile Products	59,022	13,131	9,628	1,605	0	0	0
24 Lumber and Wood Products	527,614	365,653	84,017	39,067	37,978	7,855	0
25 Furniture and Fixtures	255,926	66,925	28,021	7,761	6,711	0	0
26 Paper and Allied Products	340,316	145,198	84,684	41,353	20,161	13,018	7,715
27 Printing and Publishing	281,837	162,668	46,694	3,727	0	0	0
28 Chemicals and Allied Products	441,725	312,013	150,652	61,373	42,188	22,907	10,488
29 Petroleum and Coal Products	249,702	301,564	147,868	48,063	22,115	7,982	3,921
30 Rubber and Misc. Plastics Products	291,858	158,294	83,980	43,333	21,087	3,583	881
31 Leather and Leather Products	30,167	16,592	1,508	0	0	0	0
32 Stone, Clay and Glass Products	124,758	71,507	15,985	1,685	851	0	0
33 Primary Metal Industries	562,893	267,197	109,118	36,177	21,583	17,381	9,377
34 Fabricated Metal Products	653,886	144,267	48,251	9,554	5,778	332	0
35 Industrial Machinery and Equipment	1,701,528	418,924	75,977	4,608	6,800	0	0
36 Electronic and Other Electric Equip.	234,434	92,496	35,997	17,081	740	0	0
37 Transportation Equipment	311,072	203,332	85,345	13,749	5,929	4,267	2,051
38 Instuments and Related Products	437,458	171,646	19,618	140	6,515	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Average Energy - Year 3 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,548	24,748	97,165	214,472	327,171	614,317	1,561,349
21 Tobacco Products							
22 Textile Mill Products	6,084	24,032	48,410	190,083	386,654	874,954	1,620,007
23 Apparel and Other Textile Products	3,256	4,028	73,717	116,361			
24 Lumber and Wood Products	2,768	11,582	46,437	133,080	207,819	325,522	
25 Furniture and Fixtures	2,416	11,536	35,381	47,144	177,941		
26 Paper and Allied Products	5,428	30,764	104,878	323,028	632,725	1,515,051	5,108,301
27 Printing and Publishing	4,299	9,128	43,775	354,118			
28 Chemicals and Allied Products	5,204	28,973	86,470	217,386	485,852	1,136,567	5,661,504
29 Petroleum and Coal Products	2,000	9,397	41,211	125,503	307,795	985,901	4,800,956
30 Rubber and Misc. Plastics Products	5,003	27,655	91,868	240,321	459,510	1,032,547	2,814,007
31 Leather and Leather Products	1,450	24,002	757				
32 Stone, Clay and Glass Products	3,195	12,064	47,876	2,870	372,045		
33 Primary Metal Industries	6,064	22,587	79,613	249,388	520,751	1,014,082	3,702,272
34 Fabricated Metal Products	3,003	11,881	43,043	88,925	76,350	2,009,159	
35 Industrial Machinery and Equipment	1,336	5,624	17,472	17,445	283,185		
36 Electronic and Other Electric Equip.	8,530	35,789	108,540	234,666	899,473		
37 Transportation Equipment	3,994	29,991	55,332	160,452	194,667	1,567,267	3,066,786
38 Instuments and Related Products	3,542	12,775	51,621	106,040	202,726		
39 Misc. Manufacturing Industries							

Industry Groups	Average Efficiency - Year 3 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8125	0.8654	0.8875	0.9123	0.9203	0.9229	0.9163
21 Tobacco Products							
22 Textile Mill Products	0.8106	0.8535	0.8893	0.9038	0.9153	0.9138	0.9148
23 Apparel and Other Textile Products	0.8039	0.8501	0.9025	0.9157			
24 Lumber and Wood Products	0.8681	0.9084	0.9116	0.9348	0.9419	0.9500	
25 Furniture and Fixtures	0.8085	0.8557	0.8796	0.9061	0.9166		
26 Paper and Allied Products	0.8182	0.8657	0.8926	0.9134	0.9185	0.9185	0.9154
27 Printing and Publishing	0.8533	0.8726	0.8911	0.9098			
28 Chemicals and Allied Products	0.8316	0.8787	0.8973	0.9127	0.9218	0.9213	0.9207
29 Petroleum and Coal Products	0.8203	0.8705	0.8824	0.8997	0.9099	0.9113	0.9106
30 Rubber and Misc. Plastics Products	0.8170	0.8651	0.8848	0.9045	0.9149	0.9168	0.8968
31 Leather and Leather Products	0.7887	0.8752	0.8849				
32 Stone, Clay and Glass Products	0.8171	0.8438	0.8720	0.8897	0.9178		
33 Primary Metal Industries	0.8179	0.8609	0.8832	0.9069	0.9132	0.9152	0.9157
34 Fabricated Metal Products	0.8338	0.8783	0.8901	0.9076	0.9337	0.9757	
35 Industrial Machinery and Equipment	0.8047	0.8479	0.8786	0.9105	0.9199		
36 Electronic and Other Electric Equip.	0.8222	0.8574	0.8911	0.9003	0.9195		
37 Transportation Equipment	0.8126	0.8667	0.8787	0.8986	0.9101	0.9141	0.9104
38 Instuments and Related Products	0.8255	0.8676	0.9011	0.9115	0.9164		
39 Misc. Manufacturing Industries							

Industry Groups	Adjusted Energy - Year 3 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,526	24,487	96,261	212,752	325,777	613,542	1,561,349
21 Tobacco Products							
22 Textile Mill Products	6,070	23,932	48,060	188,250	383,810	861,996	1,592,386
23 Apparel and Other Textile Products	3,256	3,970	73,088	116,361			
24 Lumber and Wood Products	2,766	11,550	46,215	132,595	207,271	325,522	
25 Furniture and Fixtures	2,413	11,522	35,239	46,635	176,748		
26 Paper and Allied Products	5,406	30,554	104,061	320,107	626,731	1,501,512	5,074,619
27 Printing and Publishing	4,289	9,112	43,678	354,118			
28 Chemicals and Allied Products	5,159	28,636	85,679	215,493	480,423	1,125,634	5,619,983
29 Petroleum and Coal Products	1,984	9,293	40,833	124,390	303,607	968,728	4,722,828
30 Rubber and Misc. Plastics Products	4,981	27,384	91,151	237,366	457,841	1,021,684	2,814,007
31 Leather and Leather Products	1,442	23,870	744				
32 Stone, Clay and Glass Products	3,186	11,984	47,562	2,822	365,702		
33 Primary Metal Industries	6,039	22,431	78,968	247,883	517,519	1,006,075	3,687,153
34 Fabricated Metal Products	2,978	11,852	42,812	88,183	75,884	1,974,903	
35 Industrial Machinery and Equipment	1,334	5,596	17,352	17,445	282,381		
36 Electronic and Other Electric Equip.	8,416	35,436	106,722	230,045	884,137		
37 Transportation Equipment	3,965	29,690	54,985	159,653	191,701	1,552,994	3,057,168
38 Instuments and Related Products	3,523	12,748	51,277	104,232	202,355		
39 Misc. Manufacturing Industries							

Applicability - Percent Pumps

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	15.04%	44.70%	28.40%	28.16%	15.00%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	4.35%	10.14%	26.38%	22.80%	13.86%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	0.00%	0.00%	0.00%			
24 Lumber and Wood Products	1.87%	5.41%	10.14%	12.11%	0.44%	0.00%	
25 Furniture and Fixtures	4.08%	1.51%	4.05%	25.55%	0.00%		
26 Paper and Allied Products	15.46%	25.50%	31.43%	34.84%	40.08%	40.94%	21.10%
27 Printing and Publishing	0.99%	1.81%	0.00%	0.00%			
28 Chemicals and Allied Products	39.61%	53.18%	37.53%	28.65%	37.45%	33.94%	9.69%
29 Petroleum and Coal Products	34.10%	52.54%	36.08%	38.47%	63.37%	81.64%	63.21%
30 Rubber and Misc. Plastics Products	16.12%	35.63%	28.40%	53.55%	4.42%	0.00%	0.00%
31 Leather and Leather Products	20.00%	0.00%	0.00%				
32 Stone, Clay and Glass Products	9.55%	10.53%	0.00%	0.00%	0.00%		
33 Primary Metal Industries	13.88%	22.72%	28.12%	24.91%	17.68%	4.57%	0.93%
34 Fabricated Metal Products	29.62%	6.91%	2.90%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	3.75%	7.97%	28.93%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	61.32%	47.03%	47.29%	86.65%	0.00%		
37 Transportation Equipment	32.86%	36.21%	12.08%	14.86%	38.30%	0.00%	0.00%
38 Instuments and Related Products	21.04%	4.41%	0.00%	0.00%	0.00%		
39 Misc. Manufacturing Industries							

Applicability - Percent Fans

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	11.07%	20.89%	11.30%	9.05%	1.62%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	17.24%	15.46%	20.91%	18.87%	7.85%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	12.22%	0.00%	0.00%			
24 Lumber and Wood Products	5.67%	12.86%	13.42%	4.78%	9.86%	0.00%	
25 Furniture and Fixtures	7.01%	16.81%	26.01%	29.28%	64.59%		
26 Paper and Allied Products	12.96%	17.60%	10.39%	8.99%	14.17%	4.26%	24.48%
27 Printing and Publishing	6.06%	4.25%	9.87%	0.00%			
28 Chemicals and Allied Products	9.97%	7.96%	11.00%	17.24%	20.88%	12.10%	6.22%
29 Petroleum and Coal Products	19.59%	4.37%	7.79%	14.03%	12.26%	2.09%	3.66%
30 Rubber and Misc. Plastics Products	14.21%	12.74%	6.53%	0.72%	6.47%	3.41%	0.00%
31 Leather and Leather Products	20.00%	100.00%	0.00%				
32 Stone, Clay and Glass Products	18.02%	32.32%	21.18%	0.00%	0.00%		
33 Primary Metal Industries	12.22%	16.44%	20.92%	5.35%	19.76%	6.67%	15.57%
34 Fabricated Metal Products	19.12%	4.09%	1.53%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	1.74%	11.70%	0.00%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	14.49%	7.70%	2.22%	0.00%	0.00%		
37 Transportation Equipment	7.34%	39.03%	16.40%	17.61%	20.63%	1.63%	3.39%
38 Instuments and Related Products	8.12%	20.98%	0.36%	0.00%	33.33%		
39 Misc. Manufacturing Industries							

Applicability - Percent Compressors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	2.69%	2.28%	17.42%	10.94%	6.78%	7.40%	0.00%
21 Tobacco Products							
22 Textile Mill Products	3.15%	7.41%	4.51%	23.59%	24.27%	47.29%	100.00%
23 Apparel and Other Textile Products	0.00%	81.67%	50.00%	0.00%			
24 Lumber and Wood Products	0.75%	5.64%	11.67%	5.55%	11.77%	0.00%	
25 Furniture and Fixtures	0.83%	0.00%	10.36%	23.77%	18.48%		
26 Paper and Allied Products	1.51%	4.33%	5.26%	9.07%	3.74%	2.78%	5.90%
27 Printing and Publishing	10.83%	6.64%	9.87%	0.00%			
28 Chemicals and Allied Products	1.20%	3.02%	5.82%	11.74%	14.66%	12.50%	29.58%
29 Petroleum and Coal Products	1.84%	1.58%	8.74%	2.13%	1.14%	5.25%	19.75%
30 Rubber and Misc. Plastics Products	2.94%	11.27%	10.15%	8.76%	14.00%	60.60%	0.00%
31 Leather and Leather Products	0.00%	0.00%	100.00%				
32 Stone, Clay and Glass Products	0.00%	15.96%	31.62%	100.00%	100.00%		
33 Primary Metal Industries	3.36%	8.50%	7.62%	4.30%	9.19%	38.77%	17.84%
34 Fabricated Metal Products	6.00%	4.45%	27.64%	48.92%	35.83%	100.00%	
35 Industrial Machinery and Equipment	2.42%	15.55%	6.16%	0.00%	16.67%		
36 Electronic and Other Electric Equip.	1.68%	0.00%	41.78%	13.35%	100.00%		
37 Transportation Equipment	0.44%	3.42%	17.27%	6.01%	37.54%	52.89%	17.30%
38 Instuments and Related Products	3.25%	0.24%	38.93%	100.00%	0.00%		
39 Misc. Manufacturing Industries							

Savings Fraction - Pumps

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
21 Tobacco Products							
22 Textile Mill Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
23 Apparel and Other Textile Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
24 Lumber and Wood Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
25 Furniture and Fixtures	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
26 Paper and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
27 Printing and Publishing	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
28 Chemicals and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
29 Petroleum and Coal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
30 Rubber and Misc. Plastics Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
31 Leather and Leather Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
32 Stone, Clay and Glass Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
33 Primary Metal Industries	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
34 Fabricated Metal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
35 Industrial Machinery and Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
36 Electronic and Other Electric Equip.	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
37 Transportation Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
38 Instuments and Related Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
39 Misc. Manufacturing Industries							

Savings Fraction - Fans

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
21 Tobacco Products							
22 Textile Mill Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
23 Apparel and Other Textile Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
24 Lumber and Wood Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
25 Furniture and Fixtures	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
26 Paper and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
27 Printing and Publishing	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
28 Chemicals and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
29 Petroleum and Coal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
30 Rubber and Misc. Plastics Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
31 Leather and Leather Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
32 Stone, Clay and Glass Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
33 Primary Metal Industries	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
34 Fabricated Metal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
35 Industrial Machinery and Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
36 Electronic and Other Electric Equip.	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
37 Transportation Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
38 Instuments and Related Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
39 Misc. Manufacturing Industries							

Savings Fraction - Compressors

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
21 Tobacco Products							
22 Textile Mill Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
23 Apparel and Other Textile Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
24 Lumber and Wood Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
25 Furniture and Fixtures	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
26 Paper and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
27 Printing and Publishing	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
28 Chemicals and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
29 Petroleum and Coal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
30 Rubber and Misc. Plastics Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
31 Leather and Leather Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
32 Stone, Clay and Glass Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
33 Primary Metal Industries	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
34 Fabricated Metal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
35 Industrial Machinery and Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
36 Electronic and Other Electric Equip.	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
37 Transportation Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
38 Instuments and Related Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
39 Misc. Manufacturing Industries							

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Overall Savings - Year 3

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.41%	1.05%	0.93%	0.80%	0.43%	0.13%	0.00%
21 Tobacco Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22 Textile Mill Products	0.24%	0.42%	0.72%	0.96%	0.74%	1.48%	1.71%
23 Apparel and Other Textile Products	0.00%	1.46%	0.85%	0.00%	0.00%	0.00%	0.00%
24 Lumber and Wood Products	0.08%	0.28%	0.48%	0.36%	0.26%	0.00%	0.00%
25 Furniture and Fixtures	0.13%	0.12%	0.40%	1.08%	0.67%	0.00%	0.00%
26 Paper and Allied Products	0.41%	0.68%	0.78%	0.90%	0.95%	0.89%	0.66%
27 Printing and Publishing	0.24%	0.17%	0.22%	0.00%	0.00%	0.00%	0.00%
28 Chemicals and Allied Products	0.87%	1.16%	0.91%	0.87%	1.12%	0.96%	0.73%
29 Petroleum and Coal Products	0.82%	1.11%	0.92%	0.89%	1.36%	1.74%	1.63%
30 Rubber and Misc. Plastics Products	0.45%	0.98%	0.78%	1.23%	0.36%	1.05%	0.00%
31 Leather and Leather Products	0.51%	0.55%	1.71%	0.00%	0.00%	0.00%	0.00%
32 Stone, Clay and Glass Products	0.29%	0.66%	0.66%	1.71%	1.71%	0.00%	0.00%
33 Primary Metal Industries	0.40%	0.69%	0.81%	0.60%	0.62%	0.79%	0.41%
34 Fabricated Metal Products	0.80%	0.24%	0.54%	0.83%	0.61%	1.71%	0.00%
35 Industrial Machinery and Equipment	0.13%	0.49%	0.69%	0.00%	0.28%	0.00%	0.00%
36 Electronic and Other Electric Equip.	1.34%	0.99%	1.67%	1.97%	1.71%	0.00%	0.00%
37 Transportation Equipment	0.71%	1.00%	0.63%	0.50%	1.52%	0.91%	0.31%
38 Instuments and Related Products	0.52%	0.21%	0.67%	1.71%	0.18%	0.00%	0.00%
39 Misc. Manufacturing Industries	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Number of Motors - Year 3

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	660,350	226,594	61,805	24,073	18,296	8,579	4,382
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	329,269	199,524	51,264	15,685	8,013	1,400	76
23 Apparel and Other Textile Products	59,022	13,131	9,628	1,605	0	0	0
24 Lumber and Wood Products	527,614	365,653	84,017	39,067	37,978	7,855	0
25 Furniture and Fixtures	255,926	66,925	28,021	7,761	6,711	0	0
26 Paper and Allied Products	340,316	145,198	84,684	41,353	20,161	13,018	7,715
27 Printing and Publishing	281,837	162,668	46,694	3,727	0	0	0
28 Chemicals and Allied Products	441,725	312,013	150,652	61,373	42,188	22,907	10,488
29 Petroleum and Coal Products	249,702	301,564	147,868	48,063	22,115	7,982	3,921
30 Rubber and Misc. Plastics Products	291,858	158,294	83,980	43,333	21,087	3,583	881
31 Leather and Leather Products	30,167	16,592	1,508	0	0	0	0
32 Stone, Clay and Glass Products	124,758	71,507	15,985	1,685	851	0	0
33 Primary Metal Industries	562,893	267,197	109,118	36,177	21,583	17,381	9,377
34 Fabricated Metal Products	653,886	144,267	48,251	9,554	5,778	332	0
35 Industrial Machinery and Equipment	1,701,528	418,924	75,977	4,608	6,800	0	0
36 Electronic and Other Electric Equip.	234,434	92,496	35,997	17,081	740	0	0
37 Transportation Equipment	311,072	203,332	85,345	13,749	5,929	4,267	2,051
38 Instuments and Related Products	437,458	171,646	19,618	140	6,515	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Average Adjusted Energy - Year 3

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,526	24,487	96,261	212,752	325,777	613,542	1,561,349
21 Tobacco Products							
22 Textile Mill Products	6,070	23,932	48,060	188,250	383,810	861,996	1,592,386
23 Apparel and Other Textile Products	3,256	3,970	73,088	116,361			
24 Lumber and Wood Products	2,766	11,550	46,215	132,595	207,271	325,522	
25 Furniture and Fixtures	2,413	11,522	35,239	46,635	176,748		
26 Paper and Allied Products	5,406	30,554	104,061	320,107	626,731	1,501,512	5,074,619
27 Printing and Publishing	4,289	9,112	43,678	354,118			
28 Chemicals and Allied Products	5,159	28,636	85,679	215,493	480,423	1,125,634	5,619,983
29 Petroleum and Coal Products	1,984	9,293	40,833	124,390	303,607	968,728	4,722,828
30 Rubber and Misc. Plastics Products	4,981	27,384	91,151	237,366	457,841	1,021,684	2,814,007
31 Leather and Leather Products	1,442	23,870	744				
32 Stone, Clay and Glass Products	3,186	11,984	47,562	2,822	365,702		
33 Primary Metal Industries	6,039	22,431	78,968	247,883	517,519	1,006,075	3,687,153
34 Fabricated Metal Products	2,978	11,852	42,812	88,183	75,884	1,974,903	
35 Industrial Machinery and Equipment	1,334	5,596	17,352	17,445	282,381		
36 Electronic and Other Electric Equip.	8,416	35,436	106,722	230,045	884,137		
37 Transportation Equipment	3,965	29,690	54,985	159,653	191,701	1,552,994	3,057,168
38 Instuments and Related Products	3,523	12,748	51,277	104,232	202,355		
39 Misc. Manufacturing Industries							

Average Efficiency - Year 3

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8125	0.8654	0.8875	0.9123	0.9203	0.9229	0.9163
21 Tobacco Products							
22 Textile Mill Products	0.8106	0.8535	0.8893	0.9038	0.9153	0.9138	0.9148
23 Apparel and Other Textile Products	0.8039	0.8501	0.9025	0.9157			
24 Lumber and Wood Products	0.8681	0.9084	0.9116	0.9348	0.9419	0.9500	
25 Furniture and Fixtures	0.8085	0.8557	0.8796	0.9061	0.9166		
26 Paper and Allied Products	0.8182	0.8657	0.8926	0.9134	0.9185	0.9185	0.9154
27 Printing and Publishing	0.8533	0.8726	0.8911	0.9098			
28 Chemicals and Allied Products	0.8316	0.8787	0.8973	0.9127	0.9218	0.9213	0.9207
29 Petroleum and Coal Products	0.8203	0.8705	0.8824	0.8997	0.9099	0.9113	0.9106
30 Rubber and Misc. Plastics Products	0.8170	0.8651	0.8848	0.9045	0.9149	0.9168	0.8968
31 Leather and Leather Products	0.7887	0.8752	0.8849				
32 Stone, Clay and Glass Products	0.8171	0.8438	0.8720	0.8897	0.9178		
33 Primary Metal Industries	0.8179	0.8609	0.8832	0.9069	0.9132	0.9152	0.9157
34 Fabricated Metal Products	0.8338	0.8783	0.8901	0.9076	0.9337	0.9757	
35 Industrial Machinery and Equipment	0.8047	0.8479	0.8786	0.9105	0.9199		
36 Electronic and Other Electric Equip.	0.8222	0.8574	0.8911	0.9003	0.9195		
37 Transportation Equipment	0.8126	0.8667	0.8787	0.8986	0.9101	0.9141	0.9104
38 Instuments and Related Products	0.8255	0.8676	0.9011	0.9115	0.9164		
39 Misc. Manufacturing Industries							

Percent of Motors Rewound Upon Failure

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**25.69%**	**48.01%**	**85.13%**	**85.89%**	**83.37%**	**83.37%**	**83.37%**
21 Tobacco Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
22 Textile Mill Products	**44.44%**	**95.97%**	**95.97%**	**96.40%**	**96.40%**	**96.40%**	**96.40%**
23 Apparel and Other Textile Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
24 Lumber and Wood Products	**12.55%**	**69.85%**	**65.81%**	**62.22%**	**99.65%**	**99.65%**	**99.65%**
25 Furniture and Fixtures	**61.19%**	**86.51%**	**95.28%**	**100.00%**	**95.28%**	**95.28%**	**95.28%**
26 Paper and Allied Products	**16.98%**	**66.58%**	**82.53%**	**88.35%**	**90.31%**	**90.31%**	**90.31%**
27 Printing and Publishing	**0.00%**	**50.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
28 Chemicals and Allied Products	**4.35%**	**25.95%**	**77.46%**	**91.82%**	**95.08%**	**95.08%**	**95.08%**
29 Petroleum and Coal Products	**0.00%**	**7.12%**	**70.27%**	**90.15%**	**90.18%**	**90.18%**	**90.18%**
30 Rubber and Misc. Plastics Products	**27.57%**	**67.11%**	**95.82%**	**95.82%**	**96.46%**	**96.46%**	**96.46%**
31 Leather and Leather Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
32 Stone, Clay and Glass Products	**18.80%**	**83.76%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
33 Primary Metal Industries	**11.87%**	**56.02%**	**99.89%**	**95.34%**	**95.34%**	**95.34%**	**95.34%**
34 Fabricated Metal Products	**40.49%**	**64.55%**	**100.00%**	**100.00%**	**0.00%**	**0.00%**	**0.00%**
35 Industrial Machinery and Equipment	**41.52%**	**97.45%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
36 Electronic and Other Electric Equip.	**3.60%**	**80.57%**	**80.57%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
37 Transportation Equipment	**7.79%**	**23.38%**	**77.16%**	**90.85%**	**93.15%**	**93.15%**	**93.15%**
38 Instuments and Related Products	**0.00%**	**0.00%**	**0.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
39 Misc. Manufacturing Industries	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Percent of Motors Retired Upon Failure

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**4.17%**	**4.17%**	**4.17%**	**4.17%**	**4.17%**	**4.17%**	**4.17%**
21 Tobacco Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
22 Textile Mill Products	**6.69%**	**6.69%**	**6.69%**	**6.69%**	**6.69%**	**6.69%**	**6.69%**
23 Apparel and Other Textile Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
24 Lumber and Wood Products	**2.59%**	**2.59%**	**2.59%**	**2.59%**	**2.59%**	**2.59%**	**2.59%**
25 Furniture and Fixtures	**6.54%**	**6.54%**	**6.54%**	**6.54%**	**6.54%**	**6.54%**	**6.54%**
26 Paper and Allied Products	**5.23%**	**5.23%**	**5.23%**	**5.23%**	**5.23%**	**5.23%**	**5.23%**
27 Printing and Publishing	**23.18%**	**23.18%**	**23.18%**	**23.18%**	**23.18%**	**23.18%**	**23.18%**
28 Chemicals and Allied Products	**14.52%**	**14.52%**	**14.52%**	**14.52%**	**14.52%**	**14.52%**	**14.52%**
29 Petroleum and Coal Products	**0.84%**	**0.84%**	**0.84%**	**0.84%**	**0.84%**	**0.84%**	**0.84%**
30 Rubber and Misc. Plastics Products	**2.96%**	**2.96%**	**2.96%**	**2.96%**	**2.96%**	**2.96%**	**2.96%**
31 Leather and Leather Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
32 Stone, Clay and Glass Products	**1.52%**	**1.52%**	**1.52%**	**1.52%**	**1.52%**	**1.52%**	**1.52%**
33 Primary Metal Industries	**5.85%**	**5.85%**	**5.85%**	**5.85%**	**5.85%**	**5.85%**	**5.85%**
34 Fabricated Metal Products	**0.78%**	**0.78%**	**0.78%**	**0.78%**	**0.78%**	**0.78%**	**0.78%**
35 Industrial Machinery and Equipment	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**
36 Electronic and Other Electric Equip.	**3.98%**	**3.98%**	**3.98%**	**3.98%**	**3.98%**	**3.98%**	**3.98%**
37 Transportation Equipment	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**
38 Instuments and Related Products	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**
39 Misc. Manufacturing Industries	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Industry Growth Rate

Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**0.60%**	**0.60%**	**0.60%**	**0.60%**	**0.60%**	**0.60%**	**0.60%**
21 Tobacco Products	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**
22 Textile Mill Products	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**
23 Apparel and Other Textile Products	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**
24 Lumber and Wood Products	**4.22%**	**4.22%**	**4.22%**	**4.22%**	**4.22%**	**4.22%**	**4.22%**
25 Furniture and Fixtures	**2.95%**	**2.95%**	**2.95%**	**2.95%**	**2.95%**	**2.95%**	**2.95%**
26 Paper and Allied Products	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**
27 Printing and Publishing	**1.19%**	**1.19%**	**1.19%**	**1.19%**	**1.19%**	**1.19%**	**1.19%**
28 Chemicals and Allied Products	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**
29 Petroleum and Coal Products	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**
30 Rubber and Misc. Plastics Products	**3.97%**	**3.97%**	**3.97%**	**3.97%**	**3.97%**	**3.97%**	**3.97%**
31 Leather and Leather Products	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**
32 Stone, Clay and Glass Products	**2.24%**	**2.24%**	**2.24%**	**2.24%**	**2.24%**	**2.24%**	**2.24%**
33 Primary Metal Industries	**1.13%**	**1.13%**	**1.13%**	**1.13%**	**1.13%**	**1.13%**	**1.13%**
34 Fabricated Metal Products	**2.54%**	**2.54%**	**2.54%**	**2.54%**	**2.54%**	**2.54%**	**2.54%**
35 Industrial Machinery and Equipmen	**3.29%**	**3.29%**	**3.29%**	**3.29%**	**3.29%**	**3.29%**	**3.29%**
36 Electronic and Other Electric Equip.	**2.65%**	**2.65%**	**2.65%**	**2.65%**	**2.65%**	**2.65%**	**2.65%**
37 Transportation Equipment	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**
38 Instuments and Related Products	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**
39 Misc. Manufacturing Industries	**2.52%**	**2.52%**	**2.52%**	**2.52%**	**2.52%**	**2.52%**	**2.52%**

Industry Groups	Number of Purchased Motors (replaced + additions)						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	31,446	10,790	2,943	1,146	871	408	209
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	20,224	12,255	3,148	964	492	86	5
23 Apparel and Other Textile Products	-509	-113	-83	-14	0	0	0
24 Lumber and Wood Products	35,931	24,901	5,722	2,660	2,586	535	0
25 Furniture and Fixtures	24,278	6,348	2,658	737	637	0	0
26 Paper and Allied Products	17,873	7,626	4,447	2,171	1,059	684	405
27 Printing and Publishing	68,677	39,639	11,378	908	0	0	0
28 Chemicals and Allied Products	62,584	44,206	21,345	8,695	5,977	3,245	1,486
29 Petroleum and Coal Products	-5,899	-7,125	-3,493	-1,135	-522	-189	-93
30 Rubber and Misc. Plastics Products	20,236	10,976	5,823	3,005	1,462	248	61
31 Leather and Leather Products	-1,504	-827	-75	0	0	0	0
32 Stone, Clay and Glass Products	4,685	2,685	600	64	32	0	0
33 Primary Metal Industries	39,265	18,639	7,612	2,524	1,506	1,212	654
34 Fabricated Metal Products	21,696	4,787	1,601	317	192	11	0
35 Industrial Machinery and Equipment	60,828	14,976	2,716	165	243	0	0
36 Electronic and Other Electric Equip.	15,538	6,131	2,386	1,132	49	0	0
37 Transportation Equipment	-4,252	-2,779	-1,166	-188	-81	-58	-28
38 Instuments and Related Products	-9,496	-3,727	-426	-3	-142	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Number of Rewound Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	169,644	108,788	52,615	20,676	15,253	7,152	3,653
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	146,327	191,483	49,198	15,120	7,725	1,350	73
23 Apparel and Other Textile Products	0	0	0	0	0	0	0
24 Lumber and Wood Products	66,216	255,409	55,292	24,307	37,845	7,828	0
25 Furniture and Fixtures	156,601	57,897	26,698	7,761	6,394	0	0
26 Paper and Allied Products	57,786	96,673	69,890	36,535	18,207	11,757	6,967
27 Printing and Publishing	0	81,334	46,694	3,727	0	0	0
28 Chemicals and Allied Products	19,215	80,967	116,695	56,353	40,112	21,780	9,972
29 Petroleum and Coal Products	0	21,471	103,907	43,329	19,943	7,198	3,536
30 Rubber and Misc. Plastics Products	80,465	106,231	80,470	41,522	20,341	3,456	850
31 Leather and Leather Products	0	0	0	0	0	0	0
32 Stone, Clay and Glass Products	23,455	59,894	15,985	1,685	851	0	0
33 Primary Metal Industries	66,815	149,684	108,998	34,491	20,577	16,571	8,940
34 Fabricated Metal Products	264,758	93,124	48,251	9,554	0	0	0
35 Industrial Machinery and Equipment	706,474	408,241	75,977	4,608	6,800	0	0
36 Electronic and Other Electric Equip.	8,440	74,524	29,003	17,081	740	0	0
37 Transportation Equipment	24,233	47,539	65,852	12,491	5,523	3,975	1,911
38 Instuments and Related Products	0	0	0	140	6,515	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Number of Retired Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	27,514	9,441	2,575	1,003	762	357	183
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	22,033	13,351	3,430	1,050	536	94	5
23 Apparel and Other Textile Products	0	0	0	0	0	0	0
24 Lumber and Wood Products	13,684	9,483	2,179	1,013	985	204	0
25 Furniture and Fixtures	16,739	4,377	1,833	508	439	0	0
26 Paper and Allied Products	17,796	7,593	4,428	2,162	1,054	681	403
27 Printing and Publishing	65,322	37,702	10,822	864	0	0	0
28 Chemicals and Allied Products	64,145	45,309	21,877	8,912	6,126	3,326	1,523
29 Petroleum and Coal Products	2,099	2,534	1,243	404	186	67	33
30 Rubber and Misc. Plastics Products	8,648	4,691	2,489	1,284	625	106	26
31 Leather and Leather Products	0	0	0	0	0	0	0
32 Stone, Clay and Glass Products	1,892	1,084	242	26	13	0	0
33 Primary Metal Industries	32,907	15,621	6,379	2,115	1,262	1,016	548
34 Fabricated Metal Products	5,106	1,127	377	75	45	3	0
35 Industrial Machinery and Equipment	4,797	1,181	214	13	19	0	0
36 Electronic and Other Electric Equip.	9,334	3,683	1,433	680	29	0	0
37 Transportation Equipment	3,345	2,187	918	148	64	46	22
38 Instuments and Related Products	4,711	1,848	211	2	70	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Efficiency of New Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**0.8785**	**0.9204**	**0.9390**	**0.9531**	**0.9595**	**0.9620**	**0.9620**
21 Tobacco Products	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
22 Textile Mill Products	**0.8807**	**0.9212**	**0.9381**	**0.9519**	**0.9590**	**0.9620**	**0.9620**
23 Apparel and Other Textile Products	**0.8782**	**0.9170**	**0.9400**	**0.9520**	**0.0000**	**0.0000**	**0.0000**
24 Lumber and Wood Products	**0.8835**	**0.9192**	**0.9394**	**0.9534**	**0.9583**	**0.9620**	**0.0000**
25 Furniture and Fixtures	**0.8799**	**0.9199**	**0.9383**	**0.9529**	**0.9574**	**0.0000**	**0.0000**
26 Paper and Allied Products	**0.8794**	**0.9212**	**0.9392**	**0.9531**	**0.9576**	**0.9620**	**0.9620**
27 Printing and Publishing	**0.8876**	**0.9202**	**0.9372**	**0.9510**	**0.0000**	**0.0000**	**0.0000**
28 Chemicals and Allied Products	**0.8816**	**0.9212**	**0.9394**	**0.9527**	**0.9583**	**0.9620**	**0.9620**
29 Petroleum and Coal Products	**0.8837**	**0.9219**	**0.9391**	**0.9526**	**0.9580**	**0.9620**	**0.9620**
30 Rubber and Misc. Plastics Products	**0.8785**	**0.9208**	**0.9395**	**0.9528**	**0.9579**	**0.9620**	**0.9620**
31 Leather and Leather Products	**0.8650**	**0.9208**	**0.9360**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
32 Stone, Clay and Glass Products	**0.8772**	**0.9195**	**0.9379**	**0.9500**	**0.9540**	**0.0000**	**0.0000**
33 Primary Metal Industries	**0.8809**	**0.9202**	**0.9383**	**0.9530**	**0.9582**	**0.9620**	**0.9620**
34 Fabricated Metal Products	**0.8778**	**0.9207**	**0.9381**	**0.9523**	**0.9580**	**0.9620**	**0.0000**
35 Industrial Machinery and Equipmen	**0.8776**	**0.9195**	**0.9374**	**0.9527**	**0.9553**	**0.0000**	**0.0000**
36 Electronic and Other Electric Equip.	**0.8850**	**0.9206**	**0.9382**	**0.9514**	**0.9620**	**0.0000**	**0.0000**
37 Transportation Equipment	**0.8814**	**0.9224**	**0.9387**	**0.9518**	**0.9559**	**0.9620**	**0.9620**
38 Instuments and Related Products	**0.8829**	**0.9196**	**0.9415**	**0.9540**	**0.9580**	**0.0000**	**0.0000**
39 Misc. Manufacturing Industries	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Industry Groups	Efficiency of Rewound Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**0.8025**	**0.8554**	**0.8775**	**0.9023**	**0.9103**	**0.9129**	**0.9063**
21 Tobacco Products							
22 Textile Mill Products	**0.8006**	**0.8435**	**0.8793**	**0.8938**	**0.9053**	**0.9038**	**0.9048**
23 Apparel and Other Textile Products	**0.7939**	**0.8401**	**0.8925**	**0.9057**			
24 Lumber and Wood Products	**0.8581**	**0.8984**	**0.9016**	**0.9248**	**0.9319**	**0.9400**	
25 Furniture and Fixtures	**0.7985**	**0.8457**	**0.8696**	**0.8961**	**0.9066**		
26 Paper and Allied Products	**0.8082**	**0.8557**	**0.8826**	**0.9034**	**0.9085**	**0.9085**	**0.9054**
27 Printing and Publishing	**0.8433**	**0.8626**	**0.8811**	**0.8998**			
28 Chemicals and Allied Products	**0.8216**	**0.8687**	**0.8873**	**0.9027**	**0.9118**	**0.9113**	**0.9107**
29 Petroleum and Coal Products	**0.8103**	**0.8605**	**0.8724**	**0.8897**	**0.8999**	**0.9013**	**0.9006**
30 Rubber and Misc. Plastics Products	**0.8070**	**0.8551**	**0.8748**	**0.8945**	**0.9049**	**0.9068**	**0.8868**
31 Leather and Leather Products	**0.7787**	**0.8652**	**0.8749**				
32 Stone, Clay and Glass Products	**0.8071**	**0.8338**	**0.8620**	**0.8797**	**0.9078**		
33 Primary Metal Industries	**0.8079**	**0.8509**	**0.8732**	**0.8969**	**0.9032**	**0.9052**	**0.9057**
34 Fabricated Metal Products	**0.8238**	**0.8683**	**0.8801**	**0.8976**	**0.9237**	**0.9657**	
35 Industrial Machinery and Equipmen	**0.7947**	**0.8379**	**0.8686**	**0.9005**	**0.9099**		
36 Electronic and Other Electric Equip.	**0.8122**	**0.8474**	**0.8811**	**0.8903**	**0.9095**		
37 Transportation Equipment	**0.8026**	**0.8567**	**0.8687**	**0.8886**	**0.9001**	**0.9041**	**0.9004**
38 Instuments and Related Products	**0.8155**	**0.8576**	**0.8911**	**0.9015**	**0.9064**		
39 Misc. Manufacturing Industries							

Industry Groups	Average Energy of New Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,111	23,023	90,980	203,641	312,463	588,616	1,487,224
21 Tobacco Products							
22 Textile Mill Products	5,586	22,174	45,558	178,741	366,303	818,782	1,514,230
23 Apparel and Other Textile Products	2,981	3,680	70,171	111,926			
24 Lumber and Wood Products	2,718	11,414	44,849	130,003	203,728	321,463	
25 Furniture and Fixtures	2,217	10,718	33,035	44,346	169,220		
26 Paper and Allied Products	5,030	28,713	98,899	306,759	601,137	1,433,668	4,828,604
27 Printing and Publishing	4,123	8,640	41,531	338,774			
28 Chemicals and Allied Products	4,866	27,315	81,835	206,448	462,135	1,078,062	5,378,508
29 Petroleum and Coal Products	1,841	8,775	38,367	117,483	288,378	917,663	4,470,252
30 Rubber and Misc. Plastics Products	4,632	25,727	85,844	225,344	437,279	973,688	2,623,194
31 Leather and Leather Products	1,315	22,687	704				
32 Stone, Clay and Glass Products	2,968	10,998	44,220	2,643	351,806		
33 Primary Metal Industries	5,607	20,985	74,330	235,887	493,192	957,081	3,509,603
34 Fabricated Metal Products	2,829	11,306	40,623	84,047	73,962	2,002,959	
35 Industrial Machinery and Equipment	1,223	5,160	16,264	16,672	271,917		
36 Electronic and Other Electric Equip.	7,819	33,002	101,364	217,679	845,102		
37 Transportation Equipment	3,656	27,896	51,469	150,732	182,515	1,475,624	2,893,192
38 Instuments and Related Products	3,294	12,027	49,076	99,587	193,573		
39 Misc. Manufacturing Industries							

Industry Groups	Average Energy of Rewound Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,594	24,774	97,358	215,110	329,356	620,263	1,578,576
21 Tobacco Products							
22 Textile Mill Products	6,145	24,215	48,607	190,356	388,050	871,534	1,609,986
23 Apparel and Other Textile Products	3,297	4,017	73,907	117,646			
24 Lumber and Wood Products	2,798	11,679	46,728	134,029	209,495	328,985	
25 Furniture and Fixtures	2,443	11,658	35,645	47,155	178,697		
26 Paper and Allied Products	5,473	30,911	105,240	323,650	633,630	1,518,038	5,130,670
27 Printing and Publishing	4,340	9,217	44,173	358,054			
28 Chemicals and Allied Products	5,221	28,965	86,645	217,880	485,691	1,137,986	5,681,696
29 Petroleum and Coal Products	2,008	9,401	41,301	125,788	306,980	979,476	4,775,272
30 Rubber and Misc. Plastics Products	5,042	27,704	92,193	240,020	462,901	1,032,951	2,845,741
31 Leather and Leather Products	1,461	24,145	753				
32 Stone, Clay and Glass Products	3,225	12,128	48,114	2,854	369,731		
33 Primary Metal Industries	6,114	22,695	79,872	250,647	523,249	1,017,190	3,727,864
34 Fabricated Metal Products	3,015	11,989	43,298	89,166	76,706	1,995,354	
35 Industrial Machinery and Equipment	1,351	5,663	17,551	17,639	285,484		
36 Electronic and Other Electric Equip.	8,520	35,854	107,933	232,629	893,857		
37 Transportation Equipment	4,015	30,037	55,618	161,449	193,831	1,570,172	3,091,121
38 Instuments and Related Products	3,567	12,897	51,853	105,389	204,587		
39 Misc. Manufacturing Industries							

Industry Groups	Number of Motors - Year 4 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	664,282	227,943	62,173	24,216	18,405	8,630	4,408
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	327,460	198,428	50,982	15,599	7,969	1,392	76
23 Apparel and Other Textile Products	58,513	13,018	9,545	1,591	0	0	0
24 Lumber and Wood Products	549,861	381,071	87,560	40,714	39,579	8,186	0
25 Furniture and Fixtures	263,465	68,896	28,846	7,990	6,909	0	0
26 Paper and Allied Products	340,393	145,231	84,703	41,362	20,166	13,021	7,717
27 Printing and Publishing	285,192	164,605	47,250	3,771	0	0	0
28 Chemicals and Allied Products	440,164	310,910	150,120	61,156	42,039	22,826	10,451
29 Petroleum and Coal Products	241,704	291,905	143,132	46,524	21,407	7,726	3,795
30 Rubber and Misc. Plastics Products	303,446	164,579	87,314	45,054	21,924	3,725	916
31 Leather and Leather Products	28,663	15,765	1,433	0	0	0	0
32 Stone, Clay and Glass Products	127,551	73,108	16,343	1,723	870	0	0
33 Primary Metal Industries	569,251	270,215	110,351	36,586	21,827	17,577	9,483
34 Fabricated Metal Products	670,476	147,927	49,475	9,796	5,925	340	0
35 Industrial Machinery and Equipment	1,757,559	432,719	78,479	4,760	7,024	0	0
36 Electronic and Other Electric Equip.	240,638	94,944	36,950	17,533	760	0	0
37 Transportation Equipment	303,475	198,366	83,261	13,413	5,784	4,163	2,001
38 Instuments and Related Products	423,251	166,071	18,981	135	6,303	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Average Energy - Year 4 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,523	24,555	96,940	214,334	328,113	617,934	1,572,111
21 Tobacco Products							
22 Textile Mill Products	6,074	24,097	48,433	189,704	386,840	868,576	1,604,149
23 Apparel and Other Textile Products	3,258	3,972	73,113	116,400			
24 Lumber and Wood Products	2,766	11,627	46,450	133,282	209,166	328,568	
25 Furniture and Fixtures	2,413	11,562	35,411	46,929	177,858		
26 Paper and Allied Products	5,398	30,695	104,763	322,536	631,616	1,512,870	5,112,311
27 Printing and Publishing	4,249	9,051	43,651	354,313			
28 Chemicals and Allied Products	5,120	28,534	85,883	216,407	482,850	1,130,657	5,644,533
29 Petroleum and Coal Products	1,987	9,314	41,233	125,861	307,121	979,991	4,777,882
30 Rubber and Misc. Plastics Products	4,974	27,480	91,758	239,010	461,164	1,028,942	2,830,747
31 Leather and Leather Products	1,449	23,932	746				
32 Stone, Clay and Glass Products	3,185	12,066	47,979	2,846	369,132		
33 Primary Metal Industries	6,018	22,477	79,541	249,661	521,243	1,013,176	3,713,288
34 Fabricated Metal Products	2,988	11,921	43,216	89,008	75,822	1,975,811	
35 Industrial Machinery and Equipment	1,337	5,644	17,507	17,606	285,023		
36 Electronic and Other Electric Equip.	8,381	35,607	107,326	231,764	891,085		
37 Transportation Equipment	3,974	29,799	55,535	161,451	193,863	1,570,474	3,091,889
38 Instuments and Related Products	3,528	12,764	51,327	105,535	204,860		
39 Misc. Manufacturing Industries							

Industry Groups	Average Efficiency - Year 4 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8128	0.8630	0.8813	0.9056	0.9137	0.9164	0.9101
21 Tobacco Products							
22 Textile Mill Products	0.8100	0.8477	0.8824	0.8969	0.9081	0.9069	0.9081
23 Apparel and Other Textile Products	0.8033	0.8496	0.9022	0.9154			
24 Lumber and Wood Products	0.8679	0.9024	0.9070	0.9299	0.9334	0.9412	
25 Furniture and Fixtures	0.8085	0.8527	0.8753	0.9005	0.9109		
26 Paper and Allied Products	0.8195	0.8617	0.8866	0.9065	0.9114	0.9116	0.9086
27 Printing and Publishing	0.8613	0.8785	0.8917	0.9093			
28 Chemicals and Allied Products	0.8379	0.8819	0.8951	0.9089	0.9172	0.9173	0.9167
29 Petroleum and Coal Products	0.8189	0.8686	0.8738	0.8892	0.8995	0.9008	0.9001
30 Rubber and Misc. Plastics Products	0.8181	0.8620	0.8790	0.8983	0.9083	0.9103	0.8915
31 Leather and Leather Products	0.7851	0.8729	0.8824				
32 Stone, Clay and Glass Products	0.8173	0.8381	0.8644	0.8820	0.9092		
33 Primary Metal Industries	0.8208	0.8591	0.8768	0.9004	0.9066	0.9087	0.9092
34 Fabricated Metal Products	0.8312	0.8732	0.8818	0.8992	0.9345	0.9752	
35 Industrial Machinery and Equipment	0.8030	0.8407	0.8708	0.9022	0.9114		
36 Electronic and Other Electric Equip.	0.8256	0.8533	0.8861	0.8936	0.9124		
37 Transportation Equipment	0.8109	0.8635	0.8700	0.8886	0.8999	0.9039	0.9002
38 Instuments and Related Products	0.8243	0.8665	0.9002	0.9002	0.9052		
39 Misc. Manufacturing Industries							

Industry Groups	Adjusted Energy - Year 4 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,501	24,296	96,038	212,614	326,715	617,155	1,572,111
21 Tobacco Products							
22 Textile Mill Products	6,059	23,997	48,083	187,875	383,994	855,713	1,576,798
23 Apparel and Other Textile Products	3,258	3,914	72,490	116,400			
24 Lumber and Wood Products	2,764	11,595	46,228	132,796	208,614	328,568	
25 Furniture and Fixtures	2,410	11,548	35,269	46,422	176,666		
26 Paper and Allied Products	5,376	30,485	103,947	319,619	625,632	1,499,350	5,078,603
27 Printing and Publishing	4,239	9,035	43,553	354,313			
28 Chemicals and Allied Products	5,075	28,202	85,098	214,522	477,453	1,119,781	5,603,137
29 Petroleum and Coal Products	1,971	9,211	40,855	124,745	302,942	962,921	4,700,129
30 Rubber and Misc. Plastics Products	4,951	27,212	91,042	236,071	459,490	1,018,117	2,830,747
31 Leather and Leather Products	1,442	23,800	734				
32 Stone, Clay and Glass Products	3,176	11,986	47,665	2,798	362,838		
33 Primary Metal Industries	5,994	22,322	78,897	248,155	518,008	1,005,176	3,698,124
34 Fabricated Metal Products	2,964	11,892	42,983	88,265	75,359	1,942,123	
35 Industrial Machinery and Equipment	1,336	5,616	17,387	17,606	284,213		
36 Electronic and Other Electric Equip.	8,269	35,255	105,529	227,200	875,892		
37 Transportation Equipment	3,946	29,500	55,187	160,647	190,910	1,556,173	3,082,192
38 Instuments and Related Products	3,510	12,738	50,985	103,735	204,484		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Pumps 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	15.04%	44.70%	28.40%	28.16%	15.00%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	4.35%	10.14%	26.38%	22.80%	13.86%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	0.00%	0.00%	0.00%			
24 Lumber and Wood Products	1.87%	5.41%	10.14%	12.11%	0.44%	0.00%	
25 Furniture and Fixtures	4.08%	1.51%	4.05%	25.55%	0.00%		
26 Paper and Allied Products	15.46%	25.50%	31.43%	34.84%	40.08%	40.94%	21.10%
27 Printing and Publishing	0.99%	1.81%	0.00%	0.00%			
28 Chemicals and Allied Products	39.61%	53.18%	37.53%	28.65%	37.45%	33.94%	9.69%
29 Petroleum and Coal Products	34.10%	52.54%	36.08%	38.47%	63.37%	81.64%	63.21%
30 Rubber and Misc. Plastics Products	16.12%	35.63%	28.40%	53.55%	4.42%	0.00%	0.00%
31 Leather and Leather Products	20.00%	0.00%	0.00%				
32 Stone, Clay and Glass Products	9.55%	10.53%	0.00%	0.00%	0.00%		
33 Primary Metal Industries	13.88%	22.72%	28.12%	24.91%	17.68%	4.57%	0.93%
34 Fabricated Metal Products	29.62%	6.91%	2.90%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	3.75%	7.97%	28.93%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	61.32%	47.03%	47.29%	86.65%	0.00%		
37 Transportation Equipment	32.86%	36.21%	12.08%	14.86%	38.30%	0.00%	0.00%
38 Instuments and Related Products	21.04%	4.41%	0.00%	0.00%	0.00%		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Fans 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	11.07%	20.89%	11.30%	9.05%	1.62%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	17.24%	15.46%	20.91%	18.87%	7.85%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	12.22%	0.00%	0.00%			
24 Lumber and Wood Products	5.67%	12.86%	13.42%	4.78%	9.86%	0.00%	
25 Furniture and Fixtures	7.01%	16.81%	26.01%	29.28%	64.59%		
26 Paper and Allied Products	12.96%	17.60%	10.39%	8.99%	14.17%	4.26%	24.48%
27 Printing and Publishing	6.06%	4.25%	9.87%	0.00%			
28 Chemicals and Allied Products	9.97%	7.96%	11.00%	17.24%	20.88%	12.10%	6.22%
29 Petroleum and Coal Products	19.59%	4.37%	7.79%	14.03%	12.26%	2.09%	3.66%
30 Rubber and Misc. Plastics Products	14.21%	12.74%	6.53%	0.72%	6.47%	3.41%	0.00%
31 Leather and Leather Products	20.00%	100.00%	0.00%				
32 Stone, Clay and Glass Products	18.02%	32.32%	21.18%	0.00%	0.00%		
33 Primary Metal Industries	12.22%	16.44%	20.92%	5.35%	19.76%	6.67%	15.57%
34 Fabricated Metal Products	19.12%	4.09%	1.53%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	1.74%	11.70%	0.00%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	14.49%	7.70%	2.22%	0.00%	0.00%		
37 Transportation Equipment	7.34%	39.03%	16.40%	17.61%	20.63%	1.63%	3.39%
38 Instuments and Related Products	8.12%	20.98%	0.36%	0.00%	33.33%		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Compressors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	2.69%	2.28%	17.42%	10.94%	6.78%	7.40%	0.00%
21 Tobacco Products							
22 Textile Mill Products	3.15%	7.41%	4.51%	23.59%	24.27%	47.29%	100.00%
23 Apparel and Other Textile Products	0.00%	81.67%	50.00%	0.00%			
24 Lumber and Wood Products	0.75%	5.64%	11.67%	5.55%	11.77%	0.00%	
25 Furniture and Fixtures	0.83%	0.00%	10.36%	23.77%	18.48%		
26 Paper and Allied Products	1.51%	4.33%	5.26%	9.07%	3.74%	2.78%	5.90%
27 Printing and Publishing	10.83%	6.64%	9.87%	0.00%			
28 Chemicals and Allied Products	1.20%	3.02%	5.82%	11.74%	14.66%	12.50%	29.58%
29 Petroleum and Coal Products	1.84%	1.58%	8.74%	2.13%	1.14%	5.25%	19.75%
30 Rubber and Misc. Plastics Products	2.94%	11.27%	10.15%	8.76%	14.00%	60.60%	0.00%
31 Leather and Leather Products	0.00%	0.00%	100.00%				
32 Stone, Clay and Glass Products	0.00%	15.96%	31.62%	100.00%	100.00%		
33 Primary Metal Industries	3.36%	8.50%	7.62%	4.30%	9.19%	38.77%	17.84%
34 Fabricated Metal Products	6.00%	4.45%	27.64%	48.92%	35.83%	100.00%	
35 Industrial Machinery and Equipment	2.42%	15.55%	6.16%	0.00%	16.67%		
36 Electronic and Other Electric Equip.	1.68%	0.00%	41.78%	13.35%	100.00%		
37 Transportation Equipment	0.44%	3.42%	17.27%	6.01%	37.54%	52.89%	17.30%
38 Instuments and Related Products	3.25%	0.24%	38.93%	100.00%	0.00%		
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Pumps 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
21 Tobacco Products							
22 Textile Mill Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
23 Apparel and Other Textile Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
24 Lumber and Wood Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
25 Furniture and Fixtures	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
26 Paper and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
27 Printing and Publishing	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
28 Chemicals and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
29 Petroleum and Coal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
30 Rubber and Misc. Plastics Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
31 Leather and Leather Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
32 Stone, Clay and Glass Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
33 Primary Metal Industries	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
34 Fabricated Metal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
35 Industrial Machinery and Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
36 Electronic and Other Electric Equip.	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
37 Transportation Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
38 Instuments and Related Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Fans 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
21 Tobacco Products							
22 Textile Mill Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
23 Apparel and Other Textile Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
24 Lumber and Wood Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
25 Furniture and Fixtures	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
26 Paper and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
27 Printing and Publishing	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
28 Chemicals and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
29 Petroleum and Coal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
30 Rubber and Misc. Plastics Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
31 Leather and Leather Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
32 Stone, Clay and Glass Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
33 Primary Metal Industries	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
34 Fabricated Metal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
35 Industrial Machinery and Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
36 Electronic and Other Electric Equip.	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
37 Transportation Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
38 Instuments and Related Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Compressors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
21 Tobacco Products							
22 Textile Mill Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
23 Apparel and Other Textile Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
24 Lumber and Wood Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
25 Furniture and Fixtures	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
26 Paper and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
27 Printing and Publishing	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
28 Chemicals and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
29 Petroleum and Coal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
30 Rubber and Misc. Plastics Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
31 Leather and Leather Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
32 Stone, Clay and Glass Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
33 Primary Metal Industries	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
34 Fabricated Metal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
35 Industrial Machinery and Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
36 Electronic and Other Electric Equip.	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
37 Transportation Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
38 Instuments and Related Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
39 Misc. Manufacturing Industries							

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Industry Groups	Overall Savings - Year 3 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.41%	1.05%	0.93%	0.80%	0.43%	0.13%	0.00%
21 Tobacco Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22 Textile Mill Products	0.24%	0.42%	0.72%	0.96%	0.74%	1.48%	1.71%
23 Apparel and Other Textile Products	0.00%	1.46%	0.85%	0.00%	0.00%	0.00%	0.00%
24 Lumber and Wood Products	0.08%	0.28%	0.48%	0.36%	0.26%	0.00%	0.00%
25 Furniture and Fixtures	0.13%	0.12%	0.40%	1.08%	0.67%	0.00%	0.00%
26 Paper and Allied Products	0.41%	0.68%	0.78%	0.90%	0.95%	0.89%	0.66%
27 Printing and Publishing	0.24%	0.17%	0.22%	0.00%	0.00%	0.00%	0.00%
28 Chemicals and Allied Products	0.87%	1.16%	0.91%	0.87%	1.12%	0.96%	0.73%
29 Petroleum and Coal Products	0.82%	1.11%	0.92%	0.89%	1.36%	1.74%	1.63%
30 Rubber and Misc. Plastics Products	0.45%	0.98%	0.78%	1.23%	0.36%	1.05%	0.00%
31 Leather and Leather Products	0.51%	0.55%	1.71%	0.00%	0.00%	0.00%	0.00%
32 Stone, Clay and Glass Products	0.29%	0.66%	0.66%	1.71%	1.71%	0.00%	0.00%
33 Primary Metal Industries	0.40%	0.69%	0.81%	0.60%	0.62%	0.79%	0.41%
34 Fabricated Metal Products	0.80%	0.24%	0.54%	0.83%	0.61%	1.71%	0.00%
35 Industrial Machinery and Equipment	0.13%	0.49%	0.69%	0.00%	0.28%	0.00%	0.00%
36 Electronic and Other Electric Equip.	1.34%	0.99%	1.67%	1.97%	1.71%	0.00%	0.00%
37 Transportation Equipment	0.71%	1.00%	0.63%	0.50%	1.52%	0.91%	0.31%
38 Instuments and Related Products	0.52%	0.21%	0.67%	1.71%	0.18%	0.00%	0.00%
39 Misc. Manufacturing Industries	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Industry Groups	Number of Motors - Year 4 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	664,282	227,943	62,173	24,216	18,405	8,630	4,408
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	327,460	198,428	50,982	15,599	7,969	1,392	76
23 Apparel and Other Textile Products	58,513	13,018	9,545	1,591	0	0	0
24 Lumber and Wood Products	549,861	381,071	87,560	40,714	39,579	8,186	0
25 Furniture and Fixtures	263,465	68,896	28,846	7,990	6,909	0	0
26 Paper and Allied Products	340,393	145,231	84,703	41,362	20,166	13,021	7,717
27 Printing and Publishing	285,192	164,605	47,250	3,771	0	0	0
28 Chemicals and Allied Products	440,164	310,910	150,120	61,156	42,039	22,826	10,451
29 Petroleum and Coal Products	241,704	291,905	143,132	46,524	21,407	7,726	3,795
30 Rubber and Misc. Plastics Products	303,446	164,579	87,314	45,054	21,924	3,725	916
31 Leather and Leather Products	28,663	15,765	1,433	0	0	0	0
32 Stone, Clay and Glass Products	127,551	73,108	16,343	1,723	870	0	0
33 Primary Metal Industries	569,251	270,215	110,351	36,586	21,827	17,577	9,483
34 Fabricated Metal Products	670,476	147,927	49,475	9,796	5,925	340	0
35 Industrial Machinery and Equipment	1,757,559	432,719	78,479	4,760	7,024	0	0
36 Electronic and Other Electric Equip.	240,638	94,944	36,950	17,533	760	0	0
37 Transportation Equipment	303,475	198,366	83,261	13,413	5,784	4,163	2,001
38 Instuments and Related Products	423,251	166,071	18,981	135	6,303	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Average Adjusted Energy - Year 4 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,501	24,296	96,038	212,614	326,715	617,155	1,572,111
21 Tobacco Products							
22 Textile Mill Products	6,059	23,997	48,083	187,875	383,994	855,713	1,576,798
23 Apparel and Other Textile Products	3,258	3,914	72,490	116,400			
24 Lumber and Wood Products	2,764	11,595	46,228	132,796	208,614	328,568	
25 Furniture and Fixtures	2,410	11,548	35,269	46,422	176,666		
26 Paper and Allied Products	5,376	30,485	103,947	319,619	625,632	1,499,350	5,078,603
27 Printing and Publishing	4,239	9,035	43,553	354,313			
28 Chemicals and Allied Products	5,075	28,202	85,098	214,522	477,453	1,119,781	5,603,137
29 Petroleum and Coal Products	1,971	9,211	40,855	124,745	302,942	962,921	4,700,129
30 Rubber and Misc. Plastics Products	4,951	27,212	91,042	236,071	459,490	1,018,117	2,830,747
31 Leather and Leather Products	1,442	23,800	734				
32 Stone, Clay and Glass Products	3,176	11,986	47,665	2,798	362,838		
33 Primary Metal Industries	5,994	22,322	78,897	248,155	518,008	1,005,176	3,698,124
34 Fabricated Metal Products	2,964	11,892	42,983	88,265	75,359	1,942,123	
35 Industrial Machinery and Equipment	1,336	5,616	17,387	17,606	284,213		
36 Electronic and Other Electric Equip.	8,269	35,255	105,529	227,200	875,892		
37 Transportation Equipment	3,946	29,500	55,187	160,647	190,910	1,556,173	3,082,192
38 Instuments and Related Products	3,510	12,738	50,985	103,735	204,484		
39 Misc. Manufacturing Industries							

Industry Groups	Average Efficiency - Year 4 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8128	0.8630	0.8813	0.9056	0.9137	0.9164	0.9101
21 Tobacco Products							
22 Textile Mill Products	0.8100	0.8477	0.8824	0.8969	0.9081	0.9069	0.9081
23 Apparel and Other Textile Products	0.8033	0.8496	0.9022	0.9154			
24 Lumber and Wood Products	0.8679	0.9024	0.9070	0.9299	0.9334	0.9412	
25 Furniture and Fixtures	0.8085	0.8527	0.8753	0.9005	0.9109		
26 Paper and Allied Products	0.8195	0.8617	0.8866	0.9065	0.9114	0.9116	0.9086
27 Printing and Publishing	0.8613	0.8785	0.8917	0.9093			
28 Chemicals and Allied Products	0.8379	0.8819	0.8951	0.9089	0.9172	0.9173	0.9167
29 Petroleum and Coal Products	0.8189	0.8686	0.8738	0.8892	0.8995	0.9008	0.9001
30 Rubber and Misc. Plastics Products	0.8181	0.8620	0.8790	0.8983	0.9083	0.9103	0.8915
31 Leather and Leather Products	0.7851	0.8729	0.8824				
32 Stone, Clay and Glass Products	0.8173	0.8381	0.8644	0.8820	0.9092		
33 Primary Metal Industries	0.8208	0.8591	0.8768	0.9004	0.9066	0.9087	0.9092
34 Fabricated Metal Products	0.8312	0.8732	0.8818	0.8992	0.9345	0.9752	
35 Industrial Machinery and Equipment	0.8030	0.8407	0.8708	0.9022	0.9114		
36 Electronic and Other Electric Equip.	0.8256	0.8533	0.8861	0.8936	0.9124		
37 Transportation Equipment	0.8109	0.8635	0.8700	0.8886	0.8999	0.9039	0.9002
38 Instuments and Related Products	0.8243	0.8665	0.9002	0.9002	0.9052		
39 Misc. Manufacturing Industries							

Industry Groups	Percent of Motors Rewound Upon Failure 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**25.69%**	**48.01%**	**85.13%**	**85.89%**	**83.37%**	**83.37%**	**83.37%**
21 Tobacco Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
22 Textile Mill Products	**44.44%**	**95.97%**	**95.97%**	**96.40%**	**96.40%**	**96.40%**	**96.40%**
23 Apparel and Other Textile Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
24 Lumber and Wood Products	**12.55%**	**69.85%**	**65.81%**	**62.22%**	**99.65%**	**99.65%**	**99.65%**
25 Furniture and Fixtures	**61.19%**	**86.51%**	**95.28%**	**100.00%**	**95.28%**	**95.28%**	**95.28%**
26 Paper and Allied Products	**16.98%**	**66.58%**	**82.53%**	**88.35%**	**90.31%**	**90.31%**	**90.31%**
27 Printing and Publishing	**0.00%**	**50.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
28 Chemicals and Allied Products	**4.35%**	**25.95%**	**77.46%**	**91.82%**	**95.08%**	**95.08%**	**95.08%**
29 Petroleum and Coal Products	**0.00%**	**7.12%**	**70.27%**	**90.15%**	**90.18%**	**90.18%**	**90.18%**
30 Rubber and Misc. Plastics Products	**27.57%**	**67.11%**	**95.82%**	**95.82%**	**96.46%**	**96.46%**	**96.46%**
31 Leather and Leather Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
32 Stone, Clay and Glass Products	**18.80%**	**83.76%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
33 Primary Metal Industries	**11.87%**	**56.02%**	**99.89%**	**95.34%**	**95.34%**	**95.34%**	**95.34%**
34 Fabricated Metal Products	**40.49%**	**64.55%**	**100.00%**	**100.00%**	**0.00%**	**0.00%**	**0.00%**
35 Industrial Machinery and Equipment	**41.52%**	**97.45%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
36 Electronic and Other Electric Equip.	**3.60%**	**80.57%**	**80.57%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
37 Transportation Equipment	**7.79%**	**23.38%**	**77.16%**	**90.85%**	**93.15%**	**93.15%**	**93.15%**
38 Instuments and Related Products	**0.00%**	**0.00%**	**0.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
39 Misc. Manufacturing Industries	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Industry Groups	Percent of Motors Retired Upon Failure 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**4.17%**	**4.17%**	**4.17%**	**4.17%**	**4.17%**	**4.17%**	**4.17%**
21 Tobacco Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
22 Textile Mill Products	**6.69%**	**6.69%**	**6.69%**	**6.69%**	**6.69%**	**6.69%**	**6.69%**
23 Apparel and Other Textile Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
24 Lumber and Wood Products	**2.59%**	**2.59%**	**2.59%**	**2.59%**	**2.59%**	**2.59%**	**2.59%**
25 Furniture and Fixtures	**6.54%**	**6.54%**	**6.54%**	**6.54%**	**6.54%**	**6.54%**	**6.54%**
26 Paper and Allied Products	**5.23%**	**5.23%**	**5.23%**	**5.23%**	**5.23%**	**5.23%**	**5.23%**
27 Printing and Publishing	**23.18%**	**23.18%**	**23.18%**	**23.18%**	**23.18%**	**23.18%**	**23.18%**
28 Chemicals and Allied Products	**14.52%**	**14.52%**	**14.52%**	**14.52%**	**14.52%**	**14.52%**	**14.52%**
29 Petroleum and Coal Products	**0.84%**	**0.84%**	**0.84%**	**0.84%**	**0.84%**	**0.84%**	**0.84%**
30 Rubber and Misc. Plastics Products	**2.96%**	**2.96%**	**2.96%**	**2.96%**	**2.96%**	**2.96%**	**2.96%**
31 Leather and Leather Products	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
32 Stone, Clay and Glass Products	**1.52%**	**1.52%**	**1.52%**	**1.52%**	**1.52%**	**1.52%**	**1.52%**
33 Primary Metal Industries	**5.85%**	**5.85%**	**5.85%**	**5.85%**	**5.85%**	**5.85%**	**5.85%**
34 Fabricated Metal Products	**0.78%**	**0.78%**	**0.78%**	**0.78%**	**0.78%**	**0.78%**	**0.78%**
35 Industrial Machinery and Equipment	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**	**0.28%**
36 Electronic and Other Electric Equip.	**3.98%**	**3.98%**	**3.98%**	**3.98%**	**3.98%**	**3.98%**	**3.98%**
37 Transportation Equipment	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**
38 Instuments and Related Products	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**	**1.08%**
39 Misc. Manufacturing Industries	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Industry Groups	Industry Growth Rate 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	**0.60%**	**0.60%**	**0.60%**	**0.60%**	**0.60%**	**0.60%**	**0.60%**
21 Tobacco Products	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**	**-7.09%**
22 Textile Mill Products	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**	**-0.55%**
23 Apparel and Other Textile Products	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**	**-0.86%**
24 Lumber and Wood Products	**4.22%**	**4.22%**	**4.22%**	**4.22%**	**4.22%**	**4.22%**	**4.22%**
25 Furniture and Fixtures	**2.95%**	**2.95%**	**2.95%**	**2.95%**	**2.95%**	**2.95%**	**2.95%**
26 Paper and Allied Products	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.02%**
27 Printing and Publishing	**1.19%**	**1.19%**	**1.19%**	**1.19%**	**1.19%**	**1.19%**	**1.19%**
28 Chemicals and Allied Products	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**	**-0.35%**
29 Petroleum and Coal Products	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**	**-3.20%**
30 Rubber and Misc. Plastics Products	**3.97%**	**3.97%**	**3.97%**	**3.97%**	**3.97%**	**3.97%**	**3.97%**
31 Leather and Leather Products	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**	**-4.98%**
32 Stone, Clay and Glass Products	**2.24%**	**2.24%**	**2.24%**	**2.24%**	**2.24%**	**2.24%**	**2.24%**
33 Primary Metal Industries	**1.13%**	**1.13%**	**1.13%**	**1.13%**	**1.13%**	**1.13%**	**1.13%**
34 Fabricated Metal Products	**2.54%**	**2.54%**	**2.54%**	**2.54%**	**2.54%**	**2.54%**	**2.54%**
35 Industrial Machinery and Equipment	**3.29%**	**3.29%**	**3.29%**	**3.29%**	**3.29%**	**3.29%**	**3.29%**
36 Electronic and Other Electric Equip.	**2.65%**	**2.65%**	**2.65%**	**2.65%**	**2.65%**	**2.65%**	**2.65%**
37 Transportation Equipment	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**	**-2.44%**
38 Instuments and Related Products	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**	**-3.25%**
39 Misc. Manufacturing Industries	**2.52%**	**2.52%**	**2.52%**	**2.52%**	**2.52%**	**2.52%**	**2.52%**

Industry Groups	Number of Purchased Motors (replaced + additions)							Number of Rewound Motors							Number of Retired Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	31,633	10,854	2,960	1,153	877	411	210	170,654	109,435	52,928	20,799	15,344	7,195	3,675	27,678	9,497	2,590	1,009	767	360	184
21 Tobacco Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Textile Mill Products	20,113	12,188	3,132	958	489	85	5	145,523	190,431	48,927	15,037	7,682	1,342	73	21,912	13,278	3,412	1,044	533	93	5
23 Apparel and Other Textile Products	-505	-112	-82	-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Lumber and Wood Products	37,446	25,951	5,963	2,773	2,696	557	0	69,008	266,178	57,623	25,332	39,440	8,157	0	14,261	9,883	2,271	1,056	1,027	212	0
25 Furniture and Fixtures	24,994	6,536	2,737	758	656	0	0	161,214	59,602	27,484	7,990	6,583	0	0	17,233	4,506	1,887	523	452	0	0
26 Paper and Allied Products	17,877	7,627	4,448	2,172	1,060	684	406	57,799	96,695	69,905	36,543	18,212	11,759	6,969	17,800	7,594	4,429	2,163	1,055	681	404
27 Printing and Publishing	69,495	40,111	11,514	919	0	0	0	0	82,303	47,250	3,771	0	0	0	66,100	38,151	10,951	874	0	0	0
28 Chemicals and Allied Products	62,362	44,049	21,269	8,665	5,956	3,234	1,481	19,147	80,681	116,283	56,153	39,971	21,703	9,937	63,918	45,148	21,800	8,881	6,105	3,315	1,518
29 Petroleum and Coal Products	-5,711	-6,897	-3,382	-1,099	-506	-182	-90	0	20,784	100,579	41,941	19,305	6,967	3,422	2,031	2,453	1,203	391	180	65	32
30 Rubber and Misc. Plastics Products	21,040	11,412	6,054	3,124	1,520	258	63	83,660	110,449	83,664	43,171	21,148	3,593	884	8,992	4,877	2,587	1,335	650	110	27
31 Leather and Leather Products	-1,429	-786	-71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32 Stone, Clay and Glass Products	4,790	2,746	614	65	32	0	0	23,980	61,235	16,343	1,723	870	0	0	1,934	1,109	248	26	13	0	0
33 Primary Metal Industries	39,709	18,849	7,697	2,552	1,523	1,227	661	67,570	151,374	110,230	34,881	20,810	16,758	9,041	33,279	15,797	6,451	2,139	1,276	1,028	554
34 Fabricated Metal Products	22,246	4,908	1,641	325	196	12	0	271,476	95,487	49,475	9,796	0	0	0	5,236	1,155	386	76	46	3	0
35 Industrial Machinery and Equipment	62,831	15,469	2,805	170	251	0	0	729,738	421,685	78,479	4,760	7,024	0	0	4,955	1,220	221	13	20	0	0
36 Electronic and Other Electric Equip.	15,949	6,293	2,449	1,162	50	0	0	8,663	76,496	29,771	17,533	760	0	0	9,581	3,780	1,471	698	30	0	0
37 Transportation Equipment	-4,149	-2,712	-1,139	-184	-79	-57	-27	23,641	46,378	64,244	12,186	5,388	3,878	1,864	3,263	2,133	895	144	62	45	22
38 Instuments and Related Products	-9,188	-3,605	-412	-3	-137	0	0	0	0	0	135	6,303	0	0	4,558	1,788	204	1	68	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Industry Groups	Efficiency of New Motors							Efficiency of Rewound Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8785	0.9204	0.9390	0.9531	0.9595	0.9620	0.9620	0.8028	0.8530	0.8713	0.8956	0.9037	0.9064	0.9001
21 Tobacco Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000							
22 Textile Mill Products	0.8807	0.9212	0.9381	0.9519	0.9590	0.9620	0.9620	0.8000	0.8377	0.8724	0.8869	0.8981	0.8969	0.8981
23 Apparel and Other Textile Products	0.8782	0.9170	0.9400	0.9520	0.0000	0.0000	0.0000	0.7933	0.8396	0.8922	0.9054			
24 Lumber and Wood Products	0.8835	0.9192	0.9394	0.9534	0.9583	0.9620	0.0000	0.8579	0.8924	0.8970	0.9199	0.9234	0.9312	
25 Furniture and Fixtures	0.8799	0.9199	0.9383	0.9529	0.9574	0.0000	0.0000	0.7985	0.8427	0.8653	0.8905	0.9009		
26 Paper and Allied Products	0.8794	0.9212	0.9392	0.9531	0.9576	0.9620	0.9620	0.8095	0.8517	0.8766	0.8965	0.9014	0.9016	0.8986
27 Printing and Publishing	0.8876	0.9202	0.9372	0.9510	0.0000	0.0000	0.0000	0.8513	0.8685	0.8817	0.8993			
28 Chemicals and Allied Products	0.8816	0.9212	0.9394	0.9527	0.9583	0.9620	0.9620	0.8279	0.8719	0.8851	0.8989	0.9072	0.9073	0.9067
29 Petroleum and Coal Products	0.8837	0.9219	0.9391	0.9526	0.9580	0.9620	0.9620	0.8089	0.8586	0.8638	0.8792	0.8895	0.8908	0.8901
30 Rubber and Misc. Plastics Products	0.8785	0.9208	0.9395	0.9528	0.9579	0.9620	0.9620	0.8081	0.8520	0.8690	0.8883	0.8983	0.9003	0.8815
31 Leather and Leather Products	0.8650	0.9208	0.9360	0.0000	0.0000	0.0000	0.0000	0.7751	0.8629	0.8724				
32 Stone, Clay and Glass Products	0.8772	0.9195	0.9379	0.9500	0.9540	0.0000	0.0000	0.8073	0.8281	0.8544	0.8720	0.8992		
33 Primary Metal Industries	0.8809	0.9202	0.9383	0.9530	0.9582	0.9620	0.9620	0.8108	0.8491	0.8668	0.8904	0.8966	0.8987	0.8992
34 Fabricated Metal Products	0.8778	0.9207	0.9381	0.9523	0.9580	0.9620	0.0000	0.8212	0.8632	0.8718	0.8892	0.9245	0.9652	
35 Industrial Machinery and Equipment	0.8776	0.9195	0.9374	0.9527	0.9553	0.0000	0.0000	0.7930	0.8307	0.8608	0.8922	0.9014		
36 Electronic and Other Electric Equip.	0.8850	0.9206	0.9382	0.9514	0.9620	0.0000	0.0000	0.8156	0.8433	0.8761	0.8836	0.9024		
37 Transportation Equipment	0.8814	0.9224	0.9387	0.9518	0.9559	0.9620	0.9620	0.8009	0.8535	0.8600	0.8786	0.8899	0.8939	0.8902
38 Instuments and Related Products	0.8829	0.9196	0.9415	0.9540	0.9580	0.0000	0.0000	0.8143	0.8565	0.8902	0.8902	0.8952		
39 Misc. Manufacturing Industries	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000							

Industry Groups	Average Energy of New Motors							Average Energy of Rewound Motors						
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,090	22,781	90,134	202,007	311,132	587,874	1,487,224	5,569	24,581	97,140	214,988	330,330	623,964	1,589,578
21 Tobacco Products														
22 Textile Mill Products	5,573	22,082	45,229	177,018	363,609	806,656	1,488,412	6,135	24,283	48,635	189,993	388,270	865,254	1,594,356
23 Apparel and Other Textile Products	2,981	3,626	69,572	111,926				3,299	3,961	73,303	117,686			
24 Lumber and Wood Products	2,715	11,383	44,635	129,530	203,190	321,463		2,796	11,725	46,744	134,240	210,873	332,096	
25 Furniture and Fixtures	2,214	10,705	32,903	43,868	168,086			2,440	11,685	35,677	46,944	178,627		
26 Paper and Allied Products	5,010	28,516	98,129	303,985	595,442	1,420,856	4,796,767	5,442	30,843	105,133	323,185	632,573	1,515,979	5,135,119
27 Printing and Publishing	4,114	8,625	41,438	338,774				4,289	9,139	44,047	358,253			
28 Chemicals and Allied Products	4,824	26,997	81,087	204,651	456,970	1,067,692	5,339,063	5,136	28,525	86,059	216,909	482,716	1,132,123	5,664,936
29 Petroleum and Coal Products	1,826	8,678	38,015	116,441	284,454	901,679	4,397,506	1,995	9,318	41,328	126,163	306,347	973,730	4,752,936
30 Rubber and Misc. Plastics Products	4,611	25,475	85,175	222,574	435,692	963,445	2,623,194	5,012	27,531	92,090	238,729	464,605	1,029,425	2,862,861
31 Leather and Leather Products	1,309	22,562	692					1,460	24,076	742				
32 Stone, Clay and Glass Products	2,959	10,925	43,930	2,597	345,808			3,215	12,131	48,222	2,830	366,873		
33 Primary Metal Industries	5,585	20,839	73,727	234,464	490,131	949,524	3,495,270	6,068	22,585	79,807	250,942	523,785	1,016,360	3,739,249
34 Fabricated Metal Products	2,806	11,279	40,405	83,346	73,510	1,968,808		3,000	12,030	43,476	89,258	76,174	1,962,244	
35 Industrial Machinery and Equipment	1,222	5,135	16,152	16,672	271,144			1,352	5,684	17,589	17,803	287,366		
36 Electronic and Other Electric Equip.	7,714	32,676	99,666	213,392	830,693			8,370	35,673	106,733	229,771	885,599		
37 Transportation Equipment	3,630	27,617	51,146	149,981	179,735	1,462,186	2,884,119	3,995	29,846	55,828	162,475	193,055	1,573,581	3,116,817
38 Instuments and Related Products	3,277	12,002	48,749	97,889	193,219			3,553	12,887	51,558	104,900	206,769		
39 Misc. Manufacturing Industries														

Industry Groups	Number of Motors - Year 5 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	668,237	229,300	62,543	24,360	18,515	8,681	4,434
21 Tobacco Products	0	0	0	0	0	0	0
22 Textile Mill Products	325,661	197,338	50,702	15,513	7,925	1,384	76
23 Apparel and Other Textile Products	58,008	12,906	9,463	1,577	0	0	0
24 Lumber and Wood Products	573,046	397,139	91,252	42,431	41,248	8,531	0
25 Furniture and Fixtures	271,226	70,926	29,696	8,225	7,113	0	0
26 Paper and Allied Products	340,470	145,264	84,722	41,371	20,171	13,024	7,719
27 Printing and Publishing	288,587	166,565	47,813	3,816	0	0	0
28 Chemicals and Allied Products	438,608	309,811	149,589	60,940	41,890	22,745	10,414
29 Petroleum and Coal Products	233,962	282,555	138,547	45,034	20,721	7,479	3,673
30 Rubber and Misc. Plastics Products	315,494	171,114	90,781	46,843	22,794	3,873	952
31 Leather and Leather Products	27,234	14,979	1,362	0	0	0	0
32 Stone, Clay and Glass Products	130,407	74,745	16,709	1,762	889	0	0
33 Primary Metal Industries	575,681	273,267	111,597	36,999	22,074	17,776	9,590
34 Fabricated Metal Products	687,486	151,680	50,730	10,045	6,075	349	0
35 Industrial Machinery and Equipment	1,815,435	446,968	81,063	4,917	7,255	0	0
36 Electronic and Other Electric Equip.	247,006	97,457	37,928	17,997	780	0	0
37 Transportation Equipment	296,063	193,521	81,227	13,085	5,643	4,061	1,952
38 Instuments and Related Products	409,505	160,678	18,365	131	6,098	0	0
39 Misc. Manufacturing Industries	0	0	0	0	0	0	0

Industry Groups	Average Energy - Year 5 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,499	24,361	96,691	214,139	328,973	621,412	1,582,567
21 Tobacco Products							
22 Textile Mill Products	6,063	24,155	48,439	189,257	386,881	861,952	1,587,848
23 Apparel and Other Textile Products	3,261	3,917	72,515	116,440			
24 Lumber and Wood Products	2,765	11,668	46,450	133,445	210,420	331,478	
25 Furniture and Fixtures	2,410	11,585	35,428	46,693	177,689		
26 Paper and Allied Products	5,368	30,620	104,620	321,948	630,313	1,510,242	5,114,804
27 Printing and Publishing	4,209	8,988	43,532	354,464			
28 Chemicals and Allied Products	5,042	28,115	85,275	215,318	479,563	1,124,152	5,624,551
29 Petroleum and Coal Products	1,974	9,231	41,268	126,269	306,566	974,481	4,756,743
30 Rubber and Misc. Plastics Products	4,945	27,302	91,616	237,620	462,649	1,024,966	2,846,832
31 Leather and Leather Products	1,449	23,865	736				
32 Stone, Clay and Glass Products	3,175	12,066	48,073	2,822	366,174		
33 Primary Metal Industries	5,974	22,365	79,439	249,838	521,531	1,011,878	3,722,913
34 Fabricated Metal Products	2,973	11,959	43,380	89,074	75,299	1,943,041	
35 Industrial Machinery and Equipment	1,338	5,664	17,540	17,765	286,814		
36 Electronic and Other Electric Equip.	8,236	35,417	106,096	228,814	882,452		
37 Transportation Equipment	3,954	29,610	55,751	162,499	193,115	1,574,116	3,117,996
38 Instuments and Related Products	3,515	12,754	51,035	105,070	207,099		
39 Misc. Manufacturing Industries							

Industry Groups	Average Efficiency - Year 5 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.8131	0.8607	0.8753	0.8991	0.9075	0.9101	0.9040
21 Tobacco Products							
22 Textile Mill Products	0.8095	0.8421	0.8759	0.8903	0.9013	0.9003	0.9018
23 Apparel and Other Textile Products	0.8028	0.8490	0.9018	0.9151			
24 Lumber and Wood Products	0.8677	0.8967	0.9027	0.9254	0.9254	0.9329	
25 Furniture and Fixtures	0.8085	0.8500	0.8714	0.8952	0.9057		
26 Paper and Allied Products	0.8207	0.8579	0.8809	0.8999	0.9046	0.9051	0.9022
27 Printing and Publishing	0.8675	0.8831	0.8921	0.9089			
28 Chemicals and Allied Products	0.8434	0.8846	0.8933	0.9055	0.9132	0.9137	0.9132
29 Petroleum and Coal Products	0.8174	0.8666	0.8651	0.8785	0.8889	0.8901	0.8893
30 Rubber and Misc. Plastics Products	0.8192	0.8592	0.8734	0.8925	0.9021	0.9043	0.8864
31 Leather and Leather Products	0.7813	0.8705	0.8798				
32 Stone, Clay and Glass Products	0.8175	0.8326	0.8571	0.8745	0.9009		
33 Primary Metal Industries	0.8235	0.8574	0.8708	0.8944	0.9005	0.9027	0.9032
34 Fabricated Metal Products	0.8286	0.8684	0.8738	0.8911	0.9352	0.9748	
35 Industrial Machinery and Equipment	0.8013	0.8337	0.8632	0.8941	0.9031		
36 Electronic and Other Electric Equip.	0.8288	0.8494	0.8813	0.8873	0.9056		
37 Transportation Equipment	0.8092	0.8603	0.8612	0.8785	0.8897	0.8936	0.8898
38 Instuments and Related Products	0.8231	0.8654	0.8993	0.8888	0.8938		
39 Misc. Manufacturing Industries							

Industry Groups	Adjusted Energy - Year 5 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5,476	24,104	95,792	212,421	327,571	620,628	1,582,567
21 Tobacco Products							
22 Textile Mill Products	6,049	24,055	48,089	187,433	384,035	849,186	1,560,775
23 Apparel and Other Textile Products	3,261	3,859	71,897	116,440			
24 Lumber and Wood Products	2,763	11,636	46,228	132,959	209,865	331,478	
25 Furniture and Fixtures	2,406	11,571	35,286	46,189	176,498		
26 Paper and Allied Products	5,346	30,411	103,805	319,036	624,341	1,496,745	5,081,079
27 Printing and Publishing	4,199	8,972	43,435	354,464			
28 Chemicals and Allied Products	4,998	27,787	84,496	213,442	474,203	1,113,338	5,583,301
29 Petroleum and Coal Products	1,958	9,129	40,889	125,149	302,395	957,506	4,679,334
30 Rubber and Misc. Plastics Products	4,922	27,035	90,902	234,698	460,969	1,014,183	2,846,832
31 Leather and Leather Products	1,441	23,734	723				
32 Stone, Clay and Glass Products	3,166	11,986	47,758	2,774	359,930		
33 Primary Metal Industries	5,950	22,210	78,796	248,330	518,294	1,003,889	3,707,709
34 Fabricated Metal Products	2,949	11,931	43,147	88,331	74,839	1,909,912	
35 Industrial Machinery and Equipment	1,337	5,636	17,420	17,765	285,999		
36 Electronic and Other Electric Equip.	8,126	35,067	104,319	224,308	867,407		
37 Transportation Equipment	3,926	29,313	55,401	161,690	190,173	1,559,781	3,108,217
38 Instuments and Related Products	3,497	12,728	50,696	103,278	206,719		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Pumps 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	15.04%	44.70%	28.40%	28.16%	15.00%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	4.35%	10.14%	26.38%	22.80%	13.86%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	0.00%	0.00%	0.00%			
24 Lumber and Wood Products	1.87%	5.41%	10.14%	12.11%	0.44%	0.00%	
25 Furniture and Fixtures	4.08%	1.51%	4.05%	25.55%	0.00%		
26 Paper and Allied Products	15.46%	25.50%	31.43%	34.84%	40.08%	40.94%	21.10%
27 Printing and Publishing	0.99%	1.81%	0.00%	0.00%			
28 Chemicals and Allied Products	39.61%	53.18%	37.53%	28.65%	37.45%	33.94%	9.69%
29 Petroleum and Coal Products	34.10%	52.54%	36.08%	38.47%	63.37%	81.64%	63.21%
30 Rubber and Misc. Plastics Products	16.12%	35.63%	28.40%	53.55%	4.42%	0.00%	0.00%
31 Leather and Leather Products	20.00%	0.00%	0.00%				
32 Stone, Clay and Glass Products	9.55%	10.53%	0.00%	0.00%	0.00%		
33 Primary Metal Industries	13.88%	22.72%	28.12%	24.91%	17.68%	4.57%	0.93%
34 Fabricated Metal Products	29.62%	6.91%	2.90%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	3.75%	7.97%	28.93%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	61.32%	47.03%	47.29%	86.65%	0.00%		
37 Transportation Equipment	32.86%	36.21%	12.08%	14.86%	38.30%	0.00%	0.00%
38 Instuments and Related Products	21.04%	4.41%	0.00%	0.00%	0.00%		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Fans 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	11.07%	20.89%	11.30%	9.05%	1.62%	0.00%	0.00%
21 Tobacco Products							
22 Textile Mill Products	17.24%	15.46%	20.91%	18.87%	7.85%	26.36%	0.00%
23 Apparel and Other Textile Products	0.00%	12.22%	0.00%	0.00%			
24 Lumber and Wood Products	5.67%	12.86%	13.42%	4.78%	9.86%	0.00%	
25 Furniture and Fixtures	7.01%	16.81%	26.01%	29.28%	64.59%		
26 Paper and Allied Products	12.96%	17.60%	10.39%	8.99%	14.17%	4.26%	24.48%
27 Printing and Publishing	6.06%	4.25%	9.87%	0.00%			
28 Chemicals and Allied Products	9.97%	7.96%	11.00%	17.24%	20.88%	12.10%	6.22%
29 Petroleum and Coal Products	19.59%	4.37%	7.79%	14.03%	12.26%	2.09%	3.66%
30 Rubber and Misc. Plastics Products	14.21%	12.74%	6.53%	0.72%	6.47%	3.41%	0.00%
31 Leather and Leather Products	20.00%	100.00%	0.00%				
32 Stone, Clay and Glass Products	18.02%	32.32%	21.18%	0.00%	0.00%		
33 Primary Metal Industries	12.22%	16.44%	20.92%	5.35%	19.76%	6.67%	15.57%
34 Fabricated Metal Products	19.12%	4.09%	1.53%	0.00%	0.00%	0.00%	
35 Industrial Machinery and Equipment	1.74%	11.70%	0.00%	0.00%	0.00%		
36 Electronic and Other Electric Equip.	14.49%	7.70%	2.22%	0.00%	0.00%		
37 Transportation Equipment	7.34%	39.03%	16.40%	17.61%	20.63%	1.63%	3.39%
38 Instuments and Related Products	8.12%	20.98%	0.36%	0.00%	33.33%		
39 Misc. Manufacturing Industries							

Industry Groups	Applicability - Percent Compressors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	2.69%	2.28%	17.42%	10.94%	6.78%	7.40%	0.00%
21 Tobacco Products							
22 Textile Mill Products	3.15%	7.41%	4.51%	23.59%	24.27%	47.29%	100.00%
23 Apparel and Other Textile Products	0.00%	81.67%	50.00%	0.00%			
24 Lumber and Wood Products	0.75%	5.64%	11.67%	5.55%	11.77%	0.00%	
25 Furniture and Fixtures	0.83%	0.00%	10.36%	23.77%	18.48%		
26 Paper and Allied Products	1.51%	4.33%	5.26%	9.07%	3.74%	2.78%	5.90%
27 Printing and Publishing	10.83%	6.64%	9.87%	0.00%			
28 Chemicals and Allied Products	1.20%	3.02%	5.82%	11.74%	14.66%	12.50%	29.58%
29 Petroleum and Coal Products	1.84%	1.58%	8.74%	2.13%	1.14%	5.25%	19.75%
30 Rubber and Misc. Plastics Products	2.94%	11.27%	10.15%	8.76%	14.00%	60.60%	0.00%
31 Leather and Leather Products	0.00%	0.00%	100.00%				
32 Stone, Clay and Glass Products	0.00%	15.96%	31.62%	100.00%	100.00%		
33 Primary Metal Industries	3.36%	8.50%	7.62%	4.30%	9.19%	38.77%	17.84%
34 Fabricated Metal Products	6.00%	4.45%	27.64%	48.92%	35.83%	100.00%	
35 Industrial Machinery and Equipment	2.42%	15.55%	6.16%	0.00%	16.67%		
36 Electronic and Other Electric Equip.	1.68%	0.00%	41.78%	13.35%	100.00%		
37 Transportation Equipment	0.44%	3.42%	17.27%	6.01%	37.54%	52.89%	17.30%
38 Instuments and Related Products	3.25%	0.24%	38.93%	100.00%	0.00%		
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Pumps 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
21 Tobacco Products							
22 Textile Mill Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
23 Apparel and Other Textile Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
24 Lumber and Wood Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
25 Furniture and Fixtures	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
26 Paper and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
27 Printing and Publishing	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
28 Chemicals and Allied Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
29 Petroleum and Coal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
30 Rubber and Misc. Plastics Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
31 Leather and Leather Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
32 Stone, Clay and Glass Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
33 Primary Metal Industries	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
34 Fabricated Metal Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
35 Industrial Machinery and Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
36 Electronic and Other Electric Equip.	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
37 Transportation Equipment	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
38 Instuments and Related Products	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%	20.10%
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Fans 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
21 Tobacco Products							
22 Textile Mill Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
23 Apparel and Other Textile Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
24 Lumber and Wood Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
25 Furniture and Fixtures	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
26 Paper and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
27 Printing and Publishing	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
28 Chemicals and Allied Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
29 Petroleum and Coal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
30 Rubber and Misc. Plastics Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
31 Leather and Leather Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
32 Stone, Clay and Glass Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
33 Primary Metal Industries	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
34 Fabricated Metal Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
35 Industrial Machinery and Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
36 Electronic and Other Electric Equip.	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
37 Transportation Equipment	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
38 Instuments and Related Products	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%	5.50%
39 Misc. Manufacturing Industries							

Industry Groups	Savings Fraction - Compressors 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
21 Tobacco Products							
22 Textile Mill Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
23 Apparel and Other Textile Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
24 Lumber and Wood Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
25 Furniture and Fixtures	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
26 Paper and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
27 Printing and Publishing	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
28 Chemicals and Allied Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
29 Petroleum and Coal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
30 Rubber and Misc. Plastics Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
31 Leather and Leather Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
32 Stone, Clay and Glass Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
33 Primary Metal Industries	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
34 Fabricated Metal Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
35 Industrial Machinery and Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
36 Electronic and Other Electric Equip.	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
37 Transportation Equipment	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
38 Instuments and Related Products	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%	17.05%
39 Misc. Manufacturing Industries							

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Industry Groups	Overall Savings - Year 3 1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp
20 Food and Kindred Products	0.41%	1.05%	0.93%	0.80%	0.43%	0.13%	0.00%
21 Tobacco Products	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
22 Textile Mill Products	0.24%	0.42%	0.72%	0.96%	0.74%	1.48%	1.71%
23 Apparel and Other Textile Products	0.00%	1.46%	0.85%	0.00%	0.00%	0.00%	0.00%
24 Lumber and Wood Products	0.08%	0.28%	0.48%	0.36%	0.26%	0.00%	0.00%
25 Furniture and Fixtures	0.13%	0.12%	0.40%	1.08%	0.67%	0.00%	0.00%
26 Paper and Allied Products	0.41%	0.68%	0.78%	0.90%	0.95%	0.89%	0.66%
27 Printing and Publishing	0.24%	0.17%	0.22%	0.00%	0.00%	0.00%	0.00%
28 Chemicals and Allied Products	0.87%	1.16%	0.91%	0.87%	1.12%	0.96%	0.73%
29 Petroleum and Coal Products	0.82%	1.11%	0.92%	0.89%	1.36%	1.74%	1.63%
30 Rubber and Misc. Plastics Products	0.45%	0.98%	0.78%	1.23%	0.36%	1.05%	0.00%
31 Leather and Leather Products	0.51%	0.55%	1.71%	0.00%	0.00%	0.00%	0.00%
32 Stone, Clay and Glass Products	0.29%	0.66%	0.66%	1.71%	1.71%	0.00%	0.00%
33 Primary Metal Industries	0.40%	0.69%	0.81%	0.60%	0.62%	0.79%	0.41%
34 Fabricated Metal Products	0.80%	0.24%	0.54%	0.83%	0.61%	1.71%	0.00%
35 Industrial Machinery and Equipment	0.13%	0.49%	0.69%	0.00%	0.28%	0.00%	0.00%
36 Electronic and Other Electric Equip.	1.34%	0.99%	1.67%	1.97%	1.71%	0.00%	0.00%
37 Transportation Equipment	0.71%	1.00%	0.63%	0.50%	1.52%	0.91%	0.31%
38 Instuments and Related Products	0.52%	0.21%	0.67%	1.71%	0.18%	0.00%	0.00%
39 Misc. Manufacturing Industries	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Industry Groups	Number of Motors - Base Year							
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	652,557	223,920	61,075	23,790	18,080	8,478	4,331	*992,231*
21 Tobacco Products								
22 Textile Mill Products	332,917	201,735	51,832	15,860	8,102	1,416	76	*611,937*
23 Apparel and Other Textile Products	60,054	13,360	9,796	1,633				*84,842*
24 Lumber and Wood Products	485,783	336,664	77,356	35,969	34,967	7,232		*977,971*
25 Furniture and Fixtures	241,489	63,149	26,440	7,324	6,332			*344,735*
26 Paper and Allied Products	340,162	145,132	84,646	41,335	20,151	13,012	7,711	*652,149*
27 Printing and Publishing	275,244	158,863	45,602	3,640				*483,348*
28 Chemicals and Allied Products	444,864	314,230	151,722	61,809	42,488	23,070	10,563	*1,048,747*
29 Petroleum and Coal Products	266,501	321,852	157,816	51,296	23,603	8,519	4,185	*833,772*
30 Rubber and Misc. Plastics Products	269,992	146,435	77,688	40,086	19,508	3,315	815	*557,838*
31 Leather and Leather Products	33,414	18,378	1,671					*53,463*
32 Stone, Clay and Glass Products	119,354	68,410	15,293	1,612	813			*205,482*
33 Primary Metal Industries	550,389	261,262	106,693	35,374	21,103	16,995	9,169	*1,000,985*
34 Fabricated Metal Products	621,929	137,216	45,892	9,088	5,496	316		*819,936*
35 Industrial Machinery and Equipment	1,594,769	392,639	71,210	4,319	6,373			*2,069,310*
36 Electronic and Other Electric Equip.	222,501	87,788	34,165	16,212	702			*361,369*
37 Transportation Equipment	326,843	213,640	89,672	14,446	6,229	4,484	2,154	*657,467*
38 Instuments and Related Products	467,319	183,363	20,957	150	6,960			*678,748*
39 Misc. Manufacturing Industries								
Subtotal	*7,306,080*	*3,288,035*	*1,129,527*	*363,940*	*220,908*	*86,836*	*39,004*	***12,434,330***

Industry Groups	Total Energy (GWh) - Base Year							
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	3,633	5,562	5,898	5,061	5,848	5,134	6,660	*37,797*
21 Tobacco Products								
22 Textile Mill Products	2,024	4,790	2,484	2,991	3,101	1,236	123	*16,750*
23 Apparel and Other Textile Products	195	55	728	190				*1,168*
24 Lumber and Wood Products	1,342	3,847	3,566	4,746	7,138	2,305		*22,946*
25 Furniture and Fixtures	583	722	928	344	1,117			*3,694*
26 Paper and Allied Products	1,857	4,447	8,814	13,250	12,654	19,562	39,009	*99,594*
27 Printing and Publishing	1,210	1,472	1,997	1,282				*5,961*
28 Chemicals and Allied Products	2,369	9,262	13,136	13,387	20,587	26,136	59,485	*144,362*
29 Petroleum and Coal Products	536	3,047	6,445	6,353	7,207	8,364	19,986	*51,938*
30 Rubber and Misc. Plastics Products	1,358	4,052	7,084	9,600	8,850	3,403	2,262	*36,610*
31 Leather and Leather Products	48	442	1					*491*
32 Stone, Clay and Glass Products	382	819	723	5	302			*2,231*
33 Primary Metal Industries	3,370	5,906	8,422	8,731	10,879	17,092	33,534	*87,935*
34 Fabricated Metal Products	1,868	1,614	1,947	799	423	645		*7,296*
35 Industrial Machinery and Equipment	2,121	2,179	1,229	74	1,775			*7,378*
36 Electronic and Other Electric Equip.	1,938	3,136	3,722	3,815	631			*13,243*
37 Transportation Equipment	1,310	6,428	4,899	2,280	1,205	6,942	6,486	*29,549*
38 Instuments and Related Products	1,660	2,343	1,087	16	1,381			*6,487*
39 Misc. Manufacturing Industries								
Subtotal	*27,807*	*60,122*	*73,111*	*72,924*	*83,099*	*90,819*	*167,545*	***575,428***

Industry Groups	Number of Motors - Year 2							
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	656,442	225,253	61,439	23,931	18,188	8,528	4,356	*998,137*
21 Tobacco Products								
22 Textile Mill Products	331,088	200,626	51,547	15,772	8,057	1,408	76	*608,574*
23 Apparel and Other Textile Products	59,536	13,245	9,712	1,619				*84,112*
24 Lumber and Wood Products	506,267	350,859	80,618	37,486	36,441	7,537		*1,019,208*
25 Furniture and Fixtures	248,603	65,010	27,219	7,539	6,519			*354,890*
26 Paper and Allied Products	340,239	145,165	84,665	41,344	20,156	13,015	7,713	*652,297*
27 Printing and Publishing	278,521	160,754	46,145	3,683				*489,103*
28 Chemicals and Allied Products	443,292	313,120	151,186	61,591	42,338	22,988	10,525	*1,045,040*
29 Petroleum and Coal Products	257,965	311,543	152,761	49,653	22,847	8,246	4,051	*807,066*
30 Rubber and Misc. Plastics Products	280,712	152,249	80,773	41,678	20,282	3,446	847	*579,987*
31 Leather and Leather Products	31,749	17,462	1,587					*50,798*
32 Stone, Clay and Glass Products	122,026	69,941	15,635	1,648	832			*210,082*
33 Primary Metal Industries	556,606	264,213	107,899	35,773	21,342	17,187	9,272	*1,012,292*
34 Fabricated Metal Products	637,707	140,697	47,057	9,318	5,635	324		*840,738*
35 Industrial Machinery and Equipment	1,647,284	405,569	73,555	4,461	6,583			*2,137,452*
36 Electronic and Other Electric Equip.	228,390	90,111	35,069	16,641	721			*370,932*
37 Transportation Equipment	318,860	208,422	87,482	14,093	6,077	4,374	2,102	*641,410*
38 Instuments and Related Products	452,142	177,408	20,276	145	6,734			*656,705*
39 Misc. Manufacturing Industries								
Subtotal	*7,397,429*	*3,311,647*	*1,134,625*	*366,375*	*222,752*	*87,053*	*38,942*	***12,558,823***

Industry Groups	Total Energy (GWh) - Year 2							
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	3,644	5,559	5,926	5,093	5,907	5,200	6,753	*38,082*
21 Tobacco Products								
22 Textile Mill Products	2,013	4,787	2,475	2,974	3,090	1,222	122	*16,683*
23 Apparel and Other Textile Products	194	53	716	188				*1,151*
24 Lumber and Wood Products	1,401	4,035	3,724	4,961	7,501	2,429		*24,051*
25 Furniture and Fixtures	601	747	958	353	1,152			*3,811*
26 Paper and Allied Products	1,850	4,445	8,817	13,250	12,650	19,564	39,098	*99,675*
27 Printing and Publishing	1,212	1,480	2,022	1,303				*6,017*
28 Chemicals and Allied Products	2,327	9,109	13,037	13,324	20,452	25,995	59,291	*143,536*
29 Petroleum and Coal Products	515	2,921	6,236	6,161	6,954	8,039	19,232	*50,059*
30 Rubber and Misc. Plastics Products	1,407	4,195	7,369	9,943	9,249	3,532	2,369	*38,063*
31 Leather and Leather Products	46	418	1					*465*
32 Stone, Clay and Glass Products	390	838	742	5	307			*2,281*
33 Primary Metal Industries	3,388	5,955	8,525	8,854	11,030	17,300	34,072	*89,123*
34 Fabricated Metal Products	1,909	1,662	2,006	821	431	651		*7,479*
35 Industrial Machinery and Equipment	2,196	2,261	1,273	77	1,847			*7,654*
36 Electronic and Other Electric Equip.	1,957	3,209	3,784	3,875	643			*13,467*
37 Transportation Equipment	1,271	6,228	4,794	2,237	1,170	6,781	6,376	*28,856*
38 Instuments and Related Products	1,599	2,264	1,046	15	1,349			*6,273*
39 Misc. Manufacturing Industries								
Subtotal	*27,917*	*60,165*	*73,451*	*73,436*	*83,730*	*90,713*	*167,312*	***576,724***

Industry Groups	Number of Motors - Year 3							
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	660,350	226,594	61,805	24,073	18,296	8,579	4,382	*1,004,079*
21 Tobacco Products								
22 Textile Mill Products	329,269	199,524	51,264	15,685	8,013	1,400	76	*605,231*
23 Apparel and Other Textile Products	59,022	13,131	9,628	1,605				*83,386*
24 Lumber and Wood Products	527,614	365,653	84,017	39,067	37,978	7,855		*1,062,184*
25 Furniture and Fixtures	255,926	66,925	28,021	7,761	6,711			*365,344*
26 Paper and Allied Products	340,316	145,198	84,684	41,353	20,161	13,018	7,715	*652,445*
27 Printing and Publishing	281,837	162,668	46,694	3,727				*494,926*
28 Chemicals and Allied Products	441,725	312,013	150,652	61,373	42,188	22,907	10,488	*1,041,346*
29 Petroleum and Coal Products	249,702	301,564	147,868	48,063	22,115	7,982	3,921	*781,215*
30 Rubber and Misc. Plastics Products	291,858	158,294	83,980	43,333	21,087	3,583	881	*603,016*
31 Leather and Leather Products	30,167	16,592	1,508					*48,267*
32 Stone, Clay and Glass Products	124,758	71,507	15,985	1,685	851			*214,786*
33 Primary Metal Industries	562,893	267,197	109,118	36,177	21,583	17,381	9,377	*1,023,726*
34 Fabricated Metal Products	653,886	144,267	48,251	9,554	5,778	332		*862,068*
35 Industrial Machinery and Equipment	1,701,528	418,924	75,977	4,608	6,800			*2,207,837*
36 Electronic and Other Electric Equip.	234,434	92,496	35,997	17,081	740			*380,748*
37 Transportation Equipment	311,072	203,332	85,345	13,749	5,929	4,267	2,051	*625,745*
38 Instuments and Related Products	437,458	171,646	19,618	140	6,515			*635,377*
39 Misc. Manufacturing Industries								
Subtotal	*7,493,815*	*3,337,525*	*1,140,412*	*369,034*	*224,745*	*87,304*	*38,891*	***12,691,726***

Industry Groups	Total Energy (GWh) - Year 3							
	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	3,649	5,549	5,949	5,122	5,960	5,264	6,842	*38,334*
21 Tobacco Products								
22 Textile Mill Products	1,999	4,775	2,464	2,953	3,075	1,207	121	*16,593*
23 Apparel and Other Textile Products	192	52	704	187				*1,135*
24 Lumber and Wood Products	1,459	4,223	3,883	5,180	7,872	2,557		*25,174*
25 Furniture and Fixtures	618	771	987	362	1,186			*3,924*
26 Paper and Allied Products	1,840	4,436	8,812	13,237	12,636	19,547	39,151	*99,659*
27 Printing and Publishing	1,209	1,482	2,039	1,320				*6,050*
28 Chemicals and Allied Products	2,279	8,935	12,908	13,225	20,268	25,785	58,942	*142,342*
29 Petroleum and Coal Products	495	2,802	6,038	5,979	6,714	7,732	18,518	*48,279*
30 Rubber and Misc. Plastics Products	1,454	4,335	7,655	10,286	9,654	3,661	2,479	*39,523*
31 Leather and Leather Products	44	396	1					*441*
32 Stone, Clay and Glass Products	397	857	760	5	311			*2,331*
33 Primary Metal Industries	3,399	5,994	8,617	8,968	11,170	17,487	34,574	*90,208*
34 Fabricated Metal Products	1,948	1,710	2,066	843	438	656		*7,660*
35 Industrial Machinery and Equipment	2,270	2,344	1,318	80	1,920			*7,934*
36 Electronic and Other Electric Equip.	1,973	3,278	3,842	3,929	654			*13,676*
37 Transportation Equipment	1,234	6,037	4,693	2,195	1,137	6,627	6,270	*28,192*
38 Instuments and Related Products	1,541	2,188	1,006	15	1,318			*6,068*
39 Misc. Manufacturing Industries								
Subtotal	*27,999*	*60,164*	*73,742*	*73,884*	*84,315*	*90,521*	*166,898*	***577,523***

	Number of Motors - Year 4								Total Energy (GWh) - Year 4							
Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	664,282	227,943	62,173	24,216	18,405	8,630	4,408	*1,010,057*	3,654	5,538	5,971	5,149	6,013	5,326	6,930	*38,581*
21 Tobacco Products																
22 Textile Mill Products	327,460	198,428	50,982	15,599	7,969	1,392	76	*601,906*	1,984	4,762	2,451	2,931	3,060	1,191	120	*16,499*
23 Apparel and Other Textile Products	58,513	13,018	9,545	1,591				*82,667*	191	51	692	185				*1,119*
24 Lumber and Wood Products	549,861	381,071	87,560	40,714	39,579	8,186		*1,106,971*	1,520	4,419	4,048	5,407	8,257	2,690		*26,339*
25 Furniture and Fixtures	263,465	68,896	28,846	7,990	6,909			*376,106*	635	796	1,017	371	1,221			*4,039*
26 Paper and Allied Products	340,393	145,231	84,703	41,362	20,166	13,021	7,717	*652,593*	1,830	4,427	8,805	13,220	12,617	19,523	39,192	*99,613*
27 Printing and Publishing	285,192	164,605	47,250	3,771				*500,818*	1,209	1,487	2,058	1,336				*6,090*
28 Chemicals and Allied Products	440,164	310,910	150,120	61,156	42,039	22,826	10,451	*1,037,666*	2,234	8,768	12,775	13,119	20,072	25,560	58,558	*141,086*
29 Petroleum and Coal Products	241,704	291,905	143,132	46,524	21,407	7,726	3,795	*756,193*	476	2,689	5,848	5,804	6,485	7,440	17,837	*46,578*
30 Rubber and Misc. Plastics Products	303,446	164,579	87,314	45,054	21,924	3,725	916	*626,958*	1,502	4,478	7,949	10,636	10,074	3,792	2,593	*41,025*
31 Leather and Leather Products	28,663	15,765	1,433					*45,861*	41	375	1					*418*
32 Stone, Clay and Glass Products	127,551	73,108	16,343	1,723	870			*219,595*	405	876	779	5	316			*2,381*
33 Primary Metal Industries	569,251	270,215	110,351	36,586	21,827	17,577	9,483	*1,035,290*	3,412	6,032	8,706	9,079	11,307	17,668	35,069	*91,273*
34 Fabricated Metal Products	670,476	147,927	49,475	9,796	5,925	340		*883,939*	1,987	1,759	2,127	865	446	660		*7,844*
35 Industrial Machinery and Equipment	1,757,559	432,719	78,479	4,760	7,024			*2,280,541*	2,347	2,430	1,365	84	1,996			*8,222*
36 Electronic and Other Electric Equip.	240,638	94,944	36,950	17,533	760			*390,825*	1,990	3,347	3,899	3,983	666			*13,885*
37 Transportation Equipment	303,475	198,366	83,261	13,413	5,784	4,163	2,001	*610,463*	1,197	5,852	4,595	2,155	1,104	6,478	6,167	*27,549*
38 Instuments and Related Products	423,251	166,071	18,981	135	6,303			*614,741*	1,486	2,115	968	14	1,289			*5,872*
39 Misc. Manufacturing Industries																
Subtotal	*7,595,344*	*3,365,701*	*1,146,898*	*371,923*	*226,891*	*87,586*	*38,847*	***12,833,190***	*28,101*	*60,202*	*74,053*	*74,342*	*84,921*	*90,329*	*166,466*	***578,414***

	Number of Motors - Year 5								Total Energy (GWh) - Year 5							
Industry Groups	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*	1 - 5 hp	6 - 20 hp	21 - 50 hp	51 - 100 hp	101 - 200 hp	201 - 500 hp	> 500 hp	*Subtotal*
20 Food and Kindred Products	668,237	229,300	62,543	24,360	18,515	8,681	4,434	*1,016,070*	3,660	5,527	5,991	5,175	6,065	5,388	7,017	*38,822*
21 Tobacco Products																
22 Textile Mill Products	325,661	197,338	50,702	15,513	7,925	1,384	76	*598,599*	1,970	4,747	2,438	2,908	3,043	1,175	119	*16,400*
23 Apparel and Other Textile Products	58,008	12,906	9,463	1,577				*81,954*	189	50	680	184				*1,103*
24 Lumber and Wood Products	573,046	397,139	91,252	42,431	41,248	8,531		*1,153,647*	1,583	4,621	4,218	5,642	8,657	2,828		*27,549*
25 Furniture and Fixtures	271,226	70,926	29,696	8,225	7,113			*387,186*	653	821	1,048	380	1,255			*4,157*
26 Paper and Allied Products	340,470	145,264	84,722	41,371	20,171	13,024	7,719	*652,741*	1,820	4,418	8,795	13,199	12,594	19,494	39,221	*99,539*
27 Printing and Publishing	288,587	166,565	47,813	3,816				*506,781*	1,212	1,494	2,077	1,353				*6,136*
28 Chemicals and Allied Products	438,608	309,811	149,589	60,940	41,890	22,745	10,414	*1,033,997*	2,192	8,609	12,640	13,007	19,864	25,323	58,145	*139,780*
29 Petroleum and Coal Products	233,962	282,555	138,547	45,034	20,721	7,479	3,673	*731,971*	458	2,580	5,665	5,636	6,266	7,161	17,187	*44,953*
30 Rubber and Misc. Plastics Products	315,494	171,114	90,781	46,843	22,794	3,873	952	*651,851*	1,553	4,626	8,252	10,994	10,507	3,928	2,710	*42,571*
31 Leather and Leather Products	27,234	14,979	1,362					*43,575*	39	356	1					*396*
32 Stone, Clay and Glass Products	130,407	74,745	16,709	1,762	889			*224,512*	413	896	798	5	320			*2,432*
33 Primary Metal Industries	575,681	273,267	111,597	36,999	22,074	17,776	9,590	*1,046,984*	3,425	6,069	8,793	9,188	11,441	17,845	35,557	*92,319*
34 Fabricated Metal Products	687,486	151,680	50,730	10,045	6,075	349		*906,365*	2,028	1,810	2,189	887	455	667		*8,035*
35 Industrial Machinery and Equipment	1,815,435	446,968	81,063	4,917	7,255			*2,355,638*	2,427	2,519	1,412	87	2,075			*8,520*
36 Electronic and Other Electric Equip.	247,006	97,457	37,928	17,997	780			*401,168*	2,007	3,418	3,957	4,037	677			*14,095*
37 Transportation Equipment	296,063	193,521	81,227	13,085	5,643	4,061	1,952	*595,552*	1,162	5,673	4,500	2,116	1,073	6,334	6,067	*26,925*
38 Instuments and Related Products	409,505	160,678	18,365	131	6,098			*594,777*	1,432	2,045	931	14	1,261			*5,682*
39 Misc. Manufacturing Industries																
Subtotal	*7,702,116*	*3,396,213*	*1,154,089*	*375,046*	*229,191*	*87,903*	*38,810*	***12,983,368***	*28,223*	*60,277*	*74,385*	*74,810*	*85,552*	*90,142*	*166,023*	***579,412***