32 The structure of electric utility rates

In Chapter 31 the following statement was made: " . . . an energy management program cannot be instigated until the analyst has a thorough understanding of the utility's rate structure." This chapter will address the fundamentals of the philosophy and techniques most commonly employed in rate structures.

Basically, two components of cost are associated with the production and delivery of electricity. One is the fixed cost or investment cost in conversion and distribution systems. As has been stated in other chapters, this cost is related not to the energy delivered or sold but rather to the rate at which the plant *can* convert and deliver the energy. As is the case in any energy conversion system, then, the investment cost is seen to relate to the power. In electrical terms, the power unit is the watt, or more commonly the kilowatt (kW).

As a plant with a certain power capacity is operated, it delivers energy, in units of watt hours or kilowatt hours (kW-hr). The second component of cost, generally called the variable cost, relates to the energy converted. This cost includes fuel, supplies, labor, and other elements that change with plant utilization.

The most widely accepted philosophy of pricing electricity is to relate the charge to the customer to the cost to the supplier. A simple analysis of the cost to the supplier per unit of energy delivered reveals the relationship between cost and plant utilization. One way to express this utilization is by the term *load factor* (LF). The load factor, expressed for a time span of one year, is:

$$\text{LF} = \frac{\text{kW-hr produced}}{\text{kW capacity} \times \text{hr in year}}$$

or

$$\text{LF} = \text{kW-hr/kW (8760)}.$$

If, as an example, a plant can be constructed for \$500 per kW, and an amortization schedule reveals a need for \$120 per kW per year to amortize that investment, it is readily seen that if only 1 kW-hr is produced in a year, the investment component charge for that unit of energy is \$120. If, however, the plant produces 8760 kW-hr for that investment, the investment burden per kW-hr is 1.37¢. Thus, the fixed cost on a unit of energy basis varies with the load factor. Continuing the example, assume that the variable costs (fuel, labor, etc.) to produce a unit of energy are 1¢ per kW-hr. The cost per unit delivered can be expressed by the equation:

$$\text{Cost} = \text{variable cost} + \frac{\text{amortized fixed cost}}{\text{LF (8760)}}.$$

Solving this equation for our example, we obtain:

$$K_p = 1 + 1.37/\text{LF} \qquad \text{¢ per kW-hr.}$$

This equation is plotted in Fig. 32-1. The graph clearly illustrates the remarkable impact of investment cost on the cost of energy produced as plant utilization varies.

In developing rates that are the structure for charging the user, the philosophy of relating the charge to the production cost is usually implemented by treating each user as though a miniplant and distribution system were provided exclusively for him. Thus, a curve such as the one in Fig. 32-1 is theoretically applied to that customer's use pattern.

The simplest of rate structures is the straight declining energy charge, a rate generally available to small and statistically consistent users such as residences and small commercial establishments. This rate is based on a statistically defined minimum load factor; then, as usage increases (implying an increasing load factor), the unit rate drops.

A common rate for larger users, called an "hours of use" rate or a "hidden demand" rate, puts the burden of load factor control more directly on the purchaser. It is generally based on a monthly increment (approximately 720 hours) and has declining blocks of energy charges based on hours of use of the maximum metered 15-minute integrated demand. Using the data in Fig. 32-1 and assuming 10 percent above the production cost as the selling rate, the following rate might be established:

LF, %	Hours of use	¢/kW-hr
20	First 144	8.8
40	Next 144	4.5
60	Next 144	3.6
80	Next 144	3.0
100	Next 144	2.6

Generally, the last increment would be around the 80 percent step and would be stated as "all over 432 hours."

Another rate commonly applied to large commercial and industrial users is the rate that completely separates the demand and the energy charges. This type of rate uses a billing demand based on the highest 15-minute integrated demand for the month, which in essence passes the customer's share of the investment cost straight through. In the example discussed, a month's share of the annual $120 cost would be $10 per kW of demand. Some rates add to this concept a technique called a "ratchet," whereby the user's demand charge is based on the current month or the highest of any of the preceding 11 months

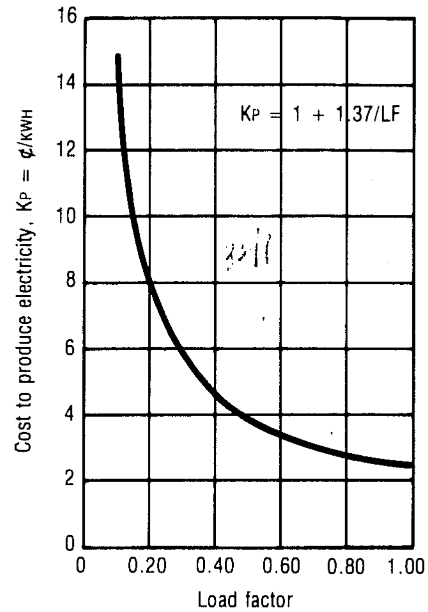

Fig. 32-1. Cost of production v. load factor.

whichever is greater. The theory is that the producer still had to have that plant capacity available. Some of these rates incorporate a reduced ratchet such as 75 percent of the previous months, but the concept is always to pass the fixed or investment costs through.

The energy charges in most demand/commodity rates are usually in decreasing cost increments, a technique to reward the user for improving the load factor (after all, it only seems fair!).

There are many other methods of relating the sale price to the production cost, some of them in use and some in the planning stages. Among them are:

- Power factor charges. The lower the power factor on an electrical system, the greater the current (amps) per unit of energy delivered. Since the capacity limitations of all the *electrical* components are related to current, low-power factor affects utilization of installed capacity. These charges are generally in the form of either power factor penalties or KVAR charges.
- Time of day adjustments. These are generally available only for large industrial users because of the cost and complexity of available metering. With construction and conse-

quently investment costs soaring, however, a good deal of attention is being given to this technique for the future.

• Time of year adjustments. The philosophy is similar to that of the time of day adjustment. It is an attempt to encourage users to purchase their energy at a time when the plant has unused capacity available. It was such seasonal adjustments that prompted such concepts as "all-electric" rates in past years.

• Fuel adjustments. This is an amount that usually varies by the month and is related to the cost of resource energy to the supplier. It is an additional multiplier that is applied to the energy use (kW-hr) charge.

In summary, the concepts in production cost control of electricity are twofold. The first is to obtain maximum use of invested capital through optimizing load factor; the second is to provide the product at the lowest resource energy consumption consistent with available resources and technology. These two should not be confused. And the underlying philosophy of rate structures is to encourage the user to mold his use patterns to enable the supplier to accomplish these.

The different rate structures throughout the world are almost innumerable. Most, however, are based on some elements of the concepts discussed above. As stated at the outset, the energy analyst should obtain a copy of the rate filing, or a syllabus thereof, at the initiation of any investigation. Then, when he is successful at duplicating historical costs, he will understand the rate and can proceed.