FUTURE DIRECTIONS OF COMMERCIAL ENERGY RESEARCH: A UTILITY PERSPECTIVE

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Abstract

Historically power utilities have operated as regulated monopolies with steady growth patterns. Consumer response to the energy crisis in the early 1970s brought less accuracy to traditional forecasting. More recently, cheaper alternative fuel and Federal deregulation have ended the electric and gas utility monopoly. Customers are making different choices about fuel, co-generation, self-generation, equipment types, and conservation measures -- all of which have an impact on energy use. Utilities may know how to answer the energy use questions that have arisen during the last 10 years, but the environment has changed. It is becoming more important for utility planning to examine energy use from the customers' point of view. This means discovering what the customers' needs are and what their likely choices will be.

The shift toward increased importance of customer orientation in planning created a need for more customer data. In the last ten years utilities have conducted mail surveys, on-site surveys, and even some end-use metering projects. Data analysis has included end-use forecasting models, conditional demand analyses, load shape analysis, market research, and program planning and evaluation. These analyses, however, have only scratched the surface in providing the utility with necessary information about its customers. The analysis that answers one question spawns others.

Utilities operate in an increasingly competitive market place. Reliable data about such things as customer choices, available alternatives, and market penetration of the alternatives are crucial in order to survive in the increasingly deregulated environment. Now that utilities are realizing what is possible, it is time to assess what is needed, to ensure the highest value for the research dollar.

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INTRODUCTION

"Power companies produced electricity for the customers and dividends for their stockholders and that was about it." (Forbes)

The energy utility industry, historically, was a relatively simple operation. All power producers were members of the same club, they did not compete with each other, and the interests of consumers were protected by regulatory agencies. Utilities generally delivered the highest standard of service possible. Barring natural disasters of a great magnitude, the generation planning criteria was to achieve, on average, less than one day of lost power per decade.

Utilities took advantage of the economies of scale inherent in large power plants. The long lead times required for design, construction and testing of large capacity plants were not a problem because growth had always been so predictable. It appeared to be independent of other economic cycles. Planning and building large power plants could easily occur as needed to serve the projected demand.

Utilities operated from a supply side perspective. Because utilities were monopolies, customers formed a captive market. The post-war experience showed that the steady growth existed independent of other economic factors and because electricity prices were constant or declining in real dollars, price elasticities did not enter into the picture. Planning consisted of building capacity to meet the steady growth. The customer-oriented departments were those who answered complaints, collected bills, repaired equipment failures, and talked to newspapers during storms and earthquakes.

The traditional utility controlled every facet of energy production and sales: design, construction, generation, transmission, distribution, sales, and provision of complete service to each customer (metering equipment installation and maintenance, power supply, and billing). Utilities were generally conservative in economic policy, linear and hierarchical in organization, and slow to respond to changes in the economic world. There were several items of "conventional wisdom" that were never questioned:

Growth in energy demand corresponds to growth in the gross national product.

Electric and gas service is most efficiently produced by a monopoly.

Economies of scale exist, which meant the most efficient way to produce power was in larger and larger plants.

This picture of the utility industry as it existed ten years ago can be contrasted to that of a utility as it might appear ten years in the future. The most fundamental change will be that the utility will exist in a competitive market and will be quick to respond to market influences. This will mean the organizational structure will have been altered to a horizontal matrix. Electricity and gas will be seen as products subject to market influences. The utility will be marketing energy to its customers much as Proctor and Gamble markets toothpaste.

The utility will no longer control all facets of power production and supply. In fact a utility may have sold most of its generating capacity to subsidiaries and now exist as a transmission and distribution company. Power might be purchased either by contracts with subsidiaries, contracts with outside producers, or from the spot market.

The utility of the future will out of necessity know more about its customers. Service will be tailored to the individual needs of customers, especially large commercial and industrial customers. The cost of energy to the customer may depend on the quality of service delivered to that customer.

We are now in the transition period for utilities. This paper describes the effect the transition will have on energy research, focussing primarily on the commercial sector. It also explores the current state of energy research in the commercial sector. (Research in the pre-1974 era is easy to describe -- there wasn't any commercial energy research.) Finally, the paper discusses the future directions in which the commercial sector is likely to go, and points out the ramifications this has for the future of commercial energy research.

THE TRANSITION FROM PAST TO FUTURE

Current Energy Utility Environment

The monopoly compact under which utilities, customers, and regulatory agencies operated is evaporating. Traditionally, utilities delivered a quality service to a market whose interests were protected by a regulatory agency. In return, the utility was able to earn a fair return on its investment. Competition, the erosion of the utility's ability to operate as a monopoly, coupled with the popular perception that energy is an entitlement, threaten the ability of a utility to recover the costs of investment. Utilities are trying to define their obligation to serve in a climate with increasing financial risks inherent in delivering the historically high level of service.

Today, because of on-site generation and improvements in end-use equipment, electricity is competing with natural gas and oil, while natural gas competes with oil. Utilities are competing with each other, with foreign suppliers, and (in the case of a utility that delivers both gas and electricity) with themselves.

Conservation, which in the last six to eight years has acted as a resource, has become more like a competitor. Excess capacity has temporarily removed the need for new generating facilities for many utilities. It was this need for generating capacity that made investment in conservation cost-effective for both utilities and ratepayers. Now, continued implementation of conservation contributes to the excess capacity in the short term while raising rates to all customers.

Current State of the Commercial Sector

The largest commercial customers resemble the industrial sector in that they can take advantage of competing sources of energy. The smallest commercial customers closely resemble the residential sector. They can take advantage of some of the competitive forces (conservation), but they are still essentially a captive market.

Overall there is a heightened awareness of energy. This educative process has been stimulated by higher prices, advertising by conservation firms, and the attention paid by utilities to all parts of the commercial sector in the form of audits, time-of-use projects, load shifting programs and other types of demand-side management.

In the past, demand-side management has been a tool used by utilities in load shifting, load curtailment, and customer relations. Currently, most conservation programs are not cost-effective for utilities that have excess capacity. The major advantage of conservation for a utility has been cost avoidance. When marginal cost has fallen below average costs, which is the current situation, there is no economic reason to spend to avoid costs in the foreseeable future. Indeed, increasing off peak electric sales would lower the average cost of energy to all ratepayers.

Utilities should continue to encourage conservation consistent with providing least-cost energy services. However, during times of excess capacity, pursuing conservation programs may increase the rates in the short-term. This makes the utility less competitive in a deregulated market and risks continued erosion of demand exacerbating the problem.

The Current State of Commercial Energy Research

The first thing one notices is that there is energy research. In the past, there was little need for utilities to be concerned with what happened "beyond the meter". Demand was regular and predictable and utilities could function with a supply-side orientation. Following the response of consumers to the jump in energy prices in the '70s, demand became less regular. In order to improve the predictability of customer

demand, utilities began end-use energy research. Attention was focussed on what happens beyond the meter with the energy-use equipment and characteristics of customers.

Many utilities have done a mail survey. The emphasis has been on information to be used in an end-use forecasting model. Mail surveys, both because of the diversity of the commercial sector and because of the almost total lack of knowledge prior to their inception, have an uncertain reliability. Further, they cannot collect the level of information necessary to support detailed analyses. The additional length of the questionnaire would provoke lower response rates and the quality of technical detail is likely to diminish markedly. While there have been some encouraging results regarding the validity of mail surveys (PGandE, 1986), two years ago researchers called for on-site surveys.

The results of mail surveys have been used to calculate energy utilization indices, with varying degrees of success. (An energy utilization index, or EUI, is a measure of the energy demand per square foot per year of a given end-use, and is used in end-use forecast models.) The variability of success in calculating EUIs resulted because there were no benchmark figures for comparison and because different methods and calculations produced widely different results (McCollister, 1986).

In order for other techniques of calculating EUIs (such as conditional demand modeling) to be accepted, end-use metering will be necessary. As mentioned above, there have been differing results in previous attempts to calculate EUIs. Until actual measurements are available to serve as a benchmark, statistical calculations lack an important validation.

PGandE is currently conducting an on-site survey of the commercial sector. We have contracted with a firm that employs engineers to collect information about commercial equipment, conservation measures, hours of operation, structural materials, size and business characteristics. We expect the information collected to be much more detailed, complete and reliable than that collected in our mail survey in 1982. The cost, however, is much higher (approximately $550 per site visit), and the sample size correspondingly smaller (1000 observations v. 5800 in 1982).

The Bonneville Power Administration is currently conducting an end-use metering project that includes about 250 commercial buildings. The data collection costs range from $20,000 to $100,000 per building (Windell, 1986). Collecting end-use metered data includes developing equipment that will accurately meter enough channels of electric use to capture all the end uses in a commercial building.

The equipment must take frequent readings of demand in order to create 'load shapes' for each end-use. In addition, the data must be consistently and accurately collected. This involves either on-site collection of tapes or telecommunications between installed meters and central computers. The large size of the data bases complicates research. Finally, since this end-use metering is at the research and development stage, and since there

are no benchmarks for comparison, data validation is difficult and the potential for error increases. The expense and complexity of end-use metering research will probably constrain utilities.

The current focus of commercial energy research is on collecting end-use information. This will not be sufficient to answer the questions arising in a competitive market. Knowledge about how customers use energy may yield information about the possible cost-effectiveness of a given competing technology, but it will not supply the data needed to determine the likelihood that a given customer, or even a given business type, will avail itself of the choices offered.

THE SHAPE OF THE FUTURE

The Utility of the Future

Unless utilities remain competitive, fixed supply costs will be spread over a decreasing customer base. The existence of outside power sources, coupled with rising rates and availability of tax advantages, may have led many municipalities to leave the utility grid. Many utilities will diversify, forming subsidiaries to finance on-site generation projects or shared savings energy management plans. Some utilities will have diversified in areas unconnected to energy.

Utilities might respond to the financial risks associated with large-generation construction projects in different ways. Subsidiaries might be formed to build and own the generating capacity, sell electricity to the utility, and take the financial risks associated with building new capacity. A utility might be a customer-oriented transmission company, buying its power from its subsidiaries, other utilities, foreign markets, or customers. Some customers might buy their energy from foreign markets and use the utility only for transmission. New generating capacity might come from smaller, decentralized sources (wind, solar, on-site generation, fuel cells) (Lihach, 1984).

Electric service to the customer will probably be unbundled. In the past, utilities provided the same high quality of service to all customers. The customer had no service options. It is to be expected that with increased competition, customers will have a range of utility service options to choose from. Some customers might accept a lower level of reliability in exchange for lower costs, or they could shift some of their demand to hours when electricity is cheaper to produce.

Utilities will find ways to become the "low-cost" energy supplier for competitive markets. On the other hand, some customers will be willing to pay higher energy prices if they receive premium service (Clemmensen, 1985). Utilities may develop options that include such things as energy management consultants or electricity delivered without voltage spikes. These plans can be created only after the utility conducts market research to find out what level of service its customers want.

The Commercial Sector in the Future

On-site generation will be a cost-effective alternative for most large customers and even some medium and small customers (Energy Daily, 1986). The utilities will have to respond by lowering energy prices to customers who are "at-risk" and by tailoring services to their needs.

In the 1982 Commercial Energy Use Survey, 0.6 percent of PGandE's commercial customers reported that they planned to install on-site generation. These customers, however, represented 4.1 percent of all commercial floorspace. Of those customers with more than 100,000 square feet of floorspace, 7 percent planned to install on-site generation in the future. This was in addition to the 1.2 percent of these largest customers who already had on-site generation in 1982 (Buller, 1985).

It is important to note here that the survey took place in 1982. The economic climate for on-site generation has changed to make this investment even more favorable. Until a few years ago, on-site generation was installed primarily as a revenue producer. Because the utility purchased the power produced at the utility's avoided costs, which were higher than average costs, the economically sensible decision was to install as much capacity as possible and sell it all to the utility. For the last few years, average costs have been higher than avoided costs. The present economic decision is for customers to install capacity to meet their thermal requirements, while also producing electricity primarily for their own use.

Other factors will operate in the commercial sector in addition to on-site generation. The increase in energy costs will contribute to an increase in energy awareness among commercial customers. Although at present, consumer interest groups (such as TURN in California) largely represent the residential sector, we could see an increase in commercial-interest lobbyists at regulatory hearings. Customers will continue to be interested in cost-effective conservation. Utilities will act as energy-brokers, working out the best energy package for each of their commercial customers.

Utilities will focus more attention on the commercial sector for several reasons. First, it is the growing sector of the economy. Second, it will soon bear more than its share of the cost of energy (anticipating that groups such as TURN will continue to effect some protection of the residential sector and that the industrial sector can take care of itself). Third, technology will provide more and more commercial customers with increasing choices.

This increasing focus on the commercial sector will increase the demand for reliable, appropriate energy use information. Programs will be designed based on customer input in addition to utility goals and will be tailored for individual customers. Possibilities existing today that we can expect to see increase include:

Time-of-use rates designed to shift load;

Customers accepting reductions in quality of service in exchange for reductions in rates;

Utilities and customers working on joint on-site generation projects; and

Thermal energy storage.

Future Commercial Energy Research

Those who have done research in the commercial sector know how difficult it is. The commercial sector is heterogeneous, skewed toward large customers, and data collection costs are high.

No matter how detailed data collection becomes, or how complex and accurate end-use energy models become, we cannot improve our ability to predict customer behavior without the addition of a different type of customer information. Changes in the environment in which power utilities operate, such as competition, require different types of information. It is no longer sufficient to count furnaces and numbers of employees in order to forecast demand. It is not that end-use models are less accurate, but that a different type of question is being asked. Utilities need to know not only what the demand will be, but who will serve that demand. They will need to determine the utility's market share.

Utilities will need to learn what will affect the commercial customer and how that customer is likely to respond. For example, the existence of on-site generation implies that we learn what sorts of generators are available, what customers are likely to find them economically rational, and which customers have the capital and business culture available to make the necessary investment.

The need to predict commercial customers' behavior implies a need for information on technology (the types of generators, and their applicability to different businesses), which business types will find the different technologies appropriate (for example, small-scale co-generators produce hot water, and while restaurants and hotels need lots of hot water, offices do not), which business types have available the necessary investment capital, and lastly, given all the above, which businesses are likely to install a generator (owners will be more likely than renters to make capital improvements).

In order to predict the impacts of any competitive technology or form of conservation, we will need to identify the market penetration as well as answer the questions about technological feasibility and economic sense. We must identify the likely proportions of innovators, leaders, mainstream implementers, laggards, and reactionaries. That is, who will implement a given device or method, even if it is not economically feasible; who will

be first off the mark for those that are economic; what proportion of the population follows the trend; what proportion implements slowly; and what proportion never implements unless forced by regulations or laws.

By developing the proper marketing tools, and identifying the applicable customer populations, a utility will be more likely to achieve a desired level of market penetration for a given program. This is only possible with reliable data of the type outlined above.

In addition to information on customers' equipment, business, building, and conservation implementation, utilities will need to know:

1) The technical options available to customers -- both conservation and energy sources outside the utility grid. Utilities will do secondary research in trade journals to identify available technologies. They will also collect information about the availability, for wheeling, of excess capacity at other utilities.

2) The quality of service desired by customers. Utilities will do customer preference research and opinion research. Market research will become more important.

3) The decision points of customers and what decisions they will make. Economic information will be collected about commercial customers. Utilities will research business practices and meet with trade associations and architects. Surveys will be designed to ascertain future customer behavior.

4) How customers respond to changes in price.

5) The future growth in the commercial sector. Utilities will need information on which business types are growing in numbers, which in size, and how big that growth will be.

6) The total demand for energy and the utility's market share. In addition to predicting the demand for energy, the utility must determine what market share, if any, its competitors will have. Utilities must decide what price to charge in order to maintain their market share.

The implications are that energy use research must branch out into areas heretofore unexplored. We will still need to collect information about customers' equipment and businesses, but we will have to ask other questions also. Utilities will focus on customer choice in a melding of economics and psychology. In addition, we will have to collect information from other sources such as trade journals.

Innovations by the earliest end-use researchers were to go "beyond the meter". The present research challenge is to better understand the needs of the customer. For example, we must seek information from the

competitive trades. Some utilities are taking advantage of information collected by independent sources rather than collecting it themselves. For example, PGandE has recently rented access to an industrial data base compiled by Dun and Bradstreet. Utilities must collect information about customers' willingness to accept a lower level of service for a lower cost. Some steps are being taken along these lines with time-of-use rates, group load curtailment, and interruptible load programs.

We must identify the factors that will create change in our customer mix and identify the effects of those factors. For some customers, such as those who presently have alternative generation capabilities, the price of fuel will be enough to cause change. For others, the availability of capital for investing in conservation or on-site generation will have to be identified. We will have to determine what price elasticities exist (they are certain to differ among commercial business types).

CONCLUSIONS

Prior to the 1970s, the utility company was a regulated monopoly operating from a supply-side perspective. Growth in demand was steady and planning involved building large generating plants to take advantage of economies of scale. Customers were a captive market.

The rapid increases in energy prices in the 1970s led to an increased energy awareness and had a profound effect on the utility approach to forecasting. The reliance on end-use models created the need for information about customers that had never before been collected. Energy researchers are getting quite good at collecting reliable information about the difficult and diverse commercial population. Information on the customer side of the meter has proved necessary and (with difficulty) possible to collect.

The monopoly compact under which utilities, customers, and regulatory agencies operated is eroding. As the utility industry becomes deregulated it is undergoing a shift from a pricing system based on reveune requirements to one based on market forces. This has increased the need for information about customers and will have an effect on commercial energy research.

On-site surveys and mail surveys will continue to be the main source of information on the commercial sector. However, the emphasis will shift to market research tailored to specific issues. Periodic, but infrequent, base-line surveys of the entire commercial sector will continue. Vigorous non-response analysis and follow-up will increase the reliability of the results. We will be able to compare the relative costs of each type of survey with its benefits. Mail surveys are much cheaper, giving a broader base of less reliable information, while on-site surveys supply much more thorough and accurate information for a smaller sample of a very heterogeneous sector.

In addition, there are new types of information that utilities must collect. We need to include research from sources other than our

customers. This would include technical information about the options available and economic information about price elasticities. Utilities will use end-use information collected by non-utilities, such as Dun and Bradstreet. There are new kinds of questions that need to be asked. We must develop new tools. We must examine our customers' choices from economic and psychological directions in addition to the equipment inventory approach.

It is not the intention of this paper to paint a gloomy picture of the future of commercial energy research. However, it cannot be denied that the heterogeneity of the commercial sector combined with the expense of large-scale research projects will seriously inhibit the ability of the commercial energy use researcher to collect reliable and appropriate information. In the future commercial energy researchers will collect different types of information than they have in the past. This will also complicate data collection.

Although it presently seems daunting to collect the types of information we will need to respond to the changing energy service market, we do well to remember our successes of the last ten years when planning our research efforts for the next ten years.

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