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The Efficient Use of Energy Resources, William D. Nordhaus and Energy Future: Report of the Energy Project at the Harvard Business School, Robert Stobaugh and Daniel Yergin, Editors

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THE EFFICIENT USE OF ENERGY RESOURCES

By WILLIAM D. NORDHAUS
New Haven and London: Yale University Press, 1979. Pp. 161.

ENERGY FUTURE: REPORT OF THE ENERGY PROJECT AT THE HARVARD BUSINESS SCHOOL

Edited by ROBERT STOBAUGH and DANIEL YERGIN
New York: Random House, 1979. Pp. 353.

Both of these books deal with the transition of the United States economy from heavy dependence on natural petroleum to alternative sources of energy. William Nordhaus combines econometric estimates of energy demand with estimates of the availability of exhaustible resources and the costs of backstop technologies to forecast the efficient time path and shadow price structure of the shift to coal, synthetic oil and gas, and nuclear power in the 21st century. Using stepped approximations to demand and cost functions permits a linear programming approach to the maximization of discounted economic surplus (the objective function). If OPEC's market power remains intact, Nordhaus argues that efficient energy utilization involves prompt transition to coal and nuclear sources for electricity generation with nuclear sources taking over all base-load generation after 1980. For industrial process heat, coal takes over after 1980 with eventual transition to a nuclear electricity backstop toward the end of the 21st century. Natural gas is the preferred fuel for residential heating and is combined with synthetic gas after 1990 on the way to complete reliance on nuclear electricity after 2050. The transportation sector remains highly dependent on natural oil until about 2000, giving way to a combination of natural and synthetic oil until nuclear electricity takes over in the production of hydrogen fuel after the middle of the next century.

Chapter one of *The Efficient Use of Energy Resources* offers a concise treatment of the Hotelling-Herfindahl (pure) theory of exhaustion, appropriately stressing resource allocation with a backstop technology under competitive and monopolistic market structures. Chapter two models per capita energy demand as a (logarithmic) function of current and lagged real GNP and current and lagged energy price relatives. Elasticities are derived for four main end-use categories: specific electricity, industrial, residential, and transportation needs. Cost functions for the exhaustible energy sources (oil and gas, coal, and natural uranium) and backstop costs for nuclear breeder, fusion, and central solar technologies are derived in chapter

three. Chapters four through seven combine the demand and cost information to produce shadow energy prices and predicted sources of energy for the United States during the 1970-2090 period during which a complete transition to nuclear generation takes place for all end-uses. A final chapter examines the implication of the efficient resource allocation model for atmospheric carbon dioxide levels as fossil fuels are economically exhausted.

Energy Future differently deals with a world of reduced natural oil consumption. For the most part, Stobaugh and Yergin confine their attention to the near term: 1980-2000. Resource exhaustion and backstop technologies are not their main worry; instead, dependence on oil means, for them, dependence on imports and "[t]he greatest single matter of concern posed by increasing U.S. oil imports is their potential link to world oil prices: The higher U.S. oil imports, the higher will be world prices."[1] The editors believe that this link means that the world price of OPEC oil drastically underestimates the true marginal social cost of imports. From the perspective of conventional international trade theory, an *optimum tariff* would be in order. Taking a political view, the editors wisely reject the optimum tariff argument in favor of subsidization and regulation of domestic energy production and consumption with the objective of holding down OPEC imports in the 1980s to current levels—about 9 million barrels per day.

The central chapters of *Energy Future* work through the various domestic energy alternatives to imported oil to see which are likely to be most responsive to encouragement. Based on declining reserves in the face of historically rising prices and exploration efforts, conventional sources of oil and gas seem unreliable to the authors as candidates for subsidization: encouragement is to be confined to price de-regulation and accelerated Alaska and offshore leasing with the hope that conventional oil and gas production in the U.S. will not fall during the 1980s. Like Nordhaus, the editors assign an important role to U.S. coal over the longer term but they see the shorter term as fraught with difficulties owing to environmental hazards, labor-management problems in the older eastern coalfields, and sluggish projections for electrical utilities' requirements in the next decade. Transition to Nordhaus' nuclear backstop is going to be politically difficult, Stobaugh and Yergin predict. Without the breeder technology, waste disposal will continue to be an important environmental issue; with breeder reactors, access to plutonium must

1. ENERGY FUTURE: REPORT OF THE ENERGY PROJECT AT THE HARVARD BUSINESS SCHOOL 223 (R. Stobaugh & D. Yergin eds. 1979).

be carefully controlled. These problems, combined with intense public awareness of reactor safety uncertainties (intensified by Three Mile Island) and the same modest predictions for electricity demand that have weakened momentum in coal development, lead the editors to revise downward the DOE estimates of available nuclear energy in the late 1980s. For the near term, the Harvard group wants to emphasize decentralized solar technologies and assiduous conservation measures. It is in these areas that subsidization and regulation will have the biggest payoff, they argue. The real challenge here is to shift a multitude of small and poorly informed energy users away from traditional levels and patterns of energy consumption. The editors believe this can be done by a program of regulation, information dissemination, public utility participation, and subsidies. Stobaugh and Yergin want to plan for twice as much energy conservation by 1990 as the DOE forecasts, and twice the reliance on broadly-defined solar sources.

Both books make valuable contributions to the current discussion. Nordhaus demonstrates the underlying strength of economic theory with its reliance on market substitution over the very long run. Stobaugh and Yergin offer a complementary approach: how to manage the contentious short-run with an aggressively monopolistic supplier and a multitude of domestic political issues. Both approaches are essential in the process of gaining perspective on the domestic and worldwide energy problem.

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