# A PROPOSAL FOR PEAK LOAD PRICING

# OF PUBLIC UTILITIES

By

Yoram C. Peles

Hebrew University of Jerusalem
and
University of Florida

forthcoming
Energy Economics
July 1981

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Ever since Peter Steiner presented his path breaking paper, analysis of peak load pricing is usually based on certain assumptions about demand. These assumptions are not necessarily a prerequisite for the existence of regulated monopolies, and, therefore, the existing application of the peak load solution to these firms is not necessarily valid.

The usual assumption about the demand for the utility products is that this demand is independent in the peak and off-peak periods and could be separated. Customers ask for given quantities in each period independent of their demand in other periods. That is, changes in prices or quantities bought in one period have no effect on the demand in other periods. Sometimes, it is recognized that the peak period demand can be transferred to the off-peak demand, so that raising the prices in the peak period can, to some extent raise the demand of the off-peak period. Thus, for example, the higher price for electricity during the peak time can cause customers to shift their demand for energy to the off-peak time, and to consume more current at the given lower prices.

However, demand in the peak and off-peak periods can be complementary. For example, a high price for energy in a peak period can bring firms to buy energy saving machines, this in turn will lower the demand for energy in the off-peak period. In such a case, the existing solution of joint costs for independent demands is no longer necessarily optimal.

* This proposal was supported by P.U.R.C., College of Business Administration, The University of Florida

Regulated utilities, such as electric companies, supply goods whose other dimensions besides quantity are important. Demand for electricity is an aggregate demand that can be separated into two broad categories: Demand which exists steadily over the year, i.e., for industry production, for regular household purposes, etc. This demand is not sporadic, but is for a steady stream of services over the year. The level of this demand is also a function of the continuity characteristic of the supply. It is, in a sense, a long-run contract between the traders to obtain a steady flow of electricity over the year. It is similar to a long-run contract to supply coal to the electric company where demand is for a continuous stream and not just for a one-time quantity. The entire set of the periodic prices, and quantities of electricity determines the input of the company, including the investment in long-run capacity. Here the utility not only produces goods and services having joint costs, but these goods and services themselves are jointly demanded. Hence, the trade contract specifies both the quantity of the goods and services as well as the continuity character of the transaction. The price determined is the function of both these dimensions of the goods and services traded. The price stated is for the entire stream, and is not affected by fluctuations in market demand.

The second source of peak demand for electricity is a specific demand existing in the peak period only; such as for air-conditioning in summer time (using specific facilities for this temporary demand). By its nature, it is similar to household demand for heating coal in winter. The specification of such a transaction states only quantities and price and not an annual continuity; it excludes a similar transaction for summer time.

In short, we have here two distinct demands. Both are for electricity, but differ with respect to one dimension of the transaction - its continuity. Thus, the entire demand can be divided; not, on the basis of time, peak and off-peak (summer and winter), but rather on continuity versus sporadic demand.

The above two approaches can be described in Figure 1. The solid line curve describes behavior over time of quantity demanded at a certain price. One amplitude - a peak and a trough - represents one year. The existing peak load pricing theory divides demand on basis of time, such that demand between $t_1$-$t_2$ and $t_3$-$t_4$ is one demand, while the demand between $t_2$-$t_3$, etc., is another demand.

The suggested approach is to segment demand along the quantity axis. Up to $Q_1$ is the long-run stable demand while above $Q_1$ is another (additional) demand.

A new customer having a year-long permanent demand, the same demand in peak and off-peak periods, raises the demand the utility faces by the same level in the peak and off-peak periods. A new customer entering peak period's demand only does not affect the off-peak demand. A utility investing in additional capacity, will consider it a joint cost for the additional year-round demand in the first case. In the second case it will be a joint cost for the additional peak demand and the additional quantity that can be supplied for the already existing demand. In other words, the utility's alternative costs for supplying the first type of customer are different (lower per unit of good) than the costs for supplying the second type of customer, although the same type of facility is needed in both cases.

Hence, marginal cost pricing for the stable, permanent demand means the same price for peak and off-peak demand. However, the temporary peak demand calls for the existing peak load pricing as suggested by Steiner.

Moreover, the two demands can be supplied by different facilities. The cost function is the minimum cost of production. However, the production can be performed under different conditions with several possible cost functions to choose from. There is that production function which is the optimal cost to produce given quantities throughout the year. This production technique usually includes heavy capacity investment yielding low operating (short-run variable) costs. Nuclear reactor generators are a type of such equipment.

Another cost function which should be considered occurs when electricity is produced during only a few months in any year (e.g., gas turbines). Here the average cost per unit produced is higher than under the previous techniques. Yet this cost is lower if operated by the same firm than by another unrelated firm. Hence, no costs savings accrue from production by only one firm. This production technique has an input mix with relatively more operating (short-run variable) cost.

A producer facing different intensities of demand, can choose a combination of the above production techniques. Another alternative which may be available, is one which has the lowest (average) cost for producing varying quantities. The average cost per unit in this technique is higher than in the first technique, but can be lower than the (average) cost of the combination of the first and second techniques.

The three functions are described in Figure 2. $AC_1$ is the long-run cost function using the first technique. $AC_2$ is the average costs using the second technique, since the first technique is already used to produce a quantity of $Q_0$. And $AC_3$ is the long-run average cost curve using the third technique. Notice that the figure is derived for a time period of one year, including peak and off-peak periods. The quantities in Figure 2 are produced during the year without stating the particular month in which they are produced.

Casual observations suggest that the electric companies find it more economical to operate a system of cost functions $AC_1$ for the steady long-run production and $AC_2$ for the short-run peak demand. Hence, we can rule out $AC_3$. Under these conditions, a new customer with a steady long run demand will influence the electric company to invest in production capacity of type $AC_1$, and therefore the marginal cost of supplying such a customer will be related to this cost function. A customer joining the peak demand market only, will influence the firm, in the long run, to use the techniques represented by $AC_2$ and hence the marginal cost will relate to this cost function.

In other words, two identical KWH produced at the the same peak period will increase the electric company's costs by different amounts, depending on the source of the demand. Moreover, the two different prices (for the seemingly identical goods) are consistent and involve no price discrimination, since they are actually goods having different characteristics and resulting from dissimilar long-run marginal (and average) costs.

The cost function of electricity raises another problem. The common peak load analysis usually assumes a cost function with two inputs. One is a short-run variable cost (fuel) and the other is a capacity cost. This function is usually assumed to be linearly homogeneous, which would eliminate the need for a regulated monopoly. A major reason for granting of monopoly rights is that these firms are natural monopolies; that is, producing under conditions of decreasing long-run average costs, and hence marginal cost falls short of average cost. Therefore, a system of marginal cost pricing, including the common peak load pricing, does not raise enough revenue to pay for total long-run costs. Therefore, one solution for the regulated monopoly to continue operating and making a fair rate of return, is to move away from a marginal cost pricing and to charge an average cost price.

Based on the above points, an alternative price system is proposed for public utilities. In the traditional Steiner's peak load pricing there is a single price for all units bought at the same period of time. In the price system proposed the price differential will be based on the variance in quantities bought by each and every customer, as follows:

1) One price for quantities produced and bought evenly over the year. This price should equal the long-run average costs for producing these quantities, as if no peak demand existed. (It is also possible to use complete marginal cost pricing by just replacing the word "average" to "marginal").

2) Another price for quantities bought in the peak period over and above the quantities in (1) above; that is, a separate price for the additional quantities forming higher demand in peak time. The revenue from supplying this demand has to cover all long-run costs of producing this additional quantity. That is, the total costs to the utility less the costs of (1) above.

The implementation of the system is quite simple. Customers pay the off-peak price during such periods. During the peak period month, customers pay the off-peak price for a quantity up to their average monthly consumption during the off-peak period. The peak period price will be paid for any additional quantity bought.

Thus, a customer who does not buy larger quantities in the firm's peak period, pays the same price throughout the year. A customer who buys in the peak period only, pays the higher price of the peak period. A customer who uses a solar heat system and buys lower quantities in the electric company's peak time, pays the same price per unit for quantities he buys in this period.

Also, a customer who buys less in the utility peak period than in the off-peak period, can be repaid the price differential between peak and off-peak periods for the difference between the peak and off-peak quantity bought. Thus, a customer pays more for an extra quantity purchased in a peak period, while a customer is given a rebate if he buys less in the peak period than in the off-peak period.

The proposed system has other advantages over the common peak load pricing. Since the proposed two-price system is based on periodic (monthly) averages, there is no need for investment in a metering system for daily observations of the operation of the peak load pricing system.

Also, similar to the traditional peak load pricing, to the extent that the peak and off-peak demands are substitutes, the proposed system encourages the transfer of use of electricity from the peak period to the off-peak one. However, to the extent that the two periods' demands are independent, the two price systems differ with respect to price behavior. In the traditional peak load system, the introduction of additional demand in peak time lowers the price of electricity paid by off-peak customers. In a sense, the peak demand subsidizes the off-peak customers. In the proposed system the additional peak demand does not affect the off-peak price, and hence, no subsidy.

The proposed system differs from the recently discussed load management. In the latter system, each customer obtains a right to buy electricity up to a certain limit. A customer can raise the limit by buying, in advance, a right to buy additional quantity. The electric company charges the same price for all KWH bought. However, the electric company has the right not to supply electricity to a customer above the upper limit. In this way customers pay in advance for given capacity, while the management of the electric company can control the peak demand by not supplying the quantity demanded above the limit. This system is inelastic in that each customer has to predict the maximum quantity demanded and there is no way he can later on buy an additional quantity even by paying a higher price. In no way can a customer correct for mistakes made in previous expectations. Also, the load management system can present problems in defining what constitutes a customer entitled to a certain quota at no extra charge. Thus, for example, a customer could split into two distinct entities and as such be entitled to twice the quota in the peak period.

However, if the electric company wants to operate a load management system, it can improve it by incorporating the proposed price system into the load management. Then, there is no difficulty in determining what constitutes a customer. The concept of a customer is a flexible notion representing the monthly average consumption during the off peak period. Hence the quota for on peak period on which the load management is imposed will be stated in relative terms, such as 20%, 50%, etc. above the off-peak monthly average. Of course, the two-price systems proposed, just as the common peak load pricing system, gives more flexibility to customers and allows them to increase quantity bought at peak periods although charging them higher prices.

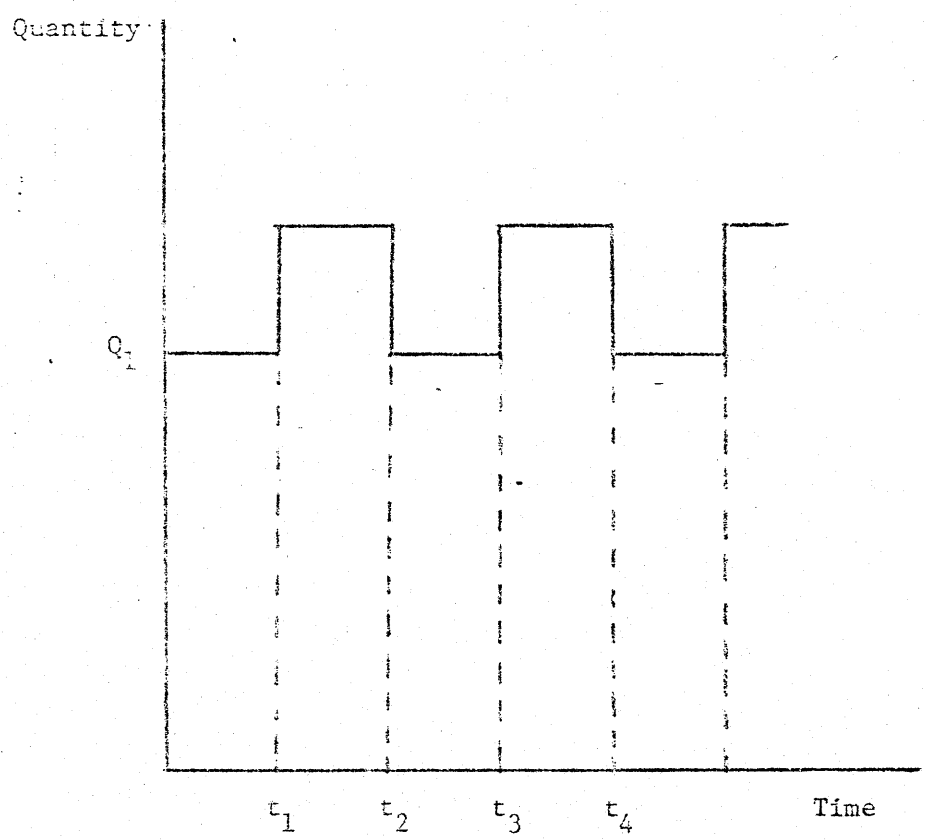


Figure 1

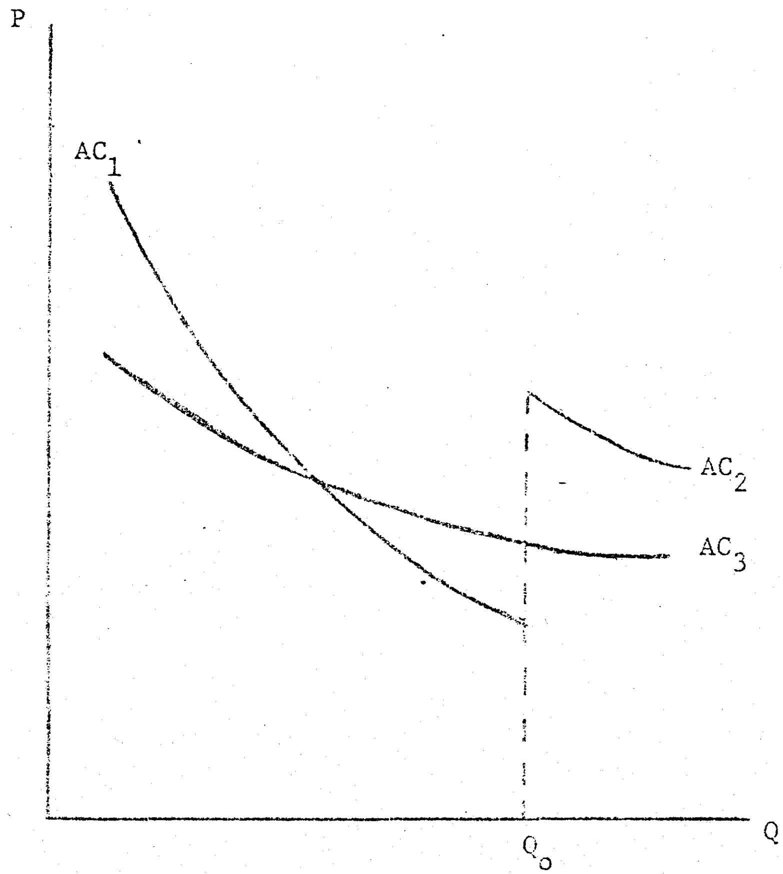


Figure 2