LET US PAY HEED TO THESE ELASTICITIES OF DEMAND*

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Estimated price elasticities of electricity demand (consumption) (1-10) are of critical importance to planning of the future supply of electricity, despite some recent views to the contrary (11-13). Economists define price elasticity as the percentage change in demand induced by a 1% change in price. Because the estimated demand response to changes in price of electricity has been found by most recent econometric studies to be both statistically significant and substantial** and because prices of electricity are expected to rise, historic rates of electricity demand growth are unlikely to persist. Accordingly, estimation of future power needs must not ignore or minimize this important relationship, just as it must not ignore any estimable offsetting future influences.

Evidence and Skepticism About Elasticities

The recent years have produced a growing number of electricity demand studies (1-9). A common aim of these studies has been to estimate as accurately as possible from historical data the quantitative relationship between demand for electricity and its important determinants, such as its own price, prices of its substitutes and the other pertinent variables, e.g., per capita income and population in the residential and commercial sectors and the value of industrial output in the industrial sector. Demand for electricity has been estimated separately for each major use sector, such as residential, commercial, or industrial.

Econometric studies have nearly exhausted all the techniques of demand estimation to date available to the economists (14).† They have employed different sets of explanatory variables within the range permitted by economic theory, used diverse data bases, sample periods and a wide range of estimation techniques, to get at the true parameters of electricity demand. Naturally, estimates of price elasticity of electricity demand differ; but they converge in the sense that the range discovered by major studies, with a few exceptions, is relatively narrow and the price-quantity relationship is invariably significant statistically.

The elasticities reported by six major studies are presented below for illustration.

Comparison of estimated long-run own-price elasticities

Author(s)	Long-run price elasticities estimated for		
	Residential sector	Commercial sector	Industrial sector
Anderson	-0.91		
Mount et al.	-1.20	-1.36	-1.82
Wilson	-1.33		
Houthakker et al.	-1.0		
Griffin	-0.52	------ -0.51 ------	
FEA	-------- -0.43 ------		-1.20

Sources: References 1, 3, 5, 7, 8, and 9 respectively.

The table gives a general idea of both the spread and convergence of the estimated parameters. Griffin after examining the sources of disparity in the estimated elasticities, recently concluded (8, p. 531) that the true price elasticity for the residential sector probably lies somewhere between -0.5 and -1.0. And in general, estimates of elasticities for commercial and industrial sectors tend to be higher than those for the residential sector.

On the other hand, in utility circles it has long been held that the demand for electricity is price inelastic — which means that consumption of electricity is not very responsive to changes in its price. As a result, demand forecasts were typically made, and often reasonably successfully, without an explicit consideration of the price effect. It turns out that much of the past success was fortuitous, resulting principally from the stable behavior pattern of the basic demand determinants such as population, income, and the prices of electricity and its substitutes and complements. In recent years, however, that behavior pattern has changed; consequently, the reliability of forecasts that continue to ignore critical factors such as price-induced changes in future consumption of electricity is in doubt.

With the recent mushrooming of econometric studies of electricity demand and the near unanimous finding that elasticity is substantial for all major consumer classes, questions have been raised about the implications of these elasticities. If other things remain constant and prices of electricity rise, the estimated own price elasticities imply that the rates of demand growth will necessarily decelerate. In reality, of course, the other determinants of demand seldom remain constant, and what we observe is the net effect of changes in both the growth-promoting and growth-retarding factors. Because many of the changes have been mutually offsetting, particularly in the period of rising prices, the growth-retarding effect of rising real prices of electricity has not been apparent, and there have been some doubts about the relevance, if not the validity, of the estimated elasticities (11-13, 15-16).

Skeptics claim that electricity demand growth remained pretty strong and persistent until 1973, despite fairly widespread increases in the real price of electricity all across the nation since 1971. During the 52-week period that ended November 1974, however, the output of electricity in the continental United States was slightly below that for the previous 52 weeks (17). Even so, the tendency in some circles has been to impute this mainly to the conservation ethic associated with the energy crisis in general and the Arab oil embargo in particular. The leveling off of consumption in 1974 is seen in those circles as a passing phenomenon, and the conviction remains that the historic growth rates in the consumption of electricity will return. Slowing down of population growth, general economic slack, mild weather, and even inflation are recognized as factors that can substantially reduce demand growth, but the rising real price of electricity is only infrequently, if at all, associated with the sluggishness of the 1974 electricity consumption.

Inadequate recognition of the present and potential price impact by utility planners has some worrisome consequences, especially since the real price of electricity is expected to continue to rise because of a variety of well recognized factors — notably, the growing scarcity and rising cost of primary energy sources, internalization of environmental costs, and rising labor, materials, and

*Work sponsored by the National Science Foundation RANN Program under the U.S. Energy Research and Development Administration's contract with Union Carbide Corporation. Helpful comments received from R. S. Carlsmith, S. E. Beall, Jr., and W. S. Chern are gratefully acknowledged. The responsibility for views expressed, however, remains with the author.

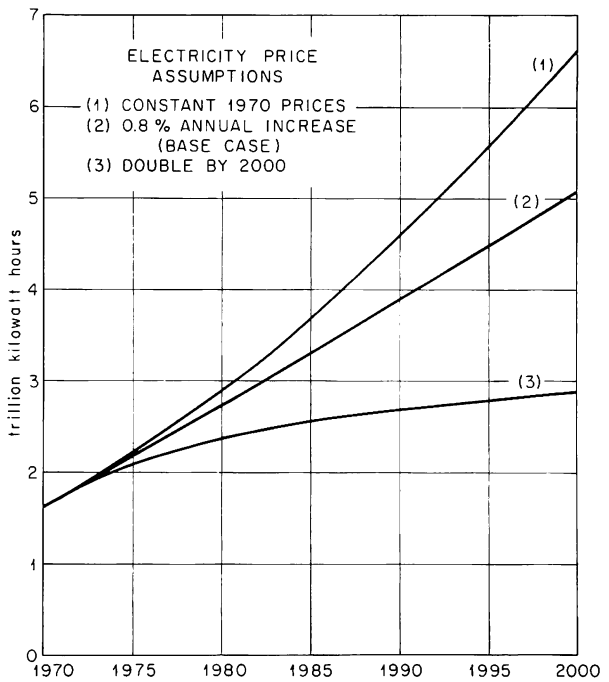
**Reference 10 may be cited as an exception. A critical review of reference 10 above is available in reference 4.

†This does not mean that further improvements are not possible, but most potential improvements are contingent on the development of more intricate models, and most require data that are currently not available in a readily accessible form. A fairly comprehensive survey of existing demand studies including the potential directions and scope of improvements, has been made by Taylor (14).

capital costs. Consequently, we must understand clearly the future impact of rising prices on the demand for electricity if we are to avoid the social costs of building excess generating capacity.

The consumer's responsiveness to price may and indeed does offer a ray of hope in the otherwise rather dark short-run energy picture. The rising prices of electricity will cause the demand for electricity to slow down and thus provide at least a partial solution to the energy dilemma.

In a recent study by T. J. Tyrrell at Oak Ridge National Laboratory, a sensitivity analysis showed that the price of electricity is easily the most critical determinant of future electricity demand growth (18). Holding the other determinants of electricity demand at their most likely future levels, Tyrrell analyzed the sensitivity of electricity demand growth to three alternative rates of possible change in its own future price. The vastly different growth paths that the future demand for electricity follows under the alternative price assumptions can be seen in the following graph.



Electricity Demand Projections from Alternative Electricity Price Assumptions.

Variations in other causal factors such as population, income, price of natural gas, and prices of appliances did influence the rate of demand growth, but none so critically as the probable variation in the price of electricity. It needs to be noted that the assumed variations in various causal factors were restricted in the aforesaid study to ranges considered realistic by experts in each area.

Indeed, there is a broad consensus among economists that rising prices of electricity (or for that matter energy in general) will reduce the growth of demand and thus alleviate at least partially the critical energy shortages. Seldom has there been such a general agreement among economists on any issue (1-9, 19-20). Yet, some commentators (11-13) still doubt the implications of demand elasticity.

Do Elasticities Really Matter?

Why is there no consensus in industry circles about the efficacy of prices? Why is not the market mechanism, to the extent it is free and unfettered, looked to for at least partial solutions? To answer these questions, a brief recapitulation of the arguments and an examination of their relevance are called for. The arguments can, for convenience, be grouped into two broad categories: technical and factual.

Technical arguments broadly ask for further refinement of demand studies to make them more complete and realistic. They do not so much question existing estimates as suggest scope and direction for further improvements. For example, statistical demand studies typically represent the price variable by either an average or marginal price. No published study includes the entire rate schedule. Ideally the entire schedule should be used, but that is difficult because of data limitations.* Progress in this direction will certainly be useful. However, the need for further improvement in no way minimizes the importance of the information already available, nor does it justify its disregard.

Other suggestions for technical improvements are consideration of regional disaggregation, more complete specification of variables, and evaluation of the impact of availability of substitutes. All these suggestions merit attention (16), and some improvements in the suggested directions are being made. A few regional studies, for instance, have recently become available (21-23). The basic price-quantity relationship does not, however, seem to change much. The demand, in general, remains price responsive, implying that we should look hard at the overwhelming evidence already available.

Care is certainly needed in assessing the relevance of a particular study and its limitations in evaluating a given application (11). The fact nevertheless remains that careful attention to the implications of relevant demand elasticity studies will provide useful clues to power planners, regulators, and policy makers for dealing with the energy problem. The exact numbers are not so important as the basic message: the demand for electricity is price elastic, and consideration of this relationship is crucial to assessments of growth-related problems and their potential solutions.**

In more factual criticisms, a point that is stressed repeatedly is that elasticities estimated from historical data are unlikely to bear strongly on future demand growth. In particular, the future unavailability of major substitutes, namely natural gas and oil, is emphasized again and again (11-13). This line of reasoning presumes that economic prosperity depends on continued growth of overall energy demand at about historic rates; thus, the vacuum created by exhaustion of natural gas and oil will have to be filled by electricity generated from uranium and abundant reserves of coal. The obvious conclusion of this argument is that the demand for electricity must accelerate, and that any implications to the contrary stemming from estimated price elasticities must be misleading.

*The Electric Power Research Institute has commissioned a one-year study to accomplish this (15, p. 127).

**Studies which explicitly consider the impact of rising future prices of energy on electricity demand growth, in general, come up with significantly lower future consumption levels than those that ignore the price effect. For example, T. J. Tyrrell's estimate of electricity generation in the year 1990 is 3.88 trillion kWhr, as opposed to *Electric World's* latest estimate of 4.64 trillion kWhr (18, Table 3; 19).

The preceding argument is not entirely persuasive for a number of reasons. First, the historic growth rate of energy consumption is not necessary for continued national prosperity and high levels of employment. Indeed, recent studies indicate that a much lower rate of growth in energy demand will not lower the GNP or increase unemployment (24-26).* A recent report by the Federal Energy Administration shows that there is no necessary connection between high standard of living and high level of energy consumption. This report shows that in five Western European countries whose per capita income is approximately equal to our own, the per capita energy consumption is only about 52%. In fact, if relative prices of energy increase faster than the prices of nonenergy substitutes (insulation materials and labor, etc.), reverse substitution can be expected to occur, slowing down the energy growth rate.

Second, the exhaustion of oil and natural gas is not really imminent. As the prices of oil and natural gas rise, discovery of new reserves and installation of new refining capacity is probable. Professor Hendrick S. Houthakker in a recent article has shown that the attainment of self-sufficiency by the U.S. in both oil and gas is entirely feasible at higher price levels (27).

Also, just as future supplies of electricity can be augmented by the use of coal and nuclear fuels as source materials, the supplies of gas and oil are likely to be supplemented by coal gasification and liquefaction. Other forms of energy substitution that would involve neither electricity, oil, nor natural gas — such as direct use of solar heat for space conditioning — are also distinctly possible in the foreseeable future. And possibilities for energy conservation through elimination of waste and introduction of energy-efficient processes or substitutes are myriad, even with existing technology (28).

So, possible shortages of oil or natural gas do not necessarily imply major increases in future electricity consumption, although some substitution will undoubtedly occur and must be carefully assessed. Econometric demand studies can be used to estimate the extent of these cross-price effects. Incidentally, this points up one weakness of many demand studies, that is, the general omission of prices of nonenergy substitutes such as insulation material from demand equations. This omission should be rectified in due course.

Conclusions

Admittedly, no one has a crystal ball to know the future with certainty. Even so, some forecasting methods are more defensible than others. The econometric method is as sound an analytical technique as we now have, and the overwhelming evidence from econometric investigations shows that the consumption of electricity is very responsive to its own price. This information lends itself to devising a variety of approaches that can help ease the problems associated with electricity demand growth. Future power generation must, therefore, be planned after taking into account the growth-arresting impact of expected increases in power prices including possible changes in rate design brought about by market prices or policy changes. Apart from market-generated price increases, factors that might slow down future rates of electricity demand growth include, for example, a gradual introduction of peak load pricing, which will have the effect of reducing the need for additional generation and also will cause the prevailing load factor to improve (29).

It is not the purpose of this paper to list exhaustively the pricing schemes that can be used effectively to reduce the need for new capacity. The main purpose here has been to stress the fact that these price elasticities are meaningful. If they are ignored, the likely result will be a colossal and wasteful locking up of scarce resources in the building of excess capacity (30). If they are recognized as fairly accurate guesses of consumer behavior, they can be used to devise pricing strategies that could ease the energy crisis on the one hand and utility financing problems on the other. It is time that price elasticities were used to provide useful clues to solutions for urgent energy problems. The alternative is to continue to ignore them; in that case, they will surely come back to haunt us.

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