The Simple Economics of Industrial Cogeneration

by Paul L. Joskow and Donald R. Jones (Department of Economics, Massachusetts Institute of Technology, Cambridge, Mass.)

Introduction

Rising energy prices and dependence on insecure supplies of foreign petroleum have led energy consumers and energy policymakers to seek methods to use energy more efficiently. Industrial cogeneration has frequently been seen as such a method. By generating electricity in conjunction with the production of steam for industrial processes, less energy is used than when process steam and electricity are produced separately. Most recent U.S. energy policy studies have spoken favorably about the potential for cogeneration. Some specific studies have indicated opportunities to replace central station electric power generation with industrial cogeneration capacity, and, in the process, to reduce domestic energy consumption substantially. Although the specific projections of economical cogeneration opportunities vary enormously from study to study.

Natural Gas Availability and the Residential Demand for Energy

by Gail R. Blattenberger, (Assistant Professor of Economics, University of Utah, Salt Lake City, Utah), Lester D. Taylor, (Professor of Economics, University of Arizona, Tucson, Arizona) and Robert K. Rennhack (Department of Economics, Yale University, New Haven, Connecticut)

Introduction

Not all households have access to pipeline-delivered natural gas. This fact affects not only the demand for natural gas but the demand for electricity and fuel oil as well. Since electricity and natural gas are substitutes in cooking, space heating, water heating, and (to a much lesser extent) cooling, the price elasticity of demand for electricity will be larger when gas is available than when it is not. Fuel oil and natural gas are substitutes in cooking, space heating, and water heating, so that one should also expect larger price elasticities for fuel oil when gas is available. Not all households have access to fuel oil distributorships, but the problem is not nearly as acute as with natural gas. The
establishment of fuel oil distributorships does not involve the capital investment of a pipeline and can be done quickly, which means that the supply of fuel oil is responsive to current demand and availability can be ignored. Natural gas pipelines, on the other hand, involve major investments in both time and money and are also regulated. Consequently, the supply of natural gas does not adjust instantaneously to changes in demand, and hence must be taken into account if biased estimates of demand elasticities are to be avoided. Ideally, availability should be measured by the number of households in a state that have access to pipeline-delivered natural gas, but such data do not exist. Hence, as a surrogate, we have used the proportion of a state's population that lives in communities served by a natural gas pipeline. These proportions, annual for the 48 contiguous states for 1960-1975, have been constructed from data published in Brown's Directory of North American Gas Companies and the 1960 and 1970 Census of Population.

Pages 47-64

The Economics of Gas Utilization in a Gas-Rich, Oil-Poor Country: The Case of Bangladesh

by Gunter Schramm (Professor of Resource Economics, School of Natural Resources, University of Michigan, Ann Arbor, Michigan)

Introduction

It has become an article of faith that clean-burning, low-polluting natural gas is a premium fuel and that on a net heat basis it is inherently more valuable than its closest competitor, fuel oil. This conclusion has been drawn by comparing pollution characteristics of both fuels. While the conclusion is correct, it is correct only in regions that have free access to both natural gas and oil delivered to the user's premises at similar costs per Btu. However, gas is a far less convenient fuel than oil. It is generally limited to certain types of uses-mainly for high-temperature heat applications, as in boilers and furnaces. It is less convenient to use (as well as capital intensive) because it requires a continuous pressurized delivery system from the gas well to the user's premises. Petroleum products, by comparison, are far more versatile. Their energy content per cubic foot is about 900 times greater than that of gas at atmospheric pressure. Petroleum products can also be moved in both large or small quantities using simple, unpressurized containers for transport. Petroleum products are most valuable in the transport sector where natural gas is difficult to use because of its low energy density. While natural gas can be converted into a liquid fuel or adapted for use in the transport sector, this is relatively expensive. It has rarely been done in the industrialized nations, which have large enough conventional markets to absorb all available gas. Traditionally, therefore, natural gas, apart from its role as an important feedstock, is largely used as a boiler or furnace fuel. In this role its delivered value is equivalent to that of low-sulfur fuel oil. Relative costs, availability, and price relationships are quite different in a number of developing countries, however. Several of them-such as most of the Middle East oil producers, most North African states, and such countries as Pakistan, Bangladesh, Thailand, Malaysia, Indonesia, Trinidad and
Tobago, Mexico, Bolivia, and Nigeria - own large gas deposits that are often far larger than present or foreseeable domestic needs. As a consequence, these deposits are either not utilized or underutilized relative to their inherent productive capacity. Where the gas is produced as associated gas in conjunction with oil, it is frequently burned because of a lack of markets. But while gas may be a surplus relative to existing or potential markets, a number of these countries are also major importers of petroleum or petroleum products. Because of the very large price increases of crude oil since 1973, their economies have suffered from financing these needed imports.

Pages 65-77

The Future of OPEC: Price Level and Cartel Stability

by George Daly, James M. Griffin, and Henry B. Steele (Department of Economics, University of Houston, Houston, Texas)

Introduction

In the wake of events associated with the Iranian revolution, the world price of oil increased from $15 to $32 per barrel. The Energy Modeling Forum's recent review of 10 world oil models shows virtual unanimity in holding that this price increase will be permanent and, indeed, that the real price of oil will increase in the future. The purpose of this paper is to seriously question the assumptions underlying such long run projections - and hence the projections themselves. We conclude that the 1978-79 price hikes may prove to be a watershed event that effects fundamental changes in the long-run supply and demand for oil. Obviously such a conclusion must rest on specific factors germane to the long-run supply and demand for oil. On the supply side, there is the promise of large supplies of conventional oil coupled with the embryonic development of synthetic oil industries in the United States, Canada, and Venezuela. Saudi Arabia's plan to build a 1.5-billion-barrel storage facility on the Red Sea suggests that the Saudis realize the importance of added production capability to help stabilize world crude oil prices. On the demand side, the declines in oil import levels since early 1980 surpassed all anticipations. This proved that prices by that time had become so high that serious conservation efforts were undertaken by many consumers. These developments suggest the reexamination of some of the long-term issues associated with the future stability of OPEC. Accordingly, we have developed a simulation model that compares cartel behavior between 1980 and 2000 at the pre-revolution price of $15/bbl and the post-revolution price of $32/bbl. Our model differs from others in several important respects. The price of oil is set exogenously, permitting simulation under different price paths. Furthermore, we use a disaggregated approach to OPEC supply. Production responses are developed for all 13 OPEC members as a function of actual and potential reserve levels, absorptive capacity, and political constraints. Each member is assigned to one of three groups on the basis of intrinsic differences in national objectives, resource bases, and development potential. Finally, in contrast to previous studies, which apply ad hoc price and income elasticities of demand, our model uses estimates of these key parameters obtained from the pooled
intercountry analysis of energy demand in Griffin (1979). We believe this model offers potentially useful insights into the issue of cartel stability. It appears that under a range of very plausible scenarios, the $32 price path requires fairly drastic market adaptations by OPEC members in order to balance supply and demand. In turn, this suggests either reconsidering the sustainability of the price path or the possibility of institutional adaptations within OPEC (such as an effective prorationing system).

Pages 79-96

The United States' Role in the international Thermal Coal Market

by D. Alec Sargent (Senior Planning Analyst, Coal and Synthetic Resource and Mining Coordination Dept., Exxon Minerals Company, 1251 Avenue of the Americas, New York, N.Y.)

Introduction

Recent studies have projected a huge buildup in international thermal coal trade, including a major role for U.S. exports (World Coal Study, 1980; International Energy Agency, 1978; Department of Energy, 1979). Given high-priced and insecure oil supplies, opposition to nuclear power, and the high cost of domestic coal supplies in Western Europe and the Far East, there is little doubt that international thermal coal trade will increase substantially. However, the role of the United States is highly uncertain. This analysis makes three main points. First, in 1979 U.S. thermal coal was in a weak competitive position for both Western European and Far Eastern markets. Second, as coal trade expands, long-run supply and transportation changes are as likely to damage as to improve the U.S. position. Third, the late 1979/early 1980 oil price increases improved the outlook for U.S. exports, but the long-run effects have been greatly exaggerated. For a more thorough analysis of these and related issues, see Sargent (1980).

Pages 99-123

The Supply, Demand, and Average Price of Natural Gas under Free-Market Conditions

by Jack W. Wilkinson (Chief Economist, Sun Company, Inc.)

Editor's note: The following paper is of particular interest because the model it summarizes is based on a market equilibration process that generates gas prices differently than the models discussed in our special issue on gas deregulation (October 1982). It should be pointed out that while this paper was reviewed by a panel of expert readers, it has not undergone the anonymous refereeing process that is standard for scholarly papers published in The Energy Journal.

Introduction
An increasing amount of debate recently has developed around the Natural Gas Policy Act of 1978 (NGPA). There are two major concerns over partial decontrol, scheduled for 1985: (a) the market-ordering and contractual problems, and (b) the price fly-up phenomenon. This paper presents a summary of a significantly different view regarding the price fly-up phenomenon. The full Sun Company system integrates economic activity and the supply, demand, and price of all primary energy forms. Only the key equations pertaining to the natural gas market are outlined in this paper. The data used for estimation generally cover the period 1958-1979. The simulation period is 1980-1990. The analysis differs from other work done to date in that the price of natural gas is determined by the interaction of natural gas supply and demand. Most of the previous work assume free-market natural gas prices to be directly related to crude oil or to products prices. The results of simulations to date with the Sun Company system of models do not indicate a price fly-up at the scheduled date decontrol as legislated by the NGPA.

Pages 125-141

Nuclear Power: Epilogue or Prologue?

by Harold R. Denton (Director, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C)

Introduction

Judging by the continuing stream of nuclear power plant cancellations and downward revisions of nuclear energy forecasts, there is nothing riskier than predicting the future of commercial nuclear power. U.S. Nuclear Regulation Commissioner John Ahearne (1981) likens the recent events affecting the nuclear power industry in the United States to a Greek tragedy. Others, particularly other nations, take a different view about the future. To understand the causal forces producing the current deep divisions about nuclear power, it is desirable to view nuclear energy in the broader, historical context of technology assessment. Technology assessment has been defined by the National Goals Research Staff (1970) as "a systematic planning or forecasting process that delineates options and costs, encompassing economic, environmental, and social considerations (both external and internal) and with special focus on technology-related 'bad,' as well as 'good' effects." Although studies by the National Academy of Sciences (1969) and the National Academy of Engineering (1969) advocated the need for technology assessment, there were those who foresaw adverse consequences in opening up the subject to public debate. Congressional testimony on Technology Assessment (1970) by Dr. Lee DuBridge, Director of the Office of Science and Technology, suggested that it would be ironic indeed if, in developing a mechanism for technology assessment, we were to stifle technological innovation. He warned that "We must be sure that we are designing a technology assessment, rather than a technology arrestment mechanism." Whether there is still time to amend our failures in technology assessment is especially relevant to the epilogue or prologue question. At best, technological forecasting is a risky business.
The Natural Gas Industry in Transition

by George H. Lawrence and Michael I. German (respectively, President and Vice President for Policy Evaluation and Analysis, American Gas Association, 1515 Wilson Blvd., Arlington, Va.)

Introduction

After 25 years of field price regulation, the U.S. natural gas industry is moving to a deregulated field market. This transition period has been made more difficult because of the international recession, depressed oil prices, and statutory restraints on gas use that were originally designed under assumptions of declining gas supply. The purpose of this article is to outline the major issues facing the gas industry today. Briefly, these issues are gas supply, gas price trends, and the outlook for gas demand. The short-term U.S. gas supply outlook is promising, with significant excess gas capacity relative to gas requirements. In 1981, gas well completions were at the highest level in history and completions in 1982 were expected to reach a new record. In addition, new federal government data show that gas reserve additions in the lower 48 states exceed production for the first time in 14 years.

Utility Diversification


Diversification by public utility companies is a topic in which I have had a longstanding interest. The second volume of my Economics of Regulation, for example, contains a 73-page chapter largely devoted to this subject. I have taken the occasion to reread that discussion, and have observed with interest - and some amusement - how similar the issues were as I saw them then to the issues with which the National Association of Regulatory Utility Commissioners is grappling today. The entire chapter consists of the advantages and possible benefits of utility company diversification, on the one side, and the possible drawbacks and dangers, on the other. The first of these could well have been written by the utility companies today; the other, by those regulators and members of the public at large who are resolutely opposed to any such dilutions of the public utility concept. My own not very striking conclusion was that "The balance of social advantage will obviously vary from one industry to another [p. 268]. . . . There is no single optimum pattern or combination for all situations [p. 324]..."
Costs and Benefits of Residential Time-of-Use Metering: Comment

by J. Stephen Henderson (The Ohio State University, Columbus, Ohio)

The costs and benefits of residential time-of-use metering were examined in a paper by Huettner, Kasulis, and Dikeman (HKD) in the July 1982 issue of The Energy Journal. These authors reported their estimates of the benefits of time-of-day-pricing for the Edmond Municipal Electric Company, a distribution company, and (less importantly) provided some information about the cost of the time-of-day meters that would be needed to implement such a policy. The paper is a significant departure from the tradition of applied welfare analysis which is associated with Harberger (1974) and Diamond and McFadden (1974) among others. There are three particular issues raised in their paper that I shall discuss separately. The reader should be aware that the final results of a traditional applied welfare analysis might be qualitatively similar to those found by HKD because some of the differences between the two approaches offset one another. The most important issue and the one that distinguishes the HKD treatment from applied welfare analysis is how to measure benefits. The HKD measure is cost reduction in the peak period only. That is, time-of-day pricing raises peak period prices, which reduces demand and therefore reduces costs. The benefits are restricted to the peak period because HKD consider off-peak demand to be perfectly inelastic, a plausible condition and one that is unimportant to this discussion. The question I wish to raise is whether cost reduction is a sensible objective. There is a great variety of possible cost reduction motives - peak or off-peak, short run or long run, unconstrained or unconstrained where the constraint itself could be one that holds revenue constant or one that requires revenue to equal cost, to mention a few. None of these, in my opinion, is a sensible basis for measuring the benefits of time-of-day pricing.

Costs and Benefits of Residential Time-of-Use Metering: Reply

by David A. Huettner, Jack Kasulis, and Neil Dikeman (University of Oklahoma, Center for Economic and Management Research, Norman, Okla.)

J. Stephen Henderson's instructive comment raises several important issues and also can be used to show how subtle changes in the model assumed can affect the interpretation of the results. Dr. Henderson raises three major issues: 1. How should benefits be measured? 2. What interest rates should be used? 3. Should marginal capacity cost vary with the amount of household consumption? Turning to the first issue, Dr. Henderson notes that we have clearly stated that our analysis is to the utility's benefit - not society's. We note at the end of our paper that the time of day (TOD) rates selected must balance utility revenues and costs. Since we have further assumed that utility revenues will not be affected by the TOD rates implemented, it is reasonable to focus on cost savings and in
particular to determine whether the additional metering costs produce sufficient capacity costs savings for all residential size categories. This assumption should have been related more clearly to the cost-benefit analysis but does not rule out prices that drive demand and/or revenue to zero. Cost reduction in this framework is a sensible goal, as is the question of whether residential customers below certain usage levels should be excluded from TOD metering.