United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Research Triangle Park NC 27711

Research and Development

EPA-600/S7-81-157 Oct. 1981

EPA

Project Summary

Electric Rates and Boiler Fuel Choice

K. T. Sherrill and J. L. Weatherby, Jr.

In a quick-look fashion, the economic tradeoffs of using purchased utility electricity as an alternative to on-site combustion of fossil fuels for industrial steam generation were examined in this study. Specifically, the impacts of marginal or incremental cost pricing of electricity and increasingly stringent industrial boiler emission controls were examined for a 44 MW_t (150 x 10^6 Btu/hr heat input) industrial boiler. Data were compared to determine if electricity, despite its lower overall thermal efficiency, could be economically competitive with direct firing of fossil fuels in this size boiler.

Marginal (incremental) costs are designed to reflect the full social costs of resources needed to deliver additional (incremental) electricity. In this study, the marginal cost pricing concept is extended to industrial steam generation.

This study is neither a definitive analysis of marginal cost pricing techniques nor a comprehensive overview of the impacts of marginal cost pricing on industrial energy sources. Only a few of the many pertinent variables were considered in estimating marginal industrial steam costs, and a number of simplifying assumptions were made because of resource limitations. Several simplifications tended to reduce the hypothetical marginal cost of electricity while increasing the estimated marginal cost of on-site fossil fuel combustion. Nevertheless, the study results show that (for the two cases evaluated) electricity would not be competitive with direct firing of fossil fuels as an industrial boiler energy source if both electricity and fossil fuels were priced at marginal cost. These results are not applicable to all situations where selection of an industrial boiler energy source has to be made, but only for the cases described and for the assumptions made.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In the industrial sector, steam is generated primarily by the combustion of fossil fuels. The objective of this study was to examine the economic tradeoffs associated with industrial fossil-fuel combustion and the use of electricity for steam generation given existing (1980) electricity rates, hypothetical rates reflecting marginal costs, unregulated 1980 market prices of four fossil fuels, and several levels of emission controls for the fossil-fuel-fired boilers. The basic issue addressed was the economic tradeoffs associated with selecting an industrial boiler energy source if all energy sources (oil, gas, coal, and purchased utility electricity) were priced at hypothetical levels reflecting their marginal costs.

A number of variables influence the selection of boiler energy sources. Two factors which were considered in this

study are: 1) the impact of electricity rate structures which more closely reflect marginal costs and which, as a result, are higher than existing regulated rates; and 2) increased costs resulting from application of emission controls to fossil-fuel-fired boilers to meet environmental regulations. While use of electricity eliminates costs associated with emission controls for industrial boilers, the much higher electricity costs (compared with fossil fuels on a dollar per million Btu basis) significantly limit the viability of this alternative.

Theoretically, marginal or incremental cost pricing is defined as pricing all units of output at a level equal to the marginal cost of the last unit of output produced.[1] The economic justification for marginal cost pricing is the efficient use of society's scarce resources. Prices set on the basis of marginal costs reflect the full costs to society of the resources used to produce the goods or services. If prices are less than marginal costs, resources are used inefficiently and society has to bear the cost of inefficient rates of resource utilization. To the extent that electric rates reflect marginal costs, rates provide signals to customers concerning the amount of consumption that is consistent with the regulatory objective of economically efficient use of resources, especially those that are energy-related.[2] Marginal cost pricing of electricity was first used in the design of promotional rates in the 1920's. Promotional rates, designed to capture specific markets, were justified by the industry as capitalizing on the economies of scale in electricity generation and producing lower costs to all customers.[3] The gradual downward trend in electricity rates was ended in the late 1960's and early 1970's by rapidly increasing fuel costs and capital costs. The current problems of utility revenue erosion have generated considerable interest in developing rate structures that could curb uneconomic growth of the peak. During the last 10 years, a version of marginal cost based on long-run incremental cost has been introduced into various rate proceedings for the purpose of providing economic insight into efficient rate design.[4]

This study is neither a definitive analysis of marginal cost pricing nor a comprehensive overview of the impacts of marginal cost pricing on industrial energy source selection. It is a modest attempt to deal with some of the issues involved in marginal cost pricing of electricity, fossil fuels, and industrial process steam. As described here, a number of simplifying assumptions were made to carry out the comparisons, and not all variables involved in estimating marginal industrial steam costs were considered.

Actual 1980 data from public utility files were collected for two utilities to estimate the hypothetical marginal costs of electricity. The selection of the two utilities was based on: 1) a significant amount of industrial electricity use; 2) location in regulatory jurisdictions that use both original (embedded) and current (replacement) cost in rate proceedings; 3) diversity in terms of geographic locations; and 4) availability of necessary data on a timely basis. The hypothetical marginal costs of electricity for the two utilities were estimated from existing electric rates and the ratio of current (replacement) cost to historical (embedded) cost. The basic procedure employed was to duplicate the existing rate-setting process but to use current (replacement) cost.[5] Four factors were adjusted: return-on-capital, depreciation, fuel costs[6], and income taxes.

To define the marginal costs of producing industrial steam, it was assumed that a hypothetical industrial steam user could choose from four alternative energy sources for the production of process steam: oil, natural gas, coal (either high-sulfur Eastern or low-sulfur Western subbituminous), and purchased electricity. The marginal costs of fossil fuels were defined as their unregulated market prices (1980)[7]. A new 44 MW_t (150 x 10^6 Btu/hr heat input) industrial boiler was assumed for the purposes of estimating the marginal cost per million Btu of process steam. Current annualized costs of controlling emissions generated by industrial fossil-fuel combustion were included with the uncontrolled boiler and fuel costs. Defining marginal costs of industrial steam in this manner is an attempt to estimate the social value of scarce energy resources and clean air.

The economic feasibility of each of these industrial boiler energy sources (oil, natural gas, coal, and electricity) was examined under the following conditions:

- Existing 1980 electricity prices of two utility companies to industrial consumers, a new 44 MW_t industrial boiler, and three levels of emission controls for the fossil-fuel-fired boilers.
- Hypothetical industrial electricity prices for two utility companies that reflect marginal cost pricing, a new 44 MW_t industrial boiler, and three levels of emission controls for the fossil-fuel-fired boilers.

Conclusions

For marginal cost pricing of all energy sources, it was found that electricity would not be competitive with fossil fuels as an industrial boiler energy source at any level of emission control for the fossil-fuel boilers. This is expected since the overall efficiency of using electricity as an industrial boiler energy source is less than half that obtained by directly firing industrial boilers with fossil fuels. It was found that use of electricity may be economically feasible for a hypothetical industrial user of electricity, given actual 1980 electricity rates of one utility, fossil fuel alternatives limited to imported oil or coal, and intermediate or stringent emission controls. Given the actual 1980 rates of the second utility, however, electricity was not found to be competitive with any fossil-fuel alternative under any level of emission control.

[1]The issues surrounding marginal cost pricing of electricity are not addressed in this study because they are beyond the scope of this work.

[2]Electric Utility Rate Design Study. *Rate Design and Load Control: Issues and Directions.* Electric Power Research Institute, Palo Alto, CA, November 1977. p. 5

[3]National Economic Research Associates. *An Overview of Regulated Ratemaking in the United States: Topic 1.1.* Report prepared for the Electric Utility Rate Design Study. National Economic Research Associates, New York, NY, February 2, 1977. p. viii.

[4]National Economic Research Associates, *op.cit.*, p. ii.

[5]This procedure will likely result in electricity costs which are different than the cost of electricity that would be generated from a newly installed power plant meeting current environmental regulations.

[6]Fuel costs were not available for one utility and could not be escalated.

[7]Because of limitations of the study, location-specific fossil fuel prices were not compiled.

K. T. Sherrill is with Radian Corporation, Austin, TX 78766 and J. L. Weatherby, Jr., is with Southwest Econometrics, Inc., Austin, TX 73731.
***Arthur R. Eckels** is the EPA Project Officer (see below).*
The complete report, entitled "Electric Rates and Boiler Fuel Choice," (Order No. PB 82-107 541; Cost: $8.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Industrial Environmental Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

☆ U S GOVERNMENT PRINTING OFFICE: 1981 — 559-017/7391

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335

Official Business
Penalty for Private Use $300