Analysis of Utility Motor-Systems Programs

R. Neal Elliott
Miriam Pye

October 1997

Prepared for the U.S. Department of Energy's Motor Challenge

1001 Connecticut Avenue, NW, Suite 801, Washington, DC 20036 (202)429-8873

CONTENTS

ACKNOWLEDGMENTS

We would like to thank the U.S. Department of Energy Office of Industrial Technology Motor Challenge Program for funding this study.

We would also like to thank our reviewers, Anibal de Almeida, Fred Gordon, Aimee McKane, Steven Nadel, and Vestal Tutterow, as well as all those who contributed information and comments, including: Robert Bolubasz, Andrew deLaski, Paul Fagerquist, Ray Farhang, Bill Grimm, Mark Hanson, Jeff Harris (Northwest Energy Efficiency Alliance), Babu Joseph, Ziba Kellum, Robert Light, Bruce Meberg, Tim McIntosh, David Mulder, Kevin Neal, Jamil Nehme, Andre Olagues, Helen Sam, Bill Scale, Paul Scheihing, Warren Smith, Kurt Thielemann, Cynthia Thomason, and Bob Zdebski.

ACRONYMS AND DEFINITIONS

ACEEE	American Council for an Energy-Efficient Economy
AE	Advanced Energy Corp. (formerly North Carolina Alternative Energy Corp.)
ASDs	adjustable speed drives
BECo	Boston Edison Company
BGE	Baltimore Gas and Electric Company
BPA	Bonneville Power Administration
CAGI	Compressed Air & Gas Institute
CEA	Canadian Electrical Association
CEE	Consortium for Energy Efficiency
CG&E	Cincinnati Gas and Electric
CP&L	Carolina Power & Light
CSA	Canadian Standards Association
DE&S	Duke Engineering and Services
DOE	U.S. Department of Energy
DSM	demand-side management
EASA	Electrical Apparatus Service Association
ECW	Energy Center of Wisconsin
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 1992
EPRI	Electric Power Research Institute
ESB	energy services business
ESCO	energy services company
EUP	End-Use Pricing Service
EWEB	Eugene Water and Electric Board
HI	The Hydraulic Institute
HVAC	heating, ventilating and air-conditioning
IEEE	Institute of Electrical and Electronic Engineers
IEL	Industrial Energy Laboratory (formerly Industrial Electrotechnology Laboratory)
kWh	kilowatt hours
LMCP	Detroit Edison's Large Manufacturing Customer Pilot Program
MC	Motor Challenge
MM+	MotorMaster+
NEEA	Northwest Energy Efficiency Alliance
NEEP	Northeast Energy Efficiency Partnerships
NEES	NEES Companies (formerly New England Electric System)
NEMA	National Electrical Manufacturers Association
NU	Northeast Utilities
NYPA	New York Power Authority
NYSEG	New York State Electric and Gas
ODP	open, drip-proof motor
OEM	original equipment manufactured

PEPCO	Potomac Electric Power Company
PG&E	Pacific Gas and Electric
POS	Performance Optimization Service
PSE&G	Public Service Electric and Gas of New Jersey
PSI	PSIEnergy of Indiana
PSP	PG&E's PowerSaving Partners
REO	PG&E's Retrofit Efficiency Options program
RPM	Responsible Power Management
SBCs	systems benefits charges
SCE	Southern California Edison
SCL	Seattle City Light
SDGE	San Diego Gas and Electric
SMUD	Sacramento Municipal Utility District
TEFC	totally enclosed, fan-cooled motors
TEPA	PG&E's Tailored Energy Planning Assistance
UE	Union Electric
UI	United Illuminating Company
ULH&P	United Light, Heat and Power of Kentucky
VFD	variable frequency drive
WEPCO	Wisconsin Electric Power Company
WSEO	Washington State Energy Office

Definitions:

In the context of motors, on a national level, "energy-efficient motors" are those that *meet* NEMA or EPAct levels, while "efficient motors" *meet or exceed* NEMA and EPAct levels.

EXECUTIVE SUMMARY

Electric motors operating in the U.S. consume more than half of the nation's electricity. Electric utilities were among the first groups to begin offering programs to promote efficiency in electric motors. The most common programs have been prescriptive rebates for the purchase of efficiency motors. While many of these programs have been popular and successful, their cost is an issue of contention between industrial consumer groups and within utilities attempting to reduce program costs.

To assess current and emerging trends in utility motor-systems programs, the American Council for an Energy-Efficient Economy (ACEEE) surveyed individual regulated utilities' traditional programs, as well as some multi-utility collaborations and select program offerings by non-regulated utility energy service businesses (ESBs). The survey was designed to ascertain types of programs/services that utilities are offering (past, present, and future programs) for motor systems and various motor-related equipment. ACEEE contacted more than 50 utilities and energy efficiency organizations to discuss current trends, and 22 completed surveys, representing more than 26 utilities[1] that offer some sort of efficient-motors-related customer service. These utilities represent about 23 percent of industrial electricity sales in the U.S.

Many utility staffs interviewed equated "motor-systems programs" with "efficient-motor rebates." However, interviews revealed that motor-systems technical assistance and incentives are an aspect of many utilities' industrial programs. Motors are frequently not dealt with discretely, but as part of an integrated program activity. The survey showed the most popular type of program/service to be providing basic technical assistance (e.g., audits), followed by publication/software tools, customer/vendor training, incentives, in-depth engineering assistance, and customer financing. Survey results indicate that utilities are providing the most services for efficient motors, adjustable-speed drives (ASDs), pumps, fans, blowers, air compressors, and systems operations and maintenance. Equipment-specific programs, along with systems optimization assistance, are frequently included as part of customized programs. Few utilities offer services addressing motor repair; belts, gears and lubricants; or system design. Financial incentives are becoming less common, although 80 percent of those utilities that offered incentives in the past are still offering financial incentives.

Discussion about restructuring the U.S. electric utility industry has created uncertainty about the future of electric utility demand-side management (DSM) programs. However, ACEEE's survey indicates that most utilities that offer motor-systems programs are planning to continue or expand these programs, and some utilities are planning to offer new programs. These programs provide extra services to key customers, and can contribute to customer loyalty when customers are allowed to select their electricity provider.

---

[1] Some organizations contacted coordinate motor-systems programs for several utilities.

The most common motivation for offering motor-systems programs mentioned in interviews with utilities was customer satisfaction, reflecting the changing dynamics of the utility industry. Several of the utilities that are establishing non-regulated ESBs indicated that motor-systems technical assistance is an important customer service. None, however, indicated that they are currently pursuing motor-systems efficiency services as a profit opportunity.

Utilities have played a critical role in creating the market for efficient motors, and are now poised to pull the market toward even higher motor/motor-systems efficiency by expanding beyond *new* motors programs to address the efficiency of *existing* motors and the systems they operate. Opportunities will continue to exist for the promotion of efficient motors, since this can serve as an important awareness-building role in a broader motor-systems program. As examples in this report show, models for the next generation of motor-systems programs already exist. Their widespread implementation will require a greater level of technical resources from utilities and greater flexibility in the design and implementation of the programs.

These utility motor-systems programs will likely fall into two categories: *public-benefit activities* and *for-profit business opportunities*. Activities in the first category are intended to permanently change market behavior. While they may start with efficient motors as their focus, they will of a necessity move to broader issues as has been seen with the most mature of these programs. Public-benefit initiatives will most likely be formed more and more on a regional basis so they can leverage market power, costs, and expertise in a multi-utility region, while still being able to respond to the unique needs of a regional marketplace. National efforts such as Motor Challenge and the Consortium for Energy Efficiency will support these initiatives, providing products and tools, and common program frameworks, respectively.

Some aspects of motor systems offer for-profit energy services business opportunities for utilities. Motors are ubiquitous among industrial customers, and technical expertise is in short supply, so utilities can continue their role of energy technology broker and fill this market need. These programs can take the form of value-added, customer-retention activities or as a new unregulated business. In the unregulated case the venture may take the form of a targeted motor service (e.g., motor management or compressed air), or may include motors as part of a comprehensive energy services offering.

In any case, several roles exist for utilities in the future of efficient motor systems. All that remains is for each utility to identify what roles best suit their future vision under restructuring, and begin building the motor-systems programs to take them into the next century. Time will tell whether these new efforts to promote motor-systems efficiency will be as successful as past efforts to promote energy-efficient motors, but with the size of industrial motor use and the proven efficient potential, it is a challenge worth pursuing.

INTRODUCTION

Electric motors operating in the U.S. consume more than half of the nation's electricity. Electric utilities were among the first groups to begin offering programs to promote efficiency in electric motors. A 1994 Electric Power Research Institute (EPRI) survey of utility demand-side management (DSM) programs found 151 efficient-motors and drives programs being offered by 95 utilities in the U.S. Participation was estimated at more than 7,500 industrial, 8,400 commercial and 1,200 agricultural customers. The most common programs have been prescriptive rebates for the purchase of efficient motors. While many of these programs have been popular and successful, their cost is an issue of contention among industrial consumer groups and within utilities attempting to reduce program costs.

With minimum motor-efficiency regulations in the Energy Policy Act of 1992 (EPAct) having gone into effect for most products in October 1997, utilities will need to move beyond simple efficient-motor rebate programs if they are to continue to offer motor programs to their customers. Promotion of efficient motors will remain an important part of utility programs, since they have proven effective in awareness-building efforts, and potential cost-effective savings remain. The focus, however, will have to shift from simply motors to motor-*systems* issues, where even greater savings exist. In addition, the utility industry is restructuring, with increased emphasis on providing value-added services to customers. Some of the more advanced program designs already being implemented by utilities in North America indicate that it is possible, with proper program design, to achieve both cost-effective energy savings and value-added customer services. In addition, market transformation initiatives have emerged as an appropriate use of utility systems benefits charges (SBCs) at both state and regional levels.

SBCs are being established in many states to provide funding for public-benefit programs while removing the cost as a competitive factor for power suppliers. Public-benefit programs involve goods and services that benefit society but for which private interests can not capture enough revenues to recover the cost (plus a profit) of providing the goods and services on a private basis (e.g., space exploration). Ideally, public-benefit programs create a market in which the private sector can offer efficiency and make money in the long run (Gordon 1997).

As a 1993 U.S. Department of Energy (DOE)-sponsored motor-systems roundtable identified, motor-systems expertise is not widely available, and many electric utilities will need assistance to develop and implement new programs. It is thus important that information be made available to these utilities on how to analyze customers' motor-systems needs, what program designs will most likely meet these needs, what resources they will need to implement their program, and where to find those resources. DOE's Motor Challenge (MC) and other program implementers have already been identifying or developing many of these resources, and many are already being used by some utilities. If utilities are provided a program context, more of them can make better use of these resources and achieve success from their own standpoint (e.g., increased customer satisfaction and improved customer retention), from the customers'

standpoint (e.g., lower motor-systems costs and improved performance), and from the national standpoint (e.g., reduced motor-systems energy consumption and lower carbon emissions).

The American Council for an Energy-Efficient Economy (ACEEE) has begun to establish this context by analyzing utility motor-systems programs. This work builds upon past ACEEE analyses of other utility energy efficiency programs and ACEEE's extensive involvement in technical aspects and design of programs involving electric motor-systems.

BACKGROUND

The background that follows summarizes the history of electric motors and utility programs in the U.S. and the implications of electric utility restructuring.

Electric Motors in the United States

The estimated billion electric motors in operation in the U.S. consume more than half of the nation's electricity. The installed base of over 25 million integral horsepower[2] AC motors is estimated to account for over three-quarters of this energy consumption (Easton 1996; Nadel et al. 1992).

Industry consumes almost half of motor energy, and commercial and residential each consume about 20 percent (Figure 1). The balance is consumed by utilities and in public work such as street lighting. Motor energy use in the residential sector is dominated by small motors, most of which are used as part of appliances. Space conditioning dominates motor use in the commercial sector, accounting for two-thirds of that sector's motor energy consumption (Nadel et al. 1992). Manufacturing accounts for most of the industrial sector motor use, where motor energy represents the largest electricity-use category at 70 percent, while process and

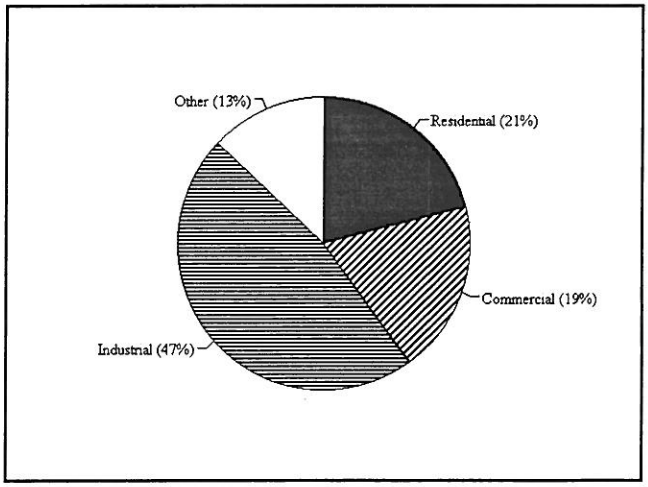

Figure 1. Distribution of U.S. Motor Energy Use (Source: Nadel et al. 1992).

[2] Integral horsepower means motors with an output power of one horsepower (0.746 kW) or more.

lighting comprise 23 and 7 percent, respectively. Centrifugal equipment, such as pumps, fans, and compressors account for almost half of this industrial motor load (Elliott 1995).

Approximately a million new, integral horsepower motors are sold every year (Census 1996). These motors are, in general, purchased by: original equipment manufacturers for inclusion in various opportunities for energy savings; end-users for new applications; and end-users to replace failed motors (Easton 1996). While electric motors are among the most efficient industrial equipment available, there exists a range of efficiencies, which combined with the high number of operating motors can result in significant cost and energy savings when higher efficiency motors are selected. The Energy Policy Act of 1992 mandates that as of October 1997, most new motors must meet minimum efficiency levels specified in the Act. The law will prohibit the manufacture or import of general purpose motors that do no meet or exceed minimum efficiency levels. Even after these standards go into effect, a range of efficiencies will remain with the most efficient being cost effective in many high operating hour applications (Elliott 1995).

For every new motor sold in the U.S., two and one-half motors are repaired. Each repair decision is an opportunity to install an efficient motor. It has long been realized that improper repair of a motor can degrade its efficiency and reliability. Until recently, however, a comprehensive understanding of the repair market place was not available, making development of strategies to influence the repair market difficult. In addition, sound research maintaining motor efficiency during repair was lacking. Most motors can, with proper attention, be repaired to maintain their efficiency and serviceability. However, an improperly repaired motor can lose up to five percent in efficiency, and will fail prematurely resulting in additional costs to the customer for both increased energy consumption and increased repair/replacement costs resulting from premature failure. The quality of service provided by repairers vary, with some doing an excellent job, but some doing a very poor job. If the more 2.5 million motors repaired annually were repaired properly, over two million megawatt hours could be saved (Schueler, Leistner and Douglass 1994).

The system that supplies electricity to motor-systems can be a source of inefficiency, while adversely affecting the reliability and life of the motor. Ideally, the electricity driving a motor should be at the design voltage and frequency, and have a sinusoidal wave form. Unfortunately, in the real world these conditions frequently are not met. System deficiencies fall into three categories:

- Voltage imbalances in three-phase systems,
- Out-of-specification electrical supply characteristics (e.g., low or high voltage and harmonics), and
- Low power factor.

While some of these deficiencies result from utility distribution system problems, many stem from problems in the plant. Utilities have been actively involved investigating and

resolving these problems. Among the measures that can be implemented are balancing loads on circuits, increasing wire size, and purchasing more efficient transformers. One of the most important areas is improving system power factor, which yields electricity savings by reducing line currents, which in turn reduces cable and transformer losses (Elliott 1995). Improved power factor can also significantly reduce electricity bills by reducing utility charges for low power factor (Dorhofer and Heffington 1994).

The equipment that motors drive plays an even more important role in energy consumption than motors themselves. Efficiency of motor-driven equipment can vary over a significant range (e.g., in air compressors, package efficiency can vary 15 to 25 percent from least to most efficient, with the motor accounting for only two to three percent (Easton 1996)). This potential is dwarfed, however, by efficiency improvements that can be achieved by optimizing the system. In compressed air systems, it is not unusual to achieve upward of 50 percent savings by eliminating leaks and optimizing controls. Capture of these savings can require significant engineering time to measure and evaluate system performance. Proper system design and operation is particularly important for centrifugal equipment, like pumps, fans and compressors, for which affinity laws apply. Affinity laws state that flow in centrifugal equipment (e.g., pumps and fans) is proportional to rotation speed, and that in a system without static pressure, power is proportional to the cube of the speed. These relations imply that change in power is theoretically proportional to change in flow. In reality, most systems have some static pressure, so the actual relationship will be between a square and a cube (Nadel et al. 1992).

History of Utility Programs

Initially, utility program strategies focused on efficient motors. This motor design was a new class of products introduced in the late 1970s with significantly higher levels of efficiency than previous products. In addition, the most efficient designs achieve maximum efficiency at two-thirds to three-quarters of full load in contrast with standard motors, which normally achieve maximum efficiency near full load. This is important because studies have shown that most motors are operated at about 60 percent of full load (Nadel et al. 1992).

Many early utility programs focused on integral horsepower, poly-phase motors between 1-200 HP, which are the most important class of motors in the industrial sector. Less difference in efficiency exists in motors above 200 HP, and these motors tend to be special-order items (Easton 1996). Some programs which focus heavily on industry, such as those in the Pacific Northwest, have focus on four pole (i.e., 1,800 RPM synchronous speed) totally enclosed, fan-cooled (TEFC) motors, which represent the largest share of new motor purchases by industrial end-users (Zdebski 1996). Those with a significant commercial sector focus need to include open, drip-proof (ODP) motors which are predominately used in heating, ventilating and air-conditioning (HVAC) applications (Easton 1996).

The most prevalent program approach has been for utilities to encourage the purchase of efficient motors by offering incentives, information on making motor selection decisions, and

databases on efficiency and characteristics of available equipment. Initially programs encouraged replacement of operating standard motors with new efficient motors. This strategy did not prove economically viable because it was difficult to justify replacing an operating motor with a higher efficiency one at low U.S. electricity prices. Most programs now attempt to influence the selection process for new motor purchases and the decision to repair or replace a failed motor (Freedman et al. 1996). These programs became a core element of many utilities' demand side management efforts.

Probably the most successful of these programs was one offered by B.C. Hydro in Canada, which served as a model for many other Canadian and U.S. programs. The B.C. Hydro Power Smart program combined an extensive customer and dealer information program with rebates to customers for purchasing efficient motors. This approach was less effective than had been hoped because distributors did not stock the motors. After incentives were offered to distributors as well, participation picked up and ultimately achieved very high levels of participation (at the peak of the program, approximately 70% of qualifying integral horsepower motors sold in the province were efficient units) (Figure 2). This high market share made it possible to convince the provincial legislature to enact mandatory motor efficiency standards (Freedman et al. 1996; McMenamin 1994; Nadel 1996). This effort will be discussed in greater depth later in this report.

Some utilities have chosen not to offer rebates as part of their motors programs. One such utility, Carolina Power and Light, has operated an effective program by providing customers audits that identify which motors should be repaired and which motors should be replaced with efficient motors upon failure. Audits identify motors with high operating hours for which efficient motors offer a good payback at time of replacement. Customers are then encouraged to mark these motors with a large yellow dot, and maintenance crews are instructed to install a new efficient motor when a yellow-dot motor fails (Nadel and Jordan 1994).

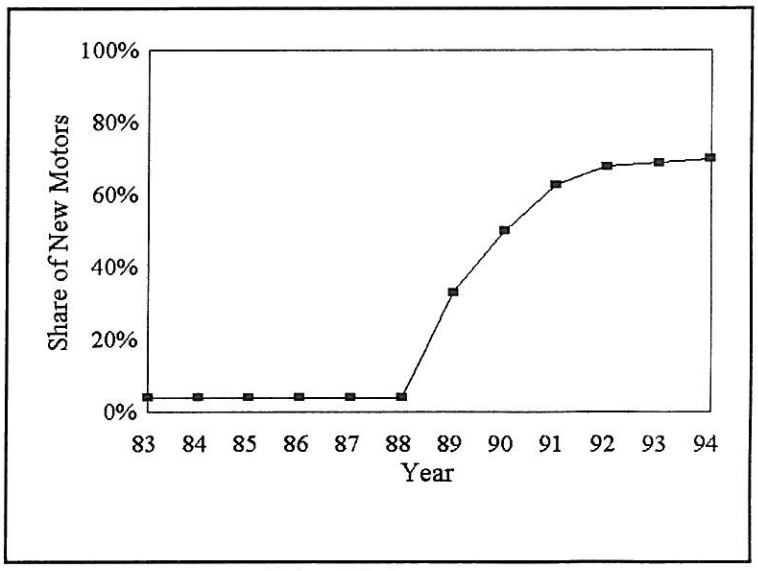

Figure 2. Share of High-Efficiency New Motor Purchases in BC Hydro Service Territory (Source: McMenamin 1994).

One of the first areas of expansion were programs that encouraged use of electronic adjustable speed drives (ASDs). Utilities began to offer these programs in the mid-1980s. This new technology allowed the speed of a motor to be varied to meet changing process needs. This technology was particularly attractive for centrifugal loads like pumps, fans and compressors

where power consumption varied as approximately the cube of the speed. Since these loads are very common, the potential for energy savings is large. A few of these programs involved prescriptive rebates for ASDs, with 1994 rebate levels being $20-100 per horsepower (Blevins 1995). The advantage of prescriptive rebates is that they are easy to understand, administer and promote. The disadvantage of prescriptive rebates is that they oversimplify complex motor systems and can encourage installation of ASDs in inappropriate applications. For these reasons, most ASD promotions involved custom incentives, in which engineers prepared proposals estimating energy savings from specific ASD applications, and incentives were paid per projected kWh of savings; in 1994 rebates ranged from 3-22¢/kWh saved in the first year (Blevins 1995).

Both types of ASD programs initially encountered a number of problems. Early drives proved unreliable and created power quality problems for users. Most equipment problems have been addressed by manufacturers through improved equipment designs and better installation practices (Elliott 1995). The other problem was that many ASD savings anticipated never materialized because actual loads were very different than those used to do economic evaluations. This problem can generally be traced to lack of accurate system-operating information. As a result, ASD programs at several utilities have evolved toward either customized programs which project savings or target rebate programs for specific proven ASD applications, such as HVAC and injection-molded plastics (Gordon 1997; Bolubasz 1995).

Ontario Hydro took another approach, and began a program that promoted a comprehensive system evaluation by experts who then proposed changes that would optimize the system. The Energy Center of Wisconsin, a utility-supported, state-wide non-profit, began developing this concept in the mid-1990s. One of the goals of their Performance Optimization Service (POS) program is to build a motor-systems expertise base in their service area. Other groups in the U.S. are looking at this design as a model for the next generation of motor-systems programs (Freedman et al. 1996).

Today, motor-systems programs are an important component of many utilities' industrial program offerings. These program offerings are evolving in response to changes in the utility industry and to the evolution of the motor marketplace and motor-systems technology.

Utility Restructuring

In recent years, the dominant topic of discussion among utility companies, regulators, and other utility industry observers has been increased competition in the utility industry, including increased wholesale competition as well as the prospect of retail competition. While the exact structure of the "new" utility industry is not yet clear, in general, the trend is toward the separation of the existing utility industry into four components: generation, bulk power transmission, local distribution, and energy procurement and services.

Much of the utility industry flux has been driven by large customers seeking service at a lower cost and threatening to relocate, self-generate, or turn to alternative electricity service providers. Large industrial customers represent a substantial customer base for most utilities, and the loss of these customers could have devastating financial consequences.

The customer energy efficiency programs that have been called DSM are also undergoing changes. DSM programs were traditionally used by electric utilities to assist customers in reducing energy use and/or demand. The prime motivation for these programs was to reduce investment needed for new power generation, transmission, and distribution facilities. Impetus for implementing these programs frequently came from regulators, and costs for these programs are generally recovered from rate payers. In a more competitive utility market, however, as experiences in countries with retail competition indicate, price becomes paramount. Many utilities and large industrial customers view DSM programs as a cost they are unwilling to pay.

In some cases, however, utilities see other competition-related reasons to offer industrial customers energy efficiency programs. These motivations include customer retention, economic development, and new business development. With utility restructuring, motivations for industrial programs to offer valuable services to industrial customers may actually increase. A significant potential for energy savings from utility/industrial programs clearly exists. In many cases potential for bill reductions from energy efficiency investments may exceed potential for bill reductions from utility restructuring. The definition of success is also changing due to changes in the utility business. Success must not only consider energy savings, but also address opportunities for cost savings and efficiency improvements of all types (e.g., process improvements) within manufacturing facilities, ultimately leading to customer satisfaction, loyalty and retention.

With the move towards a more competitive utility industry, costly industrial DSM programs in which utilities pay high incentives for energy or demand savings are disappearing. However, as some of the programs featured here demonstrate, it is possible to operate utility/industrial energy efficiency programs for utility costs of around $0.01 per kWh saved by working in partnership with customers, negotiating incentives on a customer-specific basis, and addressing energy efficiency as part of a package that also addresses other issues of concern to industrial customers. Such programs can provide valuable services beyond energy cost savings to customers and can be an important component in customer retention strategies (Elliott, Pye and Nadel 1996).

While utilities must reduce program costs to prepare for a more competitive environment, many utilities may be too quick to alter their industrial energy efficiency plans, risking the loss of customer loyalty. In many cases, refinements that reduce costs but retain judicious use of incentives may be a preferable option. These "enhanced" programs have the potential to interest and serve more customers, while limiting impact on rates and cost to all customers. A loyal customer base can provide an important foundation upon which new energy-service ventures can be built. Motor-systems programs represent an important component in these program offerings

because of the broad applicability of motors to most segments of industry (Elliott 1994), and because of the limited availability of motor-systems expertise in the market place (Freedman et al. 1996).

A meeting of motor experts in 1993 concluded that a major barrier to improve motor-systems efficiency is availably of motor expertise. Some utilities, especially those with close working relationships to their industrial customers, have gained significant experience in motor systems. However, most utilities have not developed motor-systems expertise internally, but have relied upon consultants (DOE 1993). The limited number of consultants is a problem for many utilities developing programs, especially those that have gone beyond simple motor rebates.

MOTOR-SYSTEMS PROGRAM TRENDS

As strides have been made on the efficient-motor front and knowledge increased about motor systems, the focus of utility motor-systems programs has continued to broaden, with initiatives now being offered or developed in motor repair, motor-driven equipment, and system design. In addition, some companies are now trying to make a profit by providing energy efficiency services. Many of these later service offerings are being provided by non-regulated, utility-affiliated energy service business (ESB) divisions.

Future of Efficient Motors Programs

In the early 1990s several states began examining the feasibility of establishing minimum efficiency standards for motors, based on the fact that in 1988 less than 20% of U.S. motor sales met established definitions for efficient motors, far less than the 62% market share for 1988 projected by DOE in 1980 when it decided not to pursue national motor standards. Motor manufacturers became concerned about a patchwork of state standards and worked with efficiency advocates to develop consensus national motor efficiency standards that were adopted by the U.S. Congress as part of the Energy Policy Act of 1992. National Electrical Manufacturers Association (NEMA) energy-efficient motor standards for integral horsepower polyphase motors served as the basis for these standards (see Table-1A/1B). Minimum efficiency levels go into effect in October 1997 and will prohibit the manufacture for domestic sale or import of general purpose motors that do no meet or exceed minimum efficiency levels. The same minimum efficiency levels are already in place in Canada.

While national minimum efficiency standards were becoming law in Canada and the U.S., utility and government educational and incentive programs on efficient motors continued. Potential for greater efficiency also exists from a new class of general-purpose motors with even higher efficiency, so-called "premium-efficiency" motors. A new set of efficiency levels (see Table-1A/1B) for this class of motors has been developed under the leadership of the Consortium for Energy Efficiency (CEE), a non-profit coalition of utilities, public interest groups and

TABLE 1A. EFFICIENCY LEVELS FOR OPEN DRIP PROOF (ODP) MOTORS

Horsepower	1200 RPMs		1800 RPMs		3600 RPMs	
	EPACT "Energy-Efficient"	CEE "Premium Efficiency"	EPACT "Energy-Efficient"	CEE "Premium Efficiency"	EPACT "Energy-Efficient"	CEE "Premium Efficiency"
1	80	82.5	82.5	85.5	N/A	80
1.5	84	86.5	84	86.5	82.5	85.5
2	85.5	87.5	84	86.5	84	86.5
3	86.5	89.5	86.5	89.5	84	86.5
5	87.5	89.5	87.5	89.5	85.5	89.5
7.5	88.5	91.7	88.5	91	87.5	89.5
10	90.2	91.7	89.5	91.7	88.5	90.2
15	90.2	92.4	91	93	89.5	91
20	91	92.4	91	93	90.2	92.4
25	91.7	93	91.7	93.6	91	93
30	92.4	93.6	92.4	94.1	91	93
40	93	94.1	93	94.1	91.7	93.6
50	93	94.1	93	94.5	92.4	93.6
60	93.6	95	93.6	95	93	94.1
75	93.6	95	94.1	95	93	94.5
100	94.1	95	94.1	95.4	93	94.5
125	94.1	95.4	94.5	95.4	93.6	95
150	94.5	95.8	95	95.8	93.6	95.4
200	94.5	95.4	95	95.8	94.5	95.4

Notes: Efficiency levels reported are nominal efficiencies which represent the median efficiency of a population of motors of a given design as determined by IEEE Method 112-B.

government discussed in detail later in this report (CEE 1996). Fifteen utilities serving approximately 11 percent of industrial customers have already adopted these levels, including a dozen which are using these levels for rebates. Participating utilities include NEES Companies (formerly known as New England Electric System), New York Power Authority (NYPA), Northeast Utilities (NU), Pacific Gas and Electric (PG&E), Potomac Electric Power Company (PEPCO), Public Service Electric and Gas of New Jersey (PSE&G), Southern California Edison (SCE), and United Illuminating Company (UI). Additional utilities in Vermont, and those

TABLE 1B. EFFICIENCY LEVELS FOR TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS

Horsepower	1200 RPMs		1800 RPMs		3600 RPMs	
	EPACT "Energy-Efficient"	CEE "Premium Efficiency"	EPACT "Energy-Efficient"	CEE "Premium Efficiency"	EPACT "Energy-Efficient"	CEE "Premium Efficiency"
1	80	82.5	82.5	85.5	75.5	78.5
1.5	85.5	87.5	84	86.5	82.5	85.5
2	86.5	88.5	84	86.5	84	86.5
3	87.5	89.5	87.5	89.5	85.5	88.5
5	87.5	89.5	87.5	89.5	87.5	89.5
7.5	89.5	91.7	89.5	91.7	88.5	91
10	89.5	91.7	89.5	91.7	89.5	91.7
15	90.2	92.4	91	92.4	90.2	91.7
20	90.2	92.4	91	93	90.2	92.4
25	91.7	93	92.4	93.6	91	93
30	91.7	93.6	92.4	93.6	91	93
40	93	94.1	93	94.1	91.7	93.6
50	93	94.1	93	94.5	92.4	94.1
60	93.6	94.5	93.6	95	93	94.1
75	93.6	95	94.1	95.4	93	94.5
100	94.1	95.4	94.5	95.4	93.6	95
125	94.1	95.4	94.5	95.4	94.5	95.4
150	95	95.8	95	95.8	94.5	95.4
200	95	95.8	95	96.2	95	95.8

Notes: Efficiency levels reported are nominal efficiencies which represent the median efficiency of a population of motors of a given design as determined by IEEE Method 112-B.

participating in two regional utility initiatives, the Northeast Energy Efficiency Partnerships (NEEP) and Northwest Energy Efficiency Alliance (NEEA), have adopted CEE levels (CEE 1997c).

The Energy Policy Act also calls upon the U.S. Department of Energy (DOE) to investigate similar regulations for small motors. Canada has worked, under the leadership of Natural Resources Canada, with support from the Canadian Electrical Association (CEA) and

Canadian Standards Association (CSA), to develop efficiency standards for small motors. These efforts have encountered many technical and market difficulties, including:

- lack of test procedures to test and rate small motors,
- lack of efficiency data on many small motors,
- application issues that make higher efficiency classes of motors appropriate for many but not all applications, and
- the fact that many small motors are used in home appliances which themselves are subject to minimum efficiency standards (LBNL 1996).

While Canadians are moving forward with small-motor standards, it is unlikely national standards will be set on small motors in the U.S. over the next few years.

Emergence of Market Transformation Programs

In the early 1990s, Easton Consultants, a strategy consulting firm with a market focus, completed the first in-depth study of the motor market in the Northeast (Easton 1992). The study, sponsored by NEES, NU and Boston Edison Company (BECo), characterized the structure and dynamics of the local motor market, estimated current efficiency levels, determined distributor pricing behavior, and identified market targets (i.e., end-user vs distributor) for the utilities' motors programs. These data were used to do cost analyses which provided justification for and helped harmonize efficiency levels used for programs in the region. A key finding was the importance of local stocking of efficient motors to replace failed motors, either at the distributor site or in local warehouses, to the success of these motors programs. As a result, some programs shifted to influencing distributor stocking behavior, similar to what was seen in the evolution of the BC Hydro motor program.

The study also found that over half the new motors sold in the region were sold as part of an equipment package. In response, Easton initiated a study in 1993 of motor efficiency in original equipment manufactured (OEM) equipment. This "OEM Motor Study" was a novel project that solicited sponsors to support the research, and in return allowed sponsors to provide direction for the work. Ultimately over twenty organizations contributed to the study, with early sponsorship coming from NEES, DOE's Motor Challenge Program, and Baldor Electric (Meberg 1997).

The study developed a prioritized list of OEM motor applications, ranked by structure of the market, energy consumption, and potential for energy savings. Four OEM markets were profiled in detail: plant air compressors, industrial process pumps, industrial fans and blowers, and HVAC water pumps. One of the most influential findings of the study was that the greatest opportunity for efficiency was found not in the motor itself, but in the system. Design, application, and maintenance practices were found to offer the majority of energy savings potential (Easton 1996). This study supported a move toward system-focused, motor market transformation programs.

Market transformation initiatives attempt to permanently change the structure of a product market in a desired way. The goal of these programs is to change the manner in which individuals in the marketplace design, buy/sell, maintain, and operate motors and motor systems. The long-term goal is to transform the markets so that efficient equipment and practices become the norm. The key aspect of market transformation is to identify major market barriers and then develop strategies to overcome these barriers. The transformation process: (1) increases market penetration of current technologies and services; (2) encourages development and introduction of advanced technologies; and (3) enhances current market infrastructures to facilitate the ongoing transformation process (Freedman et al. 1996). The most important change from previous program design is that the focus is on changing overall market behavior, with decreased emphasis on individual equipment decisions.

The OEM Motor Study provided important input to a round table on Electric Motor-System Market Transformation Strategies sponsored by Motor Challenge and CEE in April 1995. The unique forum brought together end-users, manufacturers, distributors, trade associations, utilities, and consultants (MC 1995). This meeting and the OEM Motor Study laid groundwork for future Motor Challenge and utility program activities. One finding from these discussions was that an unfulfilled demand existed for greater efficiency and reliability in compressed air systems, supporting Easton's assertion that increasing user sophistication regarding air compressors offered one of the best opportunities for energy savings of any OEM application (Easton 1995).

In response to this report, Motor Challenge, in cooperation with Lawrence Berkeley National Laboratory, ACEEE, and Energy Center of Wisconsin (ECW), undertook the development of a national compressed-air initiative with the goals of: increasing awareness of efficiency opportunities available in compressed-air systems; training plant compressed-air system operators on efficient practices and system management; and establishing a program to certify plant operators who demonstrate proficiency. This initiative is unique in that funding is equally provided by ten key stakeholder organizations, including Motor Challenge, the Compressed Air and Gas Institute (the equipment manufacturers' trade association), several efficiency institutes (including ECW and New York State Energy Research and Development Authority), several utilities, and an energy services company, Honeywell. The initiative is being hosted as a project by ECW, with a project-governing structure representing all stakeholder groups (National Compressed Air Initiative 1997).

In response to the initiative, independent system consultants have formed as association, the Compressed Air Efficiency Council, in order to provide efficient representation of their stakeholder interest (Scales 1997). It appears likely that compressed-air equipment distributors will similarly organize (McKane 1997). In addition, the Compressed Air & Gas Institute (CAGI) and its members have responded to the initiative by agreeing to voluntary testing, labeling, and verification guidelines for compressed air equipment (CAGI 1997).

Emergence of Efficiency Services

Selling an energy service is another utility approach to motor-systems improvement. Various forms of motor-driven equipment service are being considered, in which the contractor operates, and possibly owns, the equipment and charges the customer per unit of the product (e.g., cubic feet of compressed air at a specified pressure). Wisconsin Electric Power Company (WEPCO) has considered this type of program with its value-based, End-Use Pricing Service (EUP). Under EUP, WEPCO would design, install, own and operate end-use systems on the customers' premises in return for a flat fee. A long-term contract (10 to 15 years) for the end-use service would be negotiated, with the customer paying a flat fee subject to renegotiation at intervals during the contract. An option for customer purchase of the equipment was also included. The program began with pilots of HVAC, refrigeration and compressed air. While the pilot was successful, the program prompted complaints of unfair competition from some trade groups and was suspended (Flanigan and Hogan 1995; Gandi and DiGiacomom 1996). As the electric utility industry is restructured in the U.S., and electric service ceases to be a monopoly, these objections may no longer apply.

A number of other groups, including utilities, air compressor distributors and energy service companies, are considering offering this type of service. In some cases, utilities are partnering with companies possessing technical expertise. One such example is the partnering to offer "out-sourced utility" compressed air services of Honeywell and Duke Engineering and Services, the non-regulated ESB of Duke Power Company (Thielemann 1997). Some companies are also looking beyond compressed air, to other motor services such as pumping, cooling or even shaft horsepower. No examples exist at this time, though this appears to be an exciting area for development.

SURVEY OF UTILITY MOTOR-SYSTEMS PROGRAMS

To assess current and emerging trends in utility motors systems, ACEEE surveyed individual regulated utilities' traditional programs, as well as some multi-utility collaborations and select program offerings by non-regulated utility ESBs.

Survey Methodology

The survey was designed to ascertain types of programs/services that utilities are offering (past, present, and future programs) for motor systems and various motor-related equipment. A one-page questionnaire (see Appendix A) queried utilities regarding:

- types of services they offer:
  - publications/software tools
  - customer/vendor training
  - basic technical assistance (e.g., audits)

- in-depth engineering assistance (e.g., systems design)
- customer financing (e.g., loans)
- incentives (e.g., rebates)

- for the following motor-related areas:
  - efficient motors
  - adjustable speed drives (ASDs)
  - motor-driven equipment selection
    - pumps
    - fans and blowers
    - air compressors
  - motor repair
  - belts, gears, lubricants, etc.
  - systems operations and maintenance
  - system design

- and whether or not they:
  - currently offer the service and plan to continue the service
  - currently offer the service and plan to discontinue the service
  - do not offer the service currently, but plan to offer it
  - do not offer the service currently and do not plan to offer it.

ACEEE contacted more than 50 utilities and energy efficiency organizations to discuss current trends and request survey participation. We faxed surveys to utilities that indicated in the initial interview that they had significant motors activities. Of the 27 surveys faxed, 22 were completed and returned, representing more than 26 utilities[3] that offer some sort of efficient-motors-related customer services. These utilities represent about 23 percent of industrial electricity sales in the U.S.

Summary of Survey Findings

The most popular type of program/service (in terms of percent of sample offering the service) is providing basic technical assistance (e.g., audits), followed by publication/software tools, customer/ vendor training, incentives, in-depth engineering assistance, and customer financing. Table 2 shows the percent of sample that currently offer various services and plan to continue offering them.

[3] Some organizations contacted coordinate motor-systems programs for several utilities.

Table 2. Summary of Utility Motor-systems Program Survey

Area	Percent of Sample Offering Service					
	Pubs./ Software Tools	Train-ing	Technical Assistance	Engineer-ing Assistance	Financing	Incentive s
High efficiency motors	77%	64%	86%	27%	23%	45%
ASDs	68	59	77	36	27	36
Pumps	36	32	68	18	23	27
Fans and blowers	36	36	68	18	25	23
Air compressors	45	45	36	18	27	32
Motor repair	14	18	0	5	0	0
Belts, gears, lubricants	23	5	27	0	5	0
Systems operation & maintenance.	36	23	50	14	18	0
System design	18	18	41	23	5	9

Survey results indicate that utilities are providing the most services for efficient motors, ASDs, pumps, fans, blowers, air compressors, and systems operations and maintenance. Few utilities offer services addressing motor repair; belts, gears and lubricants; or system design.

Many of the utility staff interviewed equated "motor-systems programs" with "efficient-motor rebates." However, interviews revealed that motors technical assistance and incentives are an aspect of many utilities' customized industrial programs. Motors are frequently not dealt with discretely, but as part of an integrated program activity.

Discussion about restructuring the U.S. electric utility industry has created uncertainty about the future of electric utility DSM programs. However, ACEEE's survey indicates that most utilities that offer motor-systems programs are planning to continue or expand these programs, and some utilities are planning to begin offering new programs. Efficient motors and ASDs continue to be the primary targets for these programs, with education, training, and technical

assistance as the dominant strategies. These programs provide extra services to key customers, and can contribute to customer loyalty when customers are allowed to select their electricity provider. Financial incentives are becoming less common, although 80 percent of those utilities that offered incentives in the past are still offering financial incentives. More than a third also offered programs in motor-driven equipment, with compressed air systems being the most common equipment. These equipment-specific programs, along with systems optimization assistance, are frequently included as part of customized programs.

Certainly, some utilities are terminating their motors programs. For example, Entergy ran a motors program, which was mandated by New Orleans, for less than a year. The program offered direct rebates equal to the motor's incremental cost, and had good acceptance. The city, however, was not prepared for the cost of the program, and did not want to burden the general base of ratepayers for the cost of a service that was enjoyed primarily by only the largest commercial customers. As a result, the program was terminated in May 1996 (Olagues 1996).

The most common motivation for offering motor-systems programs mentioned in interviews with utilities was customer satisfaction, reflecting the changing dynamics of the utility industry. Several of the utilities that are establishing non-regulated energy service businesses (ESBs) indicated that motor-systems technical assistance is an important customer service. None, however, indicated that they are currently pursuing motor-systems efficiency services as a profit opportunity. A summary of survey results appears in Appendix B.

NATIONAL MOTOR-SYSTEMS PROGRAMS

A number of groups have been offering national motor programs that provide support for efficient motors. Many of the leading electric utilities participate in these programs and incorporate the work of these national initiatives into their own program offerings.

Motor Challenge

DOE created Motor Challenge (MC) in 1993 as a voluntary industry/government partnership. MC's mission is to create partnerships to deliver products and services that assist businesses in gaining a competitive advantage in managing electric motor systems while saving energy and enhancing environmental quality. The primary goal is to increase market penetration of efficient industrial electric motor-driven systems by helping industry adopt a systems approach to developing, buying, and managing motors, drives, and motor-driven equipment such as pumps, fans, and compressors. MC is a network of resources that supplies free, unbiased motor-systems information, and includes: activities among end-users, industry partners (e.g., equipment manufacturers), and allied partners (e.g., utilities); an information clearinghouse; showcase demonstrations; and technology tools (MC 1997; Scheihing 1996).

Becoming a MC Partner is the entry point into the MC program. MC Partners send a message to their employees that energy efficiency is an important consideration in developing electric motor-systems strategies and decisions. Partners also guide the program so it continues to meet industry needs. Partners and their employees may receive MotorMaster+ software, access the Information Clearinghouse, and receive the bimonthly newsletter and other publications (Scheihing 1996).

The Information Clearinghouse is the central point for accessing MC products and services. The Clearinghouse is staffed with experts in motor-systems specification, design, and maintenance who are available by toll-free telephone. Electronic resources include: the MC World Wide Web site (http://www.motor.doe.gov), databases of motor-systems components, bulletin boards, and chat services. Publications, the MC Sourcebook, partnership applications, newsletters, technical bulletins, listings of education/training opportunities, and updates on program activities are available through the Clearinghouse.

Showcase Demonstration case studies are examples of how companies have improved their electric motor systems, and benefited from energy savings, increased productivity, and waste reduction. In exchange for technical assistance and the opportunity to try new technologies, Showcase participants must undertake detailed monitoring and analysis that will help other Partners understand how to run their operations better. As of Fall 1996, there were 29 Showcases. Nine projects have been completed and have achieved collectively annual energy savings of $1.2 million. A large demand exists for well-documented case studies to be published by trade magazines.

Workshops, training sessions, and conferences provide learning options, including: attending regularly scheduled classes or workshops; working with one of the MC's Allied Partners; or using prepared training modules, which include slides, trainer notes, and handout materials. A number of training modules are available: Introduction to Motor-System Management, Motor Basics, Repair/Replace Decision-Making Policy, Using MotorMaster Software (on-line training is also available for MotorMaster+ software). In 1996, 200 people received MC training on MotorMaster+.

Technology Tools

For a nominal fee, MC offers design-decision tools, including: MotorMaster+ motor selection and management software; AIRMaster compressed air software; and ASDMaster — a design and specification tool for adjustable speed drives, developed by EPRI and Bonneville Power Administration (BPA) (Scheihing 1996).

MotorMaster+ (MM+) contains manufacturer-specific price and performance data on more than 12,000 one to 500 HP motors sold in the U.S. This software can be used to analyze a new motor purchase, whether to replace or rewind a failed motor, or replace a working motor, by taking into account motor size, price, efficiency, annual hours of use, load factor, electricity

costs, and utility rebates. MM+ also allows tracking of motor maintenance, repairs, and operating hours (CEE 1997a; Scheihing 1996).

*AIRMaster*is spreadsheet-based software that can be used to audit, analyze, and obtain improvement recommendations for compressed air systems. AIRMaster and supporting manuals are designed for general auditors or plant personnel to evaluate compressed air system operation with simple instrumentation during a short-term audit. It focuses on inexpensive operation and maintenance measures, such as fixing air leaks and improving controls that can improve compressed air system performance and reliability, without significant risk to production. The AIRMaster package includes manuals, reports and guidebooks to assist users with audits and analyses. Because air compressors are a significant and inefficient user of industrial energy, they present great potential for energy savings. In seven audits, AIRMaster identified more than 4 GWh of energy savings, equivalent to almost half of compressor energy use. With estimated annual savings of $152,000 and total implementation costs of $94,700, simple payback is less than eight months (Wheeler et al. 1997).

Industry Partnerships

Through Industry Partnerships, MC is developing new educational products, materials, and services that focus on motor-driven equipment such as air compressors, pumps, and fans and blowers. This activity draws heavily on technical strengths of trade associations that represent motor-driven-equipment manufacturers (OEMs). Since the market structure for supply and services for each type of motor-driven-equipment and end-use industry is different, MC works with industry partners and Allied Partners to find the most effective methods of presenting and delivering information. Two examples of industry partnerships are: Compressed Air & Gas Institute and Electrical Apparatus Service Association (Scheihing 1996).

Compressed Air & Gas Institute (CAGI) is a trade organization of 45 manufacturers of compressed- air-system equipment (e.g., compressors, compressed air dryers, filters, pneumatic tools, and blowers). CAGI formed an Energy Awareness Committee to work on energy-related issues for compressed air systems and recently became a MC Allied Partner. CAGI is developing the following projects to promote more efficient compressed-air systems:

- Standardized certification and performance reporting of compressors, compressed air dryers, and filters;
- Consumer fact sheets explaining methods of testing a compressor and the importance of standard performance reporting forms (standard data sheets);
- An internet-accessible database containing standard data sheet information;
- Educational video(s) on compressed-air system and component selection, installation, and maintenance; and
- A certification/training program for plant compressed air system auditors.

CAGI has also been an active participant in the formation of the National Compressed Air Initiative. In support of that initiative, CAGI has hired a nationally recognized expert to represent their interest in the initiative, and assist the initiative in developing technical and curriculum materials (CAGI 1997).

Electrical Apparatus Service Association (EASA) is an international trade organization with more than 2,500 members that sell and/or service industrial electric motors, generators, transformers, controls, variable frequency drives, DC adjustable speed drives, and related equipment. EASA publishes standards for repairing electrical apparatus, published a booklet entitled "Understanding A-C Motor Efficiency," and developed a motor repair quality management system called "EASA-Q". EASA is an Allied Partner and will publish a motor-repair guidebook and develop videos that address motor replacement and repair issues in cooperation with MC (Scheihing 1996).

Other MC industry partnerships include:

- The Hydraulic Institute (HI), a trade organization of approximately 70 pump manufacturers, is preparing and marketing a video training program, "Energy Reduction in Pumps and Pumping Systems;"
- Air Movement and Control Association International is a trade organization that certifies performance ratings on fans, louvers, dampers, and other air handling equipment;
- National Electrical Manufacturers Association (NEMA), a trade organization representing manufacturers of electric motors, drives, and other electrical equipment, works with DOE to disseminate information to manufacturers of motor-driven equipment on upcoming efficiency standards for motors as part of EPAct;
- The Power Transmission Distributors Association represents approximately 500 manufacturers and distributors of power transmission equipment;
- The Institute of Electrical and Electronics Engineers, Inc., Industry Applications Society, Pulp & Paper Industry Committee; and the Technical Association of the Pulp and Paper Industry is an international technical association with 33,000 members (Scheihing 1996).

Utility organizations working with MC include: the Consortium for Energy Efficiency (see below), the Bonneville Power Administration (AIRMaster), and the Electric Power Research Institute (ASDMaster) (Scheihing 1996).

Allied Partners

The Allied Partnership facilitates distribution of information on efficient motor-driven system technology and applications. MC recruits as Allied Partners companies and organizations that provide products and services to industry. Allied Partners make a greater level of commitment to the program than MC Partners by agreeing to promote energy-efficient motor systems to their customers and in their own company. Each Allied Partner completes an Action Plan outlining the types of product distribution and activities they will undertake. In exchange, MC makes most of its resources available to Allied Partners (in quantity and at minimal cost), which they can distribute to industrial end-users in the course of daily business or in conjunction with customer education meetings or workshops. Typical Allied Partner Activities include: MC product dissemination, conducting training workshops, Motor Master+ software (MM+) dissemination, plant surveys/audits using MM+, and cooperative advertising with MC (Scheihing 1996).

The number and actions of Allied Partners continues to rise as they attain education on MC software tools and materials that are helping them help their customers save money. There are currently 127 Allied Partners. These Partners have ordered and distributed over 5,700 copies of MM+ software, and have participated in more than 95 workshops, trade shows, or seminars (MC 1997).

Consortium for Energy Efficiency

The Consortium for Energy Efficiency (CEE) is a national non-profit organization that includes utilities, energy and environmental groups, and state energy offices. CEE's mission is "to encourage the market for super-efficient products and practices that save energy, enhance environmental quality and satisfy customers" (CEE 1997a).

In respect to motors, CEE has worked with motor experts, manufacturers, and trade associations to develop broad acceptance of motor efficiency levels that are significantly higher (0.8 percent to 4 percent) than October 1997 EPAct levels (see Table 1A/B). "CEE Premium Efficiency℠" motors are available from major manufacturers and several utilities support them through rebates and/or technical information (see Regional section of this report) (CEE 1997a). This market-based initiative, begun in June 1996, attempts to set efficiency levels that manufacturers can focus on since they are used widely by utility energy efficiency programs. CEE also provides a guideline for educating end-users on appropriate application of premium efficiency motors (CEE 1997b).

CEE is exploring additional activities to address other aspects of motor-systems efficiency. An efficient transformer initiative, based on the new NEMA TP-1 standard for low- and medium-voltage, dry-type transformers, is nearing completion, with adoption by utilities expected to begin in early 1998. Plans for a motor repair practice initiative are being revised in light of the recent introduction of Advanced Energy's motor repair shop certification (see

Advanced Energy in Regional section of this report). CEE continues to explore other program opportunities including POS and OEM equipment initiatives (deLaski 1997).

Energy Efficiency Procurement Collaborative

The Energy Efficiency Procurement Collaborative and Product Network has recently been formed to provide members with accurate, easily accessible information about energy-efficient and environmentally preferred equipment that can be incorporated into their purchasing practices. The Collaborative is made up of federal, state and local government agencies and other large facility purchasers. One product area to be addressed is motor systems, with guidance currently being provided on efficient motor purchases. The Collaborative plans to provide similar guidance on other motor-driven equipment and services in the future.

REGIONAL PROGRAMS

Subsequent to the initial, broad survey, ACEEE did more in-depth research on utility and regional programs that have unique elements, have been especially successful or are especially promising.

Northeast

Utilities in the Northeast have had progressive DSM programs since the 1980s. Three regional leaders, NEES, NU and BECo, were all offering efficient motor rebate programs by 1990. In attempt to improve program planning and design, they commissioned Easton Consultants to prepare a motor market study in 1991. The study characterized the motor marketplace; estimated current efficiency levels and distributor pricing behavior; and identified market targets (i.e., end-user vs. distributor) for utility motors programs. Data were used to cost justify and help harmonize efficiency levels used for programs in the region (Easton 1992; Meberg 1997).

Utilities in this region have also been leaders in market transformation programs. Some such as NEES were instrumental in establishing CEE to provide national coordination of energy efficiency activities, and many are now active CEE members. Interest in coordinated programs has lead to formation of a regional program development initiative, Northeast Energy Efficiency Partnerships, Inc. (NEEP).

Northeast Energy Efficiency Partnerships, Inc.

NEEP, which was formed with a grant from U.S. Environmental Protection Agency (EPA), is a non-profit organization founded in the fall of 1996 to promote cooperative efforts to increase energy efficiency in New York, New England, and the mid-Atlantic (NEEP 1997b). It coordinates market transformation efforts in the region by forming partnerships with utilities,

trade allies, government agencies, and public interest groups. One of the initial program development initiatives is a premium efficiency program, built upon the CEE Premium Efficiency initiative. Organization of this program began with a meeting in January 1997 that explored the focus and interest among utilities in a coordinated program. Elements proposed include common qualifying efficiency levels and rebate forms, possible joint marketing, sharing of a motor expert, and central processing of rebates. Broadest interest was in a distributor rebate to change stocking behavior. Eleven utilities and three other organizations have joined the working group:

Atlantic Electric Company	NEES Companies
Boston Edison Company	New York State Electric and Gas
Central Vermont Public Service Co.	Northeast Utilities
Commonwealth Electric	Public Service Electric & Gas
Eastern Utilities Associates	VT Dept. of Public Service
GPU Energy	U.S. DOE Motor Challenge
Green Mountain Power	CEE

Regional participants have agreed to implement a coordinated program beginning in January 1998 using a common program name, logo, and marketing materials (Gordon 1997; NEEP 1996, 1997a). Not all utilities have yet decided to offer rebates, but many are planning to do so. A number of other motor initiatives are under consideration including, programs to promote efficient dry-type transformers, quality motor repair services, and efficient compressed air services. Development might begin in 1998 (Gordon 1997).

NEES Companies

NEES Companies (NEES, formerly known as New England Electric System), which includes Massachusetts Electric, Narragansett Electric, and Granite State Electric, revised its motors program in 1997 to meet CEE standards most cases, and increased rebates by approximately 20 percent. Customer rebates approximate the difference in price between standard and premium efficiency levels, ranging from $6 to $2,000, depending on the size and type of motor. NEES plans to adopt CEE premium efficiency levels in their entirety in 1998 (CEE 1997c).

NEES offers motor/motor-systems rebates through two programs: Design 2000 and Energy Initiative. Design 2000 targets time-dependent opportunities for the installation of efficient equipment, promoting comprehensive efficient design and construction practices in new and renovated commercial, industrial, and municipal buildings. In addition to rebates, the program offers technical assistance and commissioning services. Energy Initiative is similar to Design 2000 except that it targets existing buildings (MECo 1996). In calculating rebates, Energy Initiative takes into account the installed cost of the premium efficiency motor, less a

contribution from the customer, resulting in a 1.5-2-year payback for the customer. Design 2000 simply provides a rebate that approximates the incremental motor cost (Fagerquist 1997).

New York State Electric and Gas

NYSEG had a moderately active motors program dating from the late 1980s, offering rebates for the purchase of efficient motors. These rebates were discontinued in recent years. As part of their experience with the efficient motors program, staff became convinced that motor repair represented an important opportunity for energy savings. In 1993, they became one of the first utilities to attempt to address the issue of quality motor repair. The program, which was in effect from 1994 through 1995, provided a rebate to end users for the difference between a "premium" and a standard quality repair. The program never developed a clear definition of what constituted a "quality" repair, and was discontinued since no customer interest was expressed (Smith 1997).

New York Power Authority

The New York Power Authority (NYPA) offers a turnkey motor replacement program, which provides full-scale audits at a customer's request. NYPA staff conduct the audits and hire personnel to implement recommended improvements. NYPA uses CEE premium efficiency standards in most cases, and will probably adopt remaining CEE levels in 1998. Measures with a payback of ten years or less are undertaken. NYPA finances upgrades at the utility's borrowing rate, and customers repay the utility in a lump sum or over a maximum of ten years (CEE 1997c).

Northeast Utilities

Northeast Utilities (NU), the largest utility in New England, is a NEEP partner and uses CEE's premium efficiency levels as a minimum standard for their motors rebate program. The program's incentives, although not yet determined, will probably cover the entire incremental cost of premium-efficiency motors versus standard motors, with 80 percent of the incentive going to the customer and 20 percent to the vendor. NU also has a new construction motors program that promotes CEE premium efficiency levels through incentives where cost effective (CEE 1997c).

United Illuminating Company

United Illuminating (UI), the second largest utility in Connecticut, started using CEE premium efficiency levels in 1997 in its Blueprint Program, which familiarizes customers and design professionals with benefits of efficient technologies and practices (CEE 1997c).

Vermont

As part of a statewide motors efficiency program, all of Vermont's utilities will start using CEE premium efficiency standards in October 1997. Customer rebates will cover the approximate incremental cost of premium-efficiency versus EPAct-energy-efficient-level motors (CEE 1997c).

Mid-Atlantic States

In the Mid-Atlantic States, utilities have been running more traditional DSM programs. Baltimore Gas and Electric is emerging as an active Motor Challenge Allied Partner and is participating in a showcase demonstration, and PEPCO has been running a motor rebate program. It is unclear how the planned merger between BG&E and PEPCO will affect their future motor-systems activities. PSE&G started a rebate program in the Spring of 1997.

Baltimore Gas and Electric Company

Baltimore Gas and Electric Company (BGE) recently received permission to eliminate rebates for motors. The utility stopped accepting rebate requests at the end of June 1997. BGE requested that rebates be eliminated because they found that rebates were not achieving their motor-systems energy efficiency goals, but were instead promoting the sale of the biggest motors. To replace rebates, BGE, with the help of Motor Challenge, is moving toward a market-based approach to promote energy efficiency in motor systems. Although currently in a transition period, BGE will be working with Motor Challenge to train their sales force. BGE will continue to offer customers financing options, education, and training (Light 1997).

Potomac Electric Power Company

Through the end of 1997, Potomac Electric Power Company (PEPCO) is offering rebates to its Maryland customers to cover a portion of the incremental costs of purchasing a premium efficiency motor. PEPCO applies CEE's premium efficiency standards to eligible motors, which include installed TEFC and ODP motors from 1 - 500 hp (CEE 1997c).

Public Service Electric & Gas Motors Program

As part of a DSM collaborative, Public Service Electric & Gas (PSE&G), the largest utility in New Jersey, began investigating the establishment of an efficient-motors program in 1996. Detailed motors-market research conducted for PSE&G showed that the proportion of premium-efficiency motor sales is very low relative to areas that have a history of rebate programs (e.g., New England baseline study (Easton 1992)). The research also showed that manufacturers plan to create new lines of motors that meet the 1997 federal minimum motor efficiency manufacturing standard but are less efficient than premium motors; however, few of these motors are on the market yet. The mandatory federal efficiency standard creates a unique,

one-time situation in which premium efficiency motors will be a better established and more familiar product among customers and vendors than less efficient motors (Gordon 1996).

In March 1997, PSE&G began a motors rebate and technical assistance program that uses this one-time opportunity to expand the market for premium motors significantly. Rebates are tied to the new CEE motor standards to ensure a common message to manufacturers from utilities. While the majority of premium motors available locally already meet the standard, this will encourage manufacturers to bring the rest of their offerings in line. Although the program has only been authorized through the end of 1997, it is expected that it will take two to three years to transform the market. The idea is to strike intensely while the market is transitioning to a new product, in order to get customers accustomed to buying CEE-qualifying premium motors. This program will be conducted in coordination with the regional NEEP program discussed below (CEE 1997c; Gordon 1996).

This program offers customer incentives ($60 to $670) intended to eliminate the incremental cost between standard and premium efficiency motors, and is offering vendor incentives ranging from $20 to $85 through September 1997. The program markets to vendors and directly to the largest customers, and offers technical assistance (CEE 1997c). It is hoped that the price difference between EPAct and premium motors will decrease as premium volume increases, that vendors will begin to preferentially stock and sell premium motors, and that customers will become accustomed to buying premium motors. Once these patterns are established for a large share of the market, it is hoped that the patterns can be sustained after the program ends. This would be assured if Federal motors standards were someday upgraded, but depending on the level of price convergence, might be possible for a significant share of the market even without standards (Gordon 1996).

A turnkey contractor is delivering the program (working directly with vendors and large customers), including marketing, providing quality control, and processing rebate applications. PSE&G field staff are assisting in customer marketing. Based on interviews with motor vendors, both technical motor vendors and at least one large retail-oriented vendor are interested in the program. PSE&G recognizes that technical issues, such as slip, sizing, repair practices, and motor/drive system optimization, surround motor choice. The utility is relying on the turnkey contractor and field staff to educate vendors using MotorMaster training materials, though the regulatory process in New Jersey has slowed program deployment (Gordon 1996, 1997).

To complement this rebate program, PSE&G has been making extensive use of Motor Challenge products available through the Allied Partners program. PSE&G is distributing Motor Challenge fact sheets to motor vendors, who use the information to help sell motors that qualify for the rebate and technical assistance program. MM+ software is also available to motor vendors and PSE&G's large customers to help them select and specify program-qualifying motors.

The Carolinas and Virginia

Utilities in North and South Carolina and Virginia have had a long history of working on electric-motors issues because of their strong industrial base. In general, their efforts have focused more on education and technical assistance than on efficient-motor promotion programs. Recently, regional efforts have focused on emerging energy service businesses (ESBs) targeting industrial customers.

Advanced Energy

The Advanced Energy Corporation (AE) (formerly North Carolina Alternative Energy Corporation) has focused on motor activities in the Carolinas and Virginia through its Industrial Energy Laboratory (IEL) (formerly Industrial Electrotechnology Laboratory). AE, founded in 1981, has received its funding from utilities in the three states, and delivers its programs in coordination with member utilities. Recently, AE expanded to a national market, undertaking contract work for utility and non-utility clients nationwide. This change in focus is intended to better position AE to survive in a restructured utility environment where member-utility funding is less certain (Kellum 1996; Thomason 1997).

Strategically, AE views itself as a unique and exclusive source of motors information, and intends to market itself as such. AE has focused on developing unique, customized capabilities that are available on an exclusive basis to customers. These capabilities currently are:

- efficiency testing to IEEE and CSA standards of both new and repaired motors
- testing VFD/motor-systems performance, reliability and efficiency
- Customer-Specific Consulting
  - failure diagnostics
  - power quality problems with respect to motor systems
  - establishment of a motor management policy at a facility
  - facility motor surveys (using in house software tool)
  - motor replacement evaluation (e.g., metric to NEMA motors)
  - evaluation of repaired motors
- Training seminars on
  - importance of motor management for managers
  - establishing a motor management program
  - application of ASDs
- Publications
  - *Metric Motors*, a technical guide to use and repair metric motors, and select NEMA frame size motors to replace metric motors
  - *Horse Power Bulletin*
  - *Motor InSight Book*, a motor management guide
  - *Motor Survey How-To Guide*

AE's most recent offering is the *Proven Excellence Verification℠ in Electric Motor Diagnostics and Repair* service. This service, launched in the summer of 1997, provides third-party quality certification to motor repair shops, involving onsite inspection of shop repair practice and laboratory verification of quality of motor repair (AE 1997).

While AE has been a Motor Challenge Partner since the beginning of the program, it has not been active in recent years. As AE has shifted to a more national focus, they have expressed an interest in more active participation. AE is currently exploring ways to share their expertise with Motor Challenge without jeopardizing the proprietary nature of much of their knowledge (Thomason 1997).

The three largest AE member utilities are Duke Power, Carolina Power & Light (CP&L), and Virginia Power. Both CP&L and Virginia Power have had long-running motor-related programs, and make use of AE's motor testing and technical assistance capabilities. Duke's motors program has not been as active, but has recently become more active, focusing on energy services (Thielemann 1997).

None of the utilities in this region has offered rebates. They have instead relied upon education and technical assistance to promote greater motor-systems efficiency. All three utilities indicated that they rely on AE as their source of motor-systems expertise and view it as a unique and valuable resource for their customers. Each utility has been using the capabilities differently. Some actively promote AE's motors capabilities to customers, and bring them into the lab, while others call upon AE to address specific customer requirements. In general, however, none is doing much DSM (i.e., conservation and load reduction). Some have a renewed focus on load growth through customer retention and expansion. As a result, the focus of motor activities is

- load retention
- customer satisfaction, and
- value-added service (e.g, fee-for-service)

All the major member utilities are establishing energy service businesses. CP&L and Virginia view AE as a valuable complement to their energy service offerings. Since these activities are non-regulated and cannot use ratepayer funds, AE has supported these ventures with a fee-for-service.

A retail energy services division of Virginia Power, EVANTAGE™, provides a full range of services tailored to individual customer needs. Virginia Power President and Chief Executive Officer, James Rhodes, said of the venture that utilities "must become full-service energy companies, able to help their customers save money and use energy more efficiently in a complicated and changing market." The venture offers energy efficiency planning and implementation, energy systems maintenance, and energy information services (Wamsted 1995). For example, EVANTAGE™ designed and built a $42 million, 38 MW combined-cycle, turbine cogeneration facility at Chesapeake Paper Products' West Point Virginia facility. The plant will

serve current and future electricity and steam needs and replace several oil-fired steam boilers at the mill. In addition, the agreement calls for EVANTAGE™ to: become Chesapeake's supplier of choice for the next 25 years for all types of energy including electricity, gas coal and fuel oil; provide training for the generating unit's operators and other Chesapeake personnel; finance the facility; and provide management services for rebuilding an existing boiler. EVANTAGE™'s involvement will assist Chesapeake in expanding the plant with the planned addition of another paper machine (PR Newswire 1995; Southerland 1995).

Duke Power, through its Duke Engineering and Services (DE&S) group, has begun to focus aggressively on "out-sourced utilities" such as compressed air. This, along with its recent merger with PanEnergy, reflects a repositioning by Duke Power. DE&S has affiliated its program with some leading companies in their target markets, such as Honeywell and Ingersoll-Rand in the compressed air system market (Thielemann 1997).

Midwest

Midwestern utilities has been actively delivering motor-systems programs for many years. Utilities in Wisconsin have led in the design of motor-systems programs since the mid-1980s. More recently their activities have moved to the Energy Center of Wisconsin, which coordinates activities for all utilities in the state. Other utilities in the region began to run successful industrial programs in the early 1990s, and interest in continuing motor-systems activities appears strong.

Energy Center of Wisconsin

The Energy Center of Wisconsin (ECW) is a private nonprofit organization that performs energy efficiency research, development, education and demonstration to help improve the State's economy while protecting the environment. ECW is funded primarily by voluntary contributions from Wisconsin's utilities, and runs two motors programs: Responsible Power Management and Performance Optimization Service.

Responsible Power Management (RPM), a model for CEE's nationwide coordinated motor program, is a collaborative effort of Wisconsin's electric utilities, coordinated and managed by ECW. RPM was created in January 1993 to reduce confusion from different utilities having a variety of motors programs and to accelerate adoption of efficient motors. RPM developed sales tools and training for motor distributors selling motors in Wisconsin:

- *MotoRater Plus* is a circular slide rule that evaluates motor cost effectiveness.
- *MotorMaster* is a database of motors and case studies, produced by Motor Challenge.
- *MotorFacts* helps distributors and customers calculate a motor's payback period.
- Motor Partners (similar to Motor Challenge Partners) receive the MotorMaster database and public recognition in exchange for agreeing to purchase efficient motors.

- Program newsletters, brochures, videos, advertising annual breakfast meetings, a toll-free Help line, and presentations emphasize cost and energy benefits.

RPM tools have been most useful for distributors with a service/advisory relationship with their customers. Other distributors sell motors more as a commodity — fast and at the lowest price — precluding the distributor from taking even a little time to use RPM tools. The biggest factor influencing efficient motor sales, however, is rebates. Declining rebate levels have been accompanied by declining efficient motor sales (Hagler Bailly 1996). As utilities restructure, industry becomes more competitive, and motor standards become more stringent, information programs such as RPM need to adjust accordingly. Hagler Bailly (1996) recommends that ECW continue to refine and improve RPM tools and their marketing; develop case studies for the most prevalent state industries; eliminate video distribution; and expand to include quality motor repair, motor systems, and OEM markets.

ECW is working with Motor Challenge to refine training and develop new marketing materials for the *Performance Optimization Service* (POS). POS built on the Canadian utilities' Performance Optimization program, which focused on identifying applications for adjustable speed drives (ASDs). This component focus proposed an answer before asking which technologies make the most sense for each customer. Consequently, POS uses a *systems* approach to optimize the entire motor-driven system.

Utility customer service representatives identify candidates for POS. A POS engineer then offers the customer a quick, free engineering "walk through" analysis of their systems. If substantial savings are projected, a feasibility-study proposal is prepared to determine what needs to be done to improve efficiency and performance, and how much it will save the customer. Once a proposal is accepted, a POS engineer collects system-load and operating data, and prepares a feasibility study report, which recommends a design strategy and details technical and economic impacts of the project.

Energy savings from fan, pump, or blower-system upgrades are estimated at 20-50 percent for systems identified as good candidates for POS. As of the Fall of 1996, POS had 30 active pilot sites. Based on known and estimated costs and energy savings for sites that are proceeding toward implementation, the average payback is 1.2 years. These estimates do not account for productivity gains known to exist at some of the sites (Hanson 1997).

Utilities have offered a range of incentives to customers to undertake POS projects: feasibility study partial reimbursement; customized rebates based on projected energy savings; low-interest loans; and shared-savings contracts through an independent financing organization. A training program was developed with support materials for utility representatives, consulting engineers, trade allies, and end users/consumers. This training is tailored for generalists and specialists according to their roles and responsibilities (Wroblewski 1996).

POS has evolved over time, and now focuses on providing information and convenience for the customer. POS gives customers a comprehensive proposal right after the initial walkthrough, outlining what needs to be done and what it will cost and save. Immediate feedback keeps up momentum and motivation. POS also provides technical expertise to customers throughout the process, which is a key factor in building customer confidence in the program. POS success is attributed to identifying opportunities throughout the process, which is facilitated by training customers. Credibility is enhanced by the objectivity of the service provider. As the electric utility market restructures, utilities are losing perceived objectivity, which makes ECW's objectivity even more important (Wroblewski 1996).

Union Electric

Union Electric (UE) in Missouri offers Motor Challenge as one of several programs that help customers use energy efficiently. UE provides free training to customers who are users of MM+ software, and installs and supports MM+ to ensure each participating customer has a fully operational motor-systems management tool. To date, UE has distributed and installed MM+software at about 50 customer locations. One of those firms, General Electric Motor Supply, is partnering with UE to provide a St. Louis business with MM+ software and quick and continuous access to efficient motors in the event of failure and need for rapid replacement (MC 1997).

Detroit Edison

In 1994, Detroit Edison implemented the Large Manufacturing Customer Pilot Program (LMCP), which developed partnerships with its largest industrial customers. The pilot's flexibility accommodated industrial customers' long decision-making time and encouraged "best practices," which allowed customers to look at projects from a larger scale and decide what technologies or process changes best suited their overall needs. LMCP offered incentives that lowered customers' payback to an acceptable level. On average, payback was lowered from 2.8 years to 2.2 years with an average utility contribution of 23 percent of total project costs. LMCP projects included compressed air, HVAC, lighting, process, and motors. Industrial participants viewed LMCP as a good start, but not as effective as its more flexible successor, Special Manufacturing Contracts (SMC) (Detroit Edison 1996).

CINergy

CINergy was formed in 1993 from the merger of Cincinnati Gas and Electric (CG&E) of Ohio, PSIEnergy (PSI) of Indiana, and United Light, Heat and Power (ULH&P) of Kentucky. Each utility's programs were operated separately for a transition period, but as the companies have been integrated, there has been a move toward common program structure.

PSI has operated one of the most successful utility industrial programs in the U.S. (Elliott, Pye, and Nadel 1996). The program has two components: prescriptive measures and

customized incentives. Within the prescriptive part of the program, rebates for efficient motors have been a major element. In the customized part of the program, individual projects are developed cooperatively by the customer and PSI field staff, with technical and financial assistance supplied by PSI. Motor systems are among the most common measures included in these projects.

In 1991, CG&E initiated their Adjustable Speed Drive (ASD) Pilot Plan. The goal of the program was to educate customers about the benefits of ASDs and to provide incentives for their use while stressing the importance of using power conditioning equipment with such installations.

Eligible customers are those in the service area with an AC induction motor equal to or greater than one horsepower, in operation at least 2,000 hours per year, and in a variable torque application. Project participants are identified primarily either through trade ally solicitation or through CG&E Service Representatives. In addition, CG&E holds informational seminars on ASDs and associated power conditioning equipment for their customers once or twice a year. CG&E then performs an initial economic analysis and provides results to the customer. Approximately 80% of the customers have chosen to purchase the ASD and power conditioning equipment based on these initial analyses.

An important aspect of the program is that CG&E requires participants to purchase and install power conditioning equipment before the rebate is paid. This was initially done because of power quality concerns associated with ASD installations. However, CG&E soon realized that power quality would likely not be an issue as long as the number of ASDs installed in a given facility were small. Nonetheless, to avoid future complaints of power quality problems related to ASDs, the utility has made it their policy to educate customers from the outset and mandate the use of power conditioning equipment. Initially, when the rebate was set at $20/hp, some customers chose to install ASDs without the rebate in order to avoid having to buy the conditioning equipment. However, the level of rebate has risen to $40/hp for each qualifying ASD installed on motors equal to or less than 100 hp, and $30/hp for ASDs installed on motors greater than 100 hp. This small increase covers the cost of the power conditioning equipment and has made the program more attractive.

The program has evolved into a full-fledged program. The primary difference is that the $15,000 per customer rebate cap has risen to $40,000. CG&E used the rebate cap originally to keep large customers from using all available funds. This kept the field open for smaller customers, which allowed the utility to evaluate the program's effectiveness with a larger sample size. Now that the cap has been raised, larger industrial customers have joined the program.

One of the major hurdles still faced by CG&E is program evaluation. Attempts to quantify load impacts have been hindered by technical barriers. The utility is seeking methods of monitoring ASD installations in order to get a representative sampling of ASD energy

savings. Load impact estimates based on current methods have been made, but such estimates may not be reliable (Bolubasz 1995).

It is anticipated that prescriptive programs will continue at least through 1999, while customized program activities will move to a non-regulated ESB unit (Mulder 1997). As of mid-1997, unregulated activities have undertaken about $2 million in work, largely focusing on lighting and HVAC efficiency measures, but will work with customers on motor-systems projects if requested. CINergy is currently looking at other customer markets, including motors, but has not yet set any specific directions (Neal 1997).

Pacific Northwest

With program leadership from Bonneville Power Administration (BPA) and technical support from the Washington State Energy Office (WSEO), the Pacific Northwest has been at the forefront of utility motor programs since the 1980s. These initiatives have supported private and public utilities in Washington and Oregon in offering efficient-motor programs with tools such as MotorMaster and AIRMaster, and research into the motor repair industry. In 1994, Motor Challenge added its support to WSEO, and technical work was expanded and became widely available throughout the country.

While recent political changes have seen the demise of WSEO and a diminution of BPA activity, the region remains active in energy efficiency. The core of technical expertise built at WSEO has been transferred to Washington State University, in large part because of continued support from Motor Challenge. Programmatic leadership has been transferred to a new regional market transformation entity, the Northwest Energy Efficiency Alliance (NEEA). This cooperative venture will allow most public and private utilities in the region to continue to offer programs to customers.

Northwest Energy Efficiency Alliance

As part of the restructuring process in the Northwest, NEEA was established in January 1997. NEEA is a utility-funded partnership of public and private utilities, and public-interest groups, which works to improve electric energy efficiency through regional market transformation programs. NEEA covers Washington, Oregon, Idaho, and western Montana. The NEEA programs are offered cooperatively with utilities members.

One of the initial NEEA offerings is a premium-efficiency motors program that seeks to change stocking practices of motor dealers so that efficient motors become the dominant inventory. The premium efficiency motors program is an expansion of a BPA-funded program operated by the Electric League of Washington State since 1994. The program offers: consistent vendor and customer incentives across the region; a motor "circuit rider" who provides marketing and technical support to customers and vendors; and centralized rebate processing. The circuit rider has been the key to the program's success, providing a single point of technical

and administrative contact for program participants. In the 33 months ending December 1996, the program rebated 1,937 motors, with combined horsepower of 57,745 and estimated energy savings of 6,514 MWh (Zdebski 1997).

To complement their participation in NEEA, starting July 30, 1997, Eugene Water and Electric Board (EWEB) began using CEE premium efficiency levels in its motor rebate program. Rebates are based on horsepower and range from $30 to $3,200. Both Seattle City Light (SCL) and Tacoma Public Utilities offer customers rebates ($20-$1,000) for motors meeting CEE premium efficiency specifications (CEE 1997c).

This program uses CEE Premium Efficiency motor levels and the CEE efficient-motor brochure developed with support by Motor Challenge. NEEA is also looking for opportunities to expand its program offering into the areas of motor repair, OEM programs, and systems optimization. To this end, NEEA is an active member of the CEE Motor Systems Committee, and has joined the National Compressed Air initiative as a sponsor (Zdebski 1997). NEEA is currently preparing a strategic plan for its future motor-systems activities, including deployment of the CEE efficient transformers initiative, and is investigating how it can bring the POS program to the Northwest (Harris 1997).

California

California utilities have been leaders in DSM since the 1980s. Most of the utilities have offered conventional efficient motors programs, in addition to customized programs that may include motor systems. San Diego Gas and Electric and Southern California Edison have been offering customers compressed air audits using staff experts.

Southern California Edison

Southern California Edison (SCE), which serves most of the Los Angeles area, offered rebates in the past for efficient equipment, but discontinued them as restructuring got underway. SCE has actively led in the development of national motor programs as an advisor to Motor Challenge and as co-chair of the CEE Motor System Committee (Farhang 1997). SCE trains sales representatives to be able to recommend premium efficiency motors to customers based on economic and environmental benefits (CEE 1997c). Providing technical training to their sales force has been a cornerstone of the SCE industrial program. Emphasis on technical assistance is reflected in a compressed air system audit service available to customers. While many utilities offer this through the use of consultants, SCE has an expert on staff who conducts audits and assists customers with compressed air system related issues (Joseph 1997). Although currently in transition, SCE will probably try to dovetail its promotion of efficient motors with California Energy Commission and Motor Challenge statewide efforts. Recent activities have included cosponsorship of Motor Challenge training in their service territory (Grimm 1997).

Pacific Gas and Electric

Pacific Gas and Electric (PG&E), the country's largest utility, has three programs that address motors. Retrofit Express offers rebates ranging from $20 to $500 for high- and premium-efficiency motors, based on CEE standards. The program has a database that allows utility account representatives to easily produce a list of products that meet both CEE standards and customer specifications (CEE 1997c).

PG&E's Retrofit Efficiency Options program (REO) offers three types of incentives: financing, rebates, or Tailored Energy Planning Assistance (TEPA). PG&E is also piloting a service option for REO customers that will offer, in exchange for a reduced rebate, equipment selection support and bid specification assistance, bid review, economic analysis and customer sales and project management. The program is available for a wide range of applications, including variable frequency drives (PG&E 1997).

PG&E developed PowerSaving Partners (PSP) to team up customers with independent energy services companies (ESCOs) that offer full design, management and implementation services, including audits, recommendations for energy-efficiency measures, flexible financing, project management, installation and maintenance of measures, and measurement and verification of energy savings. Financing options include direct financial incentives, equipment leasing, shared savings or performance contracts, and in-house implementation. ASDs are among the most common measures utilizing this program (PG&E 1997).

Sacramento Municipal Utility District

Sacramento Municipal Utility District (SMUD) offered customers motor rebates based on horsepower and CEE premium efficiency levels for the first half of 1997 (CEE 1997c).

San Diego Gas and Electric

San Diego Gas and Electric (SDGE) industrial program emphasizes technical assistance, and like SCE they have developed compressed expertise on staff. SDGE's expert conducts compressed audits and assists customers with compressed air system related issues (Nehme 1997).

THE CANADIAN UTILITY EXPERIENCE

Canada has achieved a dramatic increase in the use of efficient motors by commercial and industrial customers as a result of actively promoting their use since the late 1980s. Canadian utility motors programs began with the intent of reducing high utility costs associated with additional generation, transmission, and distribution facilities. These programs were designed based on several market studies conducted by the Canadian Electrical Association (CEA) during

the mid-1980s. These studies showed that customers and trade allies lacked knowledge of efficient motors; standard definitions and test standards for efficient motors were lacking; distributors' efficient motor inventories were inadequate; efficient motors were expensive relative to standard-efficiency motors; and the new technology was considered to be very risky (Friesen 1996).

In response to these market barriers, Canadian utilities designed programs that educated customers and trade allies, adopted common definitions and standards where available, encouraged development of new definitions and standards where needed, and implemented independent verification of manufacturer efficiency claims. Most importantly, utilities offered incentives to customers to offset the price differential and to trade allies to encourage stocking and selling of efficient motors. Incentives were structured to reward more efficient motors with higher rebates. These rebates created a significant demand for efficient motors, which encouraged manufacturers to develop and distributors to increase inventories of efficient motors. These market changes forced down prices, meaning rebates could be lower (Friesen 1996).

As a result of these efforts, the Canadian sales share of efficient motors has risen from less than five percent in 1986 to 51 percent of units (and 65 percent of horsepower) in 1995. The success of Canada's efforts is attributed to several factors:

- Utility efforts were coordinated and included a wide range of stakeholders. Eleven of the largest utilities, which together serviced 85 percent of the Canadian motor market, agreed on qualifying efficiency levels, coordinated marketing efforts, and sought cooperation and support of manufacturers, trade allies, local distributors and vendors, and service providers.

- Utility efforts were comprehensive and credible, providing a broad range of services from general information and rebates, to detailed in-plant diagnostics.

- Government legislation supported utility efforts and convinced the motor industry that the increased emphasis on motor efficiency could endure in the market (CEA 1996).

Collectively, Canada's eleven major electric utilities spent over Can $44 million to improve the energy efficiency of Canadian motor stock. Of this amount, Can $35 million was spent between June 1989 and December 1994, resulting in demand savings of approximately 68 MW at an average avoided cost of Can $517 per kW, resulting in a benefit/cost ratio of 3.4 (comparative data are not available for the entire period) (CEA 1996).

Coordination between electric utilities and government contributed to the success of Canada's effort. Due to anti-trust issues, however, this coordination exceeds what is allowable in the U.S. Therefore, while many of the technical elements and some program concepts are applicable to the U.S., the aggressive design seen in past Canadian programs can not be replicated in the U.S.

As utilities are privatized in Canada, utility programs will change even more dramatically than in the U.S. Flagship motor-systems programs, by utilities such as Ontario Hydro and B.C. Hydro, are shrinking or disappearing as utilities reduce their DSM activity in the new cost reduction environment (Sam 1996). At the same time, Canadian utilities are beginning to develop energy service ventures similar to those emerging in the U.S. Utility restructuring is also necessitating a rethinking of Canadian National motors activities. Utilities will emphasize standards activities less, and government may shift to voluntary approaches, similar to Motor Challenge (McIntosh 1997).

CONCLUSION

Utilities have played a critical role in creating the market for efficient motors, and are now poised to continue to pull the market toward even higher motor/motor-systems efficiency by expanding beyond *new* motors programs to address the efficiency of *existing* motors and the systems they operate. Opportunities continue to exist for the promotion of efficient motors, since this can serve as an important awareness-building role in a broader motor-systems program. As can be seen from the above examples, models for the next generation of motor-systems programs already exist. Their widespread implementation will require a greater level of technical resources from utilities and greater flexibility in the design and implementation of the programs.

These utility motor-systems programs will likely fall into two categories: *public-benefit activities* and *for-profit business opportunities*. Activities like those being undertaken by NEEP, NEEA, and ECW fall into the first category, intended to permanently change market behavior. While they may start with efficient motors as their focus, they will of necessity move to broader issues as has been seen with the most mature of these programs. Public-benefit initiatives will most likely be formed more and more on a regional basis so they can leverage market power, costs, and expertise in a multi-utility region, while still being able to respond to the unique needs of a regional marketplace. National efforts such as Motor Challenge and CEE will support these initiatives, providing products and tools, and common program frameworks, respectively.

Some aspects of motor systems offer a for-profit energy service business opportunity for utilities. Motors are ubiquitous among industrial customers, and technical expertise is in short supply, so utilities can continue their role of energy technology broker and fill this market need. These programs can take the form of a value-added, customer-retention activities or as a new unregulated business. In the unregulated case the venture may take the form of a targeted motor service, such as the motor management or compressed air ideas discussed above, or as in the case with Evantage, where motors are included as part of a comprehensive energy service offering.

In any case, several roles still exist for utilities in the future of efficient motor systems. All that remains is for each utility to identify what roles best suit their future vision under restructuring, and begin building the motor-systems programs to take them into the next century.

Based on program efforts and trends discussed above, the following are recommendations for the development of a comprehensive motor-systems program:

- Efficient-motors programs represent an important foundation activity. While higher efficiency standards has significantly reduced the potential for energy savings from these programs, economically justified potential still exits. As is evidenced by the adoption of the CEE Premium Efficiency℠ initiative, interest remains high. These programs are an excellent awareness-building tool, promoting the development of motor management plans that can be leveraged by other program elements. For example, an efficient transformer initiative, such as is being developed by CEE, can be added to an efficient-motors program with very little additional effort.

- Motor repair practices have long been identified as an important industrial efficiency opportunity, but utilities have had limited success developing effective programs. With recent efforts in this area by BPA, CEE, and Advanced Energy, however, the information and tools are now available to help utilities add motor repair practices to their existing programs.

- Once awareness of motor energy use is created among end-users, the "holy grail" has been to develop programs that take a comprehensive "systems approach" to motor energy use. To date, no program has achieved broad market success in this approach. Many utilities have had success with motor-systems projects undertaken as part of customized incentive programs, but they offer limited replicability. Programs such as POS offer promise in this area, but have been difficult to market and have had limited market success. POS-type training can be an effective market awareness-building tool, especially for targeted end-user groups, as has been seen with the water and waste-water operator training sponsored by Motor Challenge. Programs to promote the adoption of a systems approach represent an important area for future program development.

  If the comprehensive approach remains beyond an easy grasp, a more limited program focused on specific motor-driven systems, appears near at hand. Recent developments in the compressed-air systems area appear particularly attractive. The national initiative will provide an attractive education and training program that utilities can deploy with limited additional effort. The program, however, offers significant opportunities for enhancement by individual utilities, allowing the initiative to be tailored to a specific customer base. Similar initiatives may emerge from the collaboration between Motor Challenge and pump and fan manufacturers and trade associations.

Time will tell whether these new efforts to promote motor-systems efficiency will be as successful as past efforts to promote efficient motors, but with the size of industrial motor use and the proven efficient potential, it is a challenge worth pursuing.

REFERENCES

[AE] Advanced Energy. 1997. "Proven Excellence Verification" information package. Raleigh, N.C.: Advanced Energy Corporation.

Blevins, Robert. 1995. *1994 Survey of Utility Demand-Side Management Programs and Services*. Palo Alto, Calif.: Electric Power Research Institute.

Bolubasz, Robert. 1995. Personal communication. Cincinnati, Ohio: CINergy.

[CAGI] Compressed Air and Gas Institute. 1997. Presentation at the Motor Challenge Partners Meeting, May 13-14. New York, N.Y.

[CEA] Canadian Electricity Association. 1996. *Canadian Motor Market Study.* Montreal, Quebec: Canadian Electricity Association.

[CEE] Consortium for Energy Efficiency. 1996. *Premium Efficiency Motors Initiative*. Boston, Mass.: Consortium for Energy Efficiency.

_____. 1997a. *Efficient Motors: Selection and Application Considerations*. Boston, Mass.: Consortium for Energy Efficiency.

_____. 1997b. *CEE's Premium Efficiency Motors Initiative*. Boston, Mass.: Consortium for Energy Efficiency.

_____. 1997c. *CEE Motors Initiative: Participating Utility Programs*, May. Boston, Mass.: Consortium for Energy Efficiency.

Census, U.S. Bureau. 1996. *1995 Current Industrial Reports: Motors and Generators* (MA36H95). Washington, D.C.: U.S. Department of Commerce.

deLaski, Andrew. 1997. Personal communication. Boston, Mass.: Consortium for Energy Efficiency.

Detroit Edison. 1996. *Evaluation of Large Manufacturing Customer Pilot Program.* Raleigh, N.C.: Foresight Group, Inc.

[DOE] Office of Energy Demand Policy and Office of Industrial Technologies. 1993. *Efficient Electric Motor Systems for Industry: Report on Roundtable Discussion of Market Problems and Ways to Overcome Them*. Washington, D.C.: U.S. Department of Energy.

Easton. 1992. *New England Motor Baseline Study*. Stamford, Conn.: Easton Consultants.

_____. 1996. *Strategies to Promote Energy-Efficient Motor Systems in North America's OEM Markets*. Stamford, Conn.: Easton Consultants.

Elliott, R. Neal. 1994. *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Elliott, R. Neal. 1995. *Energy Efficiency in Electric Motor Systems*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Elliott, R. Neal, Miriam Pye and Steven Nadel. 1996. *Partnerships: A Path for the Design of Utility/Industrial Energy Efficiency Programs*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Fagerquist, Paul. 1997. Personal communication. Westborough, Mass.: NEES Companies.

Farhang, Ray. 1997. Personal communication. San Dimas, Calif.: Edison International.

Flanigan, Ted and Barb Hogan. 1995. *Industrial Energy Efficiency Programs: Building Lasting Partnerships for Mutual Benefit*. Basalt Colo.: The Results Center.

Freedman, N. Richard, R. Neal Elliott, Bruce Meberg, Jeffery Dowd, Carl Burrell, and John F. DeKorte. 1996. *Electric Motor System Market Transformation*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Friesen, Dale. 1996. *Energy Efficient Motors Programs Canadian Experience.* Manitoba, Quebec: Manitoba Hydro.

Gandi, Nikhil and Michael DiGiacomom. 1994. "Compressed Air Efficiency – Moving Beyond Custom Programs." In *Proceedings of the ACEEE 1994 Summer Study on Energy Efficiency in Buildings*, 10.35. Washington, D.C.: American Council for an Energy-Efficient Economy.

Gordon, Fred. 1996, 1997. Personal communication. Portland, Oreg.: Pacific Energy Associates.

Grimm, William. 1997. Personal communication. San Dimas, Calif.: Southern California Edison.

Hagler Bailly. 1996. *Evaluation of the RPM High Efficiency Motors Program Draft Report.* Madison, Wisc.: Hagler Bailly Consulting, Inc.

Hanson, Mark. 1997. Personal communication. Madison, Wisc.: Energy Center of Wisconsin.

Harris, Jeff. 1997. Personal communication. Portland, Oreg.: Northwest Power Planning Council.

Joseph, Babu. 1997. Personal communication. Rosemead, Calf: Southern California Edison.

Kellum, Ziba. 1996. Personal communication. Raleigh, N.C.: Advanced Energy Corporation.

[LBNL] Lawrence Berkeley National Laboratory. 1996. *Draft Report on Energy Conservation Potential for Small Electric Motors.* Berkeley, Calif.: Lawrence Berkeley National Laboratory.

Light, Robert. 1997. Personal communication. Baltimore, Md.: Baltimore Gas & Electric Co.

Meberg. Bruce. 1997. Personal communication. Stanford, Conn.: Easton Consultants.

[MECo] Massachusetts Electric Company. 1996. *1995 DSM Annual Report.* Westborough, Mass.: Massachusetts Electric Company.

[MC] Motor Challenge. 1995. *Roundtable on Market Transformation Strategies for Industrial Electric Motor Systems: Record of Meeting.* Washington, D.C.: U.S. Department of Energy.

McIntosh, Tim. 1997. Personal communication. Ottawa, Ontario: Natural Resources Canada.

McKane, Aimee. 1997. Personal communication. Washington, D.C.: Lawrence Berkeley National Laboratory.

McMenamin, J. Stewart. 1994. "DSM Technology Forecasting: Market Transformation and the Dynamic Baseline," in *Proceedings of the ACEEE 1994 Summer Study on Energy Efficiency in Buildings.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Mulder, David. 1997. Personal communication. Cincinnati, Ohio: CINergy.

Nadel, Steven and Jennifer Jordan. 1994. *Designing Industrial DSM Programs that Work.* Washington, D.C.: American Council for an Energy-Efficient Economy.

Nadel, Steven, Michael Shepard, Steve Greenberg, Gail Katz and Anibal de Almeida. 1992. *Energy-Efficient Motor Systems.* Washington, D.C.: American Council for an Energy-Efficient Economy.

National Compressed Air Initiative. 1997. Initiative prospectus and minutes of the Sept. 10 organizational Advisory Board meeting. Madison, Wisc.: Energy Center of Wisconsin.

Neal, Kevin. 1997. Personal communication. Plainfield, IN: CINergy.

[NEEP] Northeast Energy Efficiency Partnerships, Inc. 1996. *Regional Premium Efficiency Motor Program: Issues and Options for Market Transformation*. Lexington, Mass.: Northeast Energy Efficiency Partnerships, Inc.

_____. 1997a. *Regional Motor Efficiency Program Working Meeting Notes, June 3*. Lexington, Mass.: Northeast Energy Efficiency Partnerships, Inc.

_____. 1997b. *NEEP Notes*, Volume 1, Issue 1. Lexington, Mass.: Northeast Energy Efficiency Partnerships, Inc.

Nehme, Jamil. 1997. Personal communication. El Cajon, Calif.: San Diego Gas & Electric.

Olagues, Andre. 1996. Personal communication. New Orleans, La.: Entergy.

[PG&E] Pacific Gas & Electric. 1997. www.pge.com/customer_services. San Francisco, Calif.: Pacific Gas & Electric.

PR Newswire. 1995. "EVANTAGE[SM], Chesapeake Paper Products Energy Partnership." PR Newswire. Dec. 18.

Sam, Helen. 1996. Personal communication. Montréal, Québec: Canadian Electrical Association.

Scale, Bill. 1997. Personal communication. Carle Place, N.Y.: Compressed Air Efficiency Council.

Scheihing, Paul. 1996. *US Department of Energy's Motor Challenge Program: A National Strategy for Energy-Efficient Industrial Motor-Driven Systems.* Washington, D.C.: U.S. Department of Energy, Office of Industrial Technologies.

Schueler, Vince, Paul Leistner and Johnny Douglass. 1994. *Industrial Motor Repair in the United States*. Portland, Oreg.: Bonneville Power Administration.

Smith, Warren. 1997. Personal communication. Binghamton, N.Y.: New York State Electric & Gas Company.

Southerland, Daniel. 1995. "Va. Power Unveils New Venture." *Washington Post.* December 19:C3.

Thielemann, Kurt. 1997. Personal communication. Charlotte, N.C.: Duke Engineering & Services.

Thomason, Cynthia. 1997. Personal communication. Raleigh, N.C.: Advanced Energy Corp.

Wamsted, Dennis. 1995. "Virginia Power Seeks Competitive 'EVANTAGE'." *The Energy Daily*. December 19: vol. 23, no. 237.

Wheeler, Greg, Eric Bessey, Richard McGill, and Karl Vischer. 1997. "AIRMaster: Compressed Air System Audit Software," in *Proceedings from the 1997 ACEEE Summer Study on Energy Efficiency in Industry*. Washington, D.C.: American Council for an Energy-Efficient Economy.

Wroblewski, Ronald. 1996, 1997. Personal communication. Madison, Wisc.: Energy Center of Wisconsin.

Zdebski, Robert. 1996. Personal communication. Bellevue, Wash.: Northwest Energy Efficiency Alliance.

APPENDIX A: UTILITY SURVEY QUESTIONNAIRE

(Defining incentives to include rebates and financing) do you currently offer incentive programs for motor related equipment or systems?

- New motors: new purchase, replacement, or in lieu of repair
- Adjustable speed drives
- motor driven equipment
- system efficiency upgrades

If yes:

How are your current qualifying levels set or defined?

Do you plan to continue to offer incentives in the future?

Do you plan any new/restructured incentive programs?
Move from rebate to financing?
Do you anticipate changing the levels of the incentives?

Do you anticipate changing the qualifying levels in the near future? If so, how?

If no:

Are you currently planning to introduce any new incentive program?

Do you anticipate considering the introduction of any incentive program in the near future?

What is your motivation for offering motors related programs (e.g., PUC mandate, customer satisfaction)?

How do you market your programs (e.g., direct mail, bill stuffers, sales calls, through vendor allies)?

What are you evaluation criteria (current and future)?

Do you have any reported result for the program to date (program evaluation reports or DSM/IRP program results filings)?

Please mark the boxes in the matrix below according to whether:

1. You currently offer the service and plan to continue the service (mark "1")
2. You currently offer the service and plan to *dis*continue the service (mark "2")
3. You don't offer the service currently, but plan to offer it (mark "3")
4. You don't offer the service currently and don't plan to offer it. (mark "4")

Area	Publications/ Software Tools	Customer/ Vendor Training	Basic Technical Assistance (e.g., audits)	In-Depth Engineering Assistance (e.g., systems design)	Customer Financing (e.g., loans)	Incentives (e.g., rebates)
High Efficiency Motors						
Adjustable Speed Drives						
Motor Driven Equipment Selection						
pumps						
fans and blowers						
air compressors						
Motor Repair						
Belts, gears, lubricants, etc.						
Systems operations and maintenance						
System design						
Other						

Please return this questionnaire to ACEEE* along with any available descriptive material on your motors program.

APPENDIX B: SUMMARY OF SURVEY RESULTS

ENERGY-EFFICIENT MOTORS PROGRAM SURVEY: SUMMARY OF RESULTS

(see notes below for explanation of codes)

		High Eff. Motors						ASDs						Motor-Driven Eq.						Pumps						Fans						Air Compressors						Motor Repair						Belts, Gears, Lubs						Sys Ops & Maint.											
		P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I	P	C	T	E	F	I
California	SDG&E	1	4	1	4	3	1	1	4	1	4	3	1							4	4	1	4	4	1	4	4	1	4	4	1	4	4	1	4	4	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
California	SMUD		1	1		1	2		1	1					1	1					1	1		1	1*		1	1		1	2		1	1		1	1*																									
California	SCE																																																													
California	PG&E					1	1					1	1			1	1*																																														
Carolina	IEL																																																											
Carolina	Duke																																																											
Carolina	VA Power	1	1	1	4	4	4	1	1	1	4	4	4	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	1	4	4	4	1	1	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Carolina	Carolina	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	4	1	4	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4
Heartland	Union El.	1	3	1	3	3	4	1	3	1	3	3	4	1	3	1	3	3	4	1	3	1	3	3	4	1	3	1	3	3	4	1	3	1	3	3	4	1	4	4	4	4	4	4	4	1	4	4	4	4	4	4	4	1	1	1	4	4	4
Heartland	IES	1	1	1	4	3	2	1	1	1	4	3	1							1	1	1	4	3	1	1	1	1	4	3	1	1	1	1	3	3	1	1	1	4	4	3	4							1	1	1	3	3		1	1	1	3	3	1
Heartland	PSI	1	1	1	1	3	1	1	1	1	1	3	1		1		3	3	1					3					3											1				1	1	1	1			1	1			3								
Heartland	Dayton	1	1	1				1	1	1				1	1	1				1	1	1				1	1	1				1	1	1				1										1	1	1									
Mid Atl.	BGE	1	1	1	3	1	2	1	1	1	3	1	4							3	3	1	3	3	4	3	3	1	3	3	4	1	1	1	3	1	2	1	4	1	4	4	4	1	3	1	3	3	4	1	3	1	3	1	4	1	1	1	3	1	4
Northeast	NU	1	1	1	1	1	1	1	1	1	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																			1	1			
Northeast	NYSEG																																																												
Northeast	UI	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1																							
Northeast	BECo																																																											
Northeast	ConEd	1	1	1	4	4	1	1	1	1	4	4	1	4	4	4	4	4	4																			4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Northeast	NEES																																																											
Northeast	JCP&L	4	4	1	4	4	1	4	4	1	4	4	2							4	4	1	4	4	1	4	4	1	4	4	1	4	4	1	4	4	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4						
Northwest	SCL	3	4	1	4	4	1	3	1	1	1	1	4							3	3	1	4	1	4	3	3	1	4	1	4	3	1	1	1	1	4	4	4	4	4	4	4	3	4	1	4	1											
Northwest	Tacoma	1	3	1	1	4	1	1	3	1	1	1	1	1	3	1	4	4	4	3	3	1	4	1	2	3	1	1	4	1	2	3	3	1	4	1	2	3	3	1	4	4	4	3	3	3	4	4	4	1	3	3	4	4	4	1	1	1	4	4	4
Northwest	WSEO																																																											
Northwest	BPA	1	1				1	1						1																		1						1	3									1											
Northwest	EWEB	1	1	1	1	4	1	1	1	1	1	3	1							1	1	1	1	3	1	1	1	1	1	3	1	1	1	1	1	3	1	1	4	1	4	4	4	3	4	1	3	3	1	3	3	1	3	4	3	3	3	1	1	3	1
Northwest	Portland																																																											
Northwest	Puget																																																											
Northwest	PacifiCorp	1	3	1	1	1	4	1	3	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	1	1	1	4	4	4	4	4	1	4	4	4	4	4	1	4	4	3	1	1	1	4	4*	3*	1	1	1	4
Southeast	Entergy																																																											
Southeast	Tampa								1		1			1		1				1		1				1		1				1		1										1		1				1		1									
Wisconsin	ECoW	1	1	1			1																																																				
Wisconsin	ECoW	1	1	1																																																						
Canadian	BC Hydro	1	1			4	4	1	1			4	4							1	1	1	1	4	4	1	1	1	1	4	4	1	1	1	1	4	4	1	4	4	4	4	4	1	4	4	4	4	4	1	4			4	4	1	1			4	4

SMUD * reduction in size

PG&E *based on size of customer

Dayton incentives for EEMs that increase jobs

SCL other = customized incentives

PacifiCorp offer training on case-by-case basis for pubs/tools

Tampa general incentive programs for peak-shifting measures

ECoW All offer financing for ASDs if they prove savings

P = Publications/Software Tools

C = Customer/Vendor Training

T = Basic Technical assistance (e.g., audits)

E = In-depth Engineering Assistance (e.g., systems design)

F = Customer Financing

I = Incentives (e.g., rebates)

Responses:

1 = Currently offer the service and plan to continue the service

2 = Currently offer the service and plan to discontinue the service

3 = Don't offer the service currently, but plan to offer it

4 = Don't offer the service currently and don't plan to offer it.