Transforming the Market for Commercial and Industrial Distribution Transformers: A Government, Manufacturer, and Utility Collaboration

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ABSTRACT

Distribution transformers offer a largely untapped opportunity for efficiency improvements in buildings. Application of energy-efficient equipment can reduce transformer losses by about 20%, substantially cutting a facility's total electricity bill and offering typical paybacks less than three years. Since nearly all of the electricity powering the commercial and industrial sectors is stepped down in voltage by facility-owned distribution transformers, broad application of energy-efficient equipment will lead to huge economy-wide energy and dollar savings as well as associated environmental benefits.

This opportunity has led to a multi-party coordinated effort that offers a new model for national partnerships to pursue market transformation. The model, called the Informal Collaborative Model for the purposes of this paper, is characterized by voluntary commitments of multiple stakeholders to carry out key market interventions in a coordinated fashion, but without pooling resources or control. Collaborative participants are joined by a common interest in establishing and expanding the market for a new product, service, or practice that will yield substantial energy savings.

This paper summarizes the technical efficiency opportunity available in distribution transformers; discusses the market barriers to widespread adoption of energy-efficient transformers; and details an overall market transformation strategy to address the identified market barriers. The respective roles of each of the diverse players -- manufacturers, government agencies, and utility and regional energy efficiency programs -- are given particular attention. Each of the organizations involved brings a particular set of tools and capabilities for addressing the market barriers to more efficient transformers.

National Market Transformation: The Informal Collaborative Model

Eto, Prahl & Schlegel (1996) define market transformation as, "a reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed(10)." Market barriers are those market characteristics that explain the "efficiency gap," i.e., the difference between the actual level of investment in energy efficiency and a higher level that would be cost-beneficial. Market interventions are "deliberate efforts by government or utilities to reduce market barriers and thereby change the level of investment in energy efficiency (Eto, Prahl and Schlegel 1996, 8)."

Because these authors are interested in developing a framework for evaluating the impact of publicly funded programs, they limit actions to reduce market barriers to publicly-funded interventions, i.e., government (taxpayer-funded) and utility (ratepayer-funded) programs.[1] However,

[1] Eto, Prahl and Schlegel develop a framework for evaluating the market transformation impacts of California DSM programs. As such, they are concerned with the regulatory-driven programs of regulated utilities. For the purposes of this

this definition can lead to a narrowly based approach to achieving market transformation objectives. In many cases, private entities (e.g. manufacturers, distributors, energy service companies, etc.) have an interest in addressing specific barriers to energy-efficiency improvements. They may be motivated by the potential for increased market share or profits, by a desire to improve their public image, or a desire to preempt regulation through voluntary actions. Often, these private market actors are better positioned to address certain barriers than government or utilities.

A broadened vision of who might "intervene" in a market to improve energy efficiency has three important consequences for market transformation initiative development and design. First, recognition of private market actors as potential market intervenors expands the set of available tools for addressing the "efficiency gap." Now, the resources and capabilities of private sector market actors such as manufacturers, distributors, and design professionals are added to the mix of program options. Second, a broad definition of who might intervene to help transform a market leads to an inclusive approach to initiative design that identifies common interests in efficiency and marshals each market player's efforts. Such a view of the potential for private market player interventions is counter to typical practice that treats private players as subjects to be influenced by the program, or at best, allies to be recruited once the effort is underway.

The third consequence is the inverse of recognizing private interests as potential market intervenors. Now, government and utilities must be recognized as legitimate market players with their own particular interests as opposed to outsiders acting upon a market system. As a result, the exclusive burden for transforming the market is lifted from them.

By grouping government, utilities, and private market players together as market players all of which can legitimately undertake interventions to shift a market to higher efficiency levels, the potential for a new model approach for market transformation programs becomes evident. This new model for national market transformation partnerships, termed the "Informal Collaborative" for the purposes of this paper, is characterized by voluntary commitments of multiple stakeholders to carry out key market interventions in a coordinated fashion, without pooling resources or control. The collaborative participants are joined by a core objective: the establishment and subsequent market growth for a new product, service, or practice that will yield substantial energy savings. While the participants are likely to have divergent motivations, they coalesce on the Informal Collaborative's core objective.

In the Informal Collaborative approach, manufacturers and trade allies are key players are full-fledged partners who initiate elements of the overall strategy and participate in initial planning, design and development. For example, a common market transformation initiative objective is to induce manufacturers to improve the supply of energy-efficient equipment. In an Informal Collaborative, manufacturers share the core objectives, so the focus of the market transformation initiative shifts to collectively addressing the reasons why supply is inadequate, which may include capital constraints, product life cycles, or inadequate demand.

The Informal Collaborative relationship extends not only to private market actors, but also among publicly funded interests sharing the core objective. Typically, government or utilities initiate a new market transformation initiative and then recruit others to participate or coordinate efforts. The program initiator views the other publicly funded entity as a subject of their program. Program success is, in part, measured by how many other partners sign on to the initiator's program. Like private sector allies, publicly funded allies bring a set of tools and abilities for addressing specific market barriers. By

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paper, "utility" is defined as the regulated entity charged with administering and delivering efficiency programs. Obviously, the unregulated subsidiary of a utility may be interested in shifting a market for improved efficiency for reasons entirely unrelated to regulatory requirements.

involving all interested parties in the development and design phase, the diverse resources of all market players sharing the core objective are tapped most effectively.

The Informal Collaborative Approach in Practice: Commercial and Industrial Distribution Transformers

The commercial and industrial distribution transformers market offers a still-developing case study in the Informal Collaborative Model for a national market transformation initiative. After a brief discussion of the market transformation opportunity for commercial and industrial transformers, this section uncovers the roles played by the collaborators in this market transformation effort.

The Commercial Distribution Transformer Opportunity

Distribution transformers convert incoming electrical service to the lower voltages used to run equipment and lighting throughout buildings. While distribution utilities own and maintain transformers for residential and small commercial service, larger commercial and industrial customers typically take power at higher voltages and step down the power to plant or building voltages useful for their applications on the customer side of the electric meter. Therefore, large commercial and industrial utility customers pay the bill for distribution transformer inefficiency.

Commercial and industrial distribution transformer losses total to about 79 billion kWh annually (Barnes et al. 1996). Energy-efficient transformers could cut this total by about 20% (CEE 1997). Substituting energy-efficient transformers for standard equipment in new facilities, expansions and renovations could reduce total U.S. electricity use by mare than 3.2 billion kWh in 2010 for a savings of nearly $200 million (ACEEE 1998).[2] Because transformers generally last a very long time, the 2010 savings represent only a third of the total potential savings. Annual savings will continue to balloon as stock penetration grows for another twenty plus years. Barnes et al. estimate that full manufacturer participation and universal acceptance of equipment meeting a recently developed voluntary industry standard for "energy-efficient" transformers would yield energy savings approaching 2.5 quads over a 30 year period (1997).

Despite this large economy-wide savings opportunity, relatively little attention has been paid to commercial and industrial transformer efficiency. This lack of attention can be traced to several barriers. In general, facility managers, specifiers and contractors perceive transformers as already being very efficient. Because they are part of the electrical system, transformers are not generally perceived as a user of electricity, and therefore little attention is paid to their efficiency. In addition, specifiers and contractors who typically decide which transformers get installed have no direct stake in keeping operating costs low. Finally, even for the most efficiency-focused facilities, energy-saving efforts typically are directed to large end-uses such as motor and lighting systems. The net result is that most facilities choose transformers on the basis of lowest first cost, missing opportunities to cost-effectively trim operating costs by installing energy-efficient transformers.

For new facilities, expansion or renovation of existing facilities or the rare transformer failure, choices exist which can provide substantial cost-effective energy savings. By choosing energy-efficient transformers, individual commercial and industrial facilities can cut total electricity bills by 0.3% to 1.5% or more with paybacks of three to five years at national average electricity rates (CEE 1997).[3]

[2] Dollars quoted in 1997 dollars, assumes flat electricity prices. 1997 sales-weighted average of commercial and industrial rates was $0.0613/kWh.

[3] Another choice bearing further investigation is the one between dry-type and liquid-immersed equipment. The savings cited in the text assume customers stay within equipment type. However, currently available liquid-immersed equipment can reach higher efficiencies at lower equipment cost than comparable dry-type equipment. Despite the lower first costs

For instance, a medium-sized office building with a hundred 75 kVA low voltage transformers could cut its annual electric bill by 171,000 kWh by selecting energy-efficient transformers. Although choices exist, few have the knowledge, information and motivation to select cost-effective energy-efficient equipment.

Building a Market Transformation Strategy

Faced with a market that failed to yield even the most cost-effective energy efficiency improvements, the collaborative partners each contemplated individual efforts to improve transformer efficiency. In 1997, the collaborators formed a loose-knit group that began sharing information on how they could work together to move the market toward higher levels of energy efficiency. Currently, the collaborative involves manufacturers (represented by the National Electrical Manufacturers Association, NEMA), the U.S. Environmental Protection Agency (EPA), federal purchasers represented by the Federal Energy Management Program (FEMP), utility- and regionally-based energy efficiency programs, and energy-efficiency organizations.

Each of these market actors has played or will play a critical role in addressing specific market barriers. NEMA has anchored efforts to develop consensus industry definitions and standards. EPA has developed a labeling effort to make it easier to distinguish products in the market. The Consortium for Energy Efficiency (CEE) is working with its members (utilities and other organizations that design and implement regional and local programs) to develop approaches for building demand for efficient equipment. The U.S. Department of Energy's (DOE) FEMP program is developing efforts to spark Federal demand.

Together, these efforts constitute a loosely formed, yet explicit strategy to transform this market. On the supply side, the strategy emphasizes creating common definitions of energy efficiency so that manufacturers and purchasers have a clear performance target. On the demand side, efforts target creating enough initial demand to justify investments in new product lines and distribution of equipment meeting the agreed upon definition of "energy-efficient" equipment. The following sections detail the specific contributions of each partner in the Informal Collaborative.

Defining "Energy-Efficiency": NEMA Standard TP-1. Manufacturers and their industry trade association, NEMA, have played a linchpin role in creating the basis for providing customers with the products and information they need to procure more efficient transformers. For over twenty years the industry has introduced technical and manufacturing techniques that reflected utility interests in minimizing energy losses.[4] Consequently, the capability to provide cost-effective, energy-efficient equipment has been developed by the manufacturing industry.

Manufacturers' desire to be responsive to the growing interests of their customers motivated their decision to develop a standard defining energy efficiency. In addition, the public interest in saving energy gained the attention of the distribution transformer industry in 1989. At that time,

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and higher efficiencies of liquid-immersed equipment, facilities have generally specified dry-type equipment for indoors and, in some cases, outdoor equipment due to fire and safety concerns. With the availability of improved insulating materials, more users may be willing to consider liquid-immersed equipment for both outdoor and indoor applications and thus be able to reap additional efficiency gains and significant first cost and operating savings. Manufacturers of the competing equipment types argue the relative merits of their products.

[4] Widespread adoption by utilities of total owning costs (TOC) methodologies for specifying transformers has resulted in improved average efficiencies for utility-purchased transformers. TOC methodologies calculate the total cost associated with a transformer purchase by combining purchase price with a discounted stream of operating loss costs over a user specified time interval. Some utilities have used the entire expected equipment lifespan.

Congress first considered amendments that could lead to minimum efficiency standards for distribution transformers. The transformer industry, as represented by NEMA, held then and continues to maintain that product capability and performance definitions should be addressed by the private sector through industry standards. Therefore, even before the passage of the Energy Policy Act of 1992 (EPAct) in 1992, distribution transformer manufacturers agreed to undertake the development of voluntary standards through NEMA.

EPAct required DOE to make a determination regarding the technological feasibility, economic justification and energy savings potential of a minimum mandatory standard for transformer efficiency. With this provision in mind, NEMA member transformer companies embarked on the development of a series of industry standards to address efficiency levels, test methodology, and product labeling. In the industry's view, manufacturers are best positioned to assess their own products' technical capabilities and limitations and their own customers' needs. At the same time, NEMA members recognized that liaison with the DOE offices responsible for carrying out the legislative mandate regarding transformer standards would be essential. To that end, NEMA provided extensive assistance to the Oak Ridge National Labs, DOE's contractor responsible for carrying out the determination analysis. This analysis, completed in 1997, found that distribution transformer standards are technically feasible, economically justifiable and would result in significant energy savings (Barnes et al. 1996, 1997).

Concurrently, NEMA members embarked on a study of products available in the utility and commercial/industrial markets. NEMA's study concluded that a majority of utility customers used an economic formula -- total owning cost (TOC) -- in their acquisition process to access technical and economic factors of transformer selection. Widespread use of the TOC method led to utilities generally acquiring efficient transformers. However, the study also revealed that while the utility market displayed discipline in their selection process, similar procedures were lacking in the commercial and industrial sectors.

The study resulted in the development and publication of NEMA TP-1, *Guide for Determining Energy Efficiency for Distribution Transformers*, issued in mid-1996. TP-1 provides the customer and manufacturer two options for evaluating transformer efficiency in the commercial and industrial sectors. For customers willing to undertake loss evaluation, the TOC methodology used by utilities is extrapolated to the commercial and industrial situation. However, since few non-utility customers had shown a willingness to carry out this analysis, NEMA developed tables of energy efficiency values as an easy-to-use alternative to the owning cost methodology. NEMA based the standard on empirical data relating to three important considerations: energy costs, transformer loading, and willingness to pay. Using these inputs, the TOC methodology was used to identify appropriate efficiency values for the tables. Thus, the table provides efficiency level data for liquid- and dry-type transformers, single- and three-phase distribution transformers based upon capacity (in kilovolt-Amperes, kVA) and percentage of nameplate load (50% load for liquid-filled transformers, 35% load for low voltage dry-type and 50% load for medium voltage at specified temperatures).

NEMA manufacturers believe that the use of the TOC method or the tables or the methodologies will result in significant energy savings. Since the publication of TP-1, NEMA member companies have been individually promoting the document in their sales and marketing programs. To that end, the members have authorized the modification of their statistical program to report on the sales of products meeting TP-1 in order to assess the success of their individual efforts.

Recently, the industry initiated and has under review a second standard, TP-2, *Standard Test Method for Measuring the Energy Consumption of Distribution Transformers*, which outlines the methods of testing to achieve repeatable and quantifiable efficiency levels outlined in TP-1. This standard will also be based on existing consensus ANSI C-57 standards and should be published in mid-1998.

The industry group has also developed the first draft of a standard for the calibration of test equipment used to test efficiency. NEMA expects to finalize this document by mid-1998 as well. The industry group will embark on the development of a fourth document, *Standard for Labeling of Energy-Efficient Distribution Transformers,* with a completion date target of January 1999.

In sum, the manufacturers have contributed to the launching of this market transformation in three important ways. First, through industry developed standards, consensus definitions have been reached that can form the basis for industry, government and utility-based programs to encourage efficient practices. The existing trade association provides an ongoing forum where such standards can be developed. To a large degree, NEMA's development of an industry consensus standard defining energy-efficient transformers made the informal collaborative possible by offering a starting point for a coordinated effort. Second, the industry has supported government-sponsored market research and conducted its own market assessment. Data from these sources have provided information on program approaches needed to move the market to higher efficiencies. Finally, the industry's willingness to collect data on sales of equipment meeting the industry standard will help tremendously in evaluating collective impacts and developing future directions.

Creating a brand identity: EPA ENERGY STAR®. EPA has broad public policy responsibilities for encouraging improved energy efficiency to reduce greenhouse gas emissions and improve air quality. The 1997 Climate Action Report identified distribution transformers as a target for EPA's voluntary programs (U.S. Department of State, 1997,103).

EPA will launch the Energy Star program for commercial and industrial distribution transformers in the summer of 1998. The program will begin by labeling low voltage transformers meeting EPA's efficiency criteria. After careful review, EPA determined that the energy-efficiency tables in NEMA standard TP-1 were sufficiently rigorous to serve as the Energy Star program specification for this equipment class. However, the agency has decided to defer adopting an Energy Star specification for the medium voltage equipment class.[5]

Currently, the lack of efficiency information in product catalogs or on nameplates, make it virtually impossible to distinguish products on the basis of efficiency. EPA's program will provide the market an easy-to-use handle for distinguishing energy-efficient equipment from standard practice. In addition, the Energy Star program brings an established brand name and the third-party credibility of a government agency to the agreed upon common definition of "energy-efficient" transformers. As manufacturers join the program and begin to label compliant products, purchasers will be able to simply specify Energy Star. They thus will be assured that they are procuring energy-efficient products. In addition, manufacturers that choose to participate, will benefit from the EPA's third-party credibility and the marketing muscle behind the Energy Star brand name.

In addition, EPA will develop collateral tools in partnership with other Informal Collaborative members to help market Energy Star compliant equipment. Already, the agency has produced the Commercial and Industrial Transformer Cost Evaluation Model (CITCEM), now in Beta version. This

[5] Although EPA would like to offer an Energy Star specification for the medium voltage equipment class, NEMA established separate standards for dry and liquid immersed equipment. Both liquid and dry-type transformers can be applied in portions of the medium voltage commercial and industrial transformers market. In a desire to never favor one technological approach over another, EPA has avoided technology specific standards. Moreover, it appears that a large portion of current medium voltage transformer sales already meet the NEMA standard, implying that the ENERGY STAR® label would do little to distinguish between average and best practices.

software tool assists commercial and industrial purchasers in evaluating the total owning cost of transformer purchases. Lists of Energy Star qualified equipment, partner companies, program information and software tools are available on the EPA Web site.[6]

In the future, the Energy Star Buildings program (a separate EPA program) will include a component for Buildings program participants to evaluate their transformer purchases. Through the Energy Star Buildings program, EPA enlists commercial, industrial, and government partners to survey their facilities and perform cost-effective equipment and system upgrades to maximize energy efficiency. EPA encourages partners to undertake measures that reduce internal cooling and heating loads (e.g., lighting upgrades, building envelope improvements) followed by HVAC distribution system and plant upgrades. Energy Star transformers will be one of many energy saving opportunities that building owners can capitalize on in improving their building's energy efficiency.

Getting the market started with government purchasers: the FEMP program. The Federal government buys more than $10 billion in energy-using products and pays nearly $4 billion in energy costs to operate its buildings and facilities each year. In response to EPAct and a subsequent Executive Order, FEMP developed a Federal Procurement Challenge to meet public policy goals of reduced pollution and improved overall U.S. energy efficiency while saving tax dollars. By providing guidance and information that helps federal purchasers to choose products with some of the best efficiencies available, the program cost-effectively reduces the government's energy bill. Moreover, the government's immense purchasing power can serve to bolster the market position of the top energy-efficient products, particularly when coordinated with related voluntary efforts to improve the market share of energy-efficient products such as Energy Star.

Federal purchasers face many of the same barriers to choosing cost-effective efficient products as those in the private sector. Barriers include lack of information regarding energy-efficient choices, tight capital budgets which encourage low-first cost choices, lack of availability from normal government supply channels, and a general environment that favors status quo procedures and purchasing practices. The Federal Procurement Challenge seeks to spur federal purchases of efficient equipment through several tools. First, DOE publishes Product Energy Efficiency Recommendations (PEERs). These one page summaries provide the basic information that a federal purchaser needs to specify energy-efficient equipment, whether they purchase from the Federal supply system or from regular commercial suppliers. PEERs describe energy efficiency information about a product, information on cost-effectiveness, where to find efficient products and other useful advice to buyers.[7] These guides are distributed to more than 1500 Federal buyers.

A number of steps are needed to address the availability barrier within the Federal supply system. FEMP's distribution transformer initiative anticipates working with Federal specifying and procurement personnel to promote TP-1 levels as minimums for their activities. In addition, the initiative will attempt to improve information available to Federal purchasers who purchase distribution transformers directly through the Defense Logistics Agency/Defense Supply Center Columbus (DSCC). The FEMP program is working with DSCC staff to incorporate energy efficiency as one of the data elements for transformers in their database and to ensure that Federal buyers can obtain TP-1 compliant products if they want them.

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[6] See www.epa.gov/energystar.

[7] FEMP has published about 25 PEERs so far including the Distribution Transformer PEER. It is included in the DOE/FEMP "Buying Energy-Efficient Products" guide and is posted on the Web at www.eren.doe.gov/femp/procurement.

Purchasing for Federal construction projects requires a different type of approach that must address both informational barriers and Federal purchasing practices that emphasize low first costs. These purchases are generally done by a contractor in response to requirements incorporated into a specification developed by an Architect and Engineering (A&E) firm and based on a Federal guide specification. In the context of the transformer initiative, FEMP staff are working with the principal "guide spec" developers to ensure that the specifications include distribution transformer efficiency recommendations that meet or exceed those of TP-1 as guidance to an A&E firm. This also makes specifiers aware of the need to consider energy efficiency when developing facility specifications. Furthermore, FEMP outreach and training programs reiterate that Federal acquisition regulations direct that Federal purchases are to be based on lifecycle costing, which, when implemented, enables the low first-cost barrier to be overcome.

FEMP activities are addressing all of the avenues by which Federal buyers can purchase or specify distribution transformers, and TP-1 levels form the basis for the recommendations. The mechanisms include outreach and information dissemination, both hardcopy and electronically. Where there are third parties involved, such as the A&E contractors for construction projects, they are being provided the tools to make the choice for TP-1 compliant products. The scenario is still being played out, but the pieces are in place to make Federal purchasers major contributors to the overall collaboration to transform the market for commercial dry-type transformers.

Creating early demand with utility- and regionally-funded programs: The CEE Initiative. Manufacturers have consistently indicated that if purchasers demand energy-efficient transformers, they can provide the supply with relatively little notice. While the FEMP program will jump start demand from Federal purchasers, utility- and regionally-funded programs can address local barriers and spur purchaser interest.

The Consortium for Energy Efficiency (CEE) is a 50-member national organization consisting of utilities, energy-efficiency organizations, state government, and state R&D organizations. Members that design and directly administer and/or implement market transformation programs include electric utilities and regional and state market transformation organizations.[8] In December 1997, CEE adopted an initiative that serves as a framework and template for programs by its membership and others to build demand in their areas.

While the CEE initiative provides a framework and basic market information, program implementers (utilities and regional and state organizations) must design specific programs and marketing efforts for their particular area and circumstances. Several regional organizations and utilities have begun to examine more closely the opportunity for a focused effort to spur demand for energy efficient transformers. Two approaches for increasing demand could be undertaken. First, for those utilities with existing customized incentive programs, transformers can be added to the list of qualified measures and emphasized as a low cost, quick payback option for all new construction, renovation and remodeling projects. Historically, a few utilities have included transformers as an eligible energy saving measure within customized incentive programs. However, most facilities participating in these custom programs fail to take advantage of efficient transformer subsidies either because the transformer efficiency opportunity is not well understood or larger magnitude savings attract project personnel's attention (Dagher 1997). A more focused effort could bring greater attention to this particular energy saving opportunity.

[8] For example, in the Northwest, The Northwest Energy Efficiency Alliance designs and implements market transformation programs. In Wisconsin, utilities continue to implement programs, but in some cases the Energy Center of Wisconsin provides information, training and education directly to electric customers.

A second approach would be a more comprehensive marketing approach aimed at reaching key leverage points in the market with information, decision-making tools and, perhaps, short-term incentives. While the custom incentive programs described above focus exclusively on identifying and subsidizing energy savings opportunities for the customer, a marketing approach could move upstream in the market to educate equipment distributors, specifying engineers, and electrical contractors. Specific strategies could include information and training on how to specify cost-effective equipment for engineers and contractors and an awareness campaign targeted at purchasers so that they incorporate Energy Star into their required purchase specifications.

Providing the supply: Manufacturers jump into the market. In addition to participating in the collaborative through their trade association, it is anticipated that several manufacturers will become involved in the collaborative effort directly. Already, two manufacturers have indicated their intention to provide full product lines meeting the TP-1/ENERGY STAR criteria. Manufacturers that offer such product lines will undertake efforts to educate their distribution networks regarding the benefits of energy-efficient transformers. Manufacturers are extremely well-positioned to address knowledge barriers related to lack of information with the market players with whom they directly interact. These include their company sales representatives as well as independent distributors.

Square D, for example, plans to develop materials to promote TP-1 compliant equipment. ACME, another transformer manufacturer, is in the process of developing a simple software tool that would enable a customer to calculate savings. Both manufacturers envision providing these tools to their vendors.

Tools for Implementing the Market Transformation Strategy

Shared tools are a fundamental characteristic of the Informal Collaborative approach. The above sections have detailed some of the tools developed by various participants. Below, a full catalog of existing and planned resources for facilitating the purchase of energy-efficient transformers is presented.

Currently several tools are available that can help direct purchasers of commercial and industrial transformers to identify more efficient products. Some of these tools help purchasers understand the benefits of lifecycle costing, e.g., IEEE C-57.12.33; other tools provide information on how to do energy loss evaluation, e.g., TP-1; and still others provide the background calculations to enable users to easily perform loss evaluation, e.g., EPA's CITCEM software. For those purchasers unable or unwilling to conduct lifecycle cost evaluation, NEMA offers a generic specification for transformers it defines as "energy-efficient." And EPA will make it even easier for purchasers to identify efficient transformers by labeling low-voltage transformers that meet NEMA's specification with the ENERGY STAR label. In addition, several manufacturers are planning to develop educational materials and transformer selection tools to help purchasers choose appropriate low-loss transformers. And the Informal Collaborative is considering developing other tools such as: educational materials to inform purchasers about the benefits of purchasing more efficient transformers; listings of efficient products and of distributors that stock premium products; sample purchasing specifications; and guidance for offering financial incentives. Each of these tools is further described in the sections that follow.

Loss Evaluation Guidelines/Efficiency Specifications. The Institute of Electrical and Electronics Engineers (IEEE) has recently developed a draft standard, *Guide to Transformer Loss Evaluation, IEEE Draft Standard C57.12.33,* that discusses the importance and implications of loss evaluation for commercial and industrial purchasers and describes the basic methodology for conducting transformer loss evaluation. It is an easy-to-understand guide for purchasers wanting to know why they should consider loss evaluation.

As mentioned above, NEMA developed and published a voluntary efficiency standard for distribution transformers, *Guide for Determining Energy Efficiency for Distribution Transformers, NEMA Standard TP-1-1997,* in 1996. TP-1 covers dry-type transformers and liquid immersed transformers for both low- and medium voltage products ranging in capacity from 15 to 833 kVA single-phase and 15 to 2500 kVA for three phase units. TP-1 recommends that purchasers use an owning cost formula for specifying transformers and, as the name suggests, provides a methodology for evaluating losses from alternative transformer products. In addition, TP-1 includes "look up" tables with default energy efficiency values for those who chose not to do loss evaluation. The tables for dry-type transformers were developed by estimating average loading for low voltage and medium voltage equipment and calculating what could be achieved within a payback deemed acceptable to many businesses (e.g., 3 to 5 years).

Software Tools to Aid Loss Evaluation. In February 1997, EPA produced a beta version of its Commercial Industrial Transformer Cost Evaluation Model (CITCEM). This Microsoft Windows-based model is designed to help commercial and industrial facility owners and managers easily and accurately perform the complex economic analysis needed to determine the cost-effectiveness of high efficiency dry-type transformers. By inputting site-specific data, users can select the most appropriate transformer for their needs from a range of manufacturer bids. Tools like CITCEM enable utilities and distributors to offer their commercial and industrial customers a method for considering both the economic and environmental benefits of energy-efficient transformers.

Product Label. As discussed above, the ENERGY STAR label will enable purchasers of "off-the-shelf" low-voltage transformers to easily identify and specify efficient transformers.

Product Database. EPA will maintain a database of Energy Star qualified low-voltage equipment that will be available on its Web page. Such a database will prove particularly useful for low-voltage transformers, which are typically stock items. Since medium voltage equipment is built-to-order, a database of qualifying models is less likely to be a relevant tool. The FEMP program for Federal Purchasers will reference the Energy Star list.

Educational and Awareness Building Materials. Educational and technical materials and tools can help make customers aware of the opportunity, availability of products, and how the efficient products can be obtained. These may include items such as: brochures and sample purchase specifications. EPA, NEMA, CEE and DOE all anticipate the need for additional materials. Material development will be coordinated within the collaborative. It is anticipated that such collaboration will avoid unnecessary duplication of efforts and widespread sharing of jointly developed materials. Local utility and regional programs may complement these activities by developing lists of local distributors who have a full-range of high-efficiency transformers in stock.

Financial Incentives. A number of utilities have offered incentives for the purchase of efficient transformers, including Pacific Gas and Electric and NEES Companies, although these incentives were based on the purchase of "low temperature rise" transformers. These products, however, are not guaranteed to be the most efficient transformers. Modest incentives for loss-evaluated or Energy Star labeled transformers targeted at both consumers and distributors, can be used to help change purchasing and stocking practices. Transformers that meet TP-1 have approximately a 3 to 5 year simple payback relative to conventional transformers. Incentives can buy this down to a more rapid simple payback in order to "kick-start" the market for high-efficiency transformers. As the market share of high-efficiency transformers increases, incentives can be gradually reduced and ultimately eliminated.

Lessons Learned

The distribution transformer effort has yielded some experience in developing market transformation initiatives with the Informal Collaborative Model. Although this particular effort is still relatively early in its development, we can summarize some of the benefits and shortcomings of the model identified thus far.

Benefits of the informal collaborative approach include:

- Early buy-in from all participants;
- Each participant can focus their efforts where their specific capabilities lie;
- The overall effort avoids duplicative investments in tools and market research;
- Each stakeholder involved retains its independence;
- Project continues even if some stakeholders' interest wanes.

Potential shortcomings of the model include:

- Participants can back out at any time;
- Some entity must pick up the administrative burden of keeping the group together;
- Fewer opportunities to create sustained institutions to deal with specific barriers.

Summary

Several autonomous efforts targeted at building the market for energy-efficient transformers had been contemplated by various market participants interested in improving overall energy efficiency. Instead, by working together in an Informal Collaborative, these organizations are developing a cohesive set of voluntary and inter-related initiatives aimed at addressing the barriers to the application of more efficient commercial and industrial distribution transformers. This innovative collaboration offers a promising model for partnerships with broad representation from industry, government and utilities as agents for market transformation

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