ENERGY IN TRANSITION 1985–2010

FINAL REPORT OF THE
COMMITTEE ON NUCLEAR AND
ALTERNATIVE ENERGY SYSTEMS

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NATIONAL RESEARCH COUNCIL

National Academy of Sciences
Washington, D.C. 1979

W. H. Freeman and Company
San Francisco

The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

This study and report were supported under Contract EX-76-C-10-3784 between the Energy Research and Development Administration and the National Academy of Sciences.

Library of Congress Cataloging in Publication Data

National Research Council. Committee on Nuclear and Alternative Energy Systems.
Energy in transition, 1985–2010.

Includes bibliographical references and index.
1. Power resources—United States. 2. Energy policy—United States. I. Title.
TJ163.25.U6N382 1980 333.79 79-27389
ISBN 0-7167-1227-X
ISBN 0-7167-1228-8 pbk.

Printed in the United States of America

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ENERGY IN TRANSITION 1985–2010

25 December 1979

The Honorable Charles W. Duncan, Jr.
Secretary of Energy
Washington, D.C.

Dear Mr. Secretary:

I have the honor to transmit a report entitled *Energy in Transition, 1985–2010* prepared by the Committee on Nuclear and Alternative Energy Systems (CONAES) of the National Research council (NRC) and supported by Contract EX-76-C-10-3784 with the Energy Research and Development Administration (ERDA).

On April 1, 1975, Dr. Robert C. Seamans, then Administrator of ERDA, wrote to me to request that the NRC undertake "a detailed and objective analysis of the risks and benefits associated with alternative conventional and breeder reactors as sources of power." After due deliberation, the Governing Board of the NRC indicated that it would prefer "a comprehensive and objective study of the role of nuclear power in the context of alternative energy systems." These expanded terms of reference proved acceptable to ERDA, and the resultant contract between ERDA and the National Academy of Sciences so specified. Administrative management of the study within the NRC was assigned to the Assembly of Engineering.

The charge to our committee was nothing less than a detailed analysis of all aspects of the nation's energy situation. The dimensions of this charge were without precedent in the NRC. Our committees, consisting of highly qualified, public-spirited experts who serve without fee, have generally been called on to address much more narrowly circumscribed questions. The breadth of compass in this instance constituted a staggering challenge.

Harvey Brooks, then Dean of Engineering and Applied Physics at Harvard University, and Edward L. Ginzton, Chairman of the Board of Varian Associates, accepted our invitations to serve as co-chairmen of the study. The balance of the committee was then appointed after wide consultation with appropriate individuals and organizations. It was evident that the ultimate credibility of their report would rest upon public perception of the committee as balanced in composition and, in that sense, impartial. In discussing the NRC committee appointment process, my introduction to the Annual Report of the NRC for 1978 described CONAES as follows:

> An illustration of this art is afforded by the Committee on Nuclear and Alternative Energy Systems, engaged in the most complex task ever

attempted by the National Research Council. It is co-chaired by an applied physicist who is a university professor and an industrial engineer whose company manufactures scientific instruments, both of whom had previously chaired major NRC committees with great success. In all, 10 members are from academic institutions, 1 from a government laboratory, 1 from the research arm of an oil company, 1 from an instrument manufacturer, 1 from a utility company, 1 from a bank, and 1 from a law firm. From a disciplinary standpoint, there are 5 engineers, 3 physicists, 1 geophysicist, 2 economists, 1 sociologist, 1 banker, 1 physician-radiobiologist, 1 biological ecologist, and 1 "public interest" lawyer. . . . In a general way, by my appraisal when the study began, about one-third were negative, perhaps 3 were positive, and the others were genuinely open-minded concerning nuclear energy. At this writing, it is clear that the ideas that have come to be uppermost in the committee's collective thinking were central to the views of few if any of the committee members when they first met.*

The routine procedures of the NRC demand, as a condition of appointment, that each committee member file with us a disclosure of "Potential Sources of Bias" and that, at the first committee meeting, each member reveal to his colleagues the substance of that disclosure as well as the sense of his current views of the subject to be considered by the committee. That first meeting of CONAES was remarkable; the tension seemed almost physical; profound suspicion was evident; first names were rarely used; the polarization of views concerning nuclear energy was explicit. Four years later, that polarization persists, and many of the same positions are still regularly defended. But the committee has developed its own dynamic, the antagonists are personally friendly, and a very substantial measure of consensus has been achieved.

Patently, no single committee such as CONAES could embrace full competence and knowledge of all the many technical matters that would demand consideration. To provide that competence, CONAES, as described in the preface, brought into being a set of 4 major panels supported by 22 resource groups and a number of consultants, thereby acquiring the knowledge and insights of about 300 additional individuals of highly diverse backgrounds. (See Appendix C.) During January and February 1976, CONAES conducted public hearings in five major cities across the nation to test its plans for conduct of the study and to listen to approximately 100 witnesses who asked to testify. No complete summary of those hearings is available, nor did they prove particularly fruitful, but this process began the education of the CONAES members in attendance at these hearings. On 1 August 1976, CONAES adopted a Work Plan and on 12 January 1977 transmitted an Interim Report to ERDA, a planning document that remains a landmark statement of the kinds of

*In the time since, two of the original members have found it necessary to withdraw from the committee.

understandings that must be obtained if the nation is to formulate a successful energy policy.

Conduct of the study over this four-year period has been complicated by numerous developments in the nation's turbulent energy situation.

There were gasoline shortages and price rises, electricity blackouts, natural gas shortages, public debate over power plant sitings, large negative balances of payments for petroleum and for technology. Growing environmental concern was paralleled by concern that regulation is inhibiting industrial innovation and productivity. Rising prices and the debate over decontrol were accompanied by growing public distrust of the energy industries and of statements concerning the magnitude of hydrocarbon reserves. Political instability in nations on which we depend for petroleum imports made all too obvious the precariousness of the flow of imported oil. Three Mile Island revealed both the resilience designed into nuclear plants and the significance of the human factor in the operation of such plants. Established energy companies began to develop capabilities in new energy technologies, and a host of new, smaller companies entered the market for such technologies as solar heating, windmills, biomass utilization, insulation, etc.

President Carter, particularly concerned that nuclear weapons should not proliferate, took action to defer reprocessing of spent nuclear materials and to delay commercialization of a breeder reactor, while the pace of the much debated Clinch River breeder project was deliberately slowed. The President also presented to the nation energy messages emphasizing conservation, decontrol of petroleum and natural gas prices, vigorous exploration for new domestic sources, as well as a substantial synthetic fuels program to be financed from a windfall profits tax.

During this period, CONAES resource groups and panels were variously reporting that domestic uranium will be less plentifully available than had earlier been suggested, and that the linkage between growth of the energy supply and real growth of the GNP is more flexible than many had previously considered. A panel of the NRC Geophysics Research Board flagged attention to the fact that continuing buildup of atmospheric CO_2, thought to be largely due to fossil fuel combustion, would drastically alter climate, although the timing and manner of change are not yet reliably predictable. The CONAES Risk and Impact Panel reported its comparison of risks associated with various energy technologies. The work of the NRC Committee on Biological Effects of Ionizing Radiation (BEIR III) revealed the controversy concerning the biological effects of low level ionizing radiation, although, as a guide to policy makers, the differences between contending factions would appear to be rather small. The problem of planning for disposal of radioactive wastes assumed greater urgency and increasingly claimed public attention. An *ad hoc* committee under the aegis of our Committee on Science and Public Policy presented an independent analysis of the risks inherent in the nuclear fuel cycle, an analysis that highlighted, *inter alia,* the fact that uranium mining and the mine tailings

are, day by day, the most hazardous elements of the system, rather than accidents at power plants or the disposal of high level waste. Numerous analyses of various aspects of our energy situation were reported by diverse groups and individuals under several auspices. And, since CONAES finished its work, an *ad hoc* conference convened by the NRC in early October concluded that use of western oil shales must be a major contributor if the President's goals for a synthetic fuels program are to be met.

ERDA was phased out and the Department of Energy was created. The new Department, not quite responsible for initiation of this effort and concerned about the lengthy time that had already elapsed, placed a ceiling on its financial support of the CONAES endeavor. During September 1978 the funds provided by ERDA and the Department were exhausted. Since then, this effort has been supported by the private funds of NAS, in a total amount of about $300,000.

Through all of these events, CONAES labored on through draft after draft. Preparation of chapter 1, in effect a short version of the report, took on the character of negotiation of a treaty; individual words and phrases were debated at wearying length. The penultimate draft of this report was sent to our Report Review Committee during the summer of 1979. A specially appointed review panel of 22 highly qualified individuals, largely members of NAS and NAE, read it with utmost care and returned to CONAES a lengthy, extremely detailed critique. CONAES responded equally carefully, accepting much of the criticism and amending the report accordingly in many cases, preferring its own position or language in others.

Most reports of this length offer a brief, explicitly designated "summary." Determined to complete its task and nearing exhaustion, CONAES eschewed preparation of such a statement. However, an equivalent of such a summary will be found in the attached letter of transmittal, to me, by the two co-chairmen, a statement which closely coincides with that which concludes chapter 1. Readers will find it helpful to study that statement before addressing the body of the report.

Most importantly, the report is addressed to a great challenge, management of the medium-term future of our energy economy, viz., the turbulent period of transition from major dependence on fossil hydrocarbons, domestic and imported, to a more stable era of utilization of energy sources that are either renewable or available on a scale sufficient for centuries. While most current public and governmental concern is necessarily focussed on the energy difficulties of the day, it is the period of this transition that must be the principal subject of major energy policy. The present report offers no prescription for such policy but does provide an analytical base and a description of alternate future scenarios that should be of considerable assistance to those who must formulate such policy.

One aspect of the CONAES exercise was the development by various panels and resource groups of a series of models of conceivable national energy and economic futures. Whereas much of the report would retain its validity in the

absence of these models, their implications significantly affected the committee's thinking as it engaged in the numerous evaluations to be found in the report. Since the validity of these models rests on the validity, completeness, and consistency of their underlying assumptions, some of them quite dramatic, and since, patently, the energy futures so described flow from these premises, the reader will be well advised to examine those assumptions carefully. The variety of alternate energy futures here contemplated and their consequences for the national economy and life-style are impressive features of this report.

The report stresses the necessity to reduce national dependence on imported petroleum, to be accomplished by both conservation and switching to alternate technologies. The opportunities for conservation, and their scale and timing, are presented in some detail. Public decision concerning the major opportunities for non-petroleum-based energy production is constrained by concern for their attendant risks and environmental impact. A major feature of this report is its analysis of the state-of-the-art of these alternate technologies and a comparative assessment of their associated risks and impacts.

An unusual aspect of this report is its conclusion that future decisions concerning nuclear energy will be determined by public perceptions of risks and benefits at least as much as by rigorous conclusions drawn by scientists on the basis of scientific analysis. That circumstance places an unusually heavy burden of objectivity on those whose statements help to fashion public opinion. Excessive attention to either the risk or the benefit side of the equation, or failure to consider the alternatives, could seem to lead, on the one hand, to denial to the nation of all major energy sources or, on the other, to a false sense of security.

By design, the composition of CONAES reflected a wide spectrum of opinion concerning most aspects of the nation's energy problems, although, to be sure, none were advocates of the most extreme positions. Members frequently offered the special viewpoints expected from their places in society, as utility company executive, environmental advocate, investment banker, regulator, ecologist, physician, economist, etc., speaking on behalf of their own constituencies, as it were. Hence, the present report is unique in the growing literature concerning energy. It is particularly noteworthy precisely because it emerges from a reasonably representative microcosm of the conflicting relevant interests and viewpoints abroad in the land, rather than from a more homogeneous group with a unifying ideology.

To the extent possible, CONAES sought genuine consensus. But where the committee was significantly divided, both points of view are presented in the text. In addition, all members were invited to offer personal comments when they wished to clarify or to take exception to statements in the text that otherwise reflect the preponderance of CONAES opinion. These statements, some quite eloquent, will be found in footnotes and in Appendix A. The divisions of opinion indicated in the text and the disagreements noted in

footnotes and in Appendix A, while by no means trivial, should not be permitted to lessen appreciation of the force of the analysis here presented or of the general agreement achieved on some of the most critical questions considered.

Despite the long time required to complete this effort (in large measure a consequence of the initial polarized composition of CONAES) the report could not have been more timely than it is today. Some readers may find themselves disappointed by the absence of a set of crisp recommendations for federal policy and programs. But such was not our purpose. It is the thorough analysis of almost all aspects of our energy circumstances and the detailed consideration of the possible alternatives available to the nation that constitute the principal contribution of this report. The major decisions yet to be taken must occur in the political arena and in the marketplace. It is our hope that, by illuminating our circumstances and future prospects, this report will increase the likelihood that those future decisions will be rational and based on the longer-term national interest rather than on the painful exigencies of any given moment.

Much of the material earlier available to CONAES, i.e., the reports of several of its panels and resource groups, has already been published. Several more remain to be published. Appendix D is a compilation of these titles. Each has been carefully considered and used by CONAES, but they have not been put through the normal review procedures of the NRC.

In all, about 350 individuals have contributed to various aspects of this exercise. There may well be no participant who agrees with the entirety of the CONAES report, but most participants will find themselves in substantial agreement with most of this report. An unanticipated value of this endeavor may well prove to be the educations that all participants received; the insights and understandings so gained have already found their way into the national debate as these now even more knowledgeable scientists have also participated in a multiplicity of other committees, Congressional hearings, reports, classroom teaching, and boardroom discussions. Thus, by this avenue, also, the CONAES exercise will have contributed constructively to future national energy policy.

One intrinsically political aspect of our national energy circumstance is not fully discussed by CONAES, the fact that the great uncertainty concerning our energy future has, in turn, generated innumerable other public uncertainties. These uncertainties constrain decisions by energy-producing and energy-utilizing industry; they affect personal decisions concerning housing and transportation; they inhibit foreign policy formulation and, in general, cast a pall on life in these United States. The challenge to the nation is to avoid taking, prematurely, those decisions that CONAES suggests be deferred until they can be taken with greater understanding and wisdom while, as soon as possible, enunciating and beginning to follow a stated course that will hold

open as many options as possible. It is our hope that *Energy in Transition, 1985–2010* will be of assistance in that regard.

Allow me to take this opportunity to make public acknowledgment of our great debt to Harvey Brooks, who, more than any other, fashioned this report through endless hours of devoted effort and attention to all of its facets. His co-chairman, Edward L. Ginzton, earned our gratitude both by his considerable substantive contributions and by his determined drive to push the task to completion. And I am pleased to acknowledge the huge contribution of all the members of CONAES, who attended several dozen meetings and read reams of reports and drafts, who individually wrote innumerable drafts of paragraphs, pages, and chapters, and who maintained their goodwill and good humor during this prolonged exercise. Finally, let me express our profound appreciation to the panels, resource groups, consultants, and dedicated staff, without whom this report would not have been possible.

Mr. Secretary, the National Research Council is pleased, proud, and considerably relieved, to make this report available to the Department of Energy and to all Americans seriously concerned for the health of our nation's future energy economy.

Sincerely yours,

PHILIP HANDLER
Chairman, National Research Council
President, National Academy of Sciences

Enclosure

November 6, 1979

Dr. Philip Handler
Chairman
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Dear Dr. Handler:

It is our pleasure to submit to you for transmittal to the Department of Energy the final report of the National Research Council Committee on Nuclear and Alternative Energy Systems (CONAES).

The purpose of the CONAES study is indicated by its title: to assess the appropriate roles of nuclear and alternative energy systems in the nation's energy future, with a particular focus on the period between 1985 and 2010. The study is intended to assist the executive and legislative branches of the government, as well as the American people as a whole, in formulating energy policy by illuminating the kinds of options the nation may wish to keep open in the future, by considering the attendant problems, and by describing the actions that may be required to do so.

Because it was central to the study's charter to assess the need and direction for nuclear power developments, the various nuclear options are considered in considerable detail. However, the decisions regarding the proper role of nuclear energy and of the several alternatives cannot be made in a contextual vacuum. We found that neither the prospective growth of our population nor other social and economic factors rigidly determine the needs of the nation for energy in the future. The study, therefore, tried to describe and relate the many economic, social, and technical factors that bear on the country's energy development and the options that must remain open to our society until ultimate decisions need to be made. Many of these decisions are not yet timely and could well be strategically in error if made too soon and based on insufficient knowledge.

This committee has studied at length the many factors and relationships involved in our nation's energy future and offers in chapter 1 some technical and economic observations that decision makers may find useful as they develop energy policy in the larger context of the future of our society. Because of their significance it seems appropriate to bring them to the reader's attention at this point, while noting that chapter 1 records also, in footnotes, the comments and reservations of individual members of CONAES concerning these major conclusions.

Our observations focus on (1) the prime importance of energy conservation, (2) the critical near-term problem of fluid fuel supply, (3) the desirability of a balanced combination of coal and nuclear fission as the only large-scale intermediate-term options for electricity generation, (4) the need to keep the breeder option open, and (5) the importance of investing now in research and development to ensure the availability of a strong range of new energy options sustainable over the long term.

Policy changes both to improve energy efficiency and to enhance the supply of alternatives to imported oil will be necessary. The continuation of artificially low prices would inevitably widen the gap between domestic supply and demand, and this could only be made up of increased imports, a policy that would be increasingly hazardous and difficult to sustain.

The most vital of these observations is the importance of energy demand considerations in planning future energy supplies. There is great flexibility in the technical efficiency of energy use, and there is correspondingly great scope for reducing the growth of energy consumption without appreciable sacrifices in the growth of GNP or in nonenergy consumption patterns. Indeed, as energy prices rise, the nation will face important losses in economic growth if we do not significantly increase the economy's energy efficiency. Reducing the growth of energy demand should be accorded the highest priority in national energy policy.

In the very near future, substantial savings can be made by relatively simple changes in the ways we manage energy use, and by making investments in retrofits of existing capital stock and consumer durables to render them more energy efficient.

The most substantial conservation opportunities, however, will be fully achievable only over the course of two or more decades, as the existing capital stock and consumer durables are replaced. There are economically attractive opportunities for such improvements in appliances, automobiles, buildings, and industrial processes at today's prices for energy, and as prices rise, these opportunities will multiply.

This underscores the importance of clear signals from the economy about trends in the price of energy. New investments in energy-consuming equipment should be made with an eye to energy prices some years in the future. Without clear ideas of the replacement cost of energy and its impact on operating costs, consumers will be unlikely to choose appropriately efficient capital goods. These projected cost signals should be given prominence and clarity through a carefully enunciated governmental pricing policy. They can be amplified where desirable by regulation; performance standards, for example, are useful in cases (such as the automobile) where fuel prices are not strongly reflected in operating costs.

Although there is some uncertainty in these conclusions because of possible feedback effects of energy consumption on labor productivity, labor-force participation, and the propensity for leisure, calculations indicate that, with

sufficiently high energy prices, an energy/GNP ratio one half of today's could be reached, over several decades, without significant adverse effects on economic growth. Of course, so large a change in this ratio implies large price increases and consequent structural changes in the economy. This would entail major adjustments in some sectors, particularly those directly related to the production of energy and of some energy-intensive products and materials. However, given the slow introduction of these changes, paced by the rate of turnover in capital stock and consumer durables, we believe neither their magnitude nor their rate will exceed those experienced in the past owing to changes in technology and in the conditions of economic competition among nations. The possibility of reducing the nation's energy/GNP ratio should serve as a stimulus to strong conservation efforts. It should not, however, be taken as a dependable basis for foregoing simultaneous and vigorous efforts on the supply programs discussed in this report.

The most critical near-term problem in energy supply for this country is fluid fuels. World supplies of petroleum will be severely strained beginning in the 1980s, owing both to the expectation of peaking in world production about a decade later and to new world demands. Severe problems are likely to occur earlier because of political disruptions or cartel actions. Next to demand-growth reduction, therefore, highest priority should be given to the development of a domestic synthetic fuels industry, for both liquids and gas, and to vigorous exploration for conventional oil and gas, enhanced recovery, and development of unconventional sources (particularly of natural gas).

As fluid fuels are phased out of use for electricity generation, coal and nuclear power are the only economic alternatives for large-scale application in the remainder of this century. A balanced mix of coal- and nuclear-generated electricity is preferable to the predominance of either. After 1990, for example, coal will be increasingly required for the production of synthetic fuels. The requirements for nuclear capacity depend on the growth rate of electricity demand; this study's projections of electricity growth between 1975 and 2010 (for up to 3 percent annual average GNP growth) are considerably below industry and government projections, and in the highest conservation cases actually level off or decline after 1990. Such projections are sensitive also to assumptions about end-use efficiency, technological progress in electricity generation and use, and the assumed behavior of electricity prices in relation to those of primary fuels. They are therefore subject to some uncertainty.

At relatively high growth rates in the demand for electricity, the attractiveness of a breeder or other fuel-efficient reactor is greatest, all other things being equal. At the highest growth rates considered in this study, the breeder can be considered a probable necessity. For this reason, this committee recommends continued development of the LMFBR breeder, so that it can be deployed early in the next century if necessary. Any decision on deployment, however, should be deferred until the future courses of electricity demand growth, fluid fuel supplies, and other factors become clearer.

In terms of public risks from routine operation of electric power plants (including fuel production and delivery), coal-fired generation presents the highest overall level of risk, with oil-fired and nuclear generation considerably safer, and natural gas the safest. With respect to accidents, the generation of electricity from fossil fuels presents a very low risk of catastrophic accidents. The projected mean number of fatalities associated with nuclear accidents is probably less than the risk from routine operation of the nuclear fuel cycle (including mining, transportation, and waste disposal), but the large range of uncertainty that still attaches to nuclear safety calculations makes it difficult to provide a confident assessment of the probability of catastrophic reactor accidents. The spread of uncertainty in present estimates of the risks of both coal and nuclear power is such that the ranges of possible risk overlap somewhat. High-level nuclear waste management does not present catastrophic risk potential, but its long-term low-level threat demands more sophisticated and comprehensive study and planning than it has so far received, particularly in view of the acute public sensitivity to this issue.

The problem of nuclear weapons proliferation is real and is probably the most serious potentially catastrophic problem associated with nuclear power. However, there is no technical fix—even the stopping of nuclear power (especially by a single nation)—that averts the nuclear proliferation problem. At best, the danger can be delayed while better control institutions are put in place. There is a wide difference of opinion about which represents the greater threat to peace: the dangers of proliferation associated with the replacement of fossil resources by nuclear energy, or the exacerbation of international competition for access to fossil fuels that could occur in the absence of an adequate worldwide nuclear power program.

Because of their higher economic costs, solar energy technologies other than hydroelectric power will probably not contribute much more than 5 percent to energy supply in this century, unless there is massive government intervention in the market to penalize the use of nonrenewable fuels and subsidize the use of renewable energy sources. Such intervention could find justification in the generally lower social costs of solar energy in comparison to alternatives. The danger of such intervention lies in the possibility that it may lock us into obsolete and expensive technologies with high materials and resource requirements, where greater reliance on "natural" market penetration would be less costly and more efficent over the long term. Technical progress in solar technologies, especially photovoltaics, has accelerated dramatically during the last few years; nevertheless, there is still insufficient effort on long-term research and exploratory development of novel concepts. A much increased basic research effort should be directed at finding ways of using solar energy to produce fluid fuels, which may have the greatest promise in the long term.

Major further exploitation of hydroelectric power, or of biomass through terrestrial energy farms, presents ecological problems that make it inadvisable to count on these as significant future incremental energy sources for the

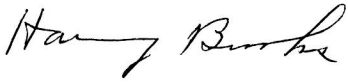
United States. (Marine biomass energy farms could have none of these problems, of course.) There is insufficient information to judge whether the large-scale exploitation of hot-dry-rock geothermal energy or the geopressured brines will ultimately be feasible or economic. Local exploitation of geothermal steam or hot water is already feasible and should be encouraged where it offers an economical substitute for petroleum.

It is too early in the investigation of controlled thermonuclear fusion to make reliable forecasts of its economic or environmental characteristics. It is not, however, an option that can be counted on to make any contribution within the time frame of this study. Nevertheless, fusion warrants sufficient technical effort to enable a realistic assessment by the early part of the next century of its long-term promise in competition with breeder reactors and solar energy technologies.

It is important to keep in mind that the energy problem does not arise from an overall physical scarcity of resources. There are several plausible options for an indefinitely sustainable energy supply, potentially accessible to all the people of the world. The problem is in effecting a socially acceptable and smooth transition from gradually depleting resources of oil and natural gas to new technologies whose potentials are not now fully developed or assessed and whose costs are generally unpredictable. This transition involves time for planning and development on the scale of half a century. The question is whether we are diligent, clever, and lucky enough to make this inevitable transition an orderly and smooth one.

Thus, energy policy involves very large social and political components that are much less well understood than the technical factors. Some of these sociopolitical considerations are amenable to better understanding through research on the social and institutional characteristics of energy systems and the factors that determine public, official, and industry perception and appraisal of them. However, there will remain an irreducible element of conflicting values and political interests that cannot be resolved except in the political arena. The acceptability of any such resolution will be a function of the processes by which it is achieved.

Sincerely,



HARVEY BROOKS
Co-Chairman

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