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ABSTRACT

This collection of excerpts and bibliographies address the three debate propositions selected as subjects of the 1978-1979 debate question for high schools selected by the National University Extension Service, "What should be the energy policy of the United States?" The collection is divided into three parts each addressing one of the debate propositions: (1) Resolved, that the Federal Government should exclusively control the development and distribution of energy resources in the United States; (2) Resolved, that the Federal Government should establish a comprehensive program to significantly reduce energy consumption in the United States; and (3) Resolved, that the Federal Government should establish a comprehensive program to significantly increase the energy independence of the United States. An introductory section summarizes the U.S. policy response to the energy dilemma. The materials are intended not as an exhaustive coverage of the subject, but to furnish debators with a basis for further research on the topic. (RE)

Senate / 95th Congress / 2d Session / Document No. 95–116

What Should Be the Energy Policy of the United States?

National Debate Topic for High Schools
1978–1979

Pursuant to Public Law 88–246

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PUBLIC LAW 88-246, 88TH CONGRESS, S. 2311, DECEMBER 30, 1963

AN ACT To provide for the preparation and printing of compilation of materials relating to annual national high school and college debate topics

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Librarian of Congress is authorized and directed to prepare compilations of pertinent excerpts, bibilographical references, and other appropriate materials relating to (1) the subject selected annually by the National University Extension Association as the national high school debate topics and (2) the subject selected annually by the American Speech Association as the national college debate topic. In preparing such compilations the Librarian shall include materials which in his judgment are representative of, and give equal emphasis to, the opposing points of view on the respective topics.

SEC. 2. The compilations on the high school debate topics shall be printed as Senate documents and the compilations on the college debate topics shall be printed as House documents, the cost of which shall be charged to the congressional allotment for printing and binding. Additional copies of such documents may be printed in such quantities and distributed in such manner as the Joint Committee on Printing directs.

Approved December 30, 1963.

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PART FOUR—RESOLVED: THAT THE FEDERAL GOVERNMENT SHOULD ESTABLISH A COMPREHENSIVE PROGRAM TO SIGNIFICANTLY INCREASE THE ENERGY INDEPENDENCE OF THE UNITED STATES

FOREWORD

The 1978–79 debate question for high schools selected by the National University Extension Service is "What should be the energy policy of the United States?" Under this general heading, the three debate propositions are:

Resolved, That the Federal Government should exclusively control the development and distribution of energy resources in the United States.

Resolved, That the Federal Government should establish a comprehensive program to significantly reduce energy consumption in the United States.

Resolved, That the Federal Government should establish a comprehensive program to significantly increase the energy independence of the United States.

The following excerpts and bibliography are divided into three parts relating to each of the three proposed topics plus an introductory part, summarizing the national policy response to the energy dilemma. These materials are not intended to provide exhaustive coverage of the subject, but only to furnish debaters with a start on their own work. While the excerpts and references have been chosen to represent a range of views and a variety of approaches to the problems raised by these topics, their inclusion does not imply any kind of approval or disapproval, or of recommendation of line of argumentation by the Congressional Research Service.

Robert L. Bamberger, analyst in energy policy, and Adrienne C. Grenfell, research librarian, with the assistance of Duane A. Thompson, analyst in energy policy in the Environment and Natural Resources Policy Division compiled the materials in the document. Bibliographic annotations, where included, were prepared by the Library Services Division.

All of the U.S. Government documents referred to in the bibliography may be found in most U.S. Government depository libraries. Information as to the location of the nearest depository library may be obtained from local public libraries. Copies will not be available for distribution by the Library of Congress.

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GILBERT GUDE,
Director, Congressional Research Service

PART ONE

THE ENERGY DILEMMA: THE NATIONAL POLICY RESPONSE

OVERVIEW*

The diagnosis of the U.S. energy crisis is quite simple: demand for energy is increasing, while supplies of oil and natural gas are diminishing. Unless the U.S. makes a timely adustment before world oil becomes very scarce and very expensive in the 1980's, the nation's economic security and the American way of life will be gravely endangered. The steps the U.S. must take now are small compared to the drastic measures that will be needed if the U.S. does nothing until it is too late.

How did this crisis come about?

Partly it came about through lack of foresight. Americans have become accustomed to abundant, cheap energy. During the decades of the 1950's and 1960's, the real price of energy in the U.S. fell 28 percent. And from 1950 until the quadrupling of world oil prices in 1973–1974, U.S. consumption of energy increased at an average annual rate of 3.5 percent. As a result of the availability of cheap energy, the U.S. developed a stock of capital goods—such as homes, cars, and factory equipment—that uses energy inefficiently.

The Nature of the Problem

The most critical increase in demand has been for oil, the most versatile and widely used energy resource. To meet that growing demand, the U.S. has turned increasingly to imports. In January and February of 1977, the U.S. imported about 9 million barrels of oil per day, half of total domestic oil consumption. By 1985, U.S. oil consumption could equal 12 to 16 million barrels per day.

U.S. domestic oil production has been declining since 1970. New production from Alaska, the deep Outer Continental Shelf, and new recovery methods should reverse the decline, but will be unable to satisfy the projected growth in U.S. demand. Other major additions to domestic oil supply are unlikely.

The principal oil-exporting countries will not be able to satisfy all the increases in demand expected to occur in the U.S. and other countries throughout the 1980's. In 1976, the 13 OPEC countries exported 29 million barrels of oil per day. If world demand continues to grow at the rates of recent years, by 1985 it could reach or exceed 50 million barrels per day. However, many OPEC countries cannot significantly expand production; and, in some, production will actually decline.

*From The National Energy Plan, Executive Office of the President, Energy Office and Planning, April 1977, p. vii–xiv, 25–33, xv–xxiii.

Thus, as a practical matter, overall OPEC production could approach the expected level of world demand only if Saudi Arabia greatly increased its oil production. Even if Saudi Arabia did so, the highest levels of OPEC production probably would be inadequate to meet increasing world demand beyond the late 1980's or early 1990's.

There are physical and economic limits on the world's supply of oil. A widely used geological estimate of total recoverable world oil resources, past and present, is about 2 trillion barrels. More than 360 billion barrels have already been consumed. Current proved crude reserves are 600 billion barrels. World consumption of oil has grown at an average annual rate of 6.6 percent since 1940, and it grew by as much as 8 percent annually during the 1960's.

If it could be assumed that world demand for oil would grow at an annual rate of only 3 percent, and if it were possible (which it is not) that production would keep pace with that rate of growth, the world's presently estimated recoverable oil resources would be exhausted before 2020. At a conjectural growth rate of 5 percent, those resources would be exhausted by 2010. Despite some uncertainty about the exact size of recoverable world oil resources, and about the rate of increase of productive capacity, this fundamental fact is clear: *within about four generations, the bulk of the world's supply of oil, created over hundreds of millions of years, will have been substantially consumed.*

Of course, actual physical exhaustion of oil resources will not occur. Even today, well over half the oil in existing fields is being left in the ground because additional recovery would be too expensive. As production by conventional methods declines and oil becomes more scarce, its price will rise and more expensive recovery methods and novel technologies will be used to produce additional oil. As this process continues, the price of oil will become prohibitive for most energy uses. Eventually the nations of the world will have to seek substitutes for oil as an energy source, and oil will have to be reserved for petrochemical and other uses in which it has maximum value.

The world now consumes about 20 billion barrels of oil per year. To maintain even that rate of consumption and keep reserves intact, *the world would have to discover another Kuwait or Iran roughly every three years, or another Texas or Alaska roughly every six months.* Although some large discoveries will be made, a continuous series of such finds is unlikely. Indeed, recent experience suggests that, compared to world oil consumption, future discoveries will be small or moderate in size, will occur in frontier areas, and will yield oil only at very high cost. Obviously, continued *high rates of growth* of oil consumption simply cannot be sustained.

Natural gas supplies are also limited. In the U.S., natural gas constitutes only 4 percent of conventional energy reserves, but supplies 27 percent of energy consumption. Gas consumption grew about 5.7 percent per year between 1960 and 1970. From 1970 to 1974, however, consumption dropped 1.3 percent. The demand for gas is considerably higher than the amount that can be supplied. Hence, gas is rationed by prohibitions on hook-ups for new homes in many areas.

Gas is not only in short supply, but its allocation across the country is distorted, and its distribution among end-uses is unsatisfactory.

Federal regulation of the wellhead price of natural gas in interstate commerce has discouraged its distribution from gas producing States to other States, and has encouraged consumption of this premium fuel for less essential uses. Industry and utilities currently consume almost 60 percent of U.S. natural gas, despite the fact that other fuels could be used in a majority of cases.

During the 1973–75 period, only 19 percent of new gas reserve additions were made available to the interstate market, and much of that gas was from the Federal domain. Since the price of intrastate gas is not regulated, there are strong economic incentives to sell gas within the producing States. *The existing distinction between intrastate and interstate sales has given intrastate users first claim to natural gas.*

Strategies and Objectives

The U.S. has three overriding energy objectives:

as an immediate objective that will become even more important in the future, to reduce dependence on foreign oil and vulnerability to supply interruptions;

in the medium term, to keep U.S. imports sufficiently low to weather the period when world oil production approaches its capacity limitation; and

in the long term, to have renewable and essentially inexhaustible sources of energy for sustained economic growth.

The U.S. and the world are at the early stage of an energy transition. Previous energy transitions in the U.S. were stimulated by new technologies, such as the development of the railroad and the mass production of automobiles, which fostered the use of coal and oil, respectively. The latest transition springs from the need to adjust to scarcity and higher prices.

To make the new transition, the U.S. should adhere to basic principles that establish a sound context for energy policy and provide its main guidelines. The energy crisis must be addressed comprehensively by the Government and by a public that understands its seriousness and is willing to make necessary sacrifices. Economic growth with high levels of employment and production must be maintained. National policies for the protection of the environment must be continued. Above all, the U.S. must solve its energy problems in a manner that is fair to all regions, sectors, and income groups.

The salient features of the National Energy Plan are:

conservation and fuel efficiency;

rational pricing and production policies;

reasonable certainty and stability in Government policies;

substitution of abundant energy resources for those in short supply; and

development of nonconventional technologies for the future.

Conservation and fuel efficiency are the cornerstone of the proposed National Energy Plan. Conservation is cheaper than production of new supplies, and is the most effective means for protection of the environment. It can contribute to international stability by moderating the growing pressure on world oil reserves. Conservation and improved efficiency can lead to quick results. For example, a significant percentage of poorly insulated homes in the United States could be brought up to strict fuel-efficiency standards in less time than it now takes to design, build, and license one nuclear powerplant.

Although conservation measures are inexpensive and clean compared with energy production and use, they do sometimes involve sacrifice and are not always easy to implement. If automobiles are to be made lighter and less powerful, the American people must accept sacrifices in comfort and horsepower. If industry is required to make energy-saving investments and to pay taxes for the use of scarce resources, there will be some increases in the cost of consumer products. These sacrifices, however, need not result in major changes in the American way of life or in reduced standards of living. Automobile fuel efficiency can be greatly improved through better design and use of materials, as well as by producing lighter and less powerful cars without inhibiting Americans' ability to travel. With improved energy efficiency, the impact of rising energy prices can be significantly moderated.

Energy conservation, properly implemented, is fully compatible with economic growth, the development of new industries, and the creation of new jobs for American workers. Energy consumption need not be reduced in absolute terms; what is necessary is a slowing down in its rate of growth. By making adjustments in energy consumption now, the U.S. can avoid a possibly severe economic recession in the mid 1980's.

The U.S. has a clear choice. If a conservation program begins now, it can be carried out in a rational and orderly manner over a period of years. It can be moderate in scope, and can apply primarily to capital goods, such as homes and automobiles. If, however, conservation is delayed until world oil production approaches its capacity limitation, it will have to be carried out hastily under emergency conditions.

It will be sudden, and drastic in scope; and because there will not be time to wait for incremental changes in capital stock, conservation measures will have to cut much more deeply into patterns of behavior, disrupt the flow of goods and services, and reduce standards of living.

Pricing policies should encourage proper responses in both the consumption and the production of energy, without creating any windfall profits. *If users pay yesterday's prices for tomorrow's energy, U.S. resources will be rapidly exhausted. If producers were to receive tomorrow's prices for yesterday's discoveries, there would be an inequitable transfer of income from the American people to the producers, whose profits would be excessive and would bear little relation to actual economic contribution.*

Currently, Federal pricing policy encourages overconsumption of the scarcest fuels by artificially holding down prices. If, for example, the cost of expensive foreign oil is averaged with cheaper domestic oil, consumers overuse oil, and oil imports are subsidized and encouraged. Consumers are thus misled into believing that they can continue to obtain additional quantities of oil at less than its replacement cost.

Artificially low prices for some energy sources also distort interfuel competition. The artificially low price of natural gas, for example, has encouraged its use by industry and electric utilities, which could use coal, and in many areas has made gas unavailable for new households, which could make better use of its premium qualities.

These misguided Government policies must be changed. But neither Government policy nor market incentives can improve on nature and create additional oil or gas in the ground. From a long-term perspective, prices are an important influence on production and use. As long as energy consumers are misled into believing they can obtain energy cheaply, they will consume energy at a rate the U.S. cannot afford to sustain. Their continued overuse will make the nation's inevitable transition more drastic and difficult.

A national energy policy should encourage production. The energy industries need adequate incentives to develop *new* resources and are entitled to sufficient profits for exploration for *new* discoveries. But they should not be allowed to reap large windfall profits as a result of circumstances unrelated to the marketplace or their risk-taking.

The fourfold increase in world oil prices in 1973–74 and [illegible]cies of the oil-exporting countries should not be permitted to create unjustified profits for domestic producers at consumer's expense. By raising the world price of oil, the oil-exporting countries have increased the value of American oil in existing wells. That increase in value has not resulted from free market forces or from any risk-taking by U.S. producers. *National energy policy should capture the increase in oil value for the American people.* The distribution of the proceeds of higher prices among domestic producers and consumers must be equitable and economically efficient if the United States is to spread the cost fairly across the population and achieve its energy goals.

The pricing of oil and natural gas should reflect the economic fact that the true value of a depleting resource is the cost of replacing it. An effective pricing system would provide the price incentives that producers of oil and natural gas need by focusing on harder to find new supplies. The system should also moderate the adjustment that households will have to make to rising fuel costs. It should end the distortions of the intrastate-interstate distinction for new natural gas, which is a national resource. It should also promote conservation by raising the ultimate price of products made by energy-intensive processes.

Reasonable certainty and stability in Government policies are needed to enable consumers and producers of energy to make investment decisions. A comprehensive national energy plan should resolve a wide range of uncertainties that have impeded the orderly development of energy policy and projects. Some uncertainties are inherent in a market economy, and Government should not shelter industry from the normal risks of doing business. But Government should provide business and the public with a clear and consistent statement of its own policies, rules, and intentions so that intelligent private investment decisions can be made.

Resources in plentiful supply should be used more widely as part of a process of moderating use of those in short supply. Although coal comprises 90 percent of United States total fossil fuel reserves, the United States meets only 18 percent of its energy needs from coal. Seventy-five percent of energy needs are met by oil and natural gas although they account for less than 8 percent of U.S. reserves. This imbalance between reserves and consumption should be corrected by shifting industrial and utility consumption from oil and gas to coal and other abundant energy sources.

As industrial firms and utilities reduce their use of oil and gas, they will have to turn to coal and other fuels. The choices now for electric utilities are basically coal and nuclear power. Expanding future use of coal will depend in large part on the introduction of new technologies that permit it to be burned in an environmentally acceptable manner, in both power plants and factories. Efforts should also be made to develop and perfect processes for making gas from coal.

Light-water nuclear reactors, subject to strict regulation, can assist in meeting the United States energy deficit. The 63 nuclear plants operating today provide approximately 10 percent of U.S. electricity, about 3 percent of total energy output. That contribution could be significantly increased. The currently projected growth rate of nuclear energy is substantially below prior expectations due mainly to the recent drop in demand for electricity, labor problems, equipment delays, health and safety problems, lack of a publicly accepted waste disposal program, and concern over nuclear proliferation. The Government should ensure that risks from nuclear power are kept as low as humanly possible, and should also establish the framework for resolving problems and removing unnecessary delays in the nuclear licensing process.

To the extent that electricity is substituted for oil and gas, the total amounts of energy used in the country will be somewhat larger due to the inherent inefficiency of electricity generation and distribution. But conserving scarce oil and natural gas is far more important than saving coal.

Finally, *the use of nonconventional sources of energy must be vigorously expanded.* Relatively clean and inexhaustible sources of energy offer a hopeful prospect of supplementing conventional energy sources in this century and becoming major sources of energy in the next. Some of these nonconventional technologies permit decentralized production, and thus provide alternatives to large, central systems. Traditional forecasts of energy use assume that nonconventional resources, such as solar and geothermal energy, will play only a minor role in the United States energy future. Unless positive and creative actions are taken by Government and the private sector, these forecasts will become self-fulfilling prophecies. Other technologies that increase the efficiency of energy use should also be encouraged, such as cogeneration, the simultaneous production of industrial process steam and electricity.

A national energy plan cannot anticipate technological miracles. Even so, nonconventional technologies are not mere curiosities. Steady technological progress is likely, breakthroughs are possible, and the estimated potential of nonconventional energy sources can be expected to improve. Some nonconventional technologies are already being used, and with encouragement their use will grow. Because nonconventional energy sources have great promise, the Government should take all reasonable steps to foster and develop them.

The National Energy Plan is based on this conceptual approach. It contains a practical blend of economic incentives and disincentives as well as some regulatory measures. It strives to keep Government intrusion into the lives of American citizens to a minimum. It would return the fiscal surpluses of higher energy taxes to the American people.

Finally, the Plan sets forth goals for 1985 which, although ambitious, can be achieved with the willing cooperation of the American people. These goals are:

Reduce the annual growth of total energy demand to below 2 percent;

Reduce gasoline consumption 10 percent below its current level;

Reduce oil imports from a potential level of 16 million barrels per day to 6 million, roughly one-eighth of total energy consumption;

Establish a Strategic Petroleum Reserve of 1 billion barrels;

Increase coal production by two-thirds, to more than 1 billion tons per year;

Bring 90 percent of existing American homes and all new buildings up to minimum energy efficiency standards; and

Use solar energy in more than 2½ million homes.

The Plan would reverse the recent trend of ever-rising oil imports and ever-increasing American dependence on uncertain foreign sources of supply. It would prepare the United States for the time when the world faces a limitation on oil production capacity and consequent skyrocketing oil prices. It would achieve substantial energy savings through conservation and increased fuel efficiency, with minimal disruption to the economy, and would stimulate the use of coal in a manner consistent with environmental protection.

The United States is at a turning point. It can choose, through piecemeal programs and policies, to continue the current state of drift. That course would require no hard decisions, no immediate sacrifices, and no adjustment to the new energy realities. That course may, for the moment, seem attractive. But, with each passing day, the United States falls farther behind in solving its energy problems. Consequently, its economic and foreign policy position weakens, its options dwindle, and the ultimate transition to scarce oil supplies and much higher oil prices becomes more difficult. If the United States faces up to the energy problem now and adopts the National Energy Plan, it will have the precious opportunity to make effective use of time and resources before world oil production reaches its capacity limitation.

The energy crisis presents a challenge to the American people. If they respond with understanding, maturity, imagination, and their traditional ingenuity, the challenge will be met. Even the "sacrifices" involved in conservation will have their immediate rewards in lower fuel bills and the sense of accomplishment that comes with achieving higher efficiency. By preparing now for the energy situation of the 1980's, the U.S. will not merely avoid a future time of adversity. It will ensure that the coming years will be among the most creative and constructive in American history.

* * * * * * *

Chapter III.—Principles and Strategy of the National Energy Plan

Broad public understanding of the gravity of the energy problem, a commitment to action, and a willingness to endure some sacrifice are all indispensable to the success of a national energy plan. In the present circumstances, an energy plan that demanded nothing from the American people would be no energy plan at all, but merely a prescription for chaos at a later date.

Changes in energy demand and supply have long leadtimes and, therefore, the coming energy transition cannot be made overnight. For the transition to be made without serious economic and social disruptions, it will have to take place over a period of years. If the United States is to be prepared for the time when world oil production approaches its capacity limitation and then begins to level off, it must take action now.

The ultimate question is whether this society is willing to exercise the internal discipline to select and pursue a coherent set of policies well in advance of a threatened disaster. Western democracies have demonstrated such discipline in the past in reacting to immediate, palpable threats to survival, as in time of war. But they have had less success in harnessing their human and material resou[illegible] less visible a[illegible]ediate t[illegible]ats to their political and [illegible] systems. When dangers appear incrementally and the day of reckoning seems far in the future, democratic political leaders have been reluctant to take decisive and perhaps unpopular action. But such action will be required to meet the energy crisis. If the nation continues to drift, it will do so in an increasingly perilous sea.

PRINCIPLES

The principles set forth in this chapter provide a framework not only for present policies, but also for development of future policies. Planning is necessarily an ongoing process. The National Energy Plan will have to be adjusted continually as new experience and knowledge are gained, as government programs take effect, as new technologies develop, and as the world's political and economic circumstances change.

The following 10 principles divide into two groups. The first five establish the context in which energy policy must be formulated. The remaining five are fundamental to the proposed comprehensive National Energy Plan.

The first principle is that the energy problem can be effectively addressed only by a Government that accepts responsibility for dealing with it comprehensively, and by a public that understands its seriousness and is ready to make necessary sacrifices. The declining availability of oil and natural gas will affect virtually all energy prices and consumption patterns in the United States, for the various energy supplies are all part of an integrated energy market. Therefore, in this democratic society, a solution can be found only in comprehensive Government policy-making informed by public comment and supported by public understanding and action.

The Federal Government can pass laws and encourage action. State and local governments can play active roles. But this society can function at its best only when citizens voluntarily work together toward a commonly accepted goal. Washington can and must lead, but the nation's real energy policy will be made in every city, town and village in the country.

The second principle is that healthy economic growth must continue. It is an axiom of public policy that full employment be promoted. The energy problem can be solved without turning off or slowing down America's economic progress. In developing energy policy, measures should be designed to minimize adverse economic and fiscal consequences by returning to the economy funds collected to carry out energy policy. National energy policy can move toward economic rationality while protecting jobs, avoiding rampant inflation, and maintaining economic growth. Conservation initiatives, for example, not only contribute to productivity, but also create a large number of new jobs. Indeed, in the long run, the nation can continue to enjoy economic health only if it solves its energy problems.

The third principle is that national policies for the protection of the environment must be maintai[illegible] and [illegible] the qu[illegible] of [illegible] American peo[illegible]. It would be ironic if, in moving toward that objective, the nation unnecessarily degraded the quality of the environment and made this country and the planet a less healthful place in which to live.

Virtually every available source of energy has its disadvantages. Storage and combustion of hydrocarbons can pollute the air. Oil imports and drilling on the Outer Continental Shelf present a risk of spills. Strip mining of coal scars the landscape, and deep mining causes deaths through accidents and black lung disease; coal combustion also presents risks to health; liquefied natural gas poses safety problems, as do light-water nuclear reactors. In energy planning, it is necessary to recognize hazards and risks and to reduce them to relatively low levels.

In the long run, there is no insurmountable conflict between the twin objectives of meeting energy needs and protecting the quality of the environment. The energy crisis and environmental pollution both arose from wasteful use of resources and economic and social policies based on the assumption of unlimited and cheap resources. The solutions to many energy and environmental problems follow a parallel course of improving efficiency and harnessing waste for productive purposes.

The fourth principle is that the United States must reduce its vulnerability to potentially devastating supply interruptions. Although conserving energy in general is an important goal, conserving oil has an even higher priority. Continued high vulnerability to interruptions of foreign oil supply is unacceptable.

Considerations of national security, as well as the problem of funding ever-increasing balance of payments deficits, suggest rejection of any "solution" to the energy problem through unrestrained growth of oil imports. Continued growth of imports would erode the nation's economic security, promote dissension with allies, and jeopardize America's world leadership. Moreover, the time is approaching when world oil production will no longer be able to supply the United States with increasing levels of imports.

The solution to the problem of vulnerability does not lie in a crash program of production to achieve energy independence. There is no justification for massive, reckless development of all U.S. energy resources, depletion of critical domestic oil and gas reserves, pollution of the environment, draconian conservation measures, and rejection of the substantial economic benefits of oil imports, all in the name of energy independence.

An appropriate and far more sensible goal is relative invulnerability. The United States should be prepared to import foreign oil for a number of years because it is an available source of supply that does not deplete domestic resources. Through effective conservation and increased use of abundant domestic resources such as [illegible] can be reduced [illegible] A large [illegible] Petroleum Reserve [illegible] of oil, and contingency plans [illegible] to deter interruptions of foreign oil supply and protect the economy should an interruption occur.

The fifth principle is that the United States must solve its energy problems in a manner that is equitable to all regions, sectors, and income groups. No segment of the population should bear an unfair share of the total burden, and none should reap undue benefits from the nation's energy problems. In particular, the elderly, the poor, and those on fixed incomes should be protected from disproportionately adverse effects on their income. Energy is as necessary to life as food and shelter.

The energy industries need adequate incentives to develop new resources and are entitled to sufficient profits to encourage exploration and development of new finds. But they should not be allowed to reap large windfall profits as a result of circumstances not associated with either the marketplace or their risk-taking. The fourfold increase in world oil prices in 1973–74 and the policies of the oil-exporting countries should not be permitted to create unjustified profits for domestic producers at consumers' expense. By raising the world price of oil, the oil-exporting countries have increased the value of American oil in existing wells. National energy policy should capture that increase in value for the American people. However, where incentives are legitimately needed to stimulate new production, energy policy should allow adequate returns to producers. The distribution of the proceeds of higher prices among domestic producers and consumers must be equitable and economically efficient if the nation is to spread the costs fairly across the population and meet its energy goals.

Some regions of the country, particularly the Gulf Coast States and Appalachia, are large energy producers. Other regions, such as the Rocky Mountain and Great Plains States, have large energy resources which have not yet been extensively developed. And still other regions, such as New England and California, import most of their energy from other regions and other nations. The Plan must assure that policies are equitable across the country, and that the special needs of each region are met. Prices for energy should be reasonably uniform to prevent economic dislocations and unjustified variations in consumer costs.

The environmental quality of producing States and States with untapped resources should be protected by strict standards effectively enforced. Producing States should be fairly compensated, and consuming States should be assured a fair share of energy supplies at reasonable prices.

The Federal Government can enact national policies to further these goals, and can recognize that the States also have important responsibilities for the formulation and execution of energy policy. But States within the various regions must also accept their share of the responsibility for national equity if the U.S. is to avoid "energy Balkanization." It would be desirable for States to develop energy policies that complement the Plan while meeting local and regional needs.

The sixth principle, and the cornerstone of National Energy Policy, is that the growth of energy demand must be restrained through conservation and improved energy efficiency. Conservation and improvement in energy efficiency is the most practical course of action for the United States and for the nations of the world. Conservation is cheaper than production of new energy supplies, and is the most effective means for protection of the environment.

Conservation and improved efficiency can lead to quick results. A significant percentage of poorly insulated homes in the United States could be brought up to strict fuel efficiency standards in less time than it now takes to design, license, and build one nuclear powerplant.

Although conservation measures are inexpensive and clean compared with energy production, they do involve sacrifice and are sometimes difficult to implement. If automobiles are to be made lighter and less powerful, the American people must accept some sacrifice in comfort and horsepower. If industry is required to make energy-saving investments and to pay taxes on the use of scarce fuels, there will be some increases in the cost of consumer products. These sacrifices, however, need not result in major changes in the American way of life or in a reduced standard of living. Automobile fuel efficiency can be greatly improved through better design of cars, and thus gasoline consumption could be significantly reduced without inhibiting Americans' ability to travel. With improved energy efficiency, the impact of rising energy prices can be significantly moderated. Energy conservation, properly implemented, is fully compatible with economic growth, the development of new industries, and the creation of new jobs for American workers. Energy consumption need not be reduced in absolute terms; what is necessary is a slowing down in its rate of growth.

If a conservation program is instituted now, it can be carried out in a rational and orderly manner over a period of several years. It can be moderate in scope, and can apply primarily to capital goods, such as homes, automobiles, factories, equipment, and appliances. If, however, conservation is delayed until world oil production approaches its capacity limitation, it will have to be carried out hastily under emergency conditions. It will then be drastic; and, because there will not be time to wait for incremental changes in capital stock, conservation measures will have to cut much more deeply into patterns of behavior, disrupt the flow of goods and services, and reduce standards of living.

Finally, conservation in America can contribute to international stability by moderating the growing pressure on world oil resources. Indeed, reduction of America's demand for world oil would be a form of assistance to the developing countries.

The seventh principle underlying the National Energy Plan is that energy prices should generally reflect the true replacement cost of energy. Energy prices should move toward a level that reflects the true value of energy in order for market signals to work in harmony with conservation policy. When the cost of expensive foreign oil is averaged with cheaper domestic oil, consumers overuse oil. Government policy that promotes overuse by artificially holding down prices misleads consumers into believing that they can continue to obtain additional quantities of oil at less than its replacement cost.

Artificially low prices for particular energy sources also distort interfuel competition. The artificially low price of natural gas, for example, has encouraged its use by industry and electric utilities, which could use coal, and has made gas unavailable for new households, which could make better use of its premium qualities.

Neither Government policy nor market incentives can create additional oil or gas in the ground. But from a long-term perspective, prices are an important influence on production and use. As long as energy consumers are enticed into believing that they can continue to pay yesterday's prices for tomorrow's energy, they will continue to use more energy than the nation can really afford, U.S. resources will be rapidly exhausted, and continued overuse will make the inevitable transition more sudden and difficult.

Although producers need incentives for exploration and new development, pricing policies should not give them windfall profits unrelated to their economic contribution. If producers were to receive tomorrow's prices for yesterday's discoveries, there would be an inequitable transfer of income from the American people to the oil and gas producers, and producers' profits would be excessive.

The eighth principle is that both energy producers and consumers are entitled to reasonable certainty as to Government policy. An inadequately organized Federal Government, conflicting signals from different Federal agencies, and unwieldy and confusing regulatory procedures have resulted in major bottlenecks in the development of energy resources. The Plan should resolve a wide range of uncertainties that have impeded the orderly development of energy policy and projects. Some uncertainties are inherent in a market economy, and Government cannot and should not shelter industry from the normal risks of doing business. But Government can and should provide business and the public with a clear and consistent statement of its own policies, rules, and intentions, so that intelligent private investment decisions can be made. In order to be able to provide certainty and consistency in energy policy-making, the Federal energy agencies should be organized into a Department of Energy.

The ninth principle is that resources in plentiful supply must be used more widely, and the nation must begin the process of moderating its use of those in short supply. Although coal comprises 90 percent of domestic fossil fuel reserves, the United States meets only 18 percent of its energy needs from coal. Seventy-five percent of energy needs are met by oil and natural gas although they account for less than 8 percent of U.S. reserves. This imbalance between reserves and consumption should be corrected by shifting from oil and gas to coal and other domestic energy sources.

If the United States is to preserve its scarce reserves of oil and gas and still reduce the growth of imports, policies must be forged to reduce consumption of oil and gas, particularly by automobiles, industry, and electric utilities. As industry reduces its use of oil and gas, it will have to turn to coal and other fuels. The choices for electric utilities for the foreseeable future will be coal and nuclear power.

Expanding future use of coal will depend in large part on the introduction of new technologies that permit it to be burned in an environmentally acceptable manner in both power plants and factories, for electricity, for process steam, and for heat. Efforts must also be made to perfect processes for low Btu gasification of coal and to develop new technologies for advanced high Btu gasification.

Light-water nuclear reactors, subject to strict regulation, can assist in meeting the nation's total net energy deficit. The 63 nuclear plants operating today provide approximately 10 percent of U.S. electricity, about 3 percent of total energy consumed. That contribution could be significantly increased. The currently projected growth rate of nuclear energy is substantially below prior expectations due mainly to the recent drop in demand for electricity, labor problems, equipment delays, health and safety problems, lack of a publicly accepted waste disposal program, and concern over nuclear proliferation. The Government should ensure that risks from nuclear power are kept as low as possible, and should also resolve problems and unnecessary delays in the nuclear licensing process.

To the extent that electricity from coal is substituted for oil and gas, the total amounts of energy used in the country will be somewhat larger due to the inherent inefficiency of electricity generation and distribution. But conserving scarce oil and natural gas is more important than saving coal.

The tenth principle is that the use of nonconventional sources of energy must be vigorously expanded. Relatively clean and inexhaustible sources of energy are a hopeful prospect, as supplements to conventional energy resources in this century, and as major sources of energy in the next. Many of these sources permit decentralized production, and thus provide alternatives to large, central systems. Traditional forecasts of energy use assume that nonconventional resources, such as solar and geothermal energy, will play only a minor role in the energy future. Unless positive and creative actions are taken by Government and the private sector, these forecasts will become self-fulfilling prophecies. Other technologies that increase efficiency of energy use, such as cogeneration of industrial process steam and electricity, should also be encouraged.

The Plan should not be premised on technological miracles. But nonconventional technologies are not mere curiosities. Steady technological progress is likely, breakthroughs are possible, and the estimated potential of nonconventional energy sources can be expected to improve. Many nonconventional technologies are already being used, and with encouragement their use will grow. Because nonconventional energy sources have great promise, the Government should take all reasonable steps to foster and develop them.

THE BROAD PERSPECTIVE

The U.S. has three overriding energy objectives. As an immediate objective, which will become even more important in the future, the U.S. must reduce its dependence on foreign oil to limit its vulnerability to supply interruptions. In the medium term, the U.S. must weather the stringency in world oil supply that will be caused by limitations on productive capacities. In the long term, the U.S. must have renewable and essentially inexhaustible sources of energy for sustained economic growth. The strategy of the Plan contains three major components to achieve these objectives.

First, by carrying out an effective conservation program in all sectors of energy use, through reform of utility rate structures, and by making energy prices reflect true replacement costs, the nation should reduce the annual rate of growth of demand to less than 2 percent. That reduction would help achieve both the immediate and the medium-term goals. It would reduce vulnerability and prepare the nation's stock of capital goods for the time when world oil production will approach capacity limitations.

Second, industries and utilities using oil and natural gas should convert to coal and other abundant fuels. Substitution of other fuels for oil and gas would reduce imports and make gas more widely available for household use. An effective conversion program would thus contribute to meeting both the immediate and the medium-term goals.

Third, the nation should pursue a vigorous research and development program to provide renewable and other resources to meet U.S. energy needs in the next century. The Federal Government should support a variety of energy alternatives in their early stages, and continue support through the development and demonstration stage for technologies that are technically, economically, and environmentally most promising.

The Plan seeks to achieve the overriding objectives by other means as well. To reduce vulnerability, the Strategic Petroleum Reserve should be expanded, foreign sources of oil should be diversified, and contingency plans should be put in place. To help weather the approaching capacity limitations on world oil production, incentives should be provided to encourage new production in Alaska, on the Outer Continental Shelf, and from advanced recovery techniques. Potential new sources of gas hold great promise and should be developed. Conversion from oil and gas to coal should be facilitated by development of more environmentally acceptable methods for using coal.

The 10 principles of the National Energy Plan provide a realistic framework for these actions. By pursuing conservation, bringing energy prices into line with replacement costs, and expanding the use of coal, the U.S. can reduce oil imports to an acceptable level and prepare for the coming stringency in oil supplies. Backed by a large Strategic Petroleum Reserve, a more diversified set of foreign oil suppliers, and contingency plans, the United States can reduce its vulnerability to supply interruptions to an acceptable level. Measures can be designed to assure that American workers, the poor, and the elderly do not suffer as a result of rising prices. Economic growth can be promoted and inflationary pressures kept within bounds. Regional and environmental imbalances can be recognized and corrected with maximum equity. And nonconventional sources of energy can be promoted to meet long-term needs.

The United States is at a turning point. It can choose, through piecemeal programs and policies, to continue the current state of drift. That course would require no hard decisions, no immediate sacrifices, and no adjustment to the new energy realities. That course may, for the moment, seem attractive. But, with each passing day, the nation falls farther behind in solving its energy problems. Consequently, its economic and foreign policy position weakens, its options dwindle, and the ultimate transition to stringency in oil supplies and higher oil prices becomes more difficult.

An alternative to continued drift is the comprehensive National Energy Plan.

SUMMARY OF THE NATIONAL ENERGY PLAN

Conservation

In the transportation sector, the Plan proposes the following major initiatives to reduce demand:

a graduated excise tax on new automobiles with fuel efficiency below the fleet average levels required under current legislation; the taxes would be returned through rebates on automobiles that meet or do better than the required fleet averages and through rebates on all electric automobiles;

a standby gasoline tax, to take effect if total national gasoline consumption exceeds stated annual targets; the tax would begin at 5 cents per gallon, and could rise to 50 cents per gallon in 10 years if targets were repeatedly exceeded by large or increasing amounts; the tax would decrease if a target were met; taxes collected would be returned to the public through the income tax system and transfer payment programs; States would be compensated for lost gasoline tax revenues through sources such as the Highway Trust Fund;

fuel efficiency standards and a graduated excise tax and rebate system for light-duty trucks;

removal of the Federal excise tax on intercity buses;

increase in excise tax for general aviation fuel, and elimination of the existing Federal excise tax preference for motorboat fuel;

improvement in the fuel efficiency of the Federal automobile fleet, and initiation of a vanpooling program for Federal employees.

To reduce waste of energy in existing buildings, the Plan proposes a major program containing the following elements:

a tax credit of 25 percent of the first $800 and 15 percent of the next $1,400 spent on approved residential conservation measures;

a requirement that regulated utilities offer their residential customers a "turnkey" insulation service, with payment to be made through monthly bills; other fuel supplies would be encouraged to offer a similar service;

facilitating residential conservation loans through opening of a secondary market for such loans;

increased funding for the current weatherization program for low-income households;

a rural home conservation loan program;

a 10 percent tax credit (in addition to the existing investment tax credit) for business investments in approved conservation measures;

a Federal grant program to assist public and non-profit schools and hospitals to insulate their buildings;

inclusion of conservation measures for State and local government buildings in the Local Public Works Program.

The development of mandatory energy efficiency standards for new buildings will be accelerated. In addition, the Federal Government will undertake a major program to increase the efficiency of its own buildings.

The Plan proposes the establishment of mandatory minimum energy efficiency standards for major appliances, such as furnaces, air conditioners, water heaters, and refrigerators.

The Plan proposes to remove major institutional barriers to co-generation, the simultaneous production of process steam and electricity by industrial firms or utilities, and to provide an additional 10 percent tax credit for investment in cogeneration equipment. Encouragement will also be given to district heating, and the Energy Research and Development Administration (ERDA) will undertake a study to determine the feasibility of a district heating demonstration program at its own facilities.

To promote further industrial conservation and improvements in industrial fuel efficiency, an additional 10 percent tax credit for energy-saving investments would be available for certain types of equipment (including equipment for use of solar energy) as well as conservation retrofits of buildings.

The Plan also contains a program for utility reform, with the following elements:

a phasing out of promotional, declining block, and other electric utility rates that do not reflect cost incidence; declining block rates for natural gas would also be phased out;

a requirement that electric utilities either offer daily off-peak rates to customers willing to pay metering costs or provide a direct load management system;

a requirement that electric utilities offer customers interruptible service at reduced rates;

a prohibition of master metering in most new structures;

a prohibition of discrimination by electric utilities against solar and other renewable energy sources;

Federal authority to require additional reforms of gas utility rates;

Federal Power Commission (FPC) authority to require interconnections and power pooling between utilities even if they are not now subject to FPC jurisdiction, and to require wheeling [third party transmission].

Oil and Natural Gas

Government policy should provide for prices that encourage development of new fields and a more rational pattern of distribution; but it should also prevent windfall profits. It should promote conservation by confronting oil and gas users with more realistic prices, particularly for those sectors of the economy where changes can be made without hardship. To promote these ends, the Plan proposes a new system for pricing oil and natural gas.

The proposal for oil pricing contains the following major elements:

price controls would be extended:

newly discovered oil would be allowed to rise over a 3 year period to the 1977 world price, adjusted to keep pace with the domestic price level: thereafter, the price of newly discovered oil would be adjusted for domestic price increases;

the incentive price for "new oil" would be applicable to oil produced from an onshore well more than 2½ miles from an existing well, or from a well more than 1,000 feet deeper than any existing well within a $2\frac{1}{2}$ mile radius; the incentive price would be applicable to oil from Federal offshore leases issued after April 20, 1977;

the current $5.25 and $11.28 price ceilings for previously discovered oil would be allowed to rise at the rate of domestic price increases;

stripper wells and incremental tertiary recovery from old fields would receive the world price;

all domestic oil would become subject in three stages to a crude oil equalization tax equal to the difference between its controlled domestic price and the world oil price; the tax would increase with the world price, except that authority would exist to discontinue an increase if the world price rose significantly faster than the general level of domestic prices;

net revenues from the tax would be entirely returned to the economy: residential consumers of fuel oil would receive a dollar-for-dollar rebate, and the remaining funds would be returned to individuals through the income tax system and transfer payment programs;

once the wellhead tax is fully in effect, the entitlements program would be terminated, along with certain related activities, but would be retained on a standby basis.

The proposal for natural gas pricing contains the following major provisions:

all new gas sold anywhere in the country from new reservoirs would be subject to a price limitation at the Btu equivalent of the average refiner acquisition cost (before tax) of all domestic crude oil;

that price limitation would be approximately $1.75 per thousand cubic feet (Mcf) at the beginning of 1978; the interstate-intrastate distinction would disappear for new gas;

new gas would be defined by the same standards used to define new oil;

currently flowing natural gas would be guaranteed price certainty at current levels, with adjustments to reflect domestic price increases;

authority would exist to establish higher incentive pricing levels for specific categories of high-cost gas, for example, from deep drilling, geopressurized zones and tight formations;

gas made available at the expiration of existing interstate contracts or by production from existing reservoirs in excess of contracted volumes would qualify for a price no higher than the current $1.42 per Mcf ceiling; gas made available under the same circumstances from existing intrastate production would qualify for the same price as new gas;

the cost of the more expensive new gas would be allocated initially to industrial rather than residential or commercial users;

Federal jurisdiction would be extended to certain synthetic natural gas facilities;

taxes would be levied on industrial and utility users of oil and natural gas to encourage conservation and conversion to coal or other energy sources.

The Plan contains the following additional proposals for oil and natural gas:

to encourage full development of the oil resources of Alaska, Alaskan oil from existing wells would be subject to the $11.28 upper tier wellhead price and would be treated as uncontrolled oil for purposes of the entitlements program; new Alaskan oil finds would be subject to the new oil wellhead price;

production from Elk Hills Naval Petroleum Reserve would be limited to a ready reserve level at least until the west-to-east transportation systems for moving the surplus Alaskan oil are in place or until California refineries have completed a major retrofit program to enable more Alaskan oil to be used in California;

the Outer Continental Shelf Lands Act would be amended to require a more flexible leasing program using bidding systems that enhance competition, to assure a fair return to the public, and to assure full development of the OCS resources;

shale oil will be entitled to the world oil price;

the guidelines established by the Energy Resources Council in the previous administration would be replaced by a more flexible policy: projects for importation of liquified natural gas (LNG) should be analyzed on a case-by-case basis with respect to the reliability of the selling country, the degree of American dependence the project would create, the safety conditions associated with any specific installation and all costs involved; imported LNG would not be concentrated in any one region; new LNG tanker docks would be prohibited in densely populated areas;

Federal programs for development of gas from geopressurized zones and Devonian shale would be expanded;

the Administration hopes to eliminate gasoline price controls and allocation regulations next fall; to maintain competition among marketers, it supports legislation similar to the pending "dealer day in court" bill;

as part of the extension of oil and natural gas price controls, the Administration would urge that independent producers receive the same tax treatment of intangible drilling costs as their corporate competitiors;

a Presidential Commission will study and make recommendations concerning the national energy transportation system.

To provide relative invulnerability from another interruption of foreign oil supply, the Strategic Petroleum Reserve will be expanded to 1 billion barrels; efforts will be made to diversify sources of oil imports; contingency plans will be transmitted to the Congress; and development of additional contingency plans will be accelerated.

Coal

Conversion by industry and utilities to coal and other fuels would be encouraged by taxes on the use of oil and natural gas.

The Plan also contains a strong regulatory program that would prohibit all new utility and industrial boilers from burning oil or natural gas, except under extraordinary conditions. Authority would also exist to prohibit the burning of oil or gas in new facilities other than boilers. Existing facilities with coal-burning capability would generally be prohibited from burning oil and gas. Permits would be required for any conversion to oil or gas rather than to coal. By 1990, virtually no utilities would be permitted to burn natural gas.

While promoting greater use of coal, the Administration will seek to achieve continued improvement in environmental quality. A strong, but consistent and certain, environmental policy can provide the confidence industry needs to make investments in energy facilities. The Administration's policy would:

require installation of the best available control technology in all new coal-fired plants, including those that burn low sulfur coal;

protect areas where the air is still clean from significant deterioration;

encourage States to classify lands to protect against significant deterioration within 3 years after enactment of Clean Air Act amendments;

require Governors to announce intent to change the classification of allowable air quality for a given area within 120 days after an application is made to construct a new source in that area;

require States to approve or disapprove the application within 1 year thereafter.

Further study is needed of the Environmental Protection Agency's policies allowing offsetting pollution trade-offs for new installations. A committee will study the health effects of increased coal production and use, and the environmental constraints on coal mining and on the construction of new coal-burning facilities. A study will also be made of the long-term effects of carbon dioxide from coal and other hydrocarbons on the atmosphere.

The Administration supports uniform national strip mining legislation.

An expansion is proposed for the Government's coal research and development program. The highest immediate priority is development of more effective and economic methods to meet air pollution control standards. The program will include research on:

air pollution control systems;
fluidized bed combustion systems;
coal cleaning systems;
solvent refined coal processes;
low Btu gasification processes;
advanced high Btu gasification processes;
synthetic liquids technology;
coal-mining technology.

Nuclear Power

It is the President's policy to defer any U.S. commitment to advanced nuclear technologies that are based on the use of plutonium while the United States seeks a better approach to the next generation of nuclear power than is provided by plutonium recycle and the plutonium breeder. The U.S. will defer indefinitely commercial reprocessing and recycling of plutonium. The President has proposed to reduce the funding for the existing breeder program, and to redirect it toward evaluation of alternative breeders, advanced converter reactors, and other fuel cycles, with emphasis on nonproliferation and safety concerns. He has also called for cancellation of construction of the Clinch River Breeder Reactor Demonstration Project and all component construction, licensing, and commercialization efforts.

To encourage other nations to pause in their development of plutonium-based technology, the United States should seek to restore confidence in its willingness and ability to supply enrichment services. The United States will reopen the order books for U.S. uranium enrichment services, and will expand its enrichment capacity by building an energy-efficient centrifuge plant. The President is also proposing legislation to guarantee the delivery of enrichment services to any country that shares U.S. nonproliferation objectives and accepts conditions consistent with those objectives.

To resolve uncertainties about the extent of domestic uranium resources, ERDA will reorient its National Uranium Resources Evaluation Program to improve uranium resources assessment. The program will also include an assessment of thorium resources.

The United States has the option of relying on light-water reactors to provide nuclear power to meet a share of its energy deficit. To enhance the safe use of light-water reactors:

the Nuclear Regulatory Commission (NRC) has already increased the required number of guards at nuclear plants and the requirements for the training that guards receive;

the President is requesting that the NRC expand its audit and inspection staff to increase the number of unannounced inspections and to assign one permanent Federal inspector to each nuclear power plant;

the President is requesting that the Commission make mandatory the current voluntary reporting of minor mishaps and component failures at operating reactors;

the President is requesting that the NRC develop firm siting criteria with clear guidelines to prevent siting of nuclear plants in densely populated locations, in valuable natural areas, or in potentially hazardous regions.

The President has directed that a study be made of the entire nuclear licensing process. He has proposed that reasonable and objective criteria be established for licensing and that plants which are based on a standard design not require extensive individual licensing.

To ensure that adequate waste storage facilities are available by 1985, ERDA's waste management program has been expanded to include development of techniques for long-term storage of spent fuel. Also, a task force will review ERDA's waste management program. Moreover, improved methods of storing spent fuel will enable most utilities at least to double their current storage capacity without constructing new facilities.

Hydroelectric Power

The Department of Defense (Corps of Engineers), together with other responsible agencies, will report on the potential for installation of additional hydroelectric generating capacity at existing dams throughout the country.

Nonconventional Resources

America's hope for long-term economic growth beyond the year 2000 rests in large measure on renewable and essentially inexhaustible sources of energy. The Federal Government should aggressively promote the development of technologies to use these resources.

Solar Energy

Solar hot water and space heating technology is now being used and is ready for widespread commercialization. To stimulate the development of a large solar market, a tax credit is proposed. The credit would start at 40 percent of the first $1,000 and 25 percent of the next $6,400 paid for qualifying solar equipment. The credit would decline in stages to 25 percent of the first $1,000 and 15 percent of the next $6,400. The credit would be supported by a joint Federal-State program of standards development, certification, training, information gathering, and public education. Solar equipment used by business and industry would be eligible for an additional 10 percent investment tax credit for energy conservation measures.

Geothermal Energy

Geothermal energy is a significant potential energy source. The tax deduction for intangible drilling costs now available for oil and gas drilling would be extended to geothermal drilling.

Research, Development and Demonstration

An effective Federal research, development and demonstration program is indispensable for the production of new energy sources. The Federal Government should support many research options in their early stages, but continue support into the later stages only for those that meet technical, economic, national security, health, safety, and environmental criteria. Research and development should be accompanied by preparation for commercialization so that successful projects can rapidly be put to practical use.

Additional research, development and demonstration initiatives are proposed, with emphasis on small, dispersed and environmentally sound energy systems.

An Office of Small-Scale Technologies would be established to fund small, innovative energy research and development projects. The office would enable individual inventors and small businesses to contribute to the national energy research and development effort.

Information

A three-part energy information program is proposed. A Petroleum Production and Reserve Information System would provide the Federal Government with detailed, audited data on petroleum reserve estimates and production levels. A Petroleum Company Financial Data System would require all large companies and a sample of small firms engaged in crude oil or natural gas production to submit detailed financial information to the Federal Government. Data required from integrated companies would permit evaluation of the performance of their various segments by providing vertical accountability. An Emergency Management Information System would provide the Federal and State governments with information needed to respond to energy emergencies.

Competition

Effective competition in the energy industries is a matter of vital concern. The Under Secretary for policy and evaluation in the proposed Department of Energy would be responsible for making certain that policies and programs of the Department promote competition. Although at this time it does not appear necessary to proceed with new legislation for either horizontal or vertical divestiture of the major oil companies, their performance will be monitored. The proposed information program would greatly assist that effort.

A present anomaly in the availability of the tax deduction for intangible drilling costs within the oil industry would be removed as part of the program for extending oil and natural gas price controls.

Emergency Assistance for Low-Income Persons

Existing emergency assistance programs are deficient in assisting low-income persons to meet sharp, temporary increases in energy costs due to shortages or severe winters. A redesigned program will be completed promptly and submitted to the Congress.

U.S. NATIONAL ENERGY POLICY: THE FEDERAL ROLE *

(By Frances A. Gulick [1])

INTRODUCTION

It has become customary to note the fact that there is no comprehensive, coordinated statement of U.S. energy policy and no comprehensive coordinated Federal energy program. More than sixty Federal agencies with multiple counterparts at regional, State and local levels wield a wide range of authorities under an even wider range of laws and regulations. Collectively, their operations make up the legal environment within which the Nation's total energy supplies are being produced and consumed, although their collective laws and regulations have not been formally codified in any statement of energy policy.

The lack of a comprehensive policy statement or a coordinated Federal program does not mean, however, that the United States has not had a Federal energy policy in the past. On the contrary, there was a national energy policy based on a broad consensus. It was fairly specific, fairly clear cut, and it operated over the past half century under widely accepted assumptions and under broad bipartisan Federal and State legislation, endorsement and support.

That policy has been to rely to the maximum degree on private enterprise to make the major investment, development, and pricing decisions affecting energy supply, to thus deliberately delegate to the private sector authority and responsibility for determining the evolving shape and direction and content of national energy policy as a whole.

TWO STATEMENTS OF U.S. ENERGY POLICY

One of the more articulate statements of this policy was presented by J. Cordell Moore, then Assistant Secretary of the U.S. Department of the Interior, to the Energy Committee of the Organization for Economic Cooperation and Development (OECD) in January 1967:

> The very core of U.S. energy policy is that industry is responsible for production, distribution, marketing, and pricing, except in markets where fair prices cannot be guaranteed by competition, such as, for example, gas and electricity in interstate commerce. The Federal Government attempts to establish a climate favorable for the growth of the energy industries. It tries to stimulate initiative, to help advance technology, and to encourage and maintain competition. It moni-

*Appearing in Project Interdependence: U.S. and World Energy Outlook Through 1990, A Report prepared by the Congressional Research Service printed for the use of the Committees on Interstate and Foreign Commerce, U.S. House of Representatives, and Energy and Natural Resources, Commerce, Science and Transportation, U.S. Senate. November 1977, pp. 99–107.

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tors the overall energy situation to be sure that the national security and the broad interests of the public are protected, it applies constraints to the operations of the private sector where the public interest so requires, and it makes liberal use of the instrument of persuasion at times to influence the course followed by the private sector. But the Federal Government does not control production, it does not direct the efforts of industry, and it does not involve itself in company affairs. Even in the regulatory field its posture is mainly reactive rather than positive. Information on costs, reserves, processes, and plans is generally closely guarded by the companies and they are not required to divulge it * * *. I stress our lack of authoritative knowledge concerning these matters because it is a basic part of our policy, and contrasts, I am sure, with the situation in nations in which the energy industries are nationalized.

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In stressing * * * the lack of direct U.S. Government control over many aspects of our energy situation, I am outlining the essence of American energy policy and strategy. We try to achieve our objectives in the energy field by stimulating initiative in the private sector rather than by directing it or doing the work ourselves. We limit regulatory measures to areas where our objecives cannot be achieved by competition. And we attempt to avoid protective and other measures that add to cost, seeking instead to solve long-range problems of security of supply, cost, and other objectives through technologic advance.[2]

This interpretation of the Federal energy role as subordinate to the decisions of the private sector was rearticulated in similar terms in the Report of the President to Congress on "The Organization of Federal Energy Functions," issued in January 1977 on the eve of the inauguration of a new Administration:

While there has been a significant increase of Federal activity in and influence on the national energy system, the private sector continues to play the dominant role in the functioning of the complex series of economic activities which constitute the total national energy system. However, as in other sectors of the market, there are imperfections in the energy markets, both national and international; there are social costs related to the production, transportation, and use of various fuels that are not reflected in the market prices of those fuels; and there are national security interests to be safeguarded. Therefore, the Federal Government is required to carry out a significant number of functions and roles in concert with or in supplementation of the activities of private firms and consumers which participate in the energy system.

Intensive R. & D. programs have been launched in pursuit of various national goals, such as the defense effort, space exploration, and overcoming disease. The goal of energy R. & D. and technology development is improved energy conservation and new and improved supply sources. Unlike the defense and space programs, however, the consumer of the energy technology produced by governmental assistance is the private sector. In short, the Federal energy R. & D. program is aimed at enhancing energy technology utilized by the private sector.

The role of the Federal Government in energy RD&D is supplementary: to do what cannot be or is not being done by the private sector. Government can establish an appropriate policy climate for private sector action, share risks with the private sector, and conduct complementary RD&D programs. The assumption is that the private sector is prepared to take risks, has the inherent flexibility to act, controls the major share of new investment funds, and possesses the necessary managerial capabilities for carrying out most of the RD&D and virtually all of technology introduction. Generally, market forces will determine the economically optimum mix of alternative energy technologies. In some situations, the Government's regulatory role greatly affects the introduction of technologies. For example, changed Government price regulations on oil and gas could make conservation technologies and more expensive enhanced-recovery

[2] "Part I: Observations on United States Energy Policy," a paper dated Nov. 1, 1966, prepared as background for the Confrontation on U.S. Energy Policy for the 11th session of the Energy Committee of the OECD in Paris, Jan. 26–27, 1967; and "Part II: Some Distinguishing Features of United States Energy Policy," his opening remarks at the session on Jan. 26, 1967. Texts reprinted in Senate Interior Committee Print, No. 93–43 (92–76). Energy Policy Papers, 1974, pp. 321–353.

techniques for oil and gas more attractive. Similarly, changing regulation or nuclear plants and other major installations, within acceptable safety standards, could speed construction and lower the cost of the technologies.[3]

BASIC ENERGY POLICY ASSUMPTIONS

Central among the basic assumptions on which this national energy policy has been based have been the following which relate to domestic energy supplies and to domestic energy prices and pricing policy:

There are and will be sufficient domestic energy supplies, available in acceptable quantity and form, to meet the country's present and foreseeable expanding economic needs.

These energy supplies can, and should, be made available at the lowest possible costs and prices, consistent with reliability of supply. Consumer choice among various kinds of fuels can be counted on to produce competition among supplies which in turn will provide incentive to keep energy prices low.

RELATIVE ROLE OF THE PRIVATE AND PUBLIC SECTOR

The relative roles of the private and public sector in framing and regulating resultant national energy policy flow from these two assumptions. Simply stated they are:

Private enterprise can, and should, be relied on to the maximum degree to explore, produce, distribute, market, and price an evolving blend of fuels.

Federal intervention in this process should, and can, be strictly limited to measures which would maintain a business and regulatory environment conducive to abundant and low cost energy and to provide a leading role in financing research in new energy technologies. It should be essentially residual, operating in the interest of and supporting the efforts of private enterprise.

It is certainly true that this limited Federal role has taken highly visible form. In addition to such readily identifiable functions as regulation of natural gas and utility rates, the Federal Government has pioneered in development of hydroelectric power and in development and demonstration of nuclear energy and in production of enriched uranium for nuclear fuel. Statistically, however, production in Federal facilities amounts to only a small fraction of total civilian electrical suppies; still less than 3 percent in 1976, mainly in the form of electric power from hydroelectric stations. TVA, the Corps of Engineers, and the Bureau of Reclamation produce and market power from both thermal and hydro sources. The Nuclear Regulatory Commission controls the imports and exports of uranium, thorium, and other fissionable materials. ERDA manufactures and markets enriched uranium and may have to provide long-term management for highly radioactive nuclear wastes. All of the electricity from nuclear power plants in the United States that are fueled with enriched uranium, therefore, depend on the Federal Government for this necessary fuel supply. As landlord, the Federal Government wields significant power,

[3] The Organization of Federal Energy Functions. Message from The President of the United States, transmitting his recommendations for the Reorganization of Federal Energy and Natural Resources Activities, pursuant to sec. 162(b) of the Energy Conservation and Production Act of 1976, Jan. 12, 1977. Issued as House Document No. 95–43, 95th Cong., 1st Sess., pp. 10, 33.

owning—and leasing to the private sector—about 34 percent of the total land area. The mineral rights to an even larger area, including the Outer Continental Shelf, are also under Federal control.

Nevertheless, as measured by both the proportion of energy produced and marketed and by the intent of the policy, the Federal role in and control over the development of energy policies and patterns of use has been deliberately subordinated to the concept of least feasible interference with market decision and maximum reliance on private initiative and enterprise.

Liberal tax incentives such as extensive depletion allowances for energy extraction and provisions allowing generous expensing of exploration costs had been regularly reenacted with only minor changes for nearly sixty years before the changes reflected in the Tax Reduction Act of 1975, Public Law 94–12, signed March 29, 1975.[4]

Similarly, Congresses of varying political persuasions have regularly reaffirmed support of the Interstate Compact to Conserve Oil and Gas,[5] an endorsement which since its first enactment in 1935 has served to reinforce the intent to rely on State laws promoting energy conservation and market stability by, among other measures, encouraging adjustment of supply to demand through prorating of production among the private producers of oil and natural gas.

An examination of energy related Federal laws and directives through 1973 confirms this relatively self-limiting Federal role in energy policy formulation.

A compilation of Federal laws relating to fuel and energy resources, prepared for the House Committee on Interior and Insular Affairs and issued in December 1972, reviewed and reprinted the energy-related sections of some 40 major laws, collating them by agency, and concluded:

> If nothing more, arranging these laws by administering agency serves to underscore both the large number of agencies and other offices having some responsibility in the energy field, and the lack of central control over energy policy.[6]

The result has been that, with very few exceptions the major substantive national energy policy decisions—decisions which are now the object of tumultuous congressional reconsideration—were deliberately made the responsibility of the private sector.

These critical responsibilities, accepted and energetically exercised by the private sector, shaped national patterns of energy production and use in such fundamental policy vectors as: The amount and direction of energy investment; the extent and location of exploration; the volume and rate of production; the direction and mode of distribution; the relative mix among various fuels; decisions on prices at wholesale and retail level; and the degree of national dependence on imported fuels.

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[4] In addition to a number of changes which reduce exemptions involving foreign income, this law repealed the 22 percent depletion allowance in its entirety for all major oil and natural gas producers, identified as those producing more than 2,000 barrels of oil per day, or 12 million cubic feet of natural gas per day postponing its abolition for independent companies who do not have retail outlets and produce less than these amounts, on a graduated schedule until 1984. The depletion allowance was continued for other extractive fuels.

[5] Most recently, in S.J. Res. 126, to extend the compact through Dec. 31, 1978, which passed the Senate Mr. 4, 1976. See "Interstate Oil Compact Extension," Hearing before the Senate Committee on Interior and Insular Affairs, 94th Cong., second sess., on S.J. Res. 126, Mar. 24, 1976, summarizes recent discussions on the role of pricing as a conservation tool, in the context of the original purposes of the compact set out in article II.

[6] U.S. House of Representatives, Committee on Insular Affairs, 92d Cong., 2d sess., "Compilation of Federal Laws Relating to Fuel and Energy Resources," Committee Print 92–7, 898 pp.

In sum, it has been U.S. policy to rely to the maximum degree on private enterprise in the competitive market system to shape and make the principal components of U.S. national energy policy.

It is in this context—an up-to-now deliberately self-limiting and residual Federal role—that U.S. national energy policy needs to be understood and is now being reassesed.

CHANGES IN THE BASIC ASSUMPTIONS

Foremost among the facts on which a major reassessment is now taking place is that the first two assumptions have greatly changed, so much so as to strip national energy policy of much of its underlying rationale.

1. Domestic supplies.—As this whole report makes abundantly clear, domestic energy supplies are no longer able to meet all of our burgeoning demands. By the end of 1976, the country was importing oil and refined oil products equal to one-fifth of total energy demand and equal to some 42 percent of total petroleum demand. In January 1977, imports soared to more than half of total petroleum demand; first quarter imports averaged 9 million b/d. Four-fifths of those imports came from OPEC lands. With the exception of DOD and other public sector procurement, virtually all petroleum imports are purchased and managed by the private sector. Production of domestic oil and natural gas has peaked, recoverable domestic reserves are dwindling and are likely to be exhausted around the end of the century. Meanwhile substantial safety, environmental and technical problems impede their rapid replacement by coal and nuclear energy.

2. Domestic prices.—Concurrently the domestic U.S. market has lost whatever independent influence it may once have had over energy price and pricing policy through competition among suppliers for a growing domestic market to keep energy prices low. The already quadrupled and still rising prices of imported crude, set now by OPEC producers, provide the main influence on not only the composite refiner acquisition costs of crude but also on other domestic energy supplies, now enhanced in value as demand for oil keeps oil prices high.

REASSESSMENT OF THE RELATIVE PRIVATE AND PUBLIC ROLES

These two changes stimulated Congress into a major reassessment of this long standing policy. A series of enactments during the 93d and 94th Congresses laid the base for a new codification of national policy on energy. (See below.) They served, if nothing else, to make Congress and the public in general far more conscious than before of how residual the Federal role in national energy policy has been.

A careful review of the substance of these recent laws confirms the fact that, while the reassessment process is well under way, the changes so far enacted represented only very limited modifications in the long standing major premises: the Federal role is still residual, the private role still dominant.

To cite just one key example, regulation of crude oil pricing: The initial price controls affecting crude oil were not directed specifically at oil alone but were part of a general wage and price management effort, dating from August 1971, to moderate inflationary pressures in the economy as a whole. By mid-1973, crude oil was the last commodity still remaining under price control and the OPEC embargo and quadrupling of oil prices interrupted a phase-out already underway.

The elaborate interim allocation/entitlement/two-tier price arrangements, authorized under and resulting from the Emergency Petroleum Allocation Act of 1973, were enacted as emergency and intentionally temporary measures to cope with a market now violently in flux.

The consensus reached in Public Law 94–163, signed December 22, 1975, and extended, as amended, by Public Law 93–385, signed August 14, 1976, as the Energy Policy and Conservation Act, established a policy, not of continued price control but of price decontrol, carefully monitored and moderated, permitting a rise over a little more than three years to a new world market rate. The graduated, instead of sharp, rise was intended to cushion the impact on an economy still coping with high levels of unemployment and inflation, but the purpose and end result was price decontrol.

NEW STATEMENT OF U.S. ENERGY POLICY

With the advent of the new Administration, a major and dramatic shift in basic U.S. energy policy has been proposed.

In a series of presidential addresses, documents and proposed legislation the Administration has laid out the outlines of a comprehensive energy plan intended to achieve a significant reduction of oil imports, by 1985, through a series of specific production, conservation and fuel switching goals.

There is very little within the detailed proposals or even the goals which can qualify as "new"—with the exception of two of the ten principles which are set forth to "provide a framework not only for present policies, but also for the development of future policies."

Eight of the ten principles represent general findings already embodied in legislation currently in force, calling for a U.S. energy policy which is healthy to the economy; protects the environment; emphasizes conservation; is secure, fair and energy efficient; is predictable; uses resources in plentiful supply and moderates the use of fuels which are scarce; and vigorously expands the use of nonconventional and renewable fuels.

Two of the principles, however, represent fundamental changes as compared with national energy policies and assumptions of the past—the assertion that (1) The Federal Government should take the leading role in dealing with the nation's energy policy comprehensively and that (2) energy prices should generally reflect the true replacement cost of energy. These are diametrically opposed to the national energy policies on which 50 years of energy and economic growth in the United States have been based.

The codification of earlier U.S. energy policy represented in the two previously quoted statements, by Interior Assistant Secretary Moore and by President Ford, is now directly challenged in the first principle of the Administration's proposed National Energy Plan:

> The energy problem can be effectively addressed only by a Government that accepts responsibility for dealing with it comprehensively and by a public that understands its seriousness and is ready to make necessary sacrifices. The declining availability of oil and natural gas will affect virtually all energy prices

and consumption patterns in the United States, for the various energy supplies are all part of an integrated energy market. Therefore, in this democratic society, a solution can be found only in comprehensive Government policymaking informed by public comment and supported by public understanding and action.[7]

The second change which is at odds with past U.S. national energy policy premises—listed as the seventh principle—is that "energy prices should generally reflect the true replacement cost of energy."[8] Clearly this is very different from a policy premise that Federal policy should be to ensure that energy supplies should be made available at the lowest possible costs and prices, consistent with reliability of supply.

Under the Federal energy reorganization now underway, the Secretary of a new Department of Energy, consolidating a very wide range of energy policy and program authorities from half a dozen major energy agencies, will be the President's principal agent in attempting to wield this greatly expanded Federal policymaking responsibility and role.

Under regulatory powers conveyed by legislation enacted and still in force, the Federal Government is already authorized to:

Set prices for old and new oil, for old and new interstate natural gas; and for uranium enriched materials.

Set production goals for fuels on public land.

Determine, under relatively general guidelines, which fuels could be burned in which boilers.

Allocate coal.

Under emergency presidential powers, allocate oil, oil products and natural gas.

Negotiate the price for up to one billion barrels of oil for strategic stockpile storage.

Determine the quantity of gasoline which can be produced in domestic refineries.

Set standards for a wide range of industrial and consumer products, auto fuel efficiencies and thermal building requirements.

Control the exports of coal, oil, uranium, nuclear plants and equipment, and electricity.

Accelerate or slow down the rate at which additional nuclear electric power generating capacity will be authorized.

Create new energy supply industries through a combination of economic incentives, pricing powers, contracting authority and technological capabilities.

In the context of the new consolidation of energy agencies and the proposed new philosophy of a primary Federal policymaking role, these powers are formidable. Collectively they represent Federal authorities exercised in the past only in times of war, national disaster and emergency—if not "the moral equivalent of war", the peacetime regulatory equivalent of wartime powers.

CONCLUSION

Whether the President or a Secretary of Energy could actually successfully carry out such powers in the absence of war or similar national emergency is still questionable, particularly if the programs

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[7] Executive Office of the President. Office of Energy Policy and Planning. The National Energy Plan. Washington, Apr. 29, 1977, 103 pp. Citation is on p. 26.
[8] Ibid, pp. 29–30.

and policies to be enforced turn out to run counter to the de facto national energy goals represented by private sector desires and intent.

Congress has not completed its own reassessment of national energy policy and it is by no means certain that it is prepared to endorse all of the proposed changes in the Federal energy policymaking role.

Meanwhile the major decisions in all the important energy policy vectors which make up national energy policy continue to be made, as they have in the past, by private sector investment plans and choice and will.

ENERGY PICTURE AT A GLANCE

Programs and authorities included in legislation already enacted

Strategic reserves.—Authorization to create a system of national strategic petroleum reserves of up to 1 billion barrels, and development and civilian use of naval petroleum reserves.

Emergency authority.—A wide range of standby energy emergency legislation, including continuing authority for allocation of scarce materials and petroleum, as well as end-use rationing of gasoline.

Energy pricing.—Permits carefully monitored and moderated increases in domestic crude oil prices to world price levels over a period of 39 months under new procedures ensuring close Congressional management, oversight and control. Stripper-well production is exempt from the price ceilings, effective September 1, 1976. Proposals for utility rate reform are to be prepared by FEA.

Conversion from oil and gas to coal.—Extended authority for the FEA Administrator to force industrial conversion from oil and natural gas to coal.

Energy conservation.—A $2 billion loan guarantee program to encourage industry and business to practice energy conservation; a $200 million grant program for a three-year weatherization assistance program administered by FEA; $82.5 million for a weatherization program administered by Community Services Administration; a two-year, $200 million loan-grant demonstration program to finance conservation and renewable resources in existing homes; $150 million to aid States in developing conservation plans; mandatory building standards are to be drawn up; mandatory labeling for energy-using appliances; additional funding to promote mass transportation, recycling and resource recovery; and mandatory fuel economy standards for passenger automobiles.

Energy, research, development, and demonstration.—Increased funding for solar and other renewable fuels, continued work on nuclear power research, and a quite substantial research and development program to promote the commercialization of electric vehicles.

Approved by the House of Representatives and by the Senate Finance Committee during the 94th Congress

Conservation tax and investment credits.—For homeowners and businesses who install new or improved insulation, better heating systems, solar and geothermal energy equipment, heat pumps and wind-related energy equipment.

Production investment credits.—Additional credits were provided to encourage investment in waste conversion equipment, organic fuel conversion, railroad equipment, deep mining coal equipment, coal liquefaction and gasification technology.

Thoroughly debated but still controversial

"Gas guzzler" taxes.

Natural gas deregulation.

Standby gasoline tax.

Tax on the business use of oil and natural gas.

Crude oil equalization tax (debated as a windfall profits/plowback investment tax).

New Proposals

The proposed utility program requiring all utilities to offer energy conservation installation and financing services.

Rebates of "gas guzzler" and gasoline taxes.

AN ECONOMIC APPRAISAL OF PRESIDENT CARTER'S ENERGY PROGRAM

(By Walter J. Mead)*

For the last 5 years there has been a uniform cry from concerned businessmen, environmentalists, oil people, and political figures calling for a "comprehensive national energy policy." National energy policy to date has consisted of a conflicting set of expedient measures, with domestic tax policies having the effect of subsidizing the flow of capital into petroleum production, while at the same time price controls have reduced profitability and tended to cancel out the first set of policies. Another tax policy has encouraged foreign oil production while import quotas prevented this subsidized production from entering the U.S. market. In the early 1970's the federal government forced public utilities to abandon coal-fired generators in favor of oil and gas turbines. Five years later the same government was mandating the opposite shift, at enormous social cost.

While a "comprehensive national energy policy" was obviously needed, very few people bothered to spell out in detail what set of policies they considered to be beneficial. Professional economists who specialize in energy research, as well as some spokesmen with a business orientation, had in mind policies which relied on the market forces of supply, demand, and price to allocate scarce energy resources among competing uses. But to political Washington, the cry for a national energy policy is interpreted as a demand for more government decision-making and less reliance on the market. Those who called for a "comprehensive national energy policy" and meant by it greater reliance on market forces must have been shocked when they read principle number one in the President's energy message. This first principle stated that "we can have an effective and comprehensive energy policy only if the Federal Government takes responsibility for it . . ." (*1*, p. 1). The essence of the President's energy message implements this first principle. Price controls for both oil and gas are not only extended to cover previously exempt areas, such as intrastate gas, but are also offered as permanent institutions (*2*, *3*).

Professional economists who have specialized in energy economics almost to a man have argued for greater reliance on market forces and less government interference in energy problems. Their strong preference for market solutions is not because they are philosophical conservatives. Rather they are acutely aware of the poor record of government interference in the energy market. That record is one of massive and repeated resource misallocation. Adelman wrote about "this whole system of organized waste" (*4*), while Erickson and Spann described the energy crisis as a "policy induced" (*5*) crisis.

*Appeared in Science, July 22, 1977, pp. 340–345. Copyright © 1977 by the American Association for the Advancement of Science. Walter Mead is professor of economics at the University of California, Santa Barbara. Reprinted by permission.

A HALF-CENTURY OF FEDERAL ENERGY POLICY IN REVIEW

The record of government intervention on behalf of various interest groups in the energy industry is well known to economists specializing in this area. The past is prologue. Congress, in legislating energy policy, must become aware of its own record. Let us briefly review the record of major federal government energy policy intervention.

(1) The percentage depletion allowance tax provision affecting oil, gas, and other minerals was introduced more than a half-century ago. One major effect was to increase the flow of capital into oil and gas exploration and production. This in turn increased the supply of petroleum from domestic sources and caused petroleum product prices to be lower than they would have been in the absence of this tax subsidy. This historically low price policy for energy led to both big cars and other evidence of wasteful consumption, and to premature depletion of the nation's resources. It contributed to the energy crisis of the 1970's.

(2) Tax provisions allowing the expensing of intangible drilling costs for productive wells contributed further to excessive capital flows into oil and gas exploration. The results were the same as those indicated in point 1 above.

(3) A third tax item, the foreign tax credit, stimulated a flow of U.S. capital into foreign petroleum exploration and therefore rapid production, artificially low prices, and more rapid resource depletion throughout the world. It also led international oil companies to enter other lines of business chartered in low-income-tax countries as a means of using excess foreign tax credits.

(4) During the 1930's, in the name of "conservation," the groundwork was laid for production controls ultimately taking the form of market demand prorationing. This is a monopolistic device enforced by government on behalf of the oil industry and was designed to reduce domestic production in order to cause oil prices to rise above competitive levels. This policy therefore tended to cancel out some of the supply effects of the tax subsidies identified in points 1 and 2 above. Market demand prorationing was authorized by two laws passed by Congress, laws authorizing the Interstate Oil Compact and the "Connally Hot Oil Act" which provided the enforcement mechanism (*6*).

(5) As another monopolistic device, in 1959 the Eisenhower Administration introduced mandatory oil import quotas having the effect of restricting petroleum supplies from abroad and thereby depleting domestic resources at a faster rate. Quotas were introduced at the insistence of independent crude oil producers, joined by coal producers, and over the opposition of the major international oil companies (*7*). Import quotas caused domestic crude oil prices to be about $1.25 per barrel above the imported crude price until about 1971. The private interest need for import quotas followed from the efforts under market demand prorationing to maintain artificially high oil prices in the United States. Market demand prorationing restrictions on domestic supply designed to increase prices could not work for long without parallel restrictions on imports. At the same time, import restrictions prevented the free flow of imported oil subsidized by the foreign tax credit listed in point 3 above. This subsidized oil therefore flowed to Western Europe and elsewhere, benefiting either

foreign consumers in the form of lower prices or foreign governments in the form of higher excise tax receipts at the expense of American taxpayers and consumers.

(6) Natural gas price controls originated in a 1938 act of Congress. A Supreme Court decision in 1954 stated that Congress intended price controls to cover the wellhead price of natural gas flowing in interstate commerce. This action, as administered by the Federal Power Commission, continued the historically low price policy for energy. Prices were set below market clearing levels leading both to wasteful consumption and to the severe shortages in early 1977.

(7) Price controls over crude oil and products were instituted in 1971 by the Nixon Administration. To the extent that oil prices are set below market clearing levels, product shortages have resulted. But there is an open-ended oil supply. Declining domestic production from a peak of 10 million barrels per day in 1970, down to about 8 million barrels per day currently, paired with increased consumption, is leading to vast increases in imports and consequent dependence and balance of payments problems.

(8) With the introduction of multiple-tier pricing as part of price controls, a mechanism must be established to decide who is to be favored with low-priced crude and who must buy the high-priced imports. This led to an allocation program requiring that some firms sell crude and products to others. This is an income redistribution system that also distorts an efficient flow of resources.

(9) In addition, the price control system led to politically perceived "inequities" between different refiners and between different parts of the country. Therefore, another offsetting income redistribution system was established called "entitlements" requiring that money in large amounts (about $1 million per year) be passed from one group of refineries to another. Even the President's document admits that the entitlements program is "an administrative nightmare" (*8*, p. 49).

(10) Early in the present century a system of four naval petroleum reserves was established. The largest known reserve is Elk Hills in California. During the Arab oil embargo, Congress debated, but was unable to authorize, a single barrel of oil production from Elk Hills to alleviate the harsh economic effects of that embargo. Now that there is an apparent glut of oil developing on the West Coast with the introduction of North Slope crude into this market, Congress has legislated production scheduled to expand to 350,000 barrels per day, thereby contributing to the West Coast oil glut.

(11) In the 1920's Congress passed the Jones Act requiring that all marine shipments between two U.S. ports be on tankers (i) built in the United States, (ii) owned by American companies, and (iii) manned by American crews. This act has created a domestic monopoly position for each of the three interest groups covered. It now requires that consumers bear the added cost of Jones Act shipping for Alaskan crude oil. The 94th Congress passed the tanker bill that would extend Jones Act conditions to 30 percent of the oil imported into the United States from abroad. This was done at a time when surplus tankers were tied up all over the world. Compliance with the tanker bill would have required massive tanker construction in the United States, there-

by contributing to the tanker surplus. It would also have imposed a burden on American consumers estimated at about $2 billion per year. But for a presidential veto, the tanker bill would be the law of the land.

Perhaps the foregoing 11 items are sufficient to illustrate why energy economists have not been enthusiastic about additional governmental intervention in the energy market. This record does not lead one to be confident that the public interest will be served by additional government intervention. This record should surprise no one. Congress and the Administration must respond to dominant organized pressures. The President's first principle, suggesting that an effective and comprehensive energy policy requires that the government take responsibility for it, implies that government intervention in the future will wisely serve the general welfare, in contrast to the historical record.

SOME COMMENDABLE FEATURES IN THE PRESIDENT'S ENERGY PROGRAM

The President's energy message contains several admirable statements and recommendations, from an economic efficiency point of view.

(1) Allocation efficiency will be improved by the President's proposal to let the price paid by users of crude oil rise to the world price. However, this is only half of the market solution, which would allow both the demand price and the supply price to be set by the market rather than by the government.

(2) A presidential directive requiring federal agencies to purchase cars that exceed the average fuel economy by 2 percent in 1978 and 4 percent in 1980 appears to be commendable, as an economy measure.

(3) Some of the reforms of public utility rate regulation will lead to greater economic efficiency in that regulated industry. First, peak-load pricing is long overdue. If implemented, it should shift power usage from normal peak-load periods and thereby reduce the need for new construction. Second, the President's proposal to phase out promotional rates and declining rates that are not justified by declining costs will contribute to greater efficiency. Third, the President's proposed prohibitions on master metering for electricity structures will lead renters to economize on power usage. The present system of master meters in such structures leads renters to treat electric power as a free good and hence to use it excessively.

(4) The President notes that oil and gas are now priced "below their marginal replacement cost and, as a result, the nation uses them wastefully with little regard to their true value." This is a true statement and one might take encouragement from the fact that it is enunciated by the President. However, in the next paragraph of his message he states that "the residential sector is sheltered as the plan would keep natural gas prices to residential users down and provide tax rebates for home oil use" (*l*, p. 15). It is clear that his policy recommendations perpetuate the very problem that he has so well identified.

(5) The President's proposal seeking legislation to limit production from the Elk Hills Naval Petroleum Reserve to a ready-reserve level until the West-to-East transportation systems for moving Alas-

kan oil surplus are in place, and until California refiners have completed a major refinery retrofit program to enable more Alaskan oil to be used in California, is commendable. The proposal could be improved by eliminating its temporary character and placing the Elk Hills Reserve in a permanent, fully developed standby reserve position.

(6) The exemption of shale oil from the President's proposed price control system will enable oil production from our vast shale oil reserves to proceed whenever cost and market conditions justify such production.

(7) The President's proposal to expand the strategic petroleum reserve to the point where the nation could withstand a 10-month supply interruption appears to to be desirable. With this reserve the nation could accept a relatively high level of imports from the Middle East. While this policy will involve balance of payments probems, it is at least consistent with the fact of life that the large remaining known reserves of crude oil are in the Middle East and not in the United States. It enables us, with reduced risk, to delay developing major supplies of very high cost energy sources as alternatives to imported crude oil.

(8) After observing that the present gasoline price control system is inoperative (prices are determined by competitive conditions), the President wisely recommends gasoline price decontrol.

SOME QUESTIONABLE POLICY PROPOSALS

In addition to the recommendations noted above, which appear to offer greater resource allocation efficiency, there are other recommendations that might possibly be worthwhile on efficiency grounds. The plan calls for a large number of programs that all suffer from a common fault—they are not supported by evidence showing that their social benefits exceed their social costs. These programs include the following:

(1) New cash subsidies for individuals, home owners, schools, and hospitals to finance weatherization and the installation of miscellaneous "approved conservation measures."

(2) New tax subsidies to business to encourage installation of "qualifying solar equipment," "approved conservation measures," and "cogeneration equipment."

(3) Federal investments in van pooling (6000 vans to be purchased) for use by federal employees in commuting to and from their jobs. The fact that large-scale unsubsidized van-pooling arrangements have not been successful leads to the suspicion that the self-supporting feature of this proposal will not materialize.

(4) In the event that voluntary programs fail to achieve prescribed results, then mandatory measures are proposed relative to weatherization, efficiency standards in new buildings, and home appliance efficiency standards.

The economic problem in all these proposals is that subsidies and governmental force will likely cause scarce resources to be allocated to uses that have a low or negative rate of return to society, unless net external benefits are present. External benefits accrue to society at large, rather than to the individual or business decision-maker. There is no showing of net external benefits in the President's analysis. Where either subsidies or force lead to resource misallocation, the standard of living of the poeple will be unnecessarily low. Before Congress enacts any of these measures, it should require evidence that the discounted present value of the benefits exceed the costs.

One of the above measures may be used to illustrate the problem. As a force measure, Congress is considering legislation that would prohibit the sale or refinancing of any home not meeting prescribed federal insulation standards. A decision to insulate a home should be based on the present costs of insulation and the flow of future savings. If costs exceed benefits, such investments should not be made. An exception occurs if there are net external benefits. None are obviously present. If this calculation is distorted by artificially low prices for gas or other energy input, then the obvious correction should be to eliminate the source of the distortion—the current price control system. The President's program perpetuates this problem by extending gas price controls and making both gas and oil price controls permanent.

Costs and benefits will differ widely by geographical area, age of the house, difficulty of retrofitting, temperature preferences of individuals, and the like. In the absence of net external benefits, home insulation decisions should be made by home owners, not by a distant Congress.

SOME OF THE PRESIDENT'S PROPOSALS ARE COUNTERPRODUCTIVE

The President proposes two extensions of existing tax subsidies.

(1) According to the President's plan, some independent oil and gas producers have been deprived of a portion of the tax reduction enacted in 1976 for the expensing of intangible drilling costs. As a solution to this problem, he proposes that the intangible drilling cost expenditure provision be liberalized. However, further liberalization of tax subsidies will make oil production more profitable after taxes. This is in conflict with the President's own price control measures, which are designed to restrain profitability. Further, a tax subsidy, unsupported by evidence of net external benefits, leads to overinvestment in the subsidized industry and to resource misallocation. Instead of further liberalization, Congress should consider eliminating existing legislation which permits expensing of intangible drilling costs for productive wells and requiring instead capitalization of such expenditures. This provision, of course, should be applicable to all oil and gas producers equally. In a similar vein, complete elimination of percentage depletion allowance for all mineral production, regardless of firm size, should be considered by Congress.

(2) In addition, the President proposes that expensing of intangible drilling costs as a tax stimulant be made available to geothermal energy production. The reasoning above applies here also. Further, a tax subsidy for geothermal energy places alternative energy sources including, for example, solar, wind, and fuel from waste at a relative disadvantage. Instead of extending tax subsidies to additional energy sources, a preferable policy would be to eliminate such non-neutral tax provisions from all present applications.

Strong endorsement is given by the President to the amendments to the Outer Continental Shelf Lands Act now being considered by Congress. Currently available economic research shows that the competitive bonus bidding system now in effect has produced more than fair market value to the government and has introduced a low level of inefficiency into the production process. In recent testimony before the House of Representatives, evidence was presented indicating that the proposed amendments to alter the bidding process would be counterproductive in that they would cause valuable petroleum resources to be left in the ground and the public would receive lower payments from lessees. This lengthy evidence is available (*9*).

The quality of the economic analysis supporting the President's program appears to be poor. First, the analysis argues that "Without constraints, U.S. oil demand probably would grow at the postwar rate of 4 percent per year, and reach 25 million barrels per day by 1985" (*8*, p. 11). This projection appears to assume that the demand for oil has a long-run elasticity of zero, a highly unlikely condition. Price appears to have been ignored in the analysis. In the absence of intervention, the price of crude oil would be about $14 per barrel, currently, compared to about $3 per barrel when the postwar consumption growth rate used in the above quotation was being established. At higher prices prevailing under uncontrolled conditions, people will economize (conserve), and consumption growth rates will be reduced.

Second, the analysis sets out to reduce "energy consumption." This is a myopic view of economic problems. Conservation, as an economic problem, requires that *all resources* be conserved, not just energy. Policies that use tax incentives and the allocation power of government to mandate reduced energy consumption lead, through resource substitution, to higher consumption of other resources (copper, insulation, steel, and the like) as if they had no value. Such policies are counterproductive with respect to resource conservation. This "energy myopia" is an unfortunate and serious economic flaw in the energy plan.

PRICE CONTROLS CREATE SHORTAGES

The most important issue in the President's energy plan is price policy. Two major alternative policies are available. First, the price system can be allowed to allocate scarce energy resources among competing uses with government interference limited to correcting for significant externalities. This would also constitute a "comprehensive national energy policy." Second, price controls can be retained with the government making the important economic decisions about energy prices and about who is to be favored with artificially low-priced energy. The President clearly chooses the second alternative. "The President is committed to the retention of domestic oil price controls for the foreseeable future . . ." (*1*, p. 15). For natural gas, the President proposes that price controls be extended to include intrastate natural gas as well as synthetic natural gas.

The nation has had a long history of periodic experience with price controls. In the case of natural gas, the Federal Power Commission has controlled wellhead prices of interstate gas since 1954. These controls have created massive shortages. As a result, consumers of natural gas who have gas hookups are able to buy gas at low prices and use all they desire while others cannot buy gas at any price. This growing shortage became acute early in 1977. Further, one can accurately forecast that, if controls are continued, the shortage will increase in severity.

After noting, first, the inconsistency in the present system which permits gas transported in intrastate commerce to be free of federal price controls while the wellhead price of gas flowing in interstate commerce is subject to control by the Federal Power Commission (8, p. ixx), and second, that, under FPC control, natural gas "is now the Nation's most underpriced and oversold fuel" (*1*, p. 16), one would expect that the President would call for decontrol of new natural gas supplies. Instead, he recommends the opposite, that wellhead price control be extended to include intrastate gas. This policy is recommended as "an important first step toward deregulation" (*1*, p. 16). He proposes that all new gas be subject to a price limitation based on a Btu (British thermal unit) equivalency which is estimated to be $1.75 per MCF (thousand cubic feet) at the beginning of 1978. However, even at 1 June 1977 prices, a Btu equivalency would require a natural gas price of about $2.35 per MCF on the basis of import prices for crude oil, and $3.15 on the basis of heating oil prices. Therefore, even ignoring any cleanliness or convenience premium that the market would automatically accord to gas, natural gas would continue to be "the Nation's most underpriced fuel."

In addition to expanding the regulatory burden to include intrastate gas, the President proposes a complex and expensive six-tier system of controls with price distinctions based on (i) new gas, (ii) old interstate gas subject to existing contracts, (iii) old interstate gas made available at the expiration of existing interstate controls, (iv) the same class of gas formerly sold in intrastate commerce, (v) "specific categories of high cost gas," (vi) synthetic natural gas.

The foregoing are producer prices. As soon as the government intervenes to set prices below market clearing levels, then a nonprice rationing system becomes a necessity. All consumers will want to receive gas at the lowest tier price. The government must then decide which users are to be the favored buyers. This adds to the expense of administration and results in a political rather than an economic allocation of resources.

Further, the President proposes an incredibly complex and confusing system of user taxes. First, industrial users (except fertilizer manufacturers and "certain agricultural users") would be subject to a 30¢ per MCF tax in 1979, increasing to an "average tax" of $1.10 per MCF. Second, the tax liabilities of fertilizer manufacturers and "certain agricultural users" are unspecified. Third, utility users of natural gas would pay a tax beginning in 1983 sufficient to raise their cost of gas to 50¢ per MCF below the Btu equivalent price of distillate, increasing by 1988 so that their cost of gas would equal the cost of distillate. Since gas has the advantages of cleanliness and capital cost saving, it would remain a bargain for all three users listed above. In the long run, these taxes would be paid by consumers. Fourth, no tax is specified for residential customers for whom prices are to be kept low. A rationing system would be established requiring that the more expensive gas be allocated to industrial users, not to residential and commercial users. By keeping gas prices low for consumers, normal incentives leading toward home insulation and toward solar heat application are reduced.

The economic problems of this price and tax control system for gas are legion and observable from past experiences. A large bureaucratic burden would be required to administer the system. This must be paid out of lower living standards. Appeals must be heard from user interest groups who want to obtain low-priced gas and from producers who want to qualify for higher selling prices. Wasteful consumption of a valuable non-renewable resource will continue because prices for all users are held below market clearing levels. Scarce gas resources are forced into less efficient uses, thereby retarding normal improvements in living standards.

A simple alternative involving insignficant administrative and resource misallocation cost is available—let the market allocate this scarce resource by (i) not extending control to intrastate gas, (ii) immediately decontrolling all newly discovered interstate gas, and (iii) phasing out over a period of not more than 5 years all controls on the price of existing interstate production. This also is a national energy policy.

The President appears to be proposing four tiers of oil price controls. First, the present price of $5.25 per barrel for "old oil" is to be continued. Second, it is proposed that the present fixed price of $11.28 per barrel be continued. This price category has included what has been called "new oil." The designation now proposed by the President is "previously discovered oil."

Third, another price category to be called "newly discovered oil" is to be given a fixed "current world price." All three tiers are subject to general inflationary price increases. Newly discovered oil is defined as oil from a well drilled more than 2.5 miles (1 mile=1.6 kilometers) from an existing onshore well as of 20 April 1977, or more than 1000 feet (1 foot=0.3 m) deeper than any well within any 2.5-mile radius. New oil offshore will be limited to oil from lands leased after 20 April 1977. This artificial distinction will guarantee that all new wells will be drilled at least 2.51 miles from an existing well. It is a wasteful and counterproductive rule.

As a fourth tier, incremental tertiary (not including secondary) recovery and stripper oil production is to be free of controls. This provision, viewed alone, is welcome. However, as part of a four-tier producer pricing system, it is difficult and expensive to administer. Further, producers have learned from repeated past experience that rules can be changed by the government after investments have been made. There is a credibility problem.

The four tiers of price controls described above are producer prices. Market prices are to be allowed to rise to world oil prices, and the difference between the producer and market price is to be collected by the government in a four-tier taxation system.

THE PRICE CONTROL DILEMMA

The dilemma in which government finds itself arises out of the fact of a fourfold increase in the price of crude oil beginning about 1973. This fact has led to two governmental "hang-ups." One is based on "windfall profits," the other, on the impact on the poor.

For all remaining oil reserves existing at the time of this price increase, substantial inventory profits would occur as a result of the large increase in crude oil prices. These profits would be shared by private and government landowners (not oil companies) in the form of royalty payments, and lessees consisting of about 10,000 crude oil producers. The term given to this class of inventory profit is "windfall profit." It refers to an unexpected gain in value. It is more of a derogatory term than a precise economic concept. The concept is of questionable public policy usefulness for the following reasons:

(1) For all oil discovered on leases purchased after about 1974 when prices reached their present level (adjusted for inflation), the term windfall gain would not be appropriate if applied to producing oil companies. It would apply to the royalty interest, but in most cases this will be federal or state governments.

(2) Apart from the politics involved in the windfall gain terminology, it is not clear from the point of view provided by economic analysis that there are windfall gains even for reserves existing prior to 1973. Oil is a nonrenewable resource. It is possible that owners of oil reserves have long been expecting price increases. During the 1950's and 1960's any expected price increases failed to materialize. From 1950, when crude oil prices averaged about $3.07 per barrel, to 1977 when prices of imported crude amounted to about $14, the real price of crude oil (adjusted by the wholesale price index) increased at a compounded annual rate of 3.29 percent. This corresponds closely with the average real rate of return on capital over many years of U.S. history. It is possible that, in 1950, owners of oil resource did in fact expect this kind of gain. The problem is, the gain failed to appear from 1950 through 1970, then in 1973 it came suddenly.

(3) If the government is to use the windfall gain concept as an excuse for price controls then why single out crude oil prices when some other prices have also increased sharply? Spot prices of coal and of Douglas fir timber, for example, have both increased fourfold since 1967. Similarly, spot uranium prices (yellow cake) have increased in about the same proportion.

(4) How long are prices to be controlled in the name of historical windfall gains? The longer that prices are controlled, the greater are the distortions and the greater the accumulated cost of administration, both for the government and for complying industry. In the case of natural resources that have reached points in their production life cycle where the cheap sources have all been produced and only high cost sources remain, the price behavior to be expected is that of rising prices. This, in fact, is the way a price system automatically plans the allocation of increasingly scarce resources. Higher prices are needed to lead people to conserve and to search out substitutes. The longer that price controls are retained, the further from reality they become and the harder it is to dispense with them.

The second hang-up concerns the impact on the poor as a result of a sharp increase in the cost of crude oil and consequent product price increases. In order to avoid an adverse impact on the poor, government policy has sought to suppress price increases by using crude oil and natural gas price controls. This is an income redistribution policy. But it also distorts the flow of resources in the economy. The income redistribution effect is haphazard. For example, poor people who do not have a natural gas hookup do not benefit by artificially low prices of natural gas, but owners of large houses with winter gas heat and summer gas air conditioning, plus swimming pools heated by gas, benefit immensely. The lesson to be learned from this experience is simple—do not adopt policies which have major resource misallocation effects in order to accomplish an income redistribution objective. Rather, if additional financial aid to the poor is desired by the nation, adopt policies that directly and efficiently (not haphazardly) serve that objective.

If the government finds it impossible politically to adjust to the new realities of crude oil prices, then the burden which we all will pay is continued price controls. The consequences of continued price controls for the nation as a whole are the following:

(1) As price controls have been administered to date, they have created shortages, particularly acute in the case of natural gas.

(2) The incentive to supply oil and natural gas from domestic sources is reduced. In the case of oil price controls, there is an open-ended supply in the form of imports. This leads to artificially high levels of imports and consequent balance of payments problems.

(3) Price controls involve administration costs in the form of allocations, entitlements, price policing, auditing, and the like. These administrative costs are not limited to government administration, but include compliance costs imposed on industry. Whether the administrative costs of control are paid by government and thus taxpayers, or by industry, the social cost is the same. Valuable and productive people are diverted from alternative uses in order to administer and comply with regulations. For the 1977 fiscal year, the Federal Energy Administration (FEA) alone employed 3478 people. The FEA budget, excluding costs for the strategic petroleum reserves, amounted to $158 million or $45,000 per employee. Rough calculations of the cost borne by the oil industry for compliance with FEA regulations indicate an annual charge of about $500 million. This, together with the FEA administrative cost, imposes a total social cost on the nation of approximately $650 million per year. It must be emphasized that this cost is both a private and a social cost, and it is only a small part of the government energy control cost. The resources involved have alternative uses. Talented and well-educated people are diverted from more productive uses of their time.

(4) When social costs are increased as a result of a control system without corresponding social benefits, economic growth and advances in living standards will be retarded. Resources that are devoted to a control system cannot be simultaneously used to produce other goods and services. One cannot argue that the talented human resources employed by the control system would draw from a pool of unemployed. For example, the system would employ a multitude of lawyers and economists. But there is no significant unemployment in either professional group. The present declining 6.9 percent unemployment rate consists primarily of unskilled labor.

The energy message asserts a contrary result claiming that the program would increase the GNP (gross national product) by 0.7 percent in 1978 and stimulate about 100,000 jobs by 1985 (*1*, p. 3). Given the mandated and tax-stimulated reallocation of capital away from uses to which such scarce resources would flow in response to normal market incentives, these favorable results are most unlikely. A recent analysis by Chase Econometrics, an economic forecasting organization, indicates GNP and employment consequences that are more realistic and in accord with economic theory. The Chase analysis concluded that "The overall effect of the energy program for the period 1978–1981 will be to reduce real GNP growth by 0.2 percent per year—[and] raise the unemployment rate by an additional 0.1 percent per year . . ." (*3*, p. 2).

What are the offsetting benefits for this annual cost? Appraisals of the social benefits of FEA have indicated negative results. A recent study by the Rand Corporation concluded that "controls have not reduced the prices of refined products" (*10*). Instead, "refiners of controlled oil receive a profit transfer from the producer of the oil, but those profits are retained by the refiner" (*10*). Another study by Mancke concluded that "current energy policies have failed to alleviate any of our four energy problems. . . . In fact, they have actually worsened each of these problems" (*11*). Most recently, the President's Task Force on FEA regulations thoroughly reviewed the record and concluded that "FEA regulations as they now exist confer few, if any, benefits on the public. . . . In return for this lack of benefits and sense of false security, the American businessman, the taxpayer, and the petroleum consumer must incur higher costs than might otherwise be the case. Indeed, continuation of the present regulatory mechanism will result in long-run inefficiencies for the American economy" (*12*).

The system of price controls has distorted crude oil prices at the expense of producers and to the benefit of refiners. It has also shifted wealth between sections of the country, principally benefitting the New England area at the expense of other regions. If there are any positive contributions resulting from the system, they do not appear to be in the area of resource allocation but rather are in the area of income redistribution. Any such income redistribution benefits are highly dubious. Instead of extending price controls to cover additional energy sectors as proposed by the President, and instead of making price controls a permanent institution in this country as recommended by the President, Congress should move to phase out price controls.

CONCLUSIONS

(1) The universal cry for a comprehensive national energy policy is a cry of frustrated desperation reflecting a history of inconsistent, conflicting, and counterproductive energy policies.

(2) The federal government has interpreted this cry as a public demand for more federal intervention in the energy market.

(3) An examination of the energy policy record leads to the conclusion that past policy has not served the general welfare. Instead, government has responded, as one should expect, to dominant organized pressures from the oil industry, the coal industry, labor unions, environmental groups, special consumer interests, and the like.

(4) There is no evidence to suggest that government behavior in the future will differ from the past. Political incentives are unchanged.

(5) The comprehensive national energy policy that most professional economists specializing in the energy area appear to favor is one which limits government intervention in resource allocation to correcting for clearly demonstrated significant externalities. Otherwise, the market, not government, should be allowed to allocate scarce resources among competing ends.

SUMMARY

An analysis of 11 major federal energy policies of the last half-century indicated a record of conflicting and counterproductive government policies. These policies contributed heavily to the energy crisis. The essence of the President's energy plan is more government interference and less reliance on the price system. Crude oil price controls are to become permanent, and natural gas price controls are to be extended. This requires that government decide who gets the low-priced energy, who pays high prices, and who increasingly goes without. Government energy policies have historically reflected dominant organized pressures.

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ENERGY: THE UNITED STATES HAS A NATIONAL POLICY, AND IT'S WORKING

(By Art Pine)*

In the international hand-wringing over America's still-heavy energy consumption, the United States frequently is portrayed as an uncaring wastrel. Citing the massive foreign trade deficit, critics bemoan the failure to pass an energy bill as evidence that the U.S. doesn't have—or want—an energy policy. If only there were some legislation, they say, it would show signs of real commitment.

The myth began with Jimmy Carter, who campaigned in 1976 on the charge that the U.S. was the only major industrial nation that didn't have an energy policy. It wasn't really so then, but Americans accepted the notion almost without question. Now the battle cry has spread to Europe as well. Financial experts are blaming the lack of an energy policy for the decline of the dollar.

The fact is, however, that despite the absence of any grandiose formal energy program, the United States does have a national energy policy—and the evidence is it's working on a fairly significant scale. The changes began after the Arab oil embargo in the autumn of 1973. And they've been intensifying steadily ever since.

Without any major energy law to require it, Americans already are well on the way toward accomplishing some of the major goals of the Carter energy proposal—from converting industry to coal-fired power plants to cutting back automobile fuel consumption to insulating homes and factories. Indeed, the progress has been quite startling, even to many critics.

Moreover, apart from the nebulous symbolism involved, experts agree there's little real evidence that the energy bill now stalemated in Congress would do very much to accelerate that process. The one major provision that might have cut oil usage even modestly—the crude oil equalization tax the president proposed—is dead, and even that wouldn't have cut imports very dramatically.

The single most important force behind this conversion has been the sharp rise in energy prices over the past 3½ years. Despite controls, average prices of domestic crude oil have risen 10 percent a year, while the average retail price of natural gas soared 88 percent in the three years ending last July. As a result, Americans have cut consumption significantly.

Moreover, legislation already on the books from previous years has prodded industry and consumers into conserving further. The Energy Policy and Conservation Act of 1975 mandated relatively stiff mileage standards for U.S. automobiles and trucks, while controls set by the 1974 energy act have prodded utilities and industry into significant coal conversion.

*From the Washington Post, March 19, 1978, p. E1, E10. © 1978 The Washington Post. Reprinted by permission.

Alan Greenspan, former administration chief economic adviser, argues that, while the effort still is not enough, "people just don't recognize what's happened" as a result of these increases in energy costs. "Some very significant action already have been taken," he says. "It's simply not true that we aren't doing anything about the problem."

The extent of the nation's turnaround from pre-1973 days is best shown by comparison with the president's program. The major aims of Carter's energy plan of last April were to raise prices and spur utilities and industries into converting to coal, improving auto fuel efficiency, broadening insulation of homes, spawning more nuclear power plants and encouraging new exploration.

While none of these proposals has become law, figures show the U.S. already has made significant progress in most of these areas (except for construction of nuclear power plants, which has become entangled in regulatory red tape). The shift, which began two years ago, is just now beginning to produce results.

There are these developments:

Conversion of utilities and industry from gas and oil to coal has gone along at a fairly rapid clip. The National Coal Association says hundreds of utilities have shifted back to coal in the past two years, and 241 new coal boilers are now on the drawing boards. Boiler industry officials report not one oil- or gas-fired boiler has been ordered since late 1975.

In basic manufacturing industries, the shift has been less dramatic, but still visible. In 1974, some 80 percent of all new boilers ordered were oil- or gas-fired compared with only 20 percent for coal or waste fuel. Last year, the orders were for 40 percent oil- or gas-fired and 60 percent coal or waste fuel. Moreover, industry leaders say the trend is likely to accelerate.

Despite suspected padding in Environmental Protection Agency mileage estimates, there's little doubt the auto industry has shifted to more-fuel efficient cars and trucks than before the 1973 oil embargo—and that buyers are more conscious of gasoline consumption. The major auto makers now offer a larger selection of small cars—a sure sign of a growing market.

Americans' push to insulate their homes has been so intense that there now is an acute shortage of insulation materials—a situation that has sent prices soaring and, in too many cases, forced buyers to turn to inferior products. Indeed, the home insulation industry has asked Congress not to pass an insulation tax credit for fear of exacerbating the situation

Conservation of electric power and other energy by industry and consumers has improved significantly in the past few years. Reports from around the country show manufacturing firms as well as private citizens are becoming more conservation-conscious. People are finding there are significant savings in cutting consumption. And they're responding in kind.

The one snag is in the shift to nuclear power plants. Mainly because of heavy restrictions and regulations, construction of nuclear plants has gone more slowly than many officials had hoped. But industry projections still show nuclear power likely to triple its share of electric power generation by 1985. Solar energy, still minuscule, is coming along faster than expected.

Finally, new exploration for energy has been increasing steadily, if not quite at the crash pace some planners had hoped for in previous years. Industry statistics show operation of new rigs at historically high rates, and recent increases in natural gas prices have spurred new exploration there. Experts say it's unlikely either will taper off very soon.

The results of all this have been fairly dramatic. While the nation's economy has grown by some 13 percent since 1973, demand for petroleum has increased only at about half that pace—7.1 percent. On a day-to-day basis, petroleum demand now is running at about 17.5 million barrels a day, on a seasonally adjusted basis—virtually unchanged from its levels in 1973.

The widely cited high level of oil imports now plaguing the nation's foreign trade deficit is mainly the result of higher prices, not import volume. U.S. oil imports are up 23 per cent since 1975. But this year, imports are running at about 8 million barrels a day compared with 9.9 million barrels in 1977, when the country was plagued with a severe winter.

And analysts at Data Resources Inc., an economic consulting firm, project that, because of the shift to more-fuel-efficient cars, demand for gasoline in this country will remain at present levels through 1980—even though Americans will be driving more miles each year. That means, in effect, that consumption levels will slow markedly.

The question is, what, if anything, would the pending energy bill do to speed this process? Not very much, according to both administration and congressional energy experts. Although the bill in its present form does contain some modest incentives for coal conversion, it has little to prod industry beyond what already is taking place.

Even if the bill had been enacted in the form Carter proposed, estimates by private consultants show it would have saved less than 2 million barrels a day by 1985—not a very dramatic difference. (The president originally predicted his plan would save 4.5 million barrels a day, but that's been pared since, both by the administration and outside experts.)

The main value of the pending energy bill now would appear to be mostly symbolic—both to end existing uncertainty over what the government plans to require from industries and consumers and to show foreigners that we really do care, after all. Both, arguably, are worthwhile and important functions. In fact, however, the bill would only be consecrating what already is under way.

Admittedly, the conservation effort now in progress isn't adequate by some planners' standards. Most experts agree the U.S. still needs to do more, and that greater conservation will be required if the nation—and the world—are to avoid a serious pinch in future years. But to say the U.S. hasn't done anything to solve its energy problem simply is dead wrong.

WILL THE REAL ENERGY PROBLEM PLEASE STAND UP?

(By David E. Gushee)*

For more than five years, energy policy has been one of the major issues before Congress. Three successive Presidents have proposed "comprehensive national energy policies" only to see them crumble into bits and pieces when subjected to open congressional debate. Does this mean that Congress is failing? Or conversely, does Congress' reluctance to endorse the proposed comprehensive policies mean that the proposed policies somehow fail to define or address the realities of the energy problem?

The intense debate in Congress and the Nation stimulated by these three Presidential energy policy proposals has revealed three major reasons for congressional concern. First, there is no national consensus on what the country's energy problem is, and on whether the President has characterized it properly in calling it a crisis. Second, the proposals now being debated, like their earlier counterparts, would not solve the energy problem as defined by the President. And third, the proposals would, without solving the problem, significantly centralize in the Federal Government the power to make energy pricing and management decisions currently made throughout the private sector.

DEFINING THE ENERGY PROBLEM

The energy problem is like the proverbial elephant—what it appears to be depends on where you touch it. As in the proverb, there are four generic perceptions of the beast, each of which appears to the perceiver to be the most significant problem and therefore the one to be emphasized in the national policy response. But because the perceivers have hold of different parts of the same animal, they are having great difficulties in communicating with each other on a common basis, let alone coming to agreement on points of contention.

The four generic perceptions are basically concerns about:

1. The Economic Role of Energy;
2. Oil Import Dependence;
3. Oil and Gas Depletion; and
4. The Social Role of Energy.

Everyone in the country is affected to some degree by all four of these concerns, since the four are tied closely to each other in a sort of seamless web. But most do not see the four as equally important; they concentrate on one or another of the four.

The Economic Role of Energy

The U.S. is built, both economically and socially, on the historical presence and the explicit national policy objective of abundant sup-

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plies of energy at low, stable, and predictable prices. For generations, and particularly during the past quarter century, cheap energy has substituted for other economic inputs which were more expensive, such as capital and labor. It has also fueled technological innovation, leading to new products, new processes, and new lifestyles. It has increased the number of jobs, workers' productivity, and take-home pay.

To maintain this economic role of energy, energy prices should be kept as low and as predictable as possible and supplies should be plentiful.

Oil Import Dependence

The U.S. depends on oil for about 50 percent of its total energy needs and is currently importing about 45 percent of the oil used. The trend in oil imports is up, and the trend in dependence on Saudi Arabia for the increment is also up.

This dependence on oil imports has two major types of effects. First are the economic effects—balance of payments deficits and resulting currency-related problems, and the macroeconomic impacts of price increases determined by forces outside the domestic economic system, primarily OPEC. Second are the security effects—reduced independence of action in defense and foreign policy, reduced security of supply.

To reduce oil import dependence, domestic energy production must increase, import volumes must be restricted, or domestic consumption must be reduced.

Oil and Gas Depletion

Domestic production of oil and gas has been declining throughout most of the 1970's. Although more drilling is being done, finding rates are declining enough that new additions to reserves are smaller than production from reserves. Coupled with increasing demand for oil and gas, these trends presage depletion of conventional U.S. oil and gas resources in the foreseeable future and depletion of conventional world oil and gas resources in the predictable future—perhaps one to two generations.

To compensate for depletion of conventional oil and gas resources, other energy sources must be brought into use more quickly than is currently the trend.

The Social Role of Energy

Ever-expanding demand for energy has a number of side effects, many of which are deemed to be negative by one or another group. Air and water pollution, strip mining, concentration of people and economic activity, centralization of energy and other life support systems, and competition for water and other natural resources are among the side effects included in this category. More fundamental, however, is the potential for changed power relationships among the Federal Government, State and local governments, large corporations, and individual citizens.

Dealing with these social effects of expanding energy use implies increased control over the consequences of our energy-related activities, changes in resource utilization patterns, changes in lifestyles, or changes in institutional relations.

WHICH PROBLEM IS THE ENERGY PROBLEM?

All of these problems are real, although they have different time frames and affect different people differently. Policy options designed to solve one or any of them tend to exacerbate the severity of the energy problem as seen from one or more of the other problem perspectives:

Holding the price of energy down to foster economic health, for example, in effect subsidizes energy consumption, which increases import dependence, hastens oil and gas depletion, delays development of alternative supplies, and increases the social impacts of domestic energy production and use.

Reducing oil imports by fiat (quotas or tariffs, for example) decreases domestic activity in the short term, raises domestic energy prices or requires allocation, and increases domestic oil and gas depletion and environmental impacts in the long term.

Converting from oil and gas to coal, electricity, or other alternative energy sources to respond to impending oil and gas depletion increases energy costs and requires short term increases in oil imports, although it has mixed social impacts.

Pollution control, land reclamation, resource recovery, and waste disposal requirements of increasing stringency all increase costs. Changes in lifestyle imposed more rapidly than the economic costs and benefits would dictate either increase costs or reduce economic activity. Changes in institutional relationships could significantly modify individual rights and the political structure of American society.

Energy conservation has often been touted as the way to avoid counterproductive impacts and thus to avoid the negative effects of other direct actions. Claims for the benefits of conservation are valid, but only up to the point where the energy conservation actions do not lead to counterproductive inefficiencies in utilization of labor, capital, or other resources.

PRESIDENTS' FOCUS ON IMPORT DEPENDENCE

Presidents Nixon, Ford, and Carter have all defined the energy policy problem as primarily one of import dependence. Presidents Nixon and Ford defined the import dependence problems as loss of domestic control over domestic energy prices, reduced freedom of action in defense and foreign policies, and reduced control over oil supply security. President Carter has defined it as a future supply and price cruch by focusing on a projected inability of world oil production to keep up with world oil consumption by 1985 or thereabouts.

All three Presidents sought to demonstrate that the various consequences of import dependence are intolerable and will get worse, in order to justify the impacts of their proposed actions on the economic role of energy, rate of depletion of domestic resources, and social factors such as increased Federal power over States, corporations, and individuals. The Congress has reacted over the years by creating a Strategic Petroleum Reserve, increasing energy research and development, setting auto fuel economy standards, fostering increased energy conservation, supporting more extensive State energy planning, and creating the Department of Energy, among other things. But it has been cautious in granting additional powers to the Executive Branch, has limited the Federal financial commitment to energy supply and conservation initiatives, and has restrained domestic energy prices.

Clearly, the Congress has concluded that the import dependence problem, though real, does not warrant a response akin to the "moral equivalent of war."

IS THE IMPORT DEPENDENCE PROBLEM CRITICAL?

The three major Presidential proposals for a comprehensive national energy policy have defined the energy problem in a 10-year context. In the current case, President Carter has specified the probable development of price and supply instabilities in or about 1985 as the basis of the need for urgent action.

The President's energy analysts, and most others, approach world oil supply and demand questions via the "energy gap" methodology. They assume future world economic growth rates mostly on the basis of the economic plans and objectives of other nations. They then extrapolate demand under a range of price assumptions, most of which are not far from "constant in constant dollars throughout the period of analysis." They assume ranges of energy conservation impacts close to those of recent experience.

On the supply side, they examine each country to estimate domestic energy production capabilities, from which they calculate domestic energy demands that cannot be met domestically. These demands, adjusted for small amounts of LNG and other fuels, are then assumed to be met with imported oil. All the national oil import requirements are added up to generate the world oil demand, which is then compared against OPEC production capabilities.

This approach underestimates feedback among energy price changes, economic growth rates, and energy demand growth rate. A major reason for this might well be the undesirable political consequences of forecasting economic growth rates lower than those required to meet the various national economic objectives.

A growing number of economists are nonetheless challenging the energy gap forecasts. It has been difficult for them to rebut these forecasts, however, because their own macroeconomic models are not much better when applied to forecast periods of such length—up to 10 years.

Over the past several months, economists' forecasts for world economic growth have become increasingly pessimistic for the period 1979–80, the only forecast period for which macroeconomic models can make a reasonable case for accuracy. Although this increasing pessimism is based on lower than predicted growth in the Western world over the past couple of years and on economic factors such as investment rates, incompatibilities between the economic objectives of West Germany and Japan, on the one hand, and the U.S. and other oil-importing countries, on the other, inflation and unemployment trends, trade patterns, currency flows, and the like, today's higher energy prices also play a major role.

Since energy demand over the short term is determined primarily by the level of economic activity, the increasingly pessimistic economic forecasts imply a slackening in oil demand compared to the demand levels forecast with the energy gap methodologies. This slackening is already taking place, as is demonstrated by the current soft oil market and the OPEC decision in January 1978 not to raise oil prices. The soft market has been made even softer by the increasing flows of Alaskan and North Sea oils.

The Administration predicts that recovery from whatever economic slowdown develops in 1979–80 will again take the shape of earlier economic recoveries and that energy demand will follow suit. But this view, too, is disputed by some economists, who hold that current higher energy prices will prevent a return to the earlier growth rates achieved when energy prices were lower. According to this school of thought, the dampening effect will take a decade or longer to work itself out through new technologies and other economic adjustments.

Another factor is the rate at which higher energy prices will cause lower energy consumption at a given level of economic activity. This question, too, is controversial, with data available to support the views of both optimists and pessimists. Preliminary estimates of U.S. performance in 1977, for example, vary considerably, with some showing a significantly lower energy demand growth rate for the equivalent GNP growth rate than others. As these preliminary estimates are refined over the next several months, this question will become somewhat clearer, although much room for argument will remain.

In sum, evidence for a world energy supply crunch in the 1980's is not convincing and is getting less so. Evidence is also mounting that the probability of significant economic problems within the next couple of years is getting higher and higher. As will be discussed below, the Administration's most controversial energy proposals have the net effect of either hurting the economy or being neutral to it over the short term, which is the period in which economic problems already threaten. No wonder, then, that Congress is finding a range of problems with the President's Plan, particularly with those parts which have the most serious negative economic impacts over the short term.

WOULD THE NATIONAL ENERGY PLAN SOLVE THE PROBLEM?

The President's National Energy Plan estimated that oil imports in 1985 would be reduced by about 4.5 million barrels per day from the level that would be reached without the Plan. This aspect of the Plan has been universally challenged—by the Congressional Research Service, the Congressional Budget Office, the General Accounting Office, and others. The censensus of these analyses was that there would be much less impact on oil imports than was claimed, because domestic energy production would probably not be as high as was estimated in the Plan and the conservation and conversion programs would be much less effective than was claimed.

The Administration has not effectively rebutted these challenges. It has maintained, however, that the Plan's initiatives are still necessary for the long term and that their passage by Congress would move the country in the right direction while also helping to strengthen the dollar compared to other currencies. The Administration recently granted that there is a danger that expectations of what the energy bill might accomplish in reducing imports and consumption may be too optimistic but claimed that the bill is needed as a demonstration of political will.

What is frequently overlooked when talking about political will, however, is the fact that congressional action in the 93rd and 94th Congresses has already put in place programs to accomplish most of the objectives of the Plan, although by different means in a couple of key areas. What is at stake in these key areas is much more where the money and power flow than where and how much energy flows.

The first key area remaining in dispute is natural gas. The Administration has proposed bringing intrastate gas under control (it is currently not controlled), setting the price for new gas at a level higher than the current interstate price but lower than many existing contracts in the intrastate market, and directing all increased gas costs to industrial and utility consumers for the next several years. This issue does not relate to conservation of natural gas through 1985, since all that can be produced will be sold regardless of price (at least up to the world oil price) but its resolution will affect the amount of new gas produced and the revenues to gas producers.

The second key area is the crude oil equalization tax (COET). This proposal would impose a tax on crude oil to bring its acquisition cost to domestic refiners up to the world oil price despite the continued control on the price the domestic oil producers would receive. Should COET be enacted, revenues will flow to the U.S. Treasury that would, under current law (Energy Policy and Conservation Act, Public Law 94–163, as amended), flow to oil producers, although on a somewhat different schedule. This proposal has the potential to conserve a relatively small amount of oil, would significantly increase Federal Government revenues, reduce oil industry profits, cause some increases (of uncertain size) in the prices of oil products, and keep the Federal Government involved in oil industry pricing decisions whereas under existing legislation (the Energy Policy and Conservation Act as amended) the Government would be phased out of control.

The third key area is the oil and gas users tax designed to stimulate conversion of utilities and industry from gas and oil to coal by making gas and oil more expensive. It would operate in conjunction with an expanded regulatory program, from which industry and utilities can escape on economic grounds. With the tax, the economic grounds would apply to fewer installations than without the tax. This tax could have a significant impact on the amount of oil used.

These three key proposals in continued dispute all have negative economic impacts: they all raise energy costs. The first two, as proposed, also reduce the amount of revenue accruing to domestic oil and gas producers compared to continuation of current policies. The third takes money from industrial oil and gas consumers which, even if rebated for capital-intensive coal-related investments, leads to increased industrial fuel costs.

Thus, all three key controversial proposals have negative effects on the economic role of energy and neutral, modest, and significant impacts respectively on oil imports through 1985. Further, all three increase the Federal presence in private sector decision-making compared to current policies and thus relate to the socal role of energy.

Clearly, the more critical the energy problem is perceived to be, the more willing Congress will be to deal with the economic and social factors involved, provided that resolution of the issues would in fact help to make the energy problem substantally less critical. On this basis, it is not surprising that the Senate version of the oil and gas users tax, which would limit the negative economic impact of the tax compared to the House version, and still have a meaningful impact on oil imports, has more driving force behind it than the House version.

Another major issue yet unresolved in the Congress is the nature and extent of tax incentives for both industrial and consumer investments in conservation and conversion. Since these are economically stimulative, in contrast to the other three issues, they are more likely to receive positive consideration. The major issue is the extent to which they should be applied, in light of their efforts on the Federal deficit directly and inflation somewhat less directly.

Since the immediate driving force for enactment of the energy package has been shifting away from solving the energy problem to helping to solve the problems of international credibility and the falling value of the dollar in international money markets, then some version of these tax incentive proposals has a good chance for passage either as part of the energy package or as part of the economic stimulus package currently under congressional consideration.

CHANGING THE PERSPECTIVE

For the past five years, the energy problem has been posed by Presidents to Congresses as a critical import dependence problem requiring actions whose impacts on economic and social values are justified by the criticality of the problem. So far, those affected negatively, have succeeded in preventing a massive national response to the import dependence problem on the inferred basis that the impacts in other areas created by such a response would be more critical than the impacts of the problem being attacked.

This conflict among economic, social, and security values is certainly real, as the recession of 1974–5 and the current slide of the dollar, among other things, show. But it is intensified by attempts to deal with the import dependence problem more rapidly than the economic system can respond to efficiently and by methods that would change the relationships between the Government and its citizens. Putting the problem in a 10-year context, and looking for a solution that can take effect that quickly is thus having the effect of making a real problem worse without offering much hope of making it better.

Over the next quarter century or so, the current import dependence problem will be resolved through increases in the price of energy phased to permit the American and world economic systems to adjust. One difficulty with this concept is the fact that today's world oil price is high compared to production costs in Saudi Arabia and is held there by a cartel. Another difficulty is the technological optimism that predicts that alternative sources of energy, once on line, will be produceable at costs near, or perhaps even below, today's world oil price. The former consideration is probably academic, since there is little likelihood that OPEC will reduce its oil prices. The latter consideration is a straw being grasped at in hopes that the economic role of energy need not change in the future.

The world is in transition between an era of cheap plentiful energy and an era of expensive plentiful energy. Cheap energy has been available for the past century through exploitation of conventional oil and gas resources. The end of these conventional resources is in sight, which is the basis for oil and gas depletion argument and one reason why OPEC feels justified in raising their price now even though production costs in the major world fields are still relatively low.

There are equivalent energy resources around the world in the form of unconventional oil and gas deposits (tar sands and shale for oil, geopressured waters and Devonian shales for gas, for example), coal, uranium, and the sun's energy in its various forms.

These cannot compete against conventional oil and gas for the simple reason that, with known or foreseeable technologies, they are harder to turn into useful energy forms than are oil and gas. They will become economic when conventional oil and gas become scarce enough for one or more of these alternative sources to become the cheapest sources at the margin. But when they become economic, they will be plentiful both in absolute size of the resource and relative to demand at the prices necessary to bring them forth.

Although one can't be sure how expensive these sources will be when they are the cheapest incremental sources of energy, it appears now that taking into account environmental protection requirements, they will cost from two to three times as much as today's world oil price in today's dollars. Since today's world oil price is about four times its pre-embargo price, this means a transition to energy sources of eight to 12 times those in force when our economy was built.

Thus, in the long run, it is the economic role of energy which must change. It is changing already in response to today's oil prices. Further, since the U.S. cannot supply itself with oil and gas in the volumes demanded at today's world oil prices, and since plentiful alternatives do now and will continue for a rather long time to cost more than world oil, the import dependence problem and the conventional oil and gas depletion problem can only be solved through this change in the economic role of energy. But since the economic role of energy is a major factor in overall U.S. economic health, the rate of adjustment is limited by the extent to which the country can engage in uneconomic activities designed to stimulate production of alternative fuels and conserve beyond the point of economic optimization.

This question of the pace and nature of economic adjustment and who will lead it is what debate over President Carter's National Energy Plan is all about.

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FACT SHEET: PHASE TWO ENERGY PLAN—A SUPPLY STRATEGY

(By Sarah Glazer)*

The policy office of the Department of Energy is in a frenzy of activity reminiscent of the days when President Carter's national energy plan was being pieced together. This time the work is on a sequel: a supply strategy. In its present very preliminary form, the strategy emphasizes federal subsidies for development of synthetic oil and natural gas from coal and oil shale.

The department originally had planned to introduce its so-called National Energy Supply Strategy (NESS) in the spring of 1979, with a detailed study preceding it this fall. The strategy will meet the legal requirement the administration has to update the national energy plan. It also will provide a comprehensive look at the nation's future needs for energy supplies and make proposals for government action.

But by a fluke of history—and congressional pressure—Energy Secretary James Schlesinger has pledged publicly to give Congress a first look at the supply strategy by May 1.

The department had just started to organize into supply task forces when Schlesinger was questioned Jan. 25 by members of the House Science Committee on his department's plans for assuring the country sufficient supplies of energy. Schlesinger replied that his department would have something up to the committee within 90 days.

The secretary instructed his staff to prepare a list of supply initiatives to be sent to the Science Committee in the form of a 25-page memorandum. Assistant Secretary Al Alm's Policy and Evaluation office is organizing the effort, which includes staff contributions from all quarters of the department.

In a meeting with Schlesinger shortly after his promise to the Science Committee, Alm's staff drew up a "wish list" of supply initiatives. The list is heavily weighted toward various forms of federal subsidies for developing synthetic oil and gas from coal and synthetic crude from oil shale.

However, so-called "soft" technologies, a term for renewable resources with decentralized application such as solar and wind energy, are on the list.

Energy conservation, which played no part in the early department discussions of the supply strategy, has since been added to the wish list. A task force has ben assigned to concentrate on conservation initiatives that could contribute to increased supplies.

How Congress will react to the upcoming proposal is uncertain. For one thing, it will be somewhat limited in scope, containing only those

*Sarah Glazer is a member of the Environmental Study Conference, an informal and impartial bipartisan legislative research organization made up of 300 members of the House and Senate. The fact sheet appears in the Congressional Record, Feb. 27, 1978, p. S2430–32. Reprinted by permission.

ideas already studied by the Energy Department. Yet, some of these ideas will constitute major new, and potentially explosive, initiatives for Congress. For another thing, the proposal will not be very specific and will not be in legislative form.

Still, members may seize on the proposal to boost certain programs. And the administration itself apparently is considering certain budget amendments, such as boosting fossil energy R&D, to meet some of the initiatives in the upcoming proposal. Budget reprogramming proposals for fiscal 1978 and 1979 also may come out of the administration.

However, in view of the already heavy legislative workload and this fall's elections, Congress appears unlikely to start moving any major new legislation this session.

Besides the Science Committee, DOE probably will send its proposal to other House energy committees and the Senate Energy Committee.

Another aspect of the department's work on this spring's proposal is a study of how much energy will be needed in different sectors of the economy between now and 1990. The department's computer is running through both original and secondary data to look at the problem.

The goal of the supply strategy is to eliminate domestic dependence on oil imports. The national energy plan called for a reduction in oil imports to seven million barrels per day by 1985. The supply strategy supposedly would reduce imports to close to zero.

The department sees the scarcity of liquid and gaseous fuels as the crucial problem arising in 1985 to 1990 and thus proposes programs to develop domestic oil and gas sources by that period.

The department's main premise is that oil prices will probably double by 1985—up to about $25 per barrel. This figure was originally postulated by Deputy Energy Secretary John O'Leary. If this price is reached, DOE assumes that synthetic fuels, which are now uneconomical could be competitive by 1985.

If world oil reaches $25 by 1985, a January DOE memo noted, "we should be willing to guarantee up to 25 dollars/barrel" for synthetic liquid fuels or $4.50 per thousand cubic feet for gas from unconventional sources.

PROJECTS UNDER CONSIDERATION

The department has divided work on the supply initiatives into about a dozen task forces. In addition to conservation, task forces are studying at least another eight technology areas. In addition, the department is looking at areas that cut across technology lines, such as impacts on the environment and economy.

The tentative proposals being considered are outlined below. The information comes from a DOE memo summarizing a January 27 meeting with Schlesinger on the supply initiatives memo.

Many proposals may be dropped or added before this spring. At press time, however, knowledgeable department sources said it still represents the rough outlines of current thinking.

Solvent Refined Coal

DOE would build one demonstration plant by 1982–1983 in the so-called SRC method, which produces a low-sulfur solid or liquid material from coal. The plant would produce about 20,000 barrels per day.

Under consideration for a possible demonstration plant is a proposal by Gulf Oil Corp. to use the SRC method. However, Gulf's product may be too expensive, perhaps more than $30 per barrel.

Synthetic Fuels

According to the memo, regulatory measures could be used to require 5 or 10 percent of all petroleum products sold to be from unconventional sources, such as synthetic fuels and alcohol, by some target date in the future. This method could save up to 600,000 to 700,000 barrels of imported oil per day by 1990, administration staff estimate.

Issues raised by this option would be how to handle imported products, how to guarantee some form of equity among producers and the time for phasing in the regulations.

One thought is to institute an entitlements program along the lines of the current program that distributes nationwide the high cost of foreign oil among domestic refiners. For refiners dependent on expensive foreign oil, the current program gives a credit for the price difference between lower priced domestic oil and foreign oil. Those areas that use mostly domestic oil must pay the difference between the domestic and world oil price. High-level officials are considering plugging high-cost synthetics into the equation. The effect would be to average high cost synthetic liquids into the cost of all oil.

Oil Shale

The government would guarantee prices to oil shale companies. Competitive bids could ensure that the guaranteed price would be as low as possible.

Oil shale might also be included in the proposed 5 to 10 percent requirement for unconventional liquids in the petroleum supply.

Oil shale, a combination of "marlstone" rock and an organic material called kerogen, produces a crude oil product when heated to very high temperatures. The richest reserves are located in Colorado's Piceance Creek Basin, below the western slope of the Rocky Mountains.

Synthetic Gas

One proposal envisions federal guarantees of loans for five large plants totaling 250,000 barrels per day in capacity.

Issues include whether to go with loan or price guarantees, the policy for liquefied natural gas, and what regulatory authority the administration has to take action in this area.

Unconventional Gas Sources

This would include expensive, exotic sources of natural gas such as geopressurized methane. Possible proposals include price guarantees of up to $4.50 per million Btu (British thermal units) by competitive bid for a set capacity and a government drilling demonstration program. Unconventional gas could be included in a program like that suggested for synthetic fuels, where a percentage of pipeline gas would have to be unconventional.

Soft Technologies

Proposals under consideration would include accelerated R&D programs and building demonstration plants to turn waste—such as wood chips—into energy and community-scale heating plants.

Among the options under most active consideration are alcohol from biomass (i.e. waste products like grain), direct burning of garbage for electricity, small-scale hydroelectric plants and wind energy.

Special concern is focused on which of these options would substitute most effectively for scarce oil and gas.

Industrial Coal Program

A number of incentives are under consideration to promote three technologies to cut down air pollution from coal burning. Included is atmospheric fluidized bed combustion, a process which eliminates through a chemical process most of the surfur from coal as it burns in a limestone bed. Another candidate is scrubbers, the prime technology now used to cut emissions in the stack. The third is coal-based gas with a low heat content, also known as low-Btu gas. Low-Btu gas is an industrial fuel. It is not practical for use in pipelines because of its low heat content, but is useful for generating electricity.

Incentives under consideration for these technologies include:

A tax credit or fast write-off

A regulatory program requiring either direct burning of coal or a choice of the above technologies

A federal purchase subsidizing one third or one half the cost of installing the above technologies.

An important issue is how such a program would relate to the national energy plan—particularly the portions requiring industry to convert to coal and encouraging conversion through taxes. The regulatory conversion portion has been approved tentatively in conference. Additional legislation may be needed.

MEDIUM-BTU GAS

Also under consideration for federal subsidies is synthetic gas from coal with intermediate heat content (between the heat content of natural gas and low-Btu gas). Medium-Btu gas is considered unsuitable for pipeline transportation, but can be useful for heating and for industry near the site of production.

The proposal would pay 25 to 50 percent of the cost of the first few years of projects for use in industry complexes or in heating plants on a community scale. Administration staff note that subsidies may be tricky for this proposal because community programs are complicated.

THE CONGRESSIONAL OUTLOOK

Perhaps the most frequently heard congressional criticism of President Carter's national energy plan was that it focused on energy conservation, without enough emphasis on increasing new sources of supply. The administration defended its approach by saying conservation is a cheaper source of supply than actual production, but opponents never bought the argument.

Demands for supply initiatives, in fact, may spell death of the pending energy package, which has languished since Christmas. Sen. Long (D-La.), chairman of the Senate Finance Committee, proposed to turn the revenues from the administration-proposed crude oil tax into a trust fund for producer incentives. Carter originally proposed to rebate those revenues to consumers. A vigorous floor fight is expected if this issue ever reaches the floor again.

Long is a key factor in the conference on the tax portion of the national energy plan. The conference is not expected to reconvene until conferees on the natural gas portion of the plan have reached agreement. Even if agreement is reached on natural gas, however, Long's staff is proclaiming the plan politically dead. Congress is not likely to vote for Carter's tax increases by the time they reach the floor—close to campaign time.

There is some speculation that the administration sees supply strategy as a lever to get the Congress moving again on the energy package. But the ploy probably will not work unless the administration shows a willingness to be more flexible than it was the last time around. The administration has continued to insist that all five bills in its energy package be passed together—or not at all—even though three of the five bills are close to congressional approval.

THE REAL PHASE TWO

The Energy Department is still planning to go ahead with its plans for developing a comprehensive supply strategy, although the sudden gearing up for the "eight-week wonder" could throw off its original schedule. The policy office is shooting for the end of March to send a draft to Schlesinger.

As part of this long-term process, the department plans to rectify some of the mistakes of the past. In particular, it plans to reach out to Congress and outside groups. By May 1, administration staff promise, they will have started a process for bringing in outsiders for suggestions.

The promise has not proved reassuring to the environmental community which is already up in arms over the way phase two is being handled.

The Natural Resources Defense Council, an environmental law firm, has written to Schlesinger urging him to establish briefings and meetings for public involvement immediately. NRDC also is urging that the department prepare a draft environmental impact statement to accompany phase two through the decision-making process.

"One of the great failures of NEP (national energy plan) has been its hasty and basically internal development, resulting in no discernible constitutency which is prepared to work for its passage," NRDC declared in its Feb. 17 letter. "It would be the height of folly to repeat those mistakes in developing phase two."

Even as members of Congress are urging quick results on an energy supply strategy, NRDC, the Sierra Club and other environmental groups also are pushing a go-slow approach. They would prefer that the department study long-term needs and initiatives in an orderly fashion.

A more deliberate pace would probably help the role of "soft technologies" such as solar energy. A high-placed DOE official working on this section of the supply strategy noted that there is less information right now on the contribution that renewable technologies can make to the nation's supply than there is on other energy sources. As a result it is hard to justify proposals for federal help in these areas with only eight weeks of preparation.

Environmental groups have expressed great concern over the short shrift that the supply strategy seems to be giving to renewable technologies. Some have termed the new proposal former Vice President Rockefeller's "Energy Independence Authority warmed over."

In the past, environmental groups have fought federal subsidies for synthetic fuel development. They have argued that federal loan guarantees, for example, will divert investment in a capital-short market from more environmentally desirable energy sources.

Proponents of loan guarantees have argued that federal backing is necessary to answer investors' doubts about the viability of coal gasification and oil shale development. Environmentalists answer that if the projects are so risky, the government should not subsidize them.

There are numerous environmental problems associated with oil shale and coal gasification, both of which are expected to lead to extensive strip mining in the West. In addition, the processes require vast amounts of water in areas where water is already scarce for agricultural and other uses.

At least some segments of the department are pushing oil shale as the most economical contender to replace oil imports. The government controls 80 percent of the shale-bearing lands in the nation, and some government estimates say oil shale can be produced at $10–17 per barrel.

One DOE memo calls oil shale's environmental problems "difficult" but "not insurmountable if the western region has the political will to develop" the resource.

Environmental groups would disagree with this assessment. Oil shale ranks as the least favored synthetic fuel of the Environmental Policy Center, the environmental group that has been most active in the synthetic fuels debate.

The richest oil shale lands are concentrated in Colorado in what some consider the most magnificant natural part of the state. Since it takes a lot of shale to produce a barrel of oil, the technology would produce vast amounts of unused waste rock, which would have to be disposed of in canyons or valleys.

PART TWO

Resolved: **That the Federal Government should exclusively control the development and distribution of energy resources in the United States**

. . . Federal energy policy in the past . . . has relied to the maximum degree on private enterprise to make the major investment, development, and pricing decisions affecting energy supply. . . .—*Frances A. Gulick*

The President's proposals would, without solving the problem, significantly centralize in the Federal Government the power to make energy pricing and management decisions currently made throughout the private sector.—*David E. Gushee*

. . . the normal functioning of our economy will not . . . produce the capital investment required to fully develop alternative energy resources within a reasonable period of time . . . .—*Vice-President Nelson A. Rockefeller*

Perhaps a federal company that competed with the private companies in exploration for oil and gas could do a better job of discovering new reserves, thereby increasing domestic supplies at lower cost . . . .—*Robert Pindyck*

As each level of government begins to take more extensive energy action, the issue of the division of state and federal authority becomes more complex. . . . either cooperation must be generated or conflict will ensue. . . .—*Jon Mills and R. D. Woodson*

[Coastal zone] law seeks to reconcile what is inherently irreconcilable—the many conflicting public and private interests that are pushed and pulled in a giant tug-of-war within and among three competing levels of bureaucracy: federal, state, and local . . . .—*Conservation Foundation*

Unfortunately, judging from federal leasing trends of the past ten years or fifteen years, consistent and rational policies are either nonexistent or, if they exist at all, they don't reflect any effective management . . . .—*Courtland Lee and David Russell*

In order to adequately determine the extent of all of America's energy resources, the Federal Government may find it necessary either to undertake to directly determine the size of these reserves, or to provide incentives for private industry to commit capital and manpower to the task under some sort of mandatory reporting procedure . . . .—*From Petroleum Industry Involvement in Alternative Sources of Energy*

The effort to break oil companies up seems to have lost its impetus. Therefore, the best way to check their growth and their alleged power seems to be to keep them out of, . . . other forms of energy . . . .
—*James Flanigan*

The comprehensive national energy policy that most professional economists . . . appear to favor is one which limits government intervention in resource allocation to correcting for clearly demonstrated significant externalities. Otherwise, the market, not government, should be allowed to allocate scarce resources among competing ends.
—*Walter J. Mead*

A. The Energy Independence Authority

STATEMENT OF NELSON A. ROCKEFELLER, VICE PRESIDENT OF THE UNITED STATES*

Vice President ROCKEFELLER. Mr. Chairman, distinguished gentlemen, I am very grateful for this opportunity to appear before your committee. I think perhaps I would do better going through the prepared text first and then come to some of the very provocative statements or questions to which you wish to get an answer. So perhaps I will just go through this to give it a backdrop and then make a few comments on the questions . . . .

I appreciate this opportunity to join with you to discuss the most challenging problem of a challenging era—the energy crisis.

First, I would like to ask, and then answer, the following questions: (1) Is there really an energy crisis? (2) What happens if we just continue as is—to depend on increasing foreign imports to meet our Nation's growing energy needs? (3) Do we, as a nation, have the resources and capacity to achieve energy independence? (4) What does it take to do it? (5) Why does government have to get into it?—Why isn't private enterprise doing it? (6) How can government play an appropriate role in achieving energy independence without subsidizing private interests, or without interfering with the free enterprise system? (7) If the answer to getting us off dead center is an Energy Independence Authority, as provided for in Senate bill 2532, how would it work? (8) With an all-out national effort, how fast can we expect to achieve the goal of energy independence?

I. IS THERE REALLY AN ENERGY CRISIS?

Unfortunately, many Americans do not believe the energy crisis is real because there is no tangible evidence of it. There is gas in the pumps and the lights go on when they flip the switch. They recognized it 2½ years ago during the Arab oil embargo when the lines formed at the service stations. But there are no lines now because we are importing 40 percent of the oil consumed in this Nation.

In 1960, we received 18 percent of our oil from foreign sources. During 1 week last month, our foreign oil imports reached more than 50 percent of our total consumption. Even more alarming is the fact that the proportion of our imports which comes from unstable Mideast sources is rising faster than the growth rate of our imports as a whole.

While imports rise, domestic production in both oil and natural gas is declining. The Northeastern part of this country is now dependent upon foreign sources for 73 percent of its oil. If this supply were suddenly cut off, there would be social and economic chaos.

*Given before the Committee on Banking, Housing and Urban Affairs, United States Senate, Apr. 12, 1976, pp. 2-9.

Should we have another embargo, the economy of this country would be shattered. Today's energy situation is, in my judgment, a clear definition of a crisis.

II. WHAT HAPPENS IF WE JUST CONTINUE AS IS—TO DEPEND ON INCREASING FOREIGN IMPORTS TO MEET OUR NATION'S NEEDS?

Between now and 1985, our energy needs will grow by 36 percent. If we continue our current course, and continue to regulate oil and natural gas prices at current levels, if we do not develop our current reserves, if we fail to increase the generating capacity of nuclear plants, if we do not adopt a strong program of conservation, and if we fail to commercialize new sources of energy, such as gas and oil from coal and shale, we will be importing between 50 and 60 percent of our oil in 1985. And it will cost us in foreign exchange not $30 billion, as it will this year, but $50 billion by 1985. It is obvious what a threat of an embargo would do to our national security and defense capabilities under such circumstances as well as to our capacity to meet our responsibilities to the other nations of the free world who, without our protection, would be equally vulnerable. I am hesitant even to speculate on the kinds of economic, political, and military pressures that could be imposed on this Nation if we continued to be more than 50 percent reliant on foreign sources.

With such a large amount of the oil coming from one area of the world, the supply lines provide a tempting opportunity for the Soviet Union, with its growing sea power, to disrupt the transport on the high seas. But there are other serious consequences that could result. The continued dependence upon foreign sources of oil could cause us to lose credibility with our allies. They would be justified in asking whether or not we would support their interests against those of our oil suppliers. Our continuing dependence on imported oil threatens our ability to maintain our leadership in the free world, our economic well-being and our national security.

Now, let's look at what happens to our economy, if we continue along our present path of depending on increasing foreign imports to meet our Nation's growing energy needs. In 1973, we were spending $4.3 billion annually for foreign oil. And in 1976 we will spend $30 billion. We now export $22 billion in agricultural products—which is up from $8 billion in 1973. Were it not for the sale of these farm products and the sale of $10 billion worth of arms, we would not have maintained our balance of payments.

On the other hand, if we just continue on the present course, we will be spending up to $50 billion overseas for imported oil to meet the growth in our domestic needs. On the other hand, if we were to spend the $30 billion at home, it would provide jobs for at least 1,200,000 people. And, by 1985, $50 billion spent at home to produce our energy requirements domestically would produce close to 2 million jobs for American workers.

If we don't follow this course, at some point, the economics of business will compel industrial concerns to locate their facilities in close proximity to energy sources abroad, rather than to their markets and customers at home. This would mean an additional loss of jobs in this country and would be detrimental to the vitality of the entire American economy..

As energy costs rise due to the arbitrary action of the OPEC cartel over which we have no control, inflationary pressures are placed on our economy. When this occurs, there is a tendency for government to enact policy which inhibits economic growth. To continue along our present path spells economic, social and political chaos.

III. DO WE AS A NATION HAVE THE RESOURCES AND CAPABILITY TO ACHIEVE ENERGY INDEPENDENCE?

The answer is yes. We are extremely fortunate as a nation to have vast reserves of resources that can be converted into energy. The North Slope of Alaska will make available significant amounts of oil and natural gas. And we have known reserves of coal that will last us for at least 100 years. It is estimated that our shale oil reserves are equivalent to four to five times the total amount of known oil reserves in the Middle East. The potential resources on the Outer Continental Shelf are expected to be substantial. We have the technology and ability to more than triple the generation of nuclear power with appropriate safeguards by 1985. We have, in this country, potential energy from geothermal, solar, and other sources. All of these can replace our dwindling present domestic supply of natural gas and oil—in a way that protects our environment.

To achieve energy independence in this century, we must develop and construct the facilities necessary to exploit these new sources and we have already lost 2 years in getting started.

IV. WHAT DOES IT TAKE TO DO IT?

To achieve energy self-sufficiency we must, in the short term, face up to the issues that confront this Congress and the American people. We must enact and employ conservation measures. We must deregulate the prices of domestic oil and gas. We must assure that we do not unduly impede the development of nuclear power. And we must assure that our environment is protected, but that the policies we adopt in doing so do not deter the development of our resources, such as coal, oil shale, and offshore oil reserves. There is no problem in achieving both goals if we all work together. Modern science and technology can assure the achievement of both goals together.

According to Federal Energy Administration estimates, if we take all the necessary actions in the next 10 years we can reduce our energy needs by 5 percent through conservation, increase domestic oil production by 50 percent, increase coal production by 100 percent, increase natural gas production by 10 percent, and increase nuclear power generation by 300 percent. This will require, among other things, deregulation of oil and gas, strong conservation measures, and $600 billion to $800 billion in private sector investment in domestic energy production and conservation. We must restore existing and construct new transportation systems where necessary. In the longer term, we must commercialize known technology for the gasification and liquefaction of coal.

And, as new technologies become known for the development of such energy sources as solar, geothermal, and urban wastes, they can be applied commercially. Energy independence can be achieved from the application of all of these approaches before the end of the century if we have an all-out national commitment.

V. WHY DOES GOVERNMENT HAVE TO GET INTO IT?

Why isn't private enterprise doing it? Energy independence is a national objective that is essential to the economic and strategic well-being of this Nation. Private enterprise alone cannot and will not do it. There is ample precedent for positive Government action to encourage the American enterprise system in achieving national objectives that contribute to economic growth, the well-being of our people, and our national security.

We have a transcontinental railroad system because the Government provided the land. We have a uniquely productive free enterprise agricultural system because of assistance by the Government through the Homestead Act, land grant colleges, the Extension Service, and the Federal Agricultural Credit System. Our civilian aviation industry evolved from the research and development of military aircraft. Because of the billions of dollars spent on our highway system by all levels of Government, we have a prosperous automotive industry which is basic to our economy. All of these are examples of the partnership between Government and industry to achieve an essential national goal which was not attainable by either acting alone.

In the case of energy, we have the raw materials to achieve self-sufficiency. However, the normal functioning of our economy will not, because of the uncertainty of the risks involved, produce the capital investment required to fully develop these resources within a reasonable period of time. Private capital sources are—for good reason—reluctant to make capital available for domestic energy production projects because of the uncertainty of Government regulation, cost and prices. For example, the development of a single coal gasification plant would require a capital investment of up to $1 billion and take approximately 6 to 10 years to construct. Because of the uncertainties of the technology and price and the long leadtimes, such a project has more than just the ordinary risk. Many projects, such as floating nuclear powerplants, railroad reconstruction, or large pipelines, are of such size and scope that financing from the private sector alone may not be adequate. Because the electrical utilities have not been able to raise the financing necessary to construct them, 92 nuclear powerplants have been cancelled or postponed, in large part. They now take 10 or more years to build, cost approximately $1 billion, and the State regulatory bodies will not give a rate increase to finance them until the power from the new plant comes on line; thus, their inability to get private financing.

This is not to suggest that these projects are destined to lose money. It only points out the uncertainties that deter private sector investment. We are not in a position to wait until these uncertainties become certainties. The longer we wait, the further into the future we push the day when these projects will add to our domestic energy production.

VI. HOW CAN GOVERNMENTAL PLAY AN APPROPRIATE ROLE WITHOUT SUBSIDIZING PRIVATE INTEREST, OR WITHOUT INTERFERING WITH THE FREE ENTERPRISE SYSTEM?

Government has traditionally played a role of providing incentives in one form or another to assure that adequate capital is available to the private sector in achieving national objectives. In this case, the

Government's role would be to provide up to a total of $100 billion of risk capital for energy projects essential to energy independence which cannot get the necessary amount of private financing. The Government loans would be on terms comparable to those offered by the private sector. In financing the development of energy resources, the Government program should function like an investment bank or other private sector financing agency—providing assistance to promising projects, but on a self-liquidating basis. This would provide an appropriate Government/private sector partnership which would work together to get this country off dead center in achieving energy independence without a giveaway or subsidy.

The legislation stipulates that the private sector would own and operate productive facilities and not the Government. The American enterprise system has shown itself to be the most efficient and capable producer in the world. By providing financial assistance to take those risks which are beyond the capacity of the private sector, the Government would act as a catalyst in getting the energy independence program into motion.

But after costs were determined and market prices established, then the competitive nature of our system would provide the incentives necessary for the successful achievement of our energy independence goals.

VII. IF THE ANSWER TO GETTING US OFF DEAD CENTER IS AN ENERGY INDEPENDENCE AUTHORITY, AS PROVIDED FOR IN SENATE BILL 2532, HOW WOULD IT WORK?

The Energy Independence Authority would have authority to provide up to $100 billion of financial assistance for energy projects which could not otherwise secure financing from private sector sources. This sum would be raised through the sale to the Treasury of up to $25 billion in equity securities and the issuance of up to $75 billion in Government-guaranteed obligations. The Authority could provide financial assistance in a variety of ways, including loans, loan or price guarantees, purchase of equity securities, or construction of facilities for lease-purchase. The Authority would not be permitted to own and operate facilities, or to provide financing at interest rates which are below those which prevail in the private sector. The Authority would be authorized to support emerging technologies in energy supply, transportation or transmission, and conservation, projects which displace oil or natural gas as fuels for electric power generation, projects which involve technologies essential to the production or use of nuclear power and projects of unusual size or scope or which involve innovative regulatory or institutional arrangements. It is also authorized to finance capital investments necessary for environmental protection. The Energy Independence Authority would be run by a board of 5 directors appointed by the President and confirmed by the Senate.

VIII. WITH AN ALL-OUT NATIONAL EFFORT, HOW FAST CAN WE EXPORT TO ACHIEVE THE GOAL OF ENERGY INDEPENDENCE?

With an all-out effort—based on the establishment of the Energy Independence Authority to assist in financing the short-term actions required to limit our vulnerability by 1985, as well as the new domestic energy sources we will need after 1985—we can achieve energy independence before the end of this century. But time is of the essence. We cannot wait another year if we are going to protect our national security and rebuild our economic strength to meet the needs of our people at home and our responsibilities abroad. The time to act, in my opinion, is now.

Mr. Chairman, if I may comment briefly on a few of the comments you made, you pointed out that the private market was a pretty good jujdge of what was sound, and that if the thing is sound the private market would do it.

The problem we face here is that we are in a situation where the OPEC countries have acted on a political basis, not on a free market basis, to raise their price of oil in the world market. At home, the President has declared that our national policy is that we shall be independent as far as the production of energy is concerned.

Both of these statements—first the action by the OPEC countries and the statement by the President—cut across a free world market. The energy companies, I think many of them, are hopeful that the OPEC cartel will break up and that they will go back to cheap oil. If that is the case, then why bother to spend money for higer cost production here at home, and that's a question, too.

The risks are very great because we have price control on natural gas and price control on oil. Therefore, it's hard to judge, if you produce new sources from new sources, whether your costs are going to relate favorably to controlled prices. We don't have a free market on prices. This concern is understandable because we have been through a period of rapidly rising costs and the Congress has taken action to hold down prices. However, this does adversely affect the free market, and does not support our national security or national well being. Therefore the EIA proposal is devised as a means whereby, during this interim period, an evolutionary period, as we adjust to higher world prices, the government can take those steps which are in the national interest. As and when these steps are taken, the properties would be sold and if there's a profit the government would realize this profit. It would not only get back its initial investment but would get back the additional money which would derive from the profit.

For instance, the production of oil from shale is still an unknown field on a commercial scale. A commercial operation would cost in the neighborhood of $200 million. We have reserves of 4 or 5 times the known reserves in the Arab world. To develop these reserves and find out what those costs would be is very much in our national interest. No private company is willing to do it because they don't know whether they would lose the $200 million and therefore they would rather go somewhere else.

This I think is the kind of thing which the government can contract for, just the way we did under the RFC with the Rubber Reserve Corp., when Jesse Jones set it up. They contracted with, I think, 6 private companies to develop synthetic rubber. Four or five processes were successful, but the whole thing was sold and we developed as a result a new industry in the United States.

This has been the history of this country and as far as the size is concerned, which is the second point you raised, $100 billion in relation to $6 or $8 hundred billion to achieve energy independence, in my opinion, is—in relation to costs today, and it's estimated that in the next 30 years we're going to use $4 trillion of new capital investment to meet the demands for growth—this is not a large amount. It is large in terms of the past, but not large in terms of where we are today or in the future.

So, from the point of view of size, the costs are astronomical in terms of our traditional way of thinking, but I think this is the time for bold action in this country if we want to preserve our leadership both in terms of economic growth at home and in terms of our responsibilities in the world.

So to me this is not one-quarter of our annual budget and it's not federal spending.

As to whether it's a blank check, of course, the definition of a blank check I guess would be a question as to Congress' control over the individual expenditures. In our system of shared responsibilities, as I understand it, the Congress sets the policies, creates the framework of laws within which then the executive branch and private enterprise operate, so any well organized banking institution would be structured within this framework—and this would be equivalent to an investment bank. We had an example with Jesse Jones from the RFC, which was designed for a slightly different purpose, but the same concept. It depends on whether it's well run. Obviously, they're not going to make irresponsible investments if they are properly run. A board of 5, appointed by the President, approved by the Congress, has got to be made up of men and women of outstanding ability and character. They would be audited, so there's no question on that. I just think to say that it's a blank check implies that there's no control or that there would be no judgment or wisdom exercised in the making of the loans. The objectives in the legislation say the loans shall only be made for those projects that contribute to energy independence which cannot receive private capital. Since there's plenty of competitive interest in providing private capital between existing investment houses if the risks warrant the investment. Under the law, as you know, you cannot make an investment if the risks are beyond what seems reasonable or you're subject to suit by the investors.

So that there are limitations which are very sharp, but national interest dictates in my opinion that certain risks be taken which may contribute in a major way to the independence of this country in energy. We have the capacity. It's just a question of finding out what the costs are in various forms of energy production domestically, and I don't think we can overstress the importance of investing the $30 billion we now spend to import oil—$50 to $60 billion later—in the United States for U.S. employment as distinct from sending this money abroad. . . .

B. The Federal Role in Developing New Energy Supplies

SHOULD THE FEDERAL GOVERNMENT ENTER THE OIL BUSINESS?

(By Robert S. Pindyck)*

It is not surprising that Congress has become interested in proposals to push the federal government into the oil and gas business. After the Organization of Petroleum Exporting Countries (OPEC) succeeded in quintupling world oil prices, the big oil companies found themselves more and more in the position of the middleman who purchases crude at a price that he cannot influence and takes a percentage markup on refining and selling. It thus seems reasonable to suppose that a federal company which had the sole right to import crude might have a stronger hand in negotiating prices with producer governments. Also, if that federal company accepted imports only under a system of sealed bids, the OPEC countries might have an incentive to undercut the cartel price in secret. In addition, the exploitation of untapped oil and gas reserves in the United States is now correctly seen as a critical factor in our ability to achieve a greater degree of energy self-sufficiency. Perhaps a federal company that competed with the private companies in exploration for oil and gas could do a better job of discovering new reserves, thereby increasing domestic supplies at lower cost.

There are a variety of proposals to establish a Federal Oil and Gas Company (FOGCO), each of which differs from the others in the extent of government participation recommended. These proposals raise issues involving not only the structure of domestic and world oil markets, but also the relative performance of public and private companies. We shall examine some of these issues in an attempt to evaluate the more representative plans.

PROPOSALS FOR A FEDERAL OIL AND GAS COMPANY

Three proposals stand out as most representative of the growing interest in federal participation in the oil business. The first has been made independently by Senator Frank Church and by the Executive Council of the AFL–CIO. This proposal would limit federal involvement in the energy business to a government monopoly for all oil and gas imports. The argument is that the private oil companies, competing among themselves to purchase crude oil from suppliers that are now sovereign states, have no power to negotiate lower prices. A federal import monopoly, on the other hand, would negotiate very large contracts and therefore be in a better position to obtain a lower price. In addition, by acting as the sole distributor of imported crude, the federal company could guarantee that the big private companies did not restrict the flow of supplies to small distributors, thereby squeezing them out of the market.

*Reprinted from *Challenge; The Magazine of Economic Affairs* by permission of M. E. Sharpe, Inc., White Plains, New York 10603. May–June 1976, p. 48–51. Robert Pindyck is Associate Professor of Economics, Sloan School of Management, Massachusetts Institute of Technology.

The second proposal, made by Senator Henry Jackson, also recommends that the federal government be the sole importer of crude (both for immediate distribution and for stockpiling), but under a system of sealed bids. The system would require anybody who wishes to sell crude to an American importer to make a sealed bid stating quantity and price. Since bids are secret, there is an opportunity for individual OPEC countries to undercut the cartel price without being found out. In addition, since bidding is competitive, there is an incentive to undercut for fear of losing part of the export market to another country that may submit a lower bid. Senator Jackson would have the federal government, rather than the private companies, act on all bids, thus increasing the stakes for undercutting—or refusing to undercut.

The most extensive proposal has been made by Senator Adlai Stevenson. He envisions a government-owned company that would explore for oil and gas, and exploit up to 20 percent of the Federal oil and gas reserves that the Administration is now trying to lease to private companies for development. This company would also have the sole right to import crude from foreign suppliers, it would ensure the delivery of sufficient supplies to small distributors, and it would even produce its own refined products to be sold to small companies. Senator Stevenson argues that by entering into the search for oil and gas, the federal company would stimulate competition among private firms and speed the exploitation of untapped reserves. The benefits that would arise from the monopoly on imports are similar to those cited by Senator Church in his proposal.

These proposals raise some interesting questions. If a federal company had sole rights to import, would its monopsony power really result in a lower import price? If a federal company imported under a sealed bid system, would this actually encourage price cutting by OPEC members? Would a federal importing company be a truly efficient means of making sure that the large companies did not squeeze the independent distributors out of the market? And finally, can we except a federal company to do a better job of finding oil and gas than the private companies?

WOULD A FEDERAL MONOPOLY ON IMPORTS HELP REDUCE THE PRICE OF OIL?

The Stevenson and Church proposals are based in part on the fact that it is not necessarily in the interest of the private oil companies to bargain hard for low prices on imports. The reason, of course, is that the private companies make much of their profit from the domestic reserves they own, and these reserves increase in value when OPEC raises the price of its oil. A federal importing company (if it did not also own domestic reserves) would not have this conflict of interest, and would bargain for a lower price.

But it is doubtful that the federal company would succeed in obtaining a lower price. Stevenson and Church assume that the federal importing company could exercise effective monopsony power in purchasing crude from producing countries. Unfortunately, for a monopsony to be effective it must be willing to cut back on its purchases if the price is too high. This means that the government must be prepared to precipitate a reduction in imports if the producing countries do not offer "reasonable" terms, that is, it must demonstrate to producers that its impact demand is elastic. It appears, however, that import demand, at least in the short run, is fairly inelastic: neither the Congress nor the Administration seems amenable to accepting sudden reductions in imports (and they should not be—witness the effects of the 1973 embargo).

Even if the U.S. could accept sudden import drops, the effect on OPEC would be limited, since this country accounts for only some 10 percent of total OPEC exports. Thus, unless Japan and the European countries could agree to form a "buyers' cartel" together with the U.S. (which seems highly unlikely), the monopsony power of the federal oil company would be quite small. American threats to cut imports by, say, 2 million barrels per day would simply not succeed in forcing OPEC to reduce its price, particularly in view of the fact that the cartel seems to be able to function quite well now with an excess capacity of around 12 million barrels per day. Furthermore, the major oil companies can purchase bulk orders, many of which are resold outside of the United States. These orders allow more room for price negotiation (and for price undercutting by cartel members) than would orders to a federal importing monopoly.

It therefore does not appear that a federal company would have the economic power to negotiate lower import prices. A federal company could, of course, supplement economic pressure with political pressure in the bargaining process. However, the U.S. government could apply political pressure to the OPEC countries no matter who does the importing. That it has not yet done so is partly due to a desire to maintain its position as mediator between Israel and the Arab countries, a position that could be damaged by excessive political intervention in the world oil market.

Senator Jackson's proposal is perhaps more interesting, for he relies on the sealed bid system to encourage cheating among the OPEC members. The sealed bid system is in fact an excellent idea, and provides at least some promise of weakening the cartel. But the effectiveness of the sealed bid system does not depend on having the government do all of the importing. If anything, a government monopoly on imports would make cheating less likely since there would be more chance of prices becoming public knowledge, and there would be no opportunity for companies to resell or transfer contracts to each other, thereby confusing the terms of sale.

A more effective scheme was suggested by Professor M. A. Adelman of MIT (*Challenge*, January/February 1976). Under the Adelman plan, import quota tickets would be sold by the government—the Federal Energy Administration (FEA) could do the actual selling—and anyone inside or outside of the United States who was willing to pay cash could bid for them. Each ticket, for example, might give the holder the right to import one barrel of oil. One use of the quota tickets, of course, would be to restrict oil imports by limiting the number issued, but that is not really our concern here. The tickets would also provide a means for OPEC countries to undercut price. The tickets would be freely transferable, and an active resale market would be encouraged. The system would therefore work by permitting OPEC countries to establish "front men" (brokers) who would bid for and purchase quota tickets in the United States.

Suppose, for example, that Libya would like to sell a certain quantity of oil to the United States and was willing to do so at a price $2.00 below the posted OPEC price. Then a broker (representing Libya) would bid for and purchase an appropriate number of tickets at a price of $2.00 per ticket. The tickets could then be transferred to an importing company in return for an agreement to buy oil from Libya. This kind of price undercutting would be hard to detect, since Libya would appear to be selling oil at the posted price, but in fact would be giving a $2.00 "rebate" to the U.S. Government in return for an assured sale. Note that this plan depends on having the private oil companies do the importing. If only a federal oil company imported, it would not be possible for OPEC companies to employ brokers to buy and transfer quota tickets.

It should also be noted that some of the OPEC countries would favor a centralization of all sale operations through the Secretariat in Vienna. Centralization of sales is difficult for any international cartel, and would be particularly so for OPEC, since it would create numerous strategic and political problems. If centralization did occur, however, the cartel would be strengthened considerably, and none of the schemes mentioned above would be effective in weakening it.

As we have seen, a federal monopoly on oil imports is not likely to achieve a reduction in the price of oil. But would such a monopoly at least serve to protect the small independent oil companies? It could be designed to do so, but would require a distribution scheme so elaborate, not to say inefficient and certainly costly, as to be a significant drawback for any federal oil company. An easier way to protect the independents would be to give them the right to purchase specified quantities of oil from the larger companies at a set of average prices. Under the current system, private companies can contract for imports to meet their planned future needs.

WOULD A FEDERAL COMPANY DO A BETTER JOB OF FINDING OIL?

Would a government-owned company be more efficient than private entrepreneurs in finding new oil and gas reserves? Here we must also ask: Might the differences in objectives (profit maximization vs., perhaps, revenue maximization subject to a breakeven on profit), or the differences in operating constraints (maximum debt levels vs., perhaps, floors on losses and risk) affect relative exploration performance? And would such differences tend to shift exploration toward inefficient risk-averse projects? Again, as to the allocation of capital, would it be shifted more toward supporting exploration or toward such activities as refining and marketing?

Unfortunately we have no quantitative answers to these questions. The "conventional wisdom" has it that private oil companies generally do better in exploration than public bodies, which are too risk-averse. True, executives of public companies would have to defend their decisions before governmental authorities—but oil exploration sometimes has to be based on contradictory sets of geological evidence, and, notoriously, often results in a series of failures. Nevertheless, it is the high-risk areas that often bring in a high return.

Can we fairly compare private-vs.-public discovery rates per dollar of expenditure? Critics of public oil companies often ignore geological differences that affect costs in one location as compared to another. They also make examples of the smaller public companies that do not enjoy economies of scale. A recent FEA report comparing financial statistics for six private and six public companies pointed out that the average net income as a percentage of equity was higher for the private companies, as were average output in barrels per day per employee, and average yearly sales per employee.

But these statistics are misleading because public companies often do not seek to maximize profit. For example, Mexico's PEMEX has been selling oil to Mexicans at $8.00 per barrel, not at the $12.00 per barrel it might get if it were interested in maximizing its net income. Similarly, Colombia's ECOPETROL, until recently, sold oil locally at about $2.00 per barrel. Private companies can also reap larger profits from refining and marketing; has any financial comparison looked *only* at the exploration side of company activities?

All in all, there is really little evidence to support the notion that public oil companies do not perform as well in exploration as private ones. In fact, there is evidence to support the argument that they do at least as well, and Senator Stevenson was right in rejecting the conventional view when he proposed a federal gas and oil company.

Examine the table, for example, which compares drilling success ratios for public and private companies exploring in the same country. (Geological conditions can vary considerably from nation to nation, so that it is not meaningful to compare drilling results as between countries.) Observe that except for the Indonesian activities of JAPEX and AGIP, the public companies generally have higher drilling success ratios than any of the private companies operating within the same country.

Obviously we cannot conclude from the fragmentary evidence in the table that public oil companies are more efficient in finding oil. The numbers do not take into account, for example, the *size* of discoveries; it may be that some of the private companies have had lower success ratios because they have been drilling in higher risk regions, where the probability of success is low but the expected size of discovery is larger.

A proper comparison must consider not only success ratios, but also the distribution of sizes of finds. In addition, there may be governmental restrictions on which companies can drill where, and local state-owned enterprises may be favored. Clearly, we need much more reliable data on the past performance of public and private oil companies in exploration and development, data describing the relative risk-return characteristics of drilling "portfolios" of public and private companies, as well as data comparing drilling costs and discovery sizes for wells drilled in areas with comparable geological conditions.

Any evaluation of the desirability of a public oil company in the United States must emphasize the probably response for such a company to risk in exploratory activity. Excluding Alaska, most of the new oil reserves to be found in the United States during the next twenty years will come mainly from offshore drilling and secondarily from drilling in the few remaining unexplored onshore areas. Even in the past decade, a few large discoveries have accounted for most of our new reserves. The issue, then, is whether a federal oil company can outperform the private companies in high-risk ventures. Unfortunately, this question cannot be answered on the basis of our current limited knowledge.

DO WE NEED FEDERAL OIL COMPANY?

It does not appear desirable at this point to establish a federal oil company for purposes of importing crude. The problems of distribution will be considerable, and there is no reason to expect that the federal importer will be able to weaken OPEC or otherwise obtain a price reduction. On the other hand, it may indeed be desirable at some point to establish a federal oil-and-gas company that explores for and develops new reserves. Perhaps the best way to find out whether a public company can do a better job of finding oil and gas in high-risk areas than private companies can may be to establish a FOGCO and watch it perform.

While in the long run a FOGCO might help increase our domestic oil and gas supplies, we cannot look to it now as a basis for our energy policy. It is true that we have not developed new domestic energy sources as rapidly as we had hoped. Indeed, oil and gas discoveries are low, and if present trends continue, we can expect an increased dependence on imported energy supplies. But this may be due in part to an inefficient pricing system that discourages both exploration and production, as well as an offshore leasing system which, by emphasizing up-front payments for exploration rights, increase risk, thus maintaining the dominance of the larger companies and discouraging competition. These problems can be solved, and solving them would help provide more domestic oil. But we also face growing uncertainty about the quantities of oil and gas that exist underground. Because of this we should accept the fact that unless we are willing to pay extremely high prices for energy, the U.S. will continue to import oil—at world market prices.

EXPLORATORY WELL DRILLING, 1968–1973 (6)-yr totals)

Country and company	Total exploratory wells drilled	Successful wells	Success ratio
Colombia:			
ECOPETROL[1]	8	3	0.375
Tenneco	18	6	.333
Shell	5	0	0
British Petroleum	1	0	0
Texaco	11	3	.273
Peru:			
PETROPERU[1]	77	35	.455
Tenneco	6	2	.333
Occidental	9	4	.444
Amoco	8	4	.500
France:			
AGIP[1]	15	10	.667
JAPEX[1]	7	4	.571
Shell-B.P	114	50	.439
Tenneco	3	0	0
Gulf	19	10	.526
Mobil	35	15	.429
Texaco	11	4	.364
Occidental	6	2	.333
Nigeria:			
ERAP[1]	17	8	.471
SNAP[1]	32	3	.094
Shell	11	2	.182
Indonesia:			
PERTAMINA[1]	38	14	.368
JAPEX[1]	17	0	0
AGIP[1]	17	1	.059
Mobil	20	4	.200
Gulf	15	0	0
Shell	6	0	0
Tenneco	15	4	.267
Libya:[2]			
AGIP[1]	17	2	.118
SNPA[1]	17	6	.353
British Petroleum	14	2	.143
Occidental	27	3	.111
Mobil	56	8	.143
Shell	8	0	0
B.P.-Hunt	16	4	.250
Amoco	7	2	.286

[1] Public companies. AGIP is a subsidiary of Italy's ENI; ERAP are SNPA and French owned; JAPEX is partly owned by the Japanese government; and ECOPETROL, PETROPERU, and PERTAMINA are respectively Colombian, Peruvian and Indonesian national oil companies.

[2] Includes only new field wildcat wells.

Sources of data: AAPG Bulletin, International Oil Scouts Association Yearbook.

TESTIMONY OF INDEPENDENT PETROLEUM ASSOCIATION OF AMERICA (IPAA)

[From Hearings before the Subcommittee on Energy and Foundations of the Senate Committee on Finance on "Incentives for Developing New Energy Sources," p. 170–188. Hearings held June 20 and 21, 1977.]*

The purpose of our presentation is to suggest critical changes which must be made in the Administration's approach [the National Energy Plan] to energy development if domestic producers are to have an opportunity to meet future needs of consumers for petroleum fuels. The administration is pressing for total Federal authority to fix the prices and "manage" the supplies of oil and gas on a basis which, in our view, would assure declining production and chronic shortages.

Because the United States already has a very large and growing deficit in its domestic supplies of both crude oil and natural gas, it is our firm conviction that adoption of the administration proposals would so aggravate our future supply position as to cause intolerable impacts on our balance of payments and unacceptable security problems arising out of our loss of control over critical supplies of energy.

The proposals suggested, Mr. Chairman, would amount to a regulatory overkill that would so limit domestic exploration-development investment that dependence on insecure foreign energy would be extended to levels which may never be corrected. When this occurs, many will say, "The industry has failed the consumer. The Government must now take over." Should that happen, our country will—in my opinion—be on a headlong course into an energy doomsday that is unnecessary and therefore avoidable.

Let's look for a moment at where we stand today. In January this year for the first time petroleum consumption exceeded 20 million barrels per day. Imports of petroleum exceeded domestic production—that is, we are approaching 50 percent dependency whereas as recently as 9 years ago we had the ability to produce more oil and natural gas than we consumed. Our January balance of trade reflected the worst deficit in the history of the United States with imported oil accounting for a major share. In 1976 the total cost of imported oil and natural gas was $37 billion. By comparison the total wellhead value of all domestic oil and gas—which provided 2½ times the energy equivalency—was about $36 billion.

There appears to be no disagreement about the need for incentives to develop alternatives to conventional oil and natural gas supplies. What does seem to be overlooked by both Congress and the Administration is the need to bridge the gap from now until that day when we can rely extensively on alternatives. Crude oil and natural gas presently supply some 75 percent of our energy. For the next several years, we will become increasingly more dependent on insecure foreign oil unless we have a vigorous, healthy and expanding domestic petroleum industry. Instead of being encouraged by sound, consistent policies, oil and gas producers have been confronted with the following:

(1) October 9, 1969—percentage depletion cut from 27½ percent to 22 percent;

(2) March 29, 1975—enactment by Congress of Tax Reduction Act of 1975, substantially repealing percentage depletion for about 85 percent of domestic oil and gas. This long-standing tax policy has been left intact for some 100 other extractive industries;

(3) February 1, 1976—rollback of approximately $1.50 per barrel for new crude oil;

(4) September 16, 1976—enactment by Congress of Tax Reform Act of 1976, retroactively imposing punitive tax on expenditures, not on income of independent oil and gas producers;

*Testimony of A. V. Jones, Jr., President, Independent Petroleum Producers of America.

(5) July 1, 1976—imposition of a price freeze on all domestic crude oil;

(6) December 31, 1976—a rollback of 20 cents per barrel for new domestic crude oil and continuation of existing price freeze on crude oil;

(7) February 1, 1977—a retroactive doubling of rental fees on most oil and gas leases on Federal onshore lands;

(8) March 1, 1977—a rollback in U.S. crude oil prices of 45 cents per barrel on new oil.

The continued impact of these actions on domestic oil and gas producers is to remove roughly $5 billion annually which otherwise would be available for additional exploration and drilling. This listing should dispel any doubt as to why our domestic oil and gas production is declining and why we grow ever more dependent on insecure foreign oil. The 10,000 independent producers and explorers who drill most of the wells should be making a maximum effort in developing new supplies. But they are not because of the counterproductive effect of adverse Government policy. During 1975 and 1976, active rotary rigs were at a standstill, averaging about 1,650 rigs. Twenty years ago there were over 2,600 rigs active. We should be utilizing 4,000 rigs if we are to bring on new production adequate to reverse our intolerable dependence on foreign supplies. This will require positive actions by Congress and the administration.

Under long years of price regimentation and punitive tax actions, total drilling in the United States declined by 51 percent on an uninterrupted downtrend from 1957 to 1972. Retrenchment by independent producers was the sole factor in the curtailment of domestic exploration and development. Expenditures by the large companies, the so-called "Chase Bank Group," actually increased during this period.

Under pressure of a progressive cost-price squeeze imposed by rigid wellhead price controls, about half of the independent explorer-producers active in the mid-1950's had merged out, sold out or simply gone broke by 1971. Some 10,000 former independents left the industry during this period. The industry was decimated for one primary reason: unrealistic and anticompetitive price-fixing by the Federal Government.

While domestic oil and natural gas exploration, development and production is the most highly competitive major industry in America, there has been a trend toward concentration since the mid-1950's. This trend was caused directly by Federal Government intervention to fix wellhead prices, which established an economic climate in which marginal producers could not survive. Under Government-administered pricing, the large units with profit centers worldwide survived better.

When Government determination and dominance of economic conditions are carried to the extreme, only the big can survive. The Carter administration energy program is a blueprint for such dominance.

From 1956 to 1972, geophysical activity, which has been a reliable barometer indicating future directions of rig and drilling activity, dropped 60 percent. Active rotary rigs declined 58 percent, and both exploration and total well completions dropped well over 50 percent.

While these basic activities directed at finding and developing oil and gas supplies were declining over these many years, the demand for oil increased 86 percent and consumption of natural gas rose 120 percent. The result was declining reserves, resulting in inevitable and progressive domestic shortages and rising dependence on foreign energy supplies.

This whole experience demonstrated the vitally important role of the thousands of independent producers. Even though the total number of independent explorer-producers dropped by half from the mid-1950's up to the time of the 1973 embargo, in the latest 5 years of this period, 1969–73, independents as a group continued to dominate in domestic petroleum exploration and development.

In the 1969–73 period, independents drilled 89 percent of domestic wildcat wells, found 75 percent of the significant new oil and gas fields and accounted for 54 percent of the oil and gas reserves found. This is a significant contribution toward the total effort to provide increased domestic petroleum supplies. The problem has been that the industry as a whole, and independents in particular, have performed at a declining and inadequate level for most of the past two decades.

Beginning in 1974, after a 17-year cost-price squeeze that progressively thinned the ranks of independent explorer-producers, the domestic industry set in motion a resurgence of effort which promises to add significantly to domestic oil and gas supplies. The industry's responsiveness in this short period has demonstrated conclusively what producers have been saying for years—that expenditures to find and develop petroleum fuels would increase in direct proportion to improved price incentives, as they always have.

While the increased drilling response since the 1973 embargo has been significant, it is barely a start toward doing what can and should be done to increase domestic gas and oil production in the next two decades until alternative energy resources can be brought on stream.

The primary stimulus for increased natural gas exploration and development has been increased incentives of market pricing for intrastate natural gas. It is significant that where difficult intrastate shortages of gas existed in 1974–75, in Texas and some areas of Oklahoma and Louisiana, the market has now cleared and contract prices are generally down by approximately 50 cents per thousand cubic feet from the peak prices of a year or so ago.

Instead of building on this positive experience, the Administration has adopted a defeatist, no-win approach which reflects a lack of faith in the proven ingenuity of our industry in finding and providing increased gas supplies, and an unjustified faith in a regulatory system that has been a failure on every count. It is disturbing that this approach is apparently grounded on a number of premises that are without support in our prior experience.

I would like now to discuss specifically some of the administration's premises which, taken together, reflect an unjustified lack of faith in our proven capacity to solve problems.

The primary and overriding premise of the Carter program is the conclusion that our petroleum resource base is not sufficient to permit significant additions to supplies. In the case of natural gas, this conclusion was expressed by Mr. John F. O'Leary, the administrator of FEA, who said that natural gas "has had it." Such a conclusion is not justified by anything in the great body of both private and Government data that reflect expert evaluations of the remaining geologic potential for both gas and crude oil.

Professional geologists nationwide agree that vast quantities of natural gas remain to be produced in this country. In 1967, the National Petroleum Council, at the request of the Department of Interior, began a study of future petroleum provinces of the United States. The results of the coordinated study, in which dozens of the nation's most prominent geologists participated, was published in two volumes in 1971. Over 3,000,000 square miles of basinal area in the United States were identified as having sediments prospective for oil and gas. This compares with only 50,000 square miles on which oil and gas production exists, or has existed to date—less than 2 percent of the prospective area, and most of that is relatively shallow. With the nation being called on to attack energy shortages with the "moral equivalent of war," it seems highly inconsistent that we should also be told to turn our backs on 98 percent of the prospective oil and gas sediments, and simply lie down under a flag of surrender. Americans have not responded to the great challenges of the past in this manner.

The U.S. Geological Survey study of 1975 is within the range of estimates of most resource base studies and is considered realistic by many. The U.S.G.S. estimates for potential conventional natural gas and oil resources are shown in the chart "U.S. Petroleum Resource Base." The proved and potential gas supplies in this evaluation amount to a 55-year supply at the 1976 production rate. Another 10 years' potential exists in "currently subeconomic" resources that U.S.G.S. believes will become available with improved technology and/or economics.

These estimates do not include potential natural gas volumes from tight shales and sands in both the Western and Eastern United States, geopressurized reservoirs on the Texas-Louisiana Gulf Coast, or in sediments below water depths of 600 feet. Attached to my statement is a summary from a draft ERDA study which estimates a total gas potential of 730 trillion cubic feet in just four tight sand basins in the Rocky Mountain area. Obviously, development of techniques which would bring these tremendous potentials into production would extend our access to natural gas not by just decades, but by more than a century.

Just as obviously, an economic climate under price regulation that would inhibit development of conventional oil and gas, which the Carter plan assuredly would, also would postpone development of these high-technology resources for the indefinite future. It would be selling the country's consumers tragically short to write off the possibility of improving future supply when we have identified potential supplies in such great abundance.

Another faulty premise upon which the Administration is basing its scheme for permanent price controls is its argument that, "Higher costs (prices to producers) do not yield more oil and gas." All past experience refutes that contention. More oil and gas always has been provided by drilling more wells. Levels of drilling always have been determined by prices at the well for oil and gas, as illustrated by the chart "U.S. Oil and Gas Prices vs. Drilling Expenditures." For each change (up or down) of 10 cents per barrel in the composite oil and gas price, there has been a corresponding change of $120 million in drilling expenditures.

Since 1973, the rise of approximately $2.36 per barrel in this composite price has stimulated increases in expenditures of $3 billion per year. Claims have been and are being made to the effect that this acceleration in drilling is not adding to supply. These statements reflect an expectation that an industry which declined for 17 consecutive years and was in an atrophied condition just four years ago should be able to achieve a turnaround in declining production in just three years. Such expectations are totally unrealistic. On the other hand, they ignore the progress which has been made. Production in 1976 was 2.5 trillion cubic feet more than it would have been had drilling continued to follow the 1960–71 trend. Except for this real gain in natural gas production as a result of increased drilling in the past four years, oil import dependence in 1976 would have been more than 1,250,000 barrels daily higher and our dollar outflow for foreign oil $6.1 billion greater.

Similarly, our data shows that the decline in domestic crude oil production has been substantially arrested, and production is some 800,000 barrels daily higher than would have been without the 1973–77 acceleration in drilling.

Last year Congress decontrolled wellhead prices of stripper well crude oil. As an indication of producer response to incentives, I note the following results. Abandonments of producing stripper wells have declined sharply . . . 44 percent in the three states which contain about one-half of all the stripper wells in the country—Texas, Louisiana, and Kansas. Total producing wells in the United States increased from 497,000 to 503,000 during 1976. This resulted from increased drilling as well as the decline in abandonment of stripper wells due to the removal of price controls and resultant increase in the economic life of many wells.

Equally important is that stripper well production now accounts for approximately 16 percent of domestic oil production—up from 13 percent a year earlier—and stripper reserves are now estimated at 7.5 billion barrels—up from 5.8 billion in 1973. These results are a response to the positive incentives of increased prices.

We have made only a small start in mobilizing the exploration-drilling arm of the domestic industry to the level of activity at which it can and should be operating. To make the oil and gas supply contribution necessary to see the nation through the transition period of the next two decades, we must effectively double the present rate of drilling. This brings me to still another unsupportable premise of the Carter energy policy staff which in one memorandum states that reduced energy growth is "fully compatible with economic growth development of new industries, and the creation of new jobs." Contrary to the facts, they state flatly, "there is no fixed relationship between energy and GNP."

But over the last 20 years, energy consumption, GNP and employment have been mirror images of each other. In fact, energy consumption equivalent to one billion barrels of oil consistently has been accompanied by $100 billion in GNP and the addition of 4 million new jobs.

What of the future? The Department of Labor's projects that our economy must accommodate 104 million working Americans by 1985. This work force would generate a 1985 GNP of $1.850 billion in 1972 dollars. Based on past experience, this expansion in economic growth will require an increase in energy use of about 50 percent.

In 1975, we consumed approximately 12 billion barrels of oil equivalent. The Chase Manhattan Bank estimates that the petroleum industry must spend some 205 billion (current) dollars in the decade 1975 to 1985 on domestic exploration and development in order to accomplish levels of energy adequate to support our workforce in 1985. With 1976 and 1977 almost behind us, the industry will have to expend at the rate of almost $25 billion per year on the average from 1978 until 1985 in order to achieve the lower level of energy supply of 15 billion barrels of oil equivalent targeted by the President's energy plan. The President's Crude Oil Pricing Policy, Natural Gas Pricing Policy and Petroleum Taxation Policy are inadequate to generate these substantial sums of necessary capital.

Unlike most other industries, the petroleum exploration industry is a high risk industry which requires investor capital in hand. Money cannot be borrowed to carry out exploratory drilling programs. The President's National Energy Plan (NEP) falls short in that it fails to acknowledge that the price of a commodity must not only provide the incentive to invest capital to bring on new supplies and also must provide the cash flow from existing production to generate the investment capital. Even if the President's definition of "new" crude oil were reasonable and provided market level incentives for significant numbers of potential investments, producers would suffer cash flow restrictions under the President's program that would disallow maximum effort to increase domestic supply.

The National Energy Plan would price crude oil an a replacement cost basis, but the Crude Oil Equalization Tax (COET) would tax all the increased cash flow from the producer. The COET amounts to a massive income redistribution plan. None of the tax would accrue to the producer for the purpose of increasing crude oil supplies. In the face of naturally declining existing production and an inadequate inflation adjustment factor to fully reflect increasing oilfield costs, the producer would be unable to generate sufficient capital to replenish the reserves he produces.

Natural Gas Pricing Policy as proposed in the NEP suffers the same basic economic failings. It would extend federal control of the price of natural gas sold in the interstate market, a concept which has failed miserably, to the intrastate market. The proposal would in fact, roll back process of some intrastate gas. Consumers of America will have less natural gas available under the President's Natural Gas Pricing Proposal than would be available under the present situation.

Although the President recognized the adverse nature of including intangible drilling expenses as a tax preference item subject to minimum tax, the National Energy Plan failed to recognize other critical limitations on capital formation for independent producers. The provision which limits allowable depletion to 65 percent of taxable income and the recent IRS Revenue Ruling 77–176 particularly inhibit independent oil and gas producers from generating internal funds and raising capital from outside investors. . . .

In summary, in order to accomplish the stated objectives of the President's program or the Chase Manhattan Bank's estimates, a favorable economic environment for investment in the domestic petroleum industry must be provided.

Finally, the faulty premises of the NEP include a highly pessimistic appraisal of the ability of the support industries supplying rigs, pipe and other materials to provide the hardware to significantly expand exploration and development. Again, the experience of our industry should allay any concern that we would be inhibited by rig shortages or other shortages—except where government policy may signal such uncertainty about the economic climate that fabrication of needed equipment is frustrated.

Almost 800 units have been added to our operable rig inventory since the preembargo year of 1972. I might say this is 200 rigs more than expert analyses within the industry itself had indicated. Again, there is no basis for selling short our ingenuity and ability to get on with the task of developing critically needed energy resources.

SUMMARY

IPAA firmly believes that the solution to our intolerable dependence on foreign crude oil is to unleash private enterprise by relying on market forces to efficiently allocate existing energy supplies, stimulate innovations to conserve our natural resources, and maximize efforts to increase domestic supplies to balance demand with supply. The United States has the potential petroleum resources; and with the proper economic environment, the support industries have the capability of responding to increased demand for their drilling rigs, pipe and equipment.

We must recognize that conservation alone cannot solve our energy problems. To rely on conservation is to risk a highly regimented economy with staggering unemployment and unprecedented invasion of individual freedom of choice which is a cornerstone of the American system.

In the long term alternative sources of energy will be able to assume a greater share of our energy burden. However, in the shorter term of the next decade or so, crude oil and natural gas will continue to provide the bulk of our energy requirement. The only real question remaining is whether crude oil and natural gas will be developed from our domestic resource base or whether we will allow ourselves to become increasingly dependent on foreign nations for our energy lifeblood. The attendant balance of payment problems and the precarious national security situation make it clear that U.S. consumers should rely on U.S. producers, not foreign countries, for their energy supplies.

RECOMMENDATIONS

Recognizing that replacement cost of energy in the United States is the cost of imported energy and that it is economically efficient and prudent to encourage domestic crude oil and natural gas production at market prices up to that cost to maximize domestic production, stimulate conservation and conversion to alternative fuels, and reduce energy imports, we urge adoption of:

A. Crude oil pricing policy

1. Decontrol the price of upper tier crude oil and all economically marginal crude oil. This will maximize incentives to increase production and prevent the premature abandonment or shutting in of domestic production which would otherwise have to be replaced by foreign imports.

2. Phase out price controls on lower tier crude oil by the end of May, 1979. This would provide the capital necessary for exploration and development to increase the supply of energy for consumers. This would also eliminate the need for a cumbersome entitlements program and other regulatory burdens. Consumers would be given a clear signal that future prices of energy will reflect replacement costs.

B. Natural gas pricing policy

Encourage increased natural gas production by deregulating the price of new natural gas and phasing out controls on old gas. IPAA specifically supports H.R. 2088, introduced by Congressman Krueger, et al., and S. 256, introduced by Senators Pearson and Bentsen.

C. Petroleum taxation policy

The Congress must provide a sound, reliable oil and gas taxation policy which encourages capital formation and spending in the domestic oil and gas producing industry. The Congress must also correct past taxation policies which are now inhibiting investments in drilling crude oil and natural gas exploratory and development wells. Specifically, Congress should:

1. Eliminate for independent producers intangible drilling expenses as a tax preference item subject to the minimum tax. Such a tax is not a tax on income, but instead is a tax on expenditures.

2. Repeal the 65 percent of taxable income limitations on allowed depletion for independent producers of crude oil and natural gas. This provision discourages independent producers from maximizing their drilling investments.

3. Prevent further deterioration in the percentage depletion rate and allowable volume. This would alleviate further deterioration of the capital base of independent producers.

4. Provide for expensing of geological and geophysical expenses rather than requiring their capitalization.

5. Enact an Energy Development Investment Tax Credit which would allow a direct credit against federal income tax for expenditures intended to result in greater domestic energy supplies.

D. Accelerate leasing program

Accelerate the leasing of federal lands on the Outer Continental Shelf for oil and gas exploration and production and reverse federal public lands policies which result in the withdrawal of significant areas from mineral exploration and development.

E. Conservation

Stimulate conservation of energy and our national resources not through artificial taxes, end use controls, or rationing, but by pricing energy according to the competition. This is the most efficient and least disruptive way to achieve desired results.

F. Regulatory reform

Eliminate counterproductive regulations and streamline procedures for the siting of energy facilities and transportation systems.

We have the natural resources, knowledge and capacity to solve our energy problem. What we lack are adequate incentives which the market place will provide if unreasonable government interference is removed.

C. The Relationship Between Federal and State Government in Energy Policy Planning

ENERGY POLICY: A TEST FOR FEDERALISM

(By Jon Mills and R.D. Woodson)*

The central problem of federalism results from the lack of a clear demarcation of authority between the states and the federal government. The extent of state power has been a point of contention from the writing of the federalist papers to the cry of states' rights during the school desegregation controversy. In recent years the dispute has focused on clashes between state and federal energy policy. State and federal perspectives regarding energy may differ markedly. To the federal government the energy issue involves balance of payments, foreign relations, and national security. To state and local governments, on the other hand, the focus is pragmatic and localized, the welfare of the state and its citizens being the primary concern. Thus, for instance, concern for safety may make a locality leery of nuclear power, while the federal government sees it as the only alternative to drastic increases in oil imports.

Three possible allocations of governmental responsibility are possible. In certain areas of exclusive federal responsibility, the preemption doctrine precludes any role for the states. Traditional examples of preemptive activity are found in the federal government's leasing of oil bearing lands on the Outer Continental Shelf [OCS] beyond the 3-mile limit and the Federal Power Commission's [FPC] control over pricing of natural gas intended for the interstate market. In other areas, where the federal government has failed to act expressly or impliedly or where the Constitution has been interpreted as failing to delegate authority to the federal government, the state may act under the police power to protect its citizenry from potential adverse impacts of energy development and utilization. These principles are consistent with traditional notions of federalism, whereby the state and federal governments are viewed as pitted against one another for authority or jurisdiction, with the judiciary as the final arbiter.

The third possibility reflects a more modern view of federalism which embraces the concept of state-federal cooperation. Cooperative efforts, in addition to avoiding divisive power struggles, can utilize the strengths of each level of government: a federal mandate may give added force to an enactment and counteract certain local pressures on state governments, while state involvement will increase sensitivity to local problems and conditions and contribute to effective ultimate

*From the Arizona Law Review, Vol. 18, no. 2, 1976. p. 405–451. Footnotes have been omitted in the interest of brevity. At the time the article was published, Jon Mills was Executive Director of the Center of Governmental Responsibility, University of Florida, and R. D. Woodson was Assistant Director. Reprinted by permission.

implementation. Perhaps the most significant advantage is the ability of the combined federal-state authorities to draw on all the power allocated to government in the American constitutional system. The increasingly complex nature of energy problems and solutions seems to favor the cooperative approach of this new federalism, under which a solution tailored to the diverse energy needs of America's varying geographical and sociological conditions is more readily achievable.

Under neither the traditional nor the new federalism can the numerous facets of the energy problem be resolved in a single effort. Energy policy development affects numerous topics critical to the states, ranging from land use to air and water pollution to public transportation. It thus is not a unified issue, but a conglomerate of otherwise tangentially related matters linked only because all involve energy. The consequence of this diversity is that policy formulation appears as either a shotgun effort to treat all aspects without adequate depth in any, or as an overly narrow policy that fails to treat comprehensively the ramifications of the whole energy question. Because energy is elemental to an industralized society, the implications of energy policy change as suddenly as the society and its technology. Therefore, no evaluation of energy policy or energy conservation can hope to solve completely the energy problem. Similarly, the variable nature of energy problems and policies precludes a final demarcation of the boundaries of state and federal authority in this area. However, certain limits and desirable patterns can be defined to guide legislators at the state and federal levels in determining appropriate areas for exercise of their authority.

This Article will examine the bases of state and federal power, exploring areas of both potential and existing conflict within the energy field. Situations in which either the state or federal government appears to have exclusive authority also will be scrutinized. Possible answers to problems caused by the clashing of governmental interests will be suggested, with an eye toward aiding policymakers to reach agreements which may avert such conflicts. Finally, a prognosis of the future of federalism in regard to the energy issue will be offered.

SOURCES OF GOVERNMENTAL POWER

It is fundamental constitutional doctrine that the United States government is one solely of delegated powers. Those powers not expressly granted to the federal government in the Constitution are reserved to the states. It is from this basis that an examination of the respective powers of each level of government must proceed.

Powers Delegated to the Federal Government

Any analysis of state and federal authority to make energy policy should begin with the supremacy clause since it is the Constitution's most direct statement on the state-federal power relationship. This clause gives preemptive power to federal enactments supported by constitutionally enumerated federal powers, thus enabling them to override conflicting state laws. Preemption can become operative through an express congressional statement to that effect, or it can be implied from the circumstances. For instance, implied preemption may be found where a state regulation produces results inconsistent with the purpose and goals of a federal statute, where federal regulation is so pervasive as to preclude state authority, or where the particular subject regulated demands uniformity among all states.

Caution must be exercised in concluding that a matter is one giving rise to implied preemption. Even though a matter may be one amenable to nationwide regulation, Congress may allow the states a role in an area where federal preemption might be otherwise assumed. An example is provided by the case of *Askew v. American Waterways Operators, Inc.*, ruling on the constitutionality of Florida's Oil Spill Prevention and Pollution Control Act. The contested state legislation, which imposed strict liability for damage resulting from an oil spill in Florida's territorial waters, was alleged to be preempted by the Water Quality Improvement Act of 1970 and overriding principles of federal maritime law. Despite the pervasiveness of federal controls under the Water Quality Improvement Act and the federal government's historical domination of maritime law, however, the Supreme Court upheld the state legislation, pointing to specific congressional expressions of an intent to maintain a role for the state in regulating oil pollution. The Court declared that "sea-to-shore pollution" was "historically within reach of the police power of the states," and that the federal and state enactments were "harmonious parts of an integrated whole." This decision clearly demonstrates that, despite the possibility of preemption, federal statutes may set standards relating to energy and at the same time allow or encourage state standards which may be more stringent.

Most disputes over application of the supremacy clause involve neither a manifest congressional approval, such as that present in the *Askew* case, nor a clear expression of preemption. The Supreme Court itself has recognized that each case is decided on its own pecularities and that "prior cases on preemption are not precise guidelines" to be followed. Because the issue is subject to such wide-ranging judicial discretion, a court's evaluation of the subject matter as national or local can be conclusive. The existing cases establish that, as a general rule, preemption of a traditional state power is not favored, therefore, when preemption or lack thereof is not clear on the face of the statute, the nature of the power exercised by the state apparently will influence the determination. From these general trends, however, no long-term guidelines can be formulated. Conceivably, a local matter of today will be a matter requiring nationwide uniformity in the future, or vice versa. Preemption doctrine thus can be clarified little further than a delineation of the three somewhat broad questions that must enter into any preemption determination. First, is the basic claim of federal authority constitutionally exercised? Additionally, did Congress express an intent as to whether preemption should operate? Finally, if congressional intent is not manifest, does the subject matter require preemption or is it a local matter? In energy matters, the answer to the first of these questions generally depends on interpretation of the constitutional delegations to the federal government of the power to tax and spend and the power over interstate commerce. Occasionally, the war power also may have relevance.

The Spending and Taxing Powers.—The federal spending power, which originates in article I of the Constitution, authorizes Congress to appropriate and spend in promotion of any objectives deemed worthwhile in furtherance of the general welfare and subject to the limitations of the Bill of Rights. The spending power is often used as a public policy tool, to provide incentives for citizens and local governments to take actions not ordinarily within federal control. With this type of federal action, therefore, development of state energy policies can be subjected to a broadened federal influence.

"Buying compliance," as in the Emergency Highway Energy Conservation Act, is the most significant such exercise of the spending power. Conditions imposed on grants, contracts, and other expenditures by the federal government ensure state cooperation with stipulations which Congress could not otherwise constitutionally impose. Courts recognize no legal restrictions on such conditions so long as there is no abridgement of due process. The states, of course, are free to ignore federal policy thus imposed simply by rejecting conditional grants; once money has been accepted on conditions, however, the conditions must be satisfied.

Congress' authority to lay and collect taxes also is subject to few limitations. Although the basic purpose of this power is production of revenue, other objectives such as the conservation of energy may be accomplished through tax incentives. Taxes have been used to affect energy policy, for example with the oil depletion allowance. Tax incentives relating to energy conservation, such as increased gasoline taxes, have been continually proposed.

The Commerce Power.—As initially interpreted, the distribution of federal and state powers effectuated by the commerce clause embodied the concept of dual sovereignty, in which the states and the nation exercised exclusive authority in their respective spheres. Thus a dichotomy existed between interstate and intrastate commerce which was also the dividing line for government authority. With the growth of industry and commerce to national dimensions and the advent of social and economic focus transcending local concern, the artificial interstate-intrastate dichotomy animating the concept proved to be untenable. The resultant break with traditional doctrine was achieved through the Supreme Court's expensive redefinition of the federal interstate commerce power to include matters formerly considered intrastate in nature. Such power, however, is not limitless. In determining the validity of a congressional exercise of commerce clause power to regulate purely intrastate activity, the determinative question is whether Congress has a rational basis for finding that the regulated activity affects interstate commerce. If it does, the means selected by Congress to eliminate the evil must be reasonable and appropriate. Congressional power may not be extended so as to encompass effects upon interstate commerce so indirect and remote as to obliterate the distinction between what is national and what is local. The Supreme Court, in establishing these principles, has recognized the need to reserve some matters of commerce regulation to the state and to place some restrictions on congressional power.

Nevertheless, the expansion of federal interstate commerce authority has resulted in increasing judicial scrutiny of state regulation of commerce. The Supreme Court has recognized that despite Congress' power over interstate commerce, the states are not precluded from exercising their police powers in matters of local concern, even if such an exercise affects interstate commerce. However, substantial limitations remain on state regulaton of interstate commerce. A major restraint, and one relevant in establishing energy policy, is the prohibition against a state's attempting to isolate itself from problems shared nationally. Additionally, any attempt at state regulation must be reasonable and necessary in light of local interests and concerns. In *Cities Service Gas Co.* v. *Peerless Oil & Gas Co.*, for example, the Supreme Court held that state regulation must protect a manifest local interest and must outweigh any national interest in equivalent regulation. Upheld in that case was the power of a state to set natural gas prices at the wellhead as a means of preventing uneconomic dissipation. The state and federal interests in conservation coincided, and the state means adopted were held reasonably related to this legitimate end. This case illustrates that where regulation of local matters also operates as a regulation of interstate commerce, reconciliation of conflicting claims of state and national power may be attained only by appraisal and accommodation of the competing demands of the state and national interests involved. Where the balancing of interests indicate a considerable state interest in the regulation, impingement upon the underlying federal commerce power may be allowed.

War Powers.—Under the war powers clause of the Constitution, the federal government has exclusive control over matters affecting national security. Where federal authority is based on war powers, preemptive effect is uniformly recognized. In relation to energy, three areas of war power authority have been recognized: control of oil policy, generation of electric power, and atomic energy.

Recognition of the relationship between oil policy and national security began in 1904 when President Taft withdrew several million acres of public lands as naval oil reserves to ensure the Navy's ability to fulfill its fuel requirements. Furthermore, as early as 1954 the need to supplement domestic supply with imported oil was thought to present a threat to national security. In partial response to this perceived threat the Trade Agreements Extension Act of 1955 was passed, requiring the Director of the Office of Defense Mobilization to advise the President, whenever there was reason to believe that any article was being imported in such quantities as to threaten national security. Pursuant to this Act, the Mandatory Oil Import Program was established in 1959, giving the President authority to regulate quota levels and allocations to domestic claimants. This function has been handled by various agencies in the executive branch, and currently is controlled by the Federal Energy Administration [FEA].

The FEA has been given great leeway by the courts in the control of imports and allocation. In *Gulf Oil Corp.* v. *Simon* an oil company challenged FEA regulations as violative of the National Environmental Policy Act [NEPA], arguing that no environmental impact statement was prepared prior to promulgation of regulations. The court held that because of Congress' intention for swift emergency action due to the national energy crisis, the FEA's actions took precedence over NEPA. Thus federal activity in the area of fuel allocation has preempted any allocation conflicting with the federal scheme. A designation of necessity to national security pursuant to the war power in any phase of oil policy seemingly would similarly preempt state activity.

The second area in which the war power has played an important role is the generation of electric power. In *Ashwander* v. *Tennessee Valley Authority* the Supreme Court upheld the construction of a dam and electrical generating facilities pursuant to the war power as necessary to national security, even though the construction took place during peacetime. The case demonstrates both the breadth of the war power and the importance of the generation of electricity to national security. From it can be inferred the possibility of war power preemption of state control over electrical generation.

The war power is most controversial in relation to nuclear power. The Atomic Energy Act of 1946 established the Atomic Energy Commission [AEC] to control policy aspects of atomic energy development. The emphasis in relation to power development was shifted to private companies by the AEC retaining power as licensing agency. Under current law nuclear power is controlled at the federal level by the Nuclear Regulatory Commission. Although for a long period states refrained from acting in the area, the role of the states is currently in a state of uncertainty, due to an increasing tendency by state governments to insert themselves in this field, at least as to siting procedures. However, the bases for federal authority in relation to nuclear power—the war power and supremacy clauses—are formidable obstacles for the states to surmount.

Powers Reserved to the States

State energy legislation must be based on some inherent or constitutional power of the state, generally the inherent authority termed the police power. The police power, which is implicitly recognized in the tenth amendment to the Constitution, entails the broad authority possessed by a sovereignty to legislate in furtherance of the health, safety, morals, and general welfare of its citizenry. Few judicial limits have been placed on this power, and a legislative declaration that a law promotes the public welfare generally is sufficient to ensure its recognition as a legitimate exercise of the police power. Thus, in recognition of its broad scope, the police power has been characterized as the power "to promote the public welfare by restraining and regulating the use of liberty and property limited only by constitutional and reasonable judicial requirements." Because of the changing social, economic, and political conditions, it is a flexible power, constantly evolving to fulfill its purpose of promoting the public health, safety, morals, and general welfare.

One of the strongest justifications for the state regulation in the energy area is public safety. For example, the storage and distribution of gasoline may be regulated to protect the state's citizens from danger of personal injury. Similarly, the inherent dangers of operating motor vehicles justify state regulation under the police power despite an unavoidable impact upon interstate commerce. Similarly, the enactment of 55 mile-per-hour speed limits in all states for energy conservation could be justified under the safety aspect of the police power, since the result has been a decrease in highway deaths. Most energy-related regulations, however, are justified as promotive of the general welfare. This is the case, for instance, with laws aimed at conservation of energy resources, an area which is likely to be a major thrust of state energy policy action. These illustrations should demonstrate the breadth of the police power as a justification for state energy legislation and regulations. Were it not for the preemptive effect of federal pronouncements, doubtless the state police power would provide ample authority for virtually any type of energy-related regulation. Thus the primary questions revolve around the scope of federal rather than state power; where federal power does not preclude state activity, state power generally exists.

AREAS OF PRESENT INTERGOVERNMENTAL CONFLICT

Although some areas of energy control fall clearly within the ambit of either state or federal authority, the uncertainties in other areas have given rise to various intergovernmental clashes. Energy development almost inevitably seems to entail threats to the natural and human environment; thus potential for conflict inheres in the growing public and governmental concern regarding both energy supply and environmental protection. The most heated conflicts to date have occurred in relation to nuclear power facilities and development of offshore oil resources. An examination of these controversies is illustrative of the sort of intergovernmental problems likely to arise as the move for energy independence continues, and may provide some guidance to officials seeking to minimize future clashes.

Nuclear Power

The nuclear power controversy currently sparks the most heated debate. Several states, concerned with the potentially devastating effects of malfunction or sabotage, are considering measures to ban or control the development of nuclear power within their borders. At the same time the federal government, in particular the executive branch, has been promoting the case of nuclear power. As yet the constitutional delineations of power have not been finally resolved, although the federal preemptive claim seems to be prevailing in regard to most tested aspects of the nuclear power problem.

It is reasonable to assume that both the state police power and the congressional power to regulate interstate commerce afford sufficient basis for the regulation of the design, construction, and operation of nuclear power reactor. Thus, the demarcation is dependent upon the extent of express or implied preemption currently operative. The revelent federal enactment against which preemption must be gauged is the Atomic Energy Act, the critical provision of which states, "[n]othing in this section shall be construed to affect the authority of any State or local agency to regulate activities for purposes other than protection against radiation hazards." This provision has been interpreted as expressing a congressional intent to endow the federal government with exclusive authority to regulate the construction and operation of nuclear plants, including the discharge of nuclear waste. According to the eighth circuit court, such federal preemption is necessary in order to ensure that industrial energy development is not stifled by overly stringent requirements. Under this reading, the state would be precluded from imposing requirements stricter than those of the federal government. Even under this view, however, a state role might be possible in such matters as the siting of nuclear plants.

A separate question is presented by a total state exclusion of future nuclear plants or even perhaps a conditional exclusion: should exclusion have the same legal effect as regulation? General principles developed in relation to the commerce clause indicate that exclusion would not be permissible if it resulted in an undue interference with interstate commerce or if it imposed an unduly detrimental effect on other states. Commentators have stated, however, "[t]here is no room for any argument that state bills imposing a prohibition or moratorium on the construction of nuclear power plants are not within the intended scope of preemption because Congress did not directly contemplate this type of state 'regulaton' in enacting [section 2021]."

Future litigation of the nuclear issue is certain. It is also possible that future federal legislation may attempt to clarify the area. Despite claims to the contrary, it appears that states may have a role in regulating some aspects of nuclear power plants. The extent to which this regulation will be allowed remains to be determined.

Offshore Oil and Gas Development

Jurisdiction over offshore oil reserves has been subject to continued dispute for over 20 years. Nonetheless, the United States has turned increasingly to development of this resource in an effort to reduce dependence on foreign oil. In *United States* v. *California* the Supreme Court held that the federal government had full dominion over the 3-mile territorial sea and the land thereunder as an incident of national sovereignty. This decision was partially nullified by the enactment of the Submerged Lands Act whereby the federal government relinquished to the coastal states submerged lands lying seaward from their respective boundaries for a distance of 3 geographical miles.

Under the Submerged Lands Act the United States retains control of the land and water of this belt for purposes of commerce, navigation, national defense, and international affairs. The Act indicates that the rights retained by the federal government are paramount to the proprietary rights granted to the states but do not exclude exercise of those rights. The states have power to administer, lease, and develop the submerged lands and the natural resources of the marginal belt subject to the priority of the federal interest in those areas named. These reservations by the federal government are in recognition that the territorial sea is a major channel of interstate commerce with important defense implications, but they do not reduce the states' title to such lands beyond that inherent in the supremacy clause of the Constitution. Thus the Submerged Lands Act granted to the coastal states dominion over the offshore seabed within the territorial sea. The Act expressly declared that its provisions in no way affected federal control over the OCS beyond the marginal shelf. By the Outer Continental Shelf Lands Act of 1953 Congress had declared it to be the policy of the United States that the subsoil and seabed of the OCS are subject to its jurisdiction, control, and power of disposition.

The Outer Continental Shelf Lands Act expressly authorizes the Secretary of Interior to prescribe rules and regulations which he deems necessary for the leasing of OCS lands. This authority has been used to formulate regulations designed to insure that development and operation of oil and gas wells are done in a safe and efficient manner. All oil and gas leases issued under the authority of the Outer Continental Shelf Lands Act are subject to forfeiture for any breach of the rules and regulaitons formulated by the Secretary. Not only does the Secretary have the right to lease OCS lands for oil and gas development, but he also has authority to grant rights of way through these lands for the transport of oil or gas. Such authority gives the federal government the ability to control the location of pipeline corridors up the states' territorial sea. The successful completion of corridors to the shore depends on the coastal state. Thus, the rules indicate that a coastal state may not arbitrarily exclude or unreasonably restrict energy production and transmission facilities. The standards effectively condition grants under the Coastal Zone Management Act on the states' meeting their obligations for energy-related siting within their coastal zones.

The federal government therefore has a tremendous impact on energy-related development through its direct control over the disposition of federal lands. In turn, this federal power can have a strong impact on state land use decisions. Presently the federal government is attempting to coordinate the disposition of federally controlled OCS lands with the affected coastal states' management programs.

POTENTIAL GOVERNMENT ROLES IN DEVELOPING ALTERNATIVE ENERGY SOURCES

Following the 1973–74 oil embargo imposed by the Organization of Petroleum Exporting Countries, attention has focused on developing alternatives to petroleum as a source of energy. In general the potential for intergovernmental conflict appears lesser in regard to solar energy, geothermal energy, wind energy, and energy generated by solid wastes than is true of the traditional fossil fuels or of nuclear energy. This is because development of such energy forms is not known to entail the dangers of nuclear power or the environmental costs of fossil fuel extraction. Correspondingly, the prospects for federal-state cooperation are greater. There are nonetheless legal questions concerning the appropriate role of each level of government in the development of each of the primary alternative energy sources, though the issues differ markedly from those raised by the previously discussed conflicts.

Solar Energy

An enormous supply of energy is received by the earth from the sun. Solar energy is estimated to have the potential for supplying 25 percent of the United States' energy needs by the year 2020. The greatest potential for early utilization of solar power lies in heating, cooling, and supplying hot water for buildings—uses which currently constitute 25 percent of United States' energy consumption. Development activities aimed at converting solar energy into electrical energy also hold promise, though the implementation stage for such systems lies some years in the future.

Although the development and utilization of solar energy could do much to offset present and future energy shortages, initial capital costs to both potential producers and consumers are formidable. State and federal governments thus may find it desirable to offer assistance in the form of financial assistance to research and development, as well as tax incentives for commercial and private utilization. In addition to offering support of this type, governments will need also to prescribe protective standards and other regulatory measures.

Financing research and development is of nationwide importance and logically is a matter for the federal government. Congress has already taken certain steps in this area. The Solar Heating and Cooling Demonstration Act, for example, directs that $60 million be applied to promote the practical use of solar technology. Another statute, the Solar Energy Research, Development and Administration Act, allocated $77 million for research and development of solar energy on a commercial scale. Some states have taken their own initiatives in funding research and development facilities which can provide information on solar energy. Cooperative funding efforts such as these flow naturally from the state and federal governments' mutual interest in the development of clean energy.

Even under present technology, widespread use of solar energy systems for heating and cooling residences and commercial buildings is feasible, and some states may wish to encourage such use due to the diminishing supply of fossil fuels. The most effective tool available for a state to implement such policies traditionally has been the tax incentive. Specifically, exempting the construction and maintenance of solar energy facilities from state sales taxes, ad valorem taxes, corporate taxes, and in some states income taxes will provide a financial incentive to solar energy use. Corporations manufacturing equipment for such systems also could be given tax relief. Several states have already enacted such measures into their tax codes. The federal government, of course, could provide similar incentives through the federal income taxation system, and such proposals are presently being considered by Congress. Because each level of government has its own tax system, intergovernmental conflicts seem unlikely; rather, the coexistence of state and federal measures increases the incentive to produce and utilize solar devices.

The potential proliferation of solar energy users will call for some sort of governmental controls establishing, protecting, and regulating rights in solar power. Obstructions blocking access to the sun, for instance, would render units ineffective or totally useless. Although at common law prescriptive rights to light could be acquired through use over a period of years, many American jurisdictions have abrogated the right to acquire such easements. Nor has any other sort of right to the free flow of light across adjoining lands been recognized, though litigation of this issue has been scarce. If solar users are to be assured a continuing supply of their energy source, therefore, it will be necessary for states to create and define legislatively solar rights as a form of property right. Indeed, establishment of such rights would seem a necessary prerequisite to the consumer's substantial investment in solar equipment. Protection of this investment is clearly within the state's police power. Another area of police power regulation potentially requiring action to permit and encourage solar energy use involves modification of restrictive zoning controls governing residential architecture. Building codes also may require amendment.

Although these areas of regulation are preeminently within state control, a substantial supportive role can be served by the federal government. In 1928 the United States Department of Commerce published a Standard State Zoning Enabling Act as a model for state legislative enactments empowering local governments to establish land use controls. A modification of this Act to protect and encourage solar energy use would both aid states in amending their own laws and promote uniformity among the states. This is only an example of the potential guidance and technical assistance which the federal government, with its vast resources, is capable of providing to the states.

Geothermal Resources

A second energy source inviting cooperative state and federal action derives from the molten mass known as magma, which is usually found 20 miles below the earth's crust. Fissures in the earth's crust permit the magma to approach the surface, enabling man to exploit it as a source of energy.

Since geothermal resources are a complex mix of water, thermal energy, gas, hot rocks, and possibly other mineral byproducts, a fundamental legal problem associated with them is one of classification. Ownership and control of such resources on lands subject to prior mineral conveyance by the federal government are in question due to this lack of definite classification. Different laws deal with ownership and control of the minerals, gas, and water found on lands within known geothermal resource areas [KGRA]. Prompt and beneficial development of geothermal resources is dependent on determining which set of laws is the applicable one. For instance, federal rights in geothermal energy under mineral reservations contained in various conveyances of public land are dependent on this resource being classified as a mineral. If the mineral classification is upheld, however, no established leasing authority for geothermal resources on federally controlled offshore lands will exist.

Courts have varied in their classification of geothermal resources, and have classified them differently for different purposes. None seems satisfactory; having characteristics of water, mineral, and gas, geothermal resources fit neatly into no category. Water is merely a transport mechanism for the energy, and sometimes must be artifically introduced into the system. The steam produced, on the other hand, is a result of the resource and not the resource itself. Nor does geothermal energy have the characteristics traditionally associated with a mineral. Probably the most logical resolution of the classification problem would be a distinct classification of geothermal resources and enactment of separate regulations governing them. Since most of the classification problems arise in the context of federal laws and regulations, corrective action also must take place at the federal level.

The primary problem area involving potentially conflicting state and federal laws involves the presence within a KGRA of lands subject to the jurisdiction of different governmental entities. Under the Geothermal Steam Act of 1970, the Secretary of the Interior has discretion to conserve properly the geothermal pool and to require lessees to unite and operate collectively as a unit. State and privately owned land adjacent to the federal lands within a KGRA is subject to control and regulation by the states. Responsibility for the management of a single geothermal reservoir that underlies lands controlled by separate jurisdictions thus must be assigned.

The problems which might arise due to separate jurisdictional control are well illustrated by the experience of the petroleum industry. The rule of capture has characterized petroleum exploitation in the United States with unfortunate results, each developer, being entitled to whatever oil he could produce, literally raced to extract oil to protect his interest. This resulted in waste, and, on occasion, damage to the underlying oil pool. The rule of capture has recently been tempered by basin management concepts, however, these controls came late to the petroleum industry. To insure the beneficial development of geothermal resources and to prevent overproduction of the field, such controls should be introduced at the earliest possible state of development. The reduced output from a geothermal well due to overproduction can result in a loss of pressure within the well that can preclude the further generation of energy from the source. The uncertainty resulting from this doubt as to the potential duration of the source could discourage a geothermal developer. He must have reasonable assurance that the geothermal resource will support the generating facility for a sufficient period to justify the investment.

Regulations contained within the 1970 Act require compulsory pooling, and unitization in production which allows all lessees of a common pool to share equally in the production. Such a plan seems to be a significant step in solving the problem of overproduction. Some states have taken similar action. New Mexico, for example, has enacted legislation which permits holders of state geothermal leases for the same reservoir to enter voluntarily into agreements to enhance production, with the state regulating production for maximum recovery. However, the discretion is that of the developer, not the state. Consideration should be given to a functional management system, involving both state and the federal governments, that insures to each developer the control over its respective lands, but at the same time, guarantees the proper use and development of the geothermal resource by minimizing waste. A cooperative plan seems to be the most promising scheme since it takes into account the unique nature of the geothermal resource.

A governmental role in promoting geothermal development also seems an appropriate concomitant to the regulatory function. Federal tax incentives that would encourage industrial development of geothermal resources should be made available. Tax writeoffs for geothermal extractive industries, depletion schedules and depletion allowances for geothermal resources, and capital gains treatment for profits would be important economic incentives if offered to geothermal industries. The state could also offer tax incentives that would favor geothermal industries. Property used in the extraction of geothermal resources could be exempted from ad valorem property taxes, and equipment purchased for the extraction could be exempted from sales taxes. Additionally, income realized from the manufacturing and sale of equipment for the extraction of geothermal resources could be exempted from state income taxes.

Wind Energy

Wind energy, another alternative energy source in the development stage, also seems amenable to concurrent state and federal lawmaking. Aside from the obvious difficulty that only certain areas of the nation have sufficient sustained wind velocity to allow the economic utilization of this energy source, the major impediment to prompt implementation of wind energy systems may involve legal questions of aesthetic pollution. The objection to electrical transmission towers as aesthetically degrading would appear to foretell the public reaction to windmill towers; the possibility of a windmill on every other roof will probably be even less acceptable. Indeed, building codes and zoning height regulations on the state and local level may now preclude the installation of windmills or may be so used in the future. Federal and state governments should act cooperatively in this area to test and encourage public acceptance of windmills. State governments, with possible federal assistance, can also make any changes in state enabling laws necessary to allow local zoning and building code changes favorable to wind energy utilization.

Several additional problems arise from attempts to harness wind energy. A difficulty shared with solar energy is the lack of recognized legal interest in the energy source. Courts presently do not recognize any right to the air flowing across the land of another. Unless sufficient spacing is maintained, adjacent units could interfere with one another, thus discouraging widespread utilizaion. Further, the public acceptance problem could be exacerbated if a potential user's right to operate his unit without interference remains uncertain. State legislation recognizing and protecting wind energy rights is the preferable solution; in its absence, local zoning controls can remedy the situation, albeit less effectively.

Other problems arise from the lack of legal standards refining ownership in the atmosphere and its currents. Rights to wind energy from federal and state lands must be determined, and appropriate leasing procedures established. Moreover, possible windmill interference with television and microwave transmissions must be anticipated and dealt with. Construction of other tall structures—electrical transmission towers, skyscrapers, and others—has been allowed even though it interfered with electromagnetic transmissions. State and federal entities with responsibility for communications and energy development should confer regarding this problem and attempt to reconcile the competing interests.

Energy from Solid Waste

Finally, attention should focus on the use of solid waste to create energy, an area which has been the subject of considerable recent federal and state attention. Organic waste, which constitutes over half of the total waste generated each year, can produce sufficient energy to replace at least half of present oil imports. Development of this promising energy source depends on interrelated efforts of state, federal, and local governments.

In general, the municipalities are responsible for and bear the cost of collection and disposal of solid waste. This would seem to imply that the municipalities should also be responsible for implementing programs whereby recovery from solid waste would become possible. However, the initial planning and construction costs involved in converting from a disposal system to a recovery system may be prohibitive to the municipalities. Further, the quality of solid waste required to be fed into a processing unit to insure its efficient operation may require the joint operation of a unit by several municipalities, resulting in shared benefits and requiring cooperative planning and development. With no municipality having more authority than another, disputes among the municipalities concerning site location and distribution of the benefits could lead to unnecessary delays in the planning and development of the processing unit.

A plan implemented by the states with the cooperation of the municipalities appears to be a possible solution. A statewide plan would help to insure efficient planning and maximum utilization of solid waste through larger, strategically located processing units. The states could assist also in financing the planning and construction costs of the processing units. The aid of the federal government would significantly add to these cooperative efforts. Unfortunately, however, the federal government presently appears to lack a strong commitment to solid waste recovery, at least in part because waste disposal has been considered a local rather than national matter. The thrust of waste management was redirected from disposal to resource recovery and federal involvement initiated by the Resource Recovery Act of 1970, authorizing the Secretary of the Interior to carry out demonstration projects. Still, the federal effort in this area has not significantly progressed.

The federal role should be much greater. In addition to financing research and implementation projects, the federal government should coordinate overall research efforts, providing technical assistance to state and local governments, providing the necessary incentives for increased use of recycled materials, and increasing the awareness of state and local governments of the potential benefits of energy and resource recovery from solid waste. Should the states fail to begin prompt utilization of solid waste due to economic pressures or convenience, the federal government has the authority and means to overcome these problems. Solid waste is a problem national in scope and interstate in character. Prompt development of energy recovery from solid waste will require an expanded and accelerated federal role. Strong legislation is necessary to insure adequate federal support, guidance, and initiative.

The federal government, in addition, must take steps to make the economics of energy recovery from solid waste more attractive. Although state action toward this goal is also possible, the states acting alone cannot eliminate the presently existing economic disincentives. The problem lies in three primary areas: discriminatory freight rates, federal procurement policy toward products containing recycled materials, and taxes favoring utilization of depletable energy resources.

The cost of transportation may be determinative of whether energy recovery from solid waste can be economical. The marketability of recovered energy will depend on its economic competitiveness with virgin materials used as energy sources. Evidence shows that the freight rate structure discriminates against some secondary materials in favor of virgin materials. Since delivery cost represents a large percentage of the price of solid waste, such discrimination in the rate structure places recovered energy at a serious disadvantage on its economic competition with virgin resources.

A second important factor in ensuring the economic feasibility of energy recovery from solid waste is the marketability of inorganic materials separated during processing; such sales could help offset the necessary cost of processing the solid waste. The federal government, although the largest single purchaser of many United States goods and services, consumes less than 4 percent of gross domestic output. On the surface, then, it would appear that the effects of federal government purchases would be minimal; however, a government program aimed at the use of recovered materials should increase public awareness of the potential for recycling. Moreover, the widespread circulation of federal specifications on recycled material would tend to encourage state and local governments, as well as the private sector, to utilize these materials. Similar purchase policies by the states could add significantly to the development of the recovered energy market. According to the Environmental Protection Agency [EPA], federal procurement regulations in the past have favored the purchase of products containing virgin materials, requiring in certain cases that they be purchased in preference to products containing secondary materials. The General Services Administration responded by instituting a program emphasizing the procurement of products containing secondary materials. This program, aimed primarily at paper products, should be expanded so as to give maximum incentive to potential developers of energy from solid waste.

Finally, changes in the system of tax incentives are necessary. Capital gains treatment for profits, tax writeoffs for extractive industries, depreciation schedules, and depletion allowances favor the use of virgin materials. These allowances promote the use of virgin resources in place of secondary materials, in effect subsidizing virgin material use. The system of tax incentives should be reversed to favor the utilization of solid waste.

REGULATION OF ENERGY DISTRIBUTION

The allocation schemes which attend the energy crisis provided an example of both conflict and cooperation. The federal Emergency Petroleum Allocation Act had specific provisions for a state role in allocating petroleum. In some states cooperation was amicably achieved, while in others the procedures resulted in strong state objections. Since the federal government has exerted authority over distribution, it is likely that in future shortages the federal government may exert even greater controls. Given that these controls will be a result of shortages and that the goal of the states will be to obtain as much fuel for their own citizens' needs as they can, conflict seems inevitable.

The transport of energy falls to a large extent within federal regulatory authority since energy transit involves interstate commerce. Whether by pipeline or other means, the federal government, through the Interstate Commerce Commission [ICC] and the FPC largely controls the transport of energy. However, there does exisit a role for the states, particularly in controlling the distribution of electrical energy.

Electric Utilities

The electric utility industry is currently undergoing extensive transformation resulting from recent energy shortages, escalating costs, and increased public indignation at rising prices for electricity service. In the current context striking the necessary balance between investor and industry interests on one hand, and consumer interests on the other, has become an exceedingly complex process. Several federal agencies have limited authority over electricity distribution; however, the primary governmental control in this area has traditionally been with the states. State public utility agencies generally have the power to prescribe fair and reasonable rates and charges, classifications, and standards of quality and measurement, and to establish a uniform system of accounting and reporting by each public utility. Further, such agencies oversee repairs, improvements, additions, and extensions to the facilities of a public utility which are necessary to provide adequate service and promote the convenience and welfare of the public. The authority of the states to act in the area of distribution of electricity is well recognized. However, since new and possibly untried methods are called for in dealing with the current energy situation, constitutional limitations on state power should be carefully delineated.

An important source of limitation on state power to deal in the area of electricity distribution is the preemptive authority of the various federal agencies. For example, the FPC has authority over interstate sale of electricity, and requires all public electric utilities to make periodic reports of their operations and accounts. Additionally, it plays an important role in the planning and coordination of regional electric generating facilities. It may order a public utility to connect its transmission facilities with facilities of one or more individuals engaged in the transmission or sale of electrical energy, and to sell or exchange energy with such individuals. In the event of an emergency, the FPC may require temporary connections of facilities and such generation, delivery, interchange, or transmission of electric energy as it decides will best remedy the situation. Another federal agency with responsibilities which affect electric utilities is the EPA. The EPA, concurrently with state environmental agencies, has authority over the environmental impact of electric utility policies. Finally, the Nuclear Regulatory Commission is empowered to deal with the production of nuclear energy.

Thus the federal government maintains a significant level of authority over certain specific regulatory areas related to the generation of electricity. This authority is direct and affirmative, as in the determination of fuels and direct regulation of interstate sales by the FPC, as well as indirect and negative, as in the area of environmental protection by the EPA. Up to this time, however, there has been no agreement among the branches of the federal government regarding the direction a comprehensive regulatory scheme should take. State and local governments and private individuals are left to exercise considerable authority to deal with the evolving electricity conversion problem. Given this option, the states have generally chosen to concentrate on electricity distribution issues, such as rate structures, rather than to confront directly the conversion problem. It should also be noted that the electric utilities themselves maintain considerable control over the equipment used, the proposed sites to be developed, and the fuels to be burned. While the states have considerable power to regulate conversion they have generally failed to exercise this power except in the context of other issues.

Natural Gas Utilities

Natural gas is currently under extensive control by the FPC. Federal regulation began as early as 1938 as a result of requests by states which have been frustrated in their attempts to deal with the vertically integrated industry at the local level. During this early period, the Supreme Court had effectively precluded state regulation of interstate natural gas as being in violation of the commerce clause. States were permitted to regulate only where interstate commerce ended and intrastate commerce began, that is, where pipeline pressure was reduced and gas passed into local distribution systems. This left the states free to control rates charged by distributors to local consumers, but unable to control prices charged by interstate pipeline companies to distributors. The purpose of the Natural Gas Act was to fill this gap between production and distribution in which the states could not act. The FPC was given regulatory authority over the interstate transportation of natural gas, including the power to set "just and reasonable" rates. Direct sales and intrastate distribution are not within the Commission's jurisdiction, although there have been proposals to extend its power into this area.

Thus, states that import most of their natural gas supply must leave regulation largely to the federal government; however, the regulatory situation may face future changes. One of the most controversial issues in regulatory circles today is the question of decontrol or deregulation of the natural gas industry. Advocates of deregulation point to FPC price regulation as the cause of the current gas shortage. There is general agreement that domestic natural gas reserves are sufficient for domestic needs for at least the remainder of the century, given reasonable efforts to locate and produce the gas. Yet, production has not expanded to meet the demand requirements, and the impact of the shortage has been felt primarily by interstate residential consumers, the group regulation is intended to benefit most. It is argued that deregulation would effectively correct the shortage since it would induce exploration and development of supplies not currently economical to develop. Components counter that there are shortages of other petroleum products not subject to regulation; thus, this factor cannot be blamed for the industry's failure to develop available resources. A major point of contention centers on whether the industry would be sufficiently competitive without regulation to operate in a manner not detrimental to the consumer. Proponents of deregulation assert that the industry is "workably competitive," pointing out the relatively low degree of ownership concentration in the production of gas and in reserve holdings for future production. The argument is that without regulation, prices would rise to the marketclearing level and compete with other alternative supplies available to consumers. Opponents of deregulation, on the other hand, are adamant in their position that the industry is not workably competitive and must be regulated to protect consumers from exploitation. Petroleum companies are characterized as approaching oligopolistic control of all energy resources, thereby becoming full-line vertically integrated energy companies. Thus, deregulation of natural gas producers could result in the companies' using natural gas price increases to obtain higher prices for oil products, coal, and other fuels.

The states will be generally affected by any change in FPC policy, including deregulation schemes. Some states are currently using their limited power over natural gas to allocate gas within their borders. If FPC jurisdiction is broadened to include intrastate sales, state power will correspondingly diminish under the supremacy clause. Any national priority scheme established by the FPC would have to be followed by state regulatory commissions in determining end-use in individual states. Total deregulation, on the other hand, significantly broadens the states' interest in the distribution and consumption of natural gas in general.

The degree of unhappiness with the program expressed by some states thus gives rise to a suggestion that the states should establish their own allocation system, either to supplement the federal system or to replace it if the Emergency Petroleum Allocation Act expires. The body of federal law on fuel allocation is so extensive, however, that such an independent state system seems inadvisable, and may be preempted. In addition to the fuel allocation act, the Defense Production Act of 1950 and the Natural Gas Act both contain provisions relating to fuel allocation. These statutes further illustrate the pervasiveness of federal control in the area and reinforces the preemption argument.

GOVERNMENT ROLES IN ENERGY CONSERVATION

Since the increase in national awareness of the finiteness of traditional energy resources, the need for additional conservation measures has received considerable attention. Unlike the concomitant effort to develop alternative energy sources, conservation involves areas in which strict delineations of federal and state authority have been drawn over the years. The resulting jurisdictional mix may impede prompt implementation of comprehensive conservation programs, though opportunities for coordination do exist and should be utilized.

Building Construction

In the last 8 years, energy consumed in space heating for commercial buildings has almost doubled. There is evidence to suggest that savings of two-thirds in nominal lighting energies can be achieved by available technology. Making energy conservation an overriding concern in the design, construction, and operation of new buildings could result in a savings of about 40 percent of the energy per cubic foot of space now being consumed. The federal-state balance of control over building construction is somewhat nebulous. Although the state has primary control over matters such as zoning ordinances and building codes, it appears that the federal government, through its spending and taxing powers, may influence energy consumption in buildings in the future. Further, the federal government can influence construction habits by specifications included in such federal loans as those made by the Federal Housing Administration and Veterans Housing Act. Nonetheless, primary control in the area of housing codes resides in the states.

Building regulations are supported by the state police power and, if reasonable, are valid to the extent they promote the common good. So long as the regulation is not arbitrary and tends to promote the public health, safety, morals, or general welfare, it will be upheld. The requisite connection of reasonable regulation and rational relation to legitimate public purpose can be found in the broad public benefits provided by energy conservation. The goal of energy conservation thus is arguably within the ambit of public welfare for which the legislature may act.

The state may lawfully establish retroactive regulations which require reasonable changes in existing buildings to improve energy efficiency. In determining whether a substantive retroactive regulation is reasonable, the essential question under traditional due process notions is whether the public welfare requires retroactive applications and whether the property owners affected would suffer an unreasonable burden as compared with the resulting public benefits. Additionally, under substantial due process restrictions, the end sought by the legislature must be a legitimate public purpose, yet the means must not be unreasonable, arbitrary, or capricious. Generally no rights are violated if the sum required to be spent by the property owner is reasonable under the circumstances. For example, the United States Supreme Court upheld a building ordinance requiring the installation of a sprinkler system costing $7,500 in a building [illegible]. In another case, the South Carolina supreme [illegible] nance which requi[illegible] the plaintiff to repair [illegible] cost exceeding $575 for each of the over 100 units he owned. The court felt the ordinance to be reasonable and not a taking of property without compensation. Courts have also upheld energy-related housing code requirements, ranging from a provision mandating room heating facilities to a water heater requirement.

In addition to due process constraints, there are two other limitations on police power energy regulations such as those which would be instituted by a state under its building code. The supremacy clause requires that a state statute yield in case of a direct conflict with an exercise by the federal government of its constitutional powers. The remaining restriction on state statutes is the equal protection clause. Equal protection demands that the law have the same effect on all persons and property belonging to the same class and under similar conditions. "The Fourteenth Amendment permits the states a wide scope of discretion in enacting laws which affect some groups of citizens differently than others." A state statute may not be struck down as offensive of equal protection in its scheme of classification unless it is obviously arbitrary; moreover, except in the case of a statute embodying discrimination so patently without reason that no conceivable situations of fact could be found to justify it, the claimant who challenges the statute bears the burden of affirmatively demonstrating that its classifications lack rationality. This presumption of validity places a heavy burden of proof of harm on those challenging the law, and at least where the government is carrying out an essential public service, the statute may be validated simply upon an affirmative showing of a relation between the ordinance and the public health, safety, or welfare. Despite this broad state authority to clarify, however, a state regulation will be overturned if it is obviously arbitrary and discriminatory.

Pursuant to the commerce clause, Congress could enact a uniform national building code if national uniformity proves necessary to prevent inconsistent local regulation from interfering with interstate commerce. Under present preemption doctrine, however, this alone might not be sufficient to prevent totally state regulation in the area. If federal uniform building codes were to have full preemptive effect, a firm expression of congressional purpose and explicit preemption of state regulation might be required.

At present the most important source of federal standards for both existing and proposed structures is the Department of Housing and Urban Development [HUD]. If liberally construed and administered, the mortgage refinancing authority of the 1974 Housing Act, under a new section, should be used to encourage building improvements conducive to energy conservation. Traditionally, building owners have obtained funds for deferred maintenance, repairs, and rehabilitation by refinancing residential properties every 10 years or so. While institutional lenders no longer supply this financing very readily, section 223(f) can offer owners an opportunity to accomplish repairs; its authority is not limited to older areas or to low or moderate income residents. Its broad language permits HUD for the first time to insure mortgages on existing housing where "substantial rehabilitation" will not be undertaken. Participating owners will be required to make repairs and improvements to satisfy applicable local housing codes and the objectives of the HUD Minimum Property Standards. Such standards could easily include energy conservation requirements.

The impact of existing federal programs is limited, however, by the ability of the states to establish more stringent building standards to be met before local occupancy permits are granted. States generally retain the power to adopt laws affecting the subject of a federal statute, so long as the federal purpose is not undermined. Additionally, in view of the traditional role of the state police powers even a federal uniform building code could likely be viewed by the courts as an unwarranted intervention in local governmental activities. Thus, the federal role in influencing building construction for more efficient energy utilization will probably remain a limited one.

Transportation

Transportation is also a key energy policy area because of its relation to energy consumption. Transportation users depend heavily on petroleum products for their energy. Thus oil policy and foreign affairs are heavily interrelated with transportation programs, as are domestic oil production regulations. Environmental considerations also are interrelated with transportation energy consumption in such areas as vehicle emission standards and the Clean Air Act.

Federal jurisdiction in transportation affairs is similar to federal authority in other energy-related areas. Transportation policy places particular emphasis on the commerce clause and the national power to "provide for the common defense" as the basis for jurisdiction. The federal government exercises broad-ranging powers to insure that interstate commerce is not burdened. Vehicle standards, ratemaking authority, and the like are examples of federal action in pursuit of this power. Providing for the defense of the nation is a constitutional mandate for the federal government to participate in the design and development of transportation facilities. The interstate highway system is an example of a transportation facility built to assist in the national defense. States also have considerable regulatory authority over transportation by virtue of the police power.

Private Transportation.—The use of automobiles is regulated by government through taxes and licensing. There are taxes on the purchase of automobiles and on gasoline, the latter imposed by federal, state, and in some places local government. The gas tax is of particular importance because it is directly tied to automobile use. The consumption of gasoline is relatively inelastic, therefore, present taxes, totalling about 11 cents per gallon, do little to discourage auto use. A large federal tax of perhaps 40 cents a gallon, however, might result in a substantial decrease in auto use, and hence a substantial energy savings.

Presently, the federal government perpetuates America's dependence on the automobile through the Highway Trust Fund. The fund is financed through taxes, including 100 percent of the funds raised by federal taxes on gasoline, diesel fuel, tires and vehicle parts. In the past this fund has been earmarked exclusively for highway appropriations. Even though the fund has now been opened to allow expenditures for mass transit, the bias of the trust fund is clear: "it is unfair and unjust to tax motor-vehicle transportation unless the proceeds of such taxation are applied to the construction, improvement, or maintenance of highways." The federal government is not alone in segregating tax monies raised by gasoline use for maintenance and construction of roads. For example, 6/7 of the gasoline taxes collected in Florida "shall be used for the construction and maintenance of state roads." Thus, at the state level also, the perpetuation of the automobile is statutorily ordained.

A state can regulate goods under its police power without violating the commerce clause only where a mode of interstate commerce is not unduly burdened. Thus, a state would probably be limited in its ability to regulate the sale of autos. Taxes on inefficient vehicles or on fuel-consuming accessories would probably be upheld, however. If the tax imposed correlates to the weight of the vehicles, the tax can be tied to additional maintenance required on roads due to their use by heavier vehicles. However, title III of the Energy Policy and Conservation Act preempts any state efforts which would conflict with automobile fuel economy standards set by the federal government.

The obvious corollary to discouraging the sale and use of inefficient motor vehicles is to encourage the use of more efficient vehicles. Incentives could be established by exempting certain efficient accessories, such as radial tires, from the sales tax. Programs also might be implemented which discourage the use of all automobiles. For example, during the Arab oil embargo, there was a prohibition of Sunday gasoline sales.

Another energy conservation measure that seems particularly susceptible to incentives is encouragement of carpooling. Eighty-two percent of working Americans commute to their jobs in automobiles, many of them driving alone. Over 34 percent of all passenger-car travel in the United States involves commuting to and from work. Incentives aimed at encouraging carpooling can be provided through preferential traffic lanes, parking facilities, and toll rates. Federal funding is available to the states for implementation of carpool incentives through the Emergency Highway Conservation Act and the Energy Policy and Conservation Act.

Mass transit systems provide another effective alternative for decreasing automobile use. The FEA has flatly declared, "public transit is two to four times more energy efficient than the auto." Federal responsibilities concerning mass transit are mainly located in the Urban Mass Transportation Administration [UMTA] which is part of the Department of Transportation. Federal assistance for mass transit, is authorized in the Urban Mass Transportation Act of 1964, most recently amended in 1974. Such assistance, available only to urban areas, is intended "for improving the efficiency of transit services."

Projects which may be authorized under this plan include both capital and operating expenditures.

The states are the more logical level of government to handle mass transit utilization since transportational needs often are regional in nature. No one municipality can cope with the problem, and usually local governments are given only very narrow powers by the state. States have been active in considering mass transit plans; a number of them have also developed carpooling plans, both for government and private employees. States are also asked to coordinate and present statewide plans to meet federal guidelines.

It is local officials, however, to whom citizens turn when their public transit is inefficient, or incapable of getting them to a desired location at a proper time. Local responses have [illegible] [illegible]eased use of bus [illegible] pool lanes and dial-a-ride. The local role is largely one of planning and implementation. The funds appropriated under UMTA have provided an incentive for local areas to begin implementing such energy conservation measures.

Commercial Transportation.—Commercial transportation involves the movement of freight and people. The authority to regulate interstate commercial transportation lies with the federal government and is based upon the Constitution's commerce clause. State action must not unduly restrict interstate commerce, and regulation must be pursuant to a valid state interest. States have a limited role in measures to conserve energy used in commercial transportation, though the possibility of an unconstitutional regulation of interstate commerce looms large over any such proposal. For example, a state might attempt to promote more efficient commercial transportation by levying taxes upon less efficient modes. If interstate transporters were involved, jurisdiction would be limited to the intrastate portion of the carrier's business. And even then, no action could be taken which would unduly burden interstate commerce. Another argument which might be raised against regulations which vary from state to state is that commercial transportation is so interstate in nature that a uniform national system is the only feasible means of regulation.

Federal regulation of interstate commerce is among the oldest and most well established regulatory powers. The Interstate Commerce Act, passed in 1887, is the nation's oldest statute authorizing direct federal regulation of industry. Principal areas of commercial transportation regulation include air transport, domestic water transport, and surface transport, including rail carriers.

The necessity for energy conservation has altered regulation of commercial transport. In the past era of cheap and abundant fuel, neither the practices of industry itself nor the goals of government regulation stressed the conservation of energy. The purpose of federal regulation was to insure that "[a]ll charges made for any service rendered or to be rendered in the transportation of passengers or property . . . shall be just and reasonable." Shifting freight movement to more energy-efficient modes is now an important objective, as is generally decreasing the demand.

Decreasing demand for freight services cannot be as easily accomplished as decreasing demand for private transportation, however. There is less frivolous use of commercial transportation, and market forces encourage elimination of unnecessary costs. In addition, unlike private transportation, relatively little freight movement is done for pleasure. If an industry or company were impeded in its business by government regulations which prevented it from using freight transportation, a taking issue would be raised. While the use of property can be restricted by government without that action constituting a taking, the prevention of interstate commerce by this type of regulation would probably not be upheld. There are also strong policy reasons for not discouraging the use of commercial transportation. The nation is attempting economic recovery, and freight transportation is basic to business advances. This is an important factor, even when weighed against the need to [illegible]

A more promising conservation area involves increasing the efficiency of the various transportation modes. At present, many governmental regulations promote energy-inefficient uses, a notable example being the federal requirement of gateways for interstate truck transport. This requires that common carriers transport goods only according to routes authorized by the ICC, thus frequently causing truckers to travel unnecessary miles. The ICC is attempting to alleviate this situation through the elimination of gateway requirements when a carrier, by using the most direct highway route, can save up to 20 percent of its authorized route mileage. Interestingly, where a greater than 20 percent savings is involved, an appropriate application seeking direct-service authority would be required. Such government regulations requiring activities which inefficiently and unnecessarily use fuel are an anachronism. Regulations must be scrutinized to prevent government, in its regulatory capacity, from causing commercial transport to use methods which are circuitous, uneconomical, and inefficient.

Transportation issues are likely to see some dramatic and far-reaching changes in the near future. Alterations in the petroleum supply and cost situation have already had significant impact on transportation patterns. There are several significant factors which may affect future transportation programs. First, mass transit and rapid transit programs are being increasingly emphasized by the federal government. Environmental concerns, particularly standards imposed by the Clean Air Act, will have to be considered in planning transportation programs for the future. Moreover, because governmental entities are presently short of funds, proposals which require intensive capital expenditures are unlikely to be approved in the future. Finally, without federal leadership, state and local transportation planning suffers from various uncertainties in trying to project future transportation programs.

THE FUTURE OF FEDERALISM IN THE ENERGY ISSUE

A few areas of energy regulation exist which by nature will fall within the exclusive domain of the federal government. Matters relating to foreign affairs are and will continue to be exclusively federal matters. Similarly, national security is an issue of federal concern. The propriety of the exercise of that power may be questioned, however, as to whether a matter claimed to be foreign affairs or national security is properly designated. In the past, for example, the definition of national security as it relates to energy justified the construction of dams and the formation of the TVA. In the future, it may be possible that valid national concerns, such as national defense or security, may be invoked to expand federal authority. In addition, as petroleum becomes scarce, and domestic resources decrease, the actual impact of petroleum policy on national defense will [illegible]. For ex[illegible]ple, [illegible] authority to ration [illegible] during [illegible] War it was [illegible] [illegible] [illegible]ges could be utilized to justify such [illegible] on in peace time if the shortages were great enough.

The interstate commerce power, as discussed previously, is also a matter where preeminent federal power exists. Since the limits of this power are at best unclear, the limits of its exercise in the field of energy policy are less than predictable. For example, the federal government is utilizing the commerce power to claim exclusive authority over all automobile efficiency standards. Title II of the Energy Policy and Conservation Act (EPCA) preempts state efforts which conflict with federal fuel standards.

In addition to the federal government's exclusive authority, the states also retain exclusive authority over some issues. For example, the states have the power to make decisions regarding their own purchase of energy consuming items, that is, procurement. In fact, this authority is recognized specifically in the EPCA. Other examples of traditional state authority include zoning, building codes, and utility regulation. To some extent, however, each of these areas is being increasingly affected by federal activity. For example, a federal land use bill which would substantially affect the states is a recurring subject of congressional activity. In addition, a nationwide building code has been proposed. The National Flood Insurance Act of 1968 affects local zoning control. Bills have been introduced which would affect state utility regulations. Each of these cases indicates a continuing possibility of conflict or cooperation between state and federal governments. Each initiative of state and federal government without conscious coordination increases the potential for conflict. To optimize the interaction of state and federal governments, some general principles as to their respective roles should be articulated.

The Federal Role

There are unquestionably distinctions between the motives and goals of the individual states and the concerns of those states collectively as a nation. The more parochial interests of the states may not encompass the long-term national perspective required in energy policy. Therefore, the primary role of national government should be to provide guidance for the citizenry and national welfare as a whole, rather than for geographical sections. This overall guidance should include sources of energy data and information which may be utilized nationwide to avoid unnecessary duplication in research and development in several states. Further, it is the responsibility of the federal government to provide the overall framework within which the states will make their own policy. Without this guidance, conflict would occur not only between the state and federal governments, but also among the states.

The federal government may become increasingly involved in diverse matters relating to energy policy. The degree to which it becomes involved in state-related areas would likely be a function of the degree to which the states have successfully and aggressively pursued their own policies. Currently, the federal government's principal statement of guidance for state governments is the EPCA. However, much legislation is pending in Congress which could affect state energy policy. Because the federal government possesses broad powers, there are very few areas in which there is no potential for federal action. As the energy issue becomes more crucial, it is likely that the federal government's activities will grow and expand into areas which have been more traditionally of state concern, such as utility rates and housing codes. However, if the states themselves act affirmatively to implement energy policies, the federal government may not be required to intervene as substantially as it might otherwise.

The State Role

It is crucial that the states recognize that it is in the best interest of their citizens to utilize the police power to establish energy conservation as state policy. This realization can establish the foundation for utilization of the police power in many areas of concern. There is potential for the states to provide an innovative example for the federal government, and to implement programs which can provide models for other states. There are many areas of concern on the agenda for state action. One way to view the potential for state action is by phases of the energy production-consumption process.

Exploration and Production of Energy Phase.—While obtaining energy resources is a matter of concern to both state and federal governments, the states retain a large measure of control through environmental regulations over exploration within their borders. The states however, are not empowered to limit production to advance their own parochial interests if detrimental to the nation as a whole. The development of resources of the coastal states also relates to exploration and production. Offshore production has been a major source of conflict between the states and the federal government. However, a major attempt at cooperation, the Coastal Zone Management Act, is currently being implemented. While the Act is not aimed primarily at energy policy, it does provide a mechanism through the use of federal funds for state control of coastal zone development, including energy-related onshore activities.

Processing and Conversion Phase.—Changing oil resources into energy is heavily affected by environmental concerns of both the state and federal government. Processing and conversion of both petroleum and nuclear fuels are heavily controlled and regulated. Within this issue the location and siting of nuclear power plants has been and will continue to be an area of conflict. It has been the subject of initiative in the West and litigation in the East. The ultimate extent of state authority to affect nuclear power has not yet been decided under the current statutory scheme.

Under the Clean Air Act, the states are allowed to require the burning of coal with less than one percent sulfur content, thus heavily influencing conversion of coal for electricity. As pressure increases to use coal, new federal standards may be promulgated with the intent to override state restrictions. A new and emerging area of concern is control of conversion of solar energy for electricity. The primary question is who will set standards of performance for solar devices. To this point, standard setting has occurred at the state rather than the federal level. This could result in nonuniform standards among the states, which could cause problems for manufacturers and thus delay the implementation of solar energy technology.

Distribution and Transportation Phase.—The federal government has heavily controlled nationwide allocation under the Emergency Petroleum Allocation Act. It is likely that future shortages and allocation schemes will be heavily controlled by the federal government. Given that these controls are a result of shortages and the goal of states is to obtain as much fuel for their citizens' needs as they can, conflict seems inevitable in this area. Transport of energy falls largely within federal regulatory authority since energy transport involves interstate commerce. Whether by pipeline or by other means, the federal government, through the ICC and the FPC, controls the transportation of energy. One of the major examples of recognition by the federal government of the states' role occurs in the area of energy transportation. The Deepwater Port Act of 1974 grants to the governors of coastal states the right to veto the siting of deepwater ports in adjacent states. Under that Act, the federal government specifically accorded a role to the states in controlling transportation of petroleum through the use of deepwater ports.

Utilization and Consumption of Energy Phase.—The area of use control is the focus of energy conservation. Since energy conservation is of increasing importance, it is likely that both the state and federal government will be more active. However, it is here that the state possesses the greatest intrinsic authority to implement energy policy. The following is a list of energy-related policies which states should consider in utilization of its police power to reduce the consumption of energy:

(*1*) *Implementation of state zoning and land-use policies which encourage energy conservation.*—This strategy would specifically require states to consider energy matters in the location of developments, industries, and the like. In addition, zoning should be considered for protecting the use of solar devices and for improving industrial siting for optimal use of energy availability.

(*2*) *Utilization of building and housing codes.*—The EPCA has required the states to implement an energy-conscious housing code in order to receive federal funding. Numerous schemes have been devised by the states to implement or to encourage energy conservation in buildings, from tax breaks to direct building code requirements.

(*3*) *Promotion of alternative sources of energy.*—States have the capability to encourage the use of solar energy as well as the utilization of solid waste for production of electricity. In fact, many states have implemented such policies, and the broader their use of these alternative sources, the greater collective national benefit.

(*4*) *Promotion of conservation in transportation.*—States have within their power the ability to improve mass transportation and encourage its use through wise land planning and through encouragement of carpooling, vanpooling, and special traffic lanes. This is another area in which the federal government has directly mandated some state action for the receipt of federal funds.

(5) *Implementation of energy-conscious procurement.*—The authority to affect procurement is specifically recognized by the federal government, and certain states are implementing energy-wise policies. The ability of states to take the lead in consuming energy-efficient products can set both an example and encourage industry to produce such products.

(6) *Restructuring of utility rates.*—Although states traditionally have regulated utility rate structures, the goal in the past has been to ensure a fair rate of return on utility investments rather than control the amount of energy consumed. The rate-setting agencies in many states have adopted or considered rate structures which would tend to encourage the conservation of energy.

Other Policy Considerations.

There are many other issues related to energy policy which are just beginning to be raised. Increased efficiency in the utilization of resources such as the use of waste heat, solid wastes, and returnable containers, provide examples of an issue where state-federal boundaries have yet to be drawn. In many of these areas states have taken tentative steps while awaiting some definitive policy from the federal level. For example, the impact of energy policy on disadvantaged groups, such as the aged and the poor, has largely been neglected at both the state and federal levels. Increased attention is being given to this topic in areas such as "lifeline" utility rates, weatherization of low income homes, and mass transportation for the elderly.

The energy issue raises many questions of federal-state roles. The resolution of these issues is likely to cause a major evolution, if not revolution, in the concept of federalism. Assessment of the continuing areas of conflict reveals that, at best, predictions as to future disposition of various issues is uncertain. Yet, the energy issue is not one in which policy can await future clarity. Therefore, state and federal governments should begin to act in the public interest and promote energy's effective use. State governments cannot afford to wait for the federal government to solve their problems. States must act in the interest of their citizenry to alleviate energy-related problems where jurisdictional authority permits. The federal government must recognize the potentially valuable role of the states in the development of energy policy and should encourage state action. This can be accomplished through a comprehensive federal plan which provides leadership and increased certainty, on which local decisionmakers can base their decisions. The federal government should finance innovative pilot projects so that their efficacy can be tested for state implementation. There are areas where the federal government is more capable of policy formulation than the state governments, but there are corresponding areas in which states are better qualified to act. Resolution of areas of effective authority is essential for satisfactory solutions to existing energy problems.

CONCLUSION

The division of authority between state and federal governments has been a matter of continuing concern throughout the history of the country. Because of the complexity of the energy issue, it not only reaches many of the traditional areas of conflict between the state and federal governments, but also creates new ones. As each level of government begins to take more extensive action, the issue of the division of state and federal authority becomes more complex. Moreover, this complexity is intensified by the increasing diversity of energy resources and sophistication of delivery technology. In the near future it is anticipated that state and federal governments will extend their activity in the area of energy policy—the state governments through their police powers and the federal government through its constitutional authority. While it is possible that in some spheres each may operate independently, it is more likely that either cooperation must be generated or conflict will ensue.

THE COAST IS NOT CLEAR FOR ENERGY PLANNING

(By Rice Odell)*

It is hard to conceive a political enterprise more wildly ambitious than the current federal-state program to manage the nation's precious coastal zone. The fitful progress of that program, now more than four years old, is worth examining—not only because of its own far-reaching importance, but because it may forewarn us of problems likely to emerge if some type of national land-use law is enacted.

The coastal program calls for states to develop and then administer coastal zone management plans that meet certain federal conditions—as a prerequisite to receiving federal financial assistance. One key condition is that state plans make some provision for energy facilities. In return, federal agency projects are supposed to be "consistent" with state plans.

Why is the coastal zone program so ambitious and so beset with difficulties? There are three basic reasons. First, the demands on limited coastal resources are numerous and pressing, particularly with the heavy emphasis on increasing energy supplies. Second, the law seeks to reconcile what is inherently irreconcilable—the many conflicting public and private interests that are pushed and pulled in a giant tug-of-war within and among three competing levels of bureaucracy: federal, state, and local. Third, the law provides no regulatory leverage. It relies solely on the inducements of the federal purse, the proverbial carrot.

Typically, the Coastal Zone Management Act of 1972, which established the federal-state program, seeks to serve all masters. It declares a policy of both protecting coastal resources *and* developing them—"giving full consideration to ecological, cultural, historic, and esthetic values as well as to needs for economic development."

The Office of Coastal Zone Management (OCZM), in the Commerce Department's National Oceanic and Atmospheric Administration (NOAA), has interpreted this schizophrenic mandate with expressions of policy such as this:

"It must be recognized that not all development or activity in the coastal zone can or should be halted. As long as these determinations are based on sound information and processes which reflect the value of the natural environment, a process for determining where development should go, as well as where it should not, can be environmentally beneficial, for the designation of specific areas for development will focus and restrict such activities to carefully chosen sites. This will reduce the development pressures on other environmentally sensitive or valuable areas." [1]

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* From the Conservation Foundation Letter, a monthly report of The Conservation Foundation, February 1977. The foundation describes itself as a private, non-profit research and communications organization which "encourages wise management of the earth's resources." References appear at the end of the article. Reprinted by permission.

The basic thrust behind the 1972 act was a concern for environmental protection. But with extensive amendments signed into law on July 26, 1976, Congress changed the rules of the game, seeking to lay on OCZM and the states a heavy energy responsibility. The emphasis on energy—or the federal pressures for energy development—in setting coastal zone priorities has been hard for some states and some citizen groups to swallow. It has worsened a political climate already full of suspicion among federal, state, and local governments, and already rife with the resentment of property owners uptight about *any* government planning or interference.

For example, California opposes a terminal for Alaska oil at Long Beach. There has been vigorous opposition to certain oil leasing off the California, Alaska, and Atlantic coasts, to a liquified natural gas terminal in Chesapeake Bay, to an oil refinery at Eastport on the coast of Maine, and so forth.

How does the Coastal Zone Management Act seek to resolve the inevitable conflicts over issues such as energy development? To qualify for a program development grant, a state program must include "a planning process for energy facilities likely to be located in, or which may significantly affect, the coastal zone, including, but not limited to, a process for anticipating and managing the impacts from such facilities."

In its proposed regulations for implementing that requirement, NOAA says the states would be "*encouraged* to develop . . . procedures for assessing need/demand projections", and for "allocating these needs among coastal and inland locations." NOAA explains that these procedures would not be *required* "because it is felt (they) would be beyond the capability and purview of coastal management programs at this time."

The states would be *encouraged* to develop methods for "determining site suitability of alternate locations for particular facilities." They would be *required*, however, to include a procedure for assessing impacts of energy facilities and techniques for coping with these impacts.

In order to get a program approved and receive federal grants to administer it, the law says a state must see that its program provides for "adequate consideration of the national interest involved in planning for, and in the siting of, facilities (including energy facilities) which are necessary to meet requirements that are other than local in nature."

The approval of a state program triggers another provision of the law which is designed to compensate the states for looking after the national interest. That is the so-called "federal consistency" provision, stating that federal agencies undertaking or supporting any project directly affecting the coastal zone must ensure that the project is *consistent* with approved state management programs, "to the maximum extent practicable."

Antoher provision deals with activities requiring a federal license or permit, and with state and local government applications for federal assistance under other federal programs affecting the coastal zone (for example, the flood disaster protection program). Basically, these activities also must be consistent with an approved state program. However, there is a catch:

The Secretary of Commerce can overrule a recalcitrant state, requiring it to accommodate an energy facility—even if that development is incompatible with the state's management program. To do this, the Secretary need only find that the development is consistent with the law's "objectives" or is necessary "in the interest of national security." (One can expect much squabbling over the definition and application of these terms.)

Clearly, the federal government has the upper hand in dealing with a state that balks at a project. However, it should be remembered that a state can simply withdraw from the program if it wishes. Also, as the OCZM noted in connection with the proposed coastal program for the state of Washington, "The existence and approval of an explicit procedure will protect the state from the capricious imposition of actions or projects by federal agencies in the name of the national interest." [1]

This state leverage is buttressed by language in the law requiring extensive consultation and coordination, between state and federal agencies.

The Secretary of Commerce's power to overrule a state remains paramount, but the law further provides that in case of "serious disagreement" between a federal agency and a coastal state in the development or administration of a coastal management program, the Secretary, with the cooperation of the Executive Office of the President, shall seek to mediate the differences. (If the administration of a state program is involved, public hearings must be held in the local area concerned.)

Then if the mediation effort fails, and the Secretary still concludes that an activity is consistent with the law or is necessary for national security, the state can challenge that determination in court.

Some state officials have said they are hopeful that when state plans are approved, the OCZM will assert some authority to keep federal activities from conflicting with those plans.

The OCZM says it hopes to avoid the worst confrontations by having federal agencies participate fully and harmoniously in program development, so that needs and problems can be addressed early and cooperatively, and essential information can be exchanged. (States are required to provide relevant federal agencies with "the opportunity of full participation.")

However, some states have not done so, according to a General Accounting Office report.[3] A number of federal agencies recommended that Commerce reject Washington State's proposed plan on grounds they were not given a chance for meaningful participation and on grounds there was inadequate consideration of the national interest in energy facility siting. (Washington's program has since been revised and is the only state program approved so far.)

GAO also noted that some federal agencies have been slow and ineffective in meeting their own participatory responsibilities.

On the whole, the OCZM reasons that even if the procedure does not work too well it "should lead to the more deliberate and thoughtful and less fragmented and wasteful siting of such facilities in the nation as a whole." [1]

Related to this federal-state interaction is pending legislation to reform the whole outer continental shelf leasing process. This legislation was agreed to by Senate and House conferees at the end of last year's congressional session, but it was threatened with a veto and failed to win final House approval by four votes. Bills identical to the conference bill have been reintroduced.[4]

The legislation would expand the states' right to key information, and would somewhat enhance the state's role in OCS decision making. It would allow the establishment of Regional Outer Continental Shelf Advisory Boards to work with federal agencies responsible for OCS activities. Any recommendation by such a board or by a governor concerning a proposed lease sale, or a proposed development or production plan, must be accepted by the Secretary of Interior unless he determines that it is not consistent with national security or the overriding national interest.

In addition to federal-state relationships, the Coastal Zone Management Act specifies procedures for interaction between states and local governments or regional agencies. State coastal management agencies, which can allocate their grant funds to local governments, must be provided extensive authority to ensure that local regulations and decisions on coastal land and water uses "do not unreasonably or arbitrarily restrict or exclude those uses of regional benefit."

A "use of regional benefit" is defined as one that "typically provides benefits to a significant area beyond the boundaries of a single unit of the lowest level of local, general-purpose government."

As with the procedures for federal-state coordination, the law calls for extensive consultation and cooperation between the state and local agencies, as a condition of state program approval. Also, if a state agency proposes to implement any decision that would conflict with a local zoning ordinance or decision, it must notify the local government and allow it a one-month comment period.

In the 1976 amendments, Congress authorized $464 million in planning and administration grants for the states over the next four years. It will not necessarily appropriate that much. (By the end of 1976, the OCZM had awarded $36.2 million in planning grants.)

The amendments also establish a Coastal Energy Impact Program to help states and communities deal with the economic, social, and environmental consequences of coastal energy development, including the provision of additional public facilities and services. For this program, the law authorizes a variety of loans, guarantees, and grants totaling up to $1.2 billion over 10 years.

Most of the impact money represents a brazen inducement to boost OCS energy production. This is particularly true of $400 million in grants based on a statutory formula that measures OCS activity. (Alaska, which is being brought into line, and Louisiana, which is very much on-line, will be the chief beneficiaries of the $1.2 billion.)

Some skeptics have said they fear the lavish funding will *encourage* the siting in coastal zones of facilities that should be located inland—such as storage areas or refineries. Environmental groups and others have been fighting for safeguards to ensure that facilities are located away from the coast if at all possible.

Although all 30 coastal states and three territories are nibbling vigorously at the federal government's financial carrot, state commitments to the coastal zone program vary widely. "Some states are just barely going through the motions, with no support from the governor or the public," says Cary B. Hinton, a costal zone management consultant to Baltimore County.

California, however, already had plunged aggressively into coastal management. It needed no federal inducement to create the necessary public concern; the state is glad to get the money to make its program more effective. On the other hand, South Carolina and some other states seem at times to have taken the money, then bitten the hand dispensing it.

Last year, South Carolina Governor James B. Edwards twice vetoed coastal tidelands bills passed by the legislature: At one point he disparaged the legislation as a "land-use planning bill" under which bureaucrats could tell people what they can do with their property. He said it would allow the federal government to plunge its hand "into the very viscera of South Carolina." [5] Edwards—who owns a share in a coastal island himself—said he would be satisfied with a bill that had no ties to Washington—a concept that obviously flies in the face of the federal law's premises.

As this was written, the legislature was at work on a strengthened coastal management bill. Supporters figure Edwards is certain to veto again, but hope for legislative override. Meanwhile, South Carolina has received $897,257 in grants from the federal government for three years of planning. It is expected to apply for a fourth-year grant under a 1976 amendment to the law giving states an extra year if necessary to complete approved programs.

Maine provides another illustration of the sometimes politically painful evolution of a plan. Initially, public opposition was very strong. The plan was seen as a threat to local community management prerogatives; citizens claimed they had too little chance to help develop the program; and there was concern about financing at the expiration of federal funding.

So strong were the objections that Maine's governor withdrew the state's application for plan approval and ordered a reorientation of the program. He noted the "considerable controversy" over whether the preliminary application would "truly represent the needs or the desires of the people of Maine or whether it was more representative of individuals who feel privileged or that they have a divine right to control the lives and/or destinies of a majority of the people." [3]

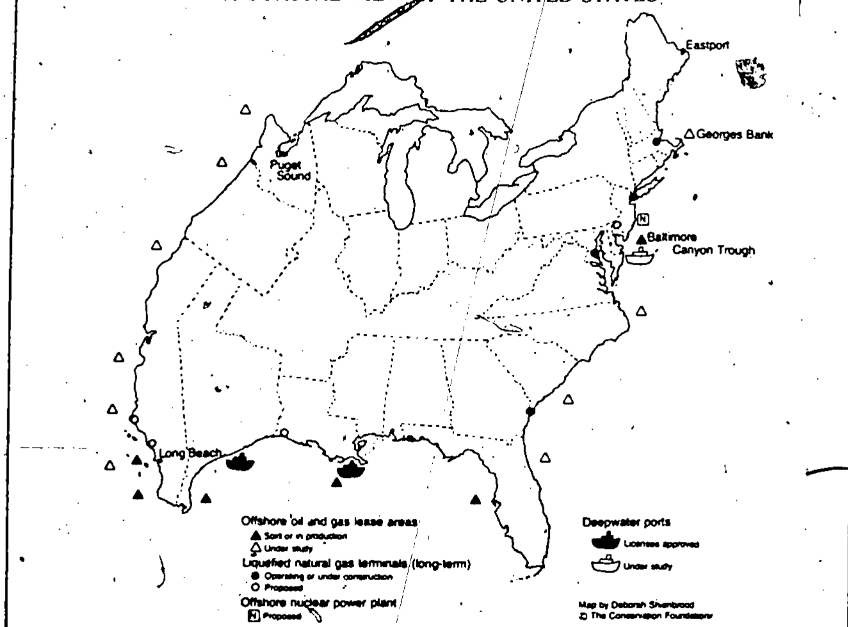
Now, however, OCZM feels there is much greater receptivity in attitude, partly the result of increased involvement by local officials. A new plan is expected to be ready around mid-year, and the governor may support it, observers feel.

If the federal carrot induces so much indigestion in states such as South Carolina and Maine, one can imagine the frenzied reaction to a stick.

Still another problem impedes the effectiveness of the program. That is the absence of a coherent national energy policy on which states can rationalize the need—or lack of need—for energy facilities. The states can't make energy policy, or assess national energy demands.

A recent study by the congressional Office of Technology Assessment voices many of the doubts raised by the general policy vacuum.

A COASTAL VIEW OF THE UNITED STATES



This slightly myopic, coastal manager's perspective of the United States shows much of the widespread energy activity taking place or proposed along the nation's shoreline. Except for the location of import terminals for liquified natural gas (LNG), the map does not identify the many onshore areas that would be impacted by industrial complexes to service and support offshore activities. Nor does it identify the nuclear and other power plants sited or planned on the coast. It should be kept in mind, too, that Alaska is almost ringed by areas proposed for oil leasing. (Tracts in the North Gulf of Alaska have been sold.)

The Department of Transportation has said it will issue licenses for two planned deepwater ports—the Seadock port off Freeport, Texas, and the LOOP port off Louisiana. As this was written, the sponsoring companies were deciding whether to accept conditions imposed by DOT. Several other deepwater port proposals have been studied, principally one that would be located in Delaware Bay.

Major LNG terminals already receiving imports or under construction are at Everett, Mass., Staten Island, N.Y., Cove Point, Md., and Savannah, Ga. Applications have been filed with the Federal Power Commission for terminals in Gloucester County, N.J., Lake Charles, La., and Port Hueneme, Calif. Several other LNG terminals have been proposed, and a number of ports, such as Boston, already import LNG under short-term licenses.

"For example," it says, "can the United States proceed indefinitely without (a) a formal process for determining total energy needs and (b) calculating the share of those needs that should be provided by OCS resources? That allocation, rather than the existing program for leasing maximum acreage in the minimum number of years, could become the guide for future leasing programs. It is also important to consider whether the United States can proceed indefinitely with offshore developments for oil and natural gas and other seabed resources, fisheries, and commercial activities, without a formal process for reconciling conflicts not only among the uses but between those uses and their impact on the ocean environment."

At another point the study, which deals with offshore energy development in the mid-Atlantic, has this to say: "Reduction of energy consumption could offer long-term advantages, but there are no specific plans at the state or national level for an energy conservation program that might eliminate the need for the energy supplies which would come from one or more of the proposed offshore systems." [2]

In the absence of policy, the energy cart sometimes gets put before the coastal planning horse. For instance, on January 17, former Commerce Secretary Elliot L. Richardson announced a $920,000 coastal zone planning grant to Alaska. Among the purposes of the money: to designate coastal areas of particular concern, to help local governments develop local coastal management programs, and to provide funds so local governments can determine the onshore impacts of OCS energy development.

The following day—with only two days left in office—former Interior Secretary Thomas S. Kleppe announced the sale on February 23 of oil and gas leases on 683,182 acres in the Cook Inlet of Alaska's outer continental shelf. This decision left open the method by which crude oil would be transported to shore. That determination, said Interior, "is to be made later, based on environmental and technical analysis at that time."

Thus do energy activities precede and preclude thorough analysis and planning. As it happens, however, new Interior Secretary Cecil D. Andrus recently cancelled the Cook Inlet lease sale, at least temporarily, so he can evaluate the program.

State officials have complained about the fragmentation of OCS functions between the Interior Department and the OCZM, and the absence of clear lines of responsibility. This is symptomatic of the absence of an overall national policy on energy supply needs as well as of specific policies on individual state responsibilities for meeting demand and siting facilities.

States sometimes have difficulty obtaining information on reserves, explorations, leasing plans, and the like. The OTA report says that Interior has refused—on the ground it is proprietary information—to share with state officials the kind of seismic data which would give them an early warning about the possible location of major exploratory activities and thus about potential coastal impacts. "Delaware officials," said OTA, "were told by the OCZM that they could use federal grants to pay for the data and interpretation which the Interior Department declines to share with them." [2]

Another embarrassment from inadequate planning is the surplus of oil from the Alaska pipeline that is expected to start building up in California in 1978. (In the running debate over what to do with it, one option is export it to Japan in exchange for oil from the Middle East.) [7]

In many cases, of course, it is too early to gauge the extent of energy development, so that a coastal zone plan is drawn up with a large gap. In a pre-draft plan issued for public review last December, Massachusetts officials included a footnote explaining that the energy section "does not address OCS facilities because, in the absence of exploration drilling, it is not yet possible to determine whether and where such facilities might be located."

Some will say that the coastal zone management program is a waste of taxpayers' money, money poured into states and localities in the vain hope they will develop and implement responsible plans for their coastlines. They will see it as one more nefarious governmental infringement on private property rights and local decision making. Or as a device to seduce states into acceptance of undesirable energy facilities.

If there is truth in these critical assessments, the coastal zone management program also can be considered a noble and necessary experiment. It is noble simply because it is designed to derive the greatest benefits from the great coastal resources. It is necessary because many of these resources are threatened by inappropriate and damaging development, and because it is important to manage them under a system that considers federal, state, and local interests and perspectives.

Coastal areas, so highly valued for their beauty and their biotic and recreational resources as well as their development potential, seem likely to stir up more citizen concern than many of the inland areas that would be targeted by a national land-use bill.

If protection of inland areas does not generate enough grass-roots support, implementation of a land-use law may not be politically feasible.

"The coastal zone program at least has the virtue of being geographically specific, and dealing with land forms that have inherent values everybody understands," says Charles E. Little, of the Library of Congress' Congressional Research Service. "If that is being fouled up, what would you expect from some vague program that involves everybody planning their hearts out?"

One answer, he notes, is more issue-specific legislation—for example, to protect agricultural lands, floodplains, outstanding or environmentally critical areas, and the like. "One must look with a gimlet eye at the grand programs," Little says. "We should pick the targets and go after them." He says he fears that while the planners and lawyers struggle along, a lot of places will be lost to development.

Another warning comes from Marvin Zeldin, an environmental consultant and writer: "What is most likley to emerge in too many states is a coastal zone management plan that embraces the status quo: business and development as usual, with only token lipservice to noneconomic values. . . . Worse yet, in too many states the public may be lulled into greater complacency because of the existence of 'a plan' for coastal areas, no matter how poor the plan." [8]

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3. "The Coastal Zone Management Program: An Uncertain Future," General Accounting Office, December 10, 1976.

4. S. 9 and H.R. 1614.

5. *Charleston News and Courier*, June 19, 1976.

6. The Coast Guard's weakness is further documented in "Just Another Oil Spill," by George Reiger, *Audubon*, January 1977.

7. The problem is discussed at length in *Not Man Apart*, mid-February 1977, and *Audubon*, January 1977.

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D. Coal From Public Lands: How Accessible?

FEDERAL LEASING: THE NEED FOR A PERSPECTIVE

(By Courtland Lee and David Russell)*

THE PRESENT DILEMMA OF FEDERAL LEASING

As settlers began occupying the nation's land, federal policy evolved more or less consistently toward the goal of maintaining mineral resources within federal control. The twofold purpose: to generate a source of public revenue, and to prevent monopolies by private parties.

To implement federal policy, legislation (some of it going as far back as a century ago) has assigned the task and responsibility of "conservation" to such agencies as the Bureau of Land Management and the US Geological Survey. Historically, the term "conservation" was recognized to mean: *intelligent, wise utilization* of the resource—and not merely a saving of it.

Land classification was, and still is, the method to gain the necessary knowledge for conservation or wise use of the nation's resources. In fact since 1879,[1] the US Geological Survey has been classifying land according to all the available information about leasable minerals. Traditionally, this vital information has been used simply to determine whether the federal government should retain mineral rights in areas where title to federal surface land is sold or exchanged.

The first step in the classification procedure has often entailed the withdrawal of land from entry, exchange or sale, until an estimate can be made of the extent of each mineral resource. When that estimate has been arrived at, and a "workable" deposit has been identified, the land is classified as a "leasing area"—and it can be leased only through a competitive bidding process.

Federal lands officially classified as having *no known deposit* of a particular mineral may (in some cases) become accessible to interested parties via the prospecting permit; if the holder of such a prospecting permit succeeds in finding a deposit, he is entitled (in some cases) to a "preference-right lease."

We have given this brief description about some of the conditions leading to the issuance of competitive leases and preference-right leases because (a) we want to emphasize that conservation, land classification, and land withdrawals *are not new activities* dreamed up by bureaucrats in recent years; and (b) we want to place within a legal-historical context our next discussion regarding the current status of federal leasing.

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*From Mining Engineering, Vol. 29, May 1977, p. 23–34. Mining Engineering is a publication of the Society of Mining Engineers. Courtland Lee is a mineral leasing specialist and David Russell is a mineral economist. Both are with the Bureau of Land Management, Department of the Interior. Footnotes appear at the end of the article. Reprinted by permission.

[1] Act of March 3, 1879, Title 43 of US code section abbreviated. (43 USC 31), supplemented by Reorganization Plan No. 3 of 1950, 43 USC 1451, and 203 Departmental Manual No. 1, Secretarial Order 2948.

Uncle Sam's Monopoly of Leasable Minerals

During the 19th century, Congress passed various land-disposal and homestead laws to induce Americans and the millions of newly arrived immigrants to settle in the West. These laws, in effect, gave our forefathers free homestead land requiring only nominal filing fees.

Several million acres of coal land, however, were excluded from the homestead or disposition laws. Thus, during the 1860's, coal land sold from $1.35 to $2.50 per acre and, after passage of the Coal Land Act of 1873, it became the highest priced federal land offered for sale, averaging from a minimum of $10 per acre for areas more than 24 km (15 miles) away from a railroad to $20 per acre for areas within 15 miles of a railroad.

In 1906, the homesteading and disposal of known coal lands was discontinued. This was brought about by a strong movement to save the resources and prevent acquisition by presumed private monopolies. In addition, the government could thereby carefully control these resources and generate greater revenues by leasing the coal rather than homesteading or selling it. But to lease it, government had to have some idea of the value of the land—i.e., the land had to be classified or identified according to its leasable minerals. This is how, in 1906, for the purpose of classification, the federal government began the first of many executive withdrawals of coal land.

By such executive orders between 1906 and 1907, government withdrew from disposal under the homestead laws 271 000 km² (67 million acres) and reserved them for classification and appraisal of coal values —which included most of the known western coal occurrences at that time. Withdrawals of coal lands were followed in 1908 by withdrawals of almost 20 000 km² (5 million acres) of phosphate and 18 000 km² (4.5 million acres) of oil lands.

All this acreage was eventually classified—and those early classifications have been modified and reworked continually to the present time. The classified minerals (alias, the mineral estate) were retained under federal ownership, and the surface (alias, the surface estate) was reserved for private use.

Table I shows the acreage that has been patented from the mineral estate owned by the federal government.

Table 2 shows the different types of classification now existing for a number of important leasable minerals.

But the degree of control exercised by the federal government greatly exceeds the acreage shown on Tables 1 and 2. The reason? Since checkerboarding and complex ownership patterns are often the rule rather than the exception, many mining operations must include at least some federal property. In addition, the federal government owns more than 2 840 000 km² (700 million acres) of surface *and* minerals, mostly in the Western States and Alaska.

We estimate that the federal government owns 70 percent of the coal as well as equivalent or greater amounts of other leasable minerals in the western half of the U.S. (see Fig. 1). Significant deposits of federally owned eastern and Alaskan coal are not shown in Fig. 1; and precise data for federal vs. nonfederal mineral ownership are not available.

TABLE 1.—*Patents issued with minerals reserved to the United States through 1975*

	Acres
All minerals	39, 450, 002
Coal	16, 217, 914
Oil and gas	3, 799, 205
Phosphate	414, 083
Oil, and gas and other	1, 109, 329
Miscellaneous combinations	2, 293, 221
Total	63, 283, 754

Source: Public Land Statistics 1975, U.S. Department of Interior.

TABLE 2.—FEDERAL MINERALS LAND CLASSIFICATIONS, WITHDRAWALS, AND LEASES (ACRES)

Commodity	Available Federal leases [1]	Uncertain PP and PRLA's [1 2]	Present potential: Known leasing areas defined	Present potential: in process	Classified mineral [3]	Withdrawn for classification [3]	Future potential: Prospectively valuable [3]	Future potential: Prospectively valuable estimated federal surface [4]	Percent of total domestic production from federal leases (1975)	Percent of domestic production supplying domestic consumption (1975)
Coal	797,555	609,438	14,239,017 [5] 9,878,000		40,938,903	20,470,929	349,971,002	100,000,000	7.2	100
Phosphate	92,380	88,193	40,393	2,560	369,742	1,620,301	30,531,093	5,600,000	11.8	100
Potash	236,824	29,869	308,620	114,398		9,411,382	80,927,661	17,000,000	87.8	[6] 51
Soda ash										100
Sodium	135,547	98,266	287,904	567,020	625,031		267,425,845	45,000,000	58.9	[7] 86

[1] Data through end of 1975 (source: USGS Annual Report, 1975).

[2] PP=prospecting permits; PRLA's=preference right lease applications.

[3] Includes state, private, and Indian lands.

[4] Figure represents a percentage by State of only Federal surface ownership. An actual survey including the 63,000,000 acres of Federal mineral estate for these categories does not exist. Inclusion of the subsurface estate should considerably increase the Federal ownership indicated in this column.

[5] Federally owned coal in Known Recoverable Coal Resource Areas (KRCRA's).

[6] 33 percent in 1976 estimated by Bureau of Mines.

[7] Sodium sulfate.

TABLE 2a.—OTHER FEDERAL MINERALS (ACRES)

	Leased	Prospectively valuable [1]
Asphaltic material, tar sand	3,890	2,600,000
Oil shale	20,400	9,000,000
Oil and gas (onshore)	89,573,447	375,000,000

[1] Estimated Federal surface.

TABLE 3.—LAND HELD UNDER FEDERAL MINERAL LEASE BY COMMODITY [1] (ACRES)

	1968 [2]	1975 [3]
Coal	690,804	797,555
Phosphate	98,516	92,380
Potash	274,969	236,824
Sodium	140,498	135,547

[1] Other commodities leased only on acquired lands are not shown.
[2] Public domain only (43,586 acres of leased acquired land were not recorded by commodity at this time).
[3] Includes both public domain and acquired land, as of Dec. 31, 1975.

Federal Leasing Today = Zero Leasing

Considering the federal government's control over mineral land, the task of making such land available for leasing becomes crucially important. A managed mineral leasing program requires consistent and rational policies. Unfortunately, judging from federal leasing trends of the past ten or 15 years, such policies are either nonexistent or, if they exist at all, they don't reflect any effective management. Here is the evidence:

Since 1961, the acreage made available through competitive-bid leasing for coal, potash, phosphate and sodium has fluctuated sharply and erratically from year to year while moving in a discernible declining pattern (see Fig. 2), causing widespread uncertainty regarding the alleged availability of federal minerals. For instance, after reaching a peak of 385 km² (95,000 acres) leased competitively in 1968, competitive leasing plunged to *zero* in 1969 and to minimal levels at present. This unsatisfactory situation, largely brought about by the interpretations of the 1969 National Environmental Policy Act, is likely to continue until more rational onshore leasing policies are developed.

Since 1968, the total acreage under lease for phosphate, potash and sodium has actually *decreased*. Coal acreage under lease has increased by about 15 percent *in nine years*.

The acreage made available under preference-right leases, also called "noncompetitive leases," has declined sharply from the 1968 peak of about 1100 km² (280,000 acres) to 11 km² (2782 acres) in 1975 (see bottom graph of Fig. 3)—while the acreage under prospecting permits has undergone a corresponding decline (see upper graph of Fig. 3). The vast amount of land under prospecting permits—2865 km² (708,000 acres) in 1975 for coal, potash, phosphate, and sodium—is essentially meaningless because, to repeat, only 2782 acres of land became available in 1975 through prospecting permits ripening into preference-right leases by discovery of valuable minerals.

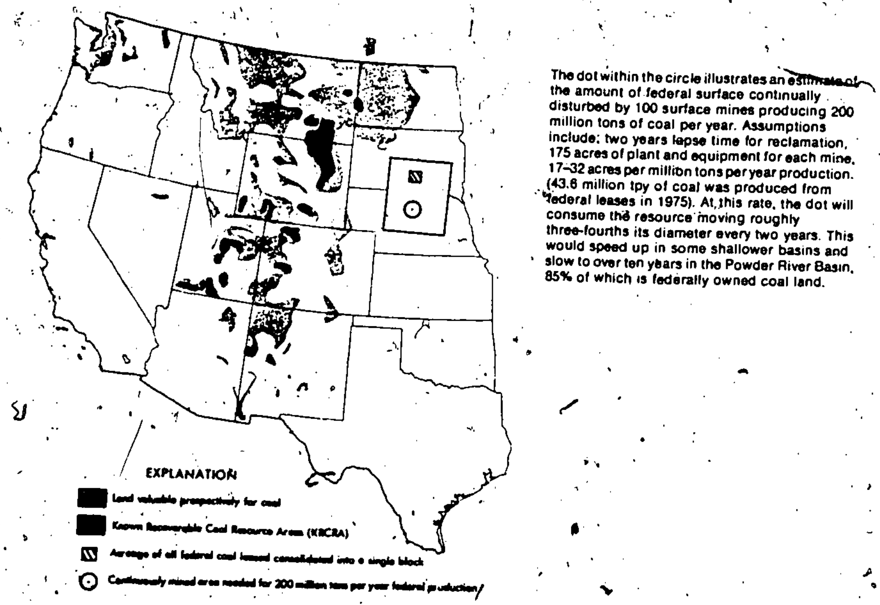
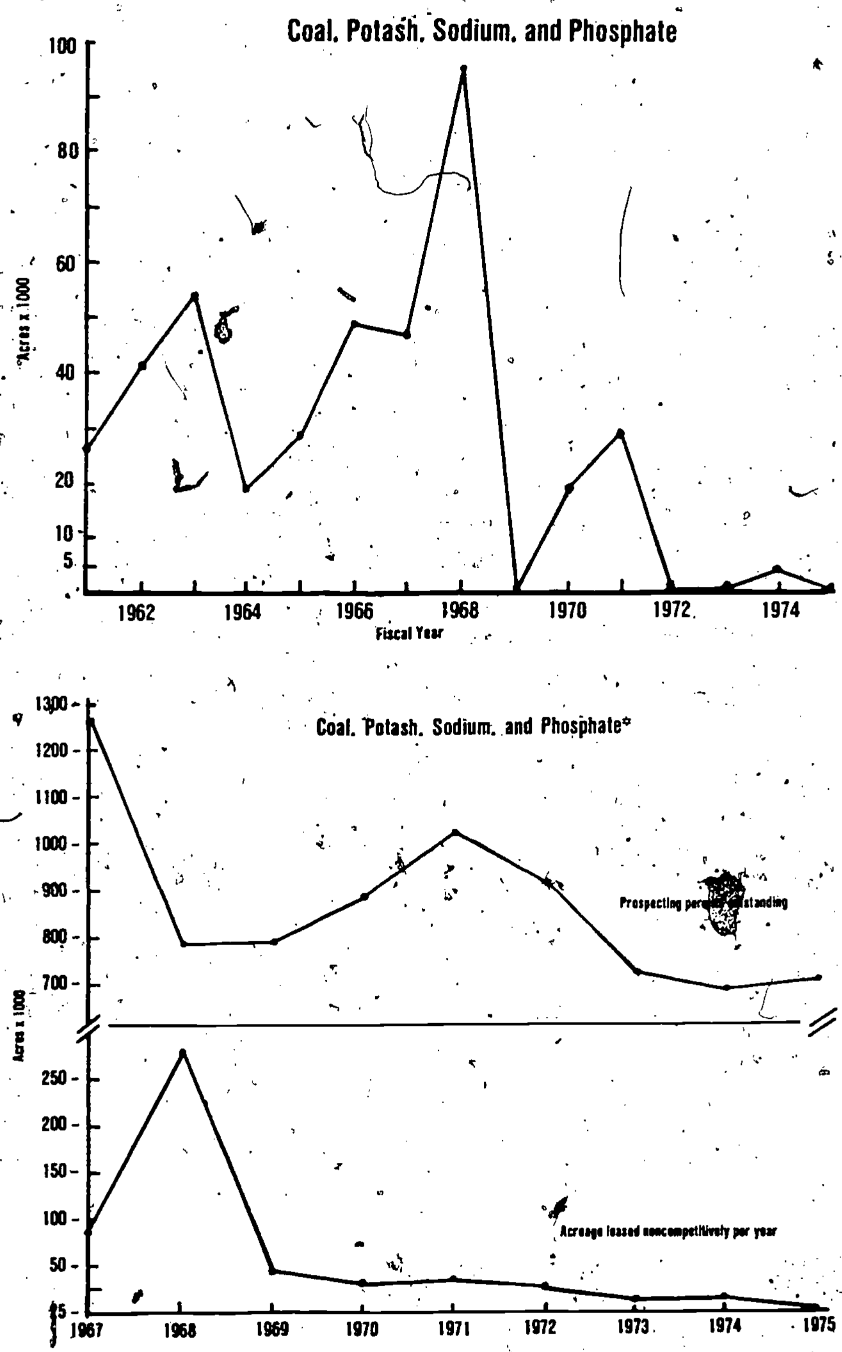


FIGURE 2.—Acreage leased competitively per year, public and acquired lands; coal, potash, phosphate, and sodium.

Noncompetitive leases have traditionally been issued outside of the so-called Known Leasing Areas, i.e., outside of areas exclusively reserved for competitive leasing. As we mentioned earlier, the first step in acquiring a noncompetitive lease has been the issuance of a prospecting permit; then, if the holder of a prospecting permit makes a valuable discovery, he is theoretically entitled to obtain a preference right lease because, after all, he has spent his own money to find a deposit in an area where no deposit was known to exist according to the U.S. Geological Survey. (This was changed for coal after passage of the 1976 Amendments to the Mineral Leasing Act: today, coal leases may be obtained only via competitive bidding.) Incidentally, thanks to prospecting permits, the government has obtained much of the valuable geological data used in the classifications shown on Table 2.

One might assume that since competitive leasing has been sharply curtailed during the last decade, noncompetitive leasing from the large pool of permit acreage would make up some of the shortfall. But this is clearly not the case, as indicated by the low level of noncompetitive leasing since 1969 (Fig. 3). Reasons for this decline in noncompetitive leasing could be attributed to long delays in processing applications for preference-right leases, changes in regulations defining what constitutes a valuable discovery—and, in many cases, competent work by the Conservation Division of the US Geological Survey reserving the valuable minerals for competitive leasing.



*No prospecting permits recorded in public land statistics

FIGURE 3.—Prospecting permits and noncompetitive leasing; coal, potash, phosphate, and sodium.

Federal Coal: Myths and Reality

Because of the decline in domestic oil and gas production since 1970, federal coal has become a much publicized solution for the nation's worsening energy problem. As things stand, *can* federal coal be a solution? Let's look at some pertinent facts.

(a) Since 1971, the acreage of federal coal under lease has languished at about 3200 km^2 (800,000 acres)—or 0.8 percent of the (100 million acres) of federally owned land prospectively valuable for coal (see Fig. 4). By contrast, six Western States have issued coal leases for about 5700 km^2 (1.4 million acres) on state land; and another 1200 km^2 (300,000 acres) are under existing coal leases on Indian land. Thus, the total acreage under lease from state and Indian lands is more than twice the acreage made available under federal leases—even though the federal government owns much more classified coal lands, including most of the exceptionally rich Powder River Basin in Wyoming.

(b) The 0.8 percent of the classified federal coal acreage is available in scattered leases acquired by coal producers and would-be coal producers prior to 1973. Most of this leased acreage, incidentally, was issued noncompetitively, meaning: it was issued outside of those "highgrade" areas that are exclusively designated for competitive leasing. Obviously, some of these noncompetitive leases will never become

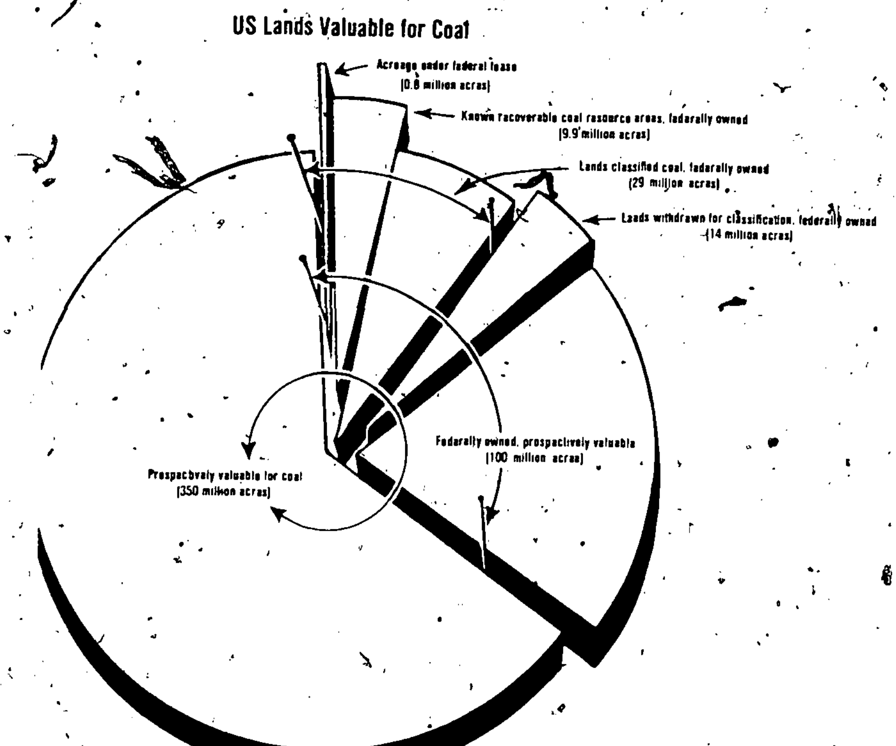


FIGURE 4.—Federal coal: only 0.8 percent of the federal acreage is under lease.

productive coal mines for economic reasons, and some will never become productive because of various environmental and regulatory reasons of fairly recent vintage. For instance:

There has been a radical change from the presumed conditions for development by leaseholders prior to 1970 and the conditions prevailing after passage of the 1976 mineral leasing act for coal. These new conditions or legal provisions will eventually cause some leaseholders to relinquish their lease without mining, particularly if leaseholders are unable to form a logical mining unit and market their coal within the legally required period. The recently published Surface Management of Federal Coal Resource Regulation [2] and Coal Mining Operation Regulations [3] will take their toll on outstanding leases, particularly in view of the newly imposed strict-diligence regulations.[4] In addition, there are the EMARS regulations,[5] which would apply to any future competitive leases.

Why has all this happened?

A major reason for the nonleasing of federal coal during the past six years has been the reliance on reserve-tonnage estimates to decide whether or not to lease coal. "Why should the federal government lease more coal when 16 billion tons of reserve are already under lease application, and an additional 9 billion under preference-right leases?" This was, and still, is the argument most frequently ventilated in political and environmental circles. If taken at face value, particularly by people who don't know much else, this reserve-under-lease argument carries the built-in conclusion: "Let's put a halt on coal leasing because the 25 billion tons already leased should be more than sufficient to satisfy all reserve requirements for the present 50 million t/y [tons/year] federal coal production, and projected 150 to 200 million t/y by 1985."

The error in the reserve-under-lease argument—as any experienced geologist, mining engineer, or mineral economist can easily point out—is that such an argument would be valid if the geology, economics and legalities were completely known and understood. In the real world, unfortunately, the reserve-under-lease approach is limited by insufficient geological knowledge, as well as by traditionally misleading interpretations of just what reserves are and what they mean as far as providing a land position sufficient for coal production.*

The distinction between poorly known mineral resources and well-known reserves available for production is frequently the most confused and troublesome area in resource management.

The two diagrams in Fig. 5 show recent attempts to clarify these concepts: At the upper left of the diagrams are measured economic reserves, and at the lower right are subeconomic undiscovered resources. Production must come from the upper left sector of our resource base, as shown by the flow of arrows. It is a gross mistake to assume (a) that speculative submarginal resources can reach productive capacity with-

* "Reserve is the portion of the identified resource from which a useable mineral and energy commodity can be economically and legally extracted at the time of determination." USGS Bulletin 1450A.

[2] Title 43 Code of Federal Regulations, part 3041, abbreviated (43 CFR 3041).

[3] 30 CFR 211.

[4] 43 CFR 3250.

[5] 43 CFR 3525, Federal Register, Vol. 42, No. 16, Jan. 25, 1977, p. 4453.

out being moved both to the left and upward in these diagrams, and (b) that reserves can move to productive capacity if legal blocks occur.

The rate at which this movement transforms reserves into "past production" depends both on the current productive capacity and the current demand level. If new high-grade deposits are not large enough to fill the gap, the price rises, and some "subeconomic" deposits move upward into reserves. This shift can also occur when new technology reduces cost—or if legal prohibitions are removed.

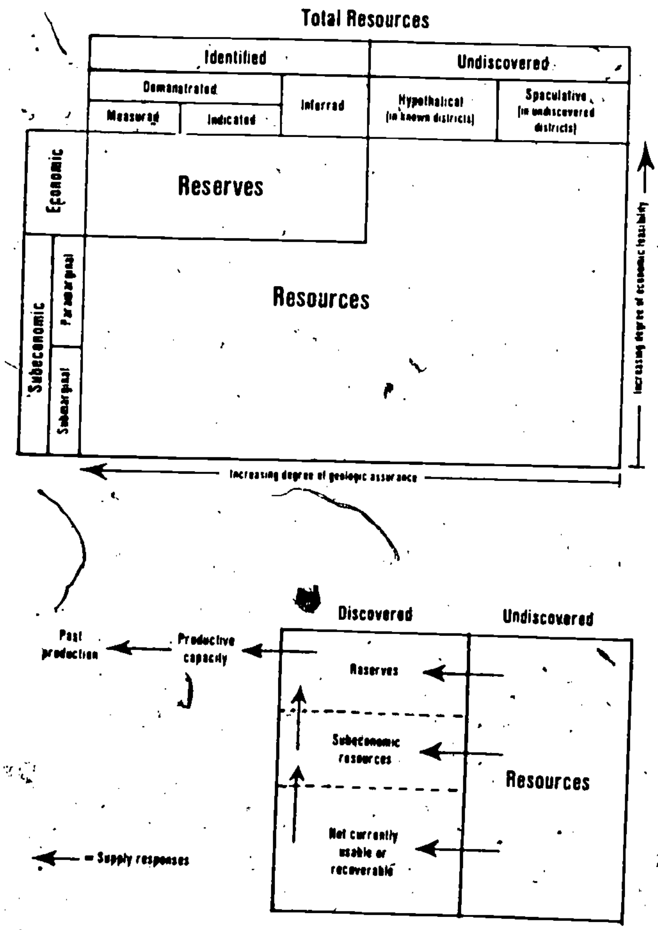


FIGURE 5.—How "resources" become reserves.

These concepts have never been applied to explain the 16 billion tons of coal under existing lease and the additional 9 billion tons under preference-right lease application; nor were these concepts incorporated into the analysis that yielded those billion-ton figures. The result: reserve-under-lease figures are a potpourri of measured, indicated, inferred, economic and subeconomic reserves and resource estimates—not all of which were economically and legally extractable even in 1973 when these figures were determined. Furthermore, the 16-billion-ton figure fails to include the fact that 30, 40, or more tons of measured recoverable coal are needed to produce just one ton annually, all of which must be in a logical mining unit. During the years of the coal leasing moratorium, many leases that had been applied for to complete logical mining units for new production had not yet been issued.

Any operator must receive timely governmental permission to economically mine coal from measured economic reserves in a logical mining unit, with a large enough reserve position to justify the initial capital expense of property, plant, and development. These factors were not considered either in totalling the 16, 25, or more billion tons of coal under lease.

Even if those bloated tonnage figures were realistic, industry would not and could not be interested in thin beds or poor quality; or in areas with high production costs; or in areas that lack a market; or in areas where federal, state, and local governments have placed so many restrictions—e.g., land withdrawals, restrictive land-use stipulations, complex and time-consuming permit requirements, prohibitive access, arbitrary anti-pollution regulations—that often raise costs on leased lands too high to justify the investment (a prime example: the Kaiparowits leases).

In our opinion, the acreage under lease—compared to total federal acreage potentially known to have value for coal production—would be a more realistic way of measuring the effectiveness of the federal coal leasing program than the undefined estimates of leased reserve tonnage, which may or may not ever be developed. Since monopolies are effectively prevented through a variety of existing mechanisms, since strict diligence is now required along with fair market value for new leases, and since environmental values are now protected in land-use plans, what difference does it make how much tonnage is under lease? What we think is more important is that enough acreage be placed under lease so that coal prices won't be held artificially high by unavailability of land.

HOW WE GOT INTO THIS MESS

Land classification is a prerequisite of minerals leasing. The agency responsible for land classification is the US Geological Survey; the agency responsible for leasing, the Bureau of Land Management (which, before 1946 used to be known as the General Land Office).

Problems of coordination between these two agencies began almost a century ago.

In 1879, the National Academy of Sciences submitted to Congress a report that recommended abolishing the Geological and Geographical Survey of the Territories, and the Geographical and Geological Survey of the Rocky Mountain Region (both in the Department of the Interior), and the Geographical Surveys west of the 100th Meridian in the Department of War. These activities were to be consolidated into a single organization, to be known as the US Geological Survey because, in the words of the National Academy:

"The best interest of the public domain require, for the purposes of intelligent administration, a thorough knowledge of its geologic structure, natural resources, and products. The domain embraces a vast mineral wealth in its soils, metals, salines, stones, clays, etc. To meet the requirements of existing law in the disposition of the agricultural, mineral, pastoral, timber, desert, and swamp lands, a thorough investigation and classification of the acreage of the public domain is imperatively demanded." [6]

Agreeing with the National Academy of Sciences, Congress in the Act of March 3, 1879,[7] provided that the newly formed Geological Survey would be responsible for "the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain."

The same act provided for a commission to codify the land laws.[8] This commission, however, did not merely classify the land laws; it also suggested that land classifications done by the US Geological Survey were "subject to correction upon proof of error satisfactory to the Commissioner of the General Land Office, and according to regulations to be prescribed by him."

In effect, contrary to congressional intent, the commission subordinated the USGS to the General Land Office—by vesting the reviewing responsibility in the General Land Office.

The very first director of the US Geological Survey, Clarence King, accepted the viewpoint of this commission establishing a tradition that continues today in spite of the enormously increased responsibilities of the USGS Conservation Division. In his first report to the Secretary of the Interior in 1880, Clarence King stated:

"I have therefore concluded that the intention of Congress was to begin a rigid scientific classification of the lands of the national domain, *not for the purposes of aiding the machinery of the General Land Office by furnishing a basis of sale*, but for the general information of the people of the country. . . ." This statement, made in 1880, illustrates how land classification became divorced from supporting mineral leasing. Since then, these two functions have never been fully coordinated for their original purpose of "intelligent administration."

King's interpretation prevailed in part until about 1906 when the pressing need of the Department of the Interior for adequate classification of mineral lands led to renewed emphasis on this function of the Geological Survey. This was not done by superseding the machinery of the General Land Office, but by cooperation between the General Land Office and the Geological Survey, augmented by a series of orders from the Secretary of the Interior. These orders defined the part that each was to bear in public land administration, making the Geological Survey chiefly responsible for the classification of lands for their mineral character.

After passage of the Mineral Leasing Act in 1920, the General Land Office (now the Bureau of Land Management) needed mineral and geological engineering expertise to administer its new mineral leasing responsibilities. It's interesting to note that this task of lease support was assigned to a new technical group in the US Bureau of Mines rather than to the US Geological Survey.

[6] USGS Bulletin No. 537, 11 (1913).
[7] 43 USC 31 (1964).
[8] US statutes at large, Vol. 20, p. 392.

In 1921, the then Secretary of the Interior, Albert Fall, using questionable authority secretly leased without competitive bidding some military oil reserves in California and Wyoming (Teapot Dome) to E. L. Doheny and Henry Sinclair.

Secretary Fall, who went as far as to call the Marines to evict Sinclair's rival claimants from the Teapot Dome reserves, was also found guilty of a corrupt conspiracy to secure for Doheny unleased land in the California reserves and accepting $100,000 in bribes.[9] This touched off a scandal rivaled only by Watergate.

The net effect of the Teapot Dome affair was the quick move of the newly created USBM group (later to be known as the Conservation Division of USGS) to the Department of Commerce. But the administrative incompatibility of the lease support function shared by two federal departments precipitated in 1925 the return of the now Conservation Division to the Department of Interior's Geological Survey.

By separating the leasing agency (BLM) from the regulation-evaluation agency (Conservation Division of USGS), Interior felt it could avoid another scandal and that a potentially cumbersome bureaucracy would be a small price to pay for the separation of power.

Public attitudes and distrust developed in the wake of the Teapot Dome scandal are still felt today and partly explain the present lack of perspective.

Still relying on the authority of the Organic Act of the Geological Survey, the USGS Director continued to be charged with the "classification of the public lands, and examination of the geological structure, mineral resources and products of the national domain." This responsibility was assigned to the USGS Conservation Division and remains today, although modified by subsequent statutes.

In October 1968, Order 2948 by Interior Secretary Rogers C. B. Morton again established certain areas of responsibility for the USGS Conservation Division and the Bureau of Land Management. The order, drafted initially by USGS, was designed to reduce the apparent overlap in responsibilities which had developed over the years. The USGS was given the charter to provide all geologic, economic, and engineering information to the BLM required to fulfill BLM's role in land use planning, environmental analysis, and, in general, minerals management. Strengthened in this order was the Conservation Division's role in classifying lands for mineral content. As a result, BLM formally began requesting of Conservation Division, mineral reports and leasable mineral maps on federal mineral estate.

Classification: A Long Overlooked Tool

The purpose of classifying the mineral character of land (federal and nonfederal) is to define the area and depth limits of each of the leasable minerals. This, in turn, allows for a scientific estimate of the extent of each mineral resource. Classification (as opposed to evaluation) of the leasable mineral anticipates the eventual arrival of conditions favorable for the development and marketing of the commodity. Classification is not concerned with economic conditions that make feasible the exploitation of the deposit at the present time.

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[9] Teapot Dome, History of Public Land Law Development, Public Land Law Review Commission 1968, p. 746.

The first step in the classification procedure has been the withdrawal of the lands containing a leasable mineral from entry, exchange, or sale by using authority granted in the Picket Act (1910).

Next, classification standards are established for each leasable mineral. Since only the ultimate use of the material is important, these standards set minimum limits on the intrinsic factors of thickness, quality, area, and maximum limits on depth.

Both informal and formal classifications are made for various leasable minerals. The informal classifications are made where the available geologic data (often obtained via prospecting permits) is present in such quantity and quality as to meet classification standards, but there is not enough information for a formal classification.

Formal classification orders are published in the *Federal Register*. In effect, lands are classified on the basis of what is known. Initially, lands are classified "prospectively valuable" or valuable in the foreseeable future to perhaps 100 or more years. When sufficient knowledge exists, these land classifications are upgraded to a "valuable" mineral area. For example, a "prospectively valuable" coal area becomes a "classified" coal area. Coal lands are, therefore, "classified" for coal or "prospectively valuable" for coal. As more mineral data is made available, lands are classified valuable for the mineral, prospectively valuable for the mineral, or declassified entirely. Classifications for the other leasable minerals follow this pattern.

Evaluation of Leasable Minerals

In addition to classification, when a leasable mineral resource is determined to be workable under existing economics and technology, it is evaluated as a "Known Leasing Area." Being a workable, economic mineral resource, this category of land includes only those resources known by the government to be most attractive for develment. A Known Leasing Area usually encompasses smaller parts of lands (classified for retention by the federal government) that may eventually be of value. Lands evaluated as Known Leasing Areas theoretically have present-day value. This is why only competitive leasing is permitted for mineral resources within Known Leasing Areas.

The evaluative responsibilities of the Conservation Division stem from the Mineral Leasing Act of 1920 and subsequent leasing acts. The purpose of mineral land evaluation is to obtain geologic data necessary for planning and estimating economic mineral reserves for federal leasing programs.

Those areas that traditionally were shown to have known workability or extent were evaluated as Known Leasing Areas and leased competitively. Unknown areas were leased through the issuance of prospecting permits leading to preference-right leases. New commercial quantity regulations[10] have broadened this traditional function from "workability" (based on intrinsic geologic properties of the mineral resource) to the inclusion of social, environmental, and economic data. However, the mass of information available on intrinsic geology of leasable minerals remains a most useful tool for lease management.

[10] Interior adopted final regulations pertaining to preference right leasing and the definition of commercial quantities in Jan. 1976. (43 CFR 3520).

The Federal Coal Leasing Amendments Act of 1975 makes all federal coal available only by competitive leasing. However, coal land still must be evaluated as Known Recoverable Coal Resource Areas to establish the existence of minable reserves under existing economic conditions and current technology. The new act also provides for non-government exploration under exploration licenses.[11] These licenses yield no preference right to a lease.

The evaluation of Known Leasing Areas should be considered as an additional tool to be added to the classification group designated as valuable and prospectively valuable.

Presently, evaluative activities are adapted to a variety of lease-management support roles. These include: special purpose lease mapping, reservoir and reserve studies, production rate determinations, drainage determinations for oil and gas and geothermal wells, development plans, unitization contracts, requests for abandonment, and many others. All these activities have been directed in the past toward assuring fair market value to the US government and toward eliminating waste of natural resources by inefficient operations. The potential role of using them as an overview tool for leasing policies has never been fully explored. Instead, analysis of "reserves" under lease has been the analytical tool for justifying lease issuance—with well-known results.

WHERE DO WE GO FROM HERE

In the 1879 statute that established the Geological Survey, Congress intended that classification of mineral lands provide an overview of what mineral wealth was contained in the nation's land. Later, the mineral leasing legislation required that comparisons be made between those mineral-resource classifications and these resources economically minable to determine whether a competitive lease or a prospecting permit should be issued. This, in turn, was meant to be contrasted with the nation's long-term needs.

The same overlooked function can be used today to provide a much needed perspective. Briefly, the working concept involves measuring how much of the available resource is being actively tied up for production and comparing that to what we know of the extent of the known resource, less certain environmental constraints.

In Fig. 6, we indicate how the existing knowledge of various mineral resources can be applied in determining minerals management policy. On the far left is an adaptation of the basic Geological Survey classification of mineral resources.[12] Both the economic column (economic feasibility) and the resource column (geologic assurance) are intended to establish relative levels of development potential under present technology and economic conditions. The base of the columns show economically recoverable deposits of measured reserves, or those deposits where tonnage can be accurately computed allowing 20 percent variation. These deposits should be minable under present economic conditions. Continuing up the column, progressively less is known of the actual characteristics and economics of the resource.

The next groupings to the right shows a generalization of existing knowledge of mineral resources either evaluated or classified by the

[11] Regulations published by Interior describing procedure concerning exploration licenses for Federal coal (43 CFR 3507).

[12] Legal Study of the Non Fuel Mineral Resources, Public Land Law Review Commission, Vol. 1-111, May 1969.

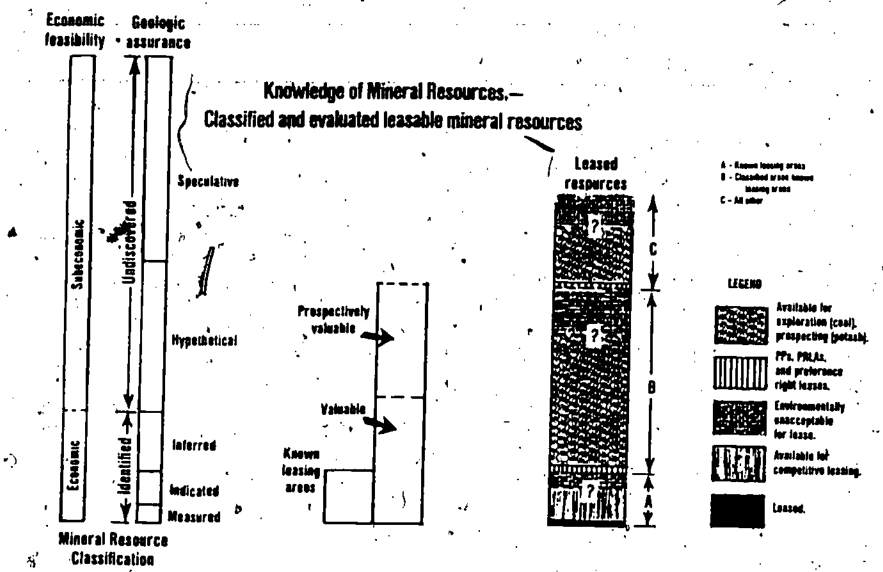

FIGURE 6.—Classification as a policy tool: issuance of mineral leases under existing statute.

Conservation Division of the Geological Survey. As more information is made available to the government through exploration licenses, prospecting permits, or other drilling information, new land not shown in these columns may be classified, or evaluated as a known leasing area (if presently known to be economic). The difference between the "prospectively valuable" classification and "valuable" classification is merely a function of existing knowledge. As more prospectively valuable land is drilled, its classification is either upgraded to valuable, or known leasing area, or declassified. There must be initial geologic evidence, however, to warrant the prospectively valuable classification in the first place. Although, much of the same geologic data is used in evaluation and classifiction, the best known and economic reserves should be found in the Known Leasing Areas.

The final column on the far right of Fig. 6 illustrates the amount of known resources leased. This amount has been divided into three categories: A, B, and C.

"A" corresponds to the acreage in Known Leasing Areas; "B" corresponds to lands classified less the Known Leasing Area; "C" to all others.

Each category can be further subdivided into lands already leased; lands unacceptable for lease because of land-use plans or environmental analysis or both; and unleased areas available for lease. By existing law, leasing is competitive in "A" (coal, for instance, is entirely under competitive leasing), but noncompetitive in "B." As category "A" is leased, additional prospecting should be encouraged to add reserves from "B" and "C." Since "A" is a measure of the known com-

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mercial or workable deposits, the policies that should be followed would obviously depend on how much or how little "A" is under lease.

The perspective provided by land classification and evaluation becomes the foundation of our proposed overview tool for policy analysis. To encourage maximum social and economic benefit from federal mineral resources, here is how the overview tool might function:

Category "A".—Competitive leases should be encouraged in the available unleased areas. If large amounts of "A" remain unleased envorinmental trade-offs within the land-use planning process may become more permissive. In Sedimentary basins where some mining methods prevent simultaneous recovery of several minerals, the commodity with the least available unleased "A" should take precedence in leasing. The total amount leased is determined only by the free market interest. This assumes that government obtains fair market value for resources leased, requires diligence in development, and ensures the protection of environmental values through multiple land-use planning systems.

Category B.—Prospecting permits leading to preference right leases (except for coal) should be issued in available areas, without serious environmental conflict, as a means of learning more about the mineral resource. If an excess of known resources is available and unleased, preference right leasing could be selective, concentrating in areas where information is needed. If an excess of available "A" does not exist: (1) Prospecting permits and preference right leasing should be actively encouraged to increase geologic information in "B" and "C"; (2) Diligence in existing leases in "A" should be reexamined and perhaps strengthened; (3) Environmental trade-offs in "A" then "B" should be reviewed; (4) Research should be encouraged to produce substitute technologies in alternate lower-grade mineral resources.

Category C.—Prospecting permits leading to preference right leases should be selectively issued (except for coal) to add acres to "B" and, eventually, to "A." If nearly all available "B" and "A" are under lease, provisions should be made for: (1) increasing the incentives for research into exploration, available substitutes, and alternate mining technologies; (2) encouraging exploration and investigating tax incentives; (3) reexamining environmental tradeoffs in "A" and "B"; (4) examining policies of strategic reserves in the ground, stockpiling, and increasing prices to encourage substitution; and (5) ensuring that large available mineral reserves are not being held for speculation through the adoption of diligence policies on existing leases.

We think that this tool for mineral-lease management can be developed quickly and easily because a great deal of geologic information already exists for leasable minerals; this body of knowledge will make unnecessary any new large-scale government exploration programs to identify resources already known to exist.

The main advantage of this tool to lease management is that the supply or rate of leasing will be determined by free market forces—such as industry interest and, therefore, commodity demand—constrained only by what is already under lease, and what regulations and procedures are ultimately adopted by the federal government to single out lands environmentally unacceptable for leasing and development.

Certain conditions, however, must be met to insure the success of such a managed leasing program:

Diligence in the development of existing leases must be fulfilled. Diligence requirements may take the form of regulations similar to those under coal (required production by a date certain and exhaustion of minable reserves within a reasonable period of time), or may simply take the form of increased holding costs on a per-acre basis.

Accurate statistics will have to be compiled to determine precisely the extent of federal ownership of classified lands, and the amount of classified land that is not available because of withdrawals, restrictions or land-use and environmental conflicts. (Although detailed ownership data exist for the federal mineral estate, such data have not been applied to classified lands, which include nonfederal mineral estate.)

The Bureau of Land Managament and the Forest Service will have to document lands unsuitable for mineral development because of conflicting resource values, and will have to keep cumulative statistics.

Environmental values will be protected through various agency land-use planning systems, reasonable lease stipulations and a cooperative spirit between the lessor (government) and lessee (industry).

Water problems will have to be considered prior to approval of mining plans.

The tool will only be applied to easily found, classified resources; other widespread resources (for example, metalliferous black shales) may eventually be classified and added to this management tool.

Exploration by the private sector through the issuance of prospecting permits leading to preference right lease outside areas classified as Known Leasing Areas would be encouraged in areas of unknown mineral values where environmental degradation can be minimized (except coal areas). The information obtained will incerase the currency and quality of classifications.

Finally, since no one can effectively classify or evaluate those deposits that are by nature geologically obscured, the "hard to find" minerals (i.e., most presently locatable minerals) will have to remain under a location-patent or simple noncompetitive lease system.

What the New Perspective Suggests

Using the proposed overview tool, we can show at a glance (see Figs. 7 and 8) the present status of federal leasing for coal, potash, phosphate and sodium.

As evident from the comparison of coal and potash (Fig. 7), less than 10 percent of the known recoverable coal resources are under lease—but roughly 70 percent of the known potash areas have already been leased.* As indicated earlier in Table 2, federal coal leases supplied only 7.2 percent of domestic coal production in 1975—but federally leased potash supplied nearly 88 percent of domestic supply in 1975. Since nearly all the known recoverable resources of potash have been leased, our overview analysis indicates that—if domestic potash

*Leased land is usually all federally owned. Other categories contain some nonfederal, although prospectively valuable categories in Figs. 7 and 8 have been reduced to estimate approximate federal ownership. These ownership estimates were based on the percentage of federal surface ownership by state. The acreage estimates are likely to be quite conservative since they do not include the 255 000 km² (63 million acres) of federal mineral estate and partial mineral ownership retained by the Government as a result of these classifications.

is to remain plentiful—more exploration and research should be encouraged now; that the Conservation Division should conduct additional classification and evaluation work; that the Bureau of Land Management should issue some additional potash prospecting permits to support this effort, thereby increasing the knowledge of economically recoverable potash reserve; and that potash leasing should take precedence over other leasable minerals where simultaneous mining of several minerals is not possible.

Unfortunately, the conclusions derived from the overview tool in this instance cannot be implemented because of the low priority assigned to potash and classification compared to other more esoteric programs performed by USGS.

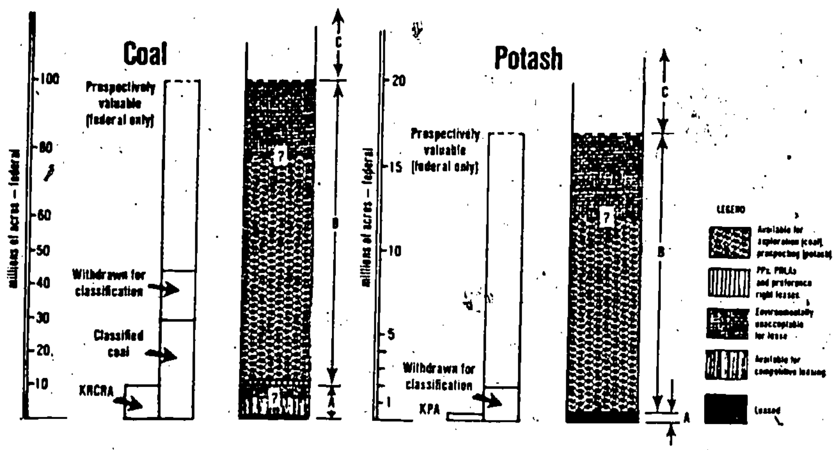

FIGURE 7.—Perspective applied to coal and potash.

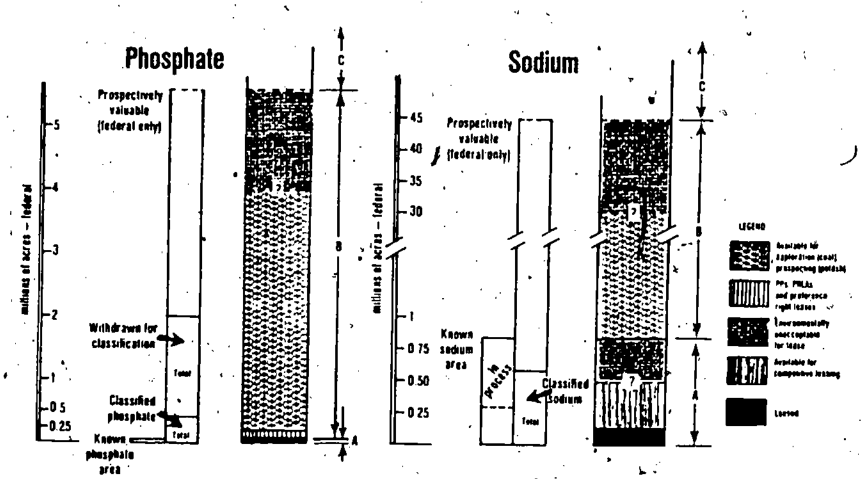

FIGURE 8.—Perspective applied to phosphate and sodium.

Without competent mineral land classification, prospecting permits themselves become unfairly branded as "give-aways." To make matters worse, few competitive leases on lands known to be valuable for a leasable resource have been issued. Impediments include formal land restrictions, informal or "de facto" restrictions through federal land-use planning systems, speculation fueled by nonavailability, and time delays through frequently cumbersome environmental impact statements. This leaves potential procedures no choice but to apply for prospecting permits on whatever land is available although that land may have poor potential for development and relatively high environmental costs.

Cases illustrating this problem can be seen in Wyoming near Rock Springs for sodium, in southeastern New Mexico for potash, and in southeastern Idaho for phosphate. More land has been leased for phosphate than has been evaluated. Even coal requires additional effort. Coal lands in areas nominated for competitive leasing in New Mexico's San Juan Basin, in north central Alabama, in east central Montana, in North Park Colorado, and in other areas have not been fully classified and evaluated. Of the more than 12,500 km² (3.1 million acres) of lands nominated by industry and eligible for federal coal leasing, over 7,300 km² (1.8 million acres), or 58 percent, have not been evaluated by the USGS. In onshore Alaska, lands withdrawn under section 16 and 17(d)(1) of the Alaska Native Claims Settlement Act can only be reopened to leasing once they have been classified by both the BLM and the Geological Surv[illegible] Negligible effort is presently being made toward this workload in[illegible]g millions of acres.

Why?

Table 4 offers some [illegible]sight into this problem: low priority and not enough funding of Conservation Division activities within the US Geological Survey.

For the entire onshore classification and evaluation of mineral lands. USGS devoted only $4.4 million in 1976—which is slightly more than 1 percent of its $364 million 1976 budget. Yet, the tasks of classification and evaluation are the very responsibilities for which USGS was established.

No proper perspective in federal lease management is possible if the responsible agency itself does not give sufficient priority to these tasks.

TABLE 4.—FUNDING FOR USGS CLASSIFICATION[1]

[In millions]

	Budget for fiscal year 1975	Budget for fiscal year 1976
U.S. Geological Survey	$338.8	$354.0
Conservation Division	36.0	41.7
Classification and evaluation (total onshore)[2]	3.9	4.4
Oil and gas	.22	.32
Coal	2.38	2.53
Oil shale	.30	.30
Geothermal	.96	.98
Nonenergy	.08	.28
OCS oil and gas tract selection and resource evaluation (total offshore)	13.1	14.6

[1] USGS Annual Report, 1976 (in preparation).
[2] Approximately $500,000 is allocated for onshore mineral land classification. The breakdown for onshore classifications and evaluation is shown for each mineral; water power classifications have been deleted.

Conclusion

A new perspective is desperately needed if long-term material needs of the country are to be met. This missing perspective can be recaptured by applying a new tool where what is known of a mineral resource is compared to what is available for lease and to what has already been leased—thereby providing for long-term management of leasable mineral resources under federal control.

Generally, leasable minerals have been subordinated in management priority to both USGS research, surface resources of federal landholding agencies, and other nonmineral development-oriented programs.

Known leasable resources economically minable today should be readily available in environmentally acceptable areas, to the free market, by timely competitive leasing. This is not presently the case. To develop new minable reserves from vaguely known reserves, prospecting permits could have a valid future as a means of aiding in classification, particularly where available reserves in known leasing areas are fully leased. Prospecting permits, with coal licenses, can avoid costly inefficient government programs for resources outside known leasing areas where minerals are of negligible present worth. Continued use of prospecting permits can only be justified under existing laws if classification and evaluation programs of the Conservation Division of the Geological Survey receive sufficient priority to maintain public confidence.

There is enough knowledge available to maximize the development of mineral resources by the free market and to plan for future mineral needs by using existing leasing programs as a management tool. No such tool is now in use. Furthermore, long-range policies for federal research programs could be integrated with what is already known of the nation's resources, allowing for timely substitutions by new technologies developed through research. This could eliminate shortages, prior to depletion, and allow for a continuous supply of leasable mineral resources, constrained only by the success of new technology and the price of the commodity—not bureaucratic red tape.

E. Diversification and Private Industry Control of Alternative Sources of Energy

(From Petroleum Industry Involvement in Alternative Sources of Energy, p. 5–11)*

HOLDING OF NONPETROLEUM ENERGY RESERVES BY OIL COMPANIES

It is important to recognize that there can be a considerable distinction between the amounts of a resource that is formally held by a company through ownership, leases, and other arrangements, and the amount of that resource that it actually controls. Control can be achieved through a variety of contractual or stockholding arrangements or because of checkerboard ownership patterns which enable resource owners to control larger areas (logical mining units) than their actual ownership would confer. Thus, a company might control more, or it might control less, reserves than it actually holds. The data presented here represent situations as reported in the literature that is cited as the source, without further analysis or interpretation. . . .

The reserve estimates of the four energy resources included in the report are subject to several limitations. A limitation common to all of the minerals is the lack of comprehensive exploration information from which more accurate estimates can be made by geologists and mining engineers. This shortage of information has led to liberal estimates made through geological extrapolation. In some cases, the lack of sufficient drill core samples has caused scientists to use different methodologies to estimate remaining coal reserves. In the case of West Virginia, wide variations in the reserve estimates resulted. Two studies within the last 10 years estimated West Virginia reserves to be approximately 60 billion tons, but another estimate placed reserves at 39 billion tons. Furthermore, reserves on private lands cannot be determined without the permission of the landowner, which may be withheld in order to avoid attaching a taxable value to the mineral.

The limitation of determining actual resources of minerals such as uranium, were described by Dr. Vincent McKelvey, Director of the U.S. Geological Survey, in the following remarks to the American Ceramic Society on April 25, 1977:

> . . . Most of the readily apparent, easily identifiable deposits that could be discovered by visual inspection have long since been found. What remains are the concealed deposits with no surface manifestations or perhaps at best with only subtle clues to their presence, so that only the most imaginative kind of detective work can elicit clues to their possible existence. Here the frontier is not geographical but intellectual, and can best be described as the capacity for devising new ways of looking at old problems.

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*A Report prepared by the Congressional Research Service and printed for the use of the Senate Committee on Energy and Natural Resources, September 1977.

This view is supported by many in the minerals industry who feel that the day of the "bonanza" discoveries by independent prospectors has given way to the extremely sophisticated technology for geochemistry and geophysics now used to locate and evaluate mineral ore bodies.

In both cases, a systematic approach is essential. For instance, exploratory drilling for uranium must be conducted in an orderly manner or the deposit may escape detection. In the case of geothermal energy, the potential for development has not been able to be completely determined because of the high degree of financial risk involved in drilling for geothermal steam deposits and the current policy of prohibiting utilities from writing off intangible drilling costs. These factors have made companies reluctant to begin exploratory programs, so that relatively few exploratory holes are being drilled. The higher cost of geothermal energy compared to other forms of fossil fuels for electric generation has also discouraged exploration, and consequently the extent of information about geothermal reserves is limited. And while the approximate location and extent of the high quality oil shales in the West have been largely determined, the U.S. Geological Survey has only recently launched an extensive program to determine the location and extent of lower-grade Eastern shales.

In order to adequately determine the extent of all of America's energy resources, the Federal Government may find it necessary either to undertake to directly determine the size of these reserves, or to provide incentives for private industry to commit capital and manpower to the task under some sort of mandatory reporting procedure. However, the institution of such a procedure could have a considerable effect on the resources industry, and on the Government's relationship with that industry, and therefore might not prove attractive.

The problem of determining who holds these energy resources is equally serious. Data on Federal leases is scattered through several agencies, and is not always in a form that can be used for this type of study. Sometimes, the data on resource holdings are only able to be released by the Government in aggregated form in order to protect confidentiality. Many of the figures reported here have only been obtainable through the American Petroleum Institute, and were compiled from data obtained from oil companies on a voluntary basis and may not be uniform.

COAL

The total estimated identified reserves of coal located less than 3,000 feet below the surface of the Earth in the United States is 1,580,987 million short tons. By rule of thumb, approximately 50 percent of this is physically able to be extracted, and of that amount about 60 percent is believed to be in seams that can be mined economically at present market prices. As a result of these approximations, the "total reserve base" of the United States is generally stated to be about 437,000 million short tons. Of this amount, it appears that 51.521 million short tons, or 11.8 percent of the total reserve base, is held by those oil companies which are among the 20 largest corporate holders of coal reserves in the United States. The addition of the coal reserves held by other oil companies would increase this number, for it would seem that at least 5 oil companies holding coal reserves are not among the "top 20" coal reserve holders. (Those companies included among the top 20 holders of coal reserves are Continental Oil. Champlin Oil, Exxon, Occidental Petroleum, Kerr-McGee, Gulf Oil, Mobil Oil, and Sun Oil.)

GEOTHERMAL SOURCES

The potential for production of energy from geothermal sources is not well determined, due in part to the rudimentary state of the technology for tapping this resource and in part to a lack of knowledge of the location, extent, and thermal capacities of these resources. In addition, new geographic locations are beginning to be located.

Oil companies are definitely active in this field, in which their drilling technology has immediate application, and they have been the principal recipients of Federal leaseholds on geothermal sources.

A number of difficult legal and regulatory questions seem to be inhibiting more rapid development of geothermal resources. Some of these involve environmental impacts and leasing regulations. One very important question is whether the steam or hot water from a geothermal resource can be treated as a depletable resource for tax purposes. It would seem that these need to be resolved before a great deal of commercial interest can develop.

The Energy Research and Development Administration is maintaining an active program to solve the technological problems in this area and to demonstrate how different types of geothermal sources can be used. Much of this research and development is being conducted jointly with industry. However, it must be recognized that useful geothermal sources are only known to exist in certain localized areas of the country, and that many geothermal sources will not provide a temperature high enough for steam generation of electrical power. Though these lower temperatures may be useful for local heating applications, the general utility of such sources would appear to be limited.

Under the considerable uncertainty that now exists about the extent and utility of geothermal sources, it is hard to assess whether the oil companies have achieved a position in geothermal energy that will be significant in the future. For the present, the oil companies would seem to be the predominant performers in geothermal energy in terms of development activities and land holdings.

OIL SHALE

Oil bearing shale is found in a number of locations in a broad belt stretching across much of the United States, but by far the richest oil concentrations are found in the western Green River Formation. These are said to contain the equivalent of more than 2 trillion barrels of crude oil. The highest grade shales in this formation can yield more than 25 gallons of oil per ton of rock, and comprise a resource equivalent to about 600 billion barrels of crude oil.

About 80 percent of the shale oil in the Green River Formation lies beneath publicly owned lands administered by the Federal Government. The potential is great, but oil from shale is only beginning to be regarded as economically attractive for extensive development by industry. In spite of Federal efforts to promote development of industrial production through various leasing arrangements of oil shale deposits, all four of the developmental efforts recently underway are currently in abeyance. Uncertainty in the cost of production is not the only factor involved in this suspension. Difficulties in mining and problems relating to air quality regulations are also involved. The adequacy of water supplies, and their possible contamination, may also be a factor, though there have been recent announcements of processes for extracting oil from shale that do not require water. Quite apart from these matters, in the long run there must be a clearer policy for the leasing of Government-held deposits, and agreement on the stringency of environmental standards to be met, so that industry can calculate production capabilities and costs.

The oil companies hold substantial amounts of oil-bearing shale deposits, primarily under State leases and fee holdings. Though it was not possible to locate complete information on the extent of oil company holdings, the data which are available indicate that the petroleum industry has a predominant position among all types of industries in terms of the extent of oil shale holdings. However, these deposits are expressed simply in terms of acres of land held, as a result of the lack of detailed knowledge of the extent and richness of the underlying shale. Thus it is currently not possible to estimate what fraction of oil shale resources are held by the oil companies. Presumably their combined holdings are not large compared with those of the Federal Government. The continuing interest of the oil companies in eventually producing shale oil is attested by the fact that oil companies outbid all other competitors for the four Federal leaseholds awarded in 1974—the only major leasehold awards in 44 years. Thus, oil companies would seem to be the only types of firms now gaining experience in all facets of the mining and restoring of oil shale.

URANIUM MINING AND MILLING

The oil companies have a very strong position in uranium mining and milling. In aggregate, they hold 47 percent of those uranium reserves now estimated to be available at prices of $30 per pound or less. Kerr-McGee is the largest single holder of these reserves, with 21 percent of the Nation's total. The next largest holder of uranium reserves is Gulf Oil, with 11.6 percent of the total. A recent report of the American Petroleum Institute indicates that oil company uranium reserves holdings are almost exclusively limited to deposits capable of producing U_3O_8 at prices below $15–$20 per pound. Of these lower priced reserves, oil companies are said to hold 71.8 percent of the total domestic amounts, with Kerr-McGee holding almost 33 percent of the total and Gulf Oil holding about 18 percent. However, it must be pointed out that substantial undiscovered deposits of uranium may exist, and that many of the sites showing the greatest promise for the discovery of new deposits are on land controlled by the Federal Government. In addition, deposits of uranium ore of lower quality than the $30 per pound category are already known to exist, and might come to be used if commercial prices become sufficiently high.

The oil companies are also active in uranium milling, the initial process of producing uranium oxide (U_3O_8) from the ore. Of the Nation's total capacity for uranium milling, the oil companies own 41.3 percent, with Kerr-McGee alone holding 24.6 percent of the national capacity. In terms of actual production of uranium oxide, the oil companies have until recently shown fairly steady annual increases in their combined share of the total national output. In 1973 the oil companies milled about 38 percent of the total output, though their total output dropped to 30 percent in 1975.

Both the uranium mining and uranium milling industries are fairly concentrated. The two largest holders, Kerr-McGee and Gulf Oil, hold a combined total of almost 33 percent of all known uranium reserves. The top four firms, of which three are oil companies, hold a total of about 42 percent of the known reserves. In contrast to the situation for oil shale reserves, very little of the land definitely known to have uranium reserve is now under Federal control in consequence (1) of numerous Federal land grants to railroads, to States, to Indian tribes, educational institutions, and the like; and (2) extensive claims under the General Mining Act of 1872.[1]

Similarly, the top 5 firms in terms of uranium milling capacity comprise about 68 percent of the Nation's total production capacity. Kerr-McGee and Exxon are among these, with the former firm commanding almost 25 percent of the total U.S. capacity.

In summary, the oil companies have achieved a strong position in uranium mining and milling, with Kerr-McGee exhibiting strength in both areas of activity.

B. Nonpetroleum Research and Development by Oil Companies

The oil companies are said to be very active in research at all levels, from the most basic to the most applied, in areas where they sense a commercial potential. This is evidenced in varying degrees by scientific publications, by patents, and by contracts with the Federal Government for the design and development of production processes to produce fuels from coal, as well as by information volunteered by the companies themselves.

Insofar as this study was able to determine, the more basic projects in science and engineering—those having the greatest potential for generating patentable ideas—are generally funded internally and are conducted on a somewhat confidential basis. There seems to have been rather little public discussion about the overall research programs of each company, and the few references that were located for this study provided little insight about the overall research objectives and R. & D. budgets of the various oil companies. However, a recent study sponsored by the American Petroleum Institute has reported figures for the combined expenditures of 23 oil companies in several of the alternative energy fields. In 1975 the total R. & D. investment of these 23 companies was $122 million, of which $29 million supported shale oil research, $51 million supported coal research, and $0.891 million sup-

[1] U.S. Congress. Senate Committee on Interior and Insular Affairs. Report to the Federal Trade Commission on Federal Energy Land Policy: Efficiency, Revenue and Competition. The National Fuels and Energy Policy Study, Serial No. 94–28, 1976. U.S. Government Printing Office, Washington, pp. 655–656.

ported geothermal research. Research support involving uranium was not reported explicitly, but was presumably part of $14.5 million reported under "other research."

Two separate approaches were used to examine the extent of Federal support being provided to the oil companies for research and development on nonpetroleum energy sources. The first consisted of a hand tabulated review of all ERDA contracts in existence. The second, and somewhat broader, approach consisted of a computer search of all grants and contracts made by Federal agencies to the oil companies, using the Energy Research, Development, and Demonstration Inventory maintained at Oak Ridge National Laboratory. These two approaches produced information which seemed to be consistent with reports that the major Federal support of the oil companies is for work that might be described as the engineering design and testing of processes to produce fuels from coal. Many of the projects in this category are fairly large undertakings which often extend over several years in duration. A hand tabulation of the internally financed research reported to the Oak Ridge Inventory of Research, Development and Demonstration provided a list of projects of similar nature. It would therefore appear that in this genre of R. & D., where activity might seem to be focused more toward the ultimate commercialization of a known process than toward the development of totally new processes for the production of a fuel, oil companies are interested in outside financial support and in cooperative arrangements with the Government. The lack of Federal contracts involving more basic stages of research would seem to be consistent with reports that oil companies would prefer to finance such projects internally, though other explanations would also seem possible.

From the standpoint of promoting more efficient planning by the Federal Government to meet the energy problem, it might appear attractive to have greater knowledge of the R. & D. activities and investments within the oil companies. Alternatively there would seem to be strong arguments in favor of maintaining the competition that now seems to exist between the oil companies in their R. & D. efforts, and strong proprietary positions would therefore seem essential. The potential rewards of being able to develop a strong commercial position, either through patents or through proprietary technical capability, in almost any of the new energy areas can be very substantial, so that any company efforts which exist to maintain secrecy would be understandable. Furthermore, the Government must also recognize that it is itself a competitor in the race to develop alternative energy sources. If a federally sponsored program makes an important advance or discovery, the Government may seek to exercise options to insure that the resulting inventions are generally accessible to industry, presumably under some sort of licensing arrangement. This may be a significant stimulus to the oil companies to maintain strong research programs and to increase their research budgets when promising opportunities appear. Thus it may not be true that greater information about oil company research and development would necessarily produce significant benefits in the pace of development of alternative energy sources. Nor is it necessarily true that private investment in energy R. & D. would be increased by changing patent laws to allow federally supported researchers to retain autonomous authority over the use of their inventions.

With so little information available, it is not possible to assess the current or potential contributions of petroleum industry research to the Nation's R. & D. effort. On the one hand, a good argument can be made favoring the incentives of private profit and the advantages of an uncoordinated heterogeneity of scientific approaches as the most rapid and productive way to develop technologies for the commercialization of nonpetroleum energy resources. On the other hand, it is possible that a good deal of the industrial research may be duplicative; that it may overemphasize targets that are not the most important from a national standpoint; and that the success of any company in creating a strong patent position in respect to one of these nonpetroleum resources could create an unacceptable market structure. These sorts of questions would seem to merit serious consideration.

DOES EXXON HAVE A FUTURE?

(By James Flanigan)*

Given two major trends, one geological and the other political and social, the mighty Exxon Corp. could be forced into at least partial liquidation within a decade—not by government edict as has been recently proposed, but out of sheer frustration. It probably won't happen. But it could.

Unless the presently unexpected occurs, the world's petroleum reserves are within a few years of their peak and will begin a slow decline to the point where oil and gas will be too valuable to use as energy. Of the oil that is left, an increasing amount—as in the North Sea—is being taken by government oil companies. This fact alone means that Exxon's future is in question.

Faced with such a situation, most corporations would choose to diversify, perhaps to conglomerate. But who would Exxon acquire that would make much difference to its future? Atlantic Richfield acquired Anaconda, but in its *best* year Anaconda would only have contributed 20 or 30 cents a share to *Exxon's* earnings. Short of acquiring something as big as Procter & Gamble, Exxon would be hard put to make a worthwhile acquisition—and Procter & Gamble is not for sale. U.S. Steel? Would Exxon want it? And if it did, would the Justice Department sit still?

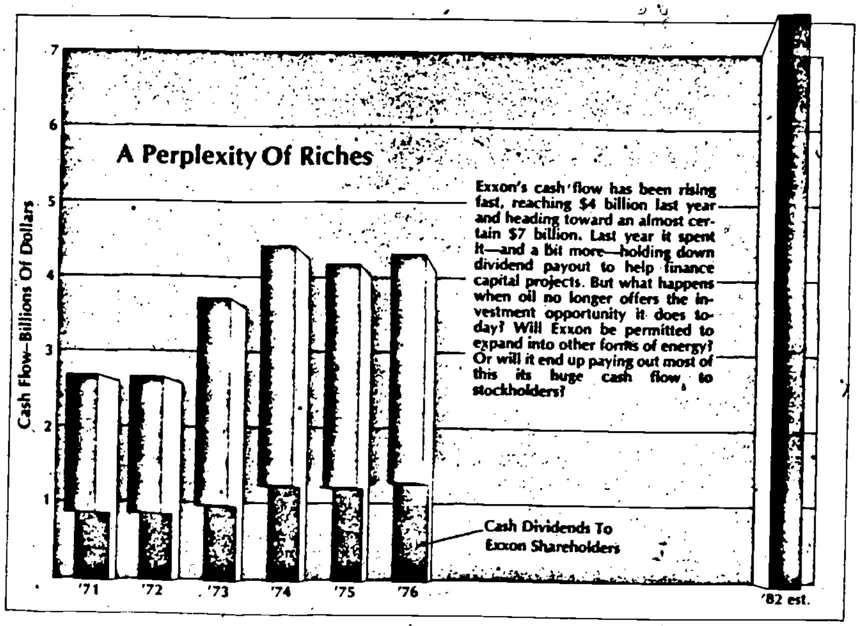
Exxon itself would prefer a different way out. It would like to use its huge resources—technological, managerial and financial—to develop other forms of energy. Even its small diversification efforts—grouped in a venture-capital division named Exxon Enterprises Inc.—reflect this attention to energy. Exxon has invested some minimal amounts in fledgling office-products companies, but far more—over $200 million—in areas such as solar energy and nuclear fuel processing. But here, too, there are problems. An alliance between some liberal congressmen and professional bureaucrats seems determined to prevent Exxon from doing in coal and in nuclear and solar energy what it has done in oil.

The question of whether oil companies should be allowed to develop other energy sources, such as coal or uranium, is before the Congress now in two bills. One is proposed by Representative Morris Udall (D–Ariz.), the other by Senator Edward Kennedy (D–Mass.). Udall's bill would prevent companies engaged, say, in coal—as most oil companies are—from bidding on federal oil leases. It is not going anywhere this session, partly because it would practically cripple U.S. efforts to begin exploration of the continental shelf. Teddy Kennedy's bill would prohibit oil companies from purchasing more coal or uranium properties and require them to sell those they have within three years. It, too, is not conceded much chance this session.

*Reprinted by permission of Forbes magazine from the August 15, 1977 issue, p. 37–41.

The issue won't go away, however, it will come up again and again, as will repeated "investigations," like the one just announced, of oil company pricing and finances. There are many people in Washington who think the oil companies are already too big, too powerful. The effort to break them up seems to have lost its impetus. Therefore, the best way to check their growth and their alleged power seems now to be to keep them out of, or restrict their growth into, other forms of energy.

It is not hard to understand why many people are appalled by the sheer size of Exxon. Exxon is a breathtaking organization. Its revenues this year should hit $55 billion and could be $100 billion by the mid-Eighties. Its earnings last year were $2.6 billion and will be higher this year; its annual cash flow is $4 billion-plus and rising; by the early Eighties cash flow could be $7 billion a year or more. (Last month's mildly disappointing second-quarter earnings report—down 3.4 percent—was a statistical decline due to foreign exchange translations, the company explained; operating earnings were up 11.7 percent.)



Its sales last year of $48.6 billion dwarfed every other U.S. company except General Motors. Exxon's earnings were three times those of Texaco and 2.7 times those of Mobil, to say nothing of more than 2.5 times those of General Electric and Ford Motor. We have big companies in America: U.S. Steel, du Pont, Eastman Kodak. But Exxon's earnings are six times those of U.S. Steel, more than five times those of du Pont and over four times those of Kodak.

Furthermore, because of early appreciation of the way change was coming to the Middle East, Exxon is better situated today than any other oil company. It has huge income-producing properties just opening up in the North Sea and in Alaska's North Slope. By 1980 each of these will be bringing between $400 million and $500 million net income to Exxon. The company's earnings by 1982 will very likely be around $4.4 billion—nearly $10 a share.

Besides this, enormous amounts of money will roll into Exxon in the early years of North Sea production, as much as $10 to $11 cash flow per barrel produced, much of it due to the accelerated depreciation mandated by the British government. Exxon will normalize such a flow for accounting purposes by putting amounts representing British taxes into a deferred-taxes account. But the cash will be there for the spending.

This for a company that is already virtually debt free. Exxon has $3.7 billion of long-term debt; on the other hand, it has $5 billion in cash and marketable securities. The only reason it has taken on debt in the last two years is because government regulations, not financial requirements, warranted it: The Federal Power Commission demanded that the Alaska pipeline be separately financed; the British government, through interest relief grants, encouraged borrowing for some North Sea work. Senior Vice President for Finance Jack F. Bennett foresees no need for outside financing for operations or capital plans in the near future.

This huge pile-up of assets canot be blamed on any reluctance of Exxon to spend money on oil. It plans laying out $4.4 billion a year for capital projects from 1977 through 1981. Opening up new areas in the continental shelf will cost big money, and Exxon is spending $3 billion a year on energy exploration and development. It has invested over $2 billion in Alaska over the last seven years and simultaneously poured $1.4 billion into development in the North Sea. As its current financial position makes clear, Exxon hasn't felt a strain.

But still the money will pile up. Exxon President Howard C. Kauffman recently told Dallas security analysts that the company's problem is not lack of cash, but lack of opportunity.

In the Middle East, where most of the oil is, the producing nations may still need Exxon's technical help, but not its dollars. Mexico is financing its own oil development.

So, unless it can go into other energy areas, coal in particular, Exxon faces a real dilemma. Should it pay out most of its earnings to shareholders rather than invest them? This would be a disguised form of partial liquidation, but if Congress eventually goes along for some kind of "integration" of personal and corporate income taxes (Forbes, *August 7*), the pressure for it could mount.

Exxon knows what it would *prefer* to do with its surplus cash flow. The company through last year had invested some $150 million in coal—not through acquisition, mind you, but through from-the-ground-up development. Since 1967 it has been purchasing coal leases and water rights in the Rocky Mountains and now owns leases on reserves of 8.4 billion tons—making it the fifth-largest holder of U.S. coal. It is opening a mine this year in Wyoming, starting construction on another. It has two mines operating in Illinois and is preparing a fifth mine in West Virginia.

By 1985 Exxon hopes to have nine coal mines operating and to be producing 40 million tons a year of coal, which it will sell to utilities for power generation. But what is that to Exxon? If it earned even $120 million from coal, the business would contribute less than 3%

of Exxon's earnings at that time. Exxon clearly has the ability to put far more into coal. But will it be permitted to?

WHAT FOR AN ENCORE?

Before Alaska began producing this year, Exxon's oil production in the U.S. had been declining 4% a year since 1972. In the early 1980's, while Alaska and the North Sea pump in new earnings, income from the European gas fields, which last year gave Exxon some $420 million of earnings, will be declining.

There is the possibility—even the probability—that the continental shelf holds a great deal of gas and oil. But even this is unlikely to absorb the $7 billion cash flow a year that Exxon will have within five years.

Chairman Clifton Garvin is 55 years old and therefore destined for a long tenure at Exxon's helm. He will guide the company through the beginning of this period of transition in energy—for the company and the U.S.—and he will have to decide what to do with the cash flow. Invest it? Or pay it out?

Garvin, a Portsmouth, Va.-born chemical engineer, is a large, mildly loquacious man. The best word to describe his manner, displayed before an annual meeting of shareholders or up close, is avuncular. He seems unflappable. Listen to Cliff Garvin on what's ahead:

"It's too early in the game to say there are not opportunities, and ample opportunities, to spend a lot of capital money. We've made it clear that going in the coal business is one of our strong desires. It's motivated by several things. One, in the short term, is its use in power generation, but longer-term there is no doubt in my mind we're going to see an awful lot of coal converted into liquids and gas. You don't see that in the Carter message, but it's in the next ten years.

"The way I read that is very practically. It's almost impossible to get any substantial amount of energy through these sources during this next ten-year period. It's the next stage beyond that. But if you look at the costs, the capital costs involved in that kind of conversion, I think it's only going to be a question of how much does a corporation want to invest in that kind of thing. Because I think you could sink as much money as anybody could possibly talk about in going into these synthetics. They just eat up so much capital.

"Also, we have opted to participate pretty strongly in phases of the nuclear business." That's putting it mildly. Exxon has said it is willing to build a plant for enriching uranium, the phase in nuclear energy heretofore reserved for classified government facilities like Oak Ridge, Tenn. For the present, the government is going to keep that franchise. President Carter has announced that the government will build, for $4.5 billion, a new uranium enrichment facility at Portsmouth, Ohio, using a new and less-energy intensive enrichment method called gas centrifuge. Still, Garvin and Exxon persist in the hope that they can get into this very expensive business in the mid-Eighties when another enrichment plant would be needed in the U.S.

The government, comments Garvin, "has left dangling the carrot that down the road these opportunities might be made available to the private sector.

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"Now we've indicated our interest in pursuing that. We haven't made the decision because we haven't had to yet. ERDA [Energy Research & Development Administration] has indicated that they want to have a number of entities in the private sector, as government contractors, to build and operate the first stages of centrifuge capacity. We may or may not opt to do that. If we do, it would be in the hope that it would lead us to the opportunities to make investments down the road."

To build a plant for the liquefaction or the gasification of coal would cost $1.5 billion today; a uranium-enrichment plant would cost no less than $4.5 billion. Where other companies would necessarily quail at such amounts, Exxon is fairly itching to spend them.

Exxon sees worldwide growth of nuclear power at 17 percent a year between now and 1990. As Garvin puts it, "The U.S. may be hung up today over whether things like breeder reactors should go ahead. But we're very much of the opinion that in time the world is going to shift and opt and recognize that more and more of its energy generation is going to have to come from nuclear. The gamble we're taking is that there will be a place for the private sector."

Exxon is already in some phases of the nuclear business—as a supplier of fuel cores and as a miner of uranium. Its investment in the business to date is roughly $150 million, about the same amount it has put into coal. For the future it sees its role as being in every phase of the nuclear fuel cycle, with the business centered on the very expensive "refining" or enriching function.

In coal conversion Exxon today is preparing to put up $75 million to ERDA's $120 million (the Electric Power Research Institute and Phillips Petroleum are other partners) to build a $240-million pilot plant for the liquefaction of coal. The pilot plant will turn 250 tons of coal a day into 600 barrels of oil. By 1982 the pilot plant will have been working 2½ years. If it is successful, Exxon plans to follow with a commercial facility for coal liquefaction which would begin operation in 1986. The commercial plant would turn 25,000 tons of coal into 60,000 barrels a day of oil. It would cost $1.5 billion if built today.

In coal gasification, Exxon has developed its own catalytic process and looks forward to signing an agreement with ERDA at the beginning of 1978 for cooperation and funding on a pilot plant. In Exxon's estimation a commercial gas-from-coal plant using its process is possible by 1988.

But given such costs, can the output of such pioneer commercial plants really be called commercial? Not today, certainly, but what might be the cost of imported energy in 1986? If the world oil price merely follows inflation at 5 percent, it will be around $22 per barrel, landed in the U.S. at that time.

Exxon is not the only company contemplating coal conversion. The natural gas pipeline companies (Panhandle Eastern, Texas Eastern and El Paso Co.), looking to a supply of future product as U.S. gas deposits dwindle, have large ventures in mind. The trouble is the financing. The cost of such plants could mean borrowings equal to the companies' total equities. Banks are not ready to lend, nor are companies ready to borrow, such life or death amounts for pioneering and risky ventures. Exxon, on the other hand, needn't even ask the bankers. It is financially self-sufficient, or nearly so.

Will the government, will the Congress, let Exxon have a relatively free hand to go where it will?

John O'Leary is administrator of the Federal Energy Administration—the equivalent, as he himself has put it, of Assistant Secretary of Energy in the new Cabinet department. O'Leary has a reputation of understanding the energy industry better than anybody else in the Carter Administration. O'Leary admires the oil companies, calls them nothing less than "the archetypal managers of large enterprises in this age."

O'Leary concedes that the oil companies have technical skills of a high order, as the traditional coal and uranium industries do not. He grants that infusing oil company technical skills into those industries could bring the nation something very useful. Says O'Leary: "I think you have to regard the oil industry as a national asset of no mean value."

But then O'Leary changes tone and wonders whether it is sound policy to allow the oil companies to dominate coal and uranium as they do oil. "We are moving in the direction where we are going to have a single energy system," he says. "The question comes down to: Do you want this whole energy system managed by a relatively small group of people—of which Exxon is a leader?"

To the question of who else could or would do it, O'Leary responds that perhaps purchasers of coal or uranium—the utilities—could put up the financing. This, however, would be like a muzzled dog or tethered horse from the very first—government regulated finance in which an allowable rate of return would be set as often for political as economic reasons. What is wrong with the oil companies doing it? O'Leary brings up his objection: "You have here a subtle point that is not reached by classic antimonopoly law. And that is the attitude and the demonstrated capacity of the oil industry to have its way with the system. The oil industry is probably more competent, with a longer and better track record in the political arena in this country than any other pressure group; maybe the railroads are as good from a historical perspective, but they haven't done as well as the oil companies lately."

O'Leary talks of the oil industry dominating public policy. He talks of the oil lobby the way President Carter, angered at having parts of his energy program changed in congressional committee, lashed out recently at it.

And yet sophisticated observers of Washington know that the power of the oil lobby has declined in recent years, especially since oil became fair game politically after the gasoline shortages and subsequent price rises of early winter 1973. The oil lobby is not nearly so powerful today as it was in the days when Lyndon Johnson of Texas was leader of the Senate, Sam Rayburn of Texas was Speaker of the House, Albert Thomas of Texas was head of the House Appropriations Committee and the most powerful senator bar none was Oklahoma oilman Robert Kerr, cofounder of Kerr-McGee. Those days are long gone.

O'Leary knows—and every politician and bureaucrat knows at heart—that the oil industry cannot seriously challenge the government. The real issue is something else. It is probably no exaggeration to say that politicians and bureaucrats, consciously or unconsciously, are jealous of the wealth and proficiency of the oil industry; its independence disturbs them. They would like to annex that proficiency to government; if not annex it, then at least tightly control it. The free market is too messy, too unpredictable for their file-cabinet way of thinking. The solution of many politicians, congressional staff members and government agency officers is to break the oil industry down to smaller units. This, in their way of thinking, would make the business more "responsive" to the people. It would also make the business more easily controllable by the government, whose "responsiveness" the bureaucrats never question.

John O'Leary knows that the issues are more subtle than that, but he feels that through Congress the country should debate and decide whether it wants the big oil companies to control the energy system or should another way be found, using smaller companies. "It seems to me," O'Leary says, "that it offers a very, very fundamental problem of public policy that ought to be looked at by the executive branch and the Congress."

Of course, Exxon and its competitors have been able to achieve the things they have because the free market has given them huge profits—in that sense, consumers have paid for Exxon's progress. But they have also greatly benefitted from them in terms of a wonderfully efficient system. Would it, then, be a bad thing if Exxon were to use surplus profits from oil to develop the coal energy and to help develop nuclear and solar energy? Certainly no other existing industry could so easily and quickly raise the kind of money needed. The government could do so, but the government cannot operate more efficiently than private industry can. It would merely be transferring the burden of development from energy users to all the taxpayers. If the oil companies are prevented from using their surplus cash to develop other forms of energy, this is precisely what must happen.

Listen to Exxon's Clifton Garvin: "If it turns out that we're going to be denied those opportunities to work in the energy field through a combination of government action or what-have-you, then we'd have two basic choices. We could either take the cash flow that's coming in from current successful kinds of investments and give it all back to our shareholders so they may make the choices on what they want to do. Or we could make those decisions that would lead us in other directions, into other fields."

Since the later course—conglomeration—is not a realistic possibility, then it would appear that if the government thwarts Exxon's move into coal and nuclear energy, the company may well go in for what will amount to controlled liquidation.

The ultimate decisions could go in either direction.

On the wall of Federal Trade Commission Chairman Michael Pertschuk's office is a quotation from Adam Smith: "The interest of the provider ought to be attended to only so far as it may be necessary for promoting that of the consumer." Pertschuk, respected in Washington as a smart and practical fellow since his days as chief counsel of the Senate Commerce Committee, has this to say against companies like Exxon: "This economic size means economic and political power. I think that concentrating economic and political power in an entity in our society is antithe'ical to the democratic tradition."

Sure it is. But how can a democrat (small "d") proffer government—itself swollen and nearly all-powerful—as an antidote to too-big business?

Concentration of economic power *is* a problem, but not just when corporations wield it. If Commissioner Pertschuck wants a motto for his wall instead of a highly idealized portrait of beneficial Government versus malevolent Business, he might settle on something along these lines:

Business profits and government taxes are but two sides of the same coin. Together with savings they comprise the surplus—the sum total of dinners done without—with which the American people satisfy their collective needs. The bulk of profits are, after all, reinvested to provide for our future wants. And government gets the lion's share of our national surplus: Total corporate cash flow—profits after taxes and depreciation—came to $155 billion; total government tax receipts came to $517 billion. Sure, Exxon's cash flow is $4 billion-plus and rising; but the Energy Research & Development Agency's cash flow is $7 billion-plus, and rising. Big government is about three times bigger than big business.

Certainly it is possible to run an economic system with taxes instead of profits. Increasingly, Britain is doing so. The history of a century of regulation of the railroads—a history of enterprise denied, investment opportunities forbidden—proves that we, too, can make the same mistake.

The question before the house is whether Americans want further to narrow the area of private economic decision-making and further to broaden the area of government decision-making. Exxon's future depends on the answer.

IMPLICATIONS OF INVESTMENTS IN THE COAL INDUSTRY BY FIRMS FROM OTHER ENERGY INDUSTRIES

(National Coal Association*)

I. ISSUE

Should firms engaged in the development or production of one energy source, such as oil or natural gas, be encouraged or discouraged from participating in the development or production of another energy source, such as coal?

II. BACKGROUND

Several bills have been introduced in the 95th Congress to prohibit firms from involvement in the development or production of more than one energy source and require firms already involved with more than one energy source to divest themselves of such involvement.

III. PRINCIPAL ARGUMENT

These legislative proposals have led to sharp disagreement between proponents and opponents of horizontal divestiture.

A. Proponents of divestiture argue

Oil and natural gas company investment in the coal industry would encourage energy monopolies which might lead to:

holding coal reserves out of production,

holding down coal production as a means to push up oil or natural gas prices,

restricting the amount of capital going into the coal industry, and

restricting investments in coal research and development.

B. Opponents of divestiture argue

The coal industry is and will continue to be a highly competitive industry.

Investments from oil, gas, and other industries have already contributed to increased (1) coal production, (2) productive capacity, (3) private R&D expenditures, and (4) the ability of coal companies to withstand adverse effects of decreased productivity and sales.

Management talent and capital from oil and natural gas firms—and from other industries—are needed to permit expansion of coal production capacity.

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*A Report published by the National Coal Association, Washington, D.C., in September 1977. An introductory abstract and some supporting appendices have been omitted here in the interests of brevity. Reprinted by permission.

Existing antitrust laws are adequate to deal with any present or future anti-competitive practices.

There is no serious possibility that a firm or group of firms could obtain a monopoly in coal or even significantly influence the price of coal.

Each of the major points in disagreement—competitiveness of the coal industry, production and reserves, production records of specific firms, capital investment, management talent and adequacy of existing antitrust laws—is analyzed below.

IV. ANALYSIS AND CONCLUSIONS

A. *Competitiveness of the Coal Industry*

1. *The coal industry is highly competitive.*—The industry is made up of over 3,000 individual firms and is characterized by a low level of concentration in production. No one firm or group of firms, oil or otherwise, is in a position to control the coal industry.

As a general rule, industries where the four top firms control less than 50 percent of production have been regarded as sufficiently competitive to prevent effective collusion.[1] In 1976:

- the top 4 coal firms produced approximately 25 percent of output,
- the top 8 coal firms produced approximately 34 percent of output, and
- the top 20 firms produced nearly 50 percent of output.

2. *The trend in the coal industry is toward reduced rather than greater concentration.*—As illustrated in Table 1 below, concentration reached a peak in 1970 and has been declining since.

TABLE 1.—U.S. BITUMINOUS COAL AND LIGNITE PRODUCTION CONCENTRATION RATIOS, 1960, 1965, 1970, AND 1972–76

Ratio	1960	1965	1970	1972	1973	1974	1975	1976
4 firms	21.4	26.6	30.7	30.2	29.1	26.6	26.1	25.1
8 firms	30.5	36.3	41.2	40.0	39.1	36.7	35.7	34.3
15 firms	39.7	45.6	52.2	50.6	50.5	46.4	45.3	44.6
20 firms	44.5	50.1	56.5	54.9	54.9	51.2	50.0	49.7
100 firms	NA	NA	75.4	78.0	78.9	74.3	74.3	73.9
200 firms	NA	NA	82.6	84.5	86.7	82.1	82.2	81.6

Source: Derived from data in "U.S. Coal Production by Company," 1960–67, Keystone Coal Industry Manual, McGraw-Hill, Inc., New York.

B. *Coal production accounted for by coal firms owned by oil and natural gas companies and by other companies with partial oil and natural gas interests*

1. *Coal firms owned by oil companies accounted for only 17.5 percent of 1976 coal production.*—As of January 1, 1977, there were nine major operating coal companies owned by oil companies:

Arch Mineral Corporation (Ashland Oil-Hunt Oil);
Ashland Coal Company (Ashland Oil);
Consolidation Coal Company (Continental Oil);

[1] See for example: Federal Trade Commission Staff Report, *Concentration Levels and Trends in the Energy Sector of the U.S. Economy*, or Bain, Joe S., *Industrial Organization*, 2d ed. (New York: John Wiley & Sons, Inc., 1968).

Hawley Fuel (Belco Petroleum);

Island Creek Coal Company (Occidental Petroleum);

Monterey Coal Company (Carter Oil, subsidiary of Exxon). Monterey is a *de novo* entrant in the coal industry; it was not an operating firm when it was started as a subsidiary of Exxon;

Old Ben Coal Company (Standard of Ohio);

Pittsburg & Midway Coal Mining Company (Gulf Oil); and

Valley Camp Coal Company (Quaker State).

In 1976, these firms produced 17.5 percent of the total U.S. output. In 1976, Sun Oil Company's Cordero mine began production which should be included in any later data compilation. Appendix A shows the details of 1976 production by coal companies affiliated with oil and gas firms.

2. *Even when coal firms controlled or owned by natural gas companies are added to those firms owned by oil companies, the total share of production is only 20.5 percent.*—As of January 1, 1977, five major coal producing firms were owned by natural gas companies:

Zeigler Coal (Houston Natural Gas);

Southern Utah Fuel (Coastal States Energy);

Youghiogheny & Ohio (Panhandle Eastern Pipeline Company);

MAPCO (Mid America Pipeline); and

Eastern Associated Coal Corp. (Eastern Gas & Fuel).

The addition of the 1976 production of these coal companies owned by natural gas companies would bring the 1976 total to 136.5 million tons or 20.5 percent of total U.S. production.

3. *Even if a major coal producing firm which is associated with, but not controlled by, an oil company is added, the total share of coal production associated with oil and gas firms is only 24.0 percent.*—Some analysts have incorrectly included Amax Coal Company as a firm controlled by an oil company. Standard Oil of California owns 20.6 percent of Amax common stock but SoCal and Amax do *not* have a parent-subsidiary relationship. Even if Amax Coal's 1976 production were added, the total of oil and gas firm-associated production would be only 24.0 percent of the total 1976 U.S. coal production.

C. Ownership of Coal Reserves

1. *Ownership of coal reserves is widely distributed and it is unlikely that a firm or group of firms could gain monopolistic control of the coal industry.*—In addition, oil companies do not control a significant portion of total U.S. coal reserves to make it possible for them to prohibit entry into the coal industry and limit competition, as some critics have alleged.

The United States Bureau of Mines (based on U.S. Geological Survey data) estimates that the "demonstrated reserve base" deemed suitable for mining by current methods is 438.3 billion tons. The Bureau of Mines has determined that recoverability varies from 40 to 90 percent depending on the characteristics of the coalbed, mining method, and the legal constraints and restrictions placed upon mining a deposit because of natural and man-made features. Mining experience in the U.S. has indicatd that, on a national basis, at least one-half of all in-place coal can be recovered.[2] Based on this, if the reserve base is discounted by 50 percent, a total recoverable reserve of 219.2 billion tons is available for mining.

Reserve data published in the Keystone Coal Industry Manual, 1977, show that reserves held by oil companies or their coal producing subsidiaries total 46.9 billion tons or 21.4 percent of estimated recoverable reserves. If reserves held by gas companies are included, the total reserves held by oil and gas companies and their coal producing subsidiaries total 55.1 billion tons, 25.1 percent of estimated recoverable reserves. These percentages are over estimated as the data on reserves held by oil and gas companies are not differentiated between recoverable and in-place reserves, whereas the estimates of U.S. reserves have been discounted to a recoverable reserve. Appendix B provides details on reserves held by oil and gas firms in 1976. Other industrial groups also control reserves.

2. *The federal government controls about half of the nation's coal reserves. These reserves are located on public domain lands. Existing laws and regulations prevent any one firm or group of firms from achieving a dominant position in coal reserves.*—The amount of reserves held by the federal government far exceeds the reserves held by oil and gas companies or their coal producing subsidiaries. Because coal is widely distributed, the U.S. Geological Survey has concluded:

> The information available on the distribution of coal and on ownership of coal rights leads convincingly to the conclusion that it would be virtually impossible for an individual, corporation, or cartel to obtain a monopoly on coal or even to significantly influence the price. The reasons for this conclusion are (1) coal is widespread and abundant in the U.S.; (2) ownership is broadly distributed; (3) the federal and state governments own substantially more than half the coal lands and coal rights in the Rocky Mountains and Northern Great Plains regions; (4) leases of Federal coal rights have practical acreage limitations for holdings in any one State;[3] and (5) most major consumers of coal have substantial coal holdings.[4]

3. *The reserves held by coal, oil, natural gas, and other private firms which are in the form of leases of Federal lands are subject to diligent development requirements.*—The Interior Department, which manages a large share of federally owned coal lands, has the authority to establish "diligent development" requirements which regulate the timely development of minerals on federally leased lands. These requirements are designed to discourage holding reserves for speculation. Firms not meeting these requirements are subject to a loss of leasing rights.[5]

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[2] See *Demonstrated Coal Reserve Base of the United States*, (January 1, 1976), Mineral Industries Survey, U.S. Department of the Interior, Bureau of Mines, p. 1, 4.

[3] Recent amendments to the Federal Mineral Leasing Act of 1920 place even greater acreage limitations on leases of Federal lands. Act of Aug. 4, 1976, Public Law 94–377, Sec. 11(b), 90 Stat. 1090, amending 30 U.S.C. Sec. 184 (1920) (codified at 30 U.S.C. 184(a)(1) (1976)).

[4] United States Geological Survey, *Coal Resources of the United States*, (January 1974), p. 89.

[5] 30 U.S.C. 207 (1976).

D. Production record of coal firms owned by oil or natural gas companies

Some who believe that oil or natural gas firms have undue control of the coal industry allege that production levels often go down after a coal firm is acquired by an oil or natural gas company. This argument needs detailed evaluation:

1. *An assessment of the production record of a firm must be made in the context of all of the factors that have affected production.*—For the periods involved, several factors deserve special attention:

a. *The principal factor which affects production from year to year is the industry-wide decline in productivity (tons per man per day) that has occurred since 1969, particularly in underground mining.*—This decline in productivity is due principally to changes in mining procedures in order for coal companies to comply with the Coal Mine Health and Safety Act of 1969. Table 2 below shows productivity from 1962 to 1976. As Table 2 clearly shows, productivity declined:

31.7 percent since 1969 in all mines.

45.5 percent since 1969 in underground mines.

TABLE 2.—LABOR PRODUCTIVITY—TONS OF COAL PRODUCED PER MAN PER DAY, 1962-76

Year	Underground	Strip	Auger	Average all mines
1962	11.97	26.76	36.51	14.72
1963	12.78	28.69	38.87	15.83
1964	13.74	29.29	42.63	16.84
1965	14.00	31.98	45.85	17.52
1966	14.64	33.57	44.43	18.52
1967	15.07	35.17	46.48	19.17
1968	15.40	34.24	40.46	19.37
1969	15.61	35.71	39.88	19.90
1970	13.76	35.96	34.26	18.84
1971	12.03	35.69	39.00	18.02
1972	11.91	35.95	43.00	17.74
1973	11.66	36.30	45.33	17.58
1974	11.31	33.16	45.00	17.58
1975	9.54	[1] 26.69	(1)	14.74
1976	[2] 8.50	[1] 26.00	(1)	13.60

[1] Auger included with strip.
[2] Preliminary.

Source: U.S. Bureau of Mines.

b. *Another major factor contributing to lower production is time lost due to strikes.*—In 1971 and 1974, time and production were lost in union mines due to strikes by the United Mine Workers when the contracts expired. In 1971 appproximately 56.4 million tons were lost during the six-week contract strike, and in 1974 approximately 26.1 million tons were lost during the November-December contract strike.[6] In addition, wildcat strikes have been a major and growing problem, particularly in West Virginia. Table 3 below shows the increase in number of man-days lost due to wildcat strikes from 1969 to 1976 and the estimated production lost due to these strikes.

[6] Source: Bituminous Coal Operators Association.

TABLE 3.—MAN-DAYS AND PRODUCTION LOSSES DUE TO WILDCAT STRIKES, 1969-76

	Man-days lost due to wildcat strikes	Estimated tonnage lost due to wildcat strikes (million tons)
Year:		
1969	626,500	12.1
1970	593,100	11.4
1971	565,000	8.8
1972	515,600	8.4
1973	529,200	7.0
1974	1,028,800	11.7
1975	1,417,400	15.8
1976	2,007,000	19.8

Source: Bituminous Coal Operators Association.

c. *Another factor contributing to production losses by some companies has been a slack demand for coal primarily caused by:*

Air quality requirements.—particularly state requirements which are more strict than federal guidelines in meeting national health standards—which reduced the demand for coal and encouraged shifts to oil and natural gas as boiler fuel. Federal and state clean air quality requirements have made coal with higher sulfur content from fields in West Kentucky, Illinois, Indiana, and Ohio less attractive for use by utilities and industry.

Lower demand for metallurgical coal.—due to the 1975 economic recession and resultant drop in use of U.S. coal in steel production, both in the U.S. and worldwide.

Artificially low prices for oil and natural gas.—due to Federal price, allocation, and entitlement regulations.

State utility commission actions.—which have had the effect of discouraging investments in new coal facilities and encouraging use of natural gas and imported oil.

2. *In general, coal firms owned by oil and natural gas companies have better production records after acquisition compared to:*

production by the same firms before acquisition,

production throughout the U.S. during the same time period, and

production by independent coal companies in the same general areas during the same time period.

Presumably, the argument that production declines after acquisition would be applicable to these five coal firms owned by oil companies:

Consolidation Coal
Hawley Fuels
Island Creek
Old Ben
Pittsburg & Midway

Arch Mineral Corporation is owned by Ashland Oil Company (48.9 percent) and Hunt Oil Company (48.9 percent). Arch Mineral Co. was formed by Ashland Oil Co. and other individuals in 1969. Ashland Coal Company is just over 2 years old, having been formed through acquisition of five small companies. Both Monterey and Sun are *de novo* entrants.

The argument apparently is also being applied to the Zeigler Coal Company which was acquired by Houston Natural Gas in 1973, Southern Utah Fuel which was acquired by Coastal States in 1973, and MAPCO which acquired its first producing mines in 1971. Youghiogheny and Ohio was acquired by Panhandle in 1976, and Eastern Associated was incorporated in 1963 as a successor to the coal division of Eastern Gas & Fuel Associates.

As one measure, Table 4 below shows each company's average experience in production during the five years preceding and succeeding acquisition.

TABLE 4.—AVERAGE PRODUCTION BY COAL FIRMS 5 YEARS BEFORE AND AFTER ACQUISITION BY AN OIL OR NATURAL GAS COMPANY AND COMPARISON WITH U.S. AND INDEPENDENTS' EXPERIENCE OVER SAME TIME PERIOD

Coal company (parent and acquisition date)	5-yr average output (thousand tons)	Percentage change		
		Company	Independents	United States
Consolidation Coal (Conoco, Sept. 15, 1966):				
Before	43,858	+35.0	+11.6	+16.6
After	59,218			
Hawley Fuel (Belco, 1968):				
Before	1,702	[2] −6.0	+4.7	+10.3
After	1,600			
Island Creek [1] (Occidental, Jan. 29, 1968):				
Before	22,514	+2.8	+6.9	+12.2
After	23,134			
Old Ben (Sohio, Aug. 30, 1968):				
Before	8,287	+37.2	+4.7	+10.3
After	11,372			
Pittsburg & Midway (Gulf, 1963):				
Before	4,869	+73.9	+23.[illegible]	+24.6
After	8,465			
Zeigler Coal [3] (Houston Natural, 1973):				
Before	4,169	+5.8	+5.2	+10.2
After	4,412			
Southern Utah Fuel [3] (Coastal States, 1973):				
Before	223	−238.1	NA	+10.2
After	754			
MAPCO [4] (first acquisition, 1971):				
Before	1,147	+100.6	+1.7	+7.9
After	2,301			

[1] To prevent a biased comparison, Island Creek's publicly reported output from 1969–73 was reduced by subtracting the production of its Maust coal properties which were acquired in 1969. If these tonnages were included, the 5-yr average production subsequent to acquisition would have been 26,293,000 tons or 16.8 percent above the preacquisition 5-yr period.

[2] Belco sold 80 percent interest in a number of mines (Hawley Coal Mining Corp.) to a French company. In October 1976, the company purchased the remaining 20 percent interest in HCMC. Production levels here reflect the sale of Hawley's ownership in these mines.

[3] 3-yr averages.

[4] 4-yr averages.

Source: "U.S. Coal Production by Company," 1962–76, Keystone Coal Industry Manual, McGraw-Hill, Inc., New York; Minerals Yearbook, 1962–75, and weekly coal reports, U.S. Bureau of Mines, Department of Interior.

3. Where production has not increased, the lower levels can be understood in the context of factors that have affected production.—In all cases except one shown in Table 4, average coal production by oil or gas affiliates—when compared over a 5-year period—has increased after acquisition. However, recent production trends may not show yearly increases, as detailed in the year-by-year comparisons of production for each company owned by an oil or natural gas company, including Monterey (a *de novo* entrant).

As summarized in Table 5 below, the production levels of several companies during the 1974–76 period are only slightly higher and some are lower than production levels during the year of acquisition. Monterey is not included in Table 5 since it is a *de novo* entrant; Valley Camp and Youghiogheny & Ohio are omitted because they were acquired in 1976.

TABLE 5.—COMPARISON OF AVERAGE 1974–76 PRODUCTION WITH PRODUCTION IN YEAR OF ACQUISITION

Company	Year of acquisition	Production year of acquisition (thousand tons)	1974–76 average production	Percent change
Consolidation Coal	1966	51,400	54,200	+5.4
Island Creek	[1] 1968	25,880	[2] 19,292	[2] −25.5
Old Ben	1968	9,915	9,469	−4.5
Pittsburg & Midway	1963	6,024	7,582	+25.9
Hawley Fuel	1968	1,540	647	−58.0
MAPCO	1971	1,124	3,211	+158.7
Zeigler Coal Co	1973	4,273	4,412	+3.3
Coastal States	1973	339	754	+122.3

[1] Date of acquisition January 1968; 1967 was used as the last full year of independent production.
[2] In 1975 and 1976, Island Creek had approximately 5–6,000,000 tons unused productive capacity. This capacity was idle due to market conditions. The average production 1974–76 is not indicative of Island Creek's coal production capacity.

These recent company production trends must be assessed in the context of the factors which have affected production.

The experience of Old Ben Coal Company and the Consolidation Coal Company illustrate the factors that have affected recent production trends.

a. Old Ben Coal Corporation

The Old Ben Coal Corporation merged with Standard Oil (Ohio) in 1968. During the subsequent 5-year period (1969–73), Old Ben's annual production averaged 11.4 million tons per year compared to 8.2 million tons in the 1963–68 period, an increase of 37.2 percent. Old Ben's annual production per employee peaked in 1969, the year the Coal Mine Health and Safety Act was passed, and began a decline to its current level—a 43 percent drop. Also, time lost to UMWA contract and wildcat strikes during the recent period has more than tripled from the previous period. Similar problems have affected all members of the industry which operate unionized deep mines.

Old Ben Coal Corp.

Annual output per employee:	
1969	6,500 tons.
1976	3,680 tons.
Time lost to strikes:	
1965–70	2.2 percent of available mine days.
1971–76	7.3 percent of available mine days.

As a direct result of time lost to strikes, production declined for 2 years in a row before increasing in 1976.

Despite steep declines in deep mine labor productivity, which are believed to be a direct result of specific work rules imposed by the UMWA and the Mining Enforcement and Safety Administration, Old Ben and Sohio have invested heavily to expand coal production capacity. Also, employment has risen 58 percent since the merger.

Average annual capital expenditures

	Million
Premerger (1963–68)	$4.8
Merger present (1969–76)	15.8
Planned future (1977–79)	43.2

Despite these efforts, recent production has remained in the 9–10 million ton range because huge boosts in investment and employment have helped offset declining productivity, increased strike losses, and property depletion. If it were assumed that Old Ben could equal its 1969 high level of output per employee, its production capability today would be over 17 million tons. This estimate is conservative because Old Ben's recent increases in strip mine capacity have masked the deep mine productivity drop on a company-wide basis. In fact, the corporate production goal set at the time of merger was 1975 production of 17.9 million tons and 1976 production of 19.5 million tons.

b. Consolidation Coal Company

Consolidation Coal Company was acquired by Continental Oil Company in 1966. While Consolidation Coal Company's production did increase during the 10 years (1966–76) after the acquisition by Conoco, it was during a period of the greatest loss of productivity in the history of the United States coal industry.

Two-thirds of Consolidation's production is from underground mining. During the 1969–76 period, the industry's underground productivity was cut almost 50 percent from about 15.6 tons per man-day to about 8.5 tons per man-day. Consol's overall experience was the same with productivity dropping from 21.93 to 12.07 tons per man-day during this period. As a result, Consolidation Coal had to increase its employees by nearly 50 percent merely to maintain tonnage. At the end of 1976 it had 21,480 employees compared to 14,527 employees in 1969.

The Federal Coal Mine Health and Safety Act of 1969 has had the greatest impact, resulting in underground mine production losses from 22 percent to 46 percent depending on the mine. The Act, coupled with a dramatic increase in absenteeism, wildcat strikes, and union work practices under new labor contracts, caused these staggering production losses. As a result, Consolidation and other companies with underground mines were forced to more than double their labor costs just to maintain production levels.

For a detailed statistical analysis of the recent production trends of Old Ben Coal Company and Consolidation Coal Company.

E. Comparison of Relative Production Experience of Independent Coal Firms with those Owned by Oil and Natural Gas Companies

As one additional basis for comparing the relative performance of coal firms owned by oil and natural gas companies, Table 6 below compares the firms of primary interest (7 oil company affiliates) with 11 independent companies operating in the same general area—Appalachia, Indiana, Illinois and Western Kentucky—and with total bituminous coal production east of the Mississippi River. Table 6 shows that oil company affiliate performance is at least equal to, if not better than, the experience of the independent coal companies operating in the same area. *This, along with the fact that production levels generally increased immediately after acquisition, demonstrates that factors other than oil company ownership acted to limit recent increases in production.* (NOTE: comparisons are limited to 1969 since it was during this time that production drops were most pronounced. Production experience of gas affiliated companies is not included here because the acquisitions are too recent—1971, 1973, and 1976.)

TABLE 6.—YEAR-TO-YEAR COMPARISON OF PRODUCTION OF OIL AFFILIATES WITH 11 INDEPENDENT COMPANIES AND TOTAL PRODUCTION EAST OF MISSISSIPPI

[Tons in thousands]

Year and change	7 oil company affiliates [1]	11 independent companies [2]	Eastern United States
1969 (tons)	113,017	58,985	527,203
1970 (tons)	115,594	59,513	558,028
Percent change 1969–70	+2.3	+0.9	+5.8
1971 [3] (tons)	98,828	55,969	501,197
Percent change 1970–71	−14.5	−6.0	−10.2
1972 (tons)	119,142	63,242	531,051
Percent change 1971–72	+20.6	+13.0	+6.0
1973 (tons)	116,999	62,290	515,303
Percent change 1972–73	−1.8	−1.5	−3.0
1974 [3] (tons)	104,642	55,341	511,500
Percent change 1973–74	−10.6	−11.2	−0.7
1975 (tons)	105,105	59,359	537,504
Percent change 1974–75	+0.4	+7.3	+5.1
1976 (tons)	109,902	57,777	530,003
Percent change 1975–76	+4.6	−2.7	−1.4

[1] Includes Consolidation Coal, Island Creek, Old Ben, Pittsburgh & Midway, Arch Mineral, Ashland Coal Co., and Hawley.
[2] Includes Pittston, North American, Westmoreland, Rochester & Pittsburgh, Jewell Coal & Coke, Blue Diamond Coal Carbon Fuel, Soveraign Coal, Baukol-Noonan, Sahara, and King Knob.
[3] United Mine Workers contract strike during year.

Source: "U.S. Coal Production, by Company," 1969–76, Keystone Coal Industry Manual, McGraw-Hill, Inc., New York; Minerals Yearbook, 1962–751 and weekly coal reports, U.S. Bureau of Mines, Department of the Interior.

F. Geographical Difference in Factors Affecting Coal Production

The three principal factors affecting production—decline in productivity, strikes, and slack demand—have contributed to the stagnation of the coal industry in the Eastern United States, the area most heavily affected by these three factors and the area where the coal companies acquired by oil and natural gas firms operate.

The *de novo* entrants into the coal industry (with the exception of Monterey) will be less affected by these factors because they are concentrated in the West.

G. New Energy Industry Entrants into Coal Industry

Oil companies which are entering the coal industry through the acquisition or lease of reserves and subsequent development through coal producing subsidiaries include:

Exxon	Kerr-McGee
Texaco	Mobil
Tenneco	Atlantic Richfield
Sunoco	Phillips
Shell	

Additionally, El Paso Natural Gas holds reserves and is currently negotiating for contracts which will enable development of these reserves.

Until 1976, the only oil company listed above to actually produce coal was Exxon (through Monterey Coal). In 1976, Sunoco began production at its Cordero mine in Wyoming with an initial production of 10,000 tons. The current status of coal development of the other companies appears to be as follows:

Mobile Oil Corporation.—expects to initiate a construction program within a year for part of its surface mineable lease near Gillette, Wyoming (subject to issuance of state and federal mining permits). Earlier development was impeded first by the *Sierra Club* v. *Kleppe* suit and then by lengthy environmental clearance procedures.

Tenneco.—holds lignite reserves for possible future activity in coal gasification.

ARCO (Atlantic Richfield).—holds western reserves and, according to the Bureau of Mines report "Projects to Expand Fuel Sources in Western States," is planning production of 9 to 12 million tons per year by 1985. Initial coal production is expected by November 1977. This production was anticipated earlier but was delayed by *Sierra Club* v. *Kleppe.*

Shell Oil Company.—entered the coal business through acquisition of reserves and plans production by 1980.

Texaco.—holds reserves which may be used for coal gasification. Texaco has developed a gasification technology which has already been demonstrated on equipment which can gasify 12 tons of coal per day. Texaco and three utilities have submitted a proposal for a gasification demonstration plant to be jointly funded by ERDA and private industry.

Kerr-McGee.—is now developing coal mines in Wyoming which are scheduled to begin production in 1979 and 1980.

Phillips.—acquired its reserves through its own exploration and acquisition efforts in heretofore undefined coal areas. Phillips, which holds lignite coal reserves, expects to be in production in the early 1980's.

El Paso Natural Gas.—is negotiating with electric utilities for the sale of coal for generation of electricity and is continuing its efforts to develop a coal gasification complex (currently in abeyance due to capital costs).

H. Capital Investment for Coal Production

1. There is considerable need for additional capital to *expand coal production.* The Federal Energy Administration estimates that, based on coal production in 1985 of 1 to 1.2 billion tons a year, the coal industry will need between $17.7 billion and $22.4 billion to expand coal production to meet projected needs.

2. *Oil and natural gas companies owning coal firms have invested large amounts of money in coal production.*—Data show that oil companies entering the coal business have and are investing large amounts of capital. For example, the five-year total capital expenditure of the four coal companies for which data were available and which are now owned by oil firms was:

$162.4 million before acquisition; and
$556.5 million after acquisition.

This is an increase of almost 243 percent or $394 million.

3. *If proposed horizontal divestiture legislation is enacted into public law, a large new source of capital for the coal industry would dry up and make expansion of production difficult.*—Proponents of horizontal divestiture have not considered the impact of such legislation on providing the capital needed by the coal industry. At a time when the coal industry is expected to nearly double production by 1985, horizontal divestiture would dry up a significant source of capital

infusion for the industry, thereby jeopardizing existing production capacity and making large-scale expansion of production much more difficult.

In order to meet 1985 production goals, the coal industry must commit itself to an aggressive program of capital expenditure. The industry must attract capital from outside sources. One source of outside capital is the oil industry which has a unique expertise in resource extraction, an understanding of resource management, and a willingness to invest in high-risk development. Horizontal divestiture will result in increased costs of attracting external capital to the coal industry and a lower debt capacity. This would probably lead to significant delays in increasing coal production.

I. Management talent for the coal industry

The declining demand for coal in the 1950's and early 1960's left a gap in the infusion of new management talent into the coal industry.— What appearerd to be a declining industry during the 1950's and 1960's was not attractive to new management talent and the financial condition of most of the industry did not permit coal companies to embark upon bold new programs. This has resulted in a gap in the management talent bank for the industry which must be filled primarily by attracting people—particularly with knowledge of energy— from other industries. Oil and natural gas industries have been a significant source of new, innovative talent for the coal industry.

J. Adequacy of Existing Antitrust Laws

Existing antitrust laws provide substantial authority for protection against anti-competitive behavior should it occur in the coal industry.— Both the Sherman and Clayton Antitrust Acts, along with the 1976 Hart-Scott-Rodino Amendments, provide the government with ample legal recourse to guarantee the competitive nature of the nation's economy.

K. Conclusion

Firms engaged in development or production of one energy source, such as oil or natural gas, should not be prevented by legislation from participating in the development or production of another energy source, such as coal.

The usual arguments for horizontal divestiture do not stand up under close scrutiny. Outside industry participation in the coal industry has not lessened competition within the industry. In fact, the coal industry is highly competitive in comparison to other industries. As illustrated in Table 1, (p. 3) the trend in the coal industry is toward reduced rather than greater concentration. The concentration of the coal industry reached a peak in 1970 and has been declining ever since. Moreover, ownership of coal reserves is widely distributed and it is unlikely that a firm or group of firms could gain monopolistic control of the coal industry through the domination of reserves.

Outside industry entry into the coal industry has enabled many coal companies to maintain production in the face of declining productivity, has enabled companies to withstand the extreme fluctuations for demand for coal, has enabled the industry to increase expenditures for research and development, and has made capital available for expansion. If a continuation of these and other contributions to the coal industry were prohibited through horizontal divestiture legislation, it is doubtful that the coal industry could retain its ability to expand rapidly enough to meet the national energy goals of the United States.

APPENDIX A

1976 COAL PRODUCTION BY COAL COMPANIES AFFLIATED WITH OIL AND GAS FIRMS [1]

Company	Production (thousand tons)	Percent total United States
Consolidation Coal Co.	55,888	8.4
Arch Mineral-Ashland Coal	[2] 18,000	2.7
Island Creek Coal Co.	17,606	2.6
Old Ben Coal Co.	9,715	1.5
Pittsburg & Midway Coal Co.	7,924	1.2
Monterey Coal Co.	2,780	.4
Hawley Fuel Corp.	769	.1
Subtotal, 8 oil affiliated companies	112,682	16.9
Valley Camp [3]	3,617	.5
Subtotal, 9 oil affiliated companies [4]	116,299	17.5
Eastern Associated Coal Corp.	7,959	1.2
Zeigler Coal Co.	5,176	.8
MAPCO	3,916	.6
Youghiogheny & Ohio Coal Co.	2,082	.3
Southern Utah Fuel Co.	1,043	.2
Total, Oil and gas affiliates [5]	136,475	20.5
Total U.S. production (priminary)	665,000	100.0

[1] "U.S. Coal Production by Company 1976", Keystone Coal Industry Manual, McGraw-Hill, Inc., New York.
[2] As reported by Ashland Oil Co.
[3] Acquired by Quaker State in 1976.
[4] Some analysts include Amax Coal Co. in this total. However, Amax's relationship with an oil firm is not the parent-subsidiary relationship as SoCal owns only 20.6 percent of Amax stock.
[5] Excludes some small companies affiliated with oil and gas interests for which data are not available. It is unlikely that total oil and gas affiliated production is seriously understated because of these exclusions.

APPENDIX B

RESERVES HELD BY OIL AND GAS FIRMS, 1976

Company	Reserves [1] (million tons)	Percent total, United States
Continental Oil (Consolidation)	13,700	6.3
Exxon (Monterey Coal-Carter Mining)	[2] 8,400	3.8
Occidental Petroleum (Island Creek)	[2] 3,574	1.6
Gulf Oil (Pittsburgh & Midway)	[2] 2,750	1.3
Mobile Oil	2,500	1.1
Sun Oil	2,200	1.0
Atlantic Richfield	2,200	1.0
Phillips	2,000	.9
Tenneco	1,700	.8
Texaco	1,650	.8
Kerr-McGee	1,500	.7
Shell Oil	1,460	.7
Sohio (Old Ben)	826	.4
Chevron	700	.3
Ashland Oil (Arch Mineral, Ashland Coal)	650	.3
Belco (Hawley Fuel)	524	.2
Quaker State (Valley Camp)	475	.2
McCulloch	50	
Total, oil companies	[2] 46,858	21.4

See footnote at end of table.

APPENDIX B

RESERVES HELD BY OIL AND GAS FIRMS, 1976—Continued

Company	Reserves[1] (million tons)	Percent total, United States
El Paso Natural Gas	5,200	2.4
Houston Natural Gas (Zeigler Coal)	1,000	.5
Eastern Gas & Fuel (Eastern Assoc. Coal)	1,058	.5
Panhandle-Eastern (Youghiogheny & Ohio)	500	.2
MAPCO	450	.2
Coastal States (Southern Utah Fuel)	[2] 35	
Total, oil and gas companies[4]	55,101	25.1
Total, United States	[5] 219,169	100.0

[1] The data reported for each company are not differentiated between recoverable or in-place reserves.
[2] Data as reported by company named.
[3] Some studies include Amax Coal Co. in this total. However, the relationship of Amax with an oil firm is not a parent-subsidiary relationship, as Standard Oil of California owns only 20.6 percent of Amax stock. If Amax were included in this figure, reserves held by oil firms in 1976 would total 51,898,000,000,000 tons or 23.7 percent of total.
[4] Excludes some reserves held by small oil and gas companies for which data are not available. It is unlikely that total oil and gas reserves are seriously understated by these exclusions.
[5] The "total demonstrated coal reserve base" defined by the U.S. Geological Survey and the Bureau of Mines as that portion of the identified resources deemed suitable for mining by current methods totals 438,300,000,000 tons. The Bureau points out that recoverability varies in a range from 40–90 percent according to the characteristics of the coal bed, the mining method, legal restraints, and the restrictions placed upon mining a deposit because of natural and man-made features. Mining experience in the United States has indicated that, on a national basis, at least one-half of the in-place coal can be recovered. Discounting the coal reserve base by 50 percent gives a total recoverable reserve of 219,200,000,000 tons.

PART THREE

Resolved: That the Federal Government should establish a comprehensive program to significantly reduce energy consumption in the United States

. . . [c]onservation is not simply an issue of waste versus non-waste; the boundary line between these two extremes is defined both by economics and by tastes and preferences. . . . —*Lee Schipper and Joel Darmstadter*

. . . [n]o fundamental scientific barriers exist to prevent substantial improvement in energy end-use effectiveness. . . .—*Thomas Widmer and Elias Gyftopoulos*

. . . [w]hen construction and station energy are considered as well, rapid rail ranks among the least energy-efficient of the conventional urban public transportation modes.—*from Urban Transportation and Energy: The Potential Savings of Different Modes*

. . . [t]he principles behind the President's plan . . . call for a reduction in the consumption of petroleum-generated energy . . . even assuming that urban rail transportation is more energy-intensive than highway-vehicle oriented transportation, rail transit can be powered by an energy source that does not use any petroleum. . . .—*Atlantic Metropolitan Rapid Transit Authority*

The portrait [the] experts paint of an energy-efficient society looks to be a far cry from the nontechnological Thoreauvian rusticity that the word "conservation" evokes. . . . Instead, it would be a tightly organized, capital-intensive society whose hallmark would be meticulous engineering.—*Tom Alexander*

Certainly, some social gains could be realised by successful adjustment to a steady-state society. . . . [but] . . . the kind of wisdom and will that is needed to move humanity away from its current obsession with forcing open the secrets of the universe, in a supreme bid for god-like power, just cannot be mustered within the institutions of the modern world.—*E. J. Mishan*

To those who insist that we can no longer tolerate economic growth, my response is simply that we cannot afford to do without it.—*Bayard Rustin*

A. The Economics of Conservation

THE LOGIC OF ENERGY CONSERVATION.

(By Lee Schipper and Joel Darmstadter)*

Energy conservation is rapidly replacing the weather as a popular and vexing topic that everybody talks about. Our ability to overcome the misunderstanding on the subject remains in doubt, for energy conservation extends far beyond the mere reduction of energy consumption. In at least some of its dimensions, energy conservation may be more far-reaching and complex than most people imagine. But, properly understood, conservation is good for us.

There are two fundamental ways to save energy: either society can use less energy per unit of any specific good or service it produces; or society can shift toward a less energy-intensive mix of goods and services. Of course, conservation is not the only factor that can prompt this shift: for example, advanced industrial economies tend toward less energy-demanding service industries.

MEASURING ENERGY CONSERVED

One complication in energy conservation is the actual measurement of energy consumption. The best unit we can use to measure energy inputs is the amount of primary resources in the economy (barrels of crude oil or tons of coal) required to produce a given product. Even if energy is conserved at an end-use or intermediary stage between production and consumption, it still should be discussed in terms of primary energy resources saved. For example, although a particular energy conservation measure may save only one unit of electricity, this indicates a savings of over three units of primary energy required to generate the electricity.

As conservation analysts, we also consider the nonenergy resource inputs, such as labor or capital, which frequently are affected by changes in energy use. Output parameters may include such overall values as Gross National Product (GNP) or "industrial value added" in a specific product line; or they may include more specific measures such as passenger-miles travelled or tons of steel produced. Energy conservation measurement thus uses a ratio of energy input per unit of output, such as energy consumed to GNP, or energy consumed per dollar of shipment in a particular industry, or energy use per passenger mile.

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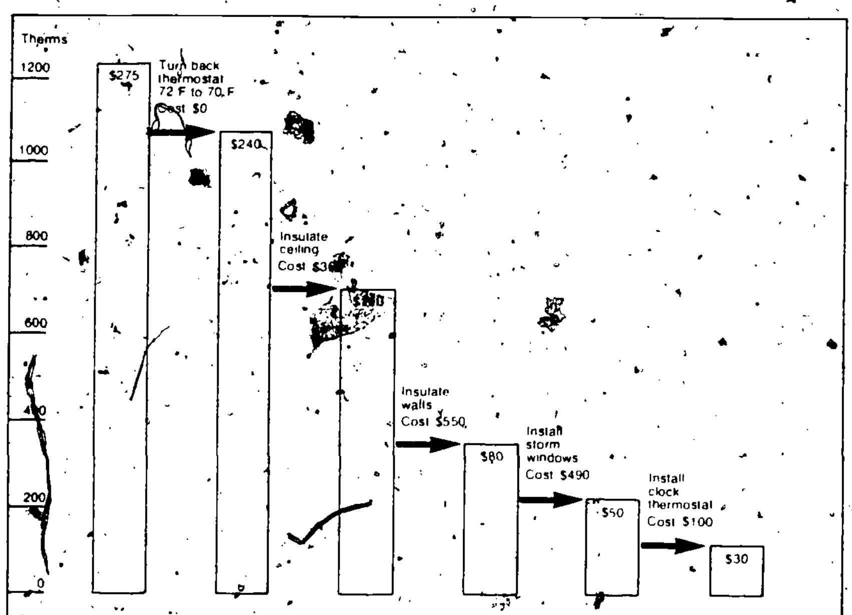
*From Technology Review, Vol. 80, No. 3, January 1978, p. 41–50. Technology Review is edited at the Massachusetts Institute of Technology. Copyright © 1978 by the Alumni Association of M.I.T. Lee Schipper, formerly an Energy Specialist with the Energy and Resources Group at the University of California, Berkeley, is now a researcher at the Lawrence Berkeley Laboratory. Joel Darmstadter is a Fellow with Resources for the Future in Washington, D.C.

In most cases, direct measures of energy intensity suffice when discussing a conservation strategy that will affect techniques of energy use in a product. However, if a conservation technique relies on resources that themselves are energy intensive (such as substituting an electric furnace for a blast furnace in steelmaking, or replacing iron and steel with plastics and aluminum in automobiles), indirect energy requirements should be included. Clearly, any changes in the consumption patterns of non-energy goods and services that alter the economy's energy requirements are complex, and must be considered on both a direct and an indirect energy-use basis. For example, the magazine you are holding represents consumption in many industries upstream from the printing press: this includes the trucking, the paper, and the chemical industries (for ink, chemicals for pulping, and chemicals for papermaking).

WASTE AND ECONOMICS

We must be careful how we measure energy conserved, for many times it is unclear what conserving or wasting really means in human terms. Homemakers insulating their homes at a cost below their fuel bill savings are certainly practicing energy conservation; but if they acquire larger homes in the Southwest or North that require more fuel to cool or heat for a given level of insulation, it is certainly improper to say that energy is being wasted. If, on the other hand, the newer homes require significantly less energy per square meter per degree-day, then we may label these homes "energy conserving." Thus, measuring energy conservation and waste requires more than mere before-and-after quantities of energy used. Knowledge of the intensities of energy use and the type of economic activity must be included.



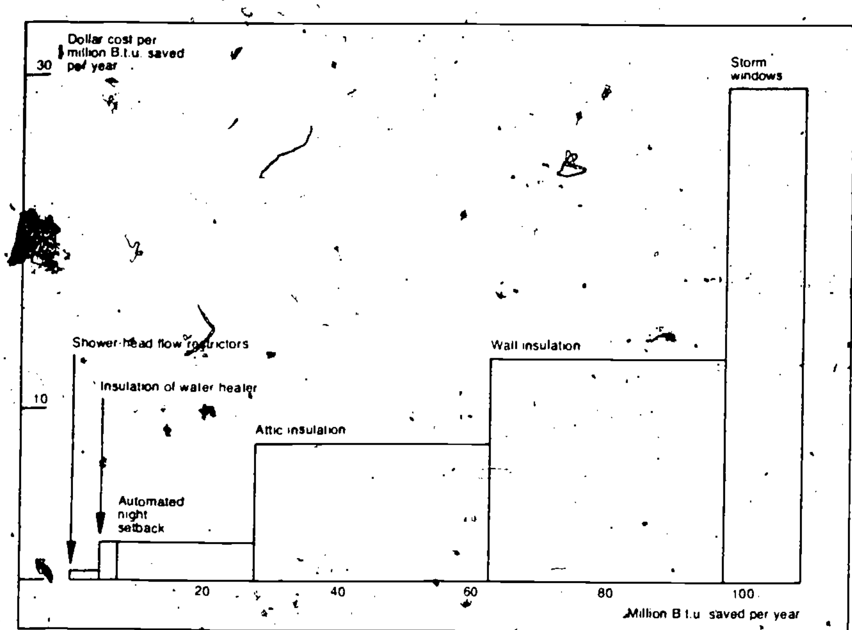
But intensity alone does not measure waste or efficiency. We doubt, for example, that trading a conventional refrigerator for a frost-free model is wasteful! The return for an unchanged level of cooling and the elimination of defrosting *is* higher electricity use, with subsequently higher bills. But such a choice is not an irrational response to a costly temptation to gadgetry. It is a trade-off of energy for time and drudgery. Similarly, substitution of automatic for manual transmissions in autos increases the energy required to operate the vehicle, but saves driver effort. Indeed, these illustrations themselves suggest that overuse or abuse of words like "sacrifice" or "Moral Equivalent of War" may blunt consumer interest in conservation.

Thus, we see that energy use alone is not a sufficient yardstick with which to measure optimality. One person's frivolity may be another's necessity; last year's indulgence, this year's need. While intensity is a physical measure, efficiency is an economic measure that requires measurement of all resource inputs.

In this light, each individual consumer should be allowed to divide up his or her energy needs (and other resource uses) into a spectrum ranging from the absolutely necessary to the absolutely unnecessary, and structure his or her life accordingly. Needs and wants, frivolities and necessities, depend on cost and perceived benefit. Denunciations of one sort of waste or another therefore should be viewed somewhat skeptically.

This leads us to the central principle which, in our opinion, should underlie any conservation policy or discussion: conservation involves changes in resource use or preferences that, in the eyes of the people conserving, maximize well being. Conservation is a means to greater welfare, not an end in itself. The most impelling factor in encouraging conservation action is the cost of not conserving.

Because of the welfare-enhancing characteristics of conservation, we question the curtailment of energy supplies (gasoline rationing, for example) as a conserving technique. Curtailment would be acceptable and appropriate if it were part of a planned emergency policy package, designed to effect rapid reduction in energy demand with minimal social and economic dislocation. Similarly, measures aimed at limiting economic growth in the interest of saving energy affect well being by restricting economic productivity by the misallocation of scarce resources. These measures may be considered appropriate by those who believe a moderation of economic growth to have virtue in its own right; they do not belong within the conservation framework.



Charts above: The annual space-heating costs for an average family living in the San Francisco Bay area could be decreased considerably through retrofitting with insulation, thermostat set-backs, etc. The predicted energy savings are shown in the first figure. Obviously the potential for savings is enormous in places like California, where most homes have little or no insulation. In the second figure, some of the same options are seen, with additional estimates on savings from hot water conservation in terms of gas conserved in a 1,400-square-foot uninsulated single-family dwelling. Here the vertical axis shows the investment cost per million B.t.u. saved per year; the horizontal axis gives the energy savings per year, and the area the total investment. If the cost of energy is known, then the straight-line rate of return can be read off as that cost divided by the investment cost of the particular option.

The dilemma for policymakers, of course, lies in the fact that a variety of factors serves to depress energy prices, and thus reduces the rate of return on conservation. Storm windows, which would be attractive in California if natural gas were made from coal (at $4.00 per million B.t.u.) or if only electric resistance heat were available, look like a poor investment for the majority of consumers who pay $2.00 per million B.t.u.—a price pushed downward by controls and other policies. If gas is so abundant as to render low prices appropriate, then we might not be concerned about "conserving" gas. But if, as many suspect, gas is more scarce than its price suggests, then most consumers will overconsume by underconserving and pass up opportunities to save that fuel. (The full documentation of "Two Zone," by Arthur Rosenfeld, et al., is found in Lawrence Berkeley Laboratory Report LBL5271.)

HOW TO CONSERVE ENERGY—AND HOW MUCH?

We have said that conservation, properly viewed, is actually the opposite of sacrifice, given rises in fuel prices or other conditions such as environmental decay. If we accept this attractive definition of conservation—and virtually every careful study of the subject (*see charts above*) points to the economic rewards—then what do we do to conserve?

Substitute other resource inputs for energy (insulation investment to reduce the energy needs for heating, for example);

Change our habits, preferences or operating procedures to reduce energy use (lower thermostats or increase maintenance of industrial boilers);

Change the mix of goods and services to demand less energy (take vacations in less distant spots.

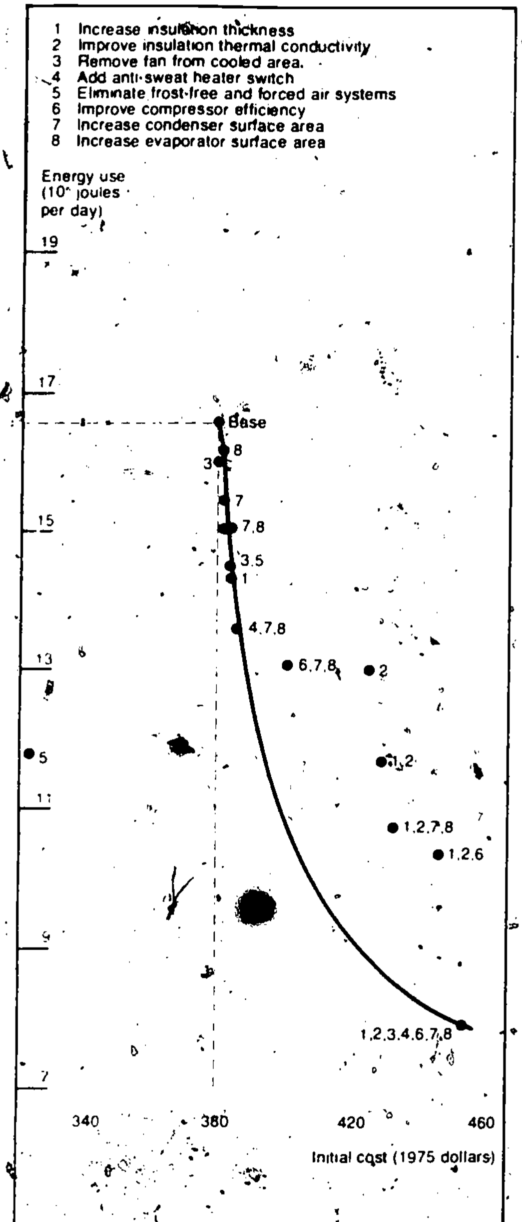
These three responses to concern about energy use should be the primary focus of conservation strategies. In strategies of the first type, studies indicate that in many important applications, most notably processs and space heating, conservation technologies can reduce the energy requirements per unit of activity by 30 to 80 per cent of today's use (*see illustration below*). Behavioral and preference changes might affect where we live, how far we travel, how many appliances we have, and what kinds of indoor environments we prefer, but it is generally acknowledged that innovative technical changes offer far greater savings in energy in the next 30 years.

While the literature (including back issues of *Technology Review*) abounds with technical prescriptions for saving B.t.u.s, economic guidelines about how much to conserve are another matter. We have emphasized that conservation is desirable whenever we can perform energy-related tasks more productively—for a smaller total resource input—taking the totality of costs into account.

Some energy conserving practices, such as lowering the thermostats at night, are essentially costless; that is, they involve no increased outlays for other resources and do not intrude significantly into living standards or behavior. However, many energy conserving options do involve significant substitutions or non-energy resources for energy. So both total resource-cost implications and energy implications must be considered in any conservation decision. For example, a steam-electric power plant produces more electricity per unit of fuel if the steam inlet temperature is increased, but requires in turn more expensive material. Is the fuel saved worth the extra capital cost?

The answer, of course, is to compare the cost of investments that save energy with the benefits of fuel savings. The price of fuel saved is central to this calculation. Indeed, Roger Sant, former Administrator for Conservation at the Federal Energy Administration, suggests that each conservation option be viewed as a source of energy, and that we compare the discounted unit value of energy saved with the cost of purchasing similar or alternative fuels. Since it costs less to produce a B.t.u. this way than to generate or produce one from any new energy source, the greatest motivation for conserving is the cost of not conserving.

Unfortunately, governmental regulatory policies such as oil and natural gas price controls, utility pricing practices, or subsidies to producers—which artificially depress price—keep the consumer from seeing or paying the marginal or replacement cost of producing the next unit of energy. This replacement cost is significantly higher than the prevailing average or historical cost. Consequently, each energy user's incentive to conserve energy falls below the economic optimum,



Improved technology can cut energy use—and the total cost of owning and operating a refrigerator—by conserving energy. An improved refrigerator merits some additional expense because it can cut energy use enormously. Moreover, the rate of return on such an investment, while dependent upon the price of electricity, almost always exceeds 25 per cent per year. In the above chart, daily energy use (or intensity) is plotted against the first cost of a 16 cubic ft. top-freezer refrigerator incorporating the given options. In this case the technologies are all available: some refrigerators incorporate them already. (Haskins and Hirst, Oak Ridge National Laboratory, 1977.)

which is set by the marginal cost. Worse, environmental costs often still are excluded from the balance sheet. Nevertheless, even with these problems, a given set of energy prices allow us to find out how much energy the economically rational user would conserve.

Bear in mind that short-term measures such as add-on investments in insulation and lowered thermostats affect energy use significantly, but by no means do they equal the impact of replacing inefficient equipment in the natural course of economic growth. New investment ushers in the most dramatic drop in energy intensities. Ironically, the faster the economy grows, the larger the opportunity for conservation, if one subscribes to this notion.

The fact that new capital equipment offers the largest and cheapest energy savings per unit of investment bears comment. First, while cars and appliances are discarded within years, structures and manufacturing equipment last for many decades. Those intent on seeing conservation bite deeply thus need to be patient: indeed, the ultimate potential conservation in buildings or industry alone over a 30-year period is greater than the total energy consumption for autos and appliances combined. Moreover, the speed of implementation depends on the economic rewards—the value of energy saved—as well as standards or implementation programs and incentives. But this also means that, while restricting the use of recreation vehicles or gaslights may be politically symbolic, these measures save little energy compared with imaginative technical approaches. For example, mass transit, while worthwhile for many non-energy concerns, may save neither energy in particular nor economic resources in general unless accompanied by regulatory incentives and/or the redesign of cities. Recall that today the tax system subsidizes purchase of single family dwellings in low-density surroundings. This may be good social policy, but it has been fatal to mass transit in many places. The energy "waste" symbolic of existing transportation arrangements and the presumed virtues of mass transit, while often mentioned in connection with conservation, therefore, should not be pushed too strongly by energy conservation advocates unless the broader aspects of those activities are also taken into account.

Evaluating the kind of conservation that substitutes non-energy resources and new technical practices for energy has become the specialty of a growing community of researchers. We think that the value or price of the energy to be saved is central to such an evaluation (see below). Nevertheless, we frequently encounter the notion that demand is not really sensitive to price. Certainly the demand for some amenities—driving, vacations, single family dwellings—may be relatively insensitive to energy prices. But the least costly ways of providing these and other energy-using amenities do depend on energy costs. Thus "how much to conserve" depends on consumer tastes as well as technology and pricing trends and policies.

THE PITFALLS OF AGGREGATE RATIOS

Although there have been numerous studies and much debate over the value of energy/GNP ratios in predicting demand, the aggregate nature of both the numerator and denominator in the ratio warn us to treat this number with extreme caution. Superficially, the ratio is a rough indication of how much energy it takes to sustain a given standard of living, insofar as GNP measures standards of living. The difficulties in evaluating and comparing GNP from a single country over time or among countries are well known. More important, the joint use of GNP and energy totals obscures economic and demographic factors.

For example, energy-use totals generally do not differentiate among particular kinds of energy, each of which have characteristic thermodynamic properties and prices. Also, the influence of climate is seen in the demand for fuel and for space conditioning, but is not reflected directly in the GNP, as is the geography and density of countries and regions. The energy embodied in products that make up the bill of import or export goods should also be kept in mind.

Unfortunately, single ratios relating energy to labor, capital, or output, especially in the aggregate, have become the popular vehicle for spirited but often uninformed analyses, ironically by both those who speak for the energy industry, such as *Energy, the Economy, and Jobs* by Winger and Nielsen of the Energy Group at the Chase Manhattan Bank, and by certain environmentalists, such as Barry Commoner in *The Poverty of Power*. Both these analysts attribute far more meaning to simple ratios than we would accept, given the subtleties of economic and political conditions that guide energy use, efficiency, and conservation.—*L.S., J.D.*

The Swedish experience, which we have studied extensively, reinforces the notion that energy price helps determine the choice of energy-using equipment. Faced with energy costs traditionally 25 to 100 per cent higher than in the U.S., Swedish factories opt for more efficient processes and practices in producing their extensive selection of energy-intensive goods. Swedish autos average 24 m.p.g., and Swedish single family dwellings use less fuel for heating than those of the same size in the U.S., in spite of a tremendous climatic difference.

A CONSERVATION PARADOX

The neglect of socio-economic factors can seriously hinder energy conservation policy. For example, district heating systems have been proclaimed by many as an excellent energy conserver, for they use waste heat from power plants or industrial processes to heat whole communities. But the Swedish experience with these systems has shown that the people using the systems can still waste energy. Apartments in Sweden which are heated by central systems are rarely metered on an individual basis, so there is no individual incentive to control temperature to save money. And the systems are not easily regulated, for usually there are no thermostats that measure indoor air temperature. Heat should be regulated by turning the radiators off or on. However, most Swedes have developed a more precise technique for controlling heat—opening the windows. As a result of these practices, the use of energy for heat in Swedish apartments is nearly as high per square meter as for single-family dwellings, even though in theory heat use should be considerably lower.—*L.S., J.D.*

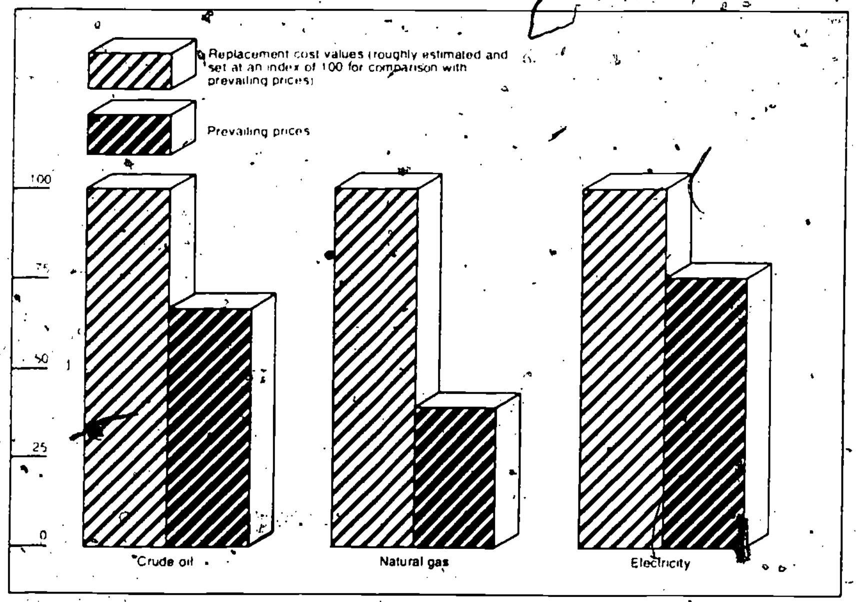
Yet Sweden is by no means an "ideal" energy consumer. This suggests that there is no definable limit to conservation, at least not until we approach both thermodynamic limits and the exhaustion of our ingenuity to modify and refine tasks. Conservation, depending as it does on the evolution of energy costs and technology, is not a one-time option, but rather a continual reevaluation of the mix of resource use that allows us to minimize the total cost of resources used to achieve an end. For this reason, conservation planners should look ahead and avoid taking measures that will foreclose even more beneficial practices in a future where energy prices and other resource costs will change. For example, restricting the area of windows to reduce heat losses would be foolish; that regulation might deprive builders or architects of the option of using large windows as passive solar heat collectors.

There is also the question of how consumers would handle conservation measures that reduce energy use and thus lower cost, but also change their perceived amenity levels. Some resource substitutions that lower the cost of a given amenity might stimulate users to seek greater levels of that amenity, bringing it back up to a previous level. For example, a well-insulated home might spur the homeowner to keep his thermoastat turned up, incurring the same heating costs as the homeowner with a lower thermostat in an uninsulated home.

Conversely, there may be consumers who, rather than blunting the impact of higher energy costs through substitution, are willing to accept less amenable conditions. These people would lower the thermostat rather than insulate. Researchers feel more secure dealing with the substitution case because it is susceptible to unambiguous cost-benefit calculations; but we should not discount the possibility of more elusive behavioral changes interacting with those that are economically deterministic.

Some consumers, given information, encouragement, and the incentive of more costly energy, may adapt their behavior to drive less than otherwise, heat less than otherwise, and use fewer applicances. Others will first investigate all the possible energy-conserving technical possibilities, such as insulation, energy-monitoring devices, and other options for existing or new homes and autos, before they adopt less energy-intensive habits. Predicting these two disparate responses is important to conservation policy research and development. Consumers do not easily relinquish amenities—many of which are energy-intensive activities or products that grew in importance as energy prices declined—related to comfort, convenience, and mobility. But this does not preclude the exploitation of attractive opportunities for technological energy conservation, which may be determined by energy prices and policies. Mobility is not curtailed while energy is conserved if, for example, automobiles are made of light aluminum rather than steel.

However, we must emphasize that only a few non-energy goods and services are energy-intensive (measured in B.t.u. consumed per dollar of final demand). Changes in energy prices will have only a small effect on the prices of most of the consumption decisions involving these activities. Energy is still the tail of the economic dog, and it seems reasonable to assume that other economic or social forces might be felt long before energy costs change the mix of goods and services consumed. Energy, notwithstanding its importance when suddenly unavailable, nevertheless accounts for only about 10 per cent of the total income we spend. Conservation, therefore, must not be oversold for its own sake, unless the value of conserving (whether easily expressed in an engineer's equation or understandable only as a contribution to national security or environmental well being) is made clear. Conservation does not justify expensive fixed-rail mass transit systems, whose energy conserving status is questionable. Energy use per mile is not the only criterion for "efficient" transportation. By the same token, such systems need not always fall back on energy conservation or on conventional profitability guidelines to be "sold"—other characteristics, such as reductions in pollution or congestion, may be of equal value.



Economic efficiency is best served when the price paid reflects what it would cost to replace or product one additional unit of the product in question. In the U.S., energy products continue to be priced on a basis far short of replacement values. As a result, demand has been higher than it might be, and a barrier has been created to investment in conservation.

Nevertheless, we believe that energy will be conserved primarily by technical means, although gradual changes in behavior and lifestyles will help as consumers find themselves as well or better off using less energy. We speak with certainty: the future will be somewhat different than the past. The cost of energy will probably rise toward the end of the century; innovation and common sense will allow us to respond to higher costs by saving that which is dear.

ENERGY AND GNP

When all the different energy uses are added together and compared with changes in the GNP, the two measures seem to be well correlated historically, with GNP growing slightly faster.

In general, the energy required to support a certain GNP is determined by both the make-up of the GNP and the intensity of energy use. Also, countries where (or eras during which) a relatively higher portion of energy is delivered to final demand (as in the U.S.) would tend to have a higher energy-to-GNP ratio than countries with similarly structured intermediate demands but lower demand for comfort heating and personal transportation. Energy delivered directly to final demand "produces" less GNP than the energy combined with other resources to produce the goods and services that make up most of the GNP. Even the relative shares of manufacturing and services need not predetermine the energy/GNP ratio. While it is widely held that services require less energy per unit of GNP than manufacturing, services are coupled to energy use via transportation and heating and cooling of buildings where services are made available. The amount of energy "required" to make a given service available depends on how far the purchaser must travel, and how the building involved is designed and run. Thus we caution that there are few firm rules that apply to understanding the relationship between energy and GNP. Energy and economic activity must be considered separately and in detail before any great conclusions can be drawn about the aggregate "efficiency" of energy use.

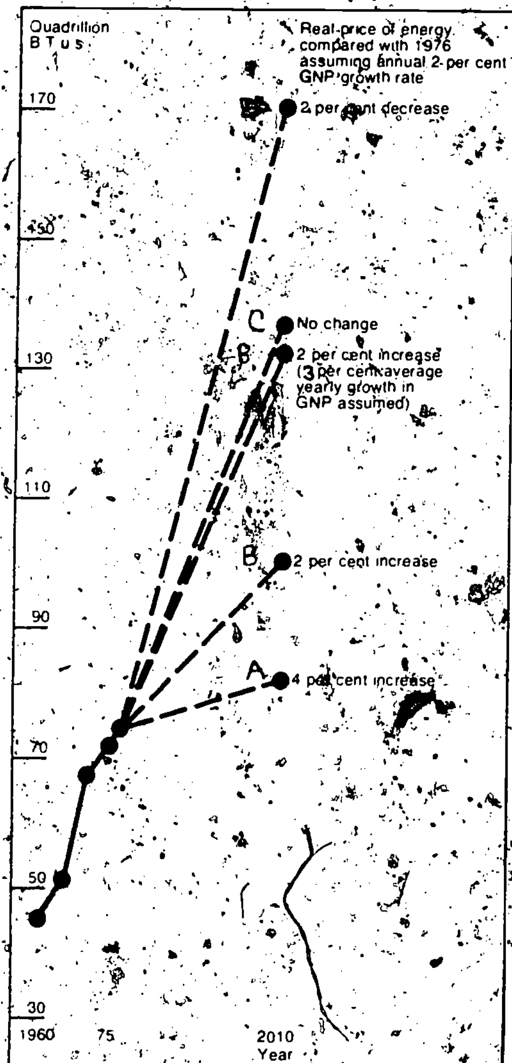
A recurrent theme of this essay has been that energy is but one of many resources that combine to produce goods and services. Simple aggregated ratios, such as energy/GNP or energy/worker, enjoy popularity in discussions of present and future energy needs. These ratios, however, omit two things; explicit consideration of structure, and substitution of resources. Most reliable information about energy use, needs, and conservation comes only from a detailed examination of the uses and factors that influence the uses of energy with other resources.

THE COST OF NOT CONSERVING

If we can overcome the temptation to correlate energy use and GNP, we will find that the future will be different from the past, if only because rising energy prices now make the cost of *not* conserving considerable. It costs more to produce energy today than to save it, at least in many of its uses. This increase in resource cost does mean a small loss in real income relative to lower cost energy, to be sure. But conservation minimizes this loss. The rate of return on most conservation investments often exceeds that of new energy supplies. Thus pushing conservation to the economic optimum stimulates an economy which had hitherto been operating below its capacity.

Looking through the range of forecasts, we find extrapolations that still foresee a near doubling of U.S. energy use and only a small drop in the energy/GNP ratio. Since the ratio has dropped anyway for the last 75 years, such forecasts incorporate little more than a prediction of what might happen if relative energy prices were to continue to fall. But more detailed, disaggregated forecasts seem to find plausible a level of energy "needs" in the year 2000 falling between 90 and 120 Quads (a Quad is 10^{15} B.t.u.) for a 70 to 100 percent increase in real GNP (*see chart below*). Of course, if energy use were inelastic with respect to price (that is, if no substitute resources or technologies existed), then energy use would keep much more in step with the GNP. Fortunately, virtually all evidence suggests that this need not be the case.

How much we "conserve" might be [illegible]ated by simply estimating how much energy would be used to supply a given quantity of goods and services in the year 2000 at today's intensities, and re[illegible]g the amount at tomorrow's (conserving) intensities. The di[illegible]e would



Neither U.S. economic history nor comparisons with other industrial countries point to a unique relationship between a nation's economic growth and its use of energy. One recent attempt to project U.S. energy-economy linkages over the next 30 years finds that, depending on the course of future energy prices and a corresponding pursuit of cost-effective conservation possibilities, a given rate of GNP growth might occur with a wide range of energy growth rates. Of course, one should not be dogmatic in such views, as the future contains many surprises. The hypothetical (and preliminary) forecasts were developed by the Demand/Conservation Panel, Committee on Nuclear and Alternative Energy Systems, National Academy of Sciences. Historical data from Bureau of Mines are plotted at 5-year benchmark intervals. All alternatives assume average yearly GNP growth rates of 2 percent except for variant B_1 at 3 percent. In all cases, assumed GNP rates are higher during early decades, lower toward end. Assumed yearly increases (or decreases) in real energy prices were: A, 4 percent; B and B_1, 2 percent; C, no change; D, minus 2 percent. Trends to 2010 are not assumed to be linear.

be attributable to conservation. Further, the likely mix of activities in the year 2000 will be intrinsically less energy-intensive, largely because we can drive only so much or heat so much space, two activities that in the past slowed the drop in the energy/GNP ratio considerably. All things considered, the amount of energy we conserve will depend on energy prices, technological development, lifestyle, tastes, policies and, of course, the rate of turnover of our capital stock. Again we emphasize that conservation, while unlikely to reduce the absolute amount of energy consumed, will slow the growth in that consumption, easing supply problems but not eliminating them all together.

Policymakers need a clear understanding of the effects of energy prices on a consumer's motivation to conserve. As we have said, prices may affect a homeowner's choice to insulate or to simply lower the thermostat. We should be wary of projections of future energy "needs" based only on historical data—or projections that ignore experience—if they do not reflect the future possibilities and motivations, both economic and otherwise, toward conservation.

Similarly, we must exercise caution when using highly aggregated statistics to project energy needs. The demand for goods and services produced with energy may decrease if energy costs rise. Estimating the energy impacts of any group of decisions will be extremely difficult because of the complexity of energy requirements of various mixes of activities. Even the often cited trend from manufacturing-oriented to service-oriented industries can, as we have indicated, be misread. Supposedly a service-oriented society would be energy conserving, but services include home upkeep, hotel stays, and gasoline, while manufactured goods include fishing gear, handheld calculators, and citizen's band radios, all with energy intensities considerably below the national average. Thus, we need to know which goods and which services the future will bring before prognostication about energy can be reliable.

CONFUSION IN WASHINGTON

Measuring energy conservation confused the Carter administration. In February, 1977, both Walter Mondale and John O'Leary (then head of the Federal Energy Administration) said that "sacrifices" such as installing home insulation—a rather profitable venture of questionable discomfort—would be called for. Thus the President, following constant advice from the media, hinted that we weren't doing enough; look at all those gas guzzlers, he admonished. Yet today's cars "guzzle" 25 per cent less gasoline per mile than those made in 1973, in spite of constant real gasoline prices after the initial price increases following oil embargo. Clearly, the President and the public have confused perceptions about conservation and its measure.

To eliminate this confusion, we can describe energy use by denoting the level of physical or economic activity in a particular sector as O_x, and the energy use per unit of output as I_x. The intensity (I) can be measured as the energy directly applied, or as the direct energy plus that emobdied in other resources also used but supplied upstream. In either case, the energy consumed in this activity E_x is given as:

$$E_x = O_x \times I_x.$$

This notation suggests that we consider the total consumption (E) as the product of two vectors O and I—representing, in effect, the entire economy.

Obviously, changes in either the O_x—the mix of activities—or I_x—the intensity of each activity—can affect the total E. Economic growth, for example, increases the absolute size of O. Smaller homes reduce the component of O related to space conditioning, while added insulation reduces the intensity of heating. Some measures, such as small cars, involve changes in both O and I; lifestyle or behavioral changes often fall on this boundary. During the post-war period for example, ownership and use of autos increased far faster than GNP, a factor that tended to push up the energy intensity of the whole economy. At the same time the manufacturing sector decreased in energy intensity. Obviously, sole consideration of total use or of oil imports would obscure the important dynamic changes in energy use or imports. I_{auto} has decreased dramatically since the embargo, while the distance traveled per capita by car has not increased at its historical rate. Given that gasoline prices have not increased in real terms after the initial spurt in early 1974, one would have to conclude that the U.S. is conserving energy in the important sector of auto transportation.

Moreover, as consumers and business people discover that there is profit in reducing energy intensities, they may be less interested in "moral war" and more interested in obtaining loans, grants, or at least competent advice covering profitable conservation investments. Great lifestyle changes (notably changes in the relative values of the O_X) may occur over longer periods of time in response to energy and other concerns. But talk of conservation must sort out the definitions of conservation and focus on the proper measure: what is being conserved. After all, confusing a sacrifice with a benefit is no small matter.—*L.S., J.D.*

Just as energy conservation is a response to a new energy price era, so significant substitution away from energy can dampen price pressures and permit a less convulsive development schedule for energy sources that now are technically, politically, financially or environmentally uncertain. And our early introduction of energy conservation measures will mean that the rate of usage of the new resources—which may or may not be environmentally benign—will, at any given time, always be lower in the future than if we had not begun to use energy more sparingly.

SOME ENDURING COMPLEXITIES

As we have said, energy conservation reflects the response of energy users to factors dominated by, though not necessarily limited to, prices and scarcity. Other interconnected issues include policies dictated by national security, environmental quality, and social impacts. Our understanding of the economics of substitution of non-energy resources for energy is improving; our knowledge about the speed of behavioral change or shifts in the mix of goods and services as a function of energy prices and policies remains far from perfect. In any case, we deem it important to delineate some of the principal forces that activate the conservation response, observing however, that the mere existence of these possibilities and a discussion of where rationality seems to lie does not guarantee implementation. (The social equity implications of higher energy prices that deter Congress from removing price controls illustrate one such issue, but this matter requires its own essay.)

From a physical standpoint, important tasks are performed with widely differing energy intensities, and we are far from thermodynamic limits. Our choices of how much energy to use depend on how the cost of energy and its substitutes interact with technology, lifestyle preferences, public policies, and institutional barriers to changes in energy-use patterns that could result in conservation. The historical record of both U.S. and foreign energy use shows considerable flexibility in energy needs—seen either from a technical (resource substitution) viewpoint or a behavioral/lifestyle viewpoint. Thus we can expect that conservation will play a great role in the energy future.

Keep in mind that conservation is not simply an issue of waste versus non-waste; the boundary line between these two extremes is defined both by economics and by tastes and preferences. In this light, however, it is nonetheless possible that growing worldwide energy consumption is raising consciousness among people in industrial nations over the moral implication of high—or low—energy consumption levels. While our economic definitions of energy conservation imply that economic considerations may be the most important criteria for determining the desirability of energy conservation strategies, we recognize the collateral importance of such difficult questions as waste, lifestyles, and growth itself in connection with energy conservation. But from the standpoint of clarity, these issues are best taken upon their own merit. If our discussion appears, therefore, to have imposed narrower bounds on the scope of energy conservation than some persons would prefer, meaningful payoffs—to energy users and to society—can still derive from soundly conceived conservation approaches within even a restricted framework. Perhaps the most pressing need for research today is to identify such payoffs—in their physical, economic, and social dimensions. We suspect that energy conservation offers the potential of large benefits to society. If that is so, conservation will play a decisive role in future demands for energy resources.

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THE IMPACT OF ENERGY CONSERVATION ON THE U.S. ECONOMY

(By Alvin Kaufman)*

INTRODUCTION

Energy conservation appears to be a concept whose time has come. Its implementation can reduce, but not eliminate, our need for additional energy. A reduction in our incremental energy requirements can reduce our vulnerability in foreign affairs and improve our balance of payments position. Conservation is also said to be less polluting and less expensive than energy derived from new sources. Despite these advantages, energy conservation has social, environmental, and economic costs as well as benefits. Whether the benefits outweigh the costs is dependent, in large measure, on one's definition and perception of conservation, as well as on one's scale of values. Energy conservation should not be looked at in isolation, but from a broader economic and social perspective, although this is difficult to do. The costs and benefits of reduced energy demand must be measured against the costs and benefits of other goals of society, such as enhanced economic opportunities, in order to arrive at the required trade-off between goals. The institution of energy conservation measures could mean a change in our way of living and our way of doing business. As a consequence, before embarking on a major conservation program, we had best understand the potential impacts of this regime. Among the possible trade-offs are the impacts on our economy, environment and national security. In this paper we will attempt to derive some measure of the economic impact of energy conservation on the U.S. economy. In doing so we will be dealing with only one small piece of the problem. A more complete evaluation of costs and benefits would have to consider effects on a large number of items such as foreign affairs, improvement in the balance of payments, environmental impacts, and so forth.

Energy conservation can be instituted as a little energy conservation, or a lot, or any degree in between. Therefore, depending on the impacts, the tradeoffs, and our value system, we can develop a conservation program to achieve the desired multiple goals.

CONSERVATION: CONCEPT AND DEFINITION

In any discussion of the economic impacts of energy conservation one finds a wide range of opinion somewhere between the sublime and the ridiculous. On the one hand, we are told that the great bulk of our

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energy is utilized for essential purposes and cannot be substantially reduced without harm to our economy and our standard of living. On the other hand, other people maintain that conservation is necessary if we are to sustain our standard of living, and maintain economic growth.

In large measure, these various perceptions of the economic impact of energy conservation are colored by the value system of the participants, the time frame within which they operate, and their expectations. This, in turn, determines the definition one uses for conservation; that in its turn, affects the kinds, diversity, and depth of impact that is perceived. For example, there are those who perceive conservation as necessary for human survival because resources are finite. To these people half of U.S. energy consumption is wasted.[1] One person's waste, however, may be another person's necessity. Some people may consider frost-free refrigerators and self-cleaning ovens as a waste of energy, but these items can save time and drudgery. In a society with a rising proportion of working women, they are worth the energy and the cost premium to a great many people.

In other cases the shift from the less energy efficient to the more energy efficient may, in the eyes of many people, be more trouble than it is worth. A move from the less energy efficient airplane to the more efficient train may not be attractive to many people due to the substantially increased time requirement for the use of the railroad, particularly to distant cities (six hours coast-to-coast by air versus some three to four days by rail). In short, in any discussion of conservation, it is important to make a distinction between the value judgments of social critics and the real costs that will be incurred by individuals and society.[2]

Given this propensity to assign impacts based on one's perception of the conservation concept, we should define the term before we proceed further. Webster's Dictionary defines conservation as careful preservation and protection, as well as the planned management of a natural resource to prevent exploitation, destruction or neglect.[3]

Preservation and protection implies, however, the postponement of consumption. This is not feasible, for we must consume energy to survive. Further, to produce and consume energy materials is to exploit and destroy, because once used these materials no longer exist in any energy form. So much for Webster.

In today's society there appear to be several major schools of thought as to what constitutes energy conservation. On the one hand, there is a group that appears to confuse the arbitrary measures to reduce energy use instituted during the 1973–74 embargo as conservation. These curtailment measures were instituted as a form of energy allocation, not as conservation measures.

To institute such measures over the long-term without a consensus of the population is to force one group's value judgment onto society,

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[1] Hayes, Denis. Energy: The Case for Conservation. World Watch Institute, Washington, 1976, p. 7.

[2] Darmstadter, Joel. Conserving Energy—Prospects and Opportunities in the New York Region. Resources for the Future, The Johns Hopkins University Press, Baltimore, 1975, pp. 98–101.

[3] Webster's New Collegiate Dictionary. G and C Merriam Company, Springfield, Massachusetts, 1973, p. 241.

as well as to distort the economy.[4] The latter would occur since only the saving of energy would guide the measures imposed. Hayes has noted that curtailment could mean giving up automobiles while conservation can mean trading in the 7 miles per gallon status symbol for 40 miles per gallon commuter vehicles. Curtailment means a cold house; conservation can mean the well insulated house with an efficient heating system.[5]

A somewhat allied school of thought would consider conservation as a substitution of other inputs for energy resulting in the reduction of uneconomical or wasteful uses of energy. This is a somewhat broader definition, and at least implies an effort to maintain total cost at a constant level.

Energy use is largely determined by the existing stock of equipment, housing structure, buildings and appliances, as well as by the kind of economy. It is used not for itself, but to produce work, heat, light, etc., that result in comfort and consumer goods of various types such as refrigerators. As a consequence, the introduction of conservation measures must be evolutionary rather than revolutionary if we are to avoid imposing substantial costs on society. For example, the production of more efficient washing machines can be encouraged through incentives, disincentives, or standards of one kind or another. The new appliances would be more energy efficient, but somewhat more costly.

The initial impact of the introduction of such devices on national energy demand would be minor. As older machines were replaced by more energy efficient units, the impact on energy use would be compounded and substantial improvement would be noted. If, on the other hand, current machines had to be retrofitted to improve energy efficiency, substantial costs would be imposed on the economy and on individuals, not to speak of the energy drain in order to manufacture all those new parts, as well as disposal of the old equipment.

Inasmuch as energy enters into the production of every item and the maintenance of life itself, it is important that disruption be kept to a minimum. We must keep in mind that energy use is simply a means to an end. A primary role of conservation can be to alleviate the effects of rising energy prices through the adoption of economically efficient measures that serve the entire society.[6]

Another school of thought would regard energy conservation as a means of reducing energy growth rates in a technically efficient manner by a system that will result in the money value of the energy saving exceeding the cost required to achieve that saving.[7] Such a definition, however, does not explicitly take account of the broader costs and

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[4] Such value judgments and economic distortions would be most unwelcome if the opinions discussed in FEA Conservation Paper 49 can be considered representative of a large segment of the U.S. population. (The Gallop Organization, Inc. Group Discussions Regarding Consumer Energy Conservation. March 26, 1976, pp. 46).

[5] Hayes, cited in footnote 1, p. 9.

[6] Lind, Robert and Robert Nathans. Benefit Cost Methodology for Evaluating Energy Conservation Programs. Science Applications, Inc., for the FEA, Dec. 1975.

[7] This is phrased in various ways by various authors. See particularly: (a) Ford Foundation Energy Policy Project. A Time to Choose: America's Energy Future. Ch. 6, Energy, Employment and Economic Growth. pp. 131–151, Ballinger Publishing Company, Cambridge, 1974. (b) Schipper, Lee. Energy Conservation: Its Nature, Hidden Benefits, and Hidden Barriers. Summer Workshop on Energy Conservation, Lawrence Berkeley Lab. June 1, 1975, UCID 3725, ERG2. (c) Seidel, Marquis R., The Economic Benefits of Energy Conservation. Presented at Energy Conservation: A National Forum. Fort Lauderdale, Florida, December 1–3, 1975, pp. 29.

benefits resulting from conservation actions. As a consequence of the pervasive nature of energy in the economy and the value judgments that must be made, a somewhat less restrictive definition seems desirable.

Herfindahl has stated that the goal of a conservation policy is to adjust output of a good over some time period in order to maximize the social return from all of the economic resources at the disposal of society.[8] Put another way, he is saying that conservation policy should be designed in a way that adjusts the trade-offs between competing interests so that the quality of life, over time, is improved, or at least sustained. To do so, may mean that conservation of a specific item will not always be a good thing. The conservation of one kind of resource may mean the sacrifice of some other resource that someone else may want to conserve. For example, conserving energy through use of more efficient air conditioners means larger heat exchangers and heavier compressors. These in their turn, will mean use of more metals than a less efficient air conditioner. Some may regard the conservation of the latter materials as of greater importance than saving energy. The costs and benefits must be weighed and a decision made. In such a weighing, the external costs and benefits imposed on others by the conservation action must also be considered. In those instances where the user does not, or cannot, take account of these external impositions, then regulation of the way in which the resource is used may be necessary.

Even in those instances where attention is paid to total social costs and benefits, the analysis may be deficient because the impact of the conservation action on the real income of particular individuals, regions or industries, may be of such magnitude as to make it socially undesirable to undertake that particular conservation activity. This again is a societal value judgment that will have to be made.

The foregoing discussion indicates that a desirable definition of energy conservation should, first of all, indicate a saving of energy, but, at the same time take account of the benefits and costs to society accruing from that action over a suitable time period. In short, conservation should strive for a tradeoff between the energy saving action and other societal wants so that the results will be an optimization of that intangible—the quality of life. To this end, we can define energy conservation as a series of energy saving procedures over the long-term that will optimize society's use of all its economic and social resources.

A possible method for determining such optimization may be through application of the concept of total productivity as put forth in 1961 by J. W. Kendrick in his book on productivity trends in the U.S. That is, if we are to achieve improved economic efficiency through better use of our energy resources then this use must not be obtained through such substantial declines in the productivity of other inputs that we end up less productive overall as a result of the conservation action. For example, if energy conservation results in improved capital productivity but decreased labor productivity then the gains from the

[8] Herfindahl, Orris G., What is Conservation? in Three Studies in Minerals Economics, Resources for the Future, 1961, pp. 1–12.

one versus the losses from the other must at least balance so that we are not worse off than before. If the productivity losses exceed the gains then we have lost economic efficiency, and we may well have a misallocation of resources as a result.

THE ECONOMIC IMPACT OF ENERGY CONSERVATION

Economic Impacts

The few studies prepared that deal with the economic impacts of conservation appear to agree that the institution of conservation measures will result in modest impacts on the economy, but will cause an increase in employment. The increased use of labor will be accompanied by a decrease in labor productivity, and presumably in a decline in average wages, according to these studies. None of the papers have estimated the impact on total productivity. It should be kept in mind that unless the lower labor productivity remains stable or improves, the impact could be inflationary, depending on what happens to aggregate demand.

The available literature anticipates that conservation will require large capital expenditures, but that these will be less than needed for supply expansion only. These studies also forecast that conservation will tend to keep the total cost of energy inputs constant, thus resulting in a reduction or stabilization in the cost of goods. The authors of these papers have generally assumed reduced wages, or, in some instances, implicitly assumed stable or improved total productivity. The anticipated decline in real price is presumed to cause an increase in discretionary income with a consequent rise in consumption and eventual economic growth.[9] This scenario may not be correct. Conservation may indeed maintain the aggregate cost of energy inputs at a stable level, but energy cost savings may be more than offset by capital and other costs incurred in implementing conservation measures. Further, the reduced labor productivity may not be fully offset by either the wage reduction, or increases in capital productivity. The presumption of reduced real price may prove to be illusory. The area of tradeoff between energy and other costs is somewhat murky.

The studies also appear to anticipate some structural changes within the economy due to shifts from skilled to unskilled jobs, but some savants see no serious impacts on any industry, State, or region. The structural shift appears predicated on the assumed movement from machinery to physical labor. It would appear more logical that more efficient machines would be substituted for those currently in use, rather than going back to more labor intensive activities. A shift to more

[9] The studies summarized above are as follows: (a) Hannon, Bruce. Energy Conservation and the Consumer. Science, July 11, 1975, Vol. 189, No. 4197, pages 95-102. (b) Lind, Robert C. Testimony before the Energy Subcommittee of the Joint Economic Committee. Congressional Record, pp. S3177–3179, March 10, 1976. Also a report by Lind and Nathans entitled *Benefit Cost Methodology for Evaluating Energy Conservation Programs.* Prepared for the FEA, Office of Conservation and Environment, referenced earlier. (c) Schipper, Lee. Energy Conservation: Its Nature, Hidden Benefits, and Hidden Barriers. Referenced earlier. (d) Seidel, Marquis R. The Economic Benefits of Energy Conservation. Referenced earlier, plus a series of other papers: The Regional Impacts of Industrial Fuel Use, September 1975, Office of Energy Systems, Federal Power Commission; Conservation Options for Energy Self Sufficiency, Presented before the Eastern Economic Association, Albany, New York, October 27, 1974; United States Energy Self Sufficiency, An Assessment of Technological Potential, Demand Curtailment, and Conservation Scenario, Office of Energy Conservation, FEO, January 7, 1974. 31 pages.

efficient machines would result in greater capital productivity and possibly higher labor productivity. A shift to unskilled labor would probably result in lower labor productivity which might not be offset by higher capital productivity. In any case, if our contention is correct, the result would be higher capital expenditures rather than a shift to less skilled workers.

In a study prepared for the Congressional Research Service,[10] Energy and Environmental Analysis, Inc., concluded that "a conserving economy will strengthen not only our welfare, but our national security by making us less dependent on foreign supplies subject to embargoes and overnight price gouging." The authors then went on to note that there would also be some sacrifices required including reduction of consumer choices, more planning and government intervention in the economy, and sacrifices involving our lifestyle. Examples of the latter would involve utilizing smaller cars, returning bottles to the grocery store and reducing the thermostat in winter. The report concluded that the trade-offs do not require a reduction in economic prosperity, the abolition of a free-market economy, unstable prices, or a reduced level of national economic performance.

A somewhat more limited study has been prepared by the Conference Board.[11] That paper only discusses the industrial situation rather than general economic effects.

The Conference Board indicates that the decline in energy-output ratio over the 1947–71 period was due to the introduction of new technology, plus a shift toward less energy intensive industries within manufacturing. The basic material industries are energy intensive, and these declined in relative importance during the period under review. It should be accented that energy savings per dollar of GNP occurred at a time when energy was becoming cheaper relative to other goods. For example, energy prices fell some 24 percent relative to the general price level in the economy. From 1970–73, however, energy rose more rapidly than general prices, and turned up even more rapidly after the Arab embargo.

The Conference Board paper notes that the Project Independence Report found that a 10 percent relative increase in energy prices will result in a 2.1 percent decrease in average industrial energy demand in the short run, with a potential 7 percent in the long run. The anticipated greater decline over the long run is due to the fact that energy is used with durable equipment which is replaced over time.

If the 1947 energy to GNP ratio (106,600 Btu per $ GNP) had held constant to 1973, instead of dropping to 90,000 Btu, energy consumption in 1973 would have been 18 percent above the actual total of 76 Quadrillion Btu (Q). Thus, the savings by industry are obvious. If the energy-GNP ratio declined at the 1947–73 rate of 0.6 percent while GNP grew at 3.5 percent annually, the energy growth rate from 1973–85 would average 3 percent per year. On the other hand, if the decline in the energy-GNP ratio was at the 1970–73 rate (which also happens to be the 1920–66 rate) of 1.2 percent per year, the energy

[10] Energy and Environmental Analysis Inc. The Implications of a Conserving Economy. Prepared for CRS, October 1974, page VII.

[11] Myers, John G. Energy Conservation and Economic Growth—Are They Incompatible? The Conference Board Record, February 1975, pages 27–32.

growth rate would be 2.3 percent. A 2 percent rate of decline in the energy-GNP ratio would drop the energy growth rate to 1.5 percent from 1973–85. (It would appear to this author to be more logical that the decline in energy-GNP radio would be at the long term rate of 1.2 percent over the next 15 years or so.) The Conference Board concluded that energy use and economic growth are certainly not independent of each other, but the link between them appears to be more elastic than previously assumed by a great many people.

Major Studies

Aside from the studies just summarized, two major analyses have been published. These tend to contradict some of the results of the above. The two major studies are those contained in the Ford Foundation Energy Project Study,[12] as well as a recently published paper by Hudson and Jorgenson.[13] The Ford sponsored study utilized two analytical approaches. In the first case, the study looked directly at the energy-economy connection by preparing a nine sector input-output model of the U.S. economy. This approach comprised the Hudson-Jorgenson model. It will be discussed in some detail below, and only the Energy Project conclusions drawn from the model will be summarized in this section.

The economic model developed for the Project by Data Resources, Inc. (Hudson-Jorgenson) indicates that a transition to slower energy growth can be accomplished without major economic cost or upheaval. The model indicated that it is economically efficient to cut the rate of energy growth at least in half over the next 25 years. The chief conclusion of the Ford study is that substantial savings are possible in U.S. energy input without significant change in the present structure of the economy, and without sacrificing continued growth of real income. The model indicates that in the year 2000, real income would be 4 percent less than would occur without conservation, but would be above current levels. It tends to corroborate other studies in that a less energy intensive economy would not reduce employment, but would, instead result in a slight increase in the demand for labor.

The Ford study also selected eight individual energy consuming activities, prepared projections of their normal growth, and from these projections computed the impact of applying available conservation technology. The results derived from this analytical technique was similar to those using the Hudson-Jorgenson model. The general conclusion seems to be that neither the economy nor employment will be seriously affected as a consequence of reduced energy growth rates. The Ford Foundation Energy Project Study concentrates on technically efficient changes in specific activities for the reduction of energy demand, but requires that these changes be economically attractive or cost effective. In other words, the cost of achieving a saving in energy must not exceed the money value of that saving.

The study concludes that energy, employment and economic growth are interdependent, but the degree of dependence can be changed. The

[12] Ford Foundation Energy Policy Project. Energy, Employment and Economic Growth. Chapter 6 in A Time to Choose: America's Energy Future, Ballinger Publishing Co., Cambridge, Mass., 1974, pp. 131–151.

[13] Hudson, Edward A. and Dale W. Jorgenson. U.S. Energy Policy and Economic Growth, 1975–2000. Bell Journal of Economics and Management Science, Volume 5, No. 2, 1974. Pages 461–514.

Ford report maintains that the slowdown in population growth indicates that economic growth may occur in less energy intensive sectors, in that an older and wealthier population will consume more services and high quality goods compared with current consumption patterns. The movement to a more service oriented economy could result in lower energy use, but this might be offset by growth of a leisure-time industry. That is, people might do more traveling for recreation, weekend ski trips, and to or from second homes.[14]

The Energy Project study further notes that the manufacturing sector of the U.S. economy realized significant energy savings in the past, even during periods of stable or declining relative prices of energy. This improvement, as measured by the decline in the energy output ratio for total U.S. manufacturing, was at the rate of approximately 1.6 percent per year. The energy output ratio is computed as the input of Btu's per constant dollar of value added. The Energy Project notes that a pre-embargo study indicates that a 2 percent rate of decline in this ratio was probable to 1980. Greater energy savings are now believed likely considering higher energy prices, the fear of future shortages, and possible government action.

The Hudson-Jorgenson Model.—The most comprehensive study of the impact of energy conservation on the economy presently available is that encompassed by the Hudson-Jorgenson model referenced earlier. The major points in that article have previously been summarized by the Congressional Research Service.[15] The model is comprised of two parts, a model of the U.S. economy and a submodel of the interaction of energy and non-energy industries in the U.S. economy.

Hudson-Jorgenson computed a base case assuming no change in U.S. or foreign government energy policy from 1974 onward. On this basis, the model calculated GNP growth at an average of 3.85 percent per year, in real terms, between 1975 and the year 2000; an inflation rate averaging 3.76 percent; and energy growth rates at 3.2 percent during the 1975–80 period, 3.3 percent in the 1980–85 era, and 2.9 percent between 1985–2000. The rate of growth of real GNP was expected to slow below the historic rate because of a decline in the rate of increase of the labor force in succeeding years. The computed energy rate was somewhat lower than historic rates because of increased fuel prices, interest in energy conservation, the changing structure of the economy, the replacement of existing capital equipment with more energy efficient capital and because of shifts in output toward less energy efficient forms. The base case indicates substantial increases in electric use, with electric prices declining 2.4 percent in the 1975–85 period in real terms, and 5 percent in the 1975–2000 period.

After computation of the base case, the model was used to evaluate the impact of a series of tax proposals on both energy and the economy. The tax proposals tested were uniform rates of tax levied on the energy content of fuels.

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[14] Schurr, S. H. and Joel Darmstadter. The Energy Connection. Resources, RFF. Fall 1976, p. 6.

[15] Hack, David E. The Hudson-Jorgenson Model of Energy Policy and Economic Growth: Analyses of Energy Policy Alternatives. Science Policy Research Division, CRS. TP 360, July 31, 1976.

Inasmuch as the Btu content of each fuel is different, the tax per physical unit varies by fuel. The testing was undertaken in two steps. In the first instance the impact of various rates of Btu tax on the economy by 1980 were determined. In the second case, an evaluation of the specific tax proposal required to eliminate all energy imports, with the exception of petroleum for fueling ships and aircraft abroad, was prepared.

The various tax rates tested in the first step ranged from a high of 50 cents per million Btu to a minimum of 10 cents (approximately $3 to $.60 per barrel equivalent). These calculations indicated a decline in energy use by 1980, relative to the base case, ranging between 8 percent to 1 percent (Table 1). The model indicates that the shift away from energy will mean a reduction in the use of capital and materials, as well as the adoption of more labor intensive production techniques in the manufacturing sector of the economy. For the entire economy, however, energy substitution will result in the use of more capital and labor.

For our purposes we have assumed the various tax levels as a proxy for energy conservation measures, and have translated the impact of the tax level into an equivalent energy growth rate as shown in Table 1. It will be noted that the decline in energy use results in a modest decline in GNP by 1980, and a modest increase in GNP price compared with the base case. The major impact of the Btu tax, however, is on energy prices. These would rise substantially compared with the base case, particularly in the case of coal, gas, and refined petroleum. Whether this would also be true if the reduced energy growth rates were achieved in some other way than through a tax is not known.

It should be noted that these shifts from the base case do not denote an actual decline from current levels, but rather a drop compared with what would have occurred if energy demand had continued to grow at the 3.2 percent per year figure anticipated in the base case. There is, of course, a possibility that the 1980 date may be too close as a planning horizon, so that all of the impacts have not quite worked through the economy by that date.

Hudson-Jorgenson also tested a tax which would start at 0 in 1975, rise to 50 cents per million Btu in 1980, and to $1.35 per million ($8 per barrel equivalent) in 1985. The $1.35 figure, according to the model, would virtually eliminate the need for imports, and would reduce energy use 16 percent compared with the base case. This constitutes a 40 percent increase in energy prices in order to eliminate imports by 1985. The result of that tax program is indicated in Table 2. The percentage figures, once again, are changes from the base case rather than actual declines in the various indicators. It should be noted that this tax program results in a modest drop in real consumption and real GNP by 1985 compared with what would have occurred in the base case. The price level, as measured both by consumption prices and GNP prices would increase.

The conclusion that can be drawn from the Hudson-Jorgenson study is that a decline in energy use need not be traumatic for the U.S. economy. The suitability of the model, and thus our ability to draw such a conclusion, is discussed below.

Some Comments on Models.—Economic modeling is a relatively young art. The effort to model the connection between the economy and the energy sector is of even more recent vintage, perhaps as much as 5 years. These efforts tend to be rather primitive.

Energy-economy models tend to fall into two broad classes: the econometric models and those that attempt to optimize. The latter have difficulty in simulating the often non-optimal, and perhaps irrational, behavior of the real world, while the econometric models have difficulty in grappling with technologic change.

The studies discussed above use standard methodology, and while a useful tool, are somewhat limited in policy analysis. Most of the comments presented below on the drawbacks of the Hudson-Jorgenson model apply with at least equal force to the other studies discussed above.

The development of the Hudson-Jorgenson model represents a breakthrough in the modeling effort to link the energy sector to the rest of the economy. This is the first effort to introduce the substitution of capital, labor, materials and energy for each other as a function of the price of each.

Despite this landmark effort, the H–J model, as currently constituted, has a limited usefulness for policy analysis. Khazzom has noted that the submodel dealing with the total economy is relatively small so that crucial assumptions have to be made regarding the allocation of investment, possible changes in productivity and the unemployment rate. These intuitive assumptions may then have an impact on the conclusions put forth by the model.[16]

In addition, the model was developed from historical data for the 1947–71 period. Considering the changes that have occurred since 1971, it may no longer be a reflection of the real world. This weakness is compounded by the manner in which the model is constructed. The input-output coefficients for a point in time are computed as a function of input prices. As a consequence, there is a built-in implicit assumption in regard to future technology in the sense that the weights derived for the 1947–71 period are presumed to also prevail in the future.

Further, a very small data sample was used to develop the input-output matrix. Information was only available for the years 1947, 1958, and 1963. The intervening years for the non-energy sectors were derived by interpolation, with the 1964–71 period assumed at the 1963 value. Thus, a rather small data base was used to erect a large edifice.

Another problem is the limited size of the input-output matrix. Only 9 sectors are covered; of these 5 are energy related, leaving 4 to cover the rest of the economy. This high degree of aggregation may mask major impacts and shifts between various industries.

As a consequence of the above difficulties, the H–J model still has a way to go. It is, however, a giant step forward in the development of models to test alternative energy policies.

There are currently underway, efforts to improve the H–J model by integrating it with the Brookhaven National Laboratory (BNL)

[16] Khazzoom, J. Daniel. A Discussion Paper of Hudson-Jorgenson's Model of U.S. Energy Policy and Economic Growth, 1975–2000. Proceedings of the Workshop on Modelling the Interrelationship Between the Energy Sector and The General Economy, Electric Power Research Institute Special Report 45, July 1976, pp. I–18 to I–32.

linear programming and input-output models.[17] This work, sponsored by ERDA, will be used in the analysis of alternative Government polies. At the moment, two types of policy variables are being analyzed. On the one hand, the impact of taxes and subsidies on energy production or consumption is being tested, while on the other hand the long-run effect of research and development expenditures on income, output, employment, capital and imports is being examined.

These efforts involve 4 models, 2 from Data Resources (DRI) and 2 from BNL. The DRI models include an economic growth model for long-run consumption and investment trends (along with the associated labor and capital requirements), together with an interindustry energy model for estimates of economic output and price structure as well as the energy-economy interaction.

BNL is providing an input-output model for estimates of energy uses and labor, capital and material requirements (actually by the University of Illinois), together with a linear programming allocation model. The latter estimates energy sector physical flows and the associated least cost energy mix.

In addition, the Electric Power Research Institute is sponsoring an Energy Modeling Forum (EMF) headquartered at Stanford University. The initial EMF project is an effort to study the link between the economy and energy through comparative tests of 6 computer models. The models being used include: Hudson-Jorgenson; Hnyilicza at MIT; Kennedy-Niemeyer at the University of Texas; Wharton Econometric; PILOT at Stanford; and the Brookhaven DRI effort.

A set of six scenarios with common assumptions have been designed. These will be run through the various models and results compared. To date, results are not yet available.

An Evaluation of Economic Impact

In an earlier section, we defined energy conservation as a series of energy saving procedures over the long-term that optimize society's use of all its economic and social resources. It follows that the overall economic effects of measures meeting this definition will be either non-existent or beneficial. In this context, it may be useful to review the possible impacts from the recently enacted series of energy conservation measures.

The Energy Policy and Conservation Act includes automobile efficiency standards, appliance labelling and efficiency improvement goals, voluntary industrial conservation and Federal-State conservation programs. The FEA estimates that these items can reduce energy demands the equivalent of 2.5 million barrels of petroleum per day, or approximately 5.3 Quadrillion Btu per year (Q), assuming a barrel contains 5.8 million Btu. The auto efficiency standards, currently set at 20 miles per gallon by 1980, 25 by 1985 and 28 by 1990 are believed to be the major conservation measure with estimated savings of 1 million barrels per day (2 Q) by 1985.[18]

The above savings are not cost free. The FEA estimates that in addition to the capital required for supply expansion, capital will be

[17] Behling, D. J. and Robert Dullien. A Combined Linear Programming and Econometric Systems Analysis of the Relation between Energy, Growth and the Economy, Brookhaven National Laboratory, BNL 21281. 1976.

[18] National Energy Outlook, February 1976, FEA, Washington, D.C., pp. 23–24 and 318–320.

needed for conservation. In arriving at these estimates, the assumption was made that any investment in conservation is not likely to be greater than the net present value of energy savings generated by that capital expenditure. This approach was used because it is not clear which part of the cost is conservation and which part is for other reasons, such as obsolescence. On this basis, and further assuming an average energy price of $3.75/million Btu in 1985 (1975 dollars), a discount rate of 8% and 40–80% of the energy savings requiring investment, FEA estimated conservation capital requirements as follows:

High	
Middle	
Low	

These requirements would be spread throughout the economy, and might substitute to some degree for capital for supply sources. If so, there would be a somewhat different mix of expenditures, possibly on the order of $460 billion for increased energy supplies, and $250 billion spread among insulation, automobile, and equipment manufacturers. The precise nature of this split is unclear.

In addition, the bill extending the life of the FEA (H.R. 12169, 94th Congress) provides for development of Federal energy conservation standards for new residential and commercial buildings, a $200 million grant program for weatherizing existing homes occupied by low income people, an energy conservation information program, a $2 billion loan guarantee program for public and commercial buildings, and a $200 million demonstration program to identify energy conservation incentives for home improvements.[19]

The FEA has estimated savings from thermal efficiency standards for new buildings at 300,000 barrels per day, and from an insulation tax credit at 100,000 barrels per day. These savings are estimated to accrue by 1985. It would thus appear that close to 3 million barrels per day, or 6 Quadrillion Btu annually, could be saved by 1985 through the various conservation measures stipulated by the Congress.

The bulk of the savings would accrue from improved auto efficiency, better building insulation, and more efficient appliances, with at least a third of the savings resulting from the auto efficiency improvements alone.

Considering the importance of the auto efficiency improvement we have elected to attempt to analyze the economic impacts that will flow from its implementation. To do so requires that we decide if auto efficiency fits our definition of conservation using total productivity impact as our guide. To this end we have constructed a possible, but certainly arguable, scenario.

We have assumed that the improved mileage will be attained by producing lighter weight cars rather than more efficient motors. This will be achieved through shrinkage of outside dimensions and greater use of lightweight materials such as plastics, aluminum, and lightweight steels. The shift to these somewhat more expensive materials coupled to the need to remodel plants to handle the new models, should result

[19] Ribicoff, A. The Congressional Record, August 5, 1976, p. S13554. See also, Conference Report, 94–1392, House of Representatives, 94th Congress, 2nd Session, August 4, 1976.

in a higher real cost per car in the short-run, but may result in lower costs over the long-run. The lower real long-run costs would occur as a consequence of generally lower materials costs because of smaller sized cars plus economies of scale resulting from completion of factory retooling plus fullscale output of the newer materials. It is assumed that if these costs were discounted over time, the present value of the benefits would be positive.

The lower long-term cost of the car plus reduced operating costs due to substantially improved miles per gallon of gasoline may have two impacts. On the one hand, disposable income should rise thus spurring consumption of other products with a resulting rise in [illegible]

GNP would rise in any case since there [illegible] demand from th[illegible]ctive industries, such [illegible] facturing. Man[illegible]uring activities gene[illegible] greater direct and indirect efforts throughout the economy compared with extractive industries. This would be offset somewhat by the effects of the expansion of aluminum and plastics production—both of which are based on extractive industries. The latter is heavily dependent on petroleum, while aluminum requires imported ores.

The move to the newer materials may cause economic dislocation in the shortrun. The move away from traditional iron and steel producers would not only cause some hardship to that industry, but to the regions in which the steel plants are located. This would be offset by expansion of the new industries in other locations.

On the other hand, the lower auto operating costs may stimulate more driving and a demand for more highways. The increased road building would have a detrimental effect on the environment. Other environmental effects should be positive. The lower use of materials to produce the cars plus reduced fuel consumption should be environmentally beneficial.

Increased driving, however, could result in increased accidents. Since small cars tend to be less safe than larger cars, accidents could be more severe, thus imposing larger social and economic costs than might otherwise be the case.

To sum up, the short-run effects in terms of capital and labor inputs, together with anticipated regional dislocation, are all negative. Over the longterm, however, GNP may increase while labor and materials inputs remain relatively stable. Capital inputs should rise, but on balance total productivity should not suffer. The improved efficiency of a major element of our economy such as the automobile should optimize the use of our economic and social resources. We can thus conclude that the economic impacts, over the long term, should be desirable.

SUMMARY AND CONCLUSIONS

Energy conservation is a concept whose time has come. Before embarking on such a voyage, however, we should have some idea of the potential impacts, as well as what we mean by the term conservation. There are various perceptions of what conservation is. Some see it as an ethical issue, a necessity for human survival. Others view it in a cost-benefit context. That is, in terms of energy-saving versus time, convenience, or whatever. The goal of conservation policy, according to some authors, is to adjust the output of a good over some time period in order to maximize the social return from all of the economic resources at the disposal of society. In short, conservation should strive for a trade-off between energy-saving actions and other societal wants in order to result in an optimization of that intangible, the quality of life. For the purposes of this paper, we can define conservation as a series of energy-saving procedures over the long term that will optimiz society's use of all its economic and social resources. The overall economic effects of measures meeting this definition will be either nonexistent or beneficial.

In an effort to determine whether a particular conservation measure meets the above definition, we suggest the use of the concept of total productivity. That is, improved energy productivity should not result in such serious declines in capital or labor productivity as to cause a drop in total productivity. Thus, if a measure that reduces energy demand also serves to improve economic and social efficiency, rather than serving as a punitive measure, the economic impacts should be acceptable, and perhaps desirable.

Several studies have been published on this subject. All agree that energy demand reducing measures will result in modest impacts on the overall economy, but will result in an increase in the need for labor. It may well be that such measures would result in an increase in capital inputs as a consequence of the replacement of equipment with more energy-efficient machines, at a higher capital cost, rather than with more labor-intensive activity.

The Ford Foundation Energy Project, one of the major studies, concluded that substantial savings in energy are possible in the U.S. economy without significant changes in the present structure of the economy, and without sacrificing the continued growth of real income. The Hudson-Jorgenson model used by that project was also subsequently used to test the economic impact of various tax levels imposed to induce energy saving. The various taxes tested had a modest negative impact on the U.S. economy, compared with a base case.

The H–J model also indicates that a reduction in energy input would mean a reduction in the use of capital and materials in manufacturing, and the adoption of more labor-intensive techniques, compared with the base case. For the overall economy, however, the model projects the use of more capital and labor. The H–J model, however, has problems with a limited data base, and the highly aggregated interindustry submodel.

This model, like all models, must be used with great care as a policy tool. As an alternative, we have prepared a review of the expected impacts from the major energy saving measure enacted by the Congress—auto efficiency standards. This review indicates the short run impacts may be negative, but over the long run GNP may increase. Total productivity should not suffer so that economic impacts, over the long term should be acceptable.

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TABLE 1.—IMPACT OF ENERGY GROWTH ON THE U.S. ECONOMY, 1980[1]

	Base case[2]	Energy growth rate: 2.9 percent	2.3 percent	1.6 percent
Tax rate (mBtu)	0	$0.10	$0.30	$0.50
Energy demand (QBtu)	90	89	86	83
Energy consumption (Q) (percent change from base):				
Coal	14.3	−0.47	−1.40	−2.33
Gas	26.9	−2.83	−7.80	−12.04
Petroleum	39.2	−1.83	−5.20	−8.26
Electric	8.9	−.42	−1.24	−2.06
Energy prices (dollar per mBtu):				
Coal	.68	+[illegible].68	+16.94	+28.33
Gas	1.44	+4.87	+14.62	+24.36
Petroleum	2.04	+4.57	+13.71	+22.85
Electric	7.50	+1.32	+3.96	+6.60
GNP		−.09	−.26	−.42
GNP prices		+.23	+.69	+1.07
Consumption		−.12	−.33	−.53
Investment		−.11	−.31	−.51

[1] Adapted from tables 16 (p. 502), 18 (p. 505), and 19 (p. 506) of the Hudson-Jorgenson article referenced in footnote 13 of the text.
[2] Energy growth rate equals 3.2 percent.

TABLE 2.—IMPACT OF AN ENERGY TAX, 1975–85[1]

	Year: 1975	1980	1985
Base case energy demand (QBtu)[2]	77	90	105
Tax rate (cents per mBtu)	0	50	135
Energy demand (Q)	77	83	88
Coal	13	14	16
Gas	25	24	22
Petroleum	34	36	36
Electric	7	9	11
Imports	16	9	1
		Percent change from the base case	
Real consumption		−0.53	−1.22
Consumption price		+1.34	+2.41
Real GNP		−.42	−.99
GNP price		+1.07	+2.04

[1] Adapted from table 21, p. 509, of the Hudson-Jorgenson article referenced in footnote 13 of the text.
[2] Assumes no energy tax.

ENERGY CONSERVATION AND A HEALTHY ECONOMY

(By Thomas F. Widmer and Elias P. Gyftopoulos)*

ENERGY CONSERVATION AND A HEALTHY ECONOMY

It is only too well known that we are exhausting our finite store of fuels at an alarming rate, especially the gaseous and liquid forms. It is also painfully clear that we are investing [illegible] more for new energy supplies and obtaining less and less for our money. International fuel prices have increased much faster than the prices of other commodities because of this scarcity of petroleum and natural gas and the high cost of new energy sources. Most indications are that this gap will keep widening for many decades to come. Fortunately, is is quite certain that we can re-optimize each energy-consuming task to achieve the same result at equal or lower cost, and use far less energy. In this paper we will show the firm technical and economic bases that underlie this seemingly bold assertion. We will show that there is an enormous opportunity for reduced energy consumption per unit of product in every sector of the economy; and if we do not take advantage of this opportunity, our economic well-being and security will be endangered.

Re-optimizing energy end-uses will, of course, require long-term commitments involving significant restructuring of all sectors of society. This restructing cannot happen automatically, because of many institutional barriers and many distortions of the free market system introducted by past decisions. But these barriers and distortions are not insurmountable. They can be largely eliminated if we attack them with a comprehensive energy policy, such as the accelerated conservation policy we propose.

TECHNICAL ROOM FOR CONSERVATION

The laws of thermodynamics give us a most convincing technical basis for estimating the possibilities for energy conservation. Specifically, the second law of thermodynamics affords a yardstick that is universally applicable to all fuels and all processes. The second law implies that energy has a "quality" about it and that this quality can only be degraded as energy is consumed to perform useful tasks. The "available work" in a system is a quantity that takes into account both the quality and the quantity of energy (*see "The Potential for Fuel Conservation" by Marc H. Ross and Robert H. Williams, February, 1977, pages 48–57*). This "available work" concept has been used in

*From Technology Review, June 1977, p. 31–40. © 1977 by the Alumni Association of the Massachusetts Institute of Technology. Thomas Widmer is Vice President of Engineering for Thermo Electron Corporation in Waltham, Massachusetts, Elias Gyftopoulos is Ford Professor of Engineering at M.I.T. Reprinted by permission.

several studies to measure the efficiencies of various energy-using processes in our society, as a function of the task to be performed, rather than the particular device used to perform that task. Some of the efficiencies estimated in these studies are:

—Residential and commercial space heating: 6 per cent,
—Residential and commercial water heating: 3 per cent,
—Air conditioning and refrigeration: 5 per cent,
—Automobile propulsion: 10 per cent,
—Steel production: 21 per cent,
—Petroleum refining: 9 per cent,
—Cement man[illegible] 10 [illegible]
[illegible]

The total amount of fuel used in these applications is about 60 per cent of all U.S. energy consumption. The average efficiency of utilization, obtained by weighting each efficiency by the amount of fuel used for the purpose, is only 8.3 per cent. Moreover, the figure of about 8 per cent is believed to be fairly representative of the overall energy effectiveness throughout the economy. The 10 per cent efficiency given for automobiles actually overstates their performance considerably, since this calculation takes into account only the efficiency of converting fuel energy to tractive effort at the driving wheels. It is extremely difficult to specify auto efficiencies precisely because of various non-technical factors affecting the vehicle design, such as add-on hardware to enhance convenience, safety, comfort, etc.

We're not suggesting that energy efficiency will ever approach 100 per cent for real devices or processes, even in the remote future. We wish to emphasize, however, that the present low values of efficiencies indicate the enormous opportunity for energy savings and that no fundamental scientific barriers exist to prevent substantial improvements in energy end-use effectiveness. Even a modest improvement, for example from 8.3 to 9.3 per cent efficiency, represents a saving of almost 10 "Quads" per year at the 1975 consumption level (where a Quad equals 10^{15} Btu's). This is the energy equivalent of 4.6 million barrels of petroleum per day.

Some analyses mistakenly associate large energy savings with reduced economic activity. In 1972, for example, an analysis for the Chase Manhattan Bank stated almost fatalistically that "analysis of the uses of energy reveals little scope for major saving. The great bulk of the energy is utilized for essential purposes, . . . Conceivably, the use of energy for such recreational purposes as vacation travel and the viewing of television might be reduced—but not without widespread economic and political repercussions. There are some minor uses of energy that could be regarded as strictly nonessential—but their elimination would not permit any significant saving."

More correctly, a report by the Energy and Environment Division of the Lawrence Berkeley Laboratories answered that "more informed studies of energy use contradict this analysis. Especially misleading is the subjective phrase *essential purposes*, which obscures the whole question of efficiency. Careful analysis of energy use has revealed an enormous potential for energy conservation. The most recent forecasts from the Energy Research and Development Administration suggest that U.S. energy needs in the 1990s could be 20 to 40 per cent below what was previously expected, as higher energy prices and new end-use technologies help Americans squeeze more economic and personal well-being from every Btu."

The process known as cogeneration offers an impressive example of the energy savings obtainable using [illegible] [illegible] process [illegible] for conservation because steam for industrial processes is produced at relatively low pressure and temperature and, hence, does not make good use of the high-temperature heat available from fuel combustion. The common practice of producing low-pressure process steam in a fuel-fired boiler is therefore thermodynamically inefficient. The practice can be made much more effective by first producing high-pressure steam in a boiler, then expanding this steam through a turbine to generate electricity and then exhausting the steam at the appropriate pressure level needed for the desired process.

The electricity thus produced is obtained at an additional fuel consumption rate less than half that achieved by the most efficient central station power plant. Since over 40 percent of industrial energy—or about 16 percent of all the nation's energy—is used in the form of process steam, the potential savings are enormous. In West Germany, cogeneration accounts for over 18 percent of electrical needs, compared to only about 5 percent in the U.S. A recent study by Thermo Electron Corp. for the Federal Energy Administration revealed that in just three industries—papermaking, chemicals, and petroleum refining—there exists the opportunity to produce over 34 percent of all the nation's electricity by means of cogeneration and waste heat recovery.

While long-term dramatic improvements in end-use efficiencies can probably be made throughout the economy there will be a significant capital cost involved, unlike the case with many of the simple measures already implemented in response to rising energy prices. Such conservation actions, involving the trade-off of energy cost savings against initial capital costs, deserve the most careful attention in formulating a new U.S. energy policy.

SKYROCKETING SUPPLY COSTS

To understand just how economically sound conservation measures really are, we can compare capital requirements for various supply and conservation measures.

On the supply side, diminishing fossil fuel resources have necessitated the investment of enormous amounts of capital per unit of energy production capacity. True, Middle East reserves are still readily accessible. However, most new petroleum or natural gas production areas—such as the U.S. outer continental shelf, North Sea, Alaska, etc.—require anywhere from $10,000 to $15,000 for each barrel per day of equivalent fuel energy provided. This translates into a capital demand of about $4.5 to $6.8 billion for every Quad per year of energy delivered. Synthetic gas and oil obtained from coal will be even more capital intensive, probably requiring more than $10 billion per annual Quad.

New coal supplies are still ob[illegible] a capital c[illegible] [illegible]2.0 billion per annual Qua[illegible] [illegible]r, coal mining [illegible] combustion produce serious environmental and safety problems [illegible] may ultimately limit the rate of coal consumption, or at least cause increases in the cost of supply. Moreover, coal cannot be as flexibly used as oil and gas. The industrial sector could undoubtedly substitute more coal to produce steam, for example, but increasing our reliance upon coal will depend mainly upon its greater use by electric utilities or the development of economical gasification methods.

Electricity as a form of energy requires a much higher capital investment. For every Quad per year of delivered electricity, the capital investment in facilities for fuel supply, generation, transmission, and distribution will range from $45 billion for coal-based systems to about 1.5 times as much for nuclear generation. We cannot directly compare electricity costs with those for coal and petroleum fuel resources, because electricity has far greater flexibility of usage than does raw fuel. Even so, the capital cost of coal-based electricity is about $15 billion per annual Quad of coal converted to electricity, or more than eight times the capital cost of raw coal supply, itself.

Despite its high capital cost, electricity occupies a unique and vital place in the spectrum of energy forms. Many tasks exist that can be performed only by energy of the highest thermodynamic grade, such as electricity. So electricity is an essential part of a balanced energy supply system. Electricity should be recognized, however, as having both special properties and high capital intensity, and therefore should not be used as a convenience fuel, as for home heating.

The enormous and growing capital required to develop new energy supplies could injure the entire economy. According to even highly optimistic projections of economic growth and capital formation, the U.S. economy is unlikely to produce more than $2.7 trillion for all purposes over the next decade. Assuming that the long-standing ratio between business and residential investments prevails, about $1.8 trillion will be available for all business investments for both new capacity and replacement purposes. A New York Stock Exchange report estimated that, of that capital, the energy supply industry would require more than $800 billion.

It is an alarming prospect that we might have to allocate almost half of all business capital to energy supply investments alone. In the recent past, the energy industry has consumed only about one-fourth of total U.S. business capital, and even this fraction had created growing stresses in the capital markets. Unless this trend is reversed, we will soon be devoting so much of our scarce capital resources to energy production that other business needs will suffer a severe lack of investment funds.

A BARGAIN IN CONSERVATION

In contrast to the rising expenditures needed to develop diminishing fuel reserves, conservation can be put to effective use with substantially smaller capital commitments.

For example, for only a modest investment we could reap large improvements in the energy efficiency of the common window air conditioner. Data published by the Federal Council on Science and

Technology showed that three commercially available room air conditioners with exactly the same 5,000-Btu-per-hour cooling capacity had the following initial costs and energy consumptions:

—$120 for a 4.58 Btu/watt-hour unit;
—$140 for a 5.80 Btu/watt-hour unit;
—$165 for a 8.70 Btu/watt-hour unit.

As you can see, by investing only $45 in additional first cost—38 per cent more—one can obtain an efficiency improvement of 89 per cent.

Since the air conditioner is likely to be used only 500 hours per year, or about 6 per cent of the time, the energy saving will be 258 kilowatt-hours per year. However, its usage is likely to coincide with the period of highest summer electrical demand. Hence, the $45 increment for conservation can be viewed as a direct substitution for more than one-half kilowatt of expensive utility system peak generation and distribution capacity, having a value of at least $200.

Unfortunately, user benefits do not reflect the same degree of advantage indicated by the capital cost comparison. In fact, the consumer would save only about $18 per year for 500 hours of use, yielding a gross payback of about four years. Even this moderately attractive return can be illusory when the ultimate consumer does not participate in the initial purchase decision, for instance if he lives in a rental apartment or housing equipped by the builder rather than by the owner.

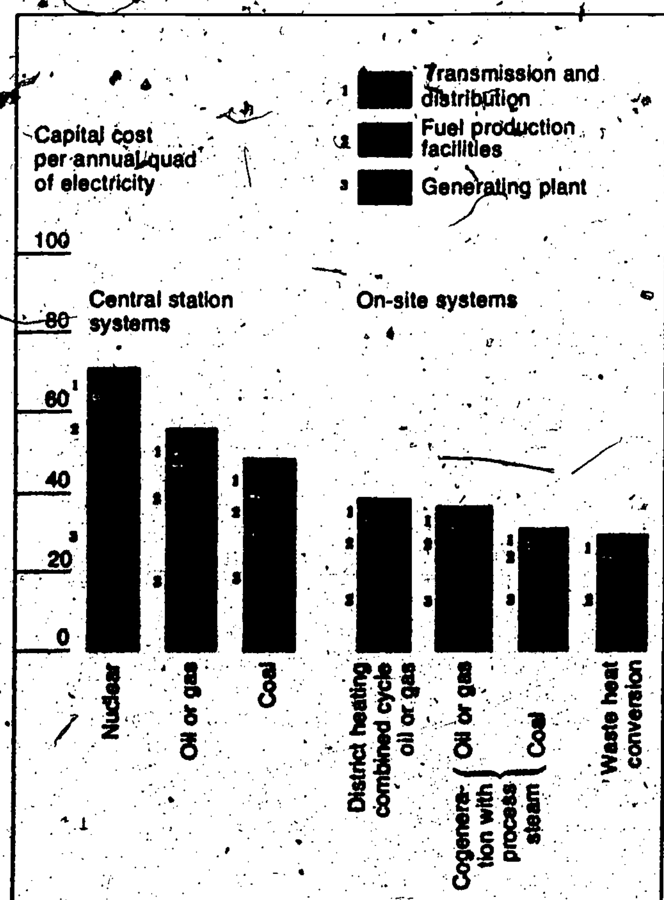
Another example of high return on conservation investment is the case of waste heat recuperators. Recuperators can provide fuel savings of at least 25 per cent on most high-temperature furnaces used for controlled-atmosphere metal processing. The cost of such recuperators is about $1,300 for each combustion burner on a radiant tube furnace, with fuel savings amounting to about 125,000 Btu per hour per recuperator. Under normal plant operating schedules, this represents capital cost investment of $1.5 billion per annual Quad of fuel saved, compared to the $6 billion per annual Quad cost of new domestic gas supply.

With the recent sharp rise in industrial gas prices, the payback period for recuperators has shortened to about three to four years, a range that is still only marginally attractive to most industrial firms whose capital budgets can barely cover essential or "main-stream" business investment needs.

The generation of electricity from waste heat also represents an excellent investment opportunity. A recent engineering study conducted for a major cement manufacturer revealed the opportunity for producing 4,700 kilowatts of electricity by capturing waste heat from the exhaust of the company's cement kilns using a steam-electric bottoming cycle system. The cost of the system was $2.7 million.

If that 4,700 kilowatts were to come half from a new coal plant and half from a new nuclear plant a capital investment of more than $7 million would be required for fuel supply facilities, generating apparatus, and transmission and distribution equipment. In terms of energy capital effectiveness, the waste heat recovery system costs less than $25 billion per annual Quad of electricity, or less than half that of the average investment required for new coal and nuclear utility capacity.

It is noteworthy that in this particular case the conservation equipment was not installed, and the cement plant continues to purchase its electricity at 2.5 cents per kilowatt-hour. Allowing for operation and maintenance of the steam-electric bottoming cycle, the savings would have been $775,000 per year, i.e., the energy conservation investment would be recovered in about 3.5 years. Since this payback did not meet the company's requirements for discretionary investments, the proposal was rejected. As a result, the failure to implement this one conservation measure in one cement plant causes a continuing loss to the nation of 180 barrels per day equivalent petroleum. In general, capital investments for on-site generation of electricity by various schemes are smaller than those for central power stations, as shown in the chart below.



These few examples have only scratched the surface of conservation investment possibilities for industry. We have identified numerous examples of energy conservation investments in the steel, aluminum, oil refining, paper, chemical and other industries that significantly outperform corresponding investments in new energy supplies. In other sectors of the economy cost effective opportunities might include:

Substitution of diesel engines for gasoline engines in light trucks, which would require less capital per unit of fuel saved than does new petroleum supply capacity.

Weight reduction in automobiles through material substitution, which can actually decrease total capital cost.

Reducing passenger space is also cost-effective, but this type of energy conservation involves changing life-style and consumer tastes rather than improving technical efficiency, which is the focus of this discussion. It is important to clarify the distinction between these two different kinds of conservation, and to dispel the popular misconception that conservation is equivalent to belt-tightening. Such actions, usually taken in response to immediate crises, tend to obscure the real and lasting benefits of conservation through improved end-use effectiveness.

SOME BARRIERS TO CONSERVATION

Because of their economic attractiveness, one might expect capital investments in conservation to proceed at a faster rate in the industrial than in the residential or other sectors of the economy. After all, in industry energy users are likely to have a greater awareness of first-cost versus operating-cost tradeoffs. However, industry has not significantly outpaced other sectors in improving its energy efficiency. Where industrial conservation investments have been made, the decision has often been influenced by factors other than simple economics; for example, the threat of outright curtailment of production due to fuel interruption.

We've identified several reasons behind industry's reluctance to invest in energy-efficient equipment:

Most energy-user companies must maintain conservative debt-to-equity ratios because of uncertainty about the future availability and cost of financing. Conservation investments, therefore, do not usually command high priority in the competition for limited capital funds. These funds must first be reserved for essential mainstream business purposes, such as tooling new products and expansion of capacity to meet market conditions.

Criteria for investment payback are more stringent for manufacturing companies than for regulated utilities whose risks are lower.

The pricing of industrial electricity and fuel is largely based on average, rather than incremental costs of supply.

These factors tend to create a major distortion in the deployment of scarce capital resources to achieve the optimum balance between investments in new energy supply and in energy conservation.

A PLAN FOR ACCELERATED ENERGY CONSERVATION

A new government policy stressing energy conservation could produce major changes in our energy usage patterns in a relatively short time and without impairing economic expansion. By comparing energy demand estimates, with and without an accelerated conservation approach, one can really see the important differences that might be anticipated during the next decade.

For our scenario of life *without* accelerated conservation, let us examine a 1975 report by the Federal Energy Administration (F.E.A.) entitled, "National Energy Outlook." In its ten-year forecast for U.S. energy production and usage the F.E.A. predicted that higher energy prices alone could cut 1985 consumption from an unconstrained demand level of 123 Quads to about 107 Quads. Demand would be restricted further, to about 101 Quads, by some additional conservation measures which were not specified.

Under the F.E.A. plan, electrification was to increase from 1.93 trillion (24 percent of all 1975 energy input) to 3.35 trillion kilowatt-hours (more than 34 percent in 1985). Thus, with the real G.N.P. expanding at about 3 percent per year (34 percent over the decade), total energy was to grow by 2.8 percent per year and electricity by 5.5 percent per year. The plan was expected to produce almost no change in the distribution of energy by the end-use sectors relative to the pattern existing in 1975: residential and commercial would still comprise 37 percent of consumption; transportation, 24 percent; and industry, 39 percent.

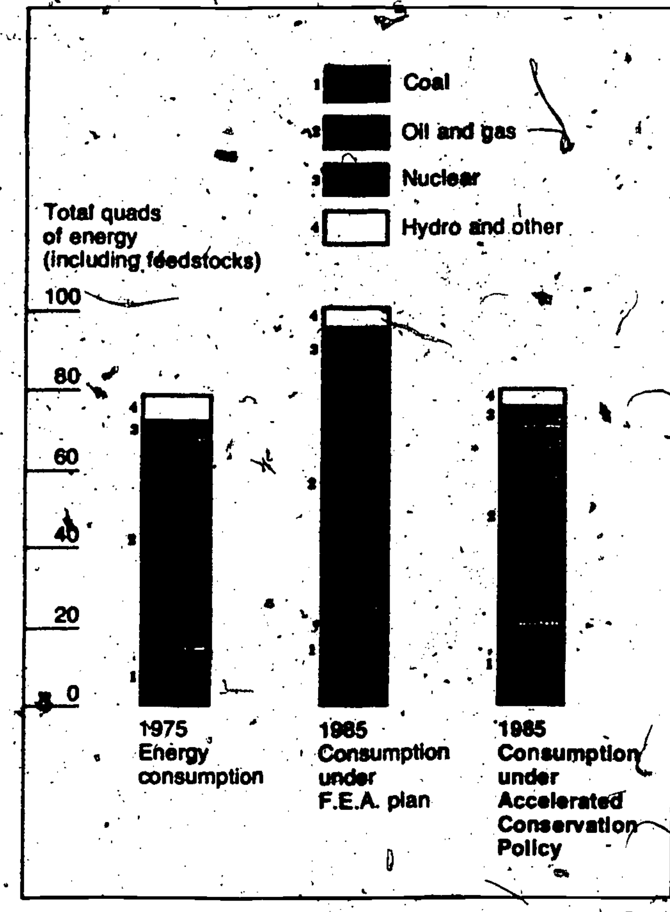
The F.E.A. projected a shift in energy resources, with coal rising from 18 per cent in 1975 to 22 per cent in 1985, nuclear energy rising from 3 per cent to almost 10 per cent (accounting for over one-fourth of electricity generation), and oil and gas declining from 74 per cent to 63 per cent (the major reduction occurring in electric utility consumption of these fuels).

To provide a framework for evaluating these forecasts we have devised an alternative plan which stresses conservation measures. Based upon the same growth in real G.N.P. as assumed in the F.E.A. plan—approximately 3 per cent per year—the alternative approach postulates no substantial social changes or curtailment of living standards. This "Accelerated Conservation Policy" is by no means the only plan that might be considered, but it illustrates some of the benefits realizable by more effective energy end-use.

A key element of the conservation policy is the transfer of a major portion of the capital now marked for new energy supplies into investments in energy conservation in each of the end-use sectors. An important result of this transfer will be a major reduction in the total amount of capital required for all energy investments.

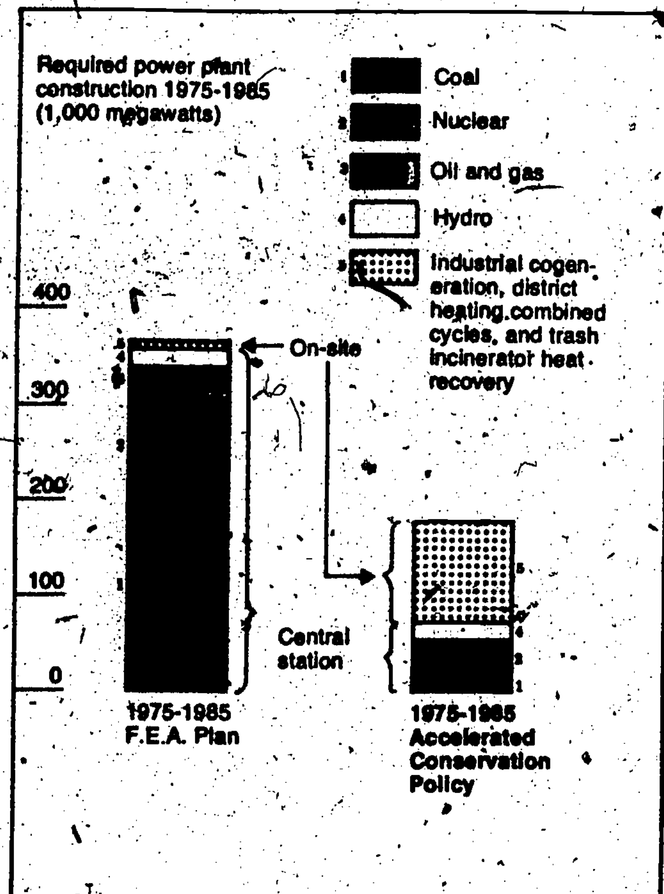
The Accelerated Conservation Policy calls for sharp curtailment in the rate of growth for electricity, the most capital intensive form of energy. It also calls for certain specific measures to improve end-use efficiencies, including:

Enforce the mandatory automobile fuel economy standards already enacted by Congress. Impressive progress is being made toward meeting the 1980 criterion of 20 miles per gallon (m.p.g.), particularly by



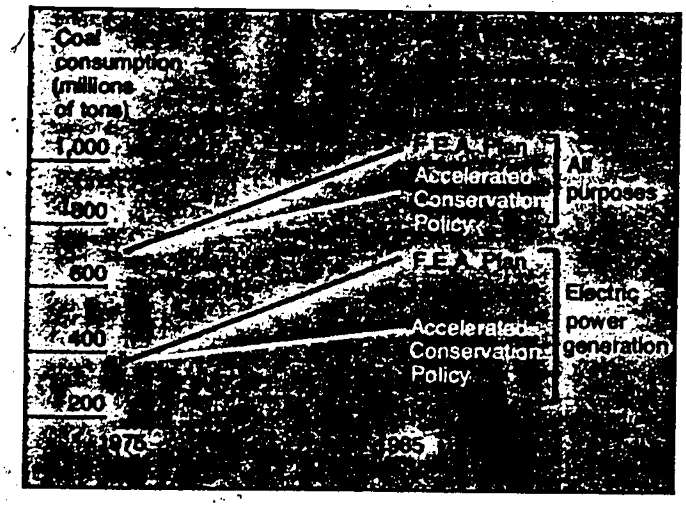
General Motors. The 1977 GM fleet average is projected to be 18.4 m.p.g. compared to 12.3 m.p.g. in 1974. Much of this improvement was accomplished through improved design and weight reduction, with little or no sacrifice in interior space or comfort. Planners should also consider a step-wise introduction of post-1980 standards, perhaps at a linear rate from 20 m.p.g. to the mandated 27.5 m.p.g. in 1985. This staged progression will insure that the improvements in average fuel economy continue without interruption for the turnover in overall population of 100-million-plus vehicles. The 27.5-m.p.g. goal is a difficult one, but there are strong indications that this level can be achieved by such strategies as the wider use of stratified charge or diesel engines, or both, improvement in transmissions, further weight reductions, etc. Some flexibility on the part of Congress with respect to emission levels of nitrogen oxides may be desirable to reach the optimum balance between fuel economy and exhaust pollutants.

Construct alternative electric generation capacity in lieu of 103,000 megawatts (Mw) of planned central station capacity. This alternative capacity would include cogeneration of electricity with industrial



process steam (64,000 Mw); generation by district plants producing both electricity and space heating for buildings (32,000 Mw); and burning trash to generate electricity (7,000 Mw). Together, these electricity sources would contribute 24.5 per cent of all U.S. electricity. To stimulate this substantial shift away from central station utilities to the far more efficient systems identified above, several actions will be required, such as mandatory rules for purchase of surplus industrial electricity by utilities; a restructuring of backup or demand charges originally designed by utilities to discourage on-site generation; provision of direct government loans to industries and apartment or commercial complexes to finance investments in on-site generating capacity; special taxes on industries and commercial businesses which do not take advantage of proven cogeneration opportunities; and changes in federal, state and local rules regulating utilities.

Establish efficiency goals for all energy-intensive industrial processing equipment and systems; examples are blast furnaces, paper-making machines, refinery and chemical plants, heat-treating equipment,



Coal consumption under the conservation policy would not rise nearly as precipitously as under the F.E.A. plan.

etc. In setting such goals consideration should be given to the efficiencies being attained in foreign countries where conservation technology has progressed further than in the United States.

Enact mandatory heating, insulation, and lighting standards for new residential and commercial construction. Standards should provide for optimum utilization of passive solar measures such as window and roof overhang design. We might also prohibit certain practices such as electric resistance space heating, and limit heat pump electric heating to those regions having moderate winter temperatures.

Enact progressively stricter efficiency standards for all major energy consuming appliances, such as water heaters, refrigerators, air conditioners, home furnaces, etc.

Phase out natural gas as a fuel, either for central-station electricity generation or for process steam applications in industry. This could mean either a direct ban on such use, or a steeply progressive tax on gas fuel that is so misused. Sufficient gas must be reserved for residential space heating and for direct-fired high-temperature industrial processes to avoid excessive growth in electricity demand.

Provide direct government loans and other economic incentives to finance the retrofitting of houses with conservation equipment, including insulation, storm windows, improved furnaces, and other cost-effective systems. This program should be continued until every structure in the nation has been modified to an extent commensurate with the capital cost of incremental new energy supply. These measures probably won't be completed until well beyond 1985, and our projections assumed less than one Quad of savings per year.

Collectively, these and several less important actions would reduce energy consumption over the next decade to 80 Quads per year, a saving of 21 Quads relative to the F.E.A. plan. In effect, energy growth can be almost halted over the ten-year span while economic activity can still expand by 3 per cent per year. Moreover, the costly electrical sector would increase to only 2.53 trillion Kwh, a growth rate of 2.8

per cent per year relative to 1975. The fraction of total energy converted to electricity, 29 per cent, is higher than in 1975, but still well below the 34 per cent figure projected by the F.E.A. plan.

In the Accelerated Conservation Policy, distribution of energy by end-use sector differs from that if the F.E.A. plan, with transportation accounting for only 20 per cent, and industry rising slightly to 42 per cent. Sources of energy would change somewhat with nuclear fuel contributing only 7 per cent instead of 10 per cent of all energy. The fraction for oil and gas is about the same for both plans—63 per cent—but the contribution of coal rises from 22 per cent to 24 per cent under the accelerated conservation alternative.

Major contributions to the 21 Quads of total energy saved under the conservation policy are due to:

- Automobile fuel economy standards (5.6 Quads),
- Alternative methods for electricity generation (2.9 Quads),
- Improved efficiencies in industrial processes (4.5 Quads), and
- Appliance efficiency standards (2.5 Quads).

The remaining 5.5 Quads of savings result from improved insulation standards for all new buildings, increased retrofitting of insulation in existing structures, some modest usage of solar-assisted water and space heating, and greater efficiency in trucks due to wider use of diesel engines, improved scheduling practices, drag reductions, etc.

None of the measures we've proposed, except for far-term automobile efficiency improvements, requires unproven technology. Moreover, the overall improvement represents only a modest aggregate gain in the absolute efficiency of devices and processes. In fact, under our policy the average efficiency of energy utilization increases to 10.9 per cent—only 2.6 percentage points over the 8.3 per cent we mentioned earlier. Approximately one-third of this gain is attributabel to automobile fuel economy improvements alone.

WHAT COST CONSERVATION?

The most striking difference between the Accelerated Conservation Policy and the F.E.A. plan is the amount of capital needed to implement these alternative programs. Over the 1975-to-1985 decade the F.E.A. plan would require $570 billion for energy supply and $78 billion for energy conservation, for a total investment of $648 billion. In sharp contrast, the Accelerated Conservation Policy would require $61 billion for supply and $157 billion for conservation, for a total of only $218 billion—*less than half the F.E.A. capital requirements.*

These enormous capital savings are due in large part to sharply lower central station electric generating capacity. Less generating capacity investment is needed, not only because of reduced total electrical demand, but also because of the lower cost of alternative combined-cycle generating equipment, such as cogeneration. The conservation policy will thus result in significant savings on nuclear and fossil generating plant construction, and on coal, oil and gas consumption.

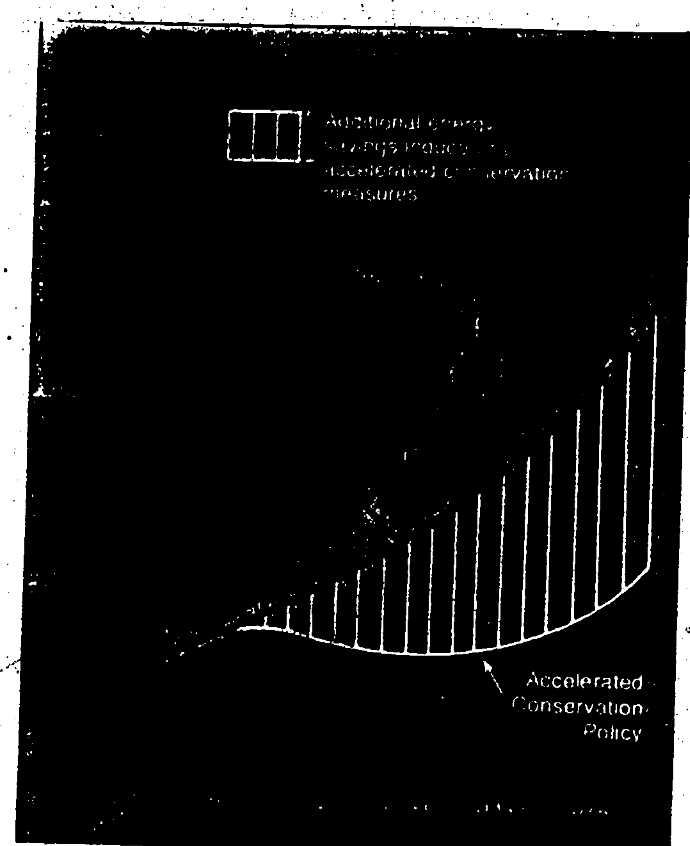
Savings on petroleum consumption will have a dramatic effect on imports. Accelerated conservation policies produce a net surplus or reserve of 4.5 Quads per year of natural gas by the end of the decade

STRONG REGULATION NEEDED

Our proposed policy for accelerated energy conservation depends heavily upon mandatory measures to improve end-use efficiency. This approach will inevitably raise arguments against tampering with the so-called "free market." Direct intervention must be considered, however, because price alone cannot provide sufficiently strong motivation for accelerated conservation.

Price increases are limited as a conservation stimulus even for the industrial sector, because energy cost still averages well below 10 percent of value added for all manufacturing. Thus, even large additional rises in fuel prices will not necessarily place overwhelming conservation pressures upon manufacturers.

Congress has recognized this aspect of energy policy, and has acted wisely in passing the mandatory automobile fuel economy legislation. By forcing the desired trend in new car efficiency, this measure will mean a continuing reduction in gasoline consumption throughout the



An Accelerated Conservation Policy which increased energy efficiency in our society by only about one percentage point every two-and-a-half years could allow an uninterrupted growth of three per cent per year in G.N.P., with little or no increase in energy demand.

further. A concerted effort in this area has not even begun, and the untapped potential for improvement may well exceed anything on the horizon among the various alternative energy supply options. If, for example, we were able to continue improving energy efficiencies by about one percentage point every two and a half years, we could sustain an uninterrupted growth in real G.N.P. of 3 percent per year for the next three decades, and still consume no more energy than we do today. Even then, our overall end-use efficiency would be only 20 percent, about equal to that of the steelmaking process today.

The improvements in energy end-use efficiency that we postulate are, in fact, not all that remarkable. As you can see from the graph above, they are still less than that accomplished over a comparable number of decades in improving electric generating plant efficiencies. The latter process, of course, has been subjected to enormous and continuing commitments of technological resources—the same prescription that is suggested here for energy end-use processes.

Some progress has already been made in overcoming the notion that the conservation of energy is synonymous with decreased economic activity. There is a growing awareness that capital investments in energy-saving devices can often yield greater dividends than comparable investments in new supply. Given appropriate stimulus, then, it is quite likely that the U.S. economy will make substantial progress toward more efficient end-use of energy over the next ten years. Unfortunately, there is little appreciation of the fact that conservation can play a major role in our long-term energy future. This misconception must be changed so that we can focus attention upon the task of developing the new conservation technology needed to insure continuing reductions in energy consumption in the period beyond 1985.

Perhaps the most decisive of all arguments in favor of conservation is the dividend that such a policy can buy in terms of time—the time needed for a thorough, searching, and balanced investigation of all possible energy supply alternatives, including the complete costs of their environmental and safety impacts.

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B. An Example of Competing Economic and Social Goals

[From Urban Transportation and Energy: The Potential Savings of Different Modes, pp. 41–54, xv.]*

CHAPTER V: CONCLUSION

. . . A balanced and realistic assessment of energy conservation in urban transportation operations requires consideration of a wide range of technological, operational, and behavioral factors. Almost all these factors are marked by considerable variation from city to city, from one time of day to another, and from route to route. Any conclusions about the energy efficiency of transportation modes, or about the conservation potential of transportation programs, must be viewed as rules with numerous exceptions. Nevertheless, the rules that emerge from examination of existing technical information differ sharply from the normally accepted rules, and they are worth noting even if they are not universally true.

Long-term energy savings are particularly uncertain because, over a period of many years, there will be shifts in the locations of jobs, stores, and houses. These shifts will occur because urban growth is influenced by zoning policies, land costs, real estate tax differentials, quality of public schools, availability of parking, and myriad other such factors. The quality of available transportation is one of the forces shaping urban development, albeit a force that is notoriously difficult to isolate. Nevertheless, any shift in transport policy that facilitates long-distance travel may direct growth so as to create more such travel, and any policy that makes it easier to move in congested central parts of cities may lead to more concentrated growth and correspondingly shorter trips. Thus, insofar as expansion of vanpooling or express bus service leads to longer trips, the energy savings per passenger-mile of these modes may be offset somewhat by increases in miles traveled, while the opposite may hold true for rapid rail, light rail, or personal rapid transit systems that serve downtown areas.

Because urban growth depends on so many factors, the influence of transportation programs per se is difficult to quantify. The largest new public transportation project completed in recent years is San Francisco's BART system, and experience to date does not suggest that any significant shifts in metropolitan development have occurred there.[1] None of the changes in bus, vanpool, or carpool programs discussed here would involve anywhere near the level of public finan-

*Written and Published by the Congressional Budget Office. U.S. Congress, December 1977. Originally appeared as a committee print of the Senate Committee on Environment and Public Works, September 1977.

[1] There is some speculation that the BART system may encourage more sprawl than concentration, although this concern has little hard evidence to support it. See Henry Bain. "New Directions for METRO: Lessons from the BART Experience," The Washington Center for Metropolitan Studies (December 1976). p. 22; and Melvin M. Webber, "The BART Experience—What Have We Learned?" *The Public Interest*, No. 24 (Fall 1976).

cial support that BART did, and the impacts of such change on urban development would probably not be any more noticeable. Nevertheless, the effects that changes in transportation policy have on metropolitan development patterns are poorly documented, and it should be noted that no developmental effects have been taken into account in making the estimates presented here.

In this context, the remainder of this section summarizes CBO's principal findings regarding energy conservation in urban transportation and some of their implications for design of the federal mass transit program.

Vanpools

Of all the urban transport modes, vanpools can probably make the greatest contribution to energy savings on a per passenger-mile basis. The chief advantage of vanpools lies, not in their technology, which is essentially that of conventional light trucks, but in the exceptionally high load factors that characterize existing vanpool operations. Indeed, if any of the other urban transportation modes could operate as near to seating capacity as do vanpools, their fuel conservation potential would be equally impressive.[2] This is unlikely, however, because none of the other public modes operate in the peak-hour-only, single direction, prearranged fashion that is characteristic of vanpools, and it is very difficult to maintain near-capacity loads in the absence of these features. Thus, the superior energy efficiency of vanpools, on a per-passenger-mile basis, is not apt to be challenged. Rather, the conservation potential of vanpools and carpools will probably increase relative to that of other public modes in future years since improvements in the fuel economy of light trucks (and hence of vanpools) are anticipated to be large compared to those of other forms of public transportation.

In spite of the clear advantages of vanpools on a per-passenger-mile basis, the contribution of vanpooling programs to national fuel conservation remains limited because of the very special conditions under which successful vanpools operate. Existing vanpool programs typically operate between relatively dense concentrations of homes and a common, distant workplace. Roundtrips of 40 to 100 miles are common among vanpools, although some operate over considerably shorter routes.[3] Because of the long trip lengths characteristic of vanpools, the potential market for this service represents a small fraction of the nation's work trips. Thus, even though vanpool programs will probably not lead to large fuel savings at the national level, they provide one of the potentially most productive parts of any program directed at urban transport energy in general.

Furthermore, vanpool programs now in existence indicate that this mode can be largely self-supporting and that massive federal assistance is not needed to start or maintain vanpools. Currently, the spread of such systems is severely impeded by state and federal regulations

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[2] Two reasons vanpools achieve such a high load factor are: first, the requirement that there be enough passengers to pay both capital and operating costs; second, the driver's financial incentive to keep the number of passengers at or near capacity.

[3] Gerald K. Miller and Melinda A. Green, "Guidelines for the Organization of Commuter Van Programs," Report prepared by the Urban Institute for the Urban Mass Transportation Administration, February 1976.

imposed by state public utility commissions, the Interstate Commerce Commission, the Bureau of Motor Carrier Safety, and various labor laws. These regulations sometimes discourage companies from getting involved in vanpooling and sometimes prevent several employers from getting together to start or extend vanpool service.

These regulatory constraints on vanpool expansion are probably the most fertile area for legislative action. In particular, the exemption from Interstate Commerce Commission and state regulation contained in the proposed National Energy Act[4] could be extended to apply to nonfederal vanpooling without damage to the existing public transportation services that these regulations are intended to protect.

In summary, vanpools can produce large fuel savings in special circumstances, although these circumstances apply to only a small segment of the overall travel market. Vanpool operations require little or no public financial support, and it does not appear that increased federal spending would be appropriate to spread the application of this energy-efficient mode. At present, state and federal regulations inhibit the expansion of vanpools, and these appear to be amenable to legislative action if the Congress elects to encourage this mode of transportation.

Buses

Of the conventional urban public transportation modes (subway, trolley, and bus), buses appear to offer the greatest promise in terms of energy conservation. Although typically the operating-energy intensity of buses is only slightly better than that of other conventional public transport modes, their modal energy is only about half that of new rail or trolley systems because of the access conditions and route coverage that generally characterize bus service. Furthermore, because express bus service can be designed to draw heavily from segments of the market that are now automobile-oriented, the energy savings of programs that promote new bus service are probably greater than programs aimed at any other public transport mode. That is, a new bus trip typically means greater energy savings than a new rapid rail, commuter rail, or trolley trip. Also, new bus services—even those requiring exclusive rights-of-way—tend to be less expensive ways to draw new patronage than these other modes.

Current federal programs provide extensive support for capital costs of transit systems on an 80 to 20 matching basis. Although private bus service provides are not eligible for this support, the overall level of capital cost support for buses does not appear to be a major problem, at least as far as existing capital programs go.

Probably the greatest constraint to expansion of energy-efficient bus service is operating costs. Operating deficits have risen at an alarming rate in recent years, and both federal and local governments are cautious about taking any steps that might aggravate this problem. Under

[4] "Neither the offering of a vanpooling arrangement pursuant to this subsection nor the operation of a van pursuant to such an arrangement shall subject any person to regulation as a motor carrier under part II of the Interstate Commerce Act (49 U.S.C. 301 et seq.) or to any similar regulation under the laws of the District of Columbia or of any State or political subdivision thereof." (H.R. 8444, section 701, subsection c6).

Section 5 of the Urban Mass Transportation Act of 1964, the Urban Mass Transportation Administration provides up to 50 percent of the transit operating deficit. These funds, however, are allocated among urban areas on a formula basis and generally cover substantially less than half of the operating losses in larger metropolitan areas. Many observers fear that increases in the federal money for this purpose would lead to more inefficient operations, and it is not clear that expansion of Section 5 support would be appropriate as part of an energy conservation program. Because bus operating costs are overwhelmingly labor costs, attempts to curb costs may immediately run counter to employment goals, and there appear to be no simple ways to make substantial cost cuts that are acceptable to all parties involved.

Nevertheless, some of the innovative bus services—particularly, subscription service such as the Reston Express bus outside Washington, D.C.; Specialty Transit in St. Louis, Missouri; and COM-BUS in Los Angeles, California—have shown that additional bus service can be operated at little or no expense to the public.[5] The growth of this service appears to be limited by local regulations that protect existing operators and by the concerns of labor (many peak-hour-only services are most efficiently run using part-time help).

By their nature, subscription buses usually provide private, peak-hour-only service. The primary need of this type of service is not federal financial support, but exemption from the institutional obstacles that limit its growth. If the Congress wishes to provide financial assistance to promote this service, its efforts would best be placed, not in existing capital or operating subsidy programs, but in programs that relax local regulations by creating job security. That is, federal underwriting of existing transit jobs or services could give localities the assurance that they need to experiment with innovative supplements to existing bus service.

Giving buses priority in traffic through special traffic signaling or reservation of lanes, and giving buses (along with carpools, vanpools, and other energy-efficient modes) exclusive right-of-way can also greatly enhance the attractiveness and patronage of the service. Existing federal programs provide for capital support of these services,[6] but in many situations the changes required to implement bus priority schemes require relatively little capital expenditure, and federal assistance offers little incentive to local officials. Exclusive right-of-ways for buses, such as those on the Shirley Highway outside Washington, D.C., are more capital-intensive than other bus priority measures, and they do not have the adverse effects on automobile traffic that separating off an existing lane for bus use implies. A more aggressive federal program in the area of acquiring and constructing exclusive right-of-ways could be a productive way to promote the energy-saving advantages of bus service. Such a program could be broadly interpreted to include relocating on-street parking to off-street which would yield additional capacity from existing facilities, and con-

[5] Ronald N. Kirby et al., *Para-Transit: Neglected Options for Urban Mobility* (The Urban Institute, 1974).

[6] Many of these projects are classified as Transportation System Management (TSM) by the Urban Mass Transportation Administration and are funded with capital grants (Section 3) or, in some cases, demonstration grants. Some Federal Highway Administration funds (primarily money for urban-systems) can also be used for these purposes.

structing bridges, by-passes, and other facilities to enhance the movement of high-occupancy vehicles. Local conditions are too diverse to attempt to specify such a program in detail, but designating additional money for Urban Mass Transportation Administration Section 3 funds for this purpose could be a fruitful approach. Additional incentives could be provided if separate federal operating assistance over and above the existing operating aid program were available for those specific projects with a relatively high potential for saving energy. As with the current aid program, the federal share of operating losses should probably be held to a maximum of 50 percent, to ensure some incentives for efficient local operations.

Carpools

Carpools can make a significant contribution to energy conservation. A typical mile of travel diverted to carpool saves more energy than does diversion to any other mode except vanpool, according to the results shown in Table 9. Unlike vanpools, for which the potential market is very small, carpools could potentially be used for a large portion of all commuter travel. It is not clear, however, to what extent additional spending can increase carpooling. Promotion programs that locate and match potential carpoolers are relatively inexpensive, but they produce modest gains at best. Incentives such as free parking, or permission to use reserved right-of-ways along with other high-occupancy vehicles are promising ways to use federal funding to promote carpools.

Dial-a-Ride

From the standpoint of energy conservation, dial-a-ride service appears to be counterproductive. Because of low load factors and high route circuity, dial-a-ride is an energy-wasteful mode by almost any measure. This service, however, has some unique advantages in being of use to the handicapped and the elderly, and its energy costs must be weighed against its social contributions.

Light Rail Transit

Although much attention has been given to light rail transit in recent discussions, the energy properties of this mode are generally comparable to those of heavy rail transit, except for some savings in construction energy and station and maintenance energy. In terms of the estimates shown in Table 9, these advantages are sufficient to make light rail transit marginally effective in conserving energy, although it appears to rank significantly lower than bus, vanpool, or carpool in terms of its conservation potential.

Automobiles

Automobiles are generally the least energy-efficient of the urban transportation modes. The figures in Table 9 show that automobiles currently require about twice as much energy per passenger-mile as do new rail rapid transit systems. Some of the differences apparent in a comparison of line-haul energy requirements become modified, however, when the access and circuity of fixed-route modes are taken into account. Moreover, the gap between the automobile's energy requirements and those of other modes will shrink even further as the fuel economy standards for new cars set out in the Energy Policy and Conservation Act and the additional automotive fuel economy measures now being considered by the Congress start to increase the average fuel economy of the nation's automobile fleet.

Even though earlier analysis by the Congressional Budget Office indicates that the 1985 fuel economy standard of 27.5 miles per gallon is unlikely to be met, average new car fuel economy (combined city and highway cycles) is nonetheless expected to jump from 17.8 miles per gallon in 1977 to 23.3 miles per gallon in 1985, and the automobile fleet as a whole will probably average more than 23 miles per gallon by 1990.[7] Comparable fuel efficiency gains are not anticipated for buses or rail systems. Thus by the time major extension to these services could be built, their fuel efficiency advantages, where they now exist, would be reduced by roughly 20 percent. Indeed, one study concludes that "with present power sources, the subways will lose their (operating) energy advantage over the automobile by the end of the century."[8]

Rapid Rail

Of all the commonly held notions about energy efficiency, probably the most misguided are those concerning rapid rail transit. The findings of the previous chapter indicate that under typical conditions, new rapid rail systems actually waste energy rather than save it. This surprising finding appears to conflict with the fact, that, in terms of operating energy per passenger-mile, rail ranks among the most energy-efficient of all modes. But when construction and station energy are considered as well, rapid rail ranks among the least energy-efficient of the conventional urban public transportation modes. Furthermore, when mode of access and circuity are included, the energy per productive mile computed over the entire trip is greater than that of all the other public modes, except dial-a-ride. The principal reason for this poor performance is the considerable use of low-occupancy private automobiles to access new rapid transit stations. Finally, the average patron of mass transit systems is drawn from a mode in which energy efficiency is better than that for the rail system. This produces a small net loss of energy overall.

As noted earlier, exceptions to patterns such as this are probably not difficult to find. Slight variations in the judgments about exactly what constitutes typical conditions could lead to a revised set of computations in which the energy impact of rapid rail transit appears somewhat favorable. But, even though it is possible to argue about the precise value of all of the factors bearing on the energy intensiveness of rail rapid transit, these fine points of discussion have little to do with the substantive conclusion that rail rapid transit offers hardly any aid to the nation's efforts to save fuel. Indeed, even wildly optimistic assumptions about all aspects of rapid rail transit lead to the same conclusion.

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[7] Congressional Budget Office, *President Carter's Energy Proposals: A Perspective*, Staff Working Paper (June 1977). (The figures reported do not assume that any new car fuel economy regulations are in force other than those contained in the Energy Policy and Conservation Act.)

[8] Regional Plan Association, "Power for the MTA." June 1977, p. 4. Subways would still play a significant role in energy conservation since they permit New York City and other large eastern cities to maintain their energy-efficient, high-density nature.

For the purposes of illustration, consider a program recently proposed in the House of Representatives that would have used half of the revenues from a 5 cent per gallon tax on gasoline and diesel fuel to fund various transit programs.[9] Although it was never intended that these revenues would be devoted to new rail transit projects exclusively, for sake of illustration it is assumed here that they are. Over ten years, the revenues from a 2.5 cent gasoline tax would total about $28 billion. Based on the existing 80 : 20 matching ratio between federal and local funds, this leads to transit construction expenditures of $35 billion over ten years. Even at today's prices, this sum would buy fewer than six systems the size of Washington's proposed 98-mile Metro. Since the gasoline tax would be collected and spent in future years when the dollar will buy less than it does now, the gasoline tax revenues would probably not even support four Metro-like systems.

Nonetheless, assume that six Metro-like systems are built and that each of these systems is fully in use by 1990. Further, suppose that each of the six new systems carries 300 million trips per year. This is the number of trips that the promoters of the Metro system claim will ride Washington's subway in 1990. This figure has been attacked as being an unrealistically optimistic projection;[10] it represents about eight times as many passengers per year as San Francisco's 72-mile BART system now attracts.

Further, suppose that each of these new trips is five miles long and that each new transit trip replaces an auto trip of identical length. Again, these assumptions overstate the likely effects of transit since many new transit patrons would be former bus or carpool travelers, and thus would not diminish automobile traffic very much. Also, a great number of transit trips would still require use of a car to get to the station.

Finally, assume that cars in 1990 average 15 miles per gallon in urban traffic, and that rail transit systems require absolutely no energy to operate. Again, these assumptions favor rail transit. The energy savings of the $35 billion program would then be: 6 new rapid rail systems $\times$ 300 million trips per year per system $\times$ 5 miles per trip $=$ 9 billion miles of automobile travel eliminated per year, assuming new transit trips replace automobile trips mile for mile. The associated fuel savings, in terms of the conventional measure of barrels per day, are: 9 billion miles of automobile travel $\div$ 15 miles per gallon $\div$ 42 gallons per barrel $\div$ 365 days per year $=$ 39,000 barrels per day, or 0.7 percent of 1976 daily consumption.

Thus, even under wildly optimistic assumptions, this $35 billion transit program would lead to 1990 fuel savings of fewer than 40,000 barrels of oil per day. If transit systems are assumed to have a life of 50 years, these savings are equivalent to a price of about $50 barrel of oil, versus the current world price of about $14.

Changing a few assumptions to more realistic values reduces the estimated fuel savings considerably. For example, assuming an average of 150 million persons per year (still four times the level of

[9] *Congressional Record*, daily ed., July 29, 1977, pp. 8232–33.
[10] "Washington Area Metro Rail System: Perspective and Alternatives." Study and Report from the Library of Congress, Congressional Research Service, for the Subcommittee on Fiscal Affairs of the Committee on the District of Columbia, House of Representatives, Committee Print S–4, February 1976.

BART) leads to fuel savings of 20 thousand barrels per day in 1990. Similarly, more realistic assumptions about the rate of which automobile trips are displaced, about inflation and the likely costs of future heavy rail systems, about future automotive fuel efficiency, and about transit fuel efficiency can be shown to lead to substantially lower fuel savings.

In view of the limited energy conservation potential of rail rapid transit and the enormous capital costs of such systems, expenditure of federal funds on these systems for purposes of energy conservation appears to be misguided and possibly even counterproductive.

MIDDLE ESTIMATES FOR VARIOUS MEASURES OF ENERGY REQUIRED BY URBAN TRANSPORTATION MODES

[All measures expressed in Btu's per passenger-mile]

Mode	Operating energy [2]	Modal energy [3]	Program energy [4]
Single-occupant automobile	11,000	14,220	(1)
Average automobile	7,860	10,160	(1)
Carpool	3,670	5,450	4,890
Vanpool	1,560	2,420	7,720
Dial-a-Ride	9,690	17,230	(12,350)
Heavy rail transit (old)	2,540	3,990	(1)
Heavy rail transit (new)	3,570	6,580	(980)
Commuter rail	2,625	5,020	970
Light rail transit	3,750	5,060	30
Bus	2,610	3,070	[5] 3,590

[1] Not applicable.
[2] Propulsion only.
[3] All forms of energy, computed on a door-to-door basis, adjusted for roundabout journeys.
[4] Energy saved (lost) per passenger-mile of travel induced by new programs.
[5] For new express bus service; regular urban bus service would show smaller savings.

[From Hearing held October 5, 1977, before the Senate Subcommittee on Transportation on the Congressional Budget Office Report "Urban Transportation and Energy: The Potential Savings of Different Modes," p. 134–137, 182–186, and printed for use of the Senate Committee on Environment and Public Works.]

A. Excerpt From Comments Prepared by the Metropolitan Atlanta Rapid Transit Authority

The paper "Urban Transportation and Energy: The Potential Savings of Different Modes", prepared by the Congressional Budget Office in September, 1977 concludes, among other things, that "new rail rapid transit systems actually waste energy rather than save it" and that: "In view of the limited energy conservation potential of rail rapid transit and the enormous capital costs of such systems, expenditure of federal funds on these systems for purposes of energy conservation appears to be misguided and possibly even counter productive."

This finding, admittedly surprising in view of its contradiction on conventional wisdom as the CBO researchers themselves point out, is arrived at after a comparison of the aggregate measures of energy use of alternative urban transport modes, leading to an estimate of the energy that would be conserved (or wasted) by switching from certain modes (including the private automobile) to others such as rail rapid transit and buses.

This paper contains serveral erroneous assumptions and generalizations in its handling of the data, which if corrected could well lead to totally different conclusions. These will be discussed in detail below. However, the study's major shortcoming is the fundamental premise on which it is based; that is, it analyzes relative energy intensiveness of the different urban transportation modes *regardless of source*. In the analysis, the energy consumption of the different modes is converted to a common unit (British Thermal Units or BTU's). No reference is found anywhere in the report, however, to the fact that all energy consumed by road-oriented public or private transportation (cars, carpools, van pools and buses) is generated from petroleum products, whereas rail public transportation is unique in that electrically powered vehicles operate on electricity which is (or can be) produced entirely from coal and other non-petroleum sources.

Any one who is even remotely aware of the so-called "energy crisis" is fully cognizant that this situation originates not from a scarcity of all sources of energy, but from the fact that the United States economy has come to depend heavily on a specific source of energy, petroleum, the domestic availability of which is rapidly being depleted, and that as a result the United States has come to depend largely on foreign suppliers for its oil. This dependency has created a seriously deteriorating balance of payments problem for this country, and potentially a precarious situation in which the economy of the United States could be "shut off" at will overnight by political factors beyond the control of this nation.

President Carter's energy message clearly points out the fundamental nature of the energy crisis:

The heart of our energy problem is that our demand for fuel keeps rising more quickly than our production, and our primary means of solving this problem is to reduce waste and inefficiency.

Oil and natural gas make up 75 percent of our consumption in this country, but they represent only about 7 per cent of our reserves. Our demand for oil has been rising by more than 5 per cent each year, but domestic oil production has been falling lately by more than 6 per cent. Our imports of oil have risen sharply—making us more vulnerable if supplies are interrupted—but early in the 1980's even foreign oil will become increasingly scarce. If it were possible for world demand to continue rising during the 1980's at the present rate of 5 per cent a year, we could use up all the proven reserves of oil in the entire world by the end of the next decade.

Accordingly, the principles behind the President's plan and goals for 1985 call for a reduction in the consumption of petroleum-generated energy and a *shift* to other forms of sources energy, primarily coal and eventually solar energy. Specifically these goals are:

To reduce the annual growth rate in our energy demand to less than 2 per cent;

To reduce gasoline consumption by 10 per cent;

To cut imports of foreign oil to 6 million barrels a day, less than half the level it would be if we did not conserve;

To establish a strategic petroleum reserve of one billion barrels, about 10 months' supply;

To increase our coal production by more than two-thirds, to over one billion tons a year;

To insulate 90 per cent of American homes and all new buildings; and

To use solar energy in more than 2½ million homes.

It is inconceivable how the Congressional Budget Office could have completely ignored the heart of the energy problem in analyzing energy intensiveness of different urban transport modes. The United States consumes about 18 million barrels of oil per day. Of this more than 50 per cent is for transportation. Highway vehicles consume 80 per cent of that petroleum, and the private automobile uses 71 per cent of that share. In other words, the private automobile uses up to 34 per cent of the total amount of petroleum consumed in the United States. The CBO report does not even allude to these facts and instead, in its very introduction the CBO report states:

However, energy is not of primary importance to transportation: less than 20 percent of the costs of owning and operating a car are traceable to gasoline and less than 5 percent of the costs of urban public transportation are related to fuel. Thus, from the vantage point of the provider of transport service, costs other than fuel costs (for example vehicle purchase costs, labor costs, repair costs, etc.) tend to be largest, thus relegating fuel costs to a position of secondary importance.

True, but are we actually dealing with the *costs* of energy as a component of transportation's total costs? Or are we talking about conserving a depleting resource regardless of its present, artificially low, price to the user. Does the present price of gasoline reflect the impending scarcity of this source of energy? Certainly the CBO would not suggest that the unavoidable shortage of petroleum will not be eventually reflected in the energy component of transportation costs. The statement above is illustrative of how the CBO has completely missed the point: *even assuming that urban rail transportation is more energy-intensive than highway-vehicle oriented transportation, rail transit can be powered by an energy source that does not use any petroleum.*

B. Excerpt From Comments Prepared by the Regional Transportation Authority (Chicago)

. . . When the oil embargo of 1973 was in effect, *a series of quick and otherwise undistinguished computations* were carried out to see whether mass transit might be of some use in conserving energy. It was reasoned that if the nation used little oil during the years when mass transit flourished and automobiles were not yet in extensive use, then a return to a modern version of that condition would greatly reduce oil use. The overwhelming numbers of automobiles, well in excess of 100 million new and increasing every year, lead the analysts to conclude this argument was not realistic. There are simply too many cars in comparison to the 50,000 odd transit vehicles. It would take at least 15 years according to traditional calculations to develop enough public transportation nationwide to replace a significant portion of auto trips. This misunderstanding of the potential of transit to influence trips came from the simple arithmetic comparison of numbers, of assuming that trips are based purely on number of occupancy seats available.

To determine whether transit had any potential for alleviating the energy crisis, analysts began carrying out detailed theoretical calculations. Unfortunately, *the only data available*, giving relative efficiencies of bus engines as compared to car engines for example, limited analysis to an established procedure of computing relative efficiencies of transit vehicles versus automobiles. Thus a bus and a car traveling side by side on an expressway could be directly compared to see which used less energy. Electric rapid transit posed a special difficulty since gasoline is not used and a conversion must be made based on various assumptions to convert kilowatts to some "equivalent" gallons per mile, a questionable approach at best.

Assumptions also had to be made about the number of people riding on a bus or car, and here a great dichotomy developed. At rush hour, transit is packed and the efficiency is very high; after rush hour, and especially after midnight, transit has few riders and is very inefficient. How can this be reconciled into a single number? There is no way to do this to produce a unique answer. Depending on how the averages are taken, any kind of efficiency can be computed. The hope was that somehow these computations for an individual bus or car would reflect total energy use patterns within the community.

Thus reports became long and involved, with any prescribed result being possible by simply juggling one or another of the complex assumptions. This unfortunate theoretical approach, so widely used, has led to more confused conclusions and blind alleys than would have been thought possible.

Reports of transit advocates thus contradicted reports of automobile advocates. A transit operation for example would point out that a large bus, with a rush hour load of 70 people, operating in at least a part-express type service generates (70 passengers) × (6 miles/gallon) = 420 passenger miles per gallon. A driver-alone compact car getting 20 miles per gallon would be achieving (20) × (1) = 20 passenger miles/gallon. For an automobile to compete with the bus at rush hour, it would need to achieve 420 miles per gallon.

Detractors of this computation complain that the bus must make a return trip, whereas the car does not, so that if the loading is less on the return trip, then some kind of average should be taken to reduce this value of 420. Advocates of transit point out this type of efficiency is achieved every day all over the country.

Comparative computations with electric rapid transit and commuter trains reveals an even deeper level of erratic reasoning. Proponents of transit like to point out that electric powered service does not operate on oil. Electricity can be generated from water, coal, nuclear or the chemicalization of garbage. In cities such as Seattle and San Francisco, all power is hydroelectric, generated at large dams. In Chicago, electric power is from combined coal and nuclear sources. Oil as a source of electrical power is fast disappearing in use and will continue to be used less as more coal is available.

Yet analysts persist in the notion that the kilowatts of power can be effectively replaced through engineering conversion to a meaningful "miles per gallon of gasoline" when in fact rapid transit systems use no gasoline. Then, by assuming very low load factors and using large average trip distances by gas guzzler cars to get to the transit station, analysts are able to so underestimate the efficiency of trains as to recommend that rails should be paved over and the passengers transferred to buses.

These convoluted arguments thus purport to show the Nation would be better off if people stopped using electrical energy to get to work and instead used buses; this leads to the non-sensical conclusion that the Nation *can reduce oil consumption by using more oil.* Legislators should not be surprised with polls showing American's faith in institutions to be on the decline.

These highly complex arguments are often bent toward other ends. If one agency or another wishes to inhibit construction programs for rapid transit, so that the money can be allocated to other needs, it can be easily arranged to produce a computer based document "proving" the point that transit does not save energy. A press release on nationwide television then announces such findings, as has happened, but fails to mention such things as the fine points of exchanging electrical for oil energy. It is an example of how easily technical problems lend themselves to misinterpretation by those who stand to gain from convoluted arguments.

Regardless of the details of these familiar techniques for computing transit efficiencies, all contain the same basic error in analysis: they neglect the feedback effect between automobiles and transit. Transit suppresses automobile use. This ability of transit to eliminate miles not by attracting auto users but simply by discouraging trips is in many cases more effective in saving energy than other considerations. The value of transit can not be determined from computing gasoline use requirements of individual vehicles. The true answers lie elsewhere. . . .

C. Soft versus Hard Paths: Amory Lovins *et al.*

ENERGY STRATEGY: THE ROAD NOT TAKEN?

(By Amory Lovins)*

2.1. OVERVIEW

Where are America's formal or de facto energy policies leading us? Where might we choose to go instead? How can we find out?

Addressing these questions can reveal deeper questions—and a few answers—that are easy to grasp, yet rich in insight and in international relevance. This chapter will seek to explore such basic concepts in energy strategy by outlining and contrasting two energy paths that the United States (or, by analogy, other countries) might follow over the next fifty years—long enough for the full implications of change to start to emerge. The first path resembles 1976–7 federal policy and is essentially an extrapolation of the recent past. It relies on rapid expansion of centralized high technologies to increase supplies of energy, especially in the form of electricity. The second path combines a prompt and serious commitment to efficient use of energy, rapid development of renewable energy sources matched in scale and in energy quality to end use needs, and special transitional fossil fuel technologies. This path, a whole greater than the sum of its parts, diverges radically from incremental past practices to pursue long-term goals. It does not try to wipe the slate clean, but rather to redirect our future efforts, taking advantage of the big energy systems we already have without multiplying them further.

Both paths, as will be argued, present difficult—but very different—problems. The first path is convincingly familiar, but the economic and sociopolitical problems lying ahead loom large, and eventually, perhaps, will prove insuperable. The second path, though it represents a shift in direction, offers many social, economic, and geopolitical advantages, including virtual elimination of nuclear proliferation from the world. It is important to recognize that the two paths are mutually exclusive. Because commitments to the first may foreclose the second, we must soon choose one or the other—before failure to stop nuclear proliferation has foreclosed both.[1]

*From *Soft Energy Paths;* copyright 1977 by Friends of the Earth. Reprinted with permission of Ballinger Publishing Company. Amory Lovins is the British representative of Friends of the Earth, a U.S. nonprofit conservation group.

[1] In this chapter the proportions assigned to the components of the two paths are only indicative and illustrative. More exact computations, now being done by several groups in the United States and abroad, involve a level of technical detail which, though an essential next step, may deflect attention from fundamental concepts. This chapter will accordingly seek technical realism without rigorous precision or completeness. See Chapter Three for methodological discussion. Further technical details are given in later chapters and their citations. See also the independent but somewhat related analysis to be published in 1977 by the Union of Concerned Scientists (1208 Massachusetts Avenue, Cambridge, Massachusetts 02138) as the report of the UCS Energy Study.

2.2. HARD ENERGY PATHS

Most official proposals for future U.S. energy policy embody the twin goals of sustaining growth in energy consumption (assumed to be closely and causally linked to GNP and to social welfare) and of minimizing oil imports. The usual proposed solution is rapid expansion of three sectors: coal (mainly strip-mined, then made into electricity and synthetic fluid fuels); oil and gas (increasingly from Arctic and offshore wells); and nuclear fission (eventually in fast breeder reactors). All domestic resources, even naval oil reserves, are squeezed hard—in a policy that David Brower calls "Strength Through Exhaustion." Conservation, usually induced by price rather than by policy, is conceded to be necessary but it is given a priority more rhetorical than real. "Unconventional" energy supply is relegated to a minor role, its significant contribution postponed until past 2000. Emphasis is overwhelmingly on the short term. Long-term sustainability is vaguely assumed to be ensured by some eventual combination of fission breeders, fusion breeders, and solar electricity. Meanwhile, aggressive subsidies and regulations are used to hold down energy prices well below economic and prevailing international levels so that growth will not be seriously constrained.

Even over the first ten years (1976–1985), the supply enterprise typically proposed in such projections is impressive. Oil and gas extraction shift dramatically to offshore and Alaskan sources, with nearly 900 new oil wells offshore of the contiguous forty-eight states alone. Some 170 new coals mines open, extracting about 200 million tons per year each from eastern underground and strip mines, plus 120 million from western stripping. The nuclear fuel cycle requires over one hundred new uranium mines, a new enrichment plant, some forty fuel fabrication plants, three fuel reprocessing plants. The electrical supply system, more than doubling, draws on some 180 new 800 megawatt coal fired stations, over one hundred forty 1000 megawatt nuclear reactors, sixty conventional and over one hundred pumped storage hydroelectric plants, and over 350 gas turbines. Work begins on new industries to make synthetic fuels from coal and oil shale. At peak, just building (not operating) all these new facilities directly requires nearly 100,000 engineers, over 420,000 craftspeople, and over 140,000 laborers. Total indirect labor requirements are twice as great.[2]

This ten year spurt is only the beginning. The year 2000 finds us with 450 to 800 reactors (including perhaps eighty fast breeders, each loaded with 2.5 metric tons of plutonium), 500 to 800 huge coal-fired power stations, 1000 to 1600 new coal mines and some fifteen million electric automobiles. Massive electrification—"the most important attempt to modify the infrastructure of industrial society since the railroad"[3]—is largely responsible for the release of waste

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[2] The foregoing data are from M. Carasso et al., *The Energy Supply Planning Model*, PB–245 382 and PB–245 383 (Springfield, Virginia: National Technical Information Service, Bechtel Corp. report to the National Science Foundation [NSF], August 1975). The figures assume the production goals of the 1975 State of the Union Message. Indirect labor requirements are calculated by C. W. Bullard and D. A. Pilati, CAC Document 178 (September 1975), Center for Advanced Computation, University of Illinois at Urbana-Champaign. See Chapter 1.2.

[3] I. C. Bupp and R. Treitel, "The Economics of Nuclear Power: De Omnibus Dubitandum," 1976 (available from Professor Bupp, Harvard Business School).

heat sufficient in principle to warm the entire freshwater runoff of the contiguous forty-eight states by 34–49° F.[4] Mining coal and uranium, increasingly in the arid West, entails inverting thousands of communities and millions of acres, often with little hope of effective restoration. The commitment to a long-term coal economy many times the scale of today's makes the doubling of atmospheric carbon dioxide concentration early in the next century virtually unavoidable, with the prospect then or soon thereafter of substantial and perhaps irreversible changes in global climate.[5] Only the exact date of such changes is in question.

The main ingredients of such an energy future are roughly sketched in Figures 2–1. For the period up to 2000, this sketch is a composite of recent projections published by the Energy Research and Development Administration (ERDA), Federal Energy Administration (FEA), Department of the Interior, Exxon, and Edison Electric Institute. Minor and relatively constant sources, such as hydroelectricity, are omitted; the nuclear component represents nuclear heat, which is roughly three times the resulting nuclear electric output; fuel imports are aggregated with domestic production. Beyond 2000, the usual cutoff date of present projections, the picture has been extrapolated to the year 2025—exactly how is not important here—in order to show its long-term implications more clearly.[6]

2.3. WHY HARD PATHS FAIL

The flaws in this type of energy policy have been pointed out by critics in and out of government. For example, despite the intensive electrification—consuming more than half the total fuel input in 2000 and more thereafter—we are still short of gaseous and liquid fuels, acutely so from the 1980s on, because of slow and incomplete substitution of electricity for the two-thirds of fuel use that is now direct. Despite enhanced recovery of resources in the ground, shortages steadily deepen in natural gas—on which plastics and nitrogen fertilizers depend—and, later, in liquid fuel for the transport sector (half our oil now runs cars). Worse, at least half the energy growth never reaches the consumer because it is lost earlier in elaborate conversions in an increasingly inefficient fuel chain dominated by electricity generation (which wastes about two-thirds of the fuel) and coal conversion (which wastes about one-third). Thus in Britain since 1900, primary energy—the input to the fuel chain—has doubled while energy at the

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[4] Computation concerning waste heat and projections to 2000 are based on data in the 1975 Energy Research and Development Administration Plan (ERDA–48).

[5] B. Bolin, "Energy and Climate," Secretariat for Future Studies (Fack, S–103 10 Stockholm); S. H. Schneider and R. D. Dennett, *Ambio* 4, 2:65–74 (1975); S. H. Schneider, *The Genesis Strategy* (New York: Plenum, 1976); W. W. Kellogg and S. H. Schneider, *Science* 186:1163:72 (1974); S. H. Schneider, *J. Atmos. Sci.* 32:2060–66 (1975); W. W. Kellogg, "Effects of Human Activities on Global Climate," (Geneva: World Meterological Organization, October 1976), and "Global Influences of Mankind on the Climate," in J. Gribbin, ed., *Climate Change* (Cambridge, England: Cambridge University Press, 1977; R. Rotty, "Global Energy Demand and Related Climate Change;" IEA(M)–75–3 (Oak Ridge: Institute for Energy Analysis, November 1975); W. Häfele, RR–76–1, IIASA (Laxenburg, Austria), pp. 15, 144–97. The CO_2 problem, as Häfele shows, is remarkably insensitive to technical (e.g., nuclear) assumptions if a high energy future is assumed.

[6] Figure 2–1 shows only *nonagricultural* energy. Yet the sunlight participating in photosynthesis in our harvested crops is comparable to our total use of nonagricultural energy, while the sunlight falling on *all* U.S. croplands and grazing lands is about twenty-five times the nonagricultural energy. By any measure, sunlight is the largest single energy input to the U.S. economy today.

point of end use—the car, furnace, or machine whose function it fuels—has increased by only a half, or by a third per capita; the other half of the growth went to fuel the fuel industries, which are the largest energy consumers.

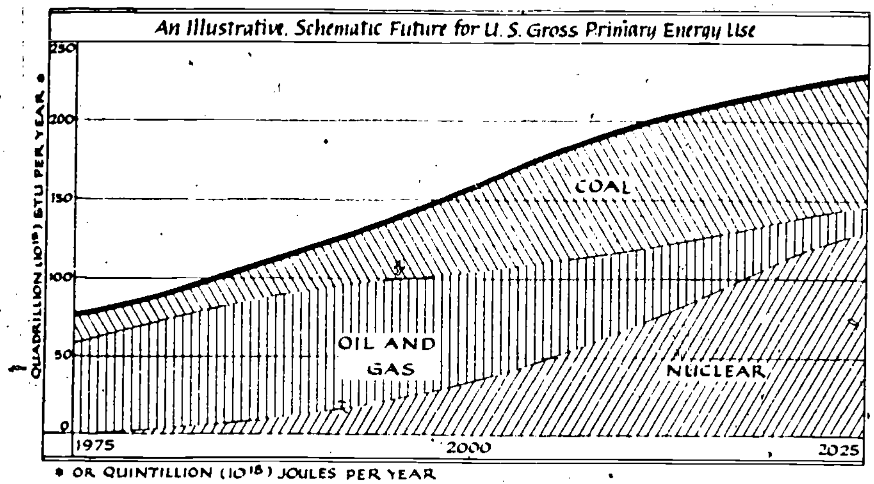

FIGURE 2–1

Among the most intractable barriers to implementing Figures 2–1 is its capital cost. In the 1960s, the total investment to increase a consumer's delivered energy supplies by the equivalent of one barrel of oil per day (about 67 kilowatts of heat) was a few thousand of today's dollars—of which, in an oil system, the wellhead investment in the Persian Gulf was and still is only a few hundred dollars. (The rest is transport, refining, marketing, and distribution.) The capital intensity of much new coal supply is still in this range. But such cheaply won resources can no longer stretch our domestic production of fluid fuels or electricity; and Figure 2–1 relies mainly on these, not on coal burned directly, so it must bear the full burden of increased capital intensity.

That burden is formidable. For the North Sea oilfields coming into production soon, the investment in the whole system is roughly $10,000 to deliver an extra barrel per day (constant 1976 dollars throughout); for U.S. frontier (Arctic and offshore) oil and gas in the 1980s it will be generally in the range from $10,000 to $25,000; for synthetic gaseous and liquid fuels made from coal, from $20,000 to $50,000 or more per daily barrel.

The scale of these capital costs is generally recognized in the industries concerned. What is less widely appreciated—partly because capital costs of electrical capacity are normally calculated per installed (not delivered) kilowatt and partly because whole system costs are rarely computed—is that capital cost is many times greater for new systems that make electricity than for those that burn fuel directly. For coal-electric capacity ordered today, a reasonable estimate would be about $170,000 for the delivered equivalent of one barrel of oil per day; for nuclear-electric capacity ordered today, about $200,000–300,000. Thus, the capital cost per delivered kilowatt of electric energy emerges as roughly one hundred times that of the traditional direct fuel technologies on which our society has been built.[7]

The capital intensity of coal conversion and, even more, of large electrical stations and distribution networks is so great that many analysts, such as the strategic planners of the Shell Group in London, have concluded that no major country outside the Persian Gulf can afford these centralized high technologies on a truly large scale, large enough to run a country. They are looking, in Monte Canfield's phrase, like future technologies whose time has passed.

Relying heavily on such technologies, the 1976–1985 energy program proposed in the January 1975 State of the Union Message turns out to cost over $1 trillion (in 1976 dollars) in initial investment, of which about 70 to 80 percent would be for new rather than replacement plants.[8] The latter figure corresponds to about three-fourths of cumulative net private domestic investment (NPDI) over the decade (assuming that NPDI remains 7 percent of gross national product and that GNP achieves real growth of 3.5 percent per year despite the adverse effects of the energy program on other investments). In contrast, the energy sector has recently required only one-fourth of NPDI. Diverting to the energy sector not only this hefty share of discretionary investment but also about two-thirds of all the rest would deprive other sectors that have their own cost escalation problems and their own v[illegible]constituencies. A powerful political response could be expecte[illegible] this capital burden is not temporary; further up the curves o[illegible]2–1 it tends to increase, and much of what might have bee[illegible]ought to be increased national wealth must be plowed back into the care and feeding of the energy system. Such long lead time, long payback time investments might also be highly inflationary.

Of the $1 trillion plus just cited, three-fourths would be for electrification. About 18 percent of the total investment could be saved just by reducing the assumed average 1976–1985 electrical growth rate from 6.5 to 5.5 percent per year.[9] Not surprisingly, the combination of disproportionate and rapidly increasing capital intensity, long lead times, and economic responses is already proving awkward to the electric utility industry, despite the protection of a 20 percent taxpayer subsidy on new power stations.[10] "Probably no industry," observes Bankers Trust Company, "has come closer to the edge of financial disaster." In many countries today an effective feedback loop is observable: large capital programs → poor cash flow → higher electricity prices → reduced de-

[7] The capital costs for frontier fluids and for electrical systems can be readily calculated from the data base of the Bechtel model (see *supra* note 2).

[8] The Bechtel model, using 1974 dollars and assuming ordering in early 1974, estimates direct construction costs totaling $559 billion, including work that is in progress but not yet commissioned in 1985. Interest, design, and administration—but not land, nor escalation beyond the GNP inflation rate—bring the total to $743 billion. Including the cost of land, and correcting to a 1976 ordering date and 1976 dollars, is estimated by M. Carasso to yield over $1 trillion.

[9] M. Carasso et al., *supra* note 2.

[10] E. Kahn et al., "Investment Planning in the Energy Sector," LBL–4479 (Berkeley, California: Lawrence Berkeley Laboratory, 1 March 1976). See also T. D. Mount & L. D. Chapman, in *Proceedings of the Workshop on Energy Demand* (22–23 May 1976), CP–76–1 (Laxenburg, Austria: IIASA, 1976), p. 164.

mand growth → worse cash flow → increased bond flotation → increased debt-to-equity ratio, worse coverage, and less attractive bonds → poor bond sales → worse cash flow → higher electricity prices → reduced (even negative) demand growth and political pressure on utility regulators → overcapacity, credit pressure, and higher cost of money → worse cash flow, etc. This "spiral of impossibility," as Mason Willrich has called it, is exacerbated by most utilities' failure to base historic prices on the long-run cost of new supply: thus some must now tell their customers that the current dollar cost of a kilowatt-hour will treble by 1985, and that two-thirds of that increase will be capital charges for new plants. Moreover, experience abroad suggests that even a national treasury cannot long afford electrification: a New York State-like position is quickly reached, or too little money is left over to finance the energy *uses*, or both.

2.4. IMPROVING ENERGY EFFICIENCY

Summarizing a similar situation in Britain, Walter Patterson concludes: "Official statements identify an anticipated 'energy gap' which can be filled only with nuclear electricity; the data do not support any such conclusion, either as regards the 'gap' or as regards the capability of filling it with nulear electricity." We have sketched one form of the latter argument; let us now consider the former.

Despite the steeply rising capital intensity of new energy supply, forecasts of energy demand made as recently as 1972 by such bodies as the Federal Power Commission and the Department of the Interior wholly ignored both price elasticity of demand and energy conservation. The Chase Manhattan Bank in 1973 (and again in 1976) saw virtually no scope for conservation save by minor curtailments: the efficiency with which energy produced economic outputs was assumed to be optimal already. In 1977, some analysts still predict economic calamity if the United States does not continue to consume twice the combined energy total for Africa, the rest of North and South America, and Asia except Japan. But what have more careful studies taught us about the scope for doing better with the energy we have? Since we can't keep the bathtub filled because the hot water keeps running out, do we really (as Malcolm MacEwen asks) need a bigger water heater, or could we do better with a cheap, low technology plug?

There are two ways, divided by a somewhat fuzzy line, to do more with less energy. First, we can plug leaks and use thriftier technologies to produce exactly the same output of goods and services—and bads and nuisances—as before, substituting other resources (capital, design, management, care, etc.) for some of the energy we formerly used. When measures of this type use today's technologies, are advantageous today by conventional economic criteria, and have no significant effect on lifestyles, they are called "technical fixes."

In addition, or instead, we can make and use a smaller quantity or a different mix of the outputs themselves, thus to some degree changing (or reflecting ulterior changes in) our lifestyles. We might do this because of changes in personal values, rationing by price or otherwise, mandatory curtailments, or gentler inducements. Such "social changes" include carpooling, smaller cars, mass transit, bicycles, walking, opening windows, dressing to suit the weather, and extensively recycling materials. Technical fixes, on the other hand, include thermal insulation, heat pumps (devices like air conditioners that move heat around—often in either direction—rather than making it from scratch), more efficient furnaces and car engines, less overlighting and overventilation in commercial buildings, and recuperators for waste heat in industrial processes. Hundreds of technical and semitechnical analyses of both kinds of conservation have been done; in the last two years especially, much analytic progress has been made.

Theoretical analysis suggests that, in the long term, technical fixes *alone* in the United States could probably improve energy efficiency by a factor of at least three or four.[11] A recent review of specific practical measures cogently argues that with only those technical fixes that could be implemented by about the turn of the century, Americans could nearly double the efficiency with which they use energy.[12] If that is correct, economic activity could increase steadily with approximately constant primary energy use for the next few decades, thus stretching present energy supplies rather than having to add massively to them. One careful comparison shows that *after* correcting for differences of climate, geography, hydroelectric capacity, etc., Americans would still use about a third less energy than they do now if they were as efficient as the Swedes (who see much room for improvement in their own efficiency).[13] U.S. per capital energy intensity, too, is about twice that of West Germany in space heating, four times in transport.[14] Much of the difference is attributable to technical fixes.

Some technical fixes are already under way in the United States. Extensive new federal and state legislation is starting to be implemented. Many factories have cut tens of percent off their fuel cost per unit output, often with practically no capital investment. New 1976 cars averaged 27 percent better mileage than 1974 models. And there is overwhelming evidence that technical fixes are generally much cheaper than increasing energy supply, as well as quicker, safer, and of more lasting benefit. They are also better for secure, broadly based employment using existing skills. Most energy conservation measures and the shifts of consumption that they occasion are relatively labor-intensive. Even making more energy-efficient home appliances is about twice as good for jobs as is building power stations: the latter is practically the least labor-intensive major investment in the whole economy.

The capital savings of conservation are particularly impressive. In the terms used above, the investments needed to *save* the equivalent of an extra barrel of oil per day are often zero to $3500, generally under $8000, and at most about $25,000—far less than the amounts needed to increase most kinds of energy supply. Indeed, to use energy efficiently in new buildings, especially commercial ones, the additional capital cost is often *negative:* savings on heating and cooling equipment more than pay for the other modifications.

To take one major area of potential saving, technical fixes in new buildings—almost anywhere in the world—can save 50 percent or more in office buildings and 80 percent or more in some new U.S.

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[11] American Institute of Physics Conference Proceedings No. 25, *Efficient Use of Energy* (New York: AIP, 1975), summarized in *Physics Today*, August 1975.

[12] M. Ross and R. H. Williams, *Bull. Atom. Scient.* 32:9, 30–38 (November 1976) and *Technology Review*, in press (1977); see also L. Schipper, *Ann. Rev. Energy* 1:455–518 (1976); and R. H. Socolow, "The Coming Age of Conservation," *Ann. Rev. Energy* 2: in press (1977).

[13] L. Schipper and A. J. Lichtenberg, *Science* 194:1001–13 (1976).

[14] R. L. Goen and R. K. White, "Comparison of Energy Consumption Between West Germany and the United States", (Menlo Park, California: Stanford Research Institute, June 1975).

houses.[15] A recent American Institute of Architects study concludes that, by 1990, improved design of new buildings and modification of old ones could save a third of our current *total* U.S. energy use—and save money too. The payback time would be only half that of the alternative investment in increased energy supply, so the same capital could be used twice over.

A second major area lies in "cogeneration," or the generating of electricity as a by-product of the process steam normally produced in many industries. A Dow study chaired by Paul McCracken reports that by 1985 U.S. industry could meet approximately half its own electricity needs (compared to about a seventh today) by this means. Such cogeneration would save $20–50 billion in investment, save fuel equivalent to two to three million barrels of oil per day, obviate the need for more than fifty large reactors, and (with flattened utility rates) yield at least 20 percent pretax return on marginal investment while reducing the price of electricity to consumers.[16] Another measure of the potential is that cogenertion, whose contribution to U.S. electricity supply has fallen from about 15 percent in 1950 to about 4 percent today, still supplies about 12 percent in West Germany. Cogeneration and more efficient use of electricity could together reduce U.S. use of electricity by a third and central station generation by 60 percent.[17] Like district heating (distribution of waste heat as hot water via insulated pipes to heat buildings), U.S. cogeneration is held back only by institutional barriers. Yet these are smaller than those that were overcome when the present utility industry was established.

So great is the scope for technical fixes now that the U.S. could spend several hundred billion dollars on them initially plus several hundred million dollars per day—and still save money compared with increasing the suppy! And one would still have the fuel (without the environmental and geopolitical problems of getting and using it). The barriers to far more efficient use of energy are not technical, nor in any fundamental sense economic. So why do we stand here, confronted, as Pogo said, by insurmountable opportunities?

The answer—apart from poor information and ideological antipathy and rigidity—is a wide array of institutional barriers, including more than 3000 conflicting and often obsolete building codes, an innovation-resistant building industry, lack of mechanisms to ease the transition

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[15] A. D. Little, Inc., "An Impact Assessment of ASHRAE Standard 90–75," report to FEA, C–78309, December 1975; J. E. Snell et al. (National Bureau of Standards), "Energy Conservation in Office Buildings: Some United States Examples," International CIB Symposium on Energy Conservation in the Built Environment (Building Research Establishment, Garston, Watford, England, April 1976 (Hornby, Lancs.: Construction Press Ltd., 1976); Owens-Corning Fiberglas (Toledo, Ohio), "The Arkansas Story," 1975; E. Hirst, *Science* *194*:1247 (1976); recent publications of the American Institute of Architects (Washington, D.C.); Dubin-Mindell-Bloome Associates, *A Study of Existing Energy Usage on Long Island and the Impact of Energy Conservation, Solar Energy, Total Energy and Wind Systems on Future Requirements* (New York, 31 October 1975).

[16] P. W. McCracken et al. *Industrial Energy Center Study*, Dow Chemical Co. et al. report to NSF, PB–243 824, NTIS, June 1975. Two important studies published more recently have examined a wider range of sizes and types of cogeneration systems and have concluded that the Dow report substantially underestimates the potential: S. E. Nydick et al., "A Study of Inplant Electric Power Generation in the Chemical, Petroleum Refining, and Paper and Pulp Industries," Thermo Electron Corporation report to FEA, PB–255–658 and –659, NTIS, May 1976; and R. H. Williams, "The Potential for Electricity Generation as a By-product of Industrial Steam Production in New Jersey," report to N.J. Cabinet Energy Committee (Princeton, New Jersey: Center for Environmental Studies, Princeton University, 21 June 1976).

[17] Ross and Williams, *supra* note 12. A further 5 quad saving in U.S. primary energy through currently economic combined heat and power stations and district heating grids—which could reach at least half the U.S. population—is calculated by J. Karkheck et al., *Science 195*:948–55 (1977).

from kinds of work that we no longer need to kinds we do need, opposition by strong unions to schemes that would transfer jobs from their members to larger numbers of less "skilled" workers, promotional utility rate structures, fee structures giving building engineers a fixed percentage of prices of heating and cooling equipment they install, inappropriate tax and mortgage policies, conflicting signals to consumers, misallocation of conservation's costs and benefits (builders versus buyers, landloards versus tenants, etc.), imperfect access to capital markets, fragmentation of government responsibility, etc.

Though economic answers are not always right answers, properly using the markets we have (see Chapter 1.5) may be the greatest single step we could take toward a sustainable, humane energy future. The sound economic principles we need to apply include flat (even inverted) utility rate structures rather than discounts for large users, pricing energy according to what extra supplies will cost in the long run ("long-run marginal cost pricing"), removing subsidies, assessing the total costs of energy-using purchases over their whole operating lifetimes ("life cycle costing"), counting the costs of complete energy systems including all support and distribution systems, properly assessing and charging environmental costs, valuing assets by what it would cost to replace them, discounting appropriately, and encouraging competition through antitrust enforcement (including at least horizontal divestiture of giant energy corporations).

Such practicing of the market principles we preach could go very far to help us use energy efficiently and get it from sustainable sources. But just as clearly, there are things the market cannot do, like reforming building codes or utility practices. And whatever our means, there is room for differences of opinion about how far we can achieve the great theoretical potential for technical fixes. How far might we instead choose, or be driven to, some of the "social changes" mentioned earlier?

There is no definitive answer to this question—though it is arguable that if we are not clever enough to overcome the institutional barriers to implementing technical fixes, we shall certainly not be clever enough to overcome the more familiar but more formidable barriers to increasing energy supplies. My own view of the evidence is, first, that North Americans are adaptable enough to use technical fixes *alone* to double, in the next few decades, the amount of social benefit wrung from each unit of end-use energy; and second, that value changes that could either replace or supplement those technical changes are also occurring rapidly. If either of these views is right, or if both are partly right, North Americans should be able to double end-use efficiency by the turn of the century or shortly thereafter, with minor or no changes in lifestyles or values save increasing comfort for modestly increasing numbers, then over the period 2010–2040 to shrink per capita primary energy use to perhaps a third or a quarter of today's.[18] (The former

[18] A calculation for Canada supports this view: A.B. Lovins, *Conserver Society Notes* (Ottawa: Science Council of Canada, May/June 1976), pp. 3–16. Technical fixes already approved in principle by the Canadian Cabinet should hold approximately constant until 1990 the energy required for the transport, commercial, and house-heating sectors; sustaining similar measures to 2025 is estimated to shrink per capita primary energy to about half today's level. Plausible social changes are estimated to yield a further halving. The Canadian and U.S. energy systems have rather similar structures. The potential for increasing end-use efficiency is considerably less in Europe than in North America: a doubling might be expected in Europe over the next fifty years or so, rather than the North American quadrupling.

would reach the per capita level of the wasteful, but hardly troglodytic, French; the latter, the level of the New Zealanders or the 1970 Swiss). Even in the case of fourfold shrinkage, the resulting society could be instantly recognizable to a visitor from the 160s and need in no sense be a pastoralist's utopia—though that option would remain open to those who may desire it.

The long-term mix of technical fixes with structural and value changes in work, leisure, agriculture, and industry will require much trial and error. It will take many years to make up our diverse minds about. It will not be easy—merely easier than not doing it. Meanwhile, it is easy only to see what not to do.

If one assumes that by resolute technical fixes and modest social innovation North Americans can double their end-use efficiency by shortly after 2000, then they could be twice as affluent as now with today's level of energy use, or as affluent as now while using only half the end-use energy they use today. Or they might be somewhere in between—significantly more affluent (and equitable) than today but with less end-use energy.

Many analysts now regard modest, zero, or negative growth in the rate of energy use in industrial countries as a realistic long-term goal. Present annual U.S. primary energy demand, for example, is about seventy-five quadrillion BTU ("quads"), and most official projections for 2000 envisage growth to 130–170 quads. However, recent work at the Institue for Energy Analysis, Oak Ridge, under the direction of Dr. Alvin Weinberg, suggests that standard projections of energy demand are far too high because they do not take into account changes in demographic and economic trends. In June 1976 the institute considered that with a conservation program far more modest than that contemplated in this article, the likely range of U.S. primary energy demand in the year 2000 would be about 101–126 quads, with the lower end of the range more probable and end-use energy being about 60–65 quads, much less than is considered here. In early 1977, Professors R. H. Williams and F. von Hippel of Princeton University likewise showed in their testimony to the Nuclear Regulatory Commission's GESMO hearings that 112 quads in 2000 could be considered a "business-as-usual" projection assuming only the conservation measures already enacted, with further modest conservation yielding only ninety-five quads. And, at the further end of the spectrum, projections of U.S. primary energy for 2010 being seriously studied by the Committee on Nuclear and Alternative Energy Systems, a major U.S. National Research Council study due to report in mid-1977, ranged as low as about seventy quads (fifty-four quads of fuels plus sixteen of solar energy), with an even lower figure (forty to fifty quads total primary energy) being examined.

As the basis for a coherent alternative to the path shown in Figure 2–1, Figure 2–2 sketches a primary energy demand of about ninety-five quads for 2000—a value that the above data suggest is by no means the lowest that could be realistically considered. Total energy demand would gradaully decline thereafter as inefficient buildings, machines, cars, and energy systems are slowly modified or replaced. Let us now explore the other ingredients of such a path—starting with the "soft" supply technologies which, spurned in Figure 2–1 as insignificant, now assume great importance.

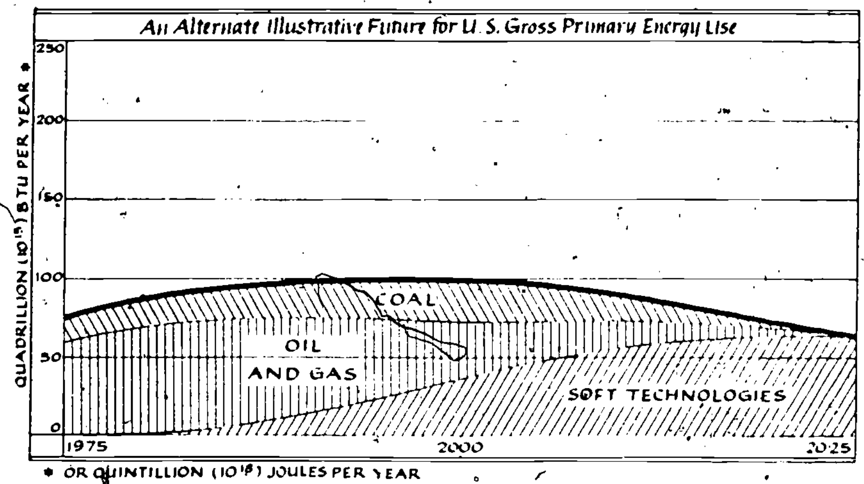

FIGURE 2-2

2.5. SOFT ENERGY TECHNOLOGIES

There exists today a body of energy technologies that have certain specific features in common and that offer great technical, economic, and political attractions, yet for which there is no generic term. For lack of a more satisfactory term, I shall call them "soft" technologies: a textural description, intended to mean not vague, mushy, speculative, or ephemeral, but rather flexible, resilient, sustainable, and benign. Energy paths dependent on soft technologies illustrated in Figure 2-2, will be called "soft" energy paths, as the "hard" technologies sketched in Chapter 2.2 constitute a "hard" path (in both senses). The distinction between hard and soft energy paths rests not on how much energy is used, but on the technical and sociopolitical *structure* of the energy system, thus focusing our attention on consequent and crucial political differences.

In Figure 2-2, then, the social structure is significantly shaped by the rapid deployment of soft technologies. These are defined by five characteristics:

1. They rely on renewable energy flows that are always there whether we use them or not, such as sun and wind and vegetation: on energy income, not on depletable energy capital.
2. They are diverse, so that as a national treasury runs on many small tax contributions, so national energy supply is an aggregate of very many individually modest contributions, each designed for maximum effectiveness in particular circumstances.
3. They are flexible and relatively low technology—which does not mean unsophisticated, but rather, easy to understand and use without esoteric skills, accessible rather than arcane (see Chapter Nine).
4. They are matched in *scale* and in geographic distribution to end use needs, taking advantage of the free distribution of most natural energy flows.

5. They are matched in *energy quality* to end-use needs: a key feature that deserves immediate explanation.

People do not want electricity or oil, nor such economic abstractions as "residential services," but rather comfortable rooms, light, vehicular motion, food, tables, and other real things. Such end-use needs can be classified by the physical nature of the task to be done (see Chapter Four). In the United States today, about 58 percent of all energy at the point of end use is required as heat, split roughly 23–25 between temperatures above and below the boiling point of water. (In Western Europe the low temperature heat alone is often a half of all end-use energy.) Another 38 percent of all U.S. end use energy provides mechanical motion: 31 percent in vehicles, 3 percent in pipelines, 4 percent in industrial electric motors. The rest, a mere 4 percent of delivered energy, represents *all lighting*, electronics, telecommunications, electrometallurgy, electrochemistry, arc welding, electric motors in home appliances and in railways, and similar end uses that now *require* electricity.

Some 8 percent of all U.S. energy end use, then, and similarly little abroad (see Chapter 4), requires electricity for purposes other than low temperature heating and cooling. Yet, since we actually use electricity for many such low grade purposes, it now meets 13 percent of U.S. end-use needs—and its generation consumes 29 percent of U.S. fossil fuels. A hard energy path would increase this 13 percent figure to 20–40 percent (depending on assumptions) by the year 2000, and far more thereafter. But this is wasteful because the laws of physics require, broadly speaking, that a power station change three units of fuel into two units of almost useless waste heat plus one unit of electricity. The electricity can do more difficult kinds of work than can the original fuel, but unless this extra quality and versatility are used to advantage, the costly process of upgrading the fuel—and losing two-thirds of it—is all for naught.

Plainly we are using premium fuels and electricity for many tasks for which their high energy quality is superfluous, wasteful, and expensive, and a hard path would make this inelegant practice even more common. Where we want only to create temperature differences of tens of degrees, we should meet the need with sources whose potential is tens or hundreds of degrees, not with a flame temperature of thousands or a nuclear reaction temperature equivalent to trillions—like cutting butter with a chainsaw.

For some applications, electricity is appropriate and indispensable: electronics, smelting, subways, most lighting, some kinds of mechanical work, and a few more. But these uses are already oversupplied, and for the other, dominant, uses remaining in our energy economy this special form of energy cannot give us our money's worth (in many parts of the United States today it already costs $50–120 per barrel equivalent). Indeed, in probably no industrial country today can additional supplies of electricity be used to thermodynamic advantage that would justify their high cost in money and fuels.

So limited are the U.S. end uses that really require electricity that by applying careful technical fixes to them we could reduce their 8 percent total to about 5 percent (mainly by reducing commercial overlighting), whereupon we could probably cover all those needs with present U.S. hydroelectric capacity plus the cogeneration capacity available in the mid to late 1980s.[19] Thus an affluent industrial economy could advantageously operate with no central power stations at all! In practice we would not necessarily want to go that far, at least not for a long time; but the possibility illustrates how far we are from supplying energy only in the quality needed for the task at hand.

Just as soft technologies' matching of energy quality to end-use needs virtually eliminates the costs and losses of secondary energy conversion, so the appropriate scale (see Chapter Five) of soft technologies can virtually eliminate the costs and losses of energy distribution. Matching scale to end uses can indeed achieve at least five important types of economies (see Chapter Five) not available to larger, more centralized systems. The first type is reduced and shared overheads. [illegible] half your electricity bill is fixed distribution costs to pay the overheads of a sprawling energy system: transmission lines, transformers, cables, meters and people to read them, planners, headquarters, billing computers, interoffice memos, advertising agencies. For [illegible] and some fossil fuel systems, distribution accounts for more than half of total capital cost, and administration for a significant fraction of total operating cost. Local or domestic energy systems can reduce or even eliminate these infrastructure costs. The resulting savings can far outweigh the extra costs of the dispersed maintenance infrastructure that the small systems require, particularly where that infrastructure already exists or can be shared (e.g., plumbers fixing solar heaters as well as sinks).

Small scale brings further savings by virtually eliminating distribution losses, which are cumulative and pervasive in centralized energy systems (particularly those using high quality energy). Small systems also avoid direct diseconomies of scale, such as the frequent unreliability of large units and the related need to provide instant "spinning reserve" capacity on electrical grids to replace large stations that suddenly fail. Small systems with short lead times greatly reduce exposure to interest, escalation, and mistimed demand forecasts—major indirect diseconomies of large scale.

The fifth type of economy available to small system arise from mass production. Consider, as Henrik Harboe suggests, the 100-odd million cars in the U.S. In round numbers, each car probably has an average cost of less than $4,000 and a shaft power over 100 kilowatts (134 horsepower). Presumably a good engineer could build a generator and upgrade an automobile engine to a reliable, 35 percent efficient diesel at no greater total cost, yielding a mass-produced diesel generator unit costing less than $40 per kW. In contrast, the motive capacity in U.S. central power stations—currently totaling about one-fortieth as much as in U.S. cars—costs perhaps ten times more per kW, partly because it is not mass produced. This is not to argue for the widespread use of diesel generators; rather, to suggest that if we could build power stations the way we build cars, they would cost at least ten times less than they do, but we can't because they're too big. In view of this scope for mass-producing small systems, it is not surprising that at least one European car maker hopes to go into the wind machine and heat pump business. Such a market can be entered in-

[19] The scale of potential conservation in this area is given in Ross and Williams, *supra* note 12; the scale of potential cogeneration capacity is from McCracken et al., and from Nydick et al., *supra* note 16.

crementally, without the billions of dollars' investment required for, say, liquefying natural gas or gasifying coal. It may require a production philosophy oriented toward technical simplicity, low replacement cost, slow obsolescence, high reliability, high volume, and low markup; but these are familiar concepts in mass production. Industrial resistance would presumably melt when—as with pollution abatement equipment—the scope for profit was perceived.

This is not to say that all energy systems need be at domestic scale. The object is to crack nuts with nutcrackers and drive pilings with triphammers, not the reverse: to use the most appropriately scaled tool for the job and so minimize costs, including social costs. In some cases this will require big systems, chiefly the existing hydroelectric dams. In most cases the scale needed will be smaller. For example, the medium scale of urban neighborhoods and rural villages offers fine prospects for solar collectors—especially for adding collectors to existing buildings of which some (perhaps with large flat roofs) can take excess collector area while others cannot take any. They could be joined via communal heat storage systems, saving on labor cost and on heat losses. The costly craftwork of remodeling existing systems—"backfitting" or "retrofitting" idiosyncratic houses with individual collectors—could thereby be greatly reduced. Despite these advantages, medium-scale solar technologies are currently receiving little attention apart from a condominium village project in Vermont sponsored by the Department of Housing and Urban Development and the one hundred dwelling unit Méjannes-le-Clap project in France.

The schemes that dominate ERDA's solar research budget—such as making electricity from huge collectors in the desert, or from temperature differences in the oceans, or from Brooklyn Bridge-like satellites in outer space—do not satisfy our criteria, for they are ingenious high technology ways to supply energy in a form and at a scale inappropriate to most end-use needs. Not all solar technologies are soft. Nor, for the same reason, is nuclear fusion a soft technology.[20] But many genuine soft technologies are now available and are now economic. What are some of them?

Solar heating and, imminently, cooling head the list. They are incrementally cheaper than electric heating, and far more inflation-proof, practically anywhere in the world.[21] In the United States (with fairly high average sunlight levels), they are cheaper than present electric heating virtually anywhere, cheaper than oil heat in many parts, and cheaper than gas and coal in some. Even in the least favor-

[20] Assuming (which is still not certain) that controlled nuclear fusion works, it will almost certainly be more difficult, complex, and costly—though safer and perhaps more permanently fueled—than fast breeder reactors. See W. D. Metz, *Science* 192: 1320–23 (1976); *193*:38–40, 76(1976); and *193*:307–309 (1976). But for three reasons we ought not to pursue fusion. First, it generally produces copious fast neutrons that can and probably would be used to make bomb materials. Second, if it turns out to be rather "dirty," as most fusion experts expect, we shall probably use it anyway, whereas if it is clean, we shall so overuse it that the resulting heat release will alter global climate: we should prefer energy sources that give us enough for our needs while denying us the excesses of concentrated energy with which we might do mischief to the earth or to each other. Third, fusion is a clever way to do something we don't really want to do, namely to find *yet another* complex, costly, large-scale, centralized, high technology way to make electricity—all of which goes in the wrong direction.

[21] Partial or total solar heating is attractive and is being demonstrated even in cloudy countries approaching the latitude of Anchorage, such as Denmark and the Netherlands (International CIB Symposium, *supra* note 15) and Britain (*Solar Energy: United Kingdom Assessment*, International Solar Energy Society, London, May 1976). See also Chapter Seven, note 38.

able parts of the continental United States, far more sunlight falls on a typical building than is required to heat and cool it without supplement; whether this is considered economic depends on how the accounts are done.[22] The difference in solar input between the most and least favorable parts of the lower forty-nine states is generally less than twofold, and in cold regions, the long heating season can improve solar economics.

Ingenious ways of backfitting existing urban and rural buildings (even large commercial ones) or their neighborhoods with efficient and exceedingly reliable solar collectors are being rapidly developed in both the private and public sectors. In some recent projects, the lead time from ordering to operation has been only a few months. Good solar hardware, often modular, is going into pilot or full scale production over the next few years, and will increasingly be integrated into buildings as a multipurpose structural element, thereby sharing costs. Such firms as Philips, Honeywell, Revere, Pittsburgh Plate Glass, and Owens-Illinois, plus many dozens of smaller firms, are applying their talents, with rapid and accelerating effect, to reducing unit costs and improving performance. Some novel types of very simple collectors with far lower costs also show promise in current experiments. Indeed, solar hardware per se is necessary only for backfitting existing buildings. If we build new buildings properly in the first place, they can use "passive" solar collectors—large south windows or glass-covered black south walls—rather than special collectors. If we did this to all new houses in the next twelve years, we would save about as much energy as we expect to recover from the Alaskan North Slope.[23]

Second, exciting developments in the conversion of agricultural, forestry, and urban wastes to methanol and other liquid and gaseous fuels now offer practical, economically interesting technologies sufficient to run an efficient U.S. transport sector.[24] Some bacterial and enzymatic routes under study look even more promising, but presently proved processes already offer sizable contributions without the inevitable climatic constraints of fossil fuel combustion. Organic conversion technologies must be sensitively integrated with agriculture and forestry so as not to deplete the soil; most current methods seem suitable in this respect, through they may change the farmer's priorities by making his whole yield of biomass (vegetable matter) salable.

The required scale of organic conversion can be estimated. Each year the U.S. beer and wine industry, for example, microbiologically produces 5 percent as many gallons (not all alchohol, of course) as the U.S. oil industry produces gasoline. Gasoline has 1.5 to 2 times the fuel value of alcohol per gallon. Thus a conversion industry

[22] Solar heating cost is traditionally computed microeconomically for a consumer whose alternative fuels are not priced at long-run marginal cost (see, e.g., G. Bennington et al.'s MITRE study M76/79, "An Economic Analysis of Solar Water and Space Heating" [November 1976], announced by the ERDA Solar Division on 29 December 1976 [release 76–376], which also assumes unrealistically high solar costs and 100% backup capacity). Another method would be to compare the total cost (capital and life cycle) of the solar system with the total cost of the other complete systems that would otherwise have to be used in the long run to heat the same space. On that basis, 100 percent solar heating, even with twice the capital cost of two-thirds or three-fourths solar heating, is almost always advantageous. See Chapter Eight, and H. A. Bethe and A. B. Lovins, exchange of letters, *Foreign Affairs*, April 1977.

[23] R. W. Bliss, *Bull. Atom Scient.* 32 : 3, 32 40 (March 1976).

[24] A.D. Poole and R.H. Williams, *Bull. Atom. Scient.* 32 :5, 48 58 (May 1976)

roughly ten to fourteen times the physical scale (in gallons of fluid output per year) of U.S. cellars and breweries, albeit using different processes, would produce roughly one-third of the present gasoline requirements of the United States. If one assumes a transport sector with three times today's average efficiency—a reasonable estimate for early in the next century—then the whole of the transport needs could be met by organic conversion. The scale of effort required does not seem unreasonable, since it would replace in function half the present refinery capacity.

Additional soft technologies include wind hydraulic systems (especially those with a vertical axis), which already seem likely in many design studies to compete with nuclear power in much of North America and Western Europe. But wind is not restricted to making electricity: it can heat, pump, heat-pump, or compress air. Solar process heat, too, is coming along rapidly as we learn to use the 5800° C potential of sunlight (much hotter than a boiler). Finally, high and low temperature solar collectors, organic converters, and wind machines can form symbiotic hybrid combinations more attractive than the separate components.

Energy storage is often said to be a major problem of energy income technologies. But this "problem" is largely an artifact of trying to recentralize, upgrade and redistribute inherently diffuse energy flows. Directly storing sunlight or wind—or, for that matter, electricity from any source—is indeed difficult on a large scale. But it is easy if done on a scale and in an energy quality matched to most end use needs. Daily, even seasonal, storage of low and medium temperature heat at the point of use is straightforward with water tanks, rock beds, or perhaps fusible salts. Neighborhood heat storage is even cheaper. In industry, wind-generated compressed air can easily (and, with due care, safely) be stored to operate machinery: the technology is simple, cheap, reliable, and highly developed. (Some European cities even used to supply compressed air as a standard utility.) Installing pipes to distribute hot water (or compressed air) tends to be considerably cheaper than installing equivalent electric distribution capacity. Hydroelectricity is stored behind dams, and organic conversion yields readily stored liquid and gaseous fuels. On the whole, therefore, energy storage is much less of a problem in a soft energy economy than in a hard one.

Recent research suggests that a largely or wholly solar economy can be constructed in the United States with straightforward soft technologies that are now demonstrated and now economic or nearly economic.[25] Such a conceptual exercise does not require "exotic" methods such as sea-thermal, hot-dry-rock geothermal, cheap (perhaps organic) photovoltaic, or solar-thermal electric systems. If developed, as some probably will be, these technologies could be convenient, but they are in no way essential for an industrial society operating solely on energy income.

Figure 2–2 shows a plausible and realistic growth pattern, based on several detailed assessments for soft technologies given aggressive sup-

[25] For examples, see the Canadian computations in A.B. Lovins *Conserver Society Notes* (*supra* note 18), Bent Sørensen's Danish estimates in *Science 189*:255–60 (1975), and, as a useful data base, the forthcoming estimates by the Union of Concerned Scientists (*supra* note 1).

port. The useful output from these technologies would overtake, starting in the 1990s, the output of nuclear electricity shown in even the most sanguine federal estimates. For illustration, Figure 2–2 shows soft technologies meeting virtually all energy needs in 2025, reflecting a judgment that a completely soft supply mix is practicable in the long run, with or without the 2000–2025 energy shrinkage shown. Though most technologists who have thought seriously about the matter will concede it conceptually, some may be uneasy about the details. Obviously the sketched curve is not definitive, for although the general direction of the soft path must be shaped soon, the details of the energy economy in 2025 would not be committed in this century. To a large extent, therefore, it is enough to ask yourself whether Figure 2–1 or 2–2 seems preferable in the 1975–2000 period.

A simple comparison, shown schematically in Figure 2–3, may help. Roughly half, perhaps more, of the gross primary energy being produced in the hard path in 2025 is lost in conversions. A further appreciable fraction is lost in distribution. Delivered end-use energy is thus not vastly greater than in the soft path, where conversion and distribution losses have been all but eliminated. (What is lost can often be used locally for heating, and is renewable, not depletable.) But the soft path makes each unit of end-use energy perform several times as much social function as it would have done in the hard path; so in a conventional sense, social welfare in the soft path in 2025 is substantially greater than in the hard path at the same date.

2.6 TRANSITIONAL ENERGY TECHNOLOGIES

To fuse into a coherent strategy the benefits of energy efficiency and of soft technologies, we need one further ingredient: transitional technologies that use fossil fuels briefly and sparingly to build a bridge to the energy income economy of 2025, conserving those fuels—especially oil and gas—for petrochemicals (ammonia, plastics, etc.) and leaving as much as possible in the ground for emergency use only.

Some transitional technologies have already been mentioned under the heading of conservation—specifically, cogenerating electricity from existing industrial steam and using existing waste heat for district heating. Given such measures, increased end-use efficiency, and the rapid development of biomass alcohol as a portable liquid fuel, the principal short- and medium-termed problem becomes, not a shortage of electricity or of portable liquid fuels, but a shortage of clean sources of heat. It is above all the sophisticated use of coal, chiefly at modest scale, that needs development. Technical measures to permit the highly efficient use of this widely available fuel would be the most valuable transitional technologies.

Neglected for so many years, coal technologies is now experiencing a virtual revolution. We are developing supercritical gas extraction, flash hydrogenation, flash pyrolysis, panel-bed filters, and similar ways to use coal cleanly at essentially any scale and to cream off valuable liquids and gases as premium fuels before burning the rest. These methods largely avoid the costs, complexity, inflexibility, technical risks, long lead times, large scale, and tar formation of the traditional processes that now dominate our research.

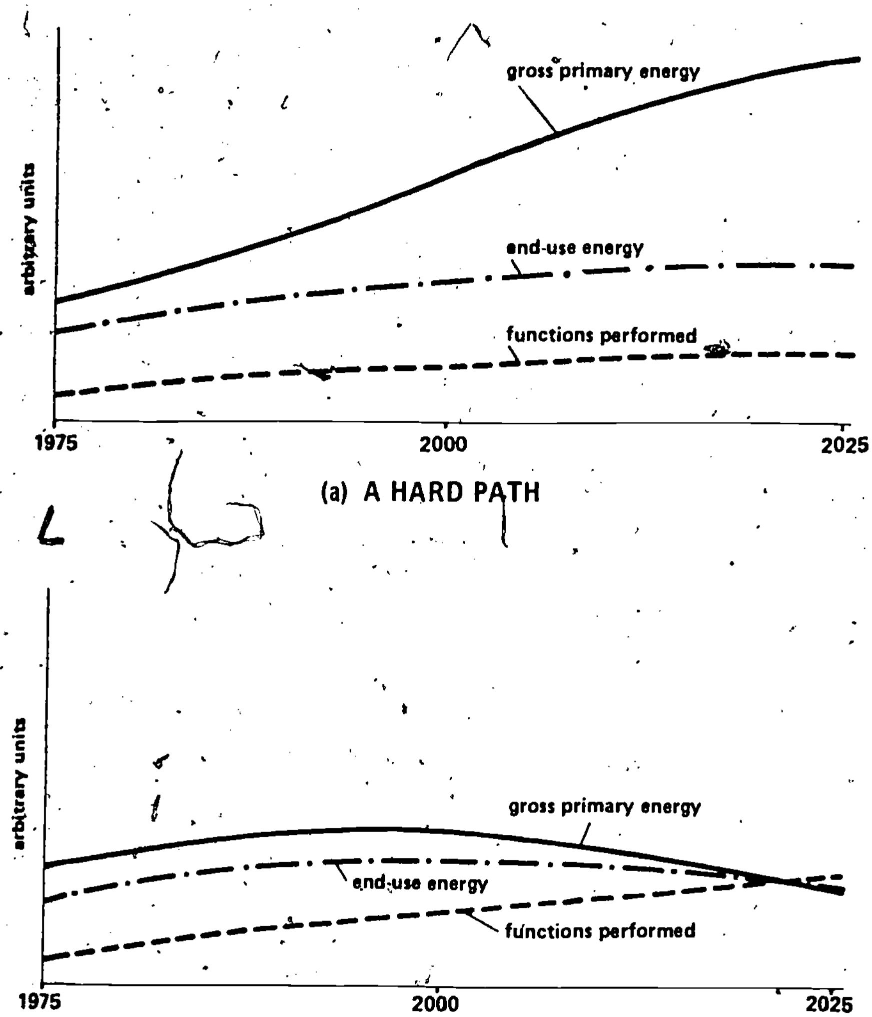

FIGURE 2–3. Schematic Sketch of Gross Primary Energy, End-Use Energy, and Quantity of Functions Performed by End-Use Energy in Hard and Soft Energy Paths.

Perhaps the most exciting current development is the so-called fluidized bed system for burning coal (or virtually any other combustible material). Fluidized beds are simple, versatile devices that add the fuel a little at a time to a much larger mass of small, inert, red-hot particles—sand or ceramic pellets—kept suspended as an agitated fluid by a stream of air continuously blown up through it from below. The efficiency of combustion, of other chemical reactions (such as sulfur removal), and of heat transfer is remarkably high because of the turbulent mixing and large surface area of the particles. Fluidized beds have long been used as chemical reactors and for burning trash, but are now ready to be commercially applied to raising steam and operating turbines. In one system currently available from Stal-Laval Turbin AB of Sweden, eight off the shelf, 70 megawatt gas turbines powered by fluidized bed combusters, together with district-heating networks and heat pumps, would heat as many houses as a $1 billion plus coal gasification plant, but would use only two fifths as much coal, cost a half to two-thirds as much to build, and burn more cleanly than a normal power station with the best modern scrubbers.[26]

Fluidized bed boilers and turbines can power giant industrial complexes, especially for cogeneration, and are relatively easy to backfit into old municipal power stations. Scaled down, a fluidized bed can be a tiny household device—clean, strikingly simple, and flexible—that can replace an ordinary furnace or grate and can recover combustion heat with an efficiency over 80 percent.[27] At medium scale such technologies offer versatile boiler backfits and improve heat recovery in flues. With only minor modifications they can burn practically any fuel. It is essential to commercialize all these systems now—not to waste a decade on highly instrumented but noncommercial pilot plants constrained to a narrow, even obsolete design philosophy.[28]

Transitional technologies can be built at appropriate scale so that soft technologies can be plugged into the system later. For example, if district heating uses hot water tanks on a neighborhood scale, those tanks can in the long run be heated by neighborhood solar collectors, wind-driven heat pumps, a factory, a pyrolyzer, a geothermal well, or whatever else becomes locally available—offering flexibility that is not possible at today's excessive scale.

Both transitional and soft technologies are worthwhile industrial investments that can recycle moribund capacity and underused skills, stimulate exports, and give engaging problems to innovative technologists. Though neither glamorous nor militarily useful, these technologies are socially effective—especially in poor countries that need such scale, versatility and simplicity even more than rich countries do.

Properly used, coal, conservation, and soft technologies together can squeeze the "oil and gas" wedge in Figure 2–2 from both sides—so far that most of the frontier extraction and medium-term imports of oil and gas become unnecessary and conventional resources are greatly stretched. Coal can fill the real gaps in the fuel economy with only a temporary and modest (less than twofold at peak) expansion of mining, not requiring the enormous infrastructure and social impacts implied by the scale of coal use in Figure 2–1.

In sum, Figure 2–2 outlines a prompt redirection of effort at the margin that lets us use fossile fuels intelligently to buy the time we need to change over to living on our energy income. The innovations required, both technical and social, compete directly and immediately with the incremental actions that constitute a hard energy path: fluidized beds versus large coal gasification plants and coal-electric

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[26] The system and its conceptual framework are described in several papers by H. Harboe, Managing Director, Stal-Laval (G.B.) Ltd., 41–7 Strand, London WC.2: "District Heating and Power Generation," 14 November 1975; "Advances in Coal Combustion and Its Applications," 20 February 1976; "Pessurized Fluidized Bed Combustion with Special Reference to Open Gas Turbines" (with C.W. Maude), May 1976. See also K.D. Kiang et al., "Fluidized-Bed Combustion of Coals," GFERC/IC-75/2 (CONF-750586), ERDA, May 1975.

[27] Small devices were pioneered by the late Professor Douglas Elliott. His associated firm, Fluidfire Development, Ltd. (Netherton), Dudley, W. Midlands, England), has sold many dozens of units for industrial heat treatment or heat recuperation. Field tests of domestic packaged fluidized bed boilers are in progress in the Netherlands and planned in Montana.

[28] In late 1977, Enköping, Sweden, expects to commission a 25 megawatt fluidized bed boiler for its district heating system. New reviews at the Institute for Energy Analysis, the U.S. House of Representatives Committee on Science and Technology, and elsewhere confirm fluidized beds' promise of rapid benefits without massive research programs. The Tennessee Valley Authority has announced plans to build a 200 MW fluidized bed boiler with or without ERDA's help.

stations, efficient cars versus offshore oil, roof insulation versus Arctic gas, cogeneration versus nuclear power. These two directions of development are mutually exclusive: the pattern of commitments of resources and time required for the hard energy path and the pervasive infrastructure that it acceretes gradually make the soft path less and less attainable. That is, our two sets of choices compete not only in what they accomplish, but also in what they allow us to contemplate later. They are logistically competitive, institutionally incompatible, and culturally antithetical. Figure 2–1 obscures this constriction of options, for it peers myopically forward, one power station at a time, extrapolating trend into destiny by self-fulfilling prophecy with no end clearly in sight. Figure 2–2, in contrast, works backward from a strategic goal, asks what we must do when in order to get there, and thus reveals the potential for a radically different path that would be invisible to anyone working forward in time by incremental ad-hocracy.

2.7. LOGISTICS AND ECONOMICS

Both the soft and the hard paths bring us, each in its own way and at broadly similar rates, to the era beyond oil and gas. But the rates of internal adaptation meanwhile are different. As we have seen, the soft path relies on smaller, far simpler supply systems entailing vastly shorter development and construction time, and on smaller, less sophisticated management systems. Even converting the urban clusters of a whole country to district heating should take only thirty to forty years. Furthermore, the soft path relies mainly on small, standard, easy to make components and on technical resources dispersed in many organizations of diverse sizes and habits; thus everyone can get into the act, unimpeded by centralized bureaucracies, and can compete for a market share through ingenuity and local adaptation. Besides having much lower and more stable operating costs than the hard path, the soft path appears to have a lower *initial* cost because of its technical simplicity, small unit size, very low overhead, scope for mass production, virtual elimination of distribution losses and of interfuel conversion losses, low exposure to escalation and interest, and prompt incremental construction (so that new capacity is built only when and where it is needed.)[29]

The actual costs of whole systems, however, are not the same as perceived costs: solar investments are borne by the householder, electric investments by a utility that can float low interest bonds and amortize over thirty years. During the transitional era, we should therefore consider ways to broaden householders' access to capital markets. For example, the utility could finance the solar investment (leaving its execution to the householder's discretion), then be repaid in installments corresponding to the householder's saving. The householder would thus minimize his or her own—and society's—long-term costs. The utility would have to raise several times less capital than it would without such a scheme—for otherwise it would have to build

[29] Estimates of the total capital cost of "soft" systems are necessarily less well developed than those for the "hard" systems, but can be calculated well enough, assuming today's technologies, to make a good case that they are cheaper than the hard systems with which they compete as long-term replacements for dwindling fossil fuels. The calculations are given in Chapter Seven, with a summary and comparison in Chapter Eight. The methodology of such cost comparisons is discussed in Chapters One and Three. The general cost advantage of soft over hard technologies is as valid in Northern Europe as in the U.S.

new electric or synthetic gas capacity at even higher cost—and would turn over its money at least twice as quickly, thus retaining an attractive rate of return on capital. The utility would also avoid social obsolescence and use its existing infrastructure. Such incentives have already led several U.S. gas utilities to use such a capital transfer scheme to finance roof insulation in more than 100,000 houses.

Next, the two paths differ even more in risks than in costs. The hard path entails serious environmental risks, many of which are poorly understood and some of which have probably not yet been thought of. Perhaps the most awkward risk is that late in this century, when it is too late to do much about it, we may well find climatic constraints on coal combustion about to become acute in a few more decades: for it now takes us only that long, not centuries or millennia, to approach such outer limits. The soft path, by minimizing all fossil fuel combustion, hedges our bets. Its environmental impacts are relatively small, tractable, and reversible.[30]

The hard path, further, relies on a very few high technologies whose success is by no means assured. The soft path distributes the technical risk among very many diverse low technologies, most of which are already known to work well. They do need sound engineering—a solar collector or heat pump can be worthless if badly designed—but the engineering is of an altogether different and more forgiving order than the hard path requires, and the cost of failure is much lower both in potential consequences and in number of people affected. The soft path also minimizes the economic risks to capital in case of error, accident, or sabotage; the hard path effectively maximizes those risks by relying on vulnerable high technology devices, each costing more than the endowment of Harvard University. Finally, the soft path appears generally more flexible—and thus robust. Its technical diversity, adaptability, and geographic dispersion make it resilient and offer a good prospect of stability under a wide range of conditions, foreseen or not. The hard path, however, is brittle; it must fail, with widespread and serious disruption, if any of its exacting technical and social conditions is not satisfied continuously and indefinitely.

2.8 GEOPOLITICS

The soft path has novel and important international implications. Just as improvements in end-use efficiency can be used at home (via innovative financing and neighborhood self-help schemes) to lessen first the disproportionate burden of energy waste on the poor, so can soft technologies and reduced pressure on oil markets especially benefit the poor abroad. Soft technologies are ideally suited for rural villagers and urban poor alike, directly helping the more than two billion people who have no electric outlet nor anything to plug into it but who need ways to heat, cook, light, and pump. Soft techniques do not carry with them inappropriate cultural patterns or values; they capitalize on poor countries' most abundant resources (including such protein-poor plants as cassava eminently suited to making fuel alcohols) helping to redress the severe energy imbalance

[30] See Chapter One, note 16, and A.B. Lovins, "Some Limits to Energy Conversion," in D. Meadows, ed., *Alternatives to Growth* (Cambridge, Massachusetts: Ballinger, 1977). The environmental and social impacts of solar technologies have been assessed in a study for the ERDA Solar Division (Chapter One, note 15).

between temperate and tropical regions; they can often be made locally from local materials and do not require a technical elite to maintain them; they resist technological dependence and commerical monopoly; they conform to modern concepts of agriculturally based ecodevelopment from the bottom up, particularly in the rural villages.

Even more crucial, unilateral adoption of a soft energy path by the United States can go a long way to control nuclear proliferation—perhaps to eliminate it entirely. Many nuclear advocates have missed this point: believing that there is no alternative to nuclear power, they say that if the United States does not export nuclear technology, others will, so the U.S. might as well get the business and try to use it as a lever to slow the inevitable spread of nuclear weapons to nations and subnational groups in other regions. Yet the genie is not wholly out of the bottle yet—thousands of reactors are planned for a few decades hence, tens of thousands thereafter—and the cork sits unnoticed in our hands.

Perhaps the most important opportunity available to us stems from the fact that for at least the next five or ten years, while nuclear dependence and commitments are still reversible, all countries will continue to rely on the United States for the technical, the economic, and especially the *political* support they need to justify their own nuclear programs. Technical and economic dependence is intricate and pervasive; political dependence is far more important, but has been almost ignored, so we do not yet realize the power of the American example in an essentially imitative world where public and private divisions over nuclear policy are already deep and grow deeper daily.

The fact is that in almost all countries the domestic political base to support nuclear power is not solid but shaky. However great their nuclear ambitions, other countries must still borrow that political support from the United States. Few are succeeding. Nuclear expansion is all but halted by grassroots opposition in Japan and the Netherlands; has been severely impeded in West Germany, France, Switzerland, Italy, and Austria; has been slowed and may soon be stopped in Sweden; has been rejected in Norway and (so far) Australia and New Zealand, as well as in several Canadian provinces; faces an uncertain prospect in Denmark and many American states; has been widely questioned in Britain, Canada and the U.S.S.R.[31]; and has been opposed in Spain, Brazil, India, Thailand, and elsewhere.

Consider the impact of three prompt, clear U.S. statements:

1. The United States will phase out its nuclear power program [32] and its support of others' nuclear power programs.
2. The United States will redirect those resources into the tasks of a soft energy path and will freely and unconditionally help any other interested countries to do the same, seeking to adapt the same broad principles to others' needs and to learn from shared experience.

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[31] Recent private reports indicate the Soviet scientific community is deeply split over the wisdom of nuclear expansion. See also *Nucleonics Week*, 13 May 1976, pp. 12–13.

[32] Current overcapacity, capacity under construction, and the potential for rapid conservation and cogeneration make this a relatively painless course, whether nuclear generation is merely frozen or phased out altogether. For an illustration (the case of California), see R. Doctor et al., *Sierra Club Bulletin*, May 1976, pp. 4ff. I believe the same is true abroad. See Introduction to *Non-Nuclear Futures* by A. B. Lovins and J. H. Price (Cambridge, Massachusetts: FOE/Ballinger, 1975).

3. The United States will start to treat nonproliferation, control of civilian fission technology, and strategic arms reduction as interrelated parts of the same problem with intertwined solutions.

I believe that such a universal, nondiscriminatory package of policies would be politically irresistible to North and South, East and West alike. It would offer perhaps our best chance of transcending the hypocrisy that has stalled arms control: by no longer artifically divorcing civilian from military nuclear technology, we would recognize officially the real driving forces behind proliferation; and we would no longer exhort others not to acquire bombs while claiming that we ourselves feel more secure with bombs than without them.

Nobody can be certain that such a package of policies, going far beyond a mere moratorium would work. The question has received far too little thought, and political judgments differ. My own, based on the past ten years' residence in the midst of the European nuclear debate, is that nuclear power could not flourish there if the United States did not want it to.[33] In giving up the export market that her own reactor designs have dominated, the U.S. would be demonstrating a desire for peace, not profit, thus allaying legitimate European commercial suspicions. Those who believes such a move would be seized upon gleefully by, say, French exporters are seriously misjudging French nuclear politics. Skeptics, too, have yet to present a more promising alternative—a credible set of technical and political measures for meticulously restricting to peaceful purposes extremely large amounts of bomb materials that, once generated, will persist for the foreseeable lifetime of our species.

I am confident that the United States can still turn off the technology that is originated and deployed. By rebottling that genie we could all move to energy and foreign policies that our grandchildren can live with. No more important step could be taken toward revitalizing the American dream and making its highest ideals a global reality.

2.9 SOCIOPOLITICS

Perhaps the most profound difference between the soft and hard paths—the difference that ultimately distinguishes them—is their domestic sociopolitical impact. Both paths, like any fifty-year energy path, entail significant social change. But the kinds of social change needed for a hard path are apt to be much less pleasant, less plausible, less compatible with social diversity and personal freedom of choice, and less consistent with traditional values than are the social changes that could make a soft path work.

It is often said that, on the contrary, a soft path must be repressive; and coercive paths to energy conservation and soft technologies can indeed be imagined. But coercion is not necessary and its use would signal a major failure of imagination, given the many policy instruments available to achieve a given technical end. Why use penal legislation to encourage roof insulation when tax incentives and education (leading to the sophisticated public understanding now being

[33] See *Nucleonics Week*, 6 May 1976, p. 7, and I. C. Bupp and J. C. Derian, "Nuclear Reactor Safety: The Twilight of Probability," *Harv. Bus. School Bull.*, March–April 1976. Bupp, after a detailed study of European nuclear politics, shares this assessment.

achieved in Canada and parts of Europe) will do? Policy tools need not harm lifestyles or liberties if chosen with reasonable sensitivity.

In contrast to the soft path's dependence on pluralistic consumer choice in deploying a myriad of small devices and refinements, the hard path depends on difficult, large-scale projects requiring a major social commitment under centralized management. We have noted in section 2.3 the extraordinary capital intensity of centralized, electrified high technologies. Their similarly heavy demands on other scarce resources—skills, labor, materials, special sites—likewise cannot be met by market allocation, but require compulsory diversion from whatever priorities are backed by the weakest constituencies. Quasi-warpowers legislation to this end has already been seriously proposed. The hard path, sometimes portrayed as the bastion of free enterprise and free markets, would instead be a world of subsidies, $100 billion bailouts, oligopolies, regulations, nationalization, eminent domain, corporate statism.

Such dirigiste autarchy is the first of many distortions of the political fabric. While soft technologies can match any settlement pattern, their diversity reflecting our own pluralism, centralized energy sources encourage industrial clustering and urbanization. While soft technologies give everyone the costs and benefits of the energy system he or she chooses, centralized systems inequitably allocate benefits to suburbanites and social costs to politically weaker rural agrarians. Siting big energy systems pits central authority against local autonomy in an increasingly divisive and wasteful form of centrifugal politics that is already proving one of the most potent constraints on expansion.

In an electrical world, your lifeline comes not from an understandable neighborhood technology run by people you know who are at your own social level, but rather from an alien, remote, and perhaps humiliatingly uncontrollable technology run by a faraway bureaucratized, technical elite who have probably never heard of you. Decisions about who shall have how much energy at what price also become centralized—a politically dangerous trend because it divides those who use energy from those who supply and regulate it. Those who do not like the decisions can simply be disconnected.

The scale and complexity of centralized grids not only make them politically inaccessible to the poor and weak, but also increase the likelihood and size of malfunctions, mistakes, and deliberate disruptions. A small fault or a few discontented people become able to turn off a country. Even a single rifleman can probably black out a typical city instantaneously. Societies may therefore be tempted to discourage disruption through stringent controls akin to a garrison state. In times of social stress, when grids become a likely target for dissidents, the sector may be paramilitarized and further isolated from grassroots politics.

If the technology used, like nuclear power, is subject to technical surprises and unique psychological handicaps, prudence or public clamor may require generic shutdowns in case of an unexpected type of malfunction: one may have to choose between turning off a country and persisting in potentially unsafe operation. Indeed, though many in the $100 billion quasi-civilian nuclear industry agree that it could be politically destroyed if a major accident occurred soon, few have considered the economic or political implications of putting at risk such a large fraction of societal capital. How far would governments go to protect against a threat—even a purely political threat—a basket full of such delicate, costly, and essential eggs? Already in individual nuclear plants, the cost of a shutdown—often many dollars a second—weighs heavily, perhaps too heavily, in operating and safety decisions.

Any demanding high technology tends to develop influential and dedicated constituencies of those who link its commercial success with both the public welfare and their own. Such sincerely held beliefs, peer pressures, and the harsh demands that the work itself places on time and energy all tend to discourage such people from acquiring a similarly thorough knowledge of alternative policies and the need to discuss them. Moreover, the money and talent invested in an electrical program tend to give it disproportionate influence in the counsels of government, often directly through staff swapping between policy- and mission-oriented agencies. This incestuous position, now well developed in most industrial countries, distorts both social and energy priorities in a lasting way that resists political remedy.

For all these reasons, if nuclear power were clean, safe, economic, assured of ample fuel, and socially benign per se, it would still be unattractive because of the political implications of the kind of energy economy it would lock us into. But fission technology also has unique sociopolitical side effects arising from the impact of human fallibility and malice on the persistently toxic and explosive materials in the fuel cycle. For example, discouraging nuclear violence and coercion requires some abrogation of civil liberties[34]; guarding long-lived wastes against geological or social contingencies implies some form of hierarchial social rigidity or homogeneity to insulate the technological priesthood from social turbulence; and making political decisions about nuclear hazards that are compulsory, remote from social experience, disputed, unknown, or unknowable may tempt governments to bypass democratic decision in favor of elitist technocracy.[35]

Even now, the inability of our political institutions to cope with nuclear hazard is straining both their competence and their perceived legitimacy. There is no scientific basis for calculating the likelihood or the maximum long-term effects of nuclear mishaps, or for guaranteeing that those effects will not exceed a particular level; we know only that all precautions are, for fundamental reasons, inherently imperfect in essentially unknown degree. Reducing that imperfection would require much social engineering whose success would be speculative. Technical success in reducing the hazards would not reduce, and might enhance, the need for such social engineering. The most attractive political feature of soft technologies and conservation—the alternatives that will let us avoid these decisions and their high political costs—may be that, like motherhood, everyone is in favor of them.

[34] R. Ayres, *Harvard Civil Rights—Civil Liberties Law Review 10*:369–443 (1975); J. H. Barton, "Intensified Nuclear Safeguards and Civil Liberties," report to USNRC, Stanford Law School, 21 October 1975; R. Grove-White and M. Flood, "Nuclear Prospects: A comment on the Individual, the State and Nuclear Power" (London: Friends of the Earth Ltd./Council for the Protection of Rural England/National Council for Civil Liberties, 27 October 1976).

[35] H. P. Green, *George Washington Law Review*, 43:791–807 (March 1975).

2.10. SOME DEEPER ISSUES

Civilization in the United States, according to some, would be inconceivable if people used only, say, half as much electricity as now. But that is what they did use in 1963, when they were at least half as civilized as now. What would life be like at the per capita levels of primary energy that Americans had in 1910 (about the present British level) but with doubled efficiency of energy use and with the important but not very energy-intensive amenities that people lacked in 1910, such as telecommunications and modern medicine? Could it not be at least as agreeable as life today? Since the energy needed today to produce a unit of GNP varies more than one hundred-fold depending on what goods or service is being produced, and since GNP in turn hardly measures social welfare, why must energy and welfare march forever in lockstep? Such questions today can be neither answered nor ignored.

Underlying energy choices are real but tacit choices of personal values. Those that make a high energy society work are all too apparent. Those that could sustain lifestyles of elegant frugality are not new; they are in the attic and could be dusted off and recycled. Such values as thrift, simplicity, diversity, neighborliness, humility, and craftsmanship—perhaps most closely preserved in politically conservative communities—are already, as we see from the ballot box and the census, embodied in a substantial social movement, camouflaged by its very pervasiveness. Offered the choice freely and equitably, many people would choose, as Herman Daly puts it, "growth in things that really count rather than in things that are merely countable": choose not to transform, in Duane Elgin's phase, "a rational concern for material well-being into an obsessive concern for unconscionable levels of material consumption."

Indeed, we are learning that many of the things we had taken to be the benefits of affluence are really remedial costs, incurred in the pursuit of benefits that might be obtainable in other ways without those costs. Thus much of our prized personal mobility is really involuntary traffic made necessary by the settlement patterns that cars create. Is that traffic a cost or a benefit?

Pricked by such doubts, our inflated craving for consumer ephemerals is giving way to a search for both personal and public purpose, to reexamination of the legitimacy of the industrial ethic. In the new age of scarcity, our ingenious strivings to substitute abstract (therefore limitless) wants for concrete (therefore reasonably bounded) needs no longer seem so virtuous. But where we used to accept unquestioningly the facile, and often self-serving, argument that traditional economic growth is essential for distributional equity, new moral and human stirrings now are nudging us. We can now ask whether we are not already so wealthy that further growth, far from being essential to addressing our equity problems, is instead an excuse not to mobilize the compassion and commitment that could solve the same problems with or without the growth.

Finally, as national purpose and trust in institutions diminish, governments, striving to halt the drift, seek ever more outward control. We are becoming more uneasily aware of the nascent risk of what a Stanford Research Institute group, quoting Bertram Gross, has called

". . . 'friendly fascism'—a managed society which rules by a faceless and widely dispersed complex of warfare-welfare-industrial-communications-police bureaucracies with a technocratic ideology." In the sphere of politics as of personal values, could many strands of observable social change be converging on a profound cultural transformation whose implications we can only vaguely sense: one in which energy policy, as an integrating principle, could be catalytic? [36]

It is not my purpose here to resolve such questions—only to stress their relevance. Though fuzzy and unscientific, they are the beginning and end of any energy policy. Making values explicit is essential to preserving a society in which diversity of values can flourish: an end that a soft energy path seems better suited to serve.

Some people suppose that a soft energy path entails mainly social problems, a hard path mainly technical problems, so that since in the past we have been better at solving the technical problems, that is the kind we should prefer to incur now. But the hard path, too, involves difficult social problems. We can no longer escape them; we must choose which kinds of social problems we want. The most important, difficult, and neglected questions of energy strategy are not mainly technical or economic but rather social and ethical. They will pose a supreme challenge to the adaptability of democratic institutions and to the vitality of our spiritual life.

2-11. EXCLUSIVITY

These choices may seem abstract, but they are sharp, imminent, and practical. We stand at a crossroads: without decisive action our options will slip away. Delay in energy conservation lets wasteful use run on so far that the logistical problems of catching up become insuperable. Delay in widely deploying diverse soft technologies pushes them so far into the future that any credible fossil fuel bridge to them has been burned: they must be well under way before the worst part of the oil and gas decline. Delay in building the fossil fuel bridge makes it too tenuous: what the sophisticated coal technologies can give us, in particular, will no longer mesh with our pattern of transitional needs as oil and gas dwindle.

Yet these kinds of delay are exactly what we can expect if we continue to devote so much money, time, skill, fuel, and political will to the hard technologies that are so demanding of them. Enterprises like nuclear power are not only unnecessary but a positive encumbrance, for they prevent us, through logistical competition and through cultural and institutional incompatibility, from pursuing the tasks of a soft path at a high enough priority to make them work together properly. A hard path can make the attainment of a soft path prohibitively difficult in three ways: by starving its components into garbled and incoherent fragments; by changing social values and perceptions in a way that makes the innovations of a soft path more painful to envisage; and by evolving institutions, policy actions, and political commitments in a way that inhibits those same innovations. Though soft and hard paths are not *technically* incompatible—reactors and solar collectors could in principle coexist—the two paths are antag-

[36] W.W. Harman, *An Incomplete Guide to the Future* (Palo Alto, California: Stanford Alumni Association, 1976).

onistic in other and more important ways that, though qualitative and judgmental, are real and unavoidable. As nations, therefore, we must choose one path before they diverge much further. Indeed, one of the infinite variations on a soft path seems inevitable, either smoothly by choice now or disruptively by necessity later; and I fear that if we do not make the choice, growing tensions between rich and poor countries may destroy the conditions that now make smooth attainment of a soft path possible.

These conditions will not be repeated. Some people think we can use oil and gas to bridge to a coal and fission economy, then use that later, if we wish, to bridge to similarly costly technologies in the hazy future. But what if the bridge we are now on is the last one? Our past major transitions in energy supply were smooth because we subsidized them with cheap fossil fuels. Now our new energy supplies are ten or a hundred times more capital-intensive and will stay that way. If our future capital is generated by economic activity fueled by synthetic gas at $30 a barrel equivalent, nuclear electricity at $60—120 a barrel equivalent, and the like, and if the energy sector itself requires much of that capital just to maintain itself, will capital still be as cheap and plentiful as it is now, or will we have fallen into a "capital trap"? Wherever we make our present transition to, once we arrive we may be stuck there for a long time. Thus if neither the soft nor the hard path were preferable on cost or other grounds, we would still be wise to use our remaining cheap fossil fuels—sparingly—to finance a transition as nearly as possible straight to our ultimate energy income sources. We shall not have another chance to get there.

MULTIPLE PATHS FOR ENERGY POLICIES: A CRITIQUE OF LOVINS' ENERGY STRATEGY

(By Harry Perry and Sally H. Streiter)*

INTRODUCTION

In a widely read article published in *Foreign Affairs* last October,[1] Amory Lovins proposed that the high technology or "hard" path to energy supply on which the United States seemed to be set was the wrong path. It was wrong because it would lead to nuclear proliferation and the end of the world, because it induced inappropriate cultural values and, anyway, it was too expensive. Another path was open, he proposed, and the paths were mutually exclusive. His path would involve, first, conservation, through the use of insulation, redesign of engines, furnaces and other appliances, reuse of waste heat through cogeneration, and redesign of buildings. This could reduce energy demand over the next fifty years to below the current level while maintaining standards of living. The reduced demand would then be filled by renewable energy sources, namely solar energy and biomass conversion with a little windpower thrown in. To get us over the hump (demand rises 30 percent between now and 2000 in Lovins' scenario, before falling off again in 2025), coal could be used in fluidized beds, but not to generate incremental electricity. Nor would he use solar energy to generate electricity. In fact, electricity is the chief villain, led by nuclear which he would like to see banned.

Lovins' critics have generally gone after his numbers without too much success; indeed, in a very public discussion, Nobel laureate Hans Bethe conceded that he had been mistaken about the potential of solar heating. We have reviewed in Section III of this paper the current status of some of the technologies he proposes, and conclude that while many of them are actually or potentially feasible in a technical sense, their introduction has been thus far delayed because they have been uneconomic. Changes in the price of the fossil fuels clearly render at least some of them more economic, but not so clearly superior as to warrant a "dirigiste autocratic" approach (to borrow a phrase) to divert the economy exclusively into soft technologies. The basic supply question that remains unanswered and unanswerable today is what the supply schedule looks like. Even the prices quoted by Lovins for current delivery are very soft, for which we cannot really fault him, but the costs of mass production and the time involved for new technologies to take hold are not at all clear.

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[1] A. B. Lovins, "Energy Strategy: The Road Not Taken?" Foreign Affairs, Vol. 55, No. 1 (October 1976), pp. 65–96.

Will solar technology be like the hand-held calculator, improving with volume and getting cheaper by the week, or will it be like the nuclear industry where the early models were cheap and bottlenecks in supply of labor and materials drove the price up? Aluminum and plate glass, the raw materials for solar collectors, are heavily dependent on electricity and natural gas in their production, and there are good reasons to suppose that incremental energy supplies to these industries will be substantially more costly than historic sources, driving up the price of solar as production increases. Biomass takes land—what will happen to the price of land if a biomass industry grows up to half the size of all current agricultural production?

The potential speed of introduction and eventual market share of the soft technologies has not yet been fully explored, but there is a wide disparity between Lovins' and other estimates of the market share potential of soft technologies. ERDA's estimates suggest 7 to 10 quads by 2000 [2] for soft technologies, whereas Lovins goes for 32 quads.

On the demand side, we have examined the various projections for energy consumption in the year 2000, most of which are considerably higher than Lovins' 95-quad scenario. We agree with him that the lockstep GNP energy hypothesis is faulty, and that there is considerable potential for dampening demand through conservation measures which are economically justified. However, we believe Lovins has overlooked a subtle point which is totally damaging to his estimate. We explain further in Section II. He has assumed that doubling energy efficiency will halve demand, whereas the effect will be also of halving the price and. if there is any demand elasticity, the full savings will not be gained. We therefore conclude that his demand scenario for 2000 has underestimated increases in demand over 1976.

Before launching into the numbers, however, we have tried to tackle the area most of Lovins' critics have avoided; we have endeavored to take his social policy arguments as seriously as he evidently does and consider their meaning and merits. We turn to this now in Section 1.

I. ENERGY DELIVERY SYSTEMS AND SOCIAL VALUES

> In the sphere of politics a sof personal values, could many strands of observable social change be converging on a profound cultural transformation whose implications we can only vaguely sense: one in which energy policy, as an integrating principle, could be catalytic? [3]

> The first path is convincingly familiar, but the economic and sociopolitical problems lying ahead loom large, and eventually, perhaps insuperable. The second path . . . offers many social, economic and geopolitical advantages, including virtual elimination of nuclear proliferation from the world. [4]

Amory Lovins is a consultant physicist but his main message is that of a social physician. Although criticisms of his work have tended to center on the strategies he proposes, their costs, benefits and feasibility, they have by and large ignored the main message. Yet it is a message which in various forms is receiving increasing acceptance in widely disparate areas of social policy. In education, in health, and now in

[2] U.S. Energy Research and Development Administration, A National Plan for Energy Research, Development and Demonstration. Creating Energy Choices for the Future, Vol. 1 (Washington, D.C.: U.S. Government Printing Office, 1976), p. B-6.
[3] Lovins, "Energy Strategy," p. 95.
[4] Lovins, "Energy Strategy," p. 65.

energy, a line of criticism is emerging which runs as follows: "What you are doing does not work. You are not managing to do even what you say you want to do. You are pouring resources into the wrong things. There are other and better ways, which you are not even considering. I think they are better because they will lead to a social organization I prefer. You, however, can reject my values but not my proposals because my proposals meet *your* test which is that they are more economic."

The radicals are not talking basically about tinkering on the edges of policy. Lovins—despite all the critics who to a man would like to see his soft energy proposals receive more research funds and be incorporated into the system where appropriate—holds fast to the view that there are two mutually exclusive paths. Charles Reich's popular book, *The Greening of America*, was based on the belief that opposition to the Vietnam War and development of a popular counterculture would truly revolutionize society. Lovins' vision perceives energy as the ideal catalyst to revolutionize the world.

The father of this approach to major changes in national priorities is Ivan Illich,[5] who has turned his prolific pen on many sacred cows. In education, his theme is to "deschool society"—he holds that pouring more teachers and more classrooms into the development of our children does harm, not good. Massive increases in education budgets have not even raised reading scores, and although Illich would not consider a reading score a useful test, his point is that the aim of the education system seems to be to produce reading scores and it cannot even do that. Thoughtful people in education report that, even if they do not share Illich's social values, they cannot deny his conclusion that "budget expansion has not been the panacea they had hoped."

In health, the same sort of criticism is current. Medical care costs are growing faster than any other item in the economy, consuming 8.6 pecent[6] of the U.S. Gross National Product. This is a higher proportion than any other country, yet the U.S. health indices compare unfavorably with those of other developed countries in terms of such measures as infant mortality and even life expectancy. The critics of the health care system suggest that its goals and methods are wrong: that there is an overemphasis on the more dramatic and costly forms of intervention and too little on the basic forms of prevention and care which affect many more people and are relatively cheap.

Even the rhetoric is the same (and note, this is the Director General of the World Health Organization, not a maverick critic).

> The director general of the World Health Organization today [May 3, 1977] urged the breaking of what he termed the 'claims of dependence on unproved, oversophisticated and overcostly health technology.'
>
> In a keynote address to the annual assembly of the 150-nation agency, Dr. Halfdan Mahler called for a technology that was 'more appropriate because it is technically sound, culturally acceptable and financially feasible.'[7]

Compare this with Lovins:

> [The soft energy path.] besides having much lower and more stable operating costs than the hard path . . . appears generally more flexible. . . . Its technical

[5] See for example. I. Illich. Tools for Conviviality (New York, Harper & Row, 1973).
[6] Congressional Research Service, 1976 figures.
[7] "W.H.O. Chief Criticizes Costly Health Technology and Urges Replacement," The New York Times (May 4, 1977), p. A-13.

diversity, adaptability, and geographic disperson make it resilient . . . [and] ideally suited for rural villages and urban poor alike. . . . Soft technologies do not carry with them inappropriate cultural patterns or values . . .[8]

When this line of argument is applied to energy delivery systems, it is tempting, though foolish, to ignore it. It is in large measure foreign to the thought of those of us who reason in equations or see the market system as arbitrating our various wants and needs in a rational manner. In our terms, the critics are arguing that there are massive externalities and grossly imperfect markets. Lovins does indeed argue for rational pricing of energy, for long-run marginal costs, and asserts that, if the paraphernalia of regulation, subsidization and controls were working properly, then that would be a first step to introducing his program which is "more economic." It is hard to argue against the idea that 52¢ natural gas made insulation relatively unattractive, or that price controls on oil have contributed to our international vulnerability.

However, tempting as it is to revert to familiar territory, we leave analysis of the economics of his proposal until later in this paper. For the message is also, very clearly, my way would be better even if it were not economic.

It it [a 100-percent solar system] cost more [than a nuclear and heat-pump system], there would still be good reasons to use it anyway; but its being cheaper makes a neater argument for people who value narrow economic rationality above unemployment, inflation, centrism, vulnerability, proliferation, and other concomitants of the nuclear option.[9]

What are the societal values which Lovins and his co-physicians are advocating?

A. Nuclear Proliferation and Its International Implications

First, Lovins' message is that a domestic nuclear program encourages international nuclear proliferation. "We must soon choose one [path] or the other—before failure to stop nuclear proliferation has foreclosed both."[10] How reasonable is his stance on proliferation?

Those who oppose nuclear power domestically frequently stress the international implications and the relationship of commercial nuclear power to weapons proliferation. The linkage is real and the problem enormous, yet the solution is not as easy as Lovins would like us to believe.

The linkage comes about through two mechanisms, people and materials. Nuclear reactor technology requires a substantial cadre of trained people for its operation, and those same people, once they know about nuclear power, also have sufficient knowledge to make nuclear bombs. Second, light water nuclear reactors both consume and produce fissile material—enriched uranium and plutonium, respectively. While this fissile material is presently covered by international safeguards [particularly provisions of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) which is enforced by the International Atomic Energy Agency (IAEA)], the safeguards are not foolproof and not all reactors are subject to them. France, South Africa and Brazil, for

[8] Lovins, "Energy Strategy," pp. 87–89.
[9] A. B. Lovins, "Comment and Correspondence," Foreign Affairs, Vol. 55, No. 3 (April 1977), p. 639.
[10] Lovins, "Energy Strategy," p. 66.

instance, refused to ratify the NPT.[11] Furthermore, some small research reactors are not subject to the safeguards.[12] It was a small research reactor that India used to manufacture its bomb,[13] and estimates of Israel's nuclear weapons capability are routinely based on the plutonium-producing capacity of its research reactor at Dimona.[14]

The reactor-bomb linkage is sufficient but not necessary. Reactors are not the only route to bombs. Countries can acquire the knowledge necessary for weapons without training a cadre of commercial reactor specialists; in fact, the information is relatively easy to obtain. On the materials side, the reactor linkage is clearer: a commercial reactor program makes access to weapons-grade materials dramatically easier. While it is not a particularly attractive direct route toward obtaining weapons, its existence provides a country with the opportunity at almost any time to extract large amounts of plutonium from spent fuel, should it decide to do so.

Only highly enriched uranium and plutonium are suitable for the construction of nuclear weapons. Because the former is still a product of highly advanced and relatively expensive technology, the control of the access to highly enriched uranium has been relatively simple. Nuclear fuel itself does not provide the necessary uranium since light water reactors are fueled with low enriched uranium (about 3 percent U_{235}), rather than the highly enriched uranium (about 90 percent U_{235}) required for the production of nuclear weapons. Therefore the construction of nuclear weapons using highly enriched uranium requires a country to make substantial economic and technical investments in enrichment technology. While the uranium route could be facilitated with the advent of laser isotope separation,[15] at least with current technology, the direct enriched uranium route to nuclear weapons remains particularly unattractive.

To date, the United States has exported very limited amounts of highly enriched uranium and has refused to export the enrichment process itself.[16] Together with the Soviet Union, the U.S. now maintains a virtual monopoly on the supply of enriched uranium to reactors in the western countries today. However, by the mid-1980s, about ten countries are expected to possess enrichment facilities built in conjunction with their commercial reactor programs.[17] This, together with the expected laser technology for uranium enrichment, will greatly increase the potential access to facilities that could conceivably be utilized to produce highly enriched uranium for weapons use.

At the present time, the critical factor in the proliferation problem is plutonium. Plutonium is produced as a by-product of nuclear fission in a commercial reactor and, if separated and accumulated can be

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[11] J. A. Yager and E. B. Steinberg, eds., Energy and U.S. Foreign Policy, "A Report to the Energy Policy Project of the Ford Foundation" (Cambridge: Ballinger, 1974), p. 375.
[12] Yager and Steinberg, Energy and U.S. Foreign Policy, p. 375.
[13] J. R. Lamarsh, "On the Construction of Plutonium-Producing Reactors by Small and/or Developing Nations," April 30, 1976, Report for the Congressional Record, Hearings for S. 1439: Export Reorganization Act of 1976 (Washington, D.C.: U.S. Government Printing Office, 1976), p. 367.
[14] "Senate Unit Is Divided on Terms of Nuclear Reactor Sale to Israel," The New York Times (June 21, 1977), p. 8.
[15] A. S. Krass, "Laser Enrichment of Uranium: The Proliferation Connection," Science, Vol. 196, No. 4291 (May 13, 1977), pp. 721–31.
[16] W. W. Lowrance, "Nuclear Futures for Sale: To Brazil from West Germany, 1975," International Security, Vol. 1, No. 2 (Fall 1976), p. 153.
[17] P. L. Joskow, "The International Nuclear Industry Today, The End of the American Monopoly," Foreign Affairs, Vol. 54, No. 4 (July 1976), p. 796.

fashioned into a relatively inefficient but still deadly nuclear weapon. The separation of plutonium from spent reactor fuel requires a relatively simple and inexpensive chemical process which is within reach of most of the countries that are now building commercial reactors. As a result, a country with commercial reactors and spent fuel will generally be in a position to relatively quickly and easily extract the plutonium required for nuclear weapons. For these countries, the roadblock to nuclear weapons is not technical, but political, including the Nuclear Nonproliferation Treaty, IAEA safeguards, bilateral safeguards and the general political and security implications of a particular country's decision to build a bomb.

Indeed, the plutonium route does not even require commercial reactors. A country could produce a relatively crude plutonium-producing reactor using natural uranium and other materials over which there are few, if any, international controls [18] and a simple reprocessing plant for extracting the plutonium.

Almost no one who has thought about or investigated the topic would deny that here is a very, very big problem. President Carter has proposed an indefinite postponement of plutonium recycling for commercial purposes and a ban on U.S. exports of plutonium reprocessing plants.[19] U.S. supplies of uranium seem to be sufficient to permit light water reactors to function without reuse of the plutonium as a fuel for at least the next twenty years, and although there are some disputes about the economics of reprocessing, the balance of opinion seems to be that using plutonium does not make economic sense in the U.S. at present anyway. Carter has postponed the construction of the plutonium-fueled breeder reactor at Clinch River indefinitely, citing the dangers of plutonium and the potential availability of thorium as a breeder fuel, although the feasibility of thorium is not clear.[20] Therefore, current U.S. policy can be summarized as follows:

Minimize the availability of plutonium abroad, by discouraging reprocessing: the assertion that it is not economic anyhow is made more believable by a domestic posture postponing plutonium recycling and the plutonium breeder.

Do not give countries an incentive to develop their own front-end and back-end facilities: the policy here is to guarantee a stable and low cost supply of enrichment services and to provide storage facilities for spent fuel that is not reprocessed.

Lovins concludes that the way to solve the problem is to "phase out [the U.S.] nuclear power program and its support of others' nuclear power programs." [21] This neglects the realities of the world market for nuclear reactors. The once near monopoly position of the U.S. in world reactor sales has been rapidly eroded by other industrialized countries such as France, West Germany and Canada.[22] Any effort to effectively control the sale of reactors and reactor technology requires the cooperation of a fairly large number of industrial countries. In fact, these countries have been meeting regularly to develop safeguards and export controls to limit the proliferation potential of com-

[18] Yager and Steinberg, Energy and U.S. Foreign Policy, p. 377.
[19] "U.S. Ready to Cease Push for Plutonium as Fuel in Reactors," The New York Times (April 7, 1977), pp. A-1, D-7.
[20] H. A. Feiveson and T. B. Taylor, "Security Implications of Alternative Fission Futures," Bulletin of the Atomic Scientists (December 1976), pp. 14-17.
[21] Lovins, "Energy Strategy," p. 90.
[22] Joskow, "The International Nuclear Industry," pp. 792-95.

mercial reactor sales.[23] Unilateral efforts by the U.S. to phase out its nuclear program, restrict access to low-enriched uranium, or ban the sale of commercial reactors are likely to be counter-productive in the long run.[24] By taking the proliferation problem seriously, the U.S. has been able to use the economic and political leverage that it does have to upgrade safeguard guarantees and to convince other countries to agree not to export additional enrichment and reprocessing technology to countries like Brazil and Pakistan. Germany, France and other countries have all apparently agreed on this point (although prior sales to Brazil and Pakistan will apparently go forward.)

An interesting solution to the problems of proliferation and inadequate controls—a market-sharing cartel—was recently proposed by Senator Ribicoff.[25] First Ribicoff would reduce the competition to sell reactors (which he views as the crux of the nuclear problem) by allocating a *pro rata* share of the market to supplier countries, based upon their productive capacities. All orders would be filed with the IAEA and placed on the basis of agreed-upon minimum sales for each supplier.

Second, the spent fuel problem could be solved if fuel enrichment, reprocessing and fabrication were concentrated in large, multinational, IAEA-controlled plants. Under this agreement, uranium enrichment services would be provided to customer nations as a credit for the plutonium contained in the spent fuel which the members deposited. Ribicoff believes that, under such a system, economies of scale and reliability of supply could be assured. The main problem he foresees is convincing France and West Germany to agree not to export the elements of the fuel cycle. Although both France and West Germany now have uranium enrichment technologies, large-scale production will not begin for several years and they are dependent meanwhile on U.S. enriched uranium for their own domestic reactors. Ribicoff sees this as a pressure point to force agreement.[26] Such an approach now seems unnecessary since these countries have agreed not to export additional critical fuel cycle facilities and have severely tightened bilateral safeguard requirements.

In the end the proliferation problem is only partially a function of access to a complete commercial fuel cycle. Germany, Japan, Canada, etc. could have developed nuclear weapons long ago. They have not because they perceived that such development might actually reduce their security rather than increase it. Controls over the commercial fuel cycle must continue to be supplemented by other security guarantees which make it unattractive for a country to want to develop nuclear weapons in the first place. Whether countries like South Korea, Taiwan, Israel, South Africa, etc. develop nuclear weapons depends much more on whether credible defense alliances with the U.S. continue, than it does on the existence of a commercial nuclear energy industry.

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[23] For example, in the recent London Suppliers Group meetings, representatives from 15 countries with nuclear industries convened for the specific purpose of establishing rules to curb the nuclear spread.

[24] N. Hawkes, "Carter Nuclear Policy Finds Few Friends," Science, Vol. 196, No. 4294 (June 3, 1977), p. 1067.

[25] A. A. Ribicoff, "A Market-Sharing Approach to the World Nuclear Sales Program," Foreign Affairs, Vol. 54, No. 4 (July 1976), pp. 764–87.

[26] This seems to be the policy Carter was following prior to the London talks with European leaders in May.

The burden of nonproliferation cannot be put on the commercial nuclear energy industries completely. Export policies, economic incentives to stay away from critical fuel cycle facilities, and safeguards can reduce the probability that a country will suddenly enter the nuclear weapons club. But such policies are only adjuncts to overall international defense and mutual-security programs. Pakistan probably wants the opportunity to develop a bomb because it does not perceive existing security guarantees as adequate in the face of Indian military capabilities; the Brazilians and the Argentinians probably feel somewhat the same.[27] Far too much of the burden of the proliferation problem has been placed on commercial nuclear power programs and far too little on the basic economic, social and political institutions that create the incentives for nations and subnational groups to acquire nuclear weapons.

We agree that Lovins has identified an important problem. But his solution simply will not work. Improved international political institutions for minimizing the risk of proliferation are certainly called for. The U.S. has the power to take the lead in negotiating international agreements that will serve to minimize the risks that additional countries will either want to or be easily able to develop nuclear weapons. But unilateral U.S. action cannot eliminate the risk of proliferation and it might even increase it.

A source close to the SALT talks puts it as follows: there are basically two views about proliferation. The first is that it is a disaster, the world is likely to blow up, but you can't stop it. This was essentially the private view of the Nixon/Ford administration. The second is that it is a disaster, the world is likely to blow up, but you can stop it. This is essentially the view of Carter and Vance. Many serious observers believe that it is perhaps the ultimate question, but apart from the superdoves, no one thinks the answers are easy.

B. Hard Energy Determinism and Soft Energy Pluralism

Lovins' second message is that our present energy delivery system is all-pervasive and controlling.

> . . . [T]he kinds of social change needed for a hard path are apt to be much less pleasant, less plausible, less compatible with social diversity and personal freedom of choice, and less consistent with traditional values than are the social changes that could make a soft path work.
>
> While soft technologies can match any settlement pattern, their diversity reflecting our own pluralism, centralized energy sources encourage industrial clustering and urbanization . . . [and] allocate benefits to suburbanites and social costs to politically weaker rural agrarians. Siting big energy systems pits central authority against local autonomy in an increasingly divisive and wasteful form of centrifugal politics. . . .[28]

Lovins has reiterated several times in his writing that "low energy futures can (but need not) be normative and pluralistic, whereas high-energy futures are bound to be coercive and to offer less scope for social diversity and individual freedom." This basic theme can be examined in two parts.

First, Lovins suggests a close linkage between social organization and energy supply systems. Alvin Weinberg has questioned the deterministic implications of this viewpoint.

[27] "Drive Against Nuclear Spread Focuses on 12 Nations," The New York Times (May 17, 1977), p. 3.
[28] Lovins, "Energy Strategy," pp. 91 92

> Indeed, the tie between energy intensity, bureaucracy, and centralization, which is so prevalent a theme among the anti-energy intellectuals, is largely a mystery to me. There are many factors in our modern society that encourage bureaucratization, centralization, and vulnerability, and I would think that energy and how we generate it are hardly the most important. For example, the technologies of mass communication are probably far more significant potential sources of malign centralization than are the technologies of energy generation: Hitler was much more the product of radio than he was of central electricity.[29]

It is hard to improve on Weinberg's comment, for it is really difficult to see how electricity dictates social organization.

Others such as E. J. Mishan[30] have argued that economic growth and/or the automobile are responsible for the decline in neighborliness and civility, which Lovins abhors, while Illich would probably cast the blame on industrial civilization. Indeed, the main villain of Illich's diatribe on energy is the automobile and the highway system.

> The typical American male devotes more than 1,600 hours a year to his car. He sits in it while it goes and while it stands idling. He parks it and searches for it. He earns the money to put down on it and to meet the monthly installments. He works to pay for petrol, tolls, insurance, taxes and tickets. He spends four of his sixteen waking hours on the road or gathering his resources for it. And this figure does not take into account the time consumed by other activities dictated by transport: time spent in hospitals, traffic courts and garages; time spent watching automobile commercials or attending consumer education meetings to improve the quality of the next buy. The model American puts in 1,600 hours to get 7,500 miles: less than five miles per hour. In countries deprived of a transportation industry, people manage to do the same, walking wherever they want to go. . . .[31]

Illich would not argue that people did not freely choose to love their automobiles, only that they were heavily influenced in doing so by free roads and by advertising and that the externalities in terms of loss of neighborliness and isolation were not readily perceived.

It is, however, difficult to make the same connection between electricity and social organization, unless perhaps one has in mind television and its effects on family life. Centralized energy sources are bad, we are told, because they "encourage industrial clustering and urbanization." But the chief complaint against the car was that it encourages suburbanization and isolation! The connecting argument seems to be that scale economies in electricity make large-scale energy supply systems inevitable, and require highly specialized (and therefore "remote?") people to run them, whereas soft energy systems are more directly attached to the people who use them.

At one level, this appears to be obviously true, although not obviously undesirable. At another level, it is not quite as true as it seems. The combustion of coal in a fluidized-bed system takes place in the consumer's own home; the combustion of coal to produce electricity takes place far from him. Yet the coal mine is still required and the transportation network for coal delivery would surely rival the complexities of the electric distribution system. Similarly, a solar collector is placed on a building and is therefore "local." But the aluminium and plate glass industries standing behind the collector are as far away and remote and technically complex as the generating station. One might also add that they are highly centralized industries. In

[29] A. Weinberg, "Book Review: Non-Nuclear Futures: The Case for an Ethical Energy Strategy," July 27, 1976 (for publication in Energy Policy), p. [illegible]

[30] E. J. Mishan, The Costs of Economic Growth (London: Staples Press, 1967).

[31] I. Illich, Energy and Equity (New York: Harper & Row, 1974), pp. 18–19.

1972, for example, the concentration ratio for the top four companies in the plate and float glass industry was 91 percent and for the top four primary aluminum producers, 80 percent.[32]

The advocates of solar energy might also be well advised to remember the fate of early heat pumps, which were killed by lack of local knowledge and standardization, and press hard for "bureaucratic and centralized" decisions to eliminate fly-by-night local contractors and the indignity of $12,000 solar roof installations that leak and crack. Solar energy will give each individual more control of his own destiny, presumably until the friendly local solar engineers become less available to fix the leaking collector than the friendly local utility is to fix the distribution outage.

Again, biomass conversion, which is Lovins' chief answer to liquid fuel supply, would take, he tells us, ten times the current U.S. brewery capacity. It is not clear that this is likely to show fewer economies of scale and less concentration than refineries, especially given the transportation problems associated with the light and bulky initial product.

It is possible to argue on many grounds that pluralism, dispersion of power and decentralization of economic decision-making are desirable things; indeed, many economists would argue that democracy is enhanced by consumers making their own economic choices among alternative products, rather than a single four-year choice between alternative politicians who then make choices for them. At some points, Lovins seems almost to argue that a *highly centralized* decision be made to progress along the soft path. There is no real need for this. The very character of the soft path is that it need not be adopted in its entirety. If the soft technologies prove economic, then they can be phased in, their very virtues of flexibility permitting their gradual adoption. Nor is the hard path so inflexible that it could not be phased out if it turns out to be desirable to do so. The effort to resolve the false dichotomy raised by Lovins seems to be more antithetical to pluralism than a less radical policy which, by pricing sensibly, encourages new technologies and removes market barriers.

Perhaps what Lovins is really getting at is the nuclear argument again. He argues that the safety risks of nuclear are unacceptable to present and future generations:

> Governments should suspend their nuclear programs, until enough infallible people can be found to operate them for the next few hundred thousand years and until all those affected by such programs have been consulted (which may present technical difficulties).[33]

In fact, Lovins' hostility to nuclear power is less obvious in his *Foreign Affairs* article than in his other writings cited in the references. His efforts on behalf of soft energy futures are, to a very considerable extent, efforts to first politicize and then outlaw nuclear.

Lovins suggests society cannot handle the nuclear genie. This will, of course, remain moot regardless of any intellectual arguments that could be raised, but serious efforts have been made to evaluate the social effects of nuclear power.[34] The Ford Foundation's Energy Policy

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[32] U.S. Bureau of the Census, 1972 Census of Manufactures, Concentration Ratios in Manufacturing, Tables 6 and 7.

[33] A. B. Lovins, World Energy Strategies: Facts, Issues and Options (Cambridge: Ballinger, 1975), p. 126.

[34] See, for example, C. Hohenemser, R. Kasperson and R. Kates, "The Distrust of Nuclear Power," Science, Vol. 196, No. 4285 (April 1, 1977), pp. 25–34.

Study Group was set up in 1975 in the belief that the nuclear debate was poorly structured and undisciplined: the ground rules were that the participants be not only highly technically qualified but also open-minded. An unusually distinguished group of twenty one people grappled with most of the problems raised by the critics of nuclear power, including the soft arguments raised by Lovins and others, and recently published its 400-page report.

On the issue of health effects of nuclear power, the group concluded that "the adverse health effects of nuclear power are less than or within the range of health effects from coal" and that [nuclear wastes and plutonium can be disposed of permanently in a safe manner. If properly buried deep underground, in geologically stable formations, there is little chance that these materials will reenter the environment in dangerous quantities. Even if material were somehow to escape eventually in larger quantities than seems possible, it would not constitute a major catastrophe, or even a major health risk, for future civilizations.] [35]

This would not be sufficient to satisfy Lovins, who contends further that our civil liberties would be jeopardized by the requirement to guard the wastes against the threat of terrorism.

. . . [I]f nuclear power were clean, safe, economic, assured of ample fuel, and socially benign per se, it would still be unattractive because of the political implications. . . . For example, discouraging nuclear violence and coercion requires some abrogation of civil liberties; guarding long-lived wastes against geological or social contingencies implies some form of hierarchical social rigidity or homogeneity to insulate the technological priesthood from social turbulence. . . . [36]

The Ford report concludes that the possibility of terrorism must be taken seriously, but that, as with airline hijacking, modest improvements in security could buy a substantial amount of protection. They recommend strengthening of physical security arrangements for nuclear facilities, but conclude that "improved security measures can be introduced without endangering civil liberties," [37] and note that while the NRC may soon require security clearance for 30,000 employees in the nuclear industry, this compares to 5 million persons already subject to security clearance.[38]

The Ford report is not the final word on these issues of values, which will continue to be debated for many years, but it does provide a substantial counterbalance to the gloomier views of Lovins.

A second strand of Lovins' domestic arguments in his championing of participatory democracy and local control.

In an electrical world, your lifeline comes not from an understandable neighborhood technology run by people you know who are at your own social level, but rather from an alien, remote, and perhaps humiliatingly uncontrollable technology run by a faraway, bureaucratized, technical elite who have probably never heard of you. Decisions about who shall have how much energy at what price also become centralized—a politically dangerous trend because it divides those who use energy from those who supply and regulate it.[39]

Lovins' energy democracy would appear to be characterized by high levels of informed public participation in energy decisions or the use

[35] Nuclear Power Issues and Choices, Report of the Nuclear Energy Policy Study Group, Sponsored by the Ford Foundation (Cambridge: Ballinger, 1977), pp. 19–20.
[36] Lovins, "Energy Strategy," p. 93.
[37] Nuclear Power Issues and Choices, p. 314.
[38] Nuclear Power Issues and Choices, p. 312.
[39] Lovins, "Energy Strategy," p. 92.

of local elected representatives as a surrogate. Past political experience does not lend much enthusiasm for the level or effectiveness of public participation. For example, Nie and Verba report that widespread political activity "is found largely for those acts that are relatively easy" and "only a small minority of the citizenry is active beyond the act of voting." [40] Mitchell found that voter participation

Number of political acts beyond the vote:	*Proportion active beyond the vote (percent)*
1	32
2	30
3	25
4	19
5	14
6±	13

[I]n the general purpose units is much higher than in the special districts, because citizens believe themselves to be more vitally affected by the traditional general governments than by the special districts providing mundane, if essential, services that private firms do not sell in the market—services such as fire protection, sewage disposal, park districts, etc.[41]

Is Lovins proposing new special energy districts to add to the present 80,000 units of governmental responsibility in the United States, which include some 21,000 special districts? Or, is he proposing to reorganize all political districts around the "central" energy theme?

Such local autonomy might also have its negative side. Water pollution control (sewage disposal) and air pollution control used to be local enterprises, but because of the effects of local decisions on the environments of neighboring jurisdictions, federal legislation has largely preempted local control. Education is also an essentially local enterprise, but the courts in various states have held that local funding discriminates against children in poor areas and have required a broader funding base. Lovins does not tell us whether he expects local control of energy to be funded by taxes or whether he simply wants local solar and insulation distributors to be smaller scale than local utilities; in fact, it is not absolutely clear what he does have in mind.

One could delve further into trying to understand what Lovins is trying to tell us about what he apparently believes to be the strong linkage between energy delivery systems and social organization. On the foreign side, we felt he had the right problem and a nonsolution; on the domestic side, we are tempted to conclude that he has a nonproblem.

II. DEMAND ASSUMPTIONS AND THE CONSERVATION POTENTIAL

Our efforts to examine the socio-political motivation of the [illegible] Lovins/Schumacher school of energy critics leave us in a position where, although we may disagree, perhaps violently, with some of the premises, an alternative premise has been offered which forces us to examine the conclusions. The soft path is not only more "benign" and humanistic, it is cheaper.

[40] N. H. Nie and S. Verba, "Political Participation," in Handbook of Political Science, Vol. 4, Nongovernmental Politics, ed. F. Greenstein and N. Polsby (Reading, Mass.: Addison-Wesley Publishing Co. 1975). The authors have calculated the proportions of the electorate acting beyond the vote as follows (p. 29).

[41] W. C. Mitchell, Why Vote? (Chicago: Markham Publishing Co., 1971), p. 136

The "soft" path envisaged by Lovins is best seen in the alternative pictures of our energy future presented in his article. The "hard" way substitutes coal and nuclear power, via electrification, for most of the oil and gas, with a gross energy consumption of over 150 quads by 2000, 230 quads by 2025. The "soft" path reduces demand via conservation (which we examine below) to 95 quads in 2000 and a mere 60 quads in 2025, and fills it by 2000 with 32 quads of soft technology, the rest with oil, gas and coal; by 2025 the entire demand is met by soft technologies, with no nuclear, coal, oil, gas, or indeed, one gathers from the text, any electricity at all except existing hydroelectric resources.

What are these miraculous soft technologies? Their chief characteristic is that they "rely on renewable energy flows." (Lovins also waxes eloquent about them, asserting that they are "flexible, resilient, sustainable and benign." Well, but any utility president would say the same of electricity. Benignity is in the eye of the beholder.) Soft technologies are also characterized as matching end-use needs in scale, quality and geographic dispersion, a concept which he develops at some length.

But before the soft technologies fill the demand (which prospects we examine in Section III), the total demand has to be reduced by conservation. In this section, we examine other peoples' projections for energy demand in 2000; the relation between GNP and energy use; the concepts of gross and net demand; and the implications of conservation through efficiency on gross energy demand. We have not examined in detail the potential for conservation, but we note in passing that a recent study by Arthur D. Little[42] makes a persuasive case for the existence of virtually cost-free conservation through insulation in new buildings: savings of up to 60 percent in energy use are obtained using a design in which the extra initial costs of insulation are (in most cases) entirely offset by the reduced size and reduced initial cost of the heating, ventilating and air-conditioning systems required. The existence of this type of conservation potential is the foundation for the discussion of the effects of conservation on gross energy demand.

A. Projections and Scenarios

How plausible is Lovins' 95-quad scenario in total quantity and in mix? What do other serious students of the energy scene foresee?

Projections used to be done with a ruler. These projections, based on the 1960s, would have told us that overall energy use would grow 3.6 percent annually, for a year-2000 total of 177 quads. But rising energy prices have put an end to simple forecasts, so now we do complicated ones with computers instead of rulers. *Projections* make assumptions about prices, technology, population and GNP, and estimate consumption. *Scenarios* make assumptions about consumption and estimate what would be required in the way of prices, technology, population and GNP. It is desperately difficult to do either well. Even the Bureau of the Census offers three projections for the population growth rates: by the year 2000 the population may have increased 35 percent, or 16 percent, or something in between, say, 24 percent, over the 1974 level. Small wonder then that the energy forecasters, who were practically invented in the last decade, can do no better than the demographers who have been at it for years.

[42] Energy Conservation in New Building Design. An Impact Assessment of ASHRAE Standard 90–75, PB-252 639, National Technical Information Service (Springfield, Virginia). A. D. Little Co., Inc. report to the U.S. Department of Commerce (March 1976)

There have been at least seven major studies of energy demand in the last three years. Their results, in terms of energy use in 1985, 2000 and various other years, are given in Table 1. The official projections of 1974 and 1975 do, as Lovins suggests, range mainly between 130–170 quads for 2000, although more recent studies come in with lower estimates. ERDA's combination case, which it uses as a projection, is 137 quads, reflecting a 2.5 percent annual growth, the same as the projected labor force growth.

B. GNP and Energy Use

Lovins accuses the official projections of assuming a close causal link between GNP and energy consumption and, in ERDA's case, this is true. The FEA and the Department of the Interior see little change if any in the assumed energy; GNP relation, which they put at 56 or 57 thousand Btu/GNP$ (1971 dollars). (See Table II.)

The main evidence that this linkage is not an inevitable lockstep comes from international data. Schipper's study of Sweden noted that "in 1971 the United States had a GNP per capita 10 percent higher than Sweden's at the then current exchange rates. However, for each dollar of GNP, Sweden required only 68 percent as much energy as the United States. Correcting for the energy embodied in foreign trade . . . reduces the 1971 Swedish figure to 61 percent." [43]

While the authors conclude that cultural, institutional, economic and technical factors all combine to reduce energy consumption, they stress the importance of prices. "The most important variable affecting energy use and energy efficiency is the relative price of energy with respect to other resources." [44] For example, gasoline has been nearly twice as expensive in Sweden as in the United States for many years, and Schipper shows per capita consumption of less than half the U.S. level in Sweden.[45] On the other hand, the mean price of electricity was similar in both countries and consumption levels were almost equal.

More recently, a study by Darmstadter, Dunkerley and Alterman for Resources for the Future compared energy consumption patterns for nine industrialized countries and found that, with the exception of Canada, the energy : GNP ratio was lower, ranging from 54 percent of the U.S. level in France to 86 percent of the U.S. level in the Netherlands. This is at least partly due to differences in geography, existing social infrastructure and taste as well as prices, and the authors warn against using the study to argue uncritically for emulation of the energy styles of the Europeans.

> [T]here are practical limits to the opportunities for instituting foreign inspired energy husbandry in the United States. The United States is not about to acquire the population density of Japan, the geographic compactness of Germany, nor very likely – the rail network of France, so that in the best of circumstances, some intercountry energy/GDP variability is bound to endure because of historical or deeply rooted reasons . . .[46]

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[43] L. Schipper and A. Lichtenberg, "Efficient Energy Use and Well Being: The Swedish Example," Science, Vol. 194, No. 4269 (December 3, 1976) pp. 1003–1004.

[44] Schipper and Lichtenberg, "Efficient Energy Use," p. 1012.

[45] Schipper and Lichtenberg, "Efficient Energy Use," Table 3, p. 1003.

[46] J. Darmstadter, J. Dunkerley and J. Alterman, "How Industrial Societies Use Energy: A Comparative Analysis," Preliminary report of a study prepared by Resources for the Future and financed by the Electric Power Research Institute (April 1977), pp. 33–34.

Clearly then it is impossible to argue a lockstep GNP: energy relationship in absolute terms. Countries can and do vary in the energy content of their GNP.

Within a single country, however, given the geography and social infrastructure, one might perhaps expect the energy: GNP ratio to be more stable. An analysis done by Shew for NERA showed an unmistakable decline over the period 1947–73 in energy intensity of GNP in the United States associated with rising per capita income, although he observes that in general, international comparisons show an overall association between energy use and per capita income. He suggests that this may be due to disparities in the range of data.

> [T]he income range of the post-war U.S. data is less than a quarter of the range of international per capita income observed. If energy intensiveness of output first rises with per capita GNP, as a consequence of increasing industrialization, and then declines, as service industries assume a larger role in output, this apparent discrepancy might be explained.[47]

We can probably reject, with Lovins, the *lockstep* energy: GNP argument and, in common sense terms, it would be surprising if it were otherwise. Energy as a factor of production will presumably be substituted for labor while it is cheap, and less so when it is expensive. If energy has been cheap relative to labor costs in the U.S., one would expect to find more energy-intensive production methods. Energy as a consumption item will be substitutable for every other type of consumption, the tradeoff depending on the price. If Swedes choose to buy other things than energy, it should hardly surprise us, particularly since gasoline, for instance, is priced at $1.35 per gallon. It would not surprise us if the Swedes found cheese more to their liking than beef, especially if beef were $5 per pound.

C. Gross and Net Energy

It does not make much sense to expect that *gross* energy use should be related to anything very much. What interests us, or what should interest us, is the work we get out of energy. People want warm houses and miles traveled, not gallons of distillate or gasoline. If technologies change, we may well be able to extract more work (or *net* energy) from a gallon of gasoline, and rising prices would be one obvious agent for technological change. With this in mind, the Resources for the Future model projects a reduction in the gross energy: GNP ratio from 68 Btu/dollar in 1975 to 47 by the year 2000; the Institute for Energy Analysis offers 42 for its low case and 50 for its high case, while DRI-Brookhaven suggests 44. (See Table II.)

Table I shows "gross" and "net" energy figures, a distinction which is now standard but somewhat misleading. Electricity, it is commonly asserted, is a wasteful energy source because only a third of the energy contained in the original fuel is turned into electricity. The net/gross distinction is based on this supposed waste. Gross energy is all the energy used either directly by consumers or in electric generating plants. It corresponds to the Btu requirements for

[47] W. B. Shew, Internal memorandum, July 31, 1976, p. 6.

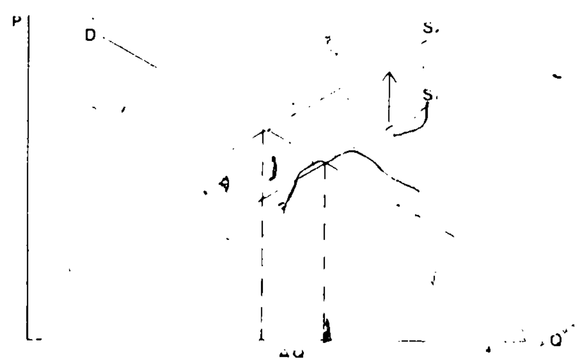
supply. Net energy is the energy that goes to consumers plus the energy that comes out of electric generating plants. Hence, the net/gross ratio depends on the proportion of electricity being used in the projection.[48]

This distinction points up the supposed inefficiency of electricity while ignoring the very substantial end-use inefficiencies of other types of fuel use. The assumed 3:1 disadvantage of electricity is misleading because it does not take into account the inefficiencies at all stages in the sequence of producing, transporting and using fuels directly. (Measured efficiency of home furnaces is close to 50 percent, although theoretically a clean efficient furnace could work at nearer 80 percent.) A more useful definition of net fuel use might be the units of work (heat, miles, motor power) required or supplied for end-use. That sort of measure, while not currently available, would have two types of use: first, it would enable us to examine energy: GNP linkages in a more useful hypothesis, namely, is the end-use quantity of work related to GNP. Second, it would clarify some of the confusion surrounding the concept of conservation.

D. Conservation

Conservation, in the broadest sense, means "using less." But it actually encompasses several different phenomena which we can review in terms of the traditional supply and demand curves.

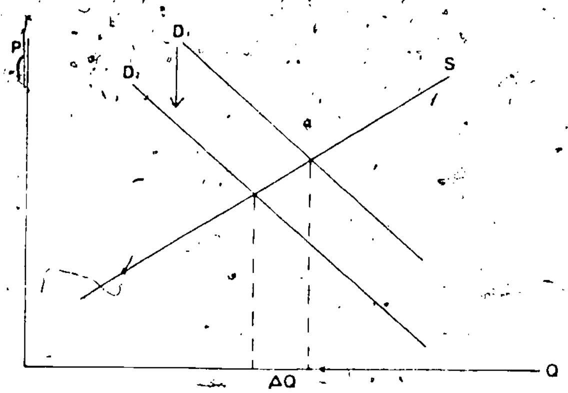
(1) Upward shift (price increase) in supply function.
No change in taste or technology.



The obvious example of this is the oil price increase. People use less at higher prices: either they drive fewer miles or have colder homes or, in the long run, they switch to fuel-saving technologies (smaller cars, insulation).

[48] For instance the Department of Interior projections for gross and net energy for 1985 are 103.5 and 77.5 quads, respectively. Gross - Net = 26 quads (this is the "waste" in electric generation). Total electric included in the gross can then be estimated by assuming 33 percent efficiency: 26 × 312 = 39 quads. Thirty-nine quads as a percentage of total gross demand equals 39/103.3 × 100 = 38 percent, as shown in Table III.

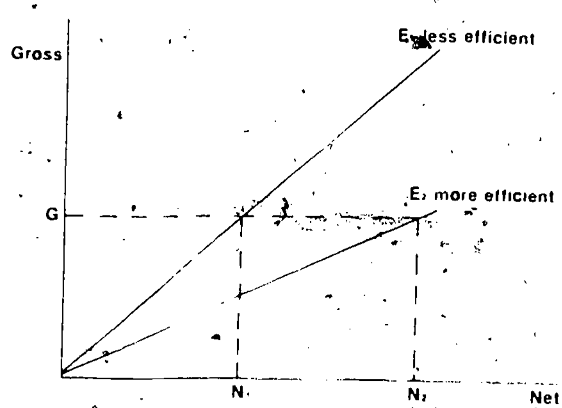
(2) Downward shift in demand function. No change in supply schedule or technology.



These are demand changes which may be caused by the availability of substitute commodities or which may reflect changes in taste and lifestyle rather than economics. Many of the social physicians hope to see bicycles replace automobiles because of their lifestyle implications. Exhortations that 65° is healthier than 72° for an indoor temperature are also attempts to shift the demand curve.

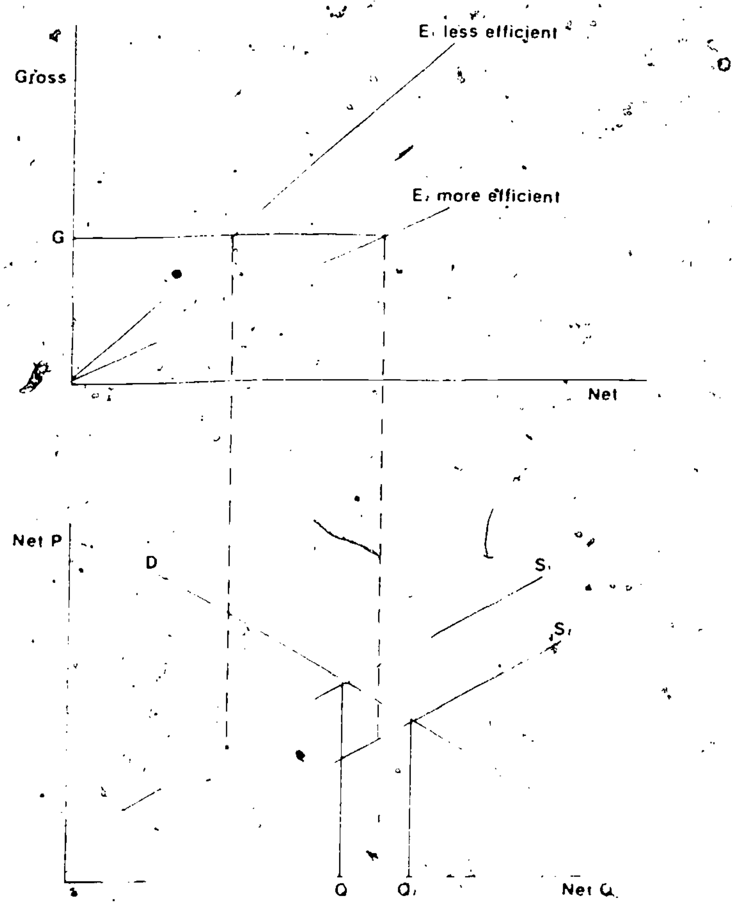
(3) Shifts in end-use conversion efficiencies through technical change

To review this, we have to specify our axes more clearly: supply and demand for what? With fixed technical efficiency options, the question does not arise. But suppose that a simple and costless invention[49] increased the end-use efficiency. What would be the effect? We must assume that demand for energy is not demand for gross Btus but for units of work (heat, miles, motor power), and that gross energy demand is a derived demand. Then a change in technical possibilities would shift a gross/net schedule in the following way:



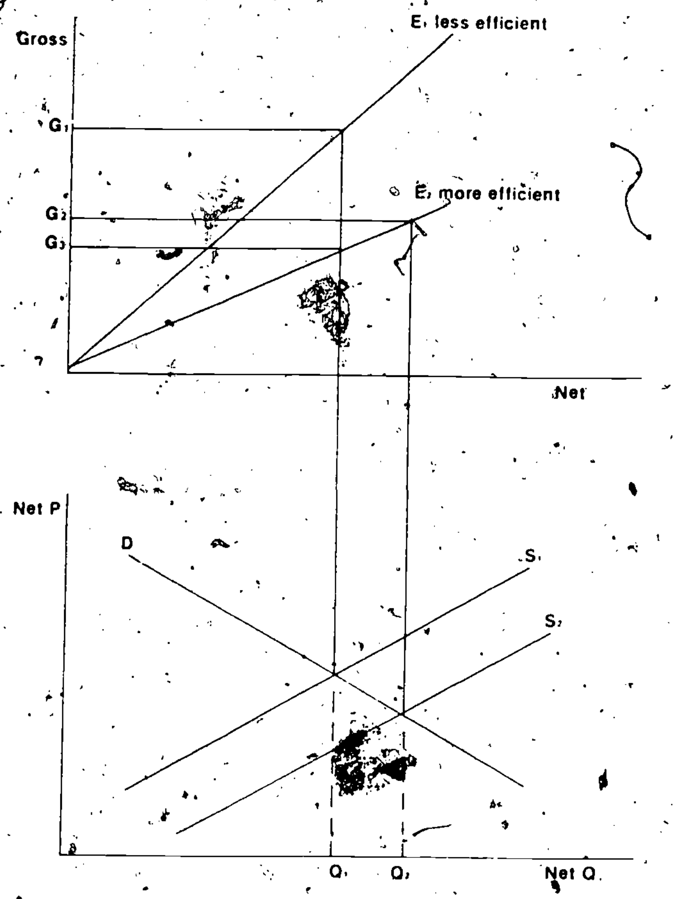
[49] Assuming the invention has a cost does not change the thrust of the argument

(E_2 yields more units of net energy per unit of gross energy.) Assuming that demand is for net energy, this has the effect of shifting the supply curve of net energy downward, while leaving the demand schedule unmoved. The same amount of gross energy at the same price (on our assumption of a costless invention) can now provide more net energy at the same price.



If there is any elasticity of demand, $\triangle Q$ net will be positive, although so long as the elasticity of demand is not greater than unity, changes in *gross* energy consumption will be negative. In more mundane terms, more miles per gallon may induce people to drive more because it is cheaper per mile than before: in any event, this effect will limit the impact of technical efficiency in reducing gross Btu consumption.

Expanding the above diagram, we can see that one might have hoped the efficiency change would reduce gross consumption from G_1 to G_3. It will, however, only reduce it to G_2



This is an extremely important result. Lovins' assertion that a 95-quad scenario for 2000 is feasible depends crucially on his assumption that conservation through technical efficiency changes alone can reduce gross energy demand. He asserts:

> Theoretical analysis suggests that in the long term, technical fixes *alone* in the United States could probably improve energy efficiency by a factor of at least three or four. A recent review of specific practical measures cogently argues that with only those technical fixes that could be implemented by about the turn of the century, we could nearly double the efficiency with which we use energy.[50]

Among the technical fixes he proposes are thermal insulation, heat pumps, more efficient furnaces and car engines, less overlighting and overventilation in commercial buildings and recuperators for waste heat in industrial processes. While all of these measures could "conserve" in the broad sense of "using less energy," all the fixes he suggests, with the possible exception of overlighting, have the effect of reducing the marginal cost of net energy or work units. They shift the supply curve downward. Lovins says:

> My own view of the evidence is, first, that we are adaptable enough to use technical fixes *alone* to double, in the next few decades, the am[illegible]ial benefit

[50] Lovins, "Energy Strategy," p. 72.

we wring from each unit of end-use energy; and, second, that value changes which could either replace or supplement those technical changes are also occurring rapidly. If either of these views is right, or if both are partly right, we should be able to double end-use efficiency by the turn of the century or shortly thereafter, with minor or no changes in lifestyles or values save increasing comfort for modestly increasing numbers.[51]

In other words, the reduction from 155 quads to 95 quads is to be accomplished by increasing, in fact doubling, end-use efficiencies; what Lovins has not realized is that if there is any demand elasticity at all, he will not be able to keep all the efficiency gain: the reduction in the marginal cost of work units or net energy will increase the net energy consumed and cut into his gross savings.

A doubling of end-use efficiency is equivalent to halving the price. This is not a small point. If the elasticity of demand of end-use energy is, say, −0.5, *net* demand will *increase* by a little more than 40 percent; gross demand will therefore not be halved, but will be reduced to 70 percent of the previous level, or 40 percent above Lovins' projection. What this means for Lovins' implied scenario is that a relatively costless technical fix, such as more efficient furnaces and automobile engines, or the heat pump, or even ASHRAE standards on new homes, will not save nearly as much energy as he hopes. Comparing his 95-quad scenario with the 155-quad projections he imputes to others, and assuming that costless technical fixes applied to 120 of the 155 quads account for the 60-quad difference, we can estimate that, on his assumption of doubling efficiency and our assumption of −0.5 demand elasticity, the 120 will go to 84 (70 percent of 120), not 60 (50 percent of 120), and the total demand would be 119 not 95 quads. (If technical fixes are not costless, the shift in the supply curve will be smaller, the net increase in demand will be smaller, and the gross savings greater from any given technical improvement.)

A revision of the 95-quad scenario to 119 would bring it much more in line with recent estimates for the year 2000, although still comfortably below the older "official estimates." Nevertheless, the growth implied over the next twenty-five years by a 95-quad scenario is only 20 quads, whereas a more realistic estimate would suggest planning for growth of at least 40 quads.

To be fair, Lovins does not ignore the other two types of conservation discussed above: he favors lifestyle changes (demand curve downward shifts) for philosophical reasons and he favors marginal cost pricing (supply curve upward shifts), a position with which we cannot possibly quarrel. Therefore, it is possible that not all of his 60-quad savings come from shifts of technology, but rather from a mixture of all three phenomena. However, if we make the crude assumption that energy is underpriced 20 percent, an increase to marginal cost, with a −0.5 elasticity would result in an end-use reduction of 9 percent, bringing us from 155 to 141 quads, and leaving 46 quads to be dealt with by technology shifts before we got to the 95-quad scenario.

The numbers outlined above are only indicative of possible problems: Lovins' thesis is, however, that technical fixes can reduce demand and soft technologies supply the reduced requirement. The latter assertion is examined in Section III, but as we have seen, the reduced demand scenario is probably substantially overdrawn.

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[51] Lovins, "Energy Strategy," p. 75

III. THE "HARD" AND "SOFT" ENERGY SUPPLY PATHS

The basic assumptions underlying Lovins' discussion of the "hard" and "soft" energy supply paths are that (1) the two paths are mutually exclusive, (2) both paths represent difficult but very different problems, and (3) many genuine soft technologies are now available and are now economic.

A number of Lovins' critics have been puzzled as to why the two paths are "mutually exclusive." Lovins offers no explanation in his original *Foreign Affairs* article or even in the rebuttals that he has written to his critics' comments. The only rationale advanced for the mutually exclusive argument is that "commitments to the first *may* foreclose the second, [and] we must soon choose one or the other . . ." [emphasis added].[52] Not only is this statement conditional, but there are no reasons given for why the assertion should be accepted as fact. On the contrary, many transitions in the sources from which energy is harnessed have taken place in the past in an orderly and compatible way. Between the 1850s and the late 1970s transitions that were not mutually exclusive have occurred as society moved in a series of steps from wood to coal, to oil, to gas and most recently to the use of nuclear energy.

While one might characterize all of these changes as merely being a replacement of one "hard" energy path by another, this is more a matter of semantics than of substance. In the 1850s the decreasing use of wood would have been viewed, using the Lovins terminology, as a replacement of a soft energy form (biomass) with a hard one (coal). However, the majority of these changes among fuel forms took place side-by-side with the availability of other proven soft technologies—windpower, hydropower and even solar energy—each of which could have become the dominant fuel source. Why they did not, if they were more economic or better in some other way, remains a mystery.

Other critics of Lovins have reviewed the analysis of the "hard" and "soft" supply paths and have frequently arrived at different interpretations of the state of the various technologies and their costs. It requires a wide background in the state of the art of various soft technologies which Lovins offers in place of the more conventional ones to evaluate how accurate his assertions are.

Claims that new technologies are both economic and ready to be applied widely on a commercial scale are common in the scientific and engineering community—even when there is little or no basis for such claims. It is only necessary to cite a few examples, chosen deliberately from the energy industries, to illustrate how carefully claims of the availability and economic competitiveness of a new technology must be evaluated. The evaluation must include not only an examination of the technical and economic status but, just as importantly, the nature of the environmental, political, institutional, legal, regulatory, and financial barriers that must be overcome before the technology can be deployed widely enough to make an important contribution to energy supply. Making such evaluations has been just as difficult for new "hard" technologies as it has been for "soft" ones.

Even if the evaluation is favorable, there are very long lead times and large costs involved in commercialization. For example, the first

[52] Lovins, "Energy Strategy," p. 65-96.

fission chain reaction to prove the basic scientific principle needed to assure that atomic power could be produced from uranium was demonstrated in 1942. Despite the enormous commitments in funds and other resources that were made by the United States Government and others to convert this knowledge to practical use, the first small commercial reactor did not begin operation until 1959, nearly seventeen years later. In 1955, at which time small experimental reactors were already operational, the National Planning Association[53] predicted that by 1980, nearly forty years after the basic scientific principle had been proven, the United States would be supplying only 10 percent of its energy from nuclear fuels. In fact, in 1976 it supplied less than 3 percent of total energy demand and is projected to supply only 8 percent by 1985.

The slow commercial development of nuclear fuels is not just the result of the special problems associated with nuclear energy but typical of the difficulties in commercializing any new energy resource. The development of oil shale, coal liquefaction and coal gasification technologies have been even less successful than those for nuclear fuels. Oil from shale was produced in a number of countries in significant quantities in the 19th century but had largely disappeared by the turn of the century with the discovery of large oil reservoirs. For example, in 1860 a total of 53 U.S. companies were producing oil from coal and shale, but the discovery of liquid petroleum in 1859 soon ended the U.S. shale oil industry.[54] Interest in oil shale was revived in the 1920s due to the relatively high price of petroleum and several pilot plants were erected, including two by the Bureau of Mines. However, oil shale activity was again halted because large discoveries of petroleum caused a decrease in its price.[55] From time to time since then, notably after 1945, as oil reserves appeared to be becoming limited, studies were made that showed that oil from shale was competitive, or nearly competitive, with petroleum. Despite these repeated claims in reports made by both industry and government, no commercial oil shale plants are currently operating. Moreover, their future looks almost as bleak today as it did fifty years ago.

Coal gasification has had a history similar to that of oil shale. As with oil shale, claims have been made repeatedly by government research reports and by large industrial firms that coal could be gasified *at competitive prices* to make a high Btu gas that could be substituted for natural gas. In spite of the clear evidence that coal gasification is feasible, it has simply not been economic. Prior to 1940, low Btu coal gasifiers were used in the United States and during the 1940s and 1950s several attempts to develop new high Btu gasification processes were made. By 1973, at least twelve new processes were ready for commercialization, but costs were estimated to be three to four times the cost of natural gas.[56] Construction has not yet been started on the first commercial coal gasification plant and there is no indication that commercial plants will be constructed soon.

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[53] T. D. Teitelbaum, Productive Uses of Nuclear Energy Report on Nuclear Energy and the U.S. Fuel Economy, 1955 1980, National Planning Association, Washington, D.C. (1958).

[54] A. Matzick, R. O. Dannenberg, J. R. Ruark, J. E. Phillips, J. D. Lankford and B. Guthrie, Development of the Bureau of Mines Gas Combustion Oil Shale Retorting Process, Bulletin 635, U.S. Bureau of Mines (1966), p. 2

[55] Matzick et al., Gas Combustion Oil-Shale Process, p. 2

[56] U.S. National Academy of Engineering: Evaluation of Coal Gasification Technology, Part I, Pipeline-Quality Gas, R&D Report No 1, prepared for U.S Office of Coal Research (1973).

freeways and shopping centers; ultimately, they could be considered the unindicted subverters of the traditional foundations of society. Modernization would have been possible without the automobile, but not American-style modernization.

Just what is it that this symbiosis of fossil fuels and technology has done to society? To begin with, it has created an intense energy addiction. Without huge amounts of energy, every modern city would come to a mechanical stop and turn to chaos; every mechanized farm would be unable to plant or harvest its crops; every industry would come to a grinding halt; every apartment building and virtually every home would be paralyzed. In the short run, there is no conceivable way a highly modernized society can kick this energy addiction, and not much evidence that it wants to, although the numbers of individuals who would like to do so are growing daily. More important still, the high consumption of energy has had a profound impact on the two most fundamental institutions of all previous societies: the family and the community.

THE IMPACT OF ENERGY AND MODERNIZATION ON THE FAMILY

That the family has been the basic building block of all prior societies seems well established. In any essay summarizing the most general propositions about which sociologists should be able to agree, Princeton sociologist Marion Levy has this, among other things, to say about the fundamental role of the family: "There are no known societies lacking in family structures. . . . Until relatively modernized societies developed, the vast majority of all people in history spent the majority of their time and had the majority of their interrelationships in a family context. Ideally and/or actually—even if not ideally—the family context was the major focus of organizational behavior. It still is for a large proportion of the people of this earth." The words, "until relatively modernized societies developed" imply, of course, that modernization was responsible for demoting the family from its position of centrality. If we accept, for the purposes of this analysis, the contention that modernization's foremost characteristic is the consumption of large amounts of energy coupled with advancing technology, then energy can be said to be the driving force behind the demotion of the family as a social institution.

The centrifugal effect of energy upon the family accords with common observation. The strains created by urbanization and the wage economy, the sharp diminution in the amount of time spent by fathers and mothers with sons and daughters in joint economic and survival efforts, as compared with agrarian societies, and by grandparents with younger generations, has obviously loosened family ties. When children became economic liabilities and hindrances to alternative forms of self-fulfillment, the gradual decline in the importance of the family became inevitable. Children became luxuries, often more expensive than Cadillacs.

To the extent that energy is responsible for the extreme urbanization and modernization of society, therefore, it seems fair to say that it is responsible for the decline of the importance of the family as the central building block of society. And to the extent that families are valued, either for their own sake or as an institution believed to be essential to the stability and durability of society, the use of large quantities of energy—large enough to produce extreme urbanization and modernization—can be said to have a negative effect.

Just how essential a healthy family structure may be to the preservation of a reasonably durable society, we can only speculate since no society has ever tried before the 20th century to operate without building upon the family as its most fundamental institution. This fact alone would seem to create a fairly strong inference that creating conditions unfavorable to the family without developing an assured and tested substitute might be a hazardous course. So far, the capacity of highly modernized societies to create effective substitutes or collateral institutions which can, in conjunction with weakened families, provide an equally firm foundation is not evident.

The educational system has been unsuccessful in serving, for our current society, in the role formerly performed successfully by the family in a low-energy society—that is, to prepare young people for adult life. If it cannot succeed in this vital role under current conditions, one must wonder what other social institution or system can. The damage done to the family by high-energy technology may be irreparable within the context of a society that is as overwhelmingly urbanized, as specialized and compartmentalized, as highly centralized and bureaucratized as is America. It may be necessary to face the almost inescapable conclusion that only a basic change of direction might reverse the deterioration of the family as an institution.

The family deserves consideration as much or more for its past and potential contributions to basic human psychological satisfactions as for its function in helping to make societies stable and durable. The two are obviously closely related. It is impossible to measure objectively the comparative psychological satisfactions that are gained by people within and outside of family contexts. There are so many variables, most of which lie in the social and economic settings within which families operate. One major factor is how hard it is to make a family a functioning and cohesive unit within the surrounding society. If the conditions of the milieu strongly discourage the possibility of a family's functioning as a cohesive unit, the satisfactions gained can hardly avoid being low and the price people are willing to pay for the marginal satisfactions that come from noncohesive families—both in dollars and in forgone alternative satisfactions—will be correspondingly low. Lower marriage rates, higher divorce rates, deliberately childless marriages, and subreplacement fertility rates are, in some degree, indicators of lessening psychological satisfaction derived from the institution of the family. They may also be indicators that society has thoughtlessly created conditions that frustrate the opportunity of people to have and to cherish cohesive families.

Social policy in the United States has rarely been designed to promote family cohesion. Quite the reverse. One of the most disgraceful chapters in the history of American social policy was the inadvertent creation and thoughtless perpetuations of a Federal-state welfare program that contained powerful pressures toward the breakup of destitute families. Daniel Patrick Moynihan has been especially critical of such schemes. Farm policies, too, were just as callous to the values inherent in cohesive families. The family farm was treated as having no other value than that of a production unit, and if it could not make its way in competition with highly capitalized industrial farms, its members had no choice but to migrate to cities and try to adjust. The centrifugal effect of low-cost energy and high-cost equipment on millions of farm families in this country is incalculable. The creation of the highway trust fund, although hardly anybody foresaw it at the time, also turned out to be an extremely destructive influence on the institution of the family and the viability of the city neighborhood, with its stimulation of suburbanization.

THE EFFECT OF HIGH-ENERGY USE ON THE COMMUNITY

The second building block of all earlier societies—the community—was, like the family, cast into the high-speed centrifuge of modernization and spun to its perimeter. Community is used here to mean a group of people with cohesion growing from a common bond to a place, a common pride in it, and group loyalty stemming from familiarity with and substantial trust of each other. Thus the concept of community is meant to apply to groups of people who live in a sufficiently circumscribed area so that each recognizes by sight and knows the names of most of the others he sees each day within that area and feels that he knows or has some meaningful access to the leaders of the community and role in it. By this definition, a small proportion of Americans live in communities, while a large proportion of the people of China live in communities. (This is not to suggest that the type of communities the Chinese live in would be suitable for Americans.) How important communities are to the fulfillment of the psychological needs of people and to the stability and durability of societies is a matter to which insufficient attention has been given. There may well be such wide variation between cultures and between individuals within the same culture as to make generalizations of little validity and value. Nevertheless, speculation is useful.

The community and its partial urban substitute, the neighborhood, have, over the years, served affirmative psychological as well as economic and protective purposes. They establish human connections with other people who have roots in the unique place in which they live and from which they take psychic nourishment. Those associations develop into varying degrees of trust and affection and frequently of unspoken loyalty to the common bond and humanity of the group. Membership in a genuine community has a strong tendency to enlarge the capacity of each member for accepting and extending mutual trust. In this sense, it provides a depth of meaning to life that is difficult to obtain by any substitute means. When trust is extended, so too is responsibilty. Some people, of course, in any environment, shrink from both trust and responsibility; the more inhospitable the environment, the greater the proportion of such people.

The community and the neighborhood also provide a source and form of security. People look out for one another. If they see strangers doing unusual things, they become suspicious and usually take whatever protective action seems called for under the circumstances. If a lone individual falls sick or is injured, his neighbors come to his aid. If a family has a catastrophe, the community pitches in and helps. Such mutual support is the essence of community or neighborhood.

The use of ever larger amounts of energy has the unfortunate effect of diminishing both the affirmative and the protective aspects of the community and the neighborhood. Even without the automobile, an affluent, high-energy society—dependent on trains, buses, and jets for transport, living in high-rise apartments, fed by an agricultural industry that uses large amounts of energy but employs only 5 percent of the work force—would have difficulty preserving the cohesive force of the community or the neighborhood. If little conscious realization existed of the importance of these institutions, and social policy were not specifically designed to preserve and enhance them, the general tendency would be toward their dissolution.

When the economics of land costs, construction, and maintenance drive builders and housing authorities to erect high-rise structures, the effect is to make neighborhoods more difficult and neighborhoods less viable. It is immensely more difficult for people to be neighborly when they live in high-rise apartments than when they live close to the ground and more about horizontally and conspicuously on their own two feet rather than vertically in self-operated elevators. High-rise apartments also diminish the inclination of people to take responsibility for each other because of the sheer numbers involved. Residents may get to know a few other people in the building, but the bigger and taller the structure, the less likely they are to have any feeling of roots in the place or loyalty to its inhabitants. An anonymous vertical city is substituted for a horizontal association of people who recognize each other and develop some sense of trust and loyalty toward each other, a feeling of belonging.

THE PLACEMENT OF THE AUTOMOBILE AT THE CENTER OF SOCIETY

Each step toward urbanization, suburbanization, and exurbanization has been accompanied by an increase in dependence on energy and an escalation in its consumption. Different methods of using energy have different degrees of centrifugal force upon communities and neighborhoods. The automobile heads the list both in terms of the amount of energy consumed and as an agent of demolition of community.

In a perceptive book entitled *Energy and Equity* (1974), Ivan Illich discusses the use of energy to enable people to move from one place to another. He uses the word "transit" to mean those movements that put human metabolic energy to use, and the word "transport" to cover the mode of movement that puts other forms of energy to use. Transit applies principally to walking and bicycling, transport to whatever mechanized modes may be widely used. So far as the United States is concerned, transport means primarily the automobile.

At the rates and range of movement that are possible in walking or riding bicycles, people are relatively equal, friendly, and communicative. Their movement is also highly efficient in the use of energy, and best of all, the cost is low in terms of time and money. In contrast, Illich paints this picture of the use of time and energy in the American automobile culture:

> The typical American male devotes more than 1,600 hours a year to his car. He sits in it while it goes and while it stands idling. He parks it and searches for it. He earns the money to put down on it and to meet the monthly install-

ments. He works to pay for petrol, tolls, insurance, taxes, and tickets. He spends four of his sixteen waking hours on the road or gathering his resources for it. And this figure does not take into account the time consumed by other activities dictated by transport: time spent in hospitals, traffic courts, and garages; time spent watching automobile commercials or attending consumer education meetings to improve the quality of the next buy. The model American puts in 1,600 hours to get 7,500 miles: less than five miles per hour. In countries deprived of a transportation industry, people manage to do the same, walking wherever they want to go, and they allocate only 3 to 8 percent of their society's time budget to traffic instead of 28 percent. What distinguishes the traffic in rich countries from the traffic in poor countries is not more mileage per hour of lifetime for the majority, but more hours of compulsory consumption of high doses of energy, packaged and unequally distributed by the transportation industry.

The automobile culture determines the configuration of social space, breaking up communities and urban neighborhoods; the more rapidly people can be transported from one place to another, the more economically insupportable neighborhoods become. Neighborhood shops and services become scarce, often nonexistent—a sure sign of the decline and perhaps imminent disappearance of the neighborhood. Traffic arteries split neighborhoods apart, and high volume, low margin shopping centers make neighborhood shops nonviable. The further one can travel in an hour's time, the greater the impetus of huge retail corporations to achieve economies of scale and provide services on a mass, impersonal, non-neighborhood basis.

Ivan Illich's greatest hope is that the combination of walking and bicycling, in conjunction with whatever mass transport may be required, will permit a "social restructuring of space that offers each person the constantly renewed experience that the centre of the world is where he stands, walks, and lives." Bicycles permit great flexibility of movement, the ultimate in efficiency, and the means of healthy exercise. Walking is in many ways superior to bicycling—it completely removes people from dependence on any mechanical contrivance, and is the ultimate in flexibility—but the feasible radius of transit is more limited. In any event, it is not necessary to opt for walking or bicycling as a general mode of transit; each can be used to fit the need of the occasion.

In a tract entitled *Autokind v. Mankind* (1971), Kenneth R. Schneider picked up and expanded upon a set of concerns expounded earlier by Lewis Mumford. Schneider coined the word "automobility" to describe the uniquely American dependence on the automobile for basic mobility:

Automobility—particularly in cities—entrenches itself in concrete, monopolizes movement, then congeals it, makes every roadway a barricade, reduces choice, hogs resources, increases costs, ravages the landscape, endangers and oppresses the pedestrian, boxes and deforms the body, contaminates the breath of life, enrages the ears, insults the eyes, makes an automaton of the nervous system, puts every citizen nearer the clutches of the law, denies casual association, rigorizes organization, distorts the public purpose, and dulls human sensibilities. Oh yes, and it kills half a million people each decade and maims millions more.

Overdrawn and caustic though it may be, such a critical characterization of what the automobile has done to both people and their social institutions is substantially deserved. To make a balanced evaluation of the automobile's costs and benefits, one would have to list its notable contributions so that they might be fairly compared with this heap of "disamenities" (only an Englishman like the economist Ezra

Mishan would think to apply such an understated term to such angry complaints, but he is one of the few economists who has not accepted the automobile as a self-evident contribution to human progress). These would include: democratizing the exhilaration of power and speed; the opportunity to travel and thereby be broadened (the boon that Francis Bacon thought would flow automatically from travel—but that was before hundreds of millions of people came to be manic and competitive travelers); a more flexible means than mass transit of transporting people from a place where they are to another place they would rather be; and the chance to economize by buying things in large quantities in supermarkets. Other items could be added to the list, but still when it is weighed against Schneider's indictment, one can only conclude that the impetus that has propelled the automobile to the center of American society, converting the human to an auto-man, is in no sense rational; it is the sheer magnetism of power, speed, and mobility.

Rational or irrational, our society has now been structured in such a way that the automobile is indispensable to most people. With few exceptions, most new construction in the last quarter-century outside of New York City has been built on the assumption that people would be transported to or from the new buildings by automobile. A person without an automobile—a person who wishes to move about by walking and by public transportation—is tantamount to a cripple. The environment has been consciously designed and constructed around the automobile; people are clearly secondary. Amazingly, as Schneider points out, the United States has built a society in which one cannot drink without driving—that is, most of the sociable drinking that occurs requires most drinkers to drive home afterward. Is it any wonder that our automobile accident rate is so high? Schneider is no less interested than Illich in the social restructuring of space to put human beings back at the center and restore the use of their feet.

The American love affair with the automobile has been so ardent that most of its devotees have been disposed to ignore its inequities. The killing of fifty to sixty thousand people a year and the injury of some four million more seems to most people a tolerable price to pay for a couple of hundred horses in their garage, ready to leap into action at their command. The fact that the totality of highway deaths has exceeded American fatalities in all wars, and that injuries vastly exceed war casualties apparently does not disturb them. The spewing of more pollution than all industry combined seems of minor concern. That automobiles choke cities and foul the countryside with trash, junked cars, and neon signs is unfortunate, to be sure, but seemingly just another cost and by-product of progress. But we can hardly ignore the facts that they engender disrespect for law (rare is the driver who does not violate speed limits when he thinks he can get away with it), clog the courts to such a degree that judicial decisions are delayed interminably, thus frustrating one of the most important purposes of the judicial process, and entice juveniles into theft and adults into going into debt over their heads.

On any given amount of paved street or highway, the more cars, obviously, the more likelihood of a traffic jam, and the more speed, the more likelihood of collisions, casualties and fatalities. With the drivers of a hundred million automobiles trying to transport themselves somewhere else as expeditiously as possible, a kinetic crowdedness (that is, having one's movements constrained by others competing to occupy the same space) is created that far exceeds that in a much denser, slower-moving non-automotive society. Studies of the effects of crowdedness on the human psyche and soma are only in their infancy, but when they become more sophisticated they will probably reveal that the American automobile culture creates a greater sense of crowdedness than is felt by many of the citizens of China and India whose physical density is much greater. Such psychological tension cannot fail to have adverse social and physical effects.

ENOUGH IS TOO MUCH

In a widely anthologized essay entitled "The Tragedy of the Commons," the biologist Garret Hardin called attention most persuasively to the adverse social effect caused when herdsmen who make use of open and commonly held pasture for grazing their cattle, raise so many cows that the common pasture is overgrazed and the capacity of the land to feed the herds collapses. Hardin develops an analogy with human populations that may not be entirely valid but is useful in relation to the automobile population of the United States. There is a certain threshold up to which additional cows or cars do not seem to do any great harm to the common area within which each may roam. Beyond that point, however, the capacity of the land is overstrained and additional units have a strongly negative effect. Yet no single individual is constrained thereby to cut back on his number of cows or cars in the interest of other users of the commons, since cutting back on his own use of the commonly held space injures him and aids others. Why, therefore, should he do it? Hardin concludes that the only conceivable answer to this difficult problem is "mutual coercion, mutually arrived at." That, of course, is what government is all about. But in a society that operates through representative government and the consent of the governed, the only way that such mutual coercion can be achieved is for the body politic to become sufficiently convinced of the imperative nature, or at least the desirability, of laws and penalties as applied to themselves as well as others, that they are willing to have such coercion universally applied.

The national park system is an example of the commons of which Hardin speaks. A half-century ago, the magnificent Western parks were the Mecca for a limited number of nature lovers, but with the democratizing effects of the automobile the parks came within reach of the average American. Picture, then, the teenage girl who had seen Yellowstone and Yosemite after a transcontinental trek in the 1920s and vowed that when she had a family of her own she would bring them to see this greatest of natural wonders. Three decades later, she piled her four teenage children into a station wagon and headed West. When she arrived at the grandest of the grand sights, as she thought of Yosemite, the family was caught in a traffic jam, competing with some 40,000 other people who wanted to share the same inspiration. They spent hours, bumper to bumper, inching along or not moving at all for long periods. The family became restless, annoyed, and tired.

What was to have been a supreme life experience turned out to be a disappointment. Yellowstone was not quite so bad, but it, too, was seriously overcrowded. The proliferation of the automobile had degraded the best parks.

The jets have visited upon much of the world what the automobile has inflicted upon the choicest natural areas and historical and cultural spots of the United States. Transporting and disgorging millions of tourists around the globe, the jets have brought commercializing and homogenizing influences to bear on the tastes and hostelry of the people of exotic lands, persuading the placid, noncompetitive Fiji Islanders, and millions of others, that their culture is backward and that they should modernize—but keep just enough of the old ways to attract tourists. Tourists now overrun natural and cultural landmarks on all continents, vulgarizing many areas.

In recent years, about two million people a year have been touring the Acropolis to view what remains of the Garden of Eden of Western thought and culture. They have so eroded the steps of the Propylaea that planking has been installed as an emergency measure. The same is happening to the Parthenon. In a variety of other ways, the overwhelming tourist traffic is degrading the Acropolis. "Tourism is good to a certain point," said Dr. George Dontas, Director of the Acropolis Museum. "Then it becomes a plague." It seems obvious to him and to others that that point has been reached and passed. The problem is how to bring matters under control. In dozens of ways, the jet age has carried the automobile age one step further in reducing the diversity and interest of the multiple cultures of the earth.

Thus we see the basic paradox of affluence: Enough for everybody turns out to be too much for anybody. If the world were to become steadily more affluent, with more and more disposable income available to be spent on travel, the world would become vastly more homogenized and uninteresting and the very purpose for which affluence was presumably intended would be defeated. The natural and cultural environments would be degraded beyond recognition, and, worst of all, so would be the people who expected to be enriched by travel.

As in the case of so many other matters in the physical world, there is a threshold effect here. We may be approaching the threshold at which disenchantment with international travel exceeds its enchantment. That point will, of course, vary widely between countries, with greater travel still ahead to selected countries where pleasure still outweighs discomfort, but in some others—especially those where crime, hijacking, begging, and anti-Americanism flourish—international tourism by Americans may already have passed its peak. In any event, it seems rather clear to anyone who examines recent trends that international air travel cannot regain its earlier accelerative thrust in the foreseeable future. High costs are, of course, an important factor, but kinetic crowdedness is taking a major toll.

"KICKING" THE AMERICAN ADDICTION TO THE AUTOMOBILE

Five years ago, one would have said that there was no reasonable possibility that Americans would have any interest during this century in "kicking" their overwhelming addiction to the automobile.

But today, the prospect that Americans may take major steps in the next decade—certainly before the year 2000—to bring their dependency under manageable control appears substantially greater. The OPEC countries suddenly made the habit annoyingly expensive, but that is not the only stimulus to change. As described earlier, large numbers of people are finding driving less and less enjoyable under the conditions that require them to contend and compete with traffic at both ends of the day and at other times as well. Their bodies are deteriorating for lack of exercise and their tempers and nerves are deteriorating from too much exercise. They are becoming psychologically ready to reduce their dependence on the automobile, but it will not be easy.

Society conspires against the person who wants to free himself or herself from the automobile habit to a greater degree than it frustrates the smoker who decides to become a nonsmoker, for he is actively discouraged from doing so by public policies that overwhelmingly favor the automobile. The difficulties and dangers of riding a bicycle on main traffic arteries during rush hours make it imprudent for most people even to consider it. Even the few hardy souls that do face the problem of parking their bicycles in places where they will not be stolen. It is quite apparent that the automobile has hogged the streets. Does this mean that those who wish to will never be able to buck the automobile, that there is no way of kicking the automobile habit? Almost, but not quite.

In 1973, more than 16 million bicycles were bought—5 million more than the number of automobiles; in 1974, the bicycle sales continued to exceed those for automobiles. The American love affair with the 10-speed bicycle had begun to warm up at the very time that its enchantment with the automobile was obviously cooling. Bicyclists are probably already sufficiently numerous to have it within their power to obtain enactment of city ordinances and other legislation that will help them alter the transit mores of the society. If not, they soon will be. The creation of one-way bicycle streets during rush hours, as in Holland, the creation of systems of parking bicycles in protective custody at key points including commuter train stations, and similar encouragements to the use of bicycles seem likely to develop in many U.S. cities and thus begin a gradual change in transit systems and habits.

Despite the lack of comprehension and support of Midwestern and Mountain state Congressmen for Federal aid for urban mass transit systems, it seems predictable that as the price of gasoline rises and as the deterioration of core cities becomes a matter of unavoidable national concern, the mass transit systems will cry out so loudly for modernization and operating subsidies that a reversal of the long degenerative process of these systems will slowly begin. The rebuilding of mass transit will be a long, slow process, but there is a certain inevitability about it as a public policy, for without it some cities—especially New York—would decline in a manner and to a degree the nation could not tolerate.

Slowly, a significant shift is occurring in a variety of public policies that should demote the automobile from its role at the center of society. Without the sudden jump in the cost of oil, and the sudden re-education of the American people concerning the future availability of oil and gas, and all the implications that flow from such abrupt changes, this lessening in importance of the automobile would have seemed unlikely in the foreseeable future. But with the end of cheap gasoline as a permanent fact of life came the real probability of a basic change in our automobile society. Smaller automobiles will gradually replace the 200–400 horsepower models, cars will sooner or later be built to last longer, and gradually new residential and commercial construction will be adjusted to appeal to people who choose to live without owning an automobile, renting a car for the limited number of occasions when it becomes indispensable. This may be an integral part of a major shift in the direction and values of American society. Needless to say, it will not be at all easy to make the kinds of adjustments required in the pattern of skills and employment of persons whose livelihoods depend directly and indirectly upon the automobile industry.

Reason, as we know, is slow to take effect in coping with an addiction. When external circumstances alter in such a way as to reinforce reason, change may come more rapidly than one would otherwise expect. The fundamental alteration in the world's petroleum market is just such an external factor.

THE COMING TRANSFORMATION

(By Willis W. Harman)*

Let me first be explicit with regard to the magnitude and pervasiveness of the transformation being posited. This is thoroughgoing systemic change, comparable in importance to such transitions as the prehistoric change from a hunting and gathering to an agricultural society or the industrial revolution. Such a systemic change involves a metamorphosis in basic cultural premises, fundamental value premises, the root image of man-in-society, and all aspects of social roles and institutions.

Our research leads me to the conclusion that *the industrialized world is simultaneously undergoing a conceptual revolution as thoroughgoing in its effects as the Copernican Revolution, and an institutional revolution as profound as the Industrial Revolution.*

Furthermore, this overall transformation is proceeding with extreme rapidity, such that the most critical period will be passed through within a decade. Whether the social structure can withstand the strain is very much at issue, and this will greatly depend on how well we can understand the nature and necessity of the transformation while we are experiencing it.

In *The Transformations of Man* (1956), Lewis Mumford notes that there have probably been not more than a half dozen profound transformations in Western society since primitive man. Here we are talking about a rare type of event, and we can only make, at best, an informed guess concerning the character of the new type of social paradigm that will succeed the industrial society we have known. But the consequences of such a transformation are so profound that we cannot afford to disregard the signs that it may occur.

SIGNS OF TRANSFORMATION

There are three major reasons why a transformation, though rare, historically, is now plausible:

First, the complex of social problems confronting the developed world appears to require changes in cultural values for their satisfactory resolution. The societal dilemmas (discussed in my previous article) appear to be unresolvable within the current paradigm, and are creating pressure for a shift in that paradigm. In *The Structure of Scientific Revolutions*, Thomas S. Kuhn vividly describes how scientific paradigms are replaced: A watershed point is reached where the accumulated weight of discrepancies and anomalies that cannot be fitted into the old paradigm tips the balance, and scientists find it

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more profitable (in emotional as well as rational terms) to seek a new paradigm than to patch up the old.

Second, various "lead indicators" that have preceded other periods of historic cultural change have been prominent during the last decade. Studies of revolutionary cultural and political changes through history suggest certain typical occurrences tend to appear one to three decades ahead of the central change. These advance indicators include:

Decreased sense of community.

Increased sense of alienation and purposelessness.

Increased frequency of personal disorders and mental illness.

Inncreased rate of violent crime.

Increased frequency and severity of social disruptions.

Increased use of police to control behavior.

Increased public acceptance of hedonistic behavior (particularly sexual), of symbols of degradation, and of lax public morality.

Increased interest in noninstitutionalized religious activities (e.g., cults, rituals, secret practices).

Signs of specific and conscious anxiety about the future.

In some cases, economic inflation.

(The news stories of the past decade suggest that these advance indicators may be observed in today's society.)

Furthermore, as Kuhn points out, a conscious challenge to an operative system in itself constitutes another lead indicator. The legitimacy of a social system and its distribution of power is based on three assumptions: that the system has been duly constituted, that it adheres to adequate guiding moral principles, and that it is effective in achieving its agreed-upon goals.

All these assumptions now are challenged. The first challenge is to the assumption that industrial society is duly constituted. Though the governments of the industrialized democracies may meet the challenge, there exist other concentrations of power that do not. These include the large multinational corporations and the world economic system as a whole. As the largest corporations begin to wield influences over human lives that are comparable to those of governments, they face a demand that has, historically, been made only of government—that they assume responsibility for the welfare of those over whom they wield power. People who currently feel themselves to be disenfranchised include members of nonindustrialized cultures, minorities, consumers, youth, the aging, women, and those who are physically handicapped.

The dominant scientific-technological establishments are being challenged as arbiters of truth, because they are dominated by the values of industrialism and promote the industrial system first and human beings second.

The second challenge is to the morality of the system. Critics argue that the industrial system is not guided by adequate moral principles, particularly with regard to the equity of distribution of the earth's resources. Economic incentives predominate over everything. There is no effective ethic or mechanism for redistribution, nor is there any effective ecological (in the broad sense) ethic. The sense of pride in striving toward noble goals seems clearly to be dwindling. There are no adequate goals, beyond self-interest, to enlist the deepest loyalties and commitments of citizens.

The third and last challenge relates directly to the dilemmas of the industrial system: The system does not foster the enhancement of the total environment. There is a shortage of satisfying work roles. Incentive structures fail to insure the welfare of future generations, especially with regard to their need for fossil fuels, mineral resources, arable land, natural fresh water, and a fruitful ocean. The system does not promote socially responsible management of the impacts of new technological applications.

THE EMERGENT PARADIGM

Third, a competitor to the industrial-state paradigm—a model that embodies the requisite kinds of value-shifts—appears to be arising. This emergent paradigm also helps to make a societal transformation seem plausible.

The shape of the future will no more be patterned after the hippie movement and the New Left philosophies than the Industrial Age could have been inferred from the "new age" values of the Anabaptists. But several signs point to the possible emergence of a new dominant paradigm:

1. *Surveys and polls* by Daniel Yankelovich and others indicate significant value shifts among certain elite groups, such as students and corporate executives, toward an increased emphasis on humanistic, spiritual, quality-of-life, community, and similar values, and a decreased emphasis on materialistic values, status goals, and unqualified economic growth.

2. *Numerous cultural indicators*, including the themes of recent books, plays and motion pictures, the goals and types of voluntary associations, rock music lyrics, contents of magazine articles, and elements of the "new age" subculture, show greatly increased interest in and tolerance for the transcendental, religious, esoteric, occult, supra-rational, mystical, and spiritual.

3. *New scientific interest* in exploring subjective and altered states of consciousness, due in part to the discovery of numerous physical and physiological correlates to inner experience—rapid-eye-movement, galvanic skin response, muscle tensions, electroencephalographic (EEG) components, body electric and magnetic field components; biofeedback signals—is resulting in a new legitimation of studies of religious beliefs, mystical experiences, meditative states, psychic phenomena, and occult mysteries.

From these indicators, particularly the last, we can infer something about the direction in which values, and the dominant image of man-in-the-universe, are likely to shift. Whenever the nature of man has been probed deeply, in both Eastern and Western traditions, the paramount fact emerging is the duality of his experience. He is found to be both physical and spiritual, with both aspects being "real" and neither fully describable in terms of the other. A fundamental characteristic of the paradigm that may be emerging is the complementarity that the paradigm gives to such currently troublesome opposites as spirit/body, science/religion, and determinism/free will. Complementarity enabled modern physics to reconcile the wave and particle metaphors for light, so that neither theory contradicts the other.

I suggest the following characteristics could emerge as a post-transformation paradigm:

Complementarity of physical and spiritual experience; recognition of all "explanation" as only metaphor; use of differing, noncontradictory "levels of explanation" for physical, biological, mental, and spiritual reality.

Teleological sense of life and evolution as having direction/purpose; ultimate reality perceived as unitary, with transcendent order.

Basis for value postulates discoverable in one's own inner experience of a hierarchy of "levels of consciousness"; potentiality of supraconscious as well as subconscious experience.

Goals of life: aware participation in individual growth and the evolutionary process; individual fulfillment thro[illegible] integration of work [illegible] and growth.

Goals of society [illegible] oster development [illegible] scendent and emergen[illegible] potentialities; economic growth, technological development, design of work roles and environments, authority structures, and social institutions are all to be used in the service of this primary goal.

"New naturalism, holism, immanentism" (Victor Ferkiss); "Re-discovery of the supernatural" (Peter L. Berger); "The counterculture is essentially an exploration of the politics of consciousness" (Theodore Roszak).

Thus the challenging paradigm assumes some sort of transcendent spiritual order, discoverable in human experience, against which human value choices are assessed. Ultimately, reality is unitary, and life and evolution have direction or purpose. Levels of consciousness are explorable, with different appropriate levels of explanation. Hence the scientific explanation of the level of sensory experience in no way contradicts religious, philosophical, or poetical interpretations of suprasensory experience. Rather, it is complementary to them.

The candidate paradigm extends rather than contradicts the modern scientific world view, much as relatively theory extended Newtonian mechanims: the latter is merely a special case and none-the-less useful in the appropriate circumstances.

THE PERENNIAL PHILOSOPHY

Moreover, the candidate paradigm is in its essence not new at all. It has formed a major stream of thought in the humanities, in Western political tradition, in "transcendentalist" movements in U.S. history, and in the major religious philosophies throughout history. However, never has anything like it been the guiding paradigm of an entire society.

Aldous Huxley, in *The Perennial Philosophy* (1945), was one of the first modern writers to suggest that this age-old set of basic assumptions about the nature of man was showing new strength. He described it as: "the metaphysic that recognizes a divine Reality substantial to the world of things and lives and minds; the psychology that finds in the soul something similar to, or even identical with, divine Reality; the ethic that places man's final end in the knowledge of the immanent and transcendent Ground of all being. . . . Rudiments of the Perennial Philosophy may be found among the traditional lore of primitive peoples in every region of the world, and in its fully developed forms it has a place in every one of the higher religions. A version of this Highest Common Factor in all preceding and subsequent theologies was first committed to writing more than twenty-five centuries ago, and since that time the inexhaustible theme has been treated again and again, from the standpoint of every religious tradition and in all the principal languages of Asia and Europe."

The perennial philosophy forms an intermittently visible stream which has had a profound effect on Western civilization. Thales, Solon, Pythagoras, and Plato journeyed to Egypt to be initiated into it mysteries, ancient even then. Much of it is woven into institutionalized Christianity. In its Hermetic, Cabbalistic, Sufistic, and Rosicrucian forms it affected the history of the Middle East and of Europe. Through the traditions of Freemasonry, its symbols were incorporated into the Great Seal of the United States, testifying to its influence on forming many of the national goals to which we still adhere. It also appears in the Transcendentalism of Emerson, the Creative Evolution of Bergson, and the writings of William James, Mohandas Gandhi, St. Francis of Assisi, and Lao Tse.

Hints of its flavor, but only the flavor, can be given in the following five statements:

Being.—Under certain conditions man can attain a higher awareness, a "cosmic consciousness," in which he experiences the reality underlying the phenomenal world. In speaking of this reality, it seems appropriate to use such words as infinite, eternal, the Divine Ground of Being, Brahman, and God. From this vantage point, a person's own growth, creativity, and participation in the evolutionary process are seen to be under the ultimate direction of a higher center (Atman, the higher Self, the Oversoul).

Awareness.—A man goes through life in a sort of hypnotic sleep, feeling that he is making decisions, having accidents happen to him, meeting chance acquaintances, and so forth. But with more awareness, the supraconscious choosing, the direction of the higher Self, becomes apparent. The person finds that the decisions he felt he had come to logically or through intuition were really reflections of choices made on the higher level of the Self; that his "inspiration" or "creativity" is essentially a breaking through of these higher processes; that experiences and relationships which he needed for his growth were attracted to him by the Self and were not as accidental as he had assumed. Because ordinary perception, compared to this higher awareness, is partial perception, language built up from ordinary perception proves inadequate to describe the greater reality; attempts often are paradoxical in form.

Motivation.—Increasing awareness reduces the pull of material and ego needs, and the person finds his deepest desire is to participate fully in the evolutionary process, achieving wholeness (haleness, health) through alignment of supraconscious, conscious, and subconscious choices. Evolution is seen to be directed by a higher consciousness and characterized by purpose.

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Potentiality.—It follows from the foregoing that the human potentiality is limitless; that all knowledge and power is ultimately accessible to the mind, looking within itself; and that all limitations (infirmities, illnesses, etc.) are ultmately self-chosen.

Attitude.—With awareness comes a new attitude toward life. One aspect of this new attitude is a desire to labor, serve, and participate consciously in the evolutionary process, the cosmic drama, the fulfillment of mankind. But the reverse side is the conscious acceptance of what is, since at a deep level of the self one has already chosen this. Related to this acceptance of reality is a certain nonattachment to everyday events, or at least being deattached from specific outcomes.

SOURCES OF SUSPICION

Modern Western man is suspicious of such a transcendental outlook for three reasons: (1) Unlike modern science, the transcendental outlook does not seem to be based on public perceptions; (2) attempts to communicate about it often sound dangerously close to superstitious nonsense; and (3) the transcendental outlook seems to connote quietistic retreat from the problems of the world.

The first objection is gradually being countered by science itself: Scientists are finding that the division between subjective and objective, observer and observed, is nowhere near so clearcut as had been assumed in the early naive period of the science-versus-religion debates. The deep-rooted attitudes and prejudices of the observer have been shown to affect his observations. The problem of what knowledge is public, universal, and therefore "true" permeates all of science, being more obviously troublesome in some fields than in others. To overcome subjective influences, it has long been a standard practice when testing new medicines to conduct "double blind" experiments in which neither the subject nor the experimental personnel know whether the drug or a placebo has been administered.

The second ground for suspicion—poor communicability—is fundamental. Language and metaphors built up from ordinary, partial perception prove inadequate to describe the expanded view of reality and are frequently mystifying. Witness this statement from the *Upanishads*, an ancient Hindu treatise: "An invisible and subtle essence is the spirit of the whole universe. That is reality. That is truth. Thou art that."

As to the third objection, some versions of the perennial philosophy do indeed sound like a quietistic retreat, at least in their Western forms. But a central concern of many of these versions, including the Masonic tradition, is the development of the knowledge by which humanity can achieve a state of mutual understanding and spiritual integrity. Work is placed at the heart of humane living—not a compulsive Protestant work ethic, nor work for economic gain, but the joy of vital and creative work.

Yet part of the growing acceptability of the "new age" world view undoubtedly has been due to its ability to draw on what has already been well-established in the culture. The perennial philosophy also bridges the gap between the "two cultures" of the sciences and humanities.

TWO GUIDING ETHICS

Growing out of this image of man as a transcendent being [illegible] a pair of complementary ethics which are most congruent with the kind of transformation necessary for the resolution of contemporary societal dilemmas. The first is an ecological ethic and the second a self-realization ethic.

The ecological ethic, as defined by Lynton Caldwell (*Environment: A Challenge to Modern Society*, 1972) recognizes the limited nature of resources, sees man as an integral part of the natural world, hence inseparable from its governing processes and laws. The ecological ethic fosters a sense of the total community of man and responsibility for the fate of the planet, and relates self-interest to the interests of fellow man and of future generations.

A "self-realization ethic" asserts that the proper end of all individual experience is the further development of the emergent self and of the human species. The appropriate function of *all* social in[illegible] create an envir[illegible] foster that process. The self-realization ethic would push society toward a restructuring of social institutions to satisfy the individual's need for full participation in the society. As corollaries to this ethic, self-determination of individuals and minority groups should be fostered, social decision-making should be highly decentralized, and the mechanism of a strong free-enterprise private sector should be preferred over public bureaucracy for the accomplishment of most social tasks.

These two ethics—one emphasizing the total community of man-in-nature and the oneness of the human race, and the other placing the highest value on the development of selfhood—are complementary, not contradictory. Together they encourage both cooperation and wholesome competition, both love and individuality. Each is a corrective against the excesses and misapplications of the other.

THE TRANSITION PERIOD

There is nothing in history to suggest that a social transformation of the magnitude suggested could occur without the most severe economic and social disruptions and systems breakdowns. If we are indeed involved with a shifting social paradigm, it follows that the main challenge to society is to bring about the transition without shaking itself apart. Actions which attempt to force the change too quickly can be socially disruptive; actions which attempt to hold it back can make the transition more difficult and perhaps bloody. Seldom in history has such delicacy of balance been required.

On the other hand, this description of a macroproblem should not be interpreted as a counsel of despair, that nothing worthwhile can be done short of some "macrosolution." It does not follow that a global problem necessitates a global solution. On the contrary, we have heard enough over the last four decades of plans for near-utopian societies to justify our considerable disenchantment with "grand designs."

What is now needed is a radical vision with adaptive incremental strategies. But these strategies need to be coordinated through widespread understanding of the interrelatedness of the separate actions.

The radical vision is not lacking—it was present at the founding of the nation and presumably has not been repudiated. The report of the President's Committee on National Goals, *Goals for Americans* (1960), included such statements as:

> The Declaration (of Independence) put the individual squarely at the center, as of supreme importance. It completely reversed the age-old order; it defined government as the servant of the individual, not his master.
>
> The paramount goal (of the nation) is to guard the rights of the individual, to ensure his development, and to enlarge his opportunity.
>
> All of our institutions—political, social, economic—must further enhance the dignity of the citizen, promote the maximum development of his capabilities, stimulate their responsible exercise, and widen the range and effectiveness of opportunities for individual choice.

But belief in this vision has diminished, only partly because of natural cynicism and institu[illegible] More [illegible] by the striking practical successes of positivistic science. Thus the most fundamental conflict of all is that the most scientifically sophisticated image of man available has led us to the prospect of Jose Delgado's "psycho-civilized society," where the right behavior is to be induced in persons through operant conditioning or through electric signals introduced into the brain, and has led us to be admonished by B. F. Skinner that notions of freedom and dignity are romantic delusions of a prescientific culture.

Several recent scholars of the future such as Robert Heilbroner, Kenneth Boulding, and Fred Polak have made much of the concept that it is the *image* of the future which is the key to that future coming into realization. "Every society," said Polak, "has an image of the future which is its real dynamic." Another way to state this is that every society has some "central project," an overall task or central goal toward which it dedicates its time and energy.

Ever-increasing material consumption and waste is no longer an adequate central project for industrial society. A society-wide self-realization ethic, coupled with a major scientific investigation of the transcendental aspects of reality, may provide an adequate substitute. With the growing realization among scientists that science does not deal with ultimate reality, but with models and metaphors, we now have a more promising climate for the exploration of inner experience.

ADAPTIVE STRATEGIES

If we are to undergo this kind of transition without tearing ourselves apart in the process, we will need to implement strategies which will allow us to adapt ourselves and our society gradually to the exigencies of a post-industrial society.

Rather than present a host of proposals for all sectors of society, let me touch a couple of areas.

Global thinking, attention to future consequences, and concern for fellow man and future generations need to enter into local and immediate decision-making. A variety of institutional changes could foster this kind of widespread citizen participation in "designing the future." This kind of participation is one of the most powerful ways of encouraging the choosing of socially responsible behavior, as opposed to imposing necessary constraints through governmental regulation. In addition, learning and planning are the two main forms of work which can absorb unlimited numbers of people when only some people, with only a fraction of their time, are needed to produce all the goods and services the society can use.

Many of these same institutions could also achieve the necessary regulation of political, social, and economic affairs at the lowest practicable level—which may be the local community for human-welfare issues and the planetary level for cosmic pollution.

The comple[illegible] demands a well-[illegible] units at local, regional, national, and planetary levels. In general, these units would have two tasks: the definition and comparison of alternatives, and the selection and actualization of the alternative to be followed. The first task is technical, requiring advanced skills and detailed information. The second is political, involving citizen participation, stimulation of needed actions, and brokerage of the resources required from concerned organizations and agencies.

THE NEXT DECADE

The forces of societal transformation have gathered impressive momentum. The next 10 to 15 years will show whether these forces are strong enough to bring about a major societal wrenching, or whether they will somehow quiet down and die away, or whether the confrontation between the new demands and the old rigidities is so violent that the result is destruction without a promising rebuilding.

This period will not be history's most comfortable one, but it will no doubt be interesting. The industrial world badly needs a positive and inspiring image of its own future, and competent policy and leadership to guide it through what will be, at best, trying times.

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Contains 7 articles offering glances at the problems of organizing to meet energy problems—at national, state, and local levels—at conservation and environmental interfaces, at what may be meant by a change in life style enforced by energy stringencies, and at what the 93rd Congress did and did not do about the whole matter of energy supplies.

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Whalen, Richard J. The real oil crisis is still to come: we may be running out of borrowed time. Washington post, Sunday, Aug. 21, 1977: C1, C4+.

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World Future Society, P.O. Box 30369, Washington, D.C. 20014

HOW TO SECURE ADDITIONAL INFORMATION ON ENERGY POLICY

1. GOVERNMENT PUBLICATIONS

Additional sources of information on energy policy in the United States are hearings and debates in the Congress and the publications of the Department of Energy; the U.S. Geological Survey; the Bureau of Mines; the U.S. Environmental Protection Agency; also the U.S. Energy and Research Development Administration and the U.S. Federal Energy Administration before 1977 when their functions were assumed by the Department of Energy.

The "Monthly Catalog of United States Government Publications," issued by the Government Printing Office, provides an index to Congressional hearings, reports, documents, and committee prints and to publications by Government agencies. Within the catalog Congressional publications are arranged by committee and the documents are in turn indexed in the back of the book by subject. If the desired documents are not available in a school or local library, they may be obtained, if still in print, by writing directly to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

The Congressional Record contains Congressional debates as well as relevant articles and speeches. Accordingly, it is a valuable source of information. It appears daily during the sessions of Congress with an index which is issued about every two weeks. At the end of a session bound volumes of The Record are published, one of which contains an index covering the complete session. The user should be alert to the fact that the pagination differs for the daily and bound editions of The Record.

2. OTHER SOURCES

Other useful sources for information are the yearly Congressional Quarterly Almanac, published since 1945, the Congressional Quarterly Weekly Report, published since 1946, C.Q.'s Congress and the Nation and its supplements, and the National Journal, published since 1969.

3. BOOKS AND PERIODICALS

In order to be aware of the latest books and magazine and newspaper articles on energy policy and power resources, the debater may wish to consult indices such as the Reader's Guide to Periodical Literature, a guide to general and non-technical periodicals; the Business Periodical Index; the Vertical File Index; the Bulletin of the Public Affairs Information Service, a subject list of the latest books, pamphlets, Government publications, reports of public and private agencies, and periodical articles, relating to economic and social conditions and public administration; The Christian Science Monitor Index; the New York Times Index; and the Wall Street Journal Index.

Most of the weekly news magazines have regular information on energy matters and the reader is urged to review major newspapers for the latest political developments.

Additional material relating to energy policy may be obtained from the following organizations:

American Gas Association, Educational Services, 1515 Wilson Boulevard, Arlington, Virginia 22209
American Petroleum Institute, 1801 K Street, N.W., Washington, D.C. 20006.
Atomic Industrial Forum, Inc., 475 Park Avenue South, New York, New York 10016
Concern, Inc., 2233 Wisconsin Avenue, Washington, D.C. 20007
Conservation Foundation, 1250 Connecticut Avenue, N.W., Washington, D.C. 20036
Edison Electric Institute, Educational Service, 90 Park Avenue, New York, New York 10016
Electrical Industries Association, 6055 East Washington Boulevard, Los Angeles, California 90040
Energy Action Committee, 1523 L Street, N.W., Washington, D.C. 20005
Energy Options EEG/EAG, 1543 North Martel Avenue, Los Angeles, California 90046
League of Women Voters, 1730 M Street, N.W., Washington, D.C. 20036
National Coal Association, Educational Division, 1130 17th Street, N.W., Washington, D.C. 20036
National Education Association, 1201 16th Street, N.W., Washington, D.C. 20036
National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009
Solar Action, 1028 Connecticut Avenue, N.W., Washington, D.C. 20036
World Future Society, P.O. Box 30369, Washington, D.C. 200114

PUBLICATIONS RELATING TO THE 1978-79 NATIONAL HIGH SCHOOL DEBATE TOPIC [1]

What Should be the Energy Policy of the United States? 1978. 534 p. 95-2:S.doc. 116; S/N 052-071-00567-6 .... $5.25

Analysis of the Proposed National Energy Plan, August 1977: This is a critique by the Office of Technology Asseessment of the National Energy Plan originally proposed by the Carter Administration in April 1977. 1977. 248 p. il. Y 3.T 22/2:2 En 2/6; S/N 052-003-00420-8 .... 4.00

Buying Solar: Solar energy for your home is here. Whether it will help you by producing real savings depends upon a number of factors, including where you live, the type of home you have or intend to build, the quality of insulation in your home, your present energy costs, and the type of solar system you purchase. Buying Solar gives you information on these five factors so that you, as an informed customer, can make decisions on solar energy that are in your best interests. 1976. 71 p. il. FE 1.2:So 4/3; S/N 041-018-00120-4 .... 1.85

Citizen Action Guide to Energy Conservation: Enormous amounts of energy are wasted in the United States, even though stopping waste is often a simple process that can be acomplished by every citizen. This booklet contains practical suggestions on how you can do something to alleviate the U.S. energy problem. There are tips on conserving energy at home, at work, and in your car, and suggestions on how citizens can combine their efforts and work toward energy conservation at the community level. The booklet gives the name and address of the State contact for energy information in every State. 1973. 64 p. il. Pr 37.8:En 8/C 49/3; S/N 040-000-00300-2 .... 1.75

Coal Combustion: This publication reports on the technology that must be developed in order to revive coal as a major source of our energy supply. A number of research topics relevant to the production and use of coal are discussed, and a series of findings and conclusions are made. 1977. 59 p. il. Y 4.Sci 2:94-2/yy; S/N 052-070-04092-1 .... 1.80

Coal Mining: This booklet deals with the origin, description, mining, processing, transportation, and use of coal. It is designed to acquaint the reader with a broad knowledge of one of America's chief energy resources. 1975. 34 p.il. I 69.8/2:1; S/N 024-019-00011-0 .... .50

Coal Resources of the United States, January 1, 1974: This book analyzes the future of coal in America, and gives the benefits we can expect to derive from its use. 1975. 131 p. il. I 19.3:[illegible]2; S/N 024-001-02703-8 .... 1.60

Concerning Energy Resources, Message From the President of the United States Concerning Energy Resources. 1973. 24 p. 93-1:H.doc. 85; S/N 052-071-00341-0 .... .35

Congress and the Nation's Environment, Energy and Natural Resources Actions of the 94th Congress. 1977. 1092 p. Y 4.In 8/13:95-5; S/N 052-070-03919-1 .... 14.00

Conservation and Efficient Use of Energy, Hearings Before the Subcommittee of the House Committee on Government Operations, House, 93d Cong., 1st Sess., May 1-2, 1973. 1973. 132 p. Y 4.C 74/7:En 2; S/N 052-070-01888-7 .... 1.20

Report to Above. 1974. 292 p. 93-2:H.Rept. 1634; S/N 052-071-00428-9 .... 2.60

[1] Subject bibliography, compiled by the U.S. Government Printing Office, available from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

Converting Solar Energy Into Electricity: A Major Breakthrough? Hearing Before the Subcommittee on Conservation, Energy, and Natural Resources of the House Committee on Government Operations, June 11, 1976. Discusses the potential and particular advantages of a recently patented invention that converts heat or solar energy into electricity. 1976. 38 p. il. Y 4.G 74/7:So. 4; S/N 052-070-03525-1 .... $0.55

Current Energy Shortages, Oversight Series: All missing parts are "Out of Print."

- Pt. 1, Conflicting Information on Fuel Shortages, Dec. 14, 1973. 1974. 111 p. il. Y 4.G 74/6:En 2/pt. 1; S/N 052-070-02193-4 .... 1.10
- Pt. 2, Major Oil Companies, Jan. 21, 1974. 1974. p. 113-275, il. Y 4.G 74/6:En 2/pt. 2; S/N 052-070-02275-2 .... 1.50
- Pt. 3, Major Oil Companies, Jan. 22, 1974. 1974. p. 277-451, il. Y 4.G 74/6:En 2/pt. 3; S/N 052-070-02308-2 .... 1.60
- Pt. 4, Major Oil Companies, Jan. 23, 1974. 1974. p. 453-593, il. Y 4.G 74/6:En 2/pt. 4; S/N 052-070-02310-4 .... 1.40
- Pt. 7. Oil Brokers, Apr. 4 and 10, 1974. 1974. p. 787-880, il. Y 4.G 74/6:En 2/pt. 7; S/N 052-070-02347-3 .... 1.10
- Pt. 8, Cutoff of Petroleum Products to U.S. Military Forces, Apr. 22, 1974. p. 881-984, il. Y 4.G 74/6:En 2/pt.8; S/N 052-070-02393-7 .... 1.15

The Data Base: The Potential for Energy Conservation in Nine Selected Industries. A well-research study that provides basic data on energy consumption in industry, and identifies opportunities for energy conservation. These opportunities are given a cost and policy analysis to determine how they can best be turned into energy savings:

- Alluminum. (Out of print) ....
- Cement. 1975. 122 p. il. FE 1.22:11; S/N 041-018-00063-1 .... 1.90
- Copper. 1975. 127 p. il. FE 1.22:12; S/N 041-018-00061-5 .... 1.90
- Energy Management Case Histories. 1975. 15 p. FE 1.22:1A; S/N 041-018-00062-3 .... .70
- Glass. 1975. 189 p. il. FE 1.22:15; S/N 041-018-000691 .... 1.95
- Petroleum Refining. 1975. 388 p. il. FE 1.22:10; S/N 041-018-00065-8 .... 4.40
- Selected Paper Products. 1975. 160 p. il. FE 1.22:16; S/N 041-018-00070-4 .... 2.35
- Selected Plastics. 1975. 144 p. il. FE 1.22:9; S/N 041-018-00064-0 .... 2.80
- Steel. 1975. 144 p. il. FE 1.22:14; S/N 041-018-00068-2 .... 2.05
- Styrene Butadiene Rubber. 1975. 133 p. il. FE 1.22:17; S/N 041-018-00071-2 .... 2.00

Energy Conservation and Conversion Act of 1975. Hearings Before the Committee on Finance, Senate, 94th Cong., 1st Sess., On H.R. 6860, An Act to Provide a Comprehensive National Energy Conservation and Conversation Program:

- Pt. 1, July 10-14, 1975. 1975. 459 p. il. Y 4.F 49:En 2/8/975/pt.1; S/N 052-070-03027-5 .... 8.95
- Pt. 2, July 15-18, 1975. 1975. 542 p. il. Y 4.F 49:En 2/8/975/pt.2; S/N 052-070-03135-2 .... 4.60

Economic and Social Costs of Coal and Nuclear Electric Generation: A Framework for Assessment and Illustrative Calculations for the Coal and Nuclear Fuel Cycles. 1976. 127 p. il. NS 1.2:C 63; S/N 038-000-00293-7 .... 2.05

Economic Evaluation of a Process to Separate Raw Urban Refuse Into its Metal, Mineral, and Energy Components. 1977. 25 p. il. I 28.27:8732; S/N 024-004-01902-6 .... .75

The Economics of Solar Home Heating: A 1976 study prepared for the Joint Economic Committee, analyzing the extent to which solar energy can be economically substituted for more conventional residential heating and hot water systems. The analysis is done on a State-by-State basis, and covers the period 1976-1990. 1977. 86 p. il. Y 4.Ec 7:So 4, S/N 052-070-03968-0 .... 1.35

Economics of the President's Proposed Energy Policies. Hearings Before the Joint Economic Committee, Congress. 95th Cong., 1st Sess., May 20 and 25, 1977. 1978. 177 p. il. Y 4.Ec 7:En 2/15; S/N 052-070-04473-0 .... 2.75

Electric Energy Systems Program: Linking Sources and Uses: This document describes the Electric Energy Systems Division of the Energy Research and Development Administration, and its role and program for electric energy system R&D. 1977. 27 p. il. ER 1.11:ERDA 77-26; S/N 060-000-00059-0 ---------- $1.40

Emergency Workshop on Energy Conservation in Buildings. 1975. 26 p. C 13.46:789-1; S/N 003-003-01439-7 ---------- .80

Energy Alternatives, A Comparative Analysis. 1975. 600 p. il. PeEx 14.2: En 2; S/N 041-011-00025-4 ---------- 9.00

Energy Conservation, Hearings Before the Joint Economic Committee, Subcommittee on Energy, Congress, 94th Cong., 2d Sess., Feb. 2, 3, and 24, and Apr. 13, 1976. 1977. 293 p. Y 4.Ec 7:En 2/3/976; S/N 052-070-03985-0 ---------- 2.70

Energy Conservation Handbook for Light Industries and Commercial Buildings. 1974. 16 p. il. C 1.8/3:En 2; S/N 003-000-00431-7 ---------- .35

Energy Conservation in Buildings, Hearings Before the Government Operations Committee, House, 94th Cong., 2d Sess., July 27-23, 1976. 1976. 323 p. Y 4.G 74/7:En 2/6; S/N 052-070-03802-1 ---------- 2.90

Energy Conservation in the Food Industry. A Bibliography: An annotated list of publications on how to conserve energy in various sectors of the food system. Includes books for food wholesalers, retailers, manufacturers, and even some for the cooking public. 1976. 73 p. il. FE 1.23: En 2; S/N 041-018-00110-7 ---------- 1.40

Energy Conservation Program Guide for Industry and Commerce: This is an important guide for those in industry and commerce who are responsible for the use of energy in intermediate to small sized firms. It discusses engineering data and factors; financial evaluation procedures; safety, health, and pollution considerations; and much more. It also provides a list of persons and organizations to contact for assistance. 1974. 206 p. il. C 13.11:115; S/N 003-003-01323-4 ---------- 2.90

Supplement 1 to Above: Provides more ideas and suggestions, and includes a revised explanation of how to start an energy conservation program, an expanded checklist of energy conservation opportunities, and other additions and revisions to the basic guide. 1975. 96 p. il., looseleaf. C 13.11:115/supp.1; S/N 003-003-01582-2 ---------- 2.25

Energy Conservation Through Effective Energy Utilization: The proceedings of a 1973 conference held at New England College, Henniker, New Hampshire. The conference focused on ways to utilize thermal energy more effectively. 1976. 261 p. il. C 13.10:403; S/N 003-003-01638-1 ---------- 3.30

Energy Effective Windows: Proceeding of a Joint DOE (ERDA), NBS Conference, Round Table on Energy Effective Windows Held in Washington, D.C., Apr. 13, 1977. 1978. 53 p. il. C 13.10:512; S/N 003-003-01929-1 ---------- 2.20

Energy From Coal. A State-of-the-Art Review. 1976. 110 p. il. ER 1.11: ERDA 76-67: S/N 052-010-00480-1 ---------- 2.05

Energy in Solid Waste: This book reveals the amount of energy in our garbage, trash, and roadside litter that is now being wastefully burned, buried, dumped in the ocean, or thrown indiscriminately across our landscape. It points out how citizens, individually and collectively, can reduce this waste at home, work, and at play, and how they can help in the recovery, recycling, and reuse of the resources now being squandered. The book also makes several recommendations on how the Federal Government can lead the way in fostering such actions. 1974. 40 p. il. Pr 37.8:En 8/En 2/2 S/N 040-000-00319-3 ---------- 1.25

Energy Management Checklist for the Home. 1975. 7 p. A 1.68:1118; S/N 001-000-03440-5 ---------- .35

The Energy Outlook for the 1980's, A Study. This booklet looks into the prospects for developing the energy resources of the United States, providing an overview of ways in which we can increase our output of energy in the years ahead. Promising resources that are individually discussed include coal, offshore production of oil and gas, Alaskan oil and gas, oil shale deposits, nuclear energy, and Canadian tar sands. A concluding review of noncompetitive practices in the petroleum industry is also included. 1973. 39 p. Y 4.Ec 7:En 2/4; S/N 052-070-02113-6 ---------- .65

Energy Policy and Conservation Act: An act to increase domestic energy supplies and availability; to restrain energy demand; to prepare for energy emergencies, and for other purposes. Approved Dec. 22, 1975. 99 p. GS 4.110:94/163; S/N 022-003-91101-4 — $1.70

Energy Recovery From Waste: Solid Waste as Supplementary Fuel in Power Plant Boilers. 1973. 24 p. il. EP 1.17:36 D 11; S/N 055-002-00116-5 — .45

Energy Statistics: Current information and statistics relevant to the formulation of our national energy policy. The data deals with various energy resources (petroleum, natural gas, coal, etc.), consumption trends, production, supply, prices, and imports. 1975. 45 p. il. Y 4.F 49:En 2/7; S/N 052-070-03005-4 — .80

Energy Use and Climate: Possible Effects of Using Solar Energy Instead of "Stored" Energy. A brief study of the possible effects on worldwide climate of using solar energy instead of "stored" energy (such as fossil and nuclear fuel) to meet future energy needs. 1975. 53 p. il. NS 1.2:En 2/5; S/N 038-000-00240-6 — 1.35

Federal Preparedness to Deal With the United States Natural Gas Shortage Emergency, Hearings Before the Committee on Government Operations. House. 94th Cong., 1st Sess., June 12 and 26, 1975. 1975. 851 p. il. Y 4.G 74/7:G 21; S/N 052-070-03083-6 — 6.70

Final Report: Oil and Gas Resources, Reserves, and Productive Capacities. This report, submitted annually by the Federal Energy Administration to the President and Congress, analyzes and estimates America's potential petroleum resources for present and future utilization. Volume one discusses final reserve and productive capacity estimates, and volume two provides summaries of engineering analyses of major domestic oil and gas fields:

- Vol. 1. 1976. 80 p. FE 1.2:Oi 5/3/v.1; S/N 041-018-00093-3 — 1.80
- Vol. 2. 1976. 160 p. FE 1.2:Oi 5/3/v.2; S/N 041-018-00094-1 — 2.70

Gasoline and Fuel Oil Shortage, Hearings Before the Subcommittee on Consumer Economics of the Joint Economic Committee. 93d Cong., 1st Sess., May 1–June 2, 1973: Such crucial matters as gasoline distribution and pricing, oil supply and demand, and related energy concerns are examined. 1973. 290 p. il. Y 4.Ec 7:G 21/2; S/N 052-070-01999-0 — 2.00

Gasoline Distribution, Hearings Before the Joint Economic Committee, Subcommittee on Consumer Economics. 93d Cong., 2d Sess., Mar. 12 and 14, 1974. 1974. 138 p. il. Y 4.Ec 7:G21/3: S/N 052-070-02429-1 — 1.30

Geothermal Energy, A National Proposal for Geothermal Resources Research. 1976. 95 p. NS 1.2:G 29: S/N 038-000-00163-9 — 1.70

A Guide to Energy Conservation for:

- Food Service. 1977. 74 p. il., chart. FE 1.8:F 73: S/N 041-018-00127-1 — 2.25
- Grocery Stores. 1977. 40 p. il., chart in pocket FE 1.8:G 89: S/N 041-018-00133-6 — 1.90

A Guide to Reducing Energy Use Budget Costs. 1977. 93 p. il. E 1.8:B 85; S/N 061-000-00003-8 — 3.00

Guidelines for Saving Energy In Existing Buildings: Engineers, Architects, and Operators Manual: This manual describes specific ways energy can be saved in the fields of heating, ventilation, cooling, domestic hot water, commercial refrigeration, lighting, and power. A bibliography, selected references, and specific examples of energy conservation are also included. 1975. 448 p. il. FE 1.22:21; S/N 041-018-00080-1 — 5.05

Handling Fuel and Fuel Problem: An Energy Handbook for Small Businesses. 1975. 16 p. FE 1.8:Sm 4/975; S/N 041-018-00072-1 — .35

Home Energy Savers' Workbook: This workbook tells you how to identify ways to make your home more energy-efficient and compute the savings you can expect to realize from each conservation measure. 1977. 29 p. il. FE 1.2:H 75/977; S/N 041-018-00116-6 — .50

In the Bank . . . Or Up the Chimney? Dollars and Cents Guide to Energy-Saving Home Improvements: The most complete and up-to-date collection of money-saving energy information ever produced by the Government for homeowners. The book takes you on a pictorial journey to virtually every corner of your home, including some you didn't know could be improved. It shows you how to determine where you can conserve energy, gives you an accurate dollar estimate of how much it's going to cost, and then shows you how to do it. Rev. 1977. 76 p. il. HH 1.6/3:En 2/3/977; S/N 023-000-00411-9 — 1.70

Industrial Energy Conservation, Hearings Before the Joint Economic Committee, Subcommittee on Energy, Congress, 95th Cong., 1st Sess., July 28, 1977. 1978. 39 p. Y 4.Ec 7:En 2/16; S/N 052-070-04500-1 $1.50

Industry Efforts in Energy Conservation. 1974. 285 p. Y 4. C 73/2:En 2/3; S/N 052-070-02586-7 3.50

Interdisciplinary Student Teacher Materials in Energy, the Environment, and the Economy:

- How a Bill Becomes a Law to Conserve Energy, Grades 9, 11, and 12. 1977. 115 p. il. E 1.9:B 49; S/N 061-000-00080-1 2.75
- United States Policy, Which Direction? Grades 11-12, Draft. 1978. 89 p. il. E 1.9:P 75/draft; S/N 061-000-00078-0 2.50

Lighting and Thermal Operations, Energy Conservation Principles Applied to Office Lighting: This book studies energy conservation principles as they apply to office lighting. It includes the relationship of illumination to visual performance and lighting energy to heating and cooling energy, and provides a summary of new techniques and equipment for energy conservation. 1975. 273 p. il. FE 1.22:18; S/N 041-018-00084-4 3.55

Liquified Natural Gas: Safety, Siting and Policy Concerns. 1978. 147 p. il. Y 4.C 73/7:G 21; S/N 052-070-04566-3 2.50

Making the Most of Your Energy Dollars in Home Heating and Cooling: This booklet tells you, for your climate and the type of energy used to heat and cool your house, what combination of energy conservation improvements to invest in to get the largest long run net savings in your heating and cooling bills. It also gives you general information you should have before you invest in any energy conservation improvements. This includes tips about storm windows and doors, weather stripping, moisture control, and insulating attics, walls and floors. 1975. 17 p. il. C 13.53:8; S/N 003-003-01446-0 .70

Material Shortages, Selected Readings on Energy Self-Sufficiency and Controlled Materials Plan. 1974. 256 p. Y 4.G 74/6:En 2/7; S/N 052-070-02475-5 2.50

Multinational Oil Companies and OPEC. Implications for U.S. Policy, Hearings Before the Joint Economic Committee, Subcommittee on Energy, Congress, 94th Cong., 2d Sess., June 2-3 and 8, 1976. 1977. 337 p. il. Y 4.Ec 7:Oi 5/10; S/N 052-070-03980-9 3.00

National Energy Act: This is the text of President Carter's proposed National Energy Act, which he transmitted to Congress on Apr. 29, 1977, and which became the subject of heated debate in Congress and throughout the nation. 1977. 283 p. 95-1:H.doc. 138; S/N 052-071-00521-8 4.00

National Energy Plan: Presents President Carter's Energy Plan submitted to Congress on Apr. 20, 1977. 1977. 103 p. il. PrEx 1.2:En 2/2; S/N 040-000-00380-1 2.00

The Natural Gas Story: This publication traces the history of the natural gas industry, the development of a growing shortage of natural gas supplies, and the potential solutions which can be undertaken by the industry and by the Federal government to assure adequate supplies of gas to meet the Nation's needs. 1975. 18 p. il. FE 1.2:G 21; S/N 041-018-00089-5 .50

Oil Shale, A Potential Source of Energy. 1972, reprinted 1977. 16 p. il. I 19.2:Oi 5/4/972; S/N 024-001-02204-4 .90

Our Prodigal Sun: Provides a brief introduction to the life and the anticipated eventual death of the sun, discusses the sun as the possible source of all future forms of energy, and talks about the problems in obtaining pure solar energy. 1974. 14 p. il. NAS 1.19:118; S/N 033-000-00569-5 .35

Petroleum Storage, Alternative Programs and Their Implications for the Federal Budget. 1976. 67 p. il. Y 10.9:14; S/N 052-070-03718-1 1.25

Polar Energy Resources Potential, A Report. 1976. 178 p. il. Y 4.Sci. 2:94-2/zz; S/N 052-070-03917-9 2.50

President Carter's Energy Proposals: A Perspective: This publication provides a preliminary evaluation of President Carter's proposed energy plan—a complex system of more than 100 interdependent proposals aimed at reducing consumption of petroleum, converting from oil and natural gas to coal as an energy source, and increasing domestic supplies of energy. 1977. 133 p. il. Y 10.2:En 2/2; S/N 052-070-04044-1 2.75

Production of Aviation Jet Fuel From Coal, Staff Report: Discusses one of several alternate fuel sources and the practical aspect of its production. 1976. 27 p. il. Y 4.Ae 8:F 95; S/N 052-070-03483-1 ---- $0.45

Project Independence Blueprint: Final Task Force Reports. Estimates the potential production capabilities for that source of energy, and the resources necessary to achieve those levels of production:

Nuclear Energy. 1974. 457 p. il. FE 1.18:N 88; S/N 041-018-00013-5 ---- 5.50

Solar Energy. 1974. 564 p. il. FE 1.18:So 4; S/N 041-018-00012-7 ---- 6.20

Projects to Expand Fuel Sources in Eastern States, Survey of Planned or Proposed Coal Mines, Coal and Noncoal Conversion Plants, Electric Generating Plants, Oil Refineries, Uranium Enrichment Facilities, and Related Intrastructure, in States East of the Mississippi River, as of June 1976. 1976. 114 p. il. I 28.27:8725; S/N 024-004-01891-7 ---- 1.85

Readings on Energy Conservation, Selected Materials Compiled by the Congressional Research Service: In an effort to provide background material with which to study the energy conservation question, a collection of literature on the subject was compiled in such subject areas as the concept, potential, and strategies of energy conservation, institutional factors, and the national energy policy. Sources for the literature include legislation, congressional reports, and magazine articles. 1975. 570 p. Y 4.In 8/13:94-1; S/N 052-070-02719-3 ---- 4.80

Solar Energy as a National Energy Resource: Did you know that solar energy is received in sufficient quality to make a major contribution to the future of U.S. heat and power requirements, and there are no technical barriers to wide application of solar energy to meet U.S. needs? These and an astonishing number of facts concerning the potential of solar energy are contained in this report. 1972. 85 p. il. NS 1.2:So 4/2; S/N 038-000-00164-7 ---- 1.50

Solar Power From Satellites, Hearings Before the Aeronautical and Space Science Committee, Subcommittee on Aerospace Technology and National Needs, Senate, 94th Cong., 2d Sess., Jan. 19 and 21, 1976. This publication surveys concepts involving advanced aerospace technology that might help satisfy one of our greatest national needs—future sources of energy. Specifically considered are ways to collect solar power in space with satellites and to beam that power down to earth to supplement our other sources of electricity. Included too, are many ways to construct those satellites. 1976. 228 p. il. Ae Y 4.8:So 4/2; S/N 052-070-03319-3 ---- 2.70

Technology Assessment of Residential Energy Conservation Innovations: Final Report: This study examines the benefits of selected technical innovations intended to reduce residential energy consumption. Such innovations as storm doors, a furnace energy recovery device, and an open air cycle air conditioning system are analyzed. 1975. 204 p. il. HH 1.2:En 2/11; S/N 023-000-00309-1 ---- 3.10

33 Money-Saving Ways to Conserve Energy in Your Business. 1973. 8 p. il. C 1.2:En 2/2; S/N 003-000-00413-9 ---- .35

Underground Coal Conversion Program, Vol. 3, Resources. 1978. p. il. E 1.18:0008/3; S/N 061-000-00039-9 ---- 4.00

Underground Coal Gasification Program. 1977. 31 p. il. ER 1.11:ERDA 77-51; S/N 060-000-00074-3 ---- 1.30

Uranium Enrichment. A Vital New Industry: This booklet discusses the Federal role in establishing a uranium enrichment industry to meet the needs of growing numbers of nuclear-generated electric power plants. 1975. 12 p. il. ER 1.11:ERDA-85; S/N 052-010-00456-5 ---- .40

Uranium Enrichment: Alternatives for Meeting the Nation's Needs and Their Implications for Federal Budget. 1976. 80 p. il. Y 10.9:7; S/N 052-070-03367-3 ---- 1.35

Usable Electricity From the Sun: A little booklet that briefly explains how electricity can be produced directly by solar cells, and describes the necessary systems to convert it to usable form. Rev. 1977. 10 p. il. ER 1.2:Su 7/corr.: S/N 060-000-00039-5 ---- .35

Window Design Strategies to Conserve Energy: Describes more than 30 design strategies to achieve energy-efficient windows. Includes cost approximations and summaries of the advantages of each strategy. 1977. 214 p. il. C 13.29/2:104; S/N 003-003-01794-9 ---- 3.75