ENERGY, ECOLOGY, ECONOMY

Economic Goods versus Environmental Bads. Intensive industrial development requires a costly complex of facilities to process needed fuels, plus a national transportation net to move them to market. Tankers and pipelines converge on oil refineries at Linden, New Jersey. Refined petroleum leaves this complex, but so do uncontrolled effluents. These render the air malodorous and sometimes unhealthy, and make the Arthur Kill waterway (above) one of the most polluted in the world. (From "Energy and Power" by Chauncey Starr. Copyright © 1971 by Scientific American, Inc. All rights reserved.)

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This book
is dedicated to
Chip

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Preface

America's frontier culture set a pattern for reckless resource exploitation, often heedless of conservation needs or adverse environmental effects. This study of the environmental impact of energy use in the United States seeks to identify and estimate the major external costs of producing, transporting, and converting fuel. Current and projected consumption patterns for coal, oil, natural gas, nuclear energy, and electric power dramatize the need for a national energy policy. Such a policy should be embedded in a sound, coherent framework of relevant environmental concepts.

No such conceptual framework now exists. Nor does this book pretend altogether to supply the gap. But it does represent, I hope, a useful start.

It is to be emphasized and re-emphasized that my efforts have been mainly conceptual and theoretical, *not* empirical or statistical. The state of quantitative data in the energy-environment field is woeful at best. Nor do the rough-and-ready statistical exercises in the following pages appreciably advance our knowledge on the empirical side. Thus the comparative cost estimates of adverse environmental impacts from fuel use are illustrative only. They are not definitive. The numbers are incomplete. They support the conclusion reached by most scholars working in this area to date—that true cost estimation in such fields as air pollution is an uncertain enterprise at best, and perhaps should be abandoned until supported by an amply funded national effort.

Yet, even after allowing heroic discounts for statistical inadequacies, research suggests that the adverse environmental effects of growing levels of energy use cost society tens of billions of dollars yearly. This figure may be understated, since these effects cannot be fully appraised in dollar terms. Hence energy policy-

makers must become sensitized to the ecological as well as to the economic dimensions of fuel use.

It was an awareness of just this need—not my own awareness, but that of policymakers in the Executive Office of the President—which led to this study. I undertook research in June 1969 as a project of Princeton University's Center of International Studies under Contract OST-21 with the Office of Science and Technology in the Executive Office. By agreement with the initiators of the study, Messrs. S. David Freeman and J. Frederick Weinbold, both of OST, research focused on the externalized costs of fuel production and conversion, with emphasis on energy-associated environmental problems. I owe innumerable debts to the OST staff, but would emphasize the independence of my work and my findings. No government office is to be identified in any way with the views expressed herein. My OST friends are most particularly absolved of any responsibility for the policy-oriented sections of the book, especially Chapters 1 and 10. These were drafted after completion of the OST-sponsored research, were supported by private funding, and were not made available even for review by any public official prior to publication.

Where convenient, the sources of statistics are cited in the text itself. In the main, the best sources are government documents published by the U.S. Government Printing Office and available therefrom. Most such studies are brief and well indexed, so specific page references are given only when an interested reader could not readily find the desired data in the cited document. At the end of each chapter a brief reference section is included, designed particularly to annotate quotes or statistics whose source is not made explicit in the text. Finally, an extraordinary freight of data came to these pages from special communications, memoranda, staff studies, and the like. In no case, however, is such information unavailable to the public. An extensive Acknowledgments section follows this Preface, arranged in general to correspond with the chapters and sections on which specific individuals proved most helpful.

This is not, of course, to say that I have always handled all data as fairly or as understandingly as I should have liked. Nor is it to deny that many of the quantitative conclusions take the form of rough extrapolations, "guesstimates," or even informed speculation. I have tried, at least, to minimize the mistakes and

explicitly to indicate when the numbers leap from other sources to the realm of personal estimates.

Also, I have tried to present the conceptual framework of the study, and especially the material in Chapter 3, in straightforward terms, with a minimum of jargon and technical abstruseness. An Appendix contains a more formal, mathematical development of the "pollution model" which the text elaborates in qualitative terms. Among other purposes, this Appendix should serve the needs of students or practitioners desiring to fill out the theoretical framework with empirical data. It specifies and formalizes relationships among the main variables in a model which generally applies to various forms of pollution, from strip mine spoil to vented sulfur dioxide, from spilled oil to power plant waste heat.

The Appendix underscores the theoretical, as opposed to the empirical, nature of this book. At the same time, it tries to evidence awareness of the need to complement theory with fact. And it suggests some directions for doing so.

This awareness points up a central theme. Solution of energy-associated environmental problems will take responses that are timely, informed by facts rather than by free enterprise doctrine or "eco-theology," and reliant on a mix of technological and policy adjustments. I hope the following pages support this conclusion on its own merits. I hope too that the conclusion does not spring merely from my own bias. For bias I have.

If any predisposition or prejudice influenced my research and writing, I think, it has been the belief that American society faces a range of critical problems. Some of these problems are probably a good deal more serious than are those of environmental degradation or resource depletion. I doubt that the nation would be well served by doctrinaire preoccupations with the so-called "ecological crisis" at the further expense of already crumbling cities, deteriorating schools, widespread hunger, and unabated race hostility. In an era of environmental ideology of the most dogmatic sort, perhaps such a bias can actually bring to this field a needed—albeit ironic—quality of perspective.

Detroit Lakes, Minnesota, August 15, 1971

Princeton, New Jersey, January 15, 1972

Acknowledgments

This study profited from many personal contributions by scholarly colleagues, government officials, and industry representatives. Two Princeton students, Neil Griffith and James Paulson, worked closely and imaginatively through the development of both conceptual framework and cost estimates. Their contribution deserves mention—and thanks—at the outset.

In April 1970, a three-day conference on “Energy and Environment” was sponsored at Princeton’s Woodrow Wilson School by the university’s Center of International Studies and the Office of Science and Technology, Executive Office of the President. The participants reviewed the initial phase of research for this volume. Many attendees made extremely helpful suggestions. Present were Lee DuBridge, then Science Advisor to the President, plus S. David Freeman, J. Frederick Weinhold, and Milton Searl from the OST staff. Other federal officials were John Ludwig, Associate Commissioner, National Air Pollution Control Administration; John Ford, White House Staff; James Ramey, Atomic Energy Commissioner; and Haskell Wald, Chief Economist, Federal Power Commission. Participants from the academic community included: William Capron of the Harvard Kennedy School; Hans Landsberg of Resources for the Future; Lawrence Hinkle, M.D. of Cornell Medical School; Mancur Olson of the University of Maryland; and from Princeton University, Robert Axtmann, Cyril Black, Harold Feiveson, Robert Gilpin, Melvin Gottlieb, Lyman Spitzer, Harold Sprout, John Tukey, and myself. Mr. Michael Core attended as a representative of the American Academy for the Advancement of Science.

Other colleagues and students who have helped, either by furnishing expertise or by critiquing portions of the study, are:

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For general quantitative ecological estimates of oil spill damage, see M. Blumer *et. al.*, "The West Falmouth Oil Spill," Woods Hole #70-44, September, 1970; M. Blumer *et. al.*, "Hydrocarbon Pollution of Edible Shellfish by an Oil Spill," 5 *Marine Biology* 195; and M. Blumer, "Oil Contamination and the Living Resources of the Sea," Woods Hole Contribution #2474. In a personal communication, Dr. Blumer also furnished the cost figures for the West Falmouth spill damage settlements.

Oil spillage estimates are based on U.S. Coast Guard reports provided by Cmdr. Daniel Charter, Chief, Environmental Coordination Branch. This office was extraordinarily helpful and responsive, and several of its members reviewed and critiqued the relevant sections of Chapter 5. Mr. Melvin Judah, Chief of Industry Programs in the Office of Pipeline Safety provided statistical data and reviewed the relevant portion of the draft.

A massive study by the Research Triangle Institute, "Comprehensive Study of Specified Air Pollution Sources to Assess the Economic Effects of Air Quality Standards," gives background to the cost issues treated in Chapter 6. This study by D. A. LeSourd *et. al.*, reported December 1970, was made available through the courtesy of Paul Gearhardt of the Environmental Protection Agency. Appreciation is also extended for help on this chapter to Fred Lawrence, an air pollution specialist with the Environmental Protection Agency, and John Ludwig, Acting

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On nuclear health effects, a paper kindly furnished by my colleague Herman Somers, "Atomic Energy and Workmen's Compensation," presented before the Pacific Coast Metal Trades Council Conference, May 1957, Long Beach, remains a lucid statement of general principles. Special thanks are due John Gofman of the Lawrence Radiation Laboratory for personal communications, including a review of Chapter 7 in draft and several detailed papers on the Gofman-Tamplin hypothesis; and to Joshua Lederberg for personal communications, including both published and unpublished analyses of the genetic danger. These most helpful correspondents are, of course, specifically exempted from any blame for errors of fact or judgment that remain in the text.

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The greatest thanks of all are due my wife Lou Ann.

A Clear-Cut Nineteenth-Century Wisconsin Forest. Reckless harvesting of the continent's forests—America's first major energy source—set the pattern for subsequent exploitation of fuel resources. (Reprinted by permission of the State Historical Society of Wisconsin.)