Electrotechnologies: Intoxicating Potential and Sobering Reality

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As the threat of competition in the electric utility industry increases, many utilities are examining electrotechnologies as a means of providing value-added customer services and increasing the profitability of serving commercial and industrial customers. Potential benefits from many electrotechnologies include improved product quality and productivity, reduced production costs, and decreased environmental impacts. Are these benefits important to customer and what are the key market barriers to adoption of these technologies? How should a utility program be designed to promote these technologies and provide valuable services for customers? This paper will present results of research conducted by a utility to address these issues. Initial analysis of the technical potential of a wide range of electrotechnologies identified three business sectors (food, woodworking and printing) and three electrotechnologies (membrane filtration, ultraviolet curing and radio frequency drying) with the highest potential within the utility's service territory. Further research has focused on more detailed analysis in order to determine the market potential and major barriers for these technologies in these three business sectors. Customer research indicates that while electrotechnologies may seem to represent an intoxicating new potential direction for utilities, significant barriers exist to increased use of many electrotechnologies. Programs must be carefully designed to target key market barriers, and utilities may benefit from additional customer research prior to devoting significant resources to the promotion of these technologies.

BACKGROUND

During the 1990's, the Sacramento Municipal Utility District's (SMUD) energy efficiency programs have been widely respected as among the industry leaders. As SMUD now begins to develop its strategic vision in response to the emerging competitive marketplace, energy efficiency is being expanded to a more encompassing vision of programs and services. These efforts are designed to not only achieve cost-effective resource acquisition through traditional DSM programs, but to provide additional customer value through the introduction of new, efficient electrotechnologies (ET) providing a win-win situation for SMUD and its commercial/industrial customers (C/I). SMUD's beneficial electrotechnologies (BET) program has several important strategic objectives for SMUD:

(1) To enable SMUD to retain existing customers;

(2) Increase SMUD's customer base through the installation of new value-added, cost effective services and activities which were not previously available to the SMUD market place; and

(3) To add beneficial load which is expected to result in increased revenues.

Electrotechnologies also offer important benefits that allow the customer to have a competitive edge. These benefits include:

- Increased productivity;
- Reduced operating costs;
- Improved product quality;
- Generation of new products; and
- Reduced environmental compliance costs.

This paper will describe the approach taken by SMUD beginning with concept definition in summer, 1995, through business plan completion, and finally to program implementation in first quarter 1996.

DEVELOPMENT OF ET BUSINESS PLAN

The business plan development process was a coordinated effort between SMUD Energy Service's staff and two private sector consulting firms, Barakat & Chamberlin, Inc. (BCI) and Product Development Consulting, Inc. (PDC). BCI was responsible for providing technical and market assessment expertise, and PDC provided guidance through the develop-

ment of the overall business plan framework and project coordination.

An initial and key step in the development cycle was the completion of a bench marking survey of leading electric utility ET programs. This assessment identified several common program characteristics:

(1) Rebates while a mainstay of DSM programs are virtually non-existent in ET programs.

(2) Environmental regulations and associated compliance are becoming well integrated in utility program offerings to industrial customers.

(3) Benefits from programs include improvements to environmental quality, additional efficiencies in customers processes, increases in customer productivity, enhanced customer relations, and strategic load growth.

Because of the relatively short operational lives for the majority of the programs, ''success'' was hard to quantify but was frequently based on several metrics: increase in energy sales, decrease in customer unit production cost, level of customer service provided, customer retention efforts, environmental goals achieved, and number of customers served. While many of the programs were able to claim a small number of ''showcase'' projects, few (if any) were able to provide performance tracking data on a larger scale.

TECHNOLOGY ASSESSMENT

The universe of electrotechnologies considered for implementation by SMUD fell under two broad categories; (1) emerging or (2) mature. Emerging technologies included those recently introduced which represent new functionality or relied on, known technology for new applications, i.e., radio frequency drying. Mature technologies, for purposes of this plan, included those technologies that had been in existence for years and whose applications were considered standard in various industries.

As a first step in this technology assessment, BCI prepared an analysis of technology applications for industrial processes. This assessment included the mapping of technologies to customer sectors, and the development of a qualitative screening matrix for comparability with SMUD's goals. Approximately 75 potential electrotechnologies were initially mapped to SMUD's largest industrial customer segments (classified by two and four digit SIC codes) using low, medium, and high applicability factors. Of SMUD's 8,500 GWh of sales (1994), approximately 10 percent can be attributed to industrial use. The targeting of this relatively small industrial customer base is further complicated by the diversity of the industries. Only a small number of customer groups can be considered as having significant energy use, and of these several are comprised of dominant individual business contributors.

The next step in the process was to conduct qualitative screening. Technologies were classified as ''emerging'' or ''established'' to provide initial risk assessment. The following criteria were included in the qualitative screening process: (1) Impact on productivity, (2) Environmental mitigation, (3) Level of economic benefits, (4) Risk; and (5) Overall business impacts/disruption.

This first level of screening winnowed the candidate technologies to the following eight that demonstrated the greatest compatibility with the above criteria and customer sectors:

- ***Ultraviolet (UV) curing:*** A liquid coating is applied to a surface that is formulated for UV curing. The surface is then exposed to UV radiation that catalyzes a chemical reaction that transfers it to a solid. UV waves are high in energy and short in wavelength that are ideal for surface drying and curing because they do not penetrate deeply into surfaces.

- ***Infrared (IR) curing:*** Systems heat from the ''outside-in'' by using a combination of radiation and conduction. Electric infrared systems use infrared radiation to transmit heat from an energized filament to an object placed in front of the filament. Electricity heats the filament to operating temperature, where it produces radiation.

- ***Radio frequency (RF) heating/drying:*** A form of electromagnetic waves that heat material from the ''inside out''. Because of their long wavelength, RF can penetrate deeper into materials than any other form of radiation. The heat produced by RF waves is a result of both molecular alignment and molecular rotation.

- ***Membrane filtration:*** A permeable or semipermeable barrier used to selectively separate or transport components from one fluid to another. The driving force may be pressure, concentration, or electromagnetic gradient.

- ***Regenerative thermal oxidizers:*** Is a method of destroying volatile organic compounds in industrial gas exhaust streams by capturing and recycling the heat resulting from their combustion.

- ***Freeze concentration:*** Uses the ''refrigeration cycle'' to lower the temperature of a mixed liquid to the freezing point of the constituents. Pure ''crystals'' (frozen constituents) are separated from mixtures mechanically or by use of compressed air.

- ***Ohmic processing:*** Ohmic thawing uses the electrical conductivity of foods to heat them directly with an electric current running in a continuos process mode. It can be used for sterilizing a product or for tempering it before it is cooked in a retort.

- ***Electric fork lift trucks:*** Flexible bulk material handling machines often used on factory floors and warehouses. They are powered by electric motors and lead acid batteries.

A product portfolio planning process was next initiated and the candidate technologies were screened based on the five following criteria:

(1) The ability of each alternative to provide a quick win for the Beneficial Electrotechnology (BET) program;

(2) The potential of each for initially wide, then growing application;

(3) The magnitude of load building potential;

(4) The degree to which the application could have a halo effect; and

(5) The ability of each application to foster long-term customer retention.

This screening process lead to a narrowing of the focus to the following three electrotechnologies: ultraviolet curing, radio frequency heating and drying, and membrane filtration. The primary benefits of each ET are outlined below:

Ultraviolet Curing

- Environmental compliance
- Increased production speed
- Increased production scope

Radio Frequency

- Increased process flexibility
- Increased production speed
- Increased product quality

Membrane Filtration

- Increased product purity
- Waste reduction
- Increased product recovery
- Reduced labor costs
- Reduced waste water

Once the screening narrowed the focus to the three technologies, the primary industries these technologies mapped to were identified. They include:

- The food industry comprised of food processing and dairies;
- The wood industry comprised of cabinet makers, furniture manufacturers, and lumber manufacturers; and
- The printing industry comprised of print shops and publishing shops.

Technical Potential

Table 1 quantifies the potential market for these electrotechnologies and presents estimates for potential demand for alternative programs. (Note: The figures are based on preliminary and limited market research).

MARKET RESEARCH

Methodology

Once the preliminary technical potential analysis identified the three technologies and associated industry sectors, SMUD conducted market research to validate the initial technical potential findings. The primary objectives of the research were to: (1) verify the applicability of priority electrotechnology applications, (2) assess customer interest in these applications and other beneficial electrification opportunities, and (3) determine particular program design parameters that SMUD could offer that customers would find attractive. SMUD staff conducted on-site interviews with approximately ten customers in each identified sector.

Food Industry Findings

Ten customers were surveyed representing about 45% of the total kWh of load for the food industry in SMUD service territory. Customers' primary concerns were for productivity and product quality. Environmental issues and operating costs represent secondary concerns to most customers interviewed. However, many customers expressed concern over the expectation that environmental regulations will increase in the near future.

Table 1. *ET Potential Market*

Technology	Industries	Potential New Load (MWH)	Revenue @ $70/MWH
Ultraviolet Curing	Painting Wood Products	7,264	$510,000
Radio Frequency Heat/Dry	Food Wood Products	2,085	$146,000
Membrane Filtration	Food Waste	2,250	$158,000

Of the ten companies surveyed, six companies, representing approximately 66% of the sample in terms of average monthly kWh, may have potential applications for membrane filtration technology. Virtually all identified potential applications of membrane filtration involved treatment of wastewater, rather than filtration of actual food products or other substances used as part of the production process. Preliminary estimates show that load impact for each application is very different. For instances where a filtration system is being replaced often a load reduction is realized. However, instances where a new process is being added, like a new separation process, often load is added. Therefore, although 66% of the sample have potential for membrane filtration, it is difficult to determine, prior to understanding each individual customer's situation, whether the installation of a membrane will result in energy savings or beneficial load.

The awareness of membrane filtration varied. Although some customers were aware of the technology, few were highly familiar with the potential costs and benefits of applying membrane filtration to their process. Of the customers that were aware of the technologies, they felt their current production requirements did not warrant the technology. Stated market barriers included high first cost, complexity of different equipment (each application requires intensive analysis), and higher O&M costs. Furthermore, none of the customers interviewed felt that membrane filtration would offer any significant benefits in terms of improved product quality or productivity. This is due primarily to the fact that virtually all potential applications of membrane filtration identified during on-site visits involved treatment of wastewater, rather than filtration of actual food products or other substances used as part of the production process. For treatment of wastewater, membrane filtration competes with relatively simple traditional technologies such as wastewater treatment tanks.

Customers feel that the major potential value of membranes stems from reduced environmental wastes. Consequently, unless the environmental regulations are stringent enough, customers do not realize any added value from investment in membrane systems. Customers who could potentially add membranes to improve their process stream stated concerns over affecting the quality of their products. These customers stated that if they were to consider membranes, they would install a pilot line first to test the impact on their product as well as to estimate costs and savings. Regarding other technologies, only one of the ten customers surveyed was found to have a potential application for radio frequency drying. Other technologies that customers expressed an interest in included freeze drying, UV curing, and infrared heating.

Regarding services, the majority of customers stated that it would be very valuable for SMUD to identify potential applications, provide preliminary design assistance, and offset some of the cost of a feasibility study. Almost all customers indicated that they would be willing to share in the cost of these services depending on the value they received. Customers realize that in order to determine the applicability of membranes for their application, extensive analysis is required. Furthermore, customers want to have a good idea regarding the impact membranes have on their process lines and the subsequent effect on their product in terms of color, texture, and taste. Consequently customers are willing to cost share with SMUD in order to have extensive analysis to answer these questions.

Woodworking Industry Findings

Ten customers were surveyed representing about 60% of the total kWh of load for the wood industry in SMUD service territory. Most businesses surveyed produce commodity-like goods in high volumes (i.e., molding, doors) and compete

primarily on cost and responsive service. Consequently, their primary concerns were productivity and low operating costs. Their main interests are to acquire low-maintenance equipment, reduce wastage, and reduce non-production-related overhead such as environmental control.

Of the ten companies surveyed, approximately three had potential applications for UV curing. All three of these shops had high production needs and at least part of their process involved flat objects. Research shows in order for there to be a potential for UV, shops must process flat surfaces such as cabinets or table tops. Because UV uses a line of sight curing method, three dimensional odd-shaped objects such as table legs are difficult to cure. Consequently, applicability is limited to shops who specialize in flat surfaced types of materials.

The potential for UV's will increase as environmental regulations become stricter. Environmental concerns are already rapidly increasing. Companies using solvent-based finishes are troubled by the threat of tighter controls on volatile organic compounds (VOCs). They feel their only alternatives are to convert to water-based finishes with long drying times and reduced sheen, or to invest in very expensive emission-control paint booths. To improve drying times associated with water-based finishes, customers anticipate having to install drying systems. These systems can be either gas convection ovens, infrared sources or UV sources.

Another primary environmental concern for almost every wood shop is dust collection. Removal of dust requires large amounts of power and is the subject of regulatory oversight. For example, one company that has invested in an expensive closed, clean collection system must now pay the local air quality management district $4,000 a year for permits to operate that system.

The awareness of UV curing and RF drying was high. Most of the companies affected by proposed restrictions on the VOC-emitting finishes are aware of UV systems. They are concerned about the quality provided by water-based finishes and expense associated with switching to water-based products. They now perceive UV as very high-cost, exotic, high-tech, and beyond their needs. However, customers stated they would consider a UV system if the cost was reasonable. Not all the companies reject the potential of water-based finishes. One of these companies already uses them, and the manager of another reported seeing good results with them.

Regarding RF drying, four companies already use at least one RF machine. While the technology is well established, it is best suited to high-output production lines where speed matters. Limitations reported by companies included high maintenance costs, need for climate control to minimize impacts on drying times, and reduced product quality due to visible glue lines left on lighter woods. Other potential technologies include computerization of cutting and machining operations as it holds significant efficiency opportunities to optimize materials and labor. Water-jet cutting was also mentioned in that it can make more complicated, irregular cuts with less wasted wood.

Regarding services, most customers interviewed stated they would find it valuable for SMUD to provide information on UV curing and other electrotechnologies, particularly through case studies of successful applications in other wood working businesses. However, there was some skepticism expressed about SMUD's knowledge of the wood industry and therefore providing design assistance with their processes and suggesting proposed changes, without ample evidence that SMUD possessed deep understanding of the woodworking industry. As a result, customers indicated it would be more valuable for SMUD to share the cost of a feasibility study by an outside specialist. Some form of financing could be useful, depending on the cost and ease of obtaining financing from SMUD compared to other sources. No company cited scarcity of capital as a problem.

Printing Industry Findings

Six customers were surveyed, four through site visits and two through telephone interviews, representing 19% of energy consumption in the District's printing sector. One company, which represents 17% of the printing energy consumption, was not considered a target for UV curing because their ink dries by evaporation and absorption, rather than being dried on the surface. The printers emphasized productivity improvement, product quality enhancement, and cost reduction as their primary concerns. Environmental requirements were a concern but generally a factor that these businesses felt they had under control.

All printers interviewed were aware of UV's and one was currently using the technology. The consensus among customers that did not have UV's, was that UV does not offer enough advantages as a print setting medium to justify changes in their existing procedures or to justify any increased cost. Some of the printers indicated that the UV process is incapable of producing sufficiently high print quality for the work that they produce. Although the printing industry is facing significant restrictions on releases of VOCs from the traditional solvent-based inks, all but one of the printers interviewed felt that they would be able to meet those restrictions through alternatives that are either less expensive than UV or less disruptive to their conventional practices. The larger printers are already utilizing thermal oxidizers to burn off the VOCs released by solvent-based inks (purported to prevent the release into the atmosphere of 95% or more of the VOCs given off in the printing process). One printer mentioned concern about toxicity of

UV inks, saying that recyclers refuse to accept paper that has been printed with UV ink.

Another barrier to UV's is its limited applicability. In the medium-to-high quality printing applications that form the bulk of this printers' business, the ink is not absorbed into the paper. Instead, one of two other approaches is used. In the first the paper is coated with a cornstarch powder after the ink is applied. In the other the ink is dried within the press through a heat set process typically fueled by natural gas. UV offers an alternative for this second type of process, in which ink is cured within the press. Therefore potential is limited to businesses that use this type of process.

The printer who had already installed a UV system felt UV was a good means of avoiding emissions control problems and it gave them flexibility to print on a greater variety of paper stock. Although this printer has been generally satisfied with its performance, he indicated that there was a significant learning curve involved in adapting to different procedures for using UV inks, which have characteristics that differ from conventional inks. This printer was fortunate in having other presses that he could use while experimenting with the new technology. However, the ''learning period'' involved in converting to UV systems could pose a significant barrier for other printers.

While interest in UV systems was limited, the printers indicated that they could become interested if it was demonstrated that UV could generate sufficiently high quality product and be economically competitive. To that end, services they would find valuable include case studies and demonstration projects. Given the experience of the one business that is using UV, technical assistance in modifying procedures to accommodate UV technology appears essential. An unrelated service that was mentioned by two of the respondents was assistance in coordinating the environmental and other permitting requirements of various government agencies.

Market Research Conclusions

Survey results indicate that membrane technology in the food industry has the most significant potential of the three targeted technologies and their associated industry sectors. The potential for membrane filtration is driven primarily not by customers' desire to improve productivity and product quality, but rather it is driven by environmental issues. Customers tend not to consider modifications until it is forced upon them, either for environmental reasons or because their equipment needs replacing. Therefore, the most effective delivery mechanism identified is to target customers at the time of replacement or the time of expansion. Furthermore, efforts should be focused at identifying potential applications, providing preliminary design assistance, and offsetting some of the costs of a feasibility study. To deliver these services, detailed analysis of individual sites is required to ascertain the applicability of the technology and to determine the costs for installation and operation as well as the benefits to the customer.

The next highest potential technology is UV curing in the wood industry. While the wood industry is aware of UV and RF, applicability is limited due to production requirements and type of material being processed. With increasing environmental restrictions on VOC's, companies are becoming more receptive to UV systems. A key advantage of promoting UV systems in the wood industry is that UV has potential in other industry sectors as well. Therefore, lessons learned from promoting UV in the wood industry could then be applied to expand a UV program.

UV in the printing industry in general has the least potential of the targeted technologies given the printer's receptivity to UV is low. Printers would need persuasive evidence that UV can deliver the product quality that they expect while not being more costly than alternatives. It appears that printers have other options for complying with environmental regulations that they find more attractive than switching to UV systems. RF technology had the least potential given that interest and applicability in all sectors were low. Table 2 summarizes results of on-site visits performed by Energy Specialists and other SMUD staff to assess the potential market for electrotechnologies in three key industrial sectors.

Because the economic viability of many electrotechnology applications is related to environmental regulations, in order to be proactive in an industry SMUD staff must understand and be aware of not only new environmental regulations being implemented, but the effect that these regulations will have on industry. Many customers surveyed said time and again, that SMUD must learn their specific industry in order to be believable and have impact. Many customers stated skepticism over SMUD's ability to offer any services until SMUD had proven that they understood their specific industry needs and issues. Therefore, in order for any ET program to be successful, extensive time would have to be spent understanding the particular industry to be targeted.

Program Development

Considering survey results, SMUD chose to promote membranes as its first technology. The first step SMUD took to develop a program was to meet with membrane vendors, manufacturers, and the California Institute of Food and Agricultural Research (CIFAR) to gather more information. Meetings with these trade allies showed clearly that membrane filtration is a complicated technology. While the membranes themselves are rather straight forward, their applicability is quite complex. In order to determine the viability of membranes for any one application, extensive customer

Table 2. *Summary of Potential Market for Electrotechnologies*

Electrotechnology		Applicability	Awareness	Interest
Food:	Membranes	High	Medium	Medium
Wood:	Ultraviolet	Low	Medium	Medium
	Radio Frequency	Low	Low	Low
Printing:	Ultraviolet	Low	High	Low
	Radio Frequency	Low	High	Low

specifics needed to be gathered regarding the customers' process lines and types of materials being processed. Furthermore, it became clear that in order for membranes to be economically attractive to a customer, often a by-product must be recovered for either re-use or resale. It quickly became apparent that SMUD staff did not have the technical expertise to evaluate each specific process to adequately determine the benefits of membranes to the customer and the impact membranes would have on processes and environmental issues.

Subsequent research has found that almost every industry could have potential applications for membranes. However to determine the economic viability analysis must be conducted for each application. For the few projects SMUD has begun to research, further economic analysis of specific projects has shown that membrane technology may not add substantial amounts of load and in some cases may actually reduce load. Therefore the value of membrane technologies to SMUD must be addressed. What started as a potential load building program must now be re-evaluated in terms of its benefits to the District.

KEY ISSUES AND CONCLUSIONS

To launch a successful electrotechnology program, utilities need to give careful consideration to the following issues before proceeding:

Assessing the Load Impacts of Electrotechnologies

Utilities are launching ET programs with the expectation of a ''win-win'' outcome: increased value for the participating customer and increased revenues for the utility. However, forecasting the potential load impacts of ET's is a more complicated process than estimating the savings from many traditional DSM measures and leads to a much more uncertain outcome. Estimating the impact, for instance, of an efficient lighting program is relatively straight forward: the per unit savings are known and can be easily applied to assumptions of the load impacted. These estimates can then be applied to customer sectors. In addition, as utility evaluations have shown, assessing the load impacts of a lighting efficiency program produces reasonably accurate estimates of total savings actually achieved.

However, estimating the load impacts of an ET program is a more complex process that leads to much less certain results. Not only is it difficult to determine if a technology is applicable for a particular customer segment, but the next step of estimating the load impact from that technology is not easy. Many electrotechnologies are not a simple addition of new equipment or a replacement of existing equipment such as the substitution of an inefficient light with an efficient one. Instead, ET's require a system approach for successful implementation which may involve changing multiple processes and equipment. For planning purposes, it is difficult to make aggregate assessments of the impact ETs will have on a utility's load. With some technologies and customer segments, it's not easy to even determine whether the effect of a utility- sponsored ET program will be a net *increase* in load or a *net decrease*. The technology itself may increase a customer's use of electricity compared to the previous equipment or process, but when installed as part of an entire system modification or upgrade, the net result may be a decrease in total consumption.

Using what were believed to be conservative assumptions, estimates for the amount of load that could be added to the system were developed for the most promising technologies. Considering these estimates of potential, SMUD proceeded with what appeared to be three ''clear winners'': ultraviolet curing for printing shops, radio frequency drying for furniture manufacturers and membrane filtration for the food industry. These three ''clear winners'' were expected to result in a quick win for the BET program. After conducting simple market research, it became readily apparent that only

one of the technologies, membrane filtration shows any promise of achieving the potential forecasted and it clearly would not provide the sought after quick win. For both technical and economic reasons, both UV curing and RF drying were not applicable for the customer segments targeted. Even membrane filtration may not provide the additional kWh forecast in the planning stages. Although applicability appears to be high, two of the earliest projects SMUD is likely to proceed with may result in a net decrease in load rather than additional sales. In both cases, the membrane filtration equipment will be installed as part of a entire system change out and although the equipment by itself will add new electric demand, the total process and equipment modification will result in net energy efficiency for the customers. For many customers, the equipment is economic only as part of a system redesign in which the filtration equipment replaces multiple processes.

Approaching Customers with Integrated Solutions

To work with customers and successfully persuade them to install these new technologies, utilities have to be willing to adopt an integrated approach to meeting their customer's needs. Utilities must learn to address not only customers' energy requirements but work with them to meet a multitude of objectives: complying with environmental regulations, improving product quality, increasing productivity and generally improving their competitive position in the market place. With traditional programs, utilities focus on providing solutions to meet customers' energy needs, such as improving power quality and reducing electric bills through the installation of efficient equipment. Benefits beyond these, such as improved air quality or increased productivity is typically considered secondary to the primary benefits of energy efficiency. However, successfully implementing an electrotechnology program requires a much more interdisciplinary approach to address multiple business concerns. From the customer perspective, the primary benefits from an electrotechnology installation may not be energy related, but rather increased productive, product quality improvements or reduced cost of environmental compliance.

Utility and Staff Resource Requirements

Typically, utilities do not posses the in-house expertise required to effectively develop and implement electrotechnology programs. Utilities must be willing to make an upfront investment in training or adding expertise to the current staffing in three area:

(1) Electrotechnology-specific knowledge: understanding both the technical and economic attributes of the technology as well as competing alternatives.

(2) Knowledge of broad business issues such as environmental regulations, business and industrial processes, productivity and product quality concerns.

(3) Industry and customer—specific expertise: developing an understanding of the unique requirements of specific types of business such as the food processing industry or paper mills.

SMUD, like many utilities, has spent the last decade developing in-house resources and now has a highly technical staff of energy specialists with expertise in energy efficiency equipment and services. For the next generation of programs to be successful, the District must be willing to invest the time and money to develop staff expertise in new technologies and our customer's broader business needs such as product quality and increased productivity. For some programs, the only successful approach to persuading customers to install ET equipment may require the utility staff to actually become expert in the business itself.

CONCLUSIONS

As the threat of competition in the electric utility industry increases, utilities are scrambling to provide value-added services to their customers as a means of increasing profitability and ensuring long-term customer retention. Electrotechnologies are one of the promising new services many utilities are examining. However, as SMUD's experience has shown, electrotechnologies are not a panacea for utility survival. Rather, electrotechnologies are just one piece of the package utilities are constructing to face the challenges in the coming era of competition.

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