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## V. ROLE OF ENABLING TECHNOLOGIES

# UTILITY AND CUSTOMER COMMUNICATION, COMPUTING AND CONTROL (UC-3C) TECHNOLOGIES

by

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## INTRODUCTION

The reason for giving a talk about utility/customer communication, computing, and control at this conference on new service opportunities for electric utilities lies in the nature of the services being considered. Essentially, these services involve the provision of information about the value of attributes of electricity supply (e.g., the value of reliability, security, or time-of-use). In order for the provision of this information to be a service, it must be communicated to customers in a timely fashion, the customers must be able to decide what to do about the information (computing), and they must do it (control). Also, to settle accounts, it will be necessary to communicate the results of the customers' actions back to the utility.

Thus, this talk is about the means of communicating, deciding about (computing), and acting on (control) information. Its purpose is to describe the outlines of a system that could perform these functions in the future, to discuss ways of getting from here to there, and to point out that, in the process of getting from here to there, we may well find opportunities for the provision of new utility services that go well beyond those being considered at this meeting.

## A VISION OF THE FUTURE

Within the next few decades the transmission and distribution networks that deliver electric power to our homes and factories will be paralleled by communications networks and electric meters will be replaced by computers. This new information technology will transform the industry in three ways: (1) existing operations will become more automated, (2) the generation, transmission, and distribution plant will be used more efficiently, and (3) a range of additional new services will be offered. Existing operations that will be automated include meter reading, connection and disconnection, capacitor switching, feeder switching, fault location, and theft detection. This automation will reduce costs and increase reliability. Plant will be used more efficiently by shifting load from peak to off-peak and by using resources that would, with today's operating practices, be needed as a reserve. Load will shift as a result of "real-time pricing" that will adjust the price of electricity at frequent intervals to reflect the marginal cost of production. Capacity that is now held in reserve for emergencies (the reserve margin) will be used by offering its output for sale at lower, interruptible rates. The ability to rapidly and selectively shed loads will allow utility customers to operate different loads on different priority schedules. For example, households will be able to operate their refrigerators with a rate that permits short interruptions for emergencies. By such means even the traditional "spinning reserve" can be displaced by rapidly interruptible loads. The automation of utility operations and the more efficient use of plant will save utility customers many billions of dollars annually. But the impact of other new utility services may be even greater. Foremost among these services will be energy management. The computer that replaces the electricity meter will transform information from the utility's communication network, sensors at the customer's premises, and databases describing the customer's preferences into control signals for the equipment (e.g., lights, air conditioners) that provides the customer with energy services. Experience to date suggests that good control can reduce energy consumption by 20 to 30 percent while improving the quality of service. Control capability opens the door for utilities to begin supplying energy services such as space conditioning instead of just supplying energy. The opportunities for reducing energy consumption and improving the quality of service multiply with this approach. Ultimately, the technological revolution in computing, communication, and control may mediate an institutional transformation of the utility industry–from energy suppliers to energy service companies.

## OBSTACLES AND OPPORTUNITIES

There are some formidable obstacles along the path to our vision. First, it won't be cheap. For example, the investment for computing and control in each of California's more than 10 million households will be on the order of $500 per household. Add to this the costs for the commercial and industrial sectors and the costs for building and maintaining a communications network and pretty soon you are talking about real money. Second, it can't be fully demonstrated on a small scale. Many of the benefits of the system that is envisioned depend on its wide-scale application. Consider the case of real-time pricing combined with priority pricing for households. Optimizing energy usage under such a pricing regime would be greatly facilitated by appliances that could be controlled by signals from the customer's meter (e.g., a refrigerator that can alter the timing of its defrost cycle and can turn itself off for short periods in response to signals from the meter). But manufacturers are unlikely to develop such products until they are confident that a market for them will exist. A little reflection will produce numerous other examples of how the success of a UC-3C system may depend on its scale. Thus, incremental development of a new system will be difficult. We are talking not only about costly systems, but also about costly experiments to prove out the benefits.

Given these obstacles, one is tempted to opt for a simpler way of providing the services being considered at this meeting: buy a radio transmitter, broadcast the prices, and let market forces generate an appropriate response. This approach has some serious drawbacks both in potential losses in efficiency and, for utility companies, the loss of an immense business opportunity. Efficiency losses may occur because of the absence of two-way communication and because of higher equipment costs resulting from the separation between metering and computing and control.

Priority pricing provides an example of the possible advantages of two-way communication. Typically, priority pricing schemes envisage that customers will be committed to a priority level for an extended period. However, it is almost certain that there would be efficiency gains if, when the moment of truth arrived, customers with a low priority had the opportunity to make trades with higher priority customers (i.e., pay the higher priority customer to take the outage). With two-way communication it would be possible to develop a spot market for reliability to complement longer-term contracts. [This market might operate through a computer-conducted matching of buyers and sellers based on prices posted in the customers' computers.]

New pricing methods such as those being discussed at this meeting will require new metering technology. If the new methods are to be effective, automated customer response will also be necessary. This latter point derives from the fact that manual response will be too expensive and too slow. In households, we cannot expect that customers will routinely attend to the small tasks required to monitor prices (e.g., read a display in the kitchen) and to optimize consumption accordingly–this is too much time and trouble for too little gain. In larger facilities, where the gains would be larger, the number of actions needed is likely to be too great and the optimization problem too complicated for an effective manual response. In a simple "broadcast the price" strategy, utilities would be responsible for the new metering technology and the market would have to supply the means for automated response. But the technology needed for metering and the technology needed for automated response are closely related and have may elements in common. A single device that does both functions is almost certain to be less expensive than two separate devices.

The strategy of broadcasting prices and letting the market work implies that utilities will not be part of the market. But utilities would have some competitive advantages in such a market. They have regular transactions with their customers–the marginal cost of additional transactions should be lower than the transaction costs of competitors. They have a monopoly position in the metering business. And, the expense of developing a UC-3C system can be largely offset by gains from automating existing operations (meter reading, capacitor switching, etc.). The proper functioning of the market does not usually require participants with competitive advantages to opt out. Indeed, the competitive advantages that would be enjoyed by utilities in such a market seem to be so large that there is room for them to earn very substantial profits while, at the same time, leaving the economy substantially better off as a result of their participation.

## GETTING FROM HERE TO THERE

Making the transition from the existing methods of operating the electricity supply system to operation with a UC-3C system won't be easy. As we have noted, these systems will be expensive and their benefits will be difficult to demonstrate of a small scale. The challenge is to find a path from here to there with steps that are large enough to produce real progress and yet are not too costly or too risky. It is not too soon to start. Indeed, utilities that hang back and wait for someone else to show that it works will be at a disadvantage. The utility of the future may not match our vision, but we think that it is inevitable that information technology will profoundly change the industry. Utilities that experiment with new methods and have a proactive stance toward new technology will be in a much better position to adjust to this change.

**A Place to Start**

One area in which we think early efforts should be concentrated is large commercial customers, particularly those whose facilities have energy management and control systems (EMCSs). EMCSs are becoming common in commercial buildings. The primary purpose of these systems is to reduce expenditures for energy and power. Among the energy-management and control strategies that are implemented by EMCSs are optimal stop and start, demand limiting, economizer control, and daylighting. They are a prototype for the customer response computers that we believe will be necessary if new methods of pricing electricity are to be fully effective. Establishing direct communication links to customer EMCSs appears an obvious first step on the path to the development of full-scale UC-3C system. This step would be (relatively) low cost and could have significant payoffs without having to involve very large numbers of customers.

**Finding Allies**

For the most part, those concerned with the development of UC-3C technologies and those concerned with new pricing methods have worked in isolation from each other. The continuation of this isolation is not in the interest of either group. The benefits from new pricing methods are probably not sufficient to justify the costs of a UC-3C system–other functions such as those we have listed will have to be performed by the system if it is to be cost effective. By the same token, the benefits from other functions alone are unlikely to be sufficient to justify the costs of a UC-3C system. Even if one or the other did provide sufficient benefits to justify the costs, the economies from combining functions would be compelling. The two groups need each other. Most of you at this meeting are interested in new pricing methods. You need to pay attention to the technology and the technologists: you need to understand the technical possibilities and limitations, you need to help the technologists understand your technical requirements, and you need to encourage and support technical research and development.