Report

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Energy-Efficient Motors and Adjustable-Speed Drives Markets in Wisconsin

1994
ENERGY-EFFICIENT MOTORS AND ADJUSTABLE-SPEED DRIVES MARKETS IN WISCONSIN

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EXECUTIVE SUMMARY

Electric motors account for nearly two-thirds of the electricity used in the industrial sector. When properly applied, energy-efficient motors (EEMS) and adjustable-speed drives (ASDs) have the potential to substantially reduce electricity consumption and demand.

To reduce both peak electric demand and customers’ energy costs, utilities have encouraged the purchase of energy-efficient drivepower options. Utility promotional activities typically incorporate audits, informational programs, and prescriptive rebates for energy efficient motors, and generally use custom rebates for ASDs. Several market barriers, however, reduce the effectiveness of these programs.

Intended for DSM program designers and managers, this report:

• outlines the market structure of electric motors and ASDs in Wisconsin
• describes barriers to utility drivepower programs
• offers recommendations for improved program design
• suggests topics for additional research.

This report is based on primary information drawn from interviews of manufacturers and distributors with secondary information developed from a literature review.

Electric Motor and Adjustable-Speed Drive Market Structures and Distribution Channels

The key players in the electric motor market are manufacturers, distributors, repair and rewind shops, original equipment manufacturers, consulting engineers, contractors, and end-users. In addition, electric utilities, government agencies, research organizations, and trade associations influence the market.

The key players in the ASD market are manufacturers, distributors, original equipment manufacturers and their distributors, consulting engineers and contractors, and end-users.

Barriers to Utility Drivepower Programs

This report discusses barriers to utility drivepower programs that the interviewed manufacturers and distributors identified. These barriers are organized by, and describe the tendencies of, key players.

• Manufacturers
  Utility DSM programs do not provide incentives for manufacturers
• Distributors/Dealers
  - Distributors and end-users treat motors up to 125 horsepower as commodities
  - Distributors believe they have neither the time nor the expertise to provide detailed information to end-users on energy-efficient motor applications
EEM AND ASD MARKETS IN WISCONSIN

- Distributors with customers in several utility service territories face DSM programs with different criteria
- Distributors and dealers report that end-users select motors based on price, reliability and delivery, rather than efficiency
- Distributors and dealers report that non-standard motor labeling creates uncertainty among end-users

• Rewinders and Repair Shop Owners
  - Many repair-rewind shops do not stock energy-efficient motors or ASDs
  - Rewinders and repair shop owners are concerned that motor DSM programs will reduce their repair business
  - Motor repair practices generally reduce motor efficiency
  - Repairing an inefficient motor eliminates an opportunity for cost-effective replacement

• Original Equipment Manufacturers
  - OEMs select motors based on price, reliability and delivery, rather than efficiency
  - Typically, oem marketing does not emphasize a product’s energy efficiency
  - OEMs have not been the target of utility DSM programs

Recommendations for Program Design
Recommendations are presented below on ways utilities can increase the effectiveness of their energy-efficient motor and ASD programs:

• Manufacturers
  - Encourage manufacturers to use standard labeling practices for electric motors
  - Consider providing incentives to manufacturers

• Distributors and End-users
  - For each audience, customize educational material that explains EEM and ASD advantages
  - Develop and distribute tools that assist in making rapid, accurate estimates of savings for typical motor and ASD applications
  - Develop and deliver training on EEM and ASD applications

• Rewinders and Repair Shop Owners
  Develop incentive, training, and certification programs for rewinders

• Original Equipment Manufacturers
  Develop motor and ASD programs that specifically target OEMs
Executive Summary

Recommendations for Additional Research

This report also suggests areas for additional research.

- Examine the role of original equipment manufacturers in the EEM and ASD markets
- Interview end-users to determine directly their views about the availability of energy-efficient motors and ASDs
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MARKET STRUCTURE AND DISTRIBUTION CHANNELS

The key players in the electric motor market are manufacturers, distributors, repair and rewind shops, original equipment manufacturers (OEMs), consulting engineers, contractors and end-users. In addition, electric utilities, government agencies, research organizations and trade associations can influence the market. Much of the text in this section is based primarily on *Energy-Efficient Motor Systems* (Nadel et al. 1991), an excellent overview of the drivepower market.

Availability of Sales Data for Electric Motors and ASDs

Since at least 1982, the National Electrical Manufacturers Association (NEMA) has been breaking out sales data into energy-efficient or standard-efficiency categories. The data are compiled nationally and represent 75 to 90 percent of U.S. manufacturers’ sales. NEMA sales data, however, are confidential and are available only to NEMA members.

The Bureau of Census collects and compiles annual national motor sales data. The data do not distinguish between standard and energy-efficient motors.

Because of the difficulty in obtaining reliable and comprehensive sales data, Ontario Hydro—a Canadian utility—has an on-going program that employs a consultant to meet with all the major manufacturers, obtain the necessary sales data, and compile the data so that the utility can evaluate the impact of their incentive program.

Electric Motor Market Structure and Distribution Channels

**Electric Motor Manufacturers**

Eight motor manufacturers account for more than 70 percent of the electric motors sold in North America. Most of their sales are to OEMs and distributors, though large motors and large volume orders are often sold directly to large industrial end-users. These direct sales account for the majority of energy-efficient motor sales, because volume discounts reduce the extra per-unit cost of high-efficiency motors.

Motor manufacturers tend to stock motors that are smaller than 250- to 350-HP in size. Larger motors are custom built. Most manufacturers produce energy-efficient motor lines in the 1- to 200-HP range for AC polyphase induction motors. These are usually available in T-Frame, open drip-proof or totally enclosed fan-cooled enclosures in speeds of 1200, 1800, and 3600 rpm. Direct sales from manufacturers to large national customers and OEMs may receive discounts as high as 50 to 70 percent off suggested list price.

**Distributors and Dealers**

Most motor distributors are small local operations; however, large regional distributors account for a disproportionate share of motor sales. Distributors primarily sell to small and medium size end-users, contractors, engineers, and some small OEMs. Many distributors also repair and rewind motors.
Distributors and contractors are generally aware of energy-efficient motors and ASDs. Although most distributors can offer at least some technical expertise, distributor order desk personnel generally have very limited technical knowledge. Many distributors are solely dependent on manufacturers as a source of technical information. In ASD applications, where greater technical expertise is required than for other motors systems, the knowledge level of distributors is improving.

**Rewinders and Repair Shop Owners**

Because they often sell both new motors and repair failed ones, motor-repair and rewind shops are often indistinguishable from small local distributors. Rewind shops usually sell at least one line of new motors. The percentage of new motor sales varies greatly among repair shops, ranging from no sales to nearly 100 percent of sales. Typically, the smaller shops focus on repair business.

Decisions about motor rewinding in industry are usually made at the plant level rather than the corporate level, and are typically made by the head electrician, lead maintenance person, or plant manager. To avoid nonscheduled downtime, many industrial plants remove operational motors at regularly scheduled intervals or when there are signs of degradation. A study of motor repair practices in the Pacific Northwest found the percent of motors removed before complete failure to be highest in the pulp and paper industry, which is also an important energy user in Wisconsin.

To promote competition, most industrial plants use more than one rewind shop. Service and quality are the primary criteria for choosing a rewind shop, though turnaround time, cost, and shop location can also play a role.

**Original Equipment Manufacturers**

Original equipment manufacturers account for approximately 80 percent of all motor purchases. They account for 80 percent of 1.5- to 5-HP motors—which comprise the bulk of the market, 75 percent of 7.5- to 20-HP motors, 65 percent of 25- to 50-HP motors, 45 percent of 60- to 125-HP motors, and 15 percent of motors greater than 125 HP. OEM sales include almost all motors in residential appliances and equipment, most motors in commercial buildings, and a substantial portion of industrial motors. OEMs typically buy motors from manufacturers or distributors, though some manufacture their own. They sell their equipment through distributors and dealers or directly to their customers. In terms of electric motor sales, the most important OEMs include manufacturers of heating, ventilation, air conditioning (HVAC) and refrigeration equipment, fans and blowers, pumps, compressors, construction and machine tools, and appliances. Table 1 shows the 15 OEMs that purchase the majority of integral horsepower motors.
Table 1  Top 15 OEM industrial users of integral horsepower electric motors, by segment

<table>
<thead>
<tr>
<th>SIC Code</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>3585</td>
<td>Refrigeration and Heating Equipment</td>
</tr>
<tr>
<td>3561</td>
<td>Pumps and Pumping Equipment</td>
</tr>
<tr>
<td>3531</td>
<td>Construction Machinery</td>
</tr>
<tr>
<td>3563</td>
<td>Air and Gas Compressors</td>
</tr>
<tr>
<td>3559</td>
<td>Special Industry Machinery</td>
</tr>
<tr>
<td>3621</td>
<td>Motors and Generators</td>
</tr>
<tr>
<td>3541</td>
<td>Machine Tools, Metal-cutting Type</td>
</tr>
<tr>
<td>3589</td>
<td>Service Industry Machinery</td>
</tr>
<tr>
<td>3519</td>
<td>Internal Combustion Engines</td>
</tr>
<tr>
<td>3532</td>
<td>Mining Machinery</td>
</tr>
<tr>
<td>3564</td>
<td>Blowers and Fans</td>
</tr>
<tr>
<td>3523</td>
<td>Farm Machinery and Equipment</td>
</tr>
<tr>
<td>3534</td>
<td>Elevators and Moving Stairways</td>
</tr>
<tr>
<td>3537</td>
<td>Industrial Trucks and Tractors</td>
</tr>
<tr>
<td>3553</td>
<td>Woodworking Machinery</td>
</tr>
</tbody>
</table>


**Engineers and Contractors**

Consulting engineers are generally hired by end-users to assist with large scale new or retrofit projects. They may prepare designs and specifications and help oversee the bid and construction process, but they typically leave installation to outside contractors. Design-build contractors, which are typically very large firms, handle both design and installation. Electrical, mechanical and HVAC contractors may also specify and install equipment.

**End-Users**

Nearly everyone in the U.S. relies on electric motors. Because residential and commercial end-users generally buy products with built-in electric motors, they have little direct influence over the efficiency of a product’s drivepower system. Industrial end-users, however, often rely on production engineers and maintenance staff to select motors for specific applications. Industrial staff are the traditional targets of utility drivepower programs.

In general, the literature suggests most end-users are aware of energy-efficient motors, yet their knowledge of the technology and its advantages can vary greatly. Large industrial users, with sophisticated engineering staffs, are by far the most aware and knowledgeable about energy-
Efficient motors. Because of favorable life cycle costs, many are now purchasing energy-efficient motors. Small end-users are less well informed.

Many end-users are also aware of ASDs, though to a lesser degree. Dramatic advances in semiconductor technology over the past two decades have lowered the cost and improved the reliability and performance of ASDs enough to make them more attractive to potential users. Nonetheless, many end-users don’t know about energy saving applications for ASDs.

**Utilities, Trade Associations, and Others**

Some electric utilities use promotional programs to encourage the installation of energy-efficient motors. These programs may include rebates for energy-efficient motor purchases, educational materials, seminars and technical assistance. Trade associations, such as NEMA, can also affect the motor market. NEMA has published a standard for single-speed, polyphase, squirrel-cage, induction motors that lists the nominal and minimum efficiency a motor must meet or exceed to be designated as energy-efficient. This standard also defines the acceptable testing procedure. Universities, government agencies, and research organizations have affected the market by promoting research and providing technical information.

**ASD Market Structure and Distribution Channels**

The key players in the ASD market are manufacturers, distributors, original equipment manufacturers and their distributors, consulting engineers and contractors, and end-users. The following text describing these key market participants is based primarily on *Energy-Efficient Motor Systems* (Nadel et al. 1991).

**Key Markets for ASDs**

ASDs can offer substantial energy savings in variable-torque load applications. Variable-torque loads, also called centrifugal loads, are associated with centrifugal pumps, fans, and compressors, in which significant energy savings can result when the speed is reduced. In addition, pumps and fans are the largest users of motor energy. For these reasons, centrifugal pump and fan ASD applications offer great potential for energy savings. The savings are greatest when replacing alternative flow control technologies, such as dampers and throttling valves.

The HVAC industry is a key market for ASDs. Variable air-volume systems can use ASDs in place of variable-inlet vanes to control the flow of supply air. ASDs can also control chilled-water-pump and air-compressor motors. Centrifugal pumps in the water and waste-water municipalities, and in the pulp and paper, dairy, and chemical industries are prime applications.

**ASD Manufacturers**

Approximately 60 companies manufacture integral horsepower ASDs. Of these, 16 are major U.S. companies and another 15 are comparable foreign companies. Most ASD manufacturers—some of which are primarily motor manufacturers—specialize in certain sizes or types of motor controls. Some offer two lines of ASDs for either constant- or variable-torque applications. Inverter-based adjustable frequency drives are the most common for use with induction motors, and account for well over 90 percent of ASDs currently sold.
MARKET STRUCTURE AND DISTRIBUTION CHANNELS

Sales are predominantly channeled through either direct salespeople or independent distributors. Distributors stock products, and sales representatives order as needed. Most manufacturers use direct salespeople. The majority of their sales are to OEMs. Most ASDs that are greater than 20 HP have been sold direct from the manufacturer to the end-user or OEM through field sales representatives.

**Distributors and Dealers**

Distributors have a growing role in the ASD market. They now account for more than one-third of adjustable speed drive sales, and their reputation for being knowledgeable is improving. Their sales tend to be primarily in the less-than 20-HP range, and they sell primarily to small OEMs and end-users. Some distributors do design work to promote sales.

**Original Equipment Manufacturers**

The largest portion of ASD equipment flows from OEMs to end-users. ASD manufacturers provide products to OEMs, and OEM equipment is purchased and re-engineered for niche markets by application engineering firms. These firms rely on service companies, which are often contracted by drive manufacturers, to provide design, sales and maintenance services.

Because motor, controller, and driven equipment function best when designed and manufactured based on an integrated design approach, many OEMs may enter the market with their own ASD products in integrated designs.

**Engineers and Contractors**

The influence of consulting engineers varies by industry. Consulting engineers are very influential in the HVAC and municipal industries, which are important markets for ASDs. In general, contractors tend to ease end-user or consulting engineer specifications because of the higher initial costs of energy-efficient equipment.

**End-Users**

Commercial end-users have almost no direct involvement with ASD marketing. Customers in these sectors simply buy and use equipment that may contain ASDs. Industrial end-users, however, rely on production engineers to use ASD technology where appropriate and, as with energy-efficient motors, represent one of the traditional targets of utility ASD programs.
**BARRIERS TO UTILITY DRIVEPOWER PROGRAMS**

Despite life-cycle cost savings, increased reliability, and improved process control, many end-users avoid purchasing energy-efficient motors and ASDs because of their higher initial cost. This end-user resistance ripples through the entire drivepower market. Manufacturers will not make, and distributors will not stock, EEMs without sufficient end-user demand. OEMs will not include efficient drivepower systems in their products unless end-users request them.

Motors are often replaced with the same brand and model number, perpetuating the presence of standard-efficiency equipment. Maintenance or purchasing personnel often make motor purchases. Typically, they have no incentive to purchase energy-efficient motors because the money that could be saved in operating expenses does not come out of their budgets. In addition, they often select motors from a preapproved list and do not have the authority to alter purchase decisions. When end-users do invest in energy-saving measures, the two-to-three-year payback they typically require makes it difficult to implement all but rapid-payback energy-saving measures. Other barriers to increased use of energy-efficient motors and ASD are described below.

**Manufacturers**

Utility DSM programs do not provide clear incentives for manufacturers. Because most utility DSM programs offer direct incentives just to end-users, motor manufacturers do not see the value of pushing the market toward energy-efficient motors and drive systems.

**Distributors and Dealers**

*In general, distributors and end-users perceive motors up to 125 horsepower as commodities.*

Motors smaller than 125 HP are often replaced with the same brand and model number, which assures fewer installation complications. Most motors in this size range are purchased through a distributor or in OEM equipment, often by non-technical personnel who choose from a preapproved list of authorized vendors.

Price competition prevents distributors from selling energy-efficient, but more expensive, motors. Several utility-program managers reported that distributors usually sell motors at discounts 30 percent to 50 percent below list prices to compete on orders. The pressure for low bids favors the sale of standard-efficiency motors.

*Manufacturers do not promote the benefits of energy-efficient drive systems.*

Several distributors said that because manufacturers do not promote the benefits of efficient drive systems, end-users do not purchase energy-efficient motors and ASDs.

*Distributors with customers in several utility service territories face dissimilar DSM programs.*

Distributors are viewed by utilities as critical links in promoting energy-efficient motor sales. However, with customers in several utility service territories, distributors often face different rebate criteria from each utility. Table 2 provides examples of rebates offered by several
Wisconsin utilities (as of 1992) for 100-HP energy-efficient motor. Differing rebate criteria and application forms add to the time distributors spend on the rebate process.

Distributors also believe that they have neither the time nor the expertise to provide detailed information to end-users on energy-efficient motor applications.

**Rewinders and Repair Shop Owners**

*Many repair-rewind shops do not stock energy-efficient motors or ASDs.*

Interview respondents gave many reasons for not selling or stocking energy-efficient motors, including lack of customer demand and the belief that energy-efficient motors are not cost-effective and create excessive maintenance problems.

*Repairing a motor eliminates an opportunity for cost-effective replacement.*

According to rewinders and repair shop owners, end-users usually have their motors repaired instead of replaced because fixing a motor of about 30-HP or greater is usually cheaper than purchasing a new one. Many old, standard-efficiency U-Frame motors are rewound rather than replaced because of the added effort, cost, and potential downtime required to switch to a T-Frame motor. Special order motors are also typically rewound. Large horsepower motors are often rewound because it is much cheaper than purchasing a new motor.

*Motor repair practices generally reduce motor efficiency.*

- Although properly rewinding stators and replacing components—such as bearings—can restore a motor’s efficiency, many repair techniques reduce it. Many rewinders are unaware the motor damage typical rewinding practices can do:
  
  For example, using burn-out ovens set at high temperatures—typically about 650°F—to soften stator windings can alter the magnetic properties of the core, reducing the motor’s efficiency.

- Rewinders have been slow to adopt alternative repair methods that reduce potential motor damage and loss of motor efficiency, even though the cost of such equipment is modest ($10,000 to $15,000).

*Rewinders and repair shop owners are concerned that motor DSM programs will reduce their repair business.*

Because when life-cycle energy costs aren’t considered, motor repair is often seen as less expensive than replacement, rewinders provide services many motor-owners consider cost-effective. Utility programs that encourage motor replacement instead of refurbishment reduce the repair-rewind market, threatening repair-shop owners.
Original Equipment Manufacturers

OEMs use price, reliability, and delivery, rather than efficiency, to determine which motor to purchase.

- To keep the price of their products competitive, OEMs select lower-priced, standard-efficiency motors instead of higher-priced, high-efficiency motors.
- Except when specified by end-users, OEMs rarely incorporate high-efficiency motors in their products.
- OEMs consider component reliability and terms of delivery to be more important than energy efficiency.

Typically, OEM marketing does not emphasize a product’s energy efficiency.

A motor sold to an OEM becomes part of a product that is then sold through the OEM’s distribution system using the OEM’s sales approach. In general, OEM marketing does not focus on the product’s energy efficiency. Moreover, end-users seldom question the efficiency of the product as a whole, let alone the product’s motor. Exceptions include HVAC products—such as packaged or split-system air conditioners—where system efficiencies, or seasonal energy efficiency ratios, are key end-user marketing signals.

OEMs have not been the target of utility DSM programs.

Utility DSM programs create incentives for end-users rather than OEMs.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Program incentives and criteria as of 1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG&amp;E</td>
<td>Custom rebate for a totally-enclosed fan-cooled (TEFC) motor with a minimum efficiency of 94.1%.</td>
</tr>
<tr>
<td></td>
<td>Custom rebate for open drip-proof (ODP) motor with a minimum efficiency of 93.6%.</td>
</tr>
<tr>
<td>NSP</td>
<td>Custom rebate determined by motor size, efficiency, and application.</td>
</tr>
<tr>
<td>WEPCO</td>
<td>Rebate of $8 per horsepower for motors with a minimum efficiency of 95.0%.</td>
</tr>
<tr>
<td>WP&amp;L</td>
<td>Rebate of $6 per horsepower for TEFC motors with a minimum efficiency of 94.1%. Rebate of $6 per horsepower for ODP motors with a minimum efficiency of 93.6%.</td>
</tr>
<tr>
<td>WPPI</td>
<td>Custom rebate for a motor with a minimum efficiency of 94.5%.</td>
</tr>
<tr>
<td>WPSC</td>
<td>Rebate of $15.50 per horsepower for motors replacing working motors with pre-approval by a utility representative. For new motors replacing failed ones, or for new motors replacing working motors without utility pre-approval, WPSC offers a rebate of $8 per horsepower for a motor with a minimum efficiency of 95.0%.</td>
</tr>
</tbody>
</table>

Sources: utility high-efficiency motor rebate schedules.
End-Users
Although this study did not poll end-users themselves, the authors did collect some perceptions of end-users that manufactures and distributors hold.

*End-users consider price, reliability, and delivery, not efficiency, to determine which motor to purchase.*

End-users tend to base purchase decisions on initial cost. This practice favors lower cost, standard-efficiency motors. Reliability and availability also are important to end-users who want to minimize production downtime.

*Non-standard motor labeling creates end-user uncertainty.*

- There is a lack of consensus in the motor industry regarding terminology. Although NEMA has set minimum efficiency standards that a motor must meet or exceed to be classified as *energy-efficient*, manufacturers use varied terminology. This includes standard-efficiency, high-efficiency, and premium-efficiency, as well as energy-efficient. Supplier comments from a Georgia Power focus group indicate the standard, high, and premium efficiency terms are recognized and used throughout the motor industry, with premium being the highest efficiency motor available.

- Several manufacturers, especially those outside the U.S., use efficiency-testing methods and labeling practices that differ from standards promulgated by the NEMA. Moreover, motor catalogs may not list motor efficiencies. Non-standard labeling creates several barriers:
  - It makes it difficult for end-users to identify energy-efficient motors.
  - One manufacturer’s “high-efficiency” motor may have a lower efficiency than another manufacturer’s standard-efficiency model.
  - Uncertainty over actual motor efficiency lowers the likelihood that end-users will pay a premium for an EEM.
  - Non-standard labeling makes it difficult for utilities to develop educational material that describes how motor efficiency is measured and which brands and models are energy efficient.
  - Distributors say that several manufacturers refer to any motor that exceeds industry average efficiency as a high-efficiency or energy-efficient motor.

*End-user acceptance of ASDs remains low.*

- Especially for drive equipment essential to production, end-users see ASD as risky.
- End-users can’t identify the most advantageous ASD applications.
- Reliability problems with first-generation ASDs have made end-users wary of ASD performance.
- Many end-users believe ASDs are too complex. Furthermore, many end-users lack on-site capability to maintain them and believe ASD service networks are inadequate.
• End-users often expect payback in three years or less, whereas ASDs typically produce paybacks that—when rebates aren’t factored in—range from three to eight years.

• ASDs also face some technical barriers to implementation. These include potential harmonics problems and mismatches between ASDs and motors.

*Custom rebates for ASDs may not encourage end-user participation.*

Custom rebates require end-users to apply for each ASD application separately. In contrast, many motor DSM programs offer prescriptive rebates for motors with minimum efficiencies, making it relatively easy for end-users to receive utility incentives. Table 3 describes criteria and rebate amounts of ASD programs offered by several Wisconsin utilities.

### Table 3  Adjustable speed drive rebates: criteria and incentives from several Wisconsin utilities

<table>
<thead>
<tr>
<th>Utility</th>
<th>Program incentives and criteria as of 1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG&amp;E</td>
<td>Custom rebate based on energy savings calculated on a case-by-case basis.</td>
</tr>
<tr>
<td>NSP</td>
<td>Rebate of $20 per horsepower for ASDs installed on existing or new 3-phase motors with a minimum size of 3 HP. Free metering tests and savings estimates with ASDs on motors with a minimum size of 50 HP.</td>
</tr>
<tr>
<td>WEPCO</td>
<td>Custom rebate based on estimated kWh saved. Energy savings are evaluated before and after ASD installation.</td>
</tr>
<tr>
<td>WP&amp;L</td>
<td>Custom rebate of up to $260 per saved kW.</td>
</tr>
<tr>
<td>WPPI</td>
<td>Custom rebate based on equipment cost and energy savings, with before and after metering to verify results.</td>
</tr>
<tr>
<td>WPSC</td>
<td>In 1991, WPSC offered a line-item rebate of $20 per horsepower for ASDs added to existing motors. This program was not continued in 1992. Currently, customers may apply for a custom rebate based on estimated energy savings.</td>
</tr>
</tbody>
</table>

Sources: utility ASD motor rebate schedules.
RECOMMENDATIONS FOR PROGRAM DESIGN

Barriers to utility programs promoting the use of energy-efficient drivepower systems are numerous. This section provides suggestions on ways to improve utility DSM programs so that they can capture a larger share of the energy and cost savings potential offered by efficient drivepower applications.

In order to overcome the concerns of skeptical end-users, ASD demonstration projects or case studies are needed to collect data on ASD costs, performance, and reliability in typical applications. This information could then be used to promote ASDs.

Program consistency is important. A firm commitment by a utility to long-term program involvement and the insurance that sufficient money will be provided to fund the incentive pool are important concerns among manufacturers, distributors, and end-users. In addition, suppliers favor rebate efficiency levels that are congruent across utility programs. Such uniformity makes it easier for suppliers to provide accurate information to customers from different utility service territories.

Rebates

Financial incentives typically take the form of rebates. Rebates are commonly offered to the end-user to shorten the payback of energy-efficient equipment. In addition to those for energy-efficient motors, end-user rebates for motor downsizing have been suggested by suppliers. Rebates may also be used to encourage distributors to stock and promote energy-efficient products. Numerous utilities have tried this, with some noted success.

Rebate programs with the following attributes do best: They are easy to understand and participate in, they are marketed through regular personal contacts with decision-makers and are coordinated closely with dealers, they include educational components for both dealers and end-users, and they provide high incentive levels to the extent justified by a utility’s avoided costs and demand-side management objectives.

Training Programs

Training programs for both vendors and end-users can be effective in addressing informational needs. Handbooks and training seminars that emphasize practical applications and one-on-one technical assistance can help end-users and consulting engineers with motor and drive analyses and designs. Training for distributors and rewinders can provide them with the skills needed to prepare dependable motor evaluations for prospective customers.

On-site assistance can range from simple computerized audits to detailed engineering analyses. On-site assistance can help end-users identify and evaluate end-use applications with high potential savings. This may include metering and testing and monitoring of load profiles. Lending of monitoring equipment and training in its use are additional services offered by some utilities.
Educational efforts regarding motor rewinds are also important. Motor end-users need information on the line-cycle economics of rewind versus replacement decisions, on monitoring procedures to ensure burned out motors are replaced when justified, and on how to select rewind shops that use non-damaging rewind techniques. Rewind shops should be educated on procedures for minimizing core damage and should be encouraged to test all motors before and after rewinding. Utilities could provide incentives for the purchase and use of necessary equipment and could establish minimum requirements for rewinds and certification of rewind shops.

Training courses and handbooks for maintenance staff can improve maintenance practices in the field. Maintenance staff should be encouraged to regularly monitor motor efficiencies, especially before and after repairs. Degraded motors should be identified and, upon burnout, be replaced with energy-efficient motors rather than rewound.

Manufacturers

Encourage manufacturers to use standard labeling practices for electric motors
Consistent, detailed labels should include a motor’s nominal and minimum efficiencies. Moreover, utilities should encourage catalog publishers to include nominal and minimum efficiencies. Both steps would eliminate distributor and end-user uncertainty about a motor’s relative efficiency.

Provide incentives to manufacturers
Several motor manufacturers suggested that utilities could provide incentives that encourage the production of high-efficiency motors. Incentives could be based on the difference in the marginal costs of production between standard-efficiency and high-efficiency motors, or rebates normally targeted toward end-users could be given to manufacturers.

Distributors and End-Users

Develop and distribute educational material that explains EEM and ASD advantages

- Utility educational material is often perceived by end-users as reliable and unbiased. Distributors and dealers find utility materials useful when making presentations to customers.
- Case studies can show distributors and end-users successful applications of EEMs and ASDs. Case studies could describe total cost savings from typical applications based on actual examples reinforced with testimonials from satisfied participants.
- Case studies should be developed for key Wisconsin industries, including pulp and paper, dairy products and municipal water and waste-water treatment.

1 Nominal efficiency refers to the average efficiency of motors from a representative sample. Minimum efficiency is based on “a near-worst-case combination of raw materials and manufacturing tolerances” (Nadel et al. 1991, p. 60).
RECOMMENDATIONS FOR PROGRAM DESIGN

• Educational material for business and institutional managers could promote cost-effective efficiency improvements for HVAC and process equipment as these systems undergo major overhaul or replacement, or when the facility undergoes renovation or expansion.

• Material for end-users could describe the environmental benefits of DSM programs. Utilities could consider helping business and institutional customers identify and publicize the positive environmental impacts of their efficiency efforts.

• Informational material for end-users could explain why the utility is offering incentives to save energy. For example, the material could explain that it’s cheaper for the utility and its ratepayers to spend money improving efficiency instead of building new generating facilities.

• Educational material developed for OEMs should stress the opportunities to increase reliability and controllability of their products that incorporate EEMs and ASDs.

**Develop and distribute tools that help potential users make rapid, accurate estimates of savings for typical motor and ASD applications**

Slide rules and computer software help distributors and end-users estimate energy savings. Slide rules, such as Ontario Hydro’s Power Rule provide quick, inexpensive estimates of annual operating costs and rebate amounts based on different motor efficiencies and sizes. For more detailed analysis, computer software can be used to calculate simple payback based on specific rate and rebate schedules. Approaches that have been used include:

• Ontario Hydro’s High Efficiency Motors—Financial Evaluation Program lets users analyze operating costs of motors with different efficiencies. It lets users customize the analysis to match specific applications and it provides estimates of simple payback and present value.

• Ontario Hydro’s Adjustable Speed Drives—Financial Evaluation Program evaluates the electrical energy and demand savings of ASDs used with fan, pump and blower systems. It can calculate ASD installation costs, annual dollar savings, simple payback period, discounted payback period, and Ontario Hydro rebate amounts.

• The U.S. Department of Energy’s MotorMaster software includes a database of more than 7,000 three-phase motors, ranging from 1 to 500 horsepower, available in the U.S. MotorMaster analyzes the cost of running a particular motor in a specific application and determines the simple payback of using a more energy-efficient motor.

**Provide training on EEM and ASD applications**

The University of Wisconsin, through its Department of Engineering Professional Development, offers courses that cover motor design and control, ASD applications and selection, industrial energy analysis (including motor systems analysis), industrial ventilation design, and HVAC system design. Utilities could offer to pay a portion of the course costs to encourage participation by distributors and end-users.
Rewinders and Repair Shop Owners

Develop incentive, training, and certification programs for rewinders

- Wisconsin utilities should work with both utilities in other states and other groups to develop programs for rewinders and repair shop personnel. The Electric Apparatus Service Association is the major trade association for repair and rewind shops and has expressed interest in working with utilities to improve rewind and repair shop practices.
- Utilities could provide incentives to rewinders for rewinding equipment that does not damage motors.
- Rewinders and repairers should be trained in repair practices that reduce the chance for motor damage.
- Rewinders and repairers should be encouraged to test motor efficiencies before returning repaired motors to customers.
- Utilities should consider certifying rewinders and repairers that adopt non-damaging repair techniques and motor testing.
RECOMMENDATIONS FOR ADDITIONAL RESEARCH

Investigate end-users’ views about the availability of energy-efficient motors and ASDs
This research should involve a quantitative exploration of the characteristics of end-users’ purchases and purchase decisions, including:

• Occasions for motor purchases and rewinds (burnout replacement, other replacement, and new equipment purchase).
• Customers’ delivery time requirements (same day, next day, three to four days, or longer) and how these are affected by customers’ stocking practices.
• Customers’ usual purchasing practices (order from previous supplier, inquire of more than one supplier, or put out to bid).
• The importance of various decision factors (such as first cost, delivery time, energy efficiency or operating costs, reputation of supplier, reputation of manufacturer, and reliability or quality) in decisions to purchase standard versus energy-efficient motors.
• The criteria that end-users employ (including availability) when deciding between rewinding motors and purchasing replacements.

Examine the role of oems in the eem and asd markets
Wisconsin utilities should consider conducting a scoping study to:

• Identify major types of equipment with significant potential for using EEMs and ASDs.
• Explore the level of customer demand for EEMs and ASDs in high-potential applications.
• Explore possible roles that utility incentive programs could play in increasing the penetration of EEMs and ASDs in OEM markets.
APPENDIX A: REVIEW OF THE LITERATURE

To assure that this study adds significantly to the base of existing knowledge about the marketing of motors and electronic adjustable speed drives, we conducted a literature review. This report describes how the review was conducted, excerpts and summarizes findings, and references all sources that were reviewed.

The focus of the literature review was to identify the distribution channels for motors and ASDs, to determine the role of each of the key players, and to identify both potential market barriers to the penetration of energy-efficient technologies and possible ways to overcome these barriers. The availability of sales and shipment data for electric motors and ASDs also was investigated.

The identification of information for review included a thorough literature search, as well as numerous personal contacts. The informational databases that were searched and the statistics concerning what was found are described below. A list of all pertinent literature sources that were identified or reviewed can be found at the end of this appendix.

Literature Search Methodology

The focus of this study was the market aspects of electric motors and ASDs. Therefore, the research initially targeted sources of business literature. Because, however, we had limited success locating pertinent information in the business literature, it was expanded to include technical literature sources as well.

Most of the literature search was conducted at three of Boston’s research libraries: the Massachusetts Institute of Technology Barker Engineering Library, the Massachusetts Institute of Technology Dewey Library for Management and Social Sciences, and the Boston University Mugar Memorial Library for Humanities and Social Sciences. Both Boston University and the Massachusetts Institute of Technology are members of the Boston Library Consortium, giving them access to extensive literary collections. This consortium includes eight university libraries, the Boston Public Library, and the Massachusetts State Library.

The search began by tapping easily accessible sources that were very broad in scope. This allowed for various search strategies, helped assess the scope of the topic, and helped identify key words and subject areas. As the search was better defined, specific sources were focused.

First, the Library of Congress Subject Headings was used to identify key words. Then the on-line catalogs at the Boston University and Massachusetts Institute of Technology libraries were searched with a focus on electric motors and marketing. Next the years 1986 through 1991 were searched in Predicasts F&S Index and the Business Periodicals Index, both of which cover business and management issues. Then the ABI/INFORM on Disc CD-ROM database, which indexes approximately 800 business and management journals, was searched.

Finally, a computerized literature search was conducted at Boston University’s Mugar Memorial Library. Five on-line databases were searched, including:
EEM AND ASD MARKETS IN WISCONSIN

- the Electric Power Research Institute’s Electric Power Database
- Predicasts’ PTS Newsletter Database indexing industry newsletters containing product, business, and management information
- Engineering Information, Inc.’s Compendex Plus, a computerized engineering index
- the Energy Science and Technology database produced by the US Department of Energy and US Office of Science and Technical Information
- the Institution of Electrical Engineers INSPEC database covering computer science, electrical, and electronics engineering.

XENERGY’s research library, which contains corporate reports, conference proceedings, professional journals, and other studies and reports, was also searched for additional references. Corporate reports or any other nonpublic documents were cited with permission.

Key Words

- Electric
- Distribution
- Frequency
- Motor
- Variable
- Drive
- Market
- Adjustable
- Industry
- Channel
- Speed
- Motors & Generators
Table 4 summarizes the results of the literature search. It presents the number of references identified, reviewed, and abstracted for each source. The abstracts are presented in the Document Summaries section.

### Table A-1  Literature search results

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<th>Sources Searched</th>
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<sup>1</sup> Reasons for non-review included: could not locate reference, further investigation indicated reference was not pertinent, and duplicate reference.

<sup>2</sup> Abstracting was done only for references that were discussed.

### Document Summaries

In this section, highlights from each of the literature sources that were reviewed are summarized. Sources are arranged alphabetically by author.


This publication is perhaps the first comprehensive study of the energy conservation potential for electric motors and pumps, including an investigation of technical, economic, and market factors. The report describes the motor and pump markets of the 1970s, and some of this dated information may no longer be relevant.

**Electric Motor Market**

- Motor distribution channels vary depending on the motor size. OEMs are very important participants in the smaller horsepower range, while direct sales and sales to architectural and engineering firms or contractors are important in large horsepower ranges. Most of the smaller horsepower motors are purchased for replacement purposes; most of the larger horsepower motors are purchased for capacity growth reasons. Because most larger motors (greater than 10 to 20 HP) are rebuilt numerous times before they are replaced, more motors over 20 HP are rebuilt each year than are sold.
Most manufacturers specialize in one or more lines of motors. Most of their sales are to OEMs and distributors or dealers. Manufacturers have little direct contact with end-users. For large, new plant construction the manufacturer negotiates with architects and engineers or contractors unless the end-user has its own in-house construction division.

Most OEMs purchase motors from manufacturers or distributors, though some manufacture their own motors. OEMs may sell their equipment directly or, more commonly, through their distributors or representatives. OEMs generally service their equipment after it is sold, and, in some cases, will supply replacement motors.

End-users select equipment from OEMs based on price, performance characteristics, and operational features. They generally do not focus on the motor that is incorporated in the OEM equipment. In some cases, however, the end-user may specify the motor to be installed in the equipment.

With respect to the electric motor market, the most important OEMs include manufacturers of refrigeration and HVAC equipment, pumps, compressors, construction machinery, machine tools, blowers and fans, and appliances.

There is little uniformity in the published efficiency rating procedures of energy-efficient models of various manufacturers. Some manufacturers’ standard motors may have efficiency ratings as high as energy-efficient models of other manufacturers.

**Purchase Decision Criteria for Electric Motors**

For motors that drive process critical equipment, reliability is perhaps the single most important factor in the purchase decision. Because of the importance of reliability, motor buyers have a list of approved vendors who have proven over the years that they can provide reliable electric motors. Given a list of approved vendors, purchase decisions are often made by a purchasing agent and, for medium and small size motors, technical people are not involved.

Given approximately equal reliability, the next criteria of selection are price and ability to deliver motors on time. If reliability and availability are equivalent, price becomes the deciding factor.

The process industries (primary metals, chemicals, pulp and paper, stone clay and glass, textile mill products, rubber and miscellaneous plastics, food, and petroleum refining) typically consume the most electricity per dollar value of sales. Because of this they have shown the greatest interest in energy conservation measures, including energy-efficient motors. However, electric motor efficiency improvement is not their top energy conservation priority because of the relatively small energy savings potential and often unfavorable rates of return.

Corporate energy managers can have a significant impact on purchasing decisions. In some cases, especially in the process industries, they have been able to educate and otherwise persuade technical and purchasing staffs on the merits of life cycle costing of electric motors. In some companies, this has resulted in changing the list of approved vendors to those who offer energy-efficient motors. However, because many individuals within a corporation are often involved in purchasing and specifying electric motors, it can be hard to set corporate guidelines.
Appendix A: Review of the Literature

- There is a general belief among suppliers and especially end-users that all medium and small size motors are alike. These motors are therefore treated like a commodity. However, efficiency is emerging as a means for differentiating a commodity product and receiving a price premium.

- End-user direct purchases often involve technically more sophisticated applications and larger motors. The technical demands typically require some engineering analysis, and the higher cost often warrants a financial analysis. In these cases a life cycle cost analysis for energy-efficient motors is more likely.

- End-users do have access to efficiency information from manufacturers. However, many consider the premiums on energy-efficient motors too high and will tend to select the highest efficiency available in a standard motor without a price premium.

- For OEMs, major concerns in motor purchases are reliability and cost. While many OEMs are attempting to improve the energy efficiency of their equipment, motor efficiency is often a very small component of the overall efficiency. Nonetheless, a number of OEMs in the air conditioning, compressor, and fan and blower manufacturing industries have indicated that they do consider life-cycle costs of electric motors.

This article describes changes that have taken place in the motor controls market in the 1980’s and the impact of these changes on buyers and manufacturers.

Motor Controls Market

- There are about 100 companies, both large and small, that supply all types of motor controls ranging from simple starters to sophisticated variable speed drives.

- Due to a myriad of semiconductor products that affect motor controls, the industry changed more in the early 1980’s than in the previous two decades. The use of semiconductors in motor controls has 1) led to new applications and corresponding spurts in demand, and 2) presented new opportunities to those companies ready and willing to adapt, while ridding the market of manufacturers who are unable or unwilling to respond.

This article discusses the increasing role electronic adjustable speed drives are playing in reducing the energy consumed by HVAC systems.

ASDs in the HVAC Market

- Variable-air-volume (VAV) HVAC systems have gained wide acceptance since the mid-1970’s, but ASD use in VAV applications has historically been limited due to the high cost of ASDs. However, continued advances in ASD technology have lowered prices so that ASDs are now cost competitive in the long run with variable-inlet vanes and other methods used to control air flow. For applications from 5 to 30 HP, ASDs can be very economical and are used frequently.
• In ASD applications, it is important to make certain that all system components are compatible and can meet the required load. Unfortunately, all of the information needed is not always readily available from manufacturers.


This report was prepared for Pacific Power Company and discusses technical, economic, and market factors affecting the ASD industry.

*Key Players in the ASD Market*

• There are approximately 60 companies manufacturing integral horsepower ASDs. Of these, 16 are major U.S. companies that have been in the power transmission industry for more than 15 years. Another 15 are comparable off-shore companies. There are also many small newcomers to the market.

• The current ASD market appears to take the form of a pyramid. The small number of major drive manufacturers provide products to OEMs of driven equipment. The OEM products are purchased and re-engineered for niche markets by application engineering firms. These firms depend on a large number of service companies who comprise a network of design, sales, distribution, and maintenance. The service companies are often under direct contract with major drive manufacturers.

• OEM influence in the market is of great importance. It represents the channel of distribution through which the greatest amount of power transmission equipment flows to the end-user. Distributors are major players, but they are generally serving small OEMs and the after sales markets.

• ASD distributors account for over one-third of the sales of adjustable frequency drives, and they have had a major impact on the offerings of most ASD manufacturers. Distributor sales tend to be in the small size range.

• Evidence is strong that many manufacturers of driven equipment will enter the market with their own ASD product in an integrated design. In general, the larger the driven machine, the greater the likelihood that the machine builder will integrate an ASD into his product. This is because of the relative value of the ASD and the driven machine. Fans and pumps have lower costs relative to an ASD, and its therefore unlikely that most fan or pump manufacturers will enter the ASD market.

• Motor, controller, and driven equipment should be designed and manufactured based on an integrated design approach. Companies who have the capability to produce integrated designs are most likely to succeed in the marketplace.

• Sales representatives and distributors of driven equipment may be the most responsible for shaping the drive industry over the next 10 years. This is because there are many applications in which induction motor controls are advantageous but are not being used because equipment manufacturers sell alternative control solutions. Significant savings can be realized in the application of electronic ASDs where alternative flow control technologies, such as throttling valves and dampers, are currently being used.
• The impact of end-user specifications is dependent on the size and nature of the driven equipment and can also vary among industries. Small, general purpose drive equipment that is not process-critical (typically less than 15 HP) is now often considered a commodity. Drive equipment in this category often finds its way to the end-user via a distributor or OEM and generally is not purchased according to end-user specifications.

• End-users want to control things that are essential to production. Costs for production downtime is frequently in the tens of thousands of dollars per hour. It is therefore commonplace for the end-user to specify process-critical drive equipment, and it is important that this equipment be maintainable by on-site staff. For this reason, technological innovation is often discouraged.

• The application of ASD controls is a rather complex matter. Traditionally, the central engineering departments of major manufacturing companies provided technical assistance. Due to leaner times in the manufacturing sector, these central engineering services have been reduced or eliminated. Consequently, end-users are more dependent on vendor information. Because of this, vendors have largely been responsible for specification content, and their marketing efforts have frequently determined the specification and rating formats in a given industry.

• Two important segments of the ASD market, the HVAC industry and municipal facilities, are strongly influenced by consulting engineers and contractors. Contractors tend to relax end-user and consulting engineer specifications because of costs.

• There exists a large latent market in the end-user population for value-added engineering services to match driven equipment to a specific process and achieve optimum payback.

**Technical Issues**

• The potential for ASDs in the induction motor market looks favorable, but market acceptance is slow because of perceived disadvantages (i.e., starting torque problems, complex control requirements, and a sales and service network which is DC-based).

• Low speed torque production difficulties have been a problem in constant-torque applications. Field Orientation Control (FOC) products, which can overcome low speed torque problems, have been on the market for more than five years and have been proven in the field. Their market penetration has been minimal, in part because of historical difficulties. Many companies have previously tried to apply non-FOC type ASDs to loads with difficult torque demands and have been unsuccessful. The net effect of this difficult and complex situation has been confusion over the power ratings of ASDs, and drives have been routinely oversized to increase developed torque.

• Most ASDs are applied to centrifugal pumps and fans (variable-torque applications), in part because they typically demand a low starting torque and thereby avoid low speed torque production difficulties.

• Centrifugal pump and fan applications usually do not require precise speed control. On the other hand, approximately one-third of all constant-torque ASD applications are selected because of precise speed control capabilities.

• In terms of energy efficiency, the overall system should take precedent because the greatest efficiency improvements can be made in system processes (i.e., fluid handling, vapor...
EEM and ASD Markets in Wisconsin

The consequences of process losses are reflected back to the power line and are amplified by the inefficiencies of each component in the system.

- During the early years of ASD technology, the increase in electronics maintenance exceeded the decrease in mechanical maintenance. However, with today’s reliability this is not the case. In addition, the cost breakdown for an ASD induction motor combination is typically 70% for the ASD and 30% for the induction motor. With a DC motor and control, the reverse is true. The ASD induction motor combination exhibits a clear advantage because, unlike the DC system, the inexpensive component is the wear item.

- Due to a lack of awareness in the user community, the important issues of harmonic distortion and electromagnetic interference are not generally deciding factors in the selection of ASD equipment. However, problem-filled experience and utility concern are rapidly changing this.

- Some local electrical codes require that motor control equipment be listed and labeled by a nationally recognized testing laboratory. This has made the listing of equipment by Underwriters Laboratories a significant factor in the ASD market.

ASD Market Segments

- The most common ASD-driven machine is the centrifugal pump, followed by the centrifugal fan. The prospect for further ASD penetration into the air conditioning and refrigeration markets looks favorable. For example, while many HVAC designers use ASDs to control the speed of the supply-air fan, control of return-air fans has been ignored. This represents a potential application for ASD controls. Potential applications for ASDs also exist in supermarket refrigeration, screw compressors for industrial refrigeration, residential air conditioners and heat pumps, and centrifugal compressors for water chillers. These applications offer potential improvements in energy efficiency and process control.

- The paper industry could benefit from mill-wide control of pumps and from the adaptation of induction motor controls to electrically sectionalized paper machine drives. These applications mainly offer potential improvements in maintenance, operation, and production.

- The food industry utilizes thousands of small pieces of machinery, and ASD equipment is being increasingly adapted to this machinery by OEMs. This trend is expected to continue and will cause many ASDs to make their way into food processing facilities. Because of the predominance of small horsepower equipment (less than 5 HP), energy savings will be small; however, benefits also include increased productivity and decreased maintenance.

- The lumber industry can benefit from the application of ASDs to log handling and sawing equipment. Again, enhanced production and decreased maintenance are the key potential benefits, rather than energy savings.


This paper presents key issues related to efficient motor systems operation with a particular emphasis on electronic ASDs. Estimated potential for savings associated with ASD applications in the residential, commercial, and industrial sectors are given. Research,
development, demonstration, and training options to promote efficient motor systems are discussed.

Energy-Efficient Motors

• Energy-efficient motors usually carry a price premium of about $8 to $12 per horsepower. For a motor with high operating hours the payback is normally under two years.

• The price premium of buying an energy-efficient motor instead of rewinding a motor is in the range of $25 to $35 per horsepower. This leads to long paybacks of normally more than four years.

• In the low horsepower range, AC induction motors are being challenged by DC permanent magnet motors, which are as durable and have higher efficiencies. In small motors, efficiency improvements can reach 10% by converting to DC permanent magnet motors.

Adjustable Speed Drives

• Electronic ASDs are the dominant speed control technology now and in the foreseeable future. They are efficient, compact, and increasingly cost competitive.

• No single electronic ASD technology is clearly superior to other types. Pulse-width modulated ASDs dominate in the low to medium horsepower range because of their lower cost and good overall performance. Above a few hundred horsepower the choice of ASD technology depends on factors such as the type of motor, horsepower, speed range, and control requirements.

• ASDs can save energy in numerous applications, including pumps and fans, centrifugal compressors and chillers, and conveyors. In high performance speed control applications, such as mills, kilns, winders, machine tools, and robotics, variable frequency drives and AC motors can replace DC motors and drives, often with improved efficiency.


This article briefly discusses the state of the electric motor market at the time it was written.

Energy-Efficient Motor Market Penetration

• Although in 1986 it was a buyers market with intense competition, energy-efficient motors were holding their own in the electric motor market. In 1981, energy-efficient motors claimed approximately 4% of the total market. In 1984, that figure grew to 15%, and forecasts were for a future market penetration of somewhere around 20%.


This report was prepared for the New York State Electric Research Development Authority. It provides a technical review of electric motors and adjustable speed drives, discusses market aspects and implementation barriers, proposes a research agenda, and estimates conservation potential.
Energy-Efficient Motor Market Barriers

- Energy-efficient motors are a mature technology, but they have not found widespread acceptance because of numerous market barriers, including:
  - The improper application of energy-efficient motors (high slip, high starts/stops) has resulted in a damaged reputation.
  - Energy-efficient motors are not available in dealers’ stock when needed.
  - Higher first costs has prevented the integration of energy-efficient motors into OEM equipment.
  - The higher cost for energy-efficient motors is only accepted if operating hours and electricity costs justify it.
  - There is a lack of knowledge about life-cycle cost-benefit analyses, which show the favorable economics of energy-efficient motors.
  - There has been a lack of labeling standards.

Energy Saving ASD Applications

- Energy savings are cited as the principal reason for purchase of 40% of all ASDs. The others are purchased for process improvement reasons. Applications of ASDs that present energy savings potential are: wastewater treatment systems (distribution and sludge pumps, agitators); air handling fans; air compressors; cooling tower pumps; and centrifugal pumps in pulp and paper, dairy, and chemical industries.

ASD Market Barriers

- Only about 5% of motors sold have ASD controls. Market barriers include:
  - ASDs are expensive items with typical paybacks of three to eight years, yet customers expect paybacks of less than three years.
  - ASDs were initially beset with reliability problems, making customers skeptical of their performance. It is important that their improved reliability be widely known in the marketplace. XENERGY has found, however, that it is very difficult to obtain a customer reference list from manufacturers. In addition, industrial end-users are often unwilling to disclose why they bought ASDs and for what application because confidential process improvements are often involved.
  - End-users are reluctant to purchase ASDs because they typically don’t have the in-house capability to maintain complex electronics equipment. Manufacturers often counter this argument, noting that ASD users only need to replace circuit boards, which are readily stocked, or call in service engineers. However, end-users often are unable to even identify what needs to be replaced, and they are reluctant to call in service engineers because of the added cost.
  - Customers are aware of ASDs, but they do not always know all of their applications or savings potentials. This often prevents them from using ASDs in applications that could benefit them.
- Technical barriers to the implementation of ASDs include potential harmonics problems and mismatches between ASDs and motors. ASDs also face competition from eddy current drives and DC drives, which are better for some applications.


The purpose of this report was to provide an analysis of the technical, commercial, economic, and market status of energy-efficient motors in Canada. The study covered AC, polyphase, induction, squirrel cage electric motors in sizes ranging from 1 to 200 HP. Research was carried out by means of interviews with motor manufacturers, OEMs, distributors, engineering firms, large end-users, and electric utilities, as well as through literature search and review procedures.

*Energy-Efficient Electric Motors*

- There are three major supply channels for AC polyphase electric motors: 57% of motor units are channeled through OEMs, 32% through regional distributors, and 11% are sold directly to large end-users. Distributors sell 64% of motors to end-users, 21% to contractors and engineers, and 14% to OEMs. The majority of energy-efficient motor sales are directly to large end-users who purchase large volumes of motors or large horsepower motors.

- Comparison of total estimated sales of energy-efficient motors indicates that 60 to 70% of energy-efficient motor sales are directly from manufacturer to end-user. In addition, three large industrial users (pulp and paper, mining, and chemicals) probably account for about 90% of current energy-efficient motor sales in Canada.

- The study identified barriers to market penetration of energy-efficient motors:
  - The higher cost of energy-efficient motors coupled with relatively low electricity rates in Canada results in payback periods that are too long.
  - In general, there is little awareness of energy-efficient motors. Manufacturers are not heavily promoting their energy-efficient motor lines, and most vendors and consultants are not well informed about energy-efficient motors. In addition, utilities (with the exception of Ontario Hydro and BC Hydro) remain largely unaware and inactive with regard to energy-efficient motors.
  - The existence of multiple motor efficiency test standards that lead to competing efficiency claims, and the wide variation in actual motor efficiency levels among different manufacturers’ energy-efficient models contributes to confusion and skepticism in the energy-efficient motor market.
  - Because of the relatively low volume of energy-efficient motor sales and distributors’ concerns about inventory costs, energy-efficient motors must typically be special ordered. Coupled with an end-user aversion to motor downtime, this lack of availability impedes potential motor sales.
  - Potential buyers often choose not to risk possible problems with a new product.

- The most important factors that determine the user cost-effectiveness of buying a energy-efficient motor are duty cycle, electricity costs, incremental motor efficiency, and
incremental motor cost. Payback periods in typical commercial and industrial applications, which range from two to 5.5 years, are slightly higher than the paybacks of two to three years required by most private companies.

- Recommendations for promoting energy-efficient motors include: information and education programs, standardized testing and certification programs, financial incentive programs, and government and utility purchase policies.


This text provides the most recent comprehensive analysis on the opportunities for energy-efficient motor systems. It was written by a team of engineers, energy analysts, and program planners and covers technical, economic, market, and program or policy issues.

**Key Players**

- The key players in the electric motor market include: end-users, motor manufacturers, motor distributors, repair and rewind shops, original equipment manufacturers, consulting engineers and design-build contractors, manufacturers’ representatives, electric utilities, universities, government agencies, and trade associations.

**End-Users**

- The typical end-user is more restrictive with capital than with operating funds. Capital expenditures tend to be closely scrutinized and must receive approval at multiple levels in a company. Conversely, operating expenses are relatively easy to obtain because they are required for production. Operating budgets are usually based on last years expenses and are only questioned if they are seriously out of line. Because of this, companies tend to choose the least expensive equipment that will do the job and typically look for investments in energy saving measures with simple paybacks of two to three years or less.

- Maintenance staff often make purchase decisions for replacement equipment. Small motors (less than about 200 HP) are treated as a commodity; large motor and ASD purchases usually involve engineering staff or consultants.

- Motor maintenance practices are generally limited to what is needed to keep equipment running rather than to optimize performance and save energy. Maintenance and engineering staff typically have little incentive to pursue energy saving investments because savings do not benefit them directly.

- Firms with full-time maintenance staff or energy managers are more likely to be interested in energy efficiency. However, even in firms with energy managers motor systems historically have not received much attention because of often incorrect perceptions that motor system improvements have high capital expense, low rates of return, and low percentage savings.

- Replace or rewind decisions are typically made at the plant level (as opposed to being governed by corporate guidelines). Rewinding is generally more expensive than replacing a small motor and less expensive than replacing a large one. Upon burnout, motors less than or equal to 5 to 10 HP are typically replaced; motors greater than 40 HP are typically rewound.
• End-users are very concerned about downtime and reliability, and typically demand quick delivery of equipment.

Manufacturers

• In 1977, eight motor manufacturers accounted for over 75% of the North American motor market. Since then, the number of major manufacturers has changed little. Alternating current 3-phase squirrel cage induction motors account for more than 75% of U.S. drivepower input.

• Within the 1 to 200 HP range, nearly all manufacturers produce both standard- and energy-efficient lines of 3-phase induction motors. However, efficiency ratings are typically not consistent across manufacturers. Energy-efficient motors are usually available in T-Frame, open drip proof (ODP) or totally enclosed fan cooled (TEFC) enclosures in speeds of 1200, 1800, or 3600 rpm. Motors below 250 to 350 HP are regularly produced and stocked by manufacturers, while larger motors are custom built to purchaser specifications, including desired efficiency levels.

• Manufacturers sell motors through local and regional distributors and directly to large national companies and original equipment manufacturers. Large national companies and OEMs have sufficient buying power to demand the lowest possible price. To achieve these low prices, manufacturers sell directly to large customers with discounts as high as 50 to 70% off suggested list prices.

Distributors

• Most distributors are independent and most are small local operations. Large regional distributors, though few, account for a disproportionate share of motor sales. Many distributors also repair and rewind motors; most repair-rewind shops sell at least one line of new motors. Motor distributors primarily sell to small and medium size motor customers and some small original equipment manufacturers.

• Dealers may compete intensely on orders that go out to bid. The pressure to come in with the low bid means standard-efficiency motors will typically be offered unless otherwise specified. Distributors generally sell motors at a discount that varies with order size, how valued the customer is, and competition for the sale. Discounts are typically 30 to 50%, though high-volume dealers sometimes provide discounts as high as 60%.

• Due to the variety of products they carry, many distributors have neither the time nor the knowledge to provide detailed information on whether a energy-efficient motor is appropriate for a particular application. Manufacturers are typically the distributor’s sole source of technical knowledge.

• Because distributors generally stock only those motors for which there is significant demand, and because many customers will only buy a energy-efficient motor if it is in stock, market penetration of energy-efficient lines remains relatively low.

• Sales of high-efficiency products are hampered by the way orders are handled:
  - Many orders are processed over the phone, providing the dealer little opportunity to explain high-efficiency products.
EEM AND ASD MARKETS IN WISCONSIN

- Orders are often placed by maintenance or purchasing staff who are primarily concerned about cost and availability.
- Most distributor order desk personnel have very limited technical knowledge.

Original Equipment Manufacturers

• Original equipment manufacturers account for approximately 80% of all motor purchases, including almost all motors used in residential equipment, most motors used in commercial buildings, and a substantial portion of industrial motors.

• OEMs usually have engineering staffs who evaluate motors and other components and provide a list of acceptable products to the purchasing department. Once the approved vendors list has been developed, technical staff are not typically involved any further in purchasing decisions, the exception being for large or specialized equipment. For OEMs, the most important technical factor in motor evaluation is reliability, not energy efficiency.

• OEMs operate in a highly competitive market that encourages them to keep costs down; therefore, they generally use standard-efficiency components. However, when an end-user specifies a energy-efficient motor, then all OEM competitors are dealing with a comparable product cost increase. In this way, end-users can influence OEM practices.

• In many cases, particularly with small orders, OEMs are unwilling to use energy-efficient motors because they face difficulties in obtaining energy-efficient motors through supply channels geared to supplying large volumes of standard-efficiency motors.

• A study of the Canadian motor market found that energy-efficient models accounted for only about 1.4% of OEM motor purchases, compared with 3% of distributor sales and approximately 30% of sales directly from manufacturers to end-users.

Consultants and Contractors

• Consultants are generally hired by end-users to assist with large projects. Engineering consultants prepare designs and specifications and help oversee the bid and construction process. Design-build contractors handle both design and construction.

• Because consultants may be held liable if their designs fail, they stress reliability and are notorious for oversizing motors to provide for a wide safety margin. On the other hand, they face strong pressures to keep first costs down. Although they sometimes recommend high-efficiency equipment, it is commonly one of the first items to be dropped from the project if the bid is too high.

• Design-build contractors are increasingly being paid through fixed-cost contracts, placing great pressure on them to keep first costs down. Under these conditions, high-efficiency equipment with increased costs are rarely specified.

Adjustable Speed Drives

• Motor speed control offers the single greatest opportunity for energy savings in drivepower systems. Variable-torque loads (i.e., centrifugal pumps and fans) typically offer the greatest energy savings.
APPENDIX A: REVIEW OF THE LITERATURE

- ASDs are used for two basic reasons: to provide accurate process control or to vary the speed of a motor-driven device to match the load requirement. Significant energy savings can be obtained when varying the speed of a variable-torque load. Centrifugal machines, including most pumps, fans, and some compressors, often consume power proportional to approximately the cube of the fluid flow rate (or speed). In addition, pumps and fans are the largest users of motor energy. For these reasons, centrifugal pump and fan ASD applications present the greatest opportunity for energy savings.

- Manufacturers of ASDs include some large firms (both motor manufacturers and independent control manufacturers) and small specialty firms. Most manufacturers specialize in particular sizes or types of controls. Many make two lines of ASDs, each suited to either variable- or constant-torque loads. Inverter-based adjustable frequency drives are the most common for use with induction motors and account for well over 90% of ASDs currently sold.

- ASDs and other electronic controls are generally sold through distributors or sales representatives; most handle more than one type of equipment. Distributors stock products, while sales representatives generally place orders as needed. Both will often do design work for end-users in an effort to sell equipment they represent. Electronic controls are typically purchased in small quantities, and large price discounts are therefore uncommon.

- Except in the low horsepower range, ASDs are not treated as a commodity product. Due to their high price and high savings, they usually receive engineering attention from either in-house or consulting engineers.

- Problems in some early ASD systems have made some end-users wary of the technology. However, dramatic advances in semi-conductor technology over the past two decades has lowered the cost of electronic ASDs and improved their performance and reliability. As a result, electronic ASDs are becoming more and more attractive to potential users.

Promotional Programs

- Programs designed to overcome market barriers to energy-efficient products include: education; technical assistance; testing, labeling and minimum efficiency standards; financial incentives; and research, development, and demonstration projects.

- The success of dealer training programs offered by utilities hinges on incentives for the target audience. The lure of increased sales is the reason for dealer interest and attendance.

- Motor distributors and utilities generally report that the most effective motor brochures combine eye-catching graphics with easy to use graphs or tables that help the end-user determine the savings that energy-efficient motors can achieve in a particular application. Publications are distributed primarily through personal contacts between the utility’s industrial marketing engineers and large industrial customers.

- Both BC Hydro and the Bonneville Power Administration (BPA) have databases available that list efficiency and power factor at one-half, three-fourths, and full load for a wide range of three-phase induction motors sold in Canada and the United States, respectively. The BC Hydro database is part of the Power Smart program. The BPA database was prepared by the Washington State Energy Office.

- One reason motor systems are not properly optimized is that decision makers have neither the time nor the skills to do the necessary calculations. Calculation aids that estimate costs and
savings for a given application address this problem with the use of simple reference tables, slide rules, and computer programs. Spreadsheets to analyze the economics of energy-efficient motors are distributed to motor distributors and customers by both Ontario Hydro and BC Hydro. The North Carolina Alternative Energy Corporation (NCAEC) is developing a similar tool.

• Computer programs are also available to assess the costs and savings of ASDs. EPRI distributes a program (ASONI) to assess the economic feasibility of retrofitting fan and pump motors (7.5 HP to 2,000 HP) with ASDs. BC Hydro also has a program that it distributes to dealers and large customers.

• As cited in the article Automating Maintenance Management in the October issue of Plant Engineering, computer software is also available to track motor maintenance practices. These programs help track and schedule recurring maintenance tasks and tend to be geared toward large firms with at least a dozen maintenance workers on the payroll.

• On-site assessments and assistance range from simple computerized energy audits to detailed engineering analyses. In one innovative program, Carolina Power and Light provides free detailed audits to its large industrial customers that includes a motor survey with metering of motor kW use and focuses on units that, upon failure, should be replaced with energy-efficient motors. Auditors recommend that customers mark candidates for replacement with yellow paint and instruct maintenance staff to purchase new motors when a yellow dot motor fails. Follow-up surveys indicate that this system works well in practice.

• Because rebates provided by the local utility make energy-efficient replacement motors attractive for many customers, Walco Electric, a motor vendor in Providence, Rhode Island, provides free motor analyses for customers and potential customers. The key to the program’s success is knowledgeable staff who can prepare motor inventories and analyses that customers can depend on. Walco Electric estimates that sales of motors have increased approximately 30% due to motor audits and utility rebates.

• To address the need for quick motor replacement, Pacific Gas and Electric’s motor program included procedures to qualify applications over the phone. When a motor failed, the customer could quickly purchase a new energy-efficient motor and still qualify for a rebate. Alternatively, Southern California Edison allows customers to receive rebates for a reasonable number of motors purchased for inventory stock. Several other utilities have adopted this latter policy.

• Efficiency information is critically important in the new motor market. Nevertheless, some manufacturers do not publish efficiency data for both their standard and energy-efficient motors in the main body of their catalogs. Some relegate efficiency data for standard motors to an appendix or supplement.

• In 1989, NEMA published a standard that lists the nominal and minimum efficiency a motor must meet or exceed in order to be designated as energy-efficient. NEMA is working to have user organizations, electric utilities, and government agencies adopt this definition for purposes of preparing motor specifications and determining eligibility for energy-efficient motor incentive programs.
Program Needs and Recommendations

• Most end-users and many consulting engineers lack adequate information on ASD performance, economics, and applications. Handbooks and training courses that emphasize practical applications and one-on-one technical assistance are needed. In particular, customers need assistance monitoring load profiles in fan and pump operations. To facilitate monitoring efforts, New England Electric System lends test equipment and provides training in its use.

• ASD demonstration projects are needed to collect detailed data on costs, savings, and reliability to overcome the concerns of skeptical end-users.

• Motor users need education programs and instruction materials that focus on the economics of rewind versus replacement decisions, on the advantages of core-loss testing of motors before and after baking, on monitoring procedures that ensure burned out motors are replaced when justified, and on how to select a rewind shop that uses non-damaging rewind procedures.

• Rewind shops should be educated on procedures for minimizing core damage and should be encouraged to test all motors for core damage before and after rewinding. Utilities could provide incentives for the purchase and use of necessary equipment. A certification program for rewind shops is another option.

• Training courses and manuals for maintenance staff and their supervisors can improve maintenance practices in the field. Users should be encouraged to measure motor efficiency when they first purchase a motor and then regularly thereafter, especially before and after repairs, to spot problems.

• Available evidence indicates that motor rebate programs with the following attributes do best:
  - Are easy for dealers and end-users to understand and participate in.
  - Are marketed by utility reps through regular contacts with decision-makers.
  - Are coordinated closely with dealers, and may include incentives for dealers to stock and market energy-efficient motors.
  - Provide high incentive levels to the extent justified by a utility’s avoided costs and its conservation and load-management objectives.
  - Include an aggressive education component for both dealers and end-users.


This paper discusses the DC permanent magnet motor market and the resulting displacement of AC motors.

DC Permanent Magnet Motors Displace AC Motors

• The long held division between the AC and DC small motor markets is beginning to blur. In the fractional and low horsepower range (below 15 HP) the AC induction motor is being
challenged by the DC permanent magnet motor. This is particularly true in the OEM market that serves end-use applications such as fans and compressors, household appliances, and electronic equipment cooling.


This paper discusses a study by Marbek Resource Consultants for Hydro-Quebec. The study’s objectives were to gain knowledge of the Quebec’s current industrial drive market, identify applications that offer the greatest opportunities for improved electrical efficiency, and quantify the potential savings for each opportunity.

**Electric Motor Market**

- Nearly half of the new motors purchased annually by industry are done so via OEMs, approximately an equal amount are sold directly to end-users, and only approximately 10% are sold through distributors.

- OEMs’ highest priorities regarding motor purchase criteria are reliability and first cost, not efficiency. This study found that less than 1% of industrial purchases of OEM equipment addressed motor efficiency.

- In Quebec, 1.5 to 2 industrial motors are rewound for every new one purchased. Each time an old motor is rewound and placed back into service, an opportunity to upgrade to a energy-efficient motor is lost. In addition, there is no regulation of rewind efficiency; therefore, energy efficiency gains realized when a new energy-efficient motor is purchased can be lost when the motor is rewound. For these reasons, the motor rewind loop within the distribution network warrants separate analysis.

- Electric utility energy-efficient motor programs typically target AC induction motors in the 1 to 200 HP size range. Although these smaller motors account for approximately 94% of annual motor sales in Quebec, AC induction motors over 200 HP account for nearly 25% of the total technical conservation potential. Consequently, AC induction motors over 200 HP warrant greater emphasis.

- AC induction motors dominate the current industrial market in Quebec, and the trend is toward an even greater future role as AC motors in conjunction with electronic ASDs replace conventional DC motor/drive combinations.

- Energy-efficient motor sales and stock penetration seem to be increasing slowly, with energy-efficient motors accounting for an estimated 5 to 10% of industrial motor sales and about 1 to 3% of Quebec industrial motor stock.

- A survey of Quebec’s major industrial plants indicates that over 75% of senior plant engineers have not even heard of energy-efficient motors. This stresses the importance of ongoing educational and promotional programs.

- There are three practical situations when the opportunity exists to purchase a energy-efficient motor instead of a standard model. From the perspective of a utility trying to promote energy-efficient motors, these are listed below in order of increasing difficulty. A fourth option, replacing an in-service motor, is considered to have a prohibitively long payback.
A new motor is purchased to either expand existing capacity or to replace a motor that is being discarded.

An existing motor fails and must either be rewound or replaced.

A new piece of OEM equipment is purchased.

- Review of motor load data provided by industrial plants indicated that approximately one-third of industrial motors run at average load factors of less than 50%. Replacing these oversized motors with properly sized energy-efficient motors could provide significant annual energy savings.

- Better utility collaboration in setting a common definition of energy-efficient motors would benefit end-users, manufacturers, distributors, and utilities in promoting energy efficiency.

**ASD Market**

- While sales of DC motor/drive sets are decreasing by about 5% per year, electronic adjustable speed drive sales are growing by approximately 10 to 15% annually. In fact, major drive suppliers estimated that greater than 95% of all adjustable speed drive sales are now ASDs. However, total sales remain low because few adjustable speed drives are being purchased.

- Initial cost and length of payback are important impediments to increased purchases of ASDs by industrial users. In addition, there is a substantial level of resistance based on the perception of the technical complexity of the technology and the fear of disrupting production. The majority of plant operators surveyed indicated a need for technical assistance in identifying the most advantageous applications in their plants and a greater assurance from manufacturers regarding after sales service.

- In the short term, ASD promotional efforts are expected to result in a much slower rate of market penetration than for energy-efficient motors. In the long-term, however, the ASD market offers a much greater savings potential. Marbek Resource Consultants recommended industrial ASD applications greater than 50 HP as the current lower bound for economically attractive investment by Hydro-Quebec.


This paper briefly discusses adjustable frequency drive technology, including applications and advantages of electronic adjustable frequency drives. Marketing techniques are also examined.

**Marketing of ASDs**

- ASDs have conventionally been marketed through manufacturers’ sales representatives and independent industrial distributors. Most ASDs greater than 20 HP have been sold direct from the manufacturer to the end-user or OEM via field sales representatives. These field sales personnel are usually able to provide effective product presentations and discuss applications.

- Industrial distributors have been an important factor in selling ASDs less than 20 HP. They usually inventory standard drives and provide quick delivery, but their technical knowledge
EEM and ASD Markets in Wisconsin

has often been limited. They have tended to handle drives as a commodity. In addition to ASDs they usually inventory and sell a large variety of industrial products.

• It is expected that industrial distributors will become more important in the ASD market. Many distributors are putting more effort into training their sales personnel on the operation and application of ASDs. Distributors who offer their customers a wide range of technical services, such as application assistance, packaging of drives and other products for systems requirements, and trouble-shooting and repair services, will be major factors in the market.

• Potential marketing techniques for ASDs include: energy pay-back analyses, which can show that the equipment will literally pay for itself over a given period; performance guarantees that allow the purchaser to return the equipment for full credit if it does not perform in a mutually agreed upon manner; and systems packaging that combines an ASD with a motor and other peripheral equipment to meet the performance demands of a specific application.


This report investigates motor repair and rewinding practices in the Bonneville Power Administration region. Interviews were conducted with both rewind shop personnel and industrial decision makers. Data was gathered to examine specific procedures in the motor rewind process and assess the impact on motor efficiency, determine the extent to which these procedures are used, and calculate the cumulative energy savings available from changing these procedures. The end-user decision process regarding motor rewinding was also investigated.

Motor Rewind Practices

• Decisions about motor rewinding in industry are typically made at the plant level rather than the corporate level. The title of the person making the decision varies with the size and complexity of the plant. Typically it is either the head electrician, lead maintenance person, or plant manager.

• In addition to replacing motors upon failure, many plants remove operational motors to prevent motor failure from shutting down a process line. Some motors are replaced when there are signs of degradation; others are replaced or rewound at regularly scheduled intervals. In most cases preventative maintenance programs are used to detect imminent motor failure. The most frequently used technique is to check for bearing noise. In this study, the percent of motors removed before complete failure was found to be highest in the pulp and paper industry.

• Industrial plants use a variety of methods to reduce downtime due to failed motors. These include: stocking spare motors in the most common sizes and for critical applications, preventative maintenance programs, minimum turnaround time for rewinding motors, and back-ups for critical equipment that can cause safety or environmental hazards upon failure.

• The decision to rewind or replace a motor is primarily driven by first cost. For most industries, it is cheaper to replace motors under 5 HP and to rewind motors larger than 10 HP. Unique or hard to replace motors, including most U-Frame and special order T-Frame motors, are also more likely to be rewound. Many old, standard-efficiency motors are U-Frame motors. The type or extent of failure can also be a factor. Unless there is a
predetermined policy on motor replacement, the suggestion of the rewind shop to rewind or replace a motor is usually followed. The salvage value of the motor does not seem to play a role.

- In order to promote competition or keep people honest, most plants use more than one rewind shop. Some plants also use one shop for smaller motors and another for larger motors. Important criteria for choosing a rewind shop include: service, quality, turnaround time, cost, and shop location. Of these, service and quality seem to be the strongest marketing points.

- Quality is a major goal for nearly all the rewind shops that were interviewed. Nonetheless, some shops use certain techniques in the rewind process that can potentially degrade motor efficiency and service life. An educational campaign to improve current rewind practices could have a major impact.

- This study found the population of motors being rewound broke out as follows: 32% were U-Frame motors, 62% were T-Frame motors, and 6% were energy-efficient motors. These figures will likely change over time as equipment with U-Frame motors are slowly replaced and more energy-efficient motors are installed. In addition, 11% were small, single-phase, fractional horsepower motors, 24% were three-phase motors below 5 HP, 48% were in the 5 HP to 100 HP range, and 17% were larger than 100 HP.


This paper examines the benefits of promoting energy-efficient motors, the barriers involved, and the evolution of motor incentive programs at New England Electric.

**Barriers to the Penetration of Energy-Efficient Motors**

- Some customers have experienced early failures of energy-efficient motors that have resulted in substantial costs and downtime. These failures were attributed mainly to improper sizing and installation and could have been easily avoided. Unfortunately, because people are typically wary of change, many customers mistakenly perceived these failures were due to a lower reliability of energy-efficient motors.

- Customers are frequently unfamiliar with the favorable life-cycle costs of energy-efficient motors and the often short payback periods. Motor incentive programs should provide customers with an analysis of the dollar savings that would result from the installation of energy-efficient motors in their facilities.

- Targeting the individuals within a company who are authorized to make motor purchase decisions is extremely difficult. Incentive programs should be designed to educate both purchasing agents and facility managers about the life-cycle cost benefits of energy-efficient motors.

- Customers are generally reluctant to shut down plant operations to replace operating standard-efficiency motors with energy-efficient motors. These shutdowns can be very costly. In addition, plant managers are burdened with so many responsibilities that the replacement of an operating motor is typically not a priority, even if it is viewed as an attractive option.
When motors fail, customers often replace them with identical models to avoid any problems with installation and thereby limit downtime. Since roughly 95% of operating motors are standard-efficiency, new purchases are often also standard-efficiency motors. In addition, motors greater than 10 HP in size are usually rewound rather than replaced because of lower capital costs.

This annual report presents data on the quantity and value of shipments of motors and generators in the U.S.

Motor Sales Data
Since 1960, the Bureau of the Census has annually compiled national data on motor sales. The quantity and value of shipments is reported. For integral horsepower motors data is broken out by AC and DC. AC motors are split into single phase and polyphase, with polyphase further broken down by frame size. No distinction is made for energy-efficient motors.

This article discusses the state of the electric motor market at the time of its writing. It discusses supply, demand, and price issues, and points out market trends.

Electric Motor Market
There has been a major trend toward consolidation of the major players in the motor market. These consolidations, which reflect a push by motors purchasers to buy from a single source, should offer buyers one-stop shopping.

One area that still promises growth is the energy-efficient motor market. This market segment is becoming more economically appealing to the customer. Although they are priced 10-25% higher than a standard motor, in many cases the customer can realize attractive paybacks with an energy-efficient motor.

This article discusses trends in motor manufacturing, including automation, innovation and communication with OEMs, and future technical advances.

OEM/Manufacturer Cooperation
OEMs are requiring quality improvements in motors, largely because of the National Appliance Energy Conservation Act. With these demands has come increased cooperation between OEMs and motor manufacturers. Many OEMs are looking at integrating motors within their products and some are designing their products around the motor. In return, motor manufacturers are designing motors for use in specific OEM applications.
Recommendations for Further Literature Research

This section discusses information that may assist with the conduct of further research and gives suggestions for further research.

Keywords

In searching indexes and databases for pertinent information, the following key words and keyword combinations were found to be most useful:

- “Motors & Generators”
- “Electric” or “Electrical” and “Motors”
- “Marketing” and “Motors” and “Electric”
- “Adjustable” or “Variable” and “Speed” or “Frequency” and “Motors” or “Drives”

It should be noted that when conducting these computerized literature searches, it is important to screen out sources with the terms “vehicle” or “automobile.”

Table A-2  Journals that included information on the EEM and ASD markets

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<thead>
<tr>
<th>Journal</th>
<th>Information</th>
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<tbody>
<tr>
<td>Appliance Manufacturer</td>
<td>OEM market trends, interactions among OEMs and manufacturers</td>
</tr>
<tr>
<td>Consulting/Specifying Engineer</td>
<td>technical information, applications and design oriented</td>
</tr>
<tr>
<td>Energy User News</td>
<td>products introduced by manufacturers</td>
</tr>
<tr>
<td>Purchasing</td>
<td>general market trends</td>
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Topics for Further Research

For the reasons described below, certain key topics may warrant further research. These include: the ASD market, the motor rewind market, and the OEM market.

ASDs offer the greatest savings in drivepower applications; however, they are expected to have a much slower market penetration than energy-efficient motors. In addition, the ASD market is less well defined, and utility incentive programs for ASDs are not as far along as motor incentive programs. Further research on the ASD market is therefore warranted. This should include: a characterization of the electronic ASD market with regard to energy savings potential and identification of key energy saving applications, a closer examination of the potential energy savings for ASDs in constant torque applications, an investigation of appropriate incentive structures for ASD applications, and program options to improve end-user awareness and meet technical information needs regarding ASDs.

Motor rewinding both competes with the option to upgrade to an energy-efficient and threatens to degrade existing motor efficiencies. For these reasons, a deeper understanding of the potential
to affect the motor rewind market is recommended. The possibility of working with the motor rewinding industry to ensure proper rewinding practices, as well as to encourage the life cycle cost analysis of rewinding versus upgrading motors should be investigated further.

Because OEMs are such a dominant player in the electric motor market, a further understanding of the potential to influence this market segment is needed. OEM practices have been affected by appliance efficiency standards, though not necessarily in the area of motors. To date it seems that end-user specifications have been the primary force influencing OEM motor practices. More concerted efforts to affect this market should be investigated. Specifically, key players in the OEM market should be surveyed to determine what would motivate them to incorporate energy-efficient motors in their products.

Sources of Further Information

**EPRI Studies**

Three studies currently underway at EPRI will address motor and drive applications in the pulp and paper, food processing, and textile industries. In addition, a profile of the motor rewind industry is being developed. These studies will cover technical and market aspects of energy-efficient motors and adjustable speed drives. EPRI reports are available from:

- Research Reports Center
  - P.O. Box 50490
  - Palo Alto, CA 94303
  - (415) 965-4081

Reports are free of charge for EPRI members or other organizations who have established an information exchange agreement with EPRI.

**Market Research Firms**

Numerous firms provide market research services. Two companies identified during this study that have reports available covering the electric motor and adjustable speed drive markets are Ducker Research Company, Inc. and Future Technology Surveys, Inc. (FTS).

The Ducker Research Company report is entitled Syndicated Study of the Current and Expected Future Market for DC and AC Adjustable Speed Drives and Position and Motion Control Devices. This study was available from Ducker Research for $6500 at the time of publication, but is now being offered for a price of $4000. The AC and DC portions of the report are now available individually for $2000 each. This study distinguishes five geographic regions in the continental U.S., but information on each specific region cannot be purchased separately. It is based on approximately 300 phone and personal interviews with industry professionals.

Study topics include: current market size, recent market changes, projected market sales, distribution channels, technological trends, issues of concern to the ASD industry, OEM and end-use customer industries, nature of purchase decisions, and a historical perspective. Current and projected market size for AC and DC drives is based on dollar and unit sales, and is broken out.
APPENDIX A: REVIEW OF THE LITERATURE

according to the following criteria: horsepower, geographic region, new vs. retrofit installation, standard vs. custom drive, distribution channel, and OEM and end-use customer industry as defined by SIC code and process description.

The FTS survey reports are entitled *Energy Efficient Motors* and *Variable Frequency Motor Drives*. They are available from FTS for a price of $200 each and can be obtained for a 30-day trial period. These reports are based on surveys conducted by written questionnaire. The *Energy Efficient Motors* report is based on responses from 11 electric motor company executives, while the *Variable Frequency Motor Drives* report draws on the responses of seven drive manufacturers.

Each of the FTS reports is approximately 30 pages in length and covers topics such as: recent advances, user trends, current and projected market size, current and projected market distribution, market share leaders, factors contributing to market share shifts, next generation products, and potential market and technological pitfalls.

**ASD Directory**

The Power Electronics Application Center in Knoxville, Tennessee, publishes the *ASD Directory* which contains a listing of manufacturers and their products, by type of electronic ASD technology, in size categories from 7.5 to 20,000 HP. Case studies, average equipment list prices, and average installation costs are also included. The directory is updated about every three years. The directory is available from EPRI at the address listed under *EPRI Studies.*
APPENDIX B: PERSONAL CONTACT SUMMARIES

To obtain the most up-to-date and pertinent information, individuals involved in the field of electric motors and adjustable speed drives were identified and contacted. This included individuals from electric utility companies, trade associations, universities and research centers, government agencies, and private research and consulting firms. Various topics regarding the electric motor and ASD markets were covered.

Trade associations such as the National Electrical Manufacturers Association (NEMA), the Electrical Apparatus Service Association (EASA), and the Small Motors Manufacturers Association (SMMA) were contacted to investigate their roles in the motor and ASD markets. The availability of sales data from NEMA, SMMA, and the U.S. Department of Commerce was investigated. Eight utility motor program managers were contacted to learn about their programs and gain insight from their experiences with the motor and ASD markets.

Twenty-five individuals were contacted. One provided notes from manufacturer and distributor focus groups. Conversations with nine personal contacts were individually summarized. Responses to the questions posed to the eight utility program managers were compiled and summarized collectively. The summaries are presented in this section.

   This discussion explored the Electrical Service Apparatus Association’s (EASA) relationship to energy-efficient motor programs.

Motor Rewind Market

- EASA is an industry association of approximately 2400 electric motor repair shops in the U.S. This accounts for about half the rewind shops in the U.S. Most members are small companies ranging from 2 to 200 employees, with an average of 12 employees. These shops repair, rewind, and sell electric motors and related equipment.

- EASA has not addressed the issue of utility-sponsored energy-efficient motor incentive programs. According to the contact, these programs will adversely affect motor rewind shops who make the majority of their profit on motor repairs. However, he said that EASA and its members would not try to stop people from purchasing energy-efficient motors. Instead, he suggested that repair/rewind shops will adapt by reducing repair crews and increasing new motor sales. Currently, motor repair shop business is divided roughly equally between motor repairs and motor sales.

- If utilities want to involve EASA in their motor programs, EASA will try to cooperate. EASA is governed by a board of directors, although members can override board decisions. Members have input through chapter meetings and mail surveys. Depending on the nature of EASA’s proposed involvement, the board would likely review the proposal and would possibly take the issue to the members for their input.
This discussion investigated work being done by the Electric Power Research Institute (EPRI) in the areas of motors and adjustable speed drives.

*EPRI Studies*

- EPRI is currently conducting studies regarding technical and market aspects of energy-efficient motors and adjustable speed drives. These studies are focusing in detail on particular industrial sectors. Three studies currently underway are addressing the pulp and paper, food processing, and textile industries. In addition, a profile of the motor rewind industry is being developed.

This discussion examined the role and function of the Small Motor Manufacturers Association, including the collection of motor sales data.

*Small Motor Market Data*

- The Small Motor Manufacturers Association (SMMA) is an industry organization representing manufacturers, suppliers, users, and other interested parties involved in the manufacturer of fractional and subfractional (less than 1/4 HP) horsepower motors. Manufacturers include those in the automotive, appliance, and office equipment markets. The Association is international in scope, but mainly represents U.S. manufacturers. Although their focus is on fractional and subfractional horsepower motors, some member manufacturers produce a full range of motor sizes.

- The Association conducts a quarterly market survey that typically represents 20 to 25 of their approximately 120 member companies. They collect sales data on AC and DC motor shipments and bookings. These data are broken out by end-use market (i.e., appliances, office equipment, and transportation). There is no distinction between standard and energy-efficient motors, motor size, or motor type. The SMMA also publishes voluntary motor standards that have been written and approved by their membership.

- The SMMA also conducts Quickie surveys on a wide range of business topics and association issues. The results of a September 1991 survey on motor energy efficiency showed that 17 of 30 members expressed that work to improve the energy efficiency of their product was a high or medium priority. Twenty of these companies cited customer requirements as the driving force, while eight cited competitive advantage. Fifteen of 27 members felt that motor efficiency improvements would come as a result of existing design improvements, while nine cited new materials as the potential source of improvement.

This discussion explored XENERGY’s efforts to track sales and shipments of energy-efficient lighting equipment as a means of measuring the impact of a utilities energy-efficient lighting rebate program.
Obtaining Sales Data

- XENERGY is working on a regional sales data collection program for energy-efficient lighting products. The method XENERGY has developed is outlined as follows:
  - Identify similar utilities who do not have rebate programs to use as a control group.
  - Identify manufacturers who supply products to the geographic areas of interest.
  - Identify the products of interest produced by each of the manufacturers.
  - Contact manufacturers and initiate data collection. Collect data for the past three years to establish a baseline, and collect data quarterly for the next three years.
  - Compile and analyze the data to estimate the impact of the efficient lighting incentive program on regional lighting sales. This would include an estimate of program freeridership.

- The primary concern of manufacturers is the confidentiality of their sales data. Providing a confidentiality and nondisclosure agreement seems to have overcome this barrier. All the major lighting manufacturers have agreed to participate; however, it remains to be seen how many will actually come through with data.

- Because the project is not a priority for them, manufacturers have been very slow to respond with data. One manufacturer was asked if a financial incentive would help speed the process. He said it would not make a difference and indicated the slow response was due to a lack of available personnel.

- A negative response was received from the majority of manufacturers to the proposal of compiling all the collected sales data and distributing a copy of this generic data to each of the participating manufacturers. They hold this data as highly confidential and do not like the idea of distributing even aggregated data to their competitors.

- It is helpful to clarify with the manufacturers that their cooperation is in their own interest because the rebate programs boost their sales.

- It is important to structure the program so it is convenient for the manufacturers. Forms should be simple to use. Geographical areas of interest and corresponding zip codes should be provided for the manufacturers’ convenience.

- It may be necessary to go to the distributors and track the distribution of products, as well. Although permission has been granted from the manufacturers to obtain this information, their distributors have not been approached.

5. Assistant Manager, Statistical Department, National Electrical Manufacturers Association, phone conversations, August 23 and September 16, 1991.
   
   This discussion investigated the content and availability of NEMA sales data.

NEMA Sales Data

- NEMA does break out electric motor sales data into energy-efficient and standard-efficiency categories. They have been doing this since at least 1982. The break-out follows the NEMA definition of an energy-efficient motor. These data are compiled nationally. A regional sales
report is also produced, but it does not break out the energy-efficient motors. A national report that breaks motor sales down by SIC code in 3 HP ranges is also produced.

- NEMA tried to establish a system for collecting ASD sales data broken out by horsepower, but the effort was dropped due to a lack of manufacturer participation. Currently, they have revived this effort. They have received data from some manufacturers, but are waiting for data from others. No reporting of the data has been done to date. The lack of cooperation from manufacturers seems to be due to a lack of available personnel and a strong reluctance to release sales data they consider highly confidential. The value of the aggregate sales data they would receive in return does not seem to be an adequate incentive to secure their participation. There is no apparent reason why NEMA has had greater success collecting sales data from motor manufacturers than from ASD manufacturers.

- NEMA sales data are confidential. It is available only to manufacturers who are NEMA members and submit their own sales data. Data are also available, for a fee, to manufacturers who are not eligible to become NEMA members (foreign companies).

This discussion explored the Bonneville Power Administration’s experience with energy-efficient motor programs.

Motor Programs

- Motor programs must be designed so that they are simple and convenient for end-users to participate. This can conflict with the need to collect data for program impact evaluation and verification.

- Program goals must be determined from the outset. If the motor program is intended to acquire energy and demand savings as part of an integrated resource package, program design must incorporate mechanisms for evaluating program impacts.

- For large companies with centralized purchasing and facilities that cross utility service territory boundaries, unique difficulties may arise. Utilities may require strict verification procedures to ensure that motors end up in their service territory. End-users may face complications if neighboring utilities have varying program requirements and incentives.

- Many old standard-efficiency motors are U-Frame types, while new energy-efficient models are T-Frame types. A significant added cost may be incurred when the upgrade to an energy-efficient motor requires a frame change.

- Most motors under 15 HP are replaced, while motors greater than 20 HP are typically rewound.

This discussion investigated a rewinder’s view of the motor rewind market.
**Motor Rewind Market**

- Most motors received for repair are specialty items (i.e., special frames, specialty motors). These motors are not affected by energy-efficient motor rebate programs because energy-efficient models are generally not available for specialty motors. The contact estimates that only about 10% of the motors received in his shop for repair could be replaced with energy-efficient models.

- Many, but not all, rewind/repair shops sell new motors. The percentage of new motor sales varies greatly among repair shops, ranging from no sales to nearly 100% of sales. Typically, the smaller shops focus on their repair business.

**Ontario Hydro’s Motor Program**

- Ontario Hydro (OH) has developed a comprehensive program that directly addresses the customer, provides rebates, provides education, and creates productive relations between the utility, the distributors, the manufacturers, and the end-users. This program has involved nationwide coordination with both manufacturers and all Canadian utilities.

- OH has worked very closely with motor distributors, including offering them a $3/HP rebate, conducting seminars, and keeping them up to date with newsletters. This has succeeded in getting distributors to stock and promote energy-efficient motors.

- The OEM channel is very hard to address; it is very diverse and very price sensitive. OH is trying to get customers to demand energy-efficient motors in original equipment and is offering a $3/HP rebate to OEMs to offset the higher cost of energy-efficient motors.

- OH has coordinated with all utilities across Canada to establish standard-efficiency levels for rebates. Key players in the motor market favor this consistency. OH has also presented each of the major motor manufacturers with a five-year program plan. This has allowed manufacturers to structure their five-year production plans accordingly.

- The marketing practices of motor manufacturers are immature. Manufacturers typically do not keep comprehensive and detailed sales data. Consequently, Ontario Hydro hired a contractor to obtain sales data from all the major manufacturers and to compile this data so that the impact of the incentive program can be evaluated. This is an on-going program.

- Incentive programs that encourage the sale of energy-efficient motors cause concern among rewind shops. OH is hoping to work with rewind shops and get them to perform comparative pay-back analyses for motor rewinds versus new energy-efficient motor purchases. They also want to interact with rewind shops to ensure motor rewinds are performed without sacrificing motor efficiency.

**References**


9. “Motor Focus Group—Notes,” Georgia Power, Atlanta, GA, May 1991. Three focus groups of up to 11 manufacturers and distributors were conducted on May 24, 1991, to receive comments about Georgia Power’s proposed motor program and to gain
information about the motor market in Georgia. Notes were taken by Georgia Power personnel during the focus groups and are summarized here. Due to the limited number of respondents, it is suggested that the reader exercise caution in generalizing the results.

- The efficiency nomenclature recognized throughout the motor industry is as follows: standard-efficiency refers to low efficiency motors, high-efficiency includes the next category up, and premium-efficiency is the highest efficiency motor available. Suppliers recommend these terms be used in promotional programs.

- About 80% of the motors sold by distributors are stock, off-the-shelf items. Key factors in motor purchases from distributors are price and availability. Distributors therefore stock an adequate supply of the most popular motor lines.

- The key decision maker varies from company to company. Titles of motor purchasers include: owner, plant manager, maintenance engineer, and purchasing agent. Larger companies typically rely on internal expertise for guidance in the purchase decision; smaller companies rely on the manufacturers and distributors.

- The decision to buy a motor is usually based on prior buying behavior. Customers tend to want new motors like their old ones to minimize complications with installation.

- According to manufacturers and distributors, information about energy-efficient motors is lacking. Even though many customers are interested in energy efficiency, the higher capital cost of energy-efficient motors often thwarts their sale. Focus group participants felt a serious effort at educating customers would be beneficial and could include pamphlets, brochures, and training. It was agreed the utility would have high credibility as a source of information about motors.

- The most important factor influencing the sale of an energy-efficient motor versus a standard unit is payback. Vendors typically do a payback analysis only when requested by the customer. Generally, motor customers like to see a one-to-three year payback, and a rebate program can ensure this.

- Most of the big companies recognize the benefits of energy-efficient motors and are already using them as standard practice. The education process should therefore be directed at small to medium-sized companies.

- Some customers have the perception that energy-efficient motors run hotter and don’t last as long as standard-efficiency motors.

- Due to the nature of their design, energy-efficient motors cannot be easily upgraded to a higher horsepower. In contrast, standard motors are generally heavier and, when older, have oversized frames, making size increases possible. This is one reason plants prefer standard-efficiency motors.

- The choice between rewinding an old motor and buying a new one is an economic one, and the economics generally favor rewinding.

- When rewinding, more copper and special lubricating greases are generally needed to ensure an energy-efficient motor remains efficient. Not all rewind shops are capable or may be willing to perform the necessary work. It is advised that the utility may want to establish minimum requirements for the rewinding of energy-efficient motors.
• Most of the reputable vendors have established trusting relationships with their major clients. In addition, vendors/distributors are very interested in working with the utility to promote premium-efficiency motors, and those in the focus group indicated a willingness to fill out some associated paperwork. Involvement of vendors in the utility’s motor program is therefore a real and desirable opportunity.

• Vendors/manufacturers are aware of other utility motor rebate programs. They noted numerous advantages:
  - Rebates induced energy-efficient motor sales significantly.
  - Motor rebate programs generated publicity.
  - Rebate programs helped make customers more receptive to other energy conservation applications and services.
  - The only negative comment was that the rewind business may shrink with the increasing use of premium-efficient motors.

• Focus group participants made several suggestions based on their knowledge of other utility programs and the market:
  - Some testing of manufacturers’ claims is needed to ensure compliance and keep vendors honest.
  - It may be desirable to have a list of approved motor efficiencies and vendors.
  - An incentive in the range of $10/HP is expected to elicit a good response from customers.
  - A sliding scale rebate program that pays more dollars per horsepower as motor efficiency increases may be desirable.
  - In keeping with other utility programs, some focus group participants felt minimum efficiency standards that are over and above NEMA standards should be considered. Most participants thought NEMA standards should be followed. Some felt rebates should be based on guaranteed minimum efficiency rather than nominal efficiency.
  - The program should cover motors from 1 to 250 HP in size. Motors over 250 HP tend to be about equally efficient, but it is felt there is enough variation in the efficiency of large motors under 250 HP to justify their inclusion.
  - Use energy audits to promote the use of energy-efficient motors, including estimates of savings and paybacks.
  - Target top management with communications and site visits explaining the benefits of energy-efficient motors. Top management will likely be more receptive to investments in energy conservation and can influence employees at lower levels to consider energy-efficient motors.
  - Several participants suggested that, because people tend to use much bigger motors than they need, the program should include incentives for motor downsizing.
- Work with local distributors to keep them informed and make sure energy-efficient motors are available. A program that provides incentives to distributors, as well as customers, was favored.

- Several participants suggested the utility work with Electrical Apparatus Service Association (EASA) repair facilities to promote and implement the program. They felt EASA members could do a good job promoting the program and auditing participating facilities to ensure program requirements are met.

- Overall, the energy-efficient motors program should be simple. Application forms should be short and easy to fill out; program guidelines should be clear and easy to understand.

- There was a mixed reaction to the requirement that old motors be traded in or made inoperable. Because these motors have value, some felt this requirement would limit program participation; others did not think it would be a hindrance. If a trade-in policy is instituted, most thought the utility, not the vendors, should collect the motors.

- Concern was expressed about the utility’s commitment to a energy-efficient motors program. Participants stressed the importance of long-term involvement and the assurance that sufficient money be provided to fund the incentive pool. One participant cited a program that failed because the utility ran out of money for incentives.


These comments primarily reflect information contained in Ducker Research Company’s Syndicated Study of the Current and Expected Future Market for AC and DC Variable Speed Drives, 1985. This study was updated in 1988. A 1991 update will be available from Ducker Research for $6500.

**ASD Market**

- The majority of ASDs are sold directly by manufacturers via their sales-people or independent representatives. Most manufacturers use direct sales-people rather than independent representatives. Sales through these channels accounted for almost two-thirds of AC drive sales in 1984. Smaller volume ASD manufacturers sell almost exclusively direct because their distributor channels are not well developed.

- The role of distributors in the ASD market is increasing. In 1984 they accounted for over one-third of AC drive sales, nearly triple the proportion they accounted for in 1979. This is due in part to the growing number of standardized off-the-shelf drives that are being sold. Because of the increased acceptance of AC drives, end-users and OEMs are gaining confidence in working with distributors rather than direct sales-people. The reputation and perceived knowledge level of distributors is improving.

- End-users and OEMs are increasingly perceiving ASDs as a commodity, particularly in the low horsepower range. This is reflected in the growing number of standardized off-the-shelf drives now being sold.

- Leading markets for ASDs include: pumps/blowers (including HVAC), paper converting, petrochemical, textile, and material handling industries, as well as electric and water municipalities. Pumps and blowers continue to be the leading AC drive market.
Utility Program Manager Interview Summaries

This entry summarizes information that was gained through phone conversations with utility program managers between August and October, 1991. Eight utilities who currently have motors or motors and drives programs were contacted. These were: British Columbia Hydro, Consolidated Edison, Long Island Lighting Company, New England Electric Service, Niagara Mohawk, Northern States Power, Ontario Hydro, and Orange and Rockland. Information concerning their specific programs, as well as a general assessment of the motor and ASD markets was gained. The names, titles, and phone numbers of the individual utility contacts can be found in this appendix.

Utility Motor Incentive Programs

- All utilities contacted offer rebates to the end-user. Some offer rebates on a simple per horsepower basis, while others award set rebates at each horsepower level. At least two programs distinguish between open and enclosed motors and between motor speeds when determining rebate levels and eligibility requirements. Two programs also offer higher incentive levels for upgrading operating motors. In general, however, the focus is on upgrading failed motors or motors for new applications.

- Four of the eight utilities contacted also offer dealer incentives. One offers $3/HP, one 50¢/HP, one 20% of the customer rebate, and one 10% of the motor sale price up to $5,000. The manager of the program offering an incentive of 50¢/HP said she had heard it was too low and has proposed to raise it to $1/HP. These dealer rebates are intended to influence stocking practices, as well as to encourage dealers to promote energy-efficient motors. Two program managers responded that dealer incentives had been effective in getting distributors to both stock and promote energy-efficient motors. One said he had not seen any indication that the incentives were working.

- Two program managers said they knew of no problems with the availability of energy-efficient motors in their territory. Four others suggested there were either problems currently, or had been problems in the past. One program manager said they had lowered their eligible efficiency requirements because initially the levels were set so high that most manufacturers did not offer qualifying motors.

- One program manager said end-users were primarily interested in meeting drivepower needs and thought that efficiency was not a major end-user concern. This indicates a need for more end-user education and training, a concern that three other program managers voiced as well.

- One program manager cited a lack of effective marketing as a reason for poor program participation rates.

- Utilities typically promote multiple DSM measures; however, these measures may compete for an end-users’ resources. Customers tend to want to implement the fastest payback measures (i.e., lighting) first and may be reluctant to get involved in too many measures at once.

- Competition for resources can also play a role on the utility side. Energy-efficient motor incentive programs have typically followed the development of other DSM programs, such as lighting and HVAC, and may take a back seat to these programs.
All the utilities surveyed have worked with the trade allies, and there seems to be agreement that involving the trade allies is very important. Contact has included both formal and informal meetings, focus groups, seminars and training sessions, promotional materials, newsletters, and distributor incentives. These efforts have been intended to: increase supplier awareness of utility incentive programs, encourage them to actively promote energy-efficient motors, and get them to stock energy-efficient motors in ample supply.

Motor programs typically cover only NEMA Design B polyphase induction motors. Some programs require a minimum number of operating hours. Efficiency ratings are generally accepted when tested in accordance with IEEE Standard 112 Test Method B.

For those utilities that provide rebates for ASDs, most only cover pump and fan applications. Generally, certain horsepower ranges are covered and a minimum number of operational hours are required. One program also requires an engineering study to estimate potential savings and offers up to $2,500 to cover the cost of the feasibility study. Rebates for ASDs are typically based on horsepower.

Of those utilities contacted, only the two Canadian utilities have addressed the issue of obtaining manufacturers’ sales data. Both BC Hydro and Ontario Hydro have data collection programs in place, which utilize the services of an outside consultant. To maintain confidentiality, the utility receives only the aggregate data.

Of the program managers interviewed, four said their programs had reached or exceeded their goals. Two managers noted low program participation rates. One noted that better marketing to end-users was needed, as well as more training and education for suppliers. The other indicated there was more interest in other DSM measures, such as lighting.