Development of a New Extended Motor Product Label for Inclusion in Energy Efficiency Programs

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ABSTRACT

Energy efficiency program administrators have for many years been aware of the significant energy savings possible with optimization of motor-driven systems. However, realization of these opportunities has historically been limited to larger systems because of the cost of the resources required to measure and verify the savings. A number of recent developments may change this. First, the development of specifications and labeling for motor-driven subsystems or packages offers the prospect of capturing some of the system effects. Low-cost sensors and control systems now also enable these packages to achieve some degree of self-optimization.

Manufacturers of electric motors, pumps, fans, and compressors are developing voluntary labels for motor-driven systems (e.g., a fan, pump, or compressor and the motor and associated controls) to reflect the equipment's relative efficiency as it is installed in a motor-system application. The development of a driven component or "extended product" label combined with implementation data could be the basis for prescriptive rebate programs with deemed savings values. Such programs would accelerate the adoption of more efficient motor-driven systems.

This paper explains the activities of a collaborative effort, the Extended Motor Product Label Initiative, to develop comparative metrics and labels for three categories of extended products. Also discussed are the ways its three working groups are ensuring the compatibility of these new extended-product labels with energy efficiency program measurement and verification needs. Finally, the paper describes the plan for development and public introduction of three or more efficiency program model proposals.

Background

Motor-driven equipment consumes one-fourth of all electricity sold in the United States each year (DOE 1998). Each year, facilities in the commercial, industrial, and institutional sectors purchase motor-driven products that total approximately 10 million horsepower in connected load (R. Boteler, Consultant, NEMA, pers. comm., December 4, 2013). As detailed in Table 1, electric induction motors are used predominantly to drive pumps, fans, compressors, and material handling and material processing equipment.

Electric utilities are constantly in search of new demand-side management program models that will help them reach their efficiency goals. Efficiency programs in the United States are spending an estimated $1 billion per year on energy efficiency (Chittum and Nowak 2010). Many programs have started to focus on the large number of motor-driven systems in the commercial and industrial sectors, but have been challenged to secure savings without requiring significant administrative resources and measurement and validation costs.

Table 1. Distribution of motors by application percentage for NEMA design a and b motors

Application	Horsepower (hp) 1–5	6–20	21–50	51–100	101–200	201–500	All hp
Air Compressor	1.8	1.3	2.2	5.6	5.4	8.3	2.2
Fans	22.5	24.9	26.6	25.7	18.9	21.7	24.0
Pumps	22.3	31.6	33.0	34.2	36.0	25.5	28.5
Material Handling & Processing	12.0	9.4	6.8	10.6	7.8	7.6	10.0
Other	41.4	32.8	31.4	23.9	31.9	36.9	35.3
Fire Pumps	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: DOE 2012, Table 7.2.3

Program administrators must be able to confirm that the energy savings and demand reductions happen as a result of the investments made with ratepayer funds. If an incentive is provided for a project that in the end does not reduce load, the utility is still required to provide power to the customer. To avoid this, measurement and verification (M&V) of savings resulting from program activities is required by public utility commissions (Chittum, Elliott, and Kaufman 2009).

The cost of M&V is included when evaluating the cost-effectiveness of programs; therefore, if the resources needed to perform M&V are too great, the cost-effectiveness of the efficiency program suffers. Efficiency programs have addressed this issue by developing portfolios of programs. Two common types of program models are those that target simple equipment replacements with “deemed” savings and provide a prescribed, or “prescriptive,” rebate, and “custom” programs that target complex projects with incentives that are proportional to the energy savings. The latter can require extensive before-and-after measurements, making them cost-effective only for larger projects.

Between the simple types of projects covered by prescriptive programs and the complex projects covered by custom programs lay a great number of opportunities to save energy through the selection of the proper motor-driven systems.

Introduction

The optimization of motor-driven systems has long been recognized by efficiency program administrators for its energy-saving potential. As indicated in Figure 1 and in the second column of Table 2, besides the energy-saving potential of more efficient components (motors, drives, and driven equipment), significant additional savings can be achieved with system optimization. System optimization, simply put, is the condition met when all the components of a system or subsystem are operating toward a common goal. A conventional motor-driven system will operate in only the on or off mode. The more ability a system has to adjust its performance to downstream demands, the less energy it will use.

Pursuit of these savings by efficiency programs has been limited to larger projects due to the challenges of quantifying the baseline energy use and measuring post-installation energy use. These activities can require specialists and be time-consuming—in other words, costly.

Recently, a number of developments offer the prospect of changing this reality. First, the development of specifications and labeling for motor-driven subsystems or packages by trade organizations (Table 2, column 3) provide a means for documenting some of the efficiency that results from system optimization and for making it readily available to end users and other interested parties, such as efficiency programs. Second, the emergence of low-cost intelligent sensors and control systems now allows these packages to achieve some degree of self-optimization.

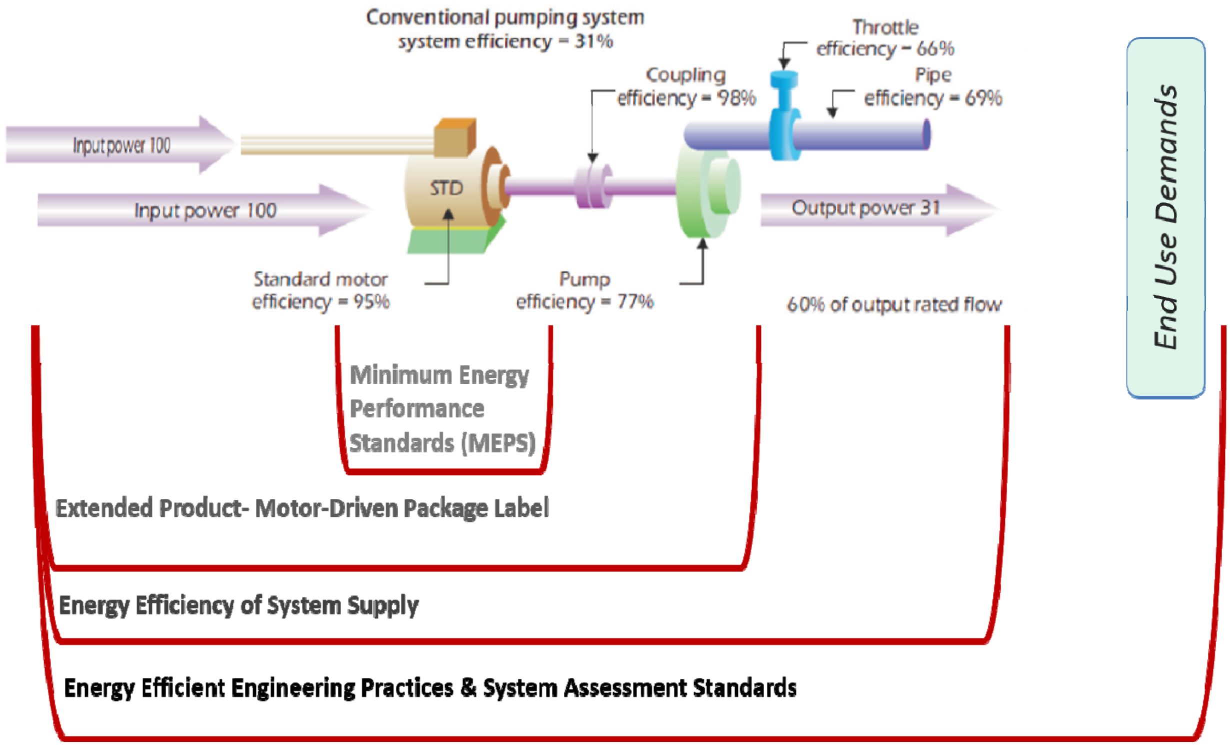

Figure 1. Extended-product example of a pumping system. *Source:* Rao 2013.

In response to these developments, manufacturers of electric motors, pumps, fans, and compressors are developing voluntary labels for motor-driven systems (e.g., a fan, pump, or compressor that is connected to a motor and associated controls) to reflect the relative efficiency of the equipment as it is installed in a motor-system application. The development of a driven component or "extended product" label combined with implementation data could be the basis for prescriptive rebate programs with deemed savings values. With motor-driven products totaling 10 million horsepower in connected load being sold every year in the United States, such programs would represent a significant new opportunity for efficiency program administrators.

This paper explores the state of development of these extended-product labeling efforts, proposes ways they can become the basis for new programs targeting the commercial and industrial sectors, discusses how they can be constructed to fulfill the measurement and verification needs of efficiency programs, and explains how they can help end users reduce energy consumption and operation costs.

Table 2. Relative efficiency gains for labeled vs. non-labeled motor-driven systems

Motor System Element	Sample % System EE Opportunity	How EE Opportunity Identified	Potential Program Response
Motor	2-5%	Label (MEPS, NEMA Premium)	Deemed Savings Eligible Product List
Drive	3 - 10%	Product class	Deemed Savings
Driven Equipment (Pump, Fan, Air Compressor)	10-25% for fans/pumps/ compressors*	Stated performance (AMCA label, CAGI data sheets, HI performance curves)	Deemed Savings Eligible Product Type Custom Program
Extended Product: Motor-Driven Package	15-35%	Label (proposed)	Eligible Product Type Custom Program
System Supply	15 - 40%	Performance Indicator (e.g. CASE) System Assessment	Technical Assistance Custom Program
Entire System	20 – 50%+	System Assessment (standards)	Technical Assistance Custom Program

Source: Rao 2013.

The Extended Motor Product Label Initiative

The Extended Motor Product Label Initiative (EMPLI) is a collaborative effort involving over two dozen representatives from the motor-drive equipment manufacturing sector, trade organizations, utilities, energy efficiency program administrators, and energy efficiency nongovernmental organizations. The participants from the trade organizations and manufacturers have expertise in performance testing and responding to U.S. and European rulemakings, as well as extensive market knowledge. The representatives from utilities and programs have expertise in program design and implementation and knowledge of regulation and program evaluation.

The American Council for an Energy-Efficient Economy (ACEEE) has functioned as the convening organization and recruited several trade associations, their members, and utility sector energy efficiency programs into the collaborative. The trade associations are the National Electric Manufacturers Association (NEMA), the Hydraulic Institute (HI), the Air Movement and Control Association (AMCA), the Compressed Air and Gas Institute (CAGI), and the Fluid Sealing Association. Efficiency programs that have participated to date include Pacific Gas and Electric (PG&E), Northeast Utilities, National Grid, the Energy Trust of Oregon, the Northwest Energy Efficiency Alliance, the Bonneville Power Administration, the Northwest Power and Conservation Council, Southern California Edison, and Consolidated Edison.

The collaborative approach facilitates communication between program administrators and the manufacturers of motor-driven equipment. The manufacturers and their respective trade organizations are interested in developing a label or comparative metric to simplify their customers' efforts to identify more-efficient products. The utilities and program administrators are interested in new methods for identifying potential energy savings.

The initiative has created three working groups (for compressors, fans, and pumps), with each being tasked with identifying a comparative performance metric for the primary component and/or the extended product. Each group includes representatives from the trade organizations, product manufacturers, utilities, and efficiency programs. The trade organization and manufacturer representatives, who are more familiar with their products and test methods, will determine the best comparative metric for inclusion in the label. A performance metric could be numerical (e.g., 40, 50, 60, and so on) or strictly comparative (e.g., “good,” “better,” “best”).

Since each of the product manufacturers is at a different stage in its development of test standards, the ability to link a label for an extended product to a certified test is limited. Therefore, some of the teams are likely to first develop a label relating the performance of the driven equipment. For example, the fan group may elect to develop a label based on the Fan Efficiency Grade. The pump team is challenged by the lack of a performance test for centrifugal pumps. In contrast, the compressor group has a wire-to-air metric that can be easily used for screw compressors. Labels based on any of these buckets still have the potential to be used in efficiency programs, so although the initial goal of the initiative was for each of the three teams to develop a label for an extended-product category, it will still be possible to develop program models for each of the product teams.

Program Types

A goal of the collaborative is for the labels to enable projects (or at least parts of projects) currently covered only under custom programs to be eligible for inclusion in prescriptive or semiprescriptive programs.

Prescriptive. Utilizes product description and performance to prequalify items for an incentive. Savings are “deemed” per piece of equipment or by size of equipment, such as per compact fluorescent lightbulb or per horsepower of a high-efficiency motor. These programs reach the most products and applications with the least amount of administrative cost.

Semiprescriptive. Utilizes a deemed savings measure to evaluate a category of products used in specific applications. For example, if the load factor of a boiler in educational facilities is different from that of a boiler in multifamily housing structures, the program might have a different multiplier for each sector to determine the net incentive per boiler horsepower. Such programs require a greater level of administrative resources to evaluate and qualify applications than prescriptive programs do, but less than custom programs.

Custom. Requires before- and after-installation measurement to determine and verify savings. Applications can be elaborate, as can post-implementation measurement and validation. Custom programs tend to apply to larger customers and larger projects.

By including representatives from the efficiency program sector in the development of these new labels, the details of the labels and the documentation supporting them can be structured to be compatible with the needs of a prescriptive or semiprescriptive rebate program.

Simplified Measurement and Verification

Efficiency program energy savings evaluation is very important in determining the success and influence of a program (Chittum 2012). A key motivation for utilities' involvement in this initiative is that these new labels will simplify the measurement and verification (M&V) for incentive programs by establishing straightforward eligibility requirements and the associated deemed energy savings. The coalition expects the results of this project to be usable and potentially accepted by a large number of utilities not directly involved with the project.

Scope of the Work

The teams have been tasked and are in the process of identifying the criteria to be included in a label as well as the supporting data that will be needed to meet program evaluation criteria. The program representatives have shared their program development methodologies, which include an understanding of the variables that drive savings and the ability to predict the savings potential with acceptable accuracy.

- Agree to the testing and labeling specifications that meet these criteria
- Collect field performance data required to estimate the average savings realized from the installation of label products in different configurations; this may result in the need to restrict the applications of labeled products for which savings can be deemed
- Work with the technical associations to create these labels and encourage their adoption by their companies
- Develop model energy efficiency programs that use these labels to incentivize motor-system efficiency, along with supporting educational materials

The working groups will then identify any other label content that may be needed to place a product within a comparative category. For example, the comparative metric for a vane axial fan will be different than for a centrifugal type of fan. Each team is filling out a template that will serve as a guide in the development of new labels and future program model proposals.

Project Outcomes

The ideal outcome of the project is for each of the three teams to develop a label for an extended-product category and an associated program model proposal. As previously discussed, the state of test procedures will not support this goal, and therefore the fan and pump teams are developing labels that assume a high-efficiency motor and appropriate drive (i.e., variable where appropriate) and provide the consumer with a wire-to-air or wire-to-water comparative metric.

Each trade association will create its own label or mark for identifying highly efficient products. Each trade association will own and manage its respective energy performance label. The trade association may elect to include a memorandum of understanding or license agreement for their respective labels. They will be responsible for any registration or trademarking of their label. NEMA is discussing cobranding with at least one of the trade organizations. Labeled products will be marketed to utilities, original equipment manufacturers, states, other trade associations, and end users.

The AMCA, HI, and CAGI are already American National Standards Institute–accredited testing organizations, and part of the value they provide for their memberships is performance testing and certification of member products. These new labels will add to this value, which will also accrue to the product sectors. It is hoped that, much as the Environmental Protection Agency's ENERGY STAR® logo has changed consumer purchasing of residential appliances, the establishment of an industry-supported and broadly accepted performance label will alter the purchasing habits of the commercial and industrial sectors, reducing their energy intensity.

Examples

There is precedent for the development of programs based on voluntary performance labels and for integrated motor-driven products with variable energy consumption profiles. NEMA Premium® motors are often the basis of utility prescriptive rebate programs. PG&E has developed a program for variable-speed pool pumps.

NEMA Premium Motors Voluntary Performance Label

This voluntary performance label became the basis for several utility sector programs, which was a catalyst for the EMPLI. Under the Energy Policy Act of 1992 (EPAct), DOE worked with industry to create a definition of electric motors and enact minimum energy performance standards (MEPS). Standards based on the "energy efficiency" level specified in NEMA's MG-1 standard (equivalent to the current levels in Table 12-11) were developed and instituted for certain electric motors of 1–200 horsepower (hp) in size. DOE adopted the Institute of Electrical and Electronics Engineers test methods for determining motor performance and adopted NEMA's performance metrics. The Energy Independence and Security Act of 2007 directed DOE to enhance those standards, and most motors covered under EPAct were required to meet higher standards as defined by NEMA MG-1 Table 12-12. As a result of DOE's rulemaking, manufacturers are now required to list the nominal efficiency of each motor on its nameplate and in published data. All motors sold in the United States must meet a minimum energy efficiency performance level.

To identify the most efficient motors on the market, NEMA used its existing reporting program to define a new efficiency level above the MEPS that the DOE had set. They trademarked that level as NEMA Premium. Shortly thereafter, the market and utilities began to adopt NEMA Premium as an incentive requirement in their efforts to accelerate the adoption of higher-performing motors. Because the difference in the energy use of a nominally efficient motor and a premium motor is relatively easy to calculate, utility programs were able to determine a likely energy savings per horsepower and design prescriptive programs around a rebate of a specified amount per horsepower.

Many companies and government agencies have started using this label as a purchasing specification. So even though it continues to be a voluntary performance standard, most manufacturers make products to this standard and energy is saved that otherwise wouldn't be.

PG&E Pool Pump Deemed Savings Program

Swimming pools can account for up to 20% of the electricity use of residential housing. That is because the pool filtration pumps, usually 1–3 hp in size, can run continuously at full power for much of the year. In California, a significant number of houses have pools, so PG&E developed a program to encourage customers to upgrade their pool pumps to more efficient variable-speed pumps (PGE 2014c). The new pumping systems save energy by virtue of their more efficient motors' ability to operate at reduced speed and the controls that minimize the time the pump runs (PGE 2014c).

A two-speed swimming pool filtration pump can reduce energy consumption by up to 55% and a variable-speed pump by up to 75%. Some customers could save $1,000 per year in electricity expenses (PGE 2014b). To encourage customers to purchase new pumps, PG&E offers rebates of up to $100 (PG&E 2014a). To encourage vendors to promote the program, PG&E has set up a certified installer program, and those vendors can receive a rebate of $200 per unit installed (PGE 2014c).

The PG&E pool pump program is instructive in that it captures the energy-saving benefits from an integrated product. Fortunately for this program, most pool pumps are sold in a package that includes the motor, pump, and controller.

One of the challenges in setting up this program was determining the energy savings per pool pump—and doing so inexpensively. The solution was to establish a short list of eligible products and then to determine the average energy savings that could be expected across this matrix of products and houses with pools. Providing the rebate through a website made applying and processing simple for the customer and inexpensive for the program administrator, contributing simultaneously to participant satisfaction and program cost-effectiveness.

All three working groups have used this example to understand the steps needed for efficiency programs to develop a new program. A template based on information collected by PG&E during the development of the pool pump program has been used by the pump working group to determine its data needs. The program proposal each of the three working groups intends to draft will use a format similar to that used by PG&E to justify its program.

Past and Future Activities

ACEEE and NEMA hosted an informal session at the 2013 ACEEE Summer Study on Energy Efficiency in Industry, held in Niagara Falls, NY, in July 2013, to gauge interest in forming a collaborative to pursue the development of new voluntary performance labels. A project launch call was hosted in October and the first in-person meeting was held in Portland, OR, in early December. At this meeting, the teams were formed, goals were established, and tasks were assigned.

ACEEE and the trade organizations have been facilitating the working groups by organizing conference calls and webinars. These meetings will continue through late May, with proposed extended-product labels anticipated in June.

The next steps are for the groups to identify existing performance data sets that can support the performance metrics and to recommend pilot project designs for collecting additional field data. This information is needed to perform a cost–benefit analysis on whether the additional cost of the more efficient equipment is justified by the additional energy cost savings. Elements of a cost–benefit analysis will include:

- KWh saved by segment or product bin
- Site-specific field testing (M&V)
- Estimated administrative costs

Data collection for the initiative will conclude in December 2014, though it is likely that data collection in support of specific program development will continue.

Late in the fourth quarter of 2014, the teams will convene a stakeholder meeting with peers to share findings, recommendations, and program model proposals. After feedback has been incorporated into the final product and additional participants added to the collaborative, a final report will be generated. Dissemination of the report will happen at a national event, possibly the annual meeting of the National Association of Regulatory Utility Commissioners in March 2015. Following the release of the report, initiative participants will engage in promotional efforts over the balance of the year to create awareness and acceptance of the three labels.

It is anticipated that the trade organizations will expand the product scope to include additional categories once the initial product labels are launched. ACEEE will drop back into an advisory, support, and promotional role, talking with state energy offices, national efficiency organizations, and different departments of DOE to increase awareness.

Summary and Conclusions

The collaborative of manufacturers, trade organizations, and efficiency programs has been working together quite successfully and is well on its way to developing comparative metrics and performance labels. Each of the groups participating in the initiative has its own reasons for joining. The trade organizations seek to provide value to their members and to coordinate responses to DOE rulemaking. Manufacturers are seeking methods to achieve product differentiation and reduce regulatory burden. Efficiency programs are seeking new program models to cost-effectively acquire energy efficiency resources from the commercial and industrial markets. By working together, each group can satisfy its needs, and the initiative seems to have effectively created a space of trust and collaboration to make this happen.

The task of developing a performance metric for extended products has, as expected, proven to be more complex and challenging than for driven products. As a result, the fan and pump working groups are considering development a device efficiency metric first, before taking on a wire-to-air or wire-to-water metric that would capture the performance of an extended product. Since the goal of the initiative is to develop models for efficiency programs, initial program proposals may be built around the simpler metric and an assumed extended product. For example, a program might assume a high-efficiency motor and an appropriate drive, but the performance metric that will form the basis of the incentive will be for fan or pump efficiency only.

The initiative is on track to produce working papers proposing efficiency program models based on the respective comparative metrics. The participating efficiency programs have indicated a desire to pilot one or more of the program models before the end of 2015. If the collaborative is successful, as it appears it will be, within the next few years several efficiency programs around the country will deploy new prescriptive rebate programs with deemed savings for common industrial and commercial fan, pump, and compressor products. These programs will accelerate the adoption rate of more efficient integrated products and bring about savings in the quadrillions of Btus over the next ten years.

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