Toward a Rational Future Energy Policy

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TOWARD A RATIONAL FUTURE ENERGY POLICY*

The energy crisis in the United States has touched almost all Americans either in terms of increased prices or by other manifestations such as brownouts, blackouts, fuel shortages, squabbles over the siting of fossil-fuel and nuclear plants, and oil spills from tankers and off-shore wells. The energy industry—oil, gas, coal and uranium companies, electric utilities—has suggested concrete methods on how that industry can handle the crisis, if only it would receive increased funding, or greater tax breaks, or less regulation, or more protection through quotas or tariffs.1 On the other hand, environmentalists have suggested a bike-riding, low energy consuming nation—favoring environmental values and de-emphasizing consumption. The Nixon Administration, while meagerly increasing funds to such promising fields as solar, geothermal, and fusion research and development, primarily pursues a nuclear energy program based on the fission nuclear reactor with the ultimate hope of developing fast breeder reactors.2 There is a general consensus among these three groups and their critics that the present distribution of research and development funding is both imbalanced and insufficient, and that much more money should be spent by both industry and government.3

The scope of this Note is to analyze the present energy use and the policy determining it, to determine criteria for a rational long-term energy policy, and to suggest a plausible alternative future program.4

While the very existence of an energy crisis, at least in the near term, has been disputed,5 the roots of the energy problem are founded in the following fact: fossil fuels, the energy basis of American society, are finite. Although the United States is endowed with a large fossil fuel base, this base is rapidly being depleted. Of the fossil

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1. This Note was substantially completed in September, 1973, and therefore does not comprehensively incorporate the events since then.
2. It may be noted that while asking for reduced taxes and less governmental regulation, the energy industry has set new earning records in 1972 and 1973.
3. Senator Mike Gravel has pointed out that $3 billion was spent on nuclear energy between 1954 and 1971 while only $1 million on solar power. "If the funding had been reversed," Senator Gravel suggests, "I wonder which would look 'competitive' today?" Intellectual Digest, July, 1973, at 19.
4. Energy conservation, integral to a comprehensive national energy policy, will only be peripherally discussed. Many of the immediate energy problems could be alleviated if people drove slower, turned down the thermostat, turned off lights, and practiced other energy conserving measures. For a comprehensive discussion, see Science, July 13, 1973, at 129-38.
fuels in significant use today only coal will be able to last for more than the next 50 years.\(^6\) While there are several alternate energy sources—solar, fusion, geothermal, wind, the relatively unused fossil fuels such as oil shale and tar sands—present industry has not tapped these in a major way because of economic, technological, or environmental constraints. However, increasing prices of foreign fossil fuels\(^7\) and diminishing domestic fuels slowly are making some of these alternative energy sources competitive. Technological improvements, while posing formidable challenges, are feasible and may use the alternative energy sources to lead us out of the present energy quagmire.

Recognition of technology’s major role in meeting energy demands is one basis for the United States having the world’s largest non-military energy R & D program—the estimate for fiscal year 1974 is $772 million.\(^8\) Of that amount $323 million (42%) is going into the development of the liquid metal fast breeder reactor, which works in theory but there is no viable prototype demonstrating the concept. Even if the breeder reactor proves feasible, the first prototype is not expected to be finished until around 1985. On the other hand, solar power, which receives less than $16 million (2%) in funding, is technologically feasible; numerous solar energy devices are supplying energy today. The hurdle is to make these devices economically competitive with fossil fuels through finding cheaper, still more efficient solar cell materials, developing cheaper solar cell casings, and developing more efficient batteries for storing electricity. The imbalance in funding between nuclear and solar energy has been largely the result of historical factors: the earlier development of nuclear energy, legislative biases toward oil, unorganized energy planning, and an ad hoc federal energy policy to meet emergencies. Although several alternative energy systems exhibit a higher potential for resolving current and prospective energy problems than does nuclear energy, the present governmental R & D funding patterns give small or token consideration to promising technologies while heavily funding nuclear fission and breeder reactors, which have increasingly come under severe criticism as insufficient, unsafe, and perhaps even unworkable in the case of the breeder reactor.

If the extremely complex and politically unattractive energy prob-

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\(^{7}\) As domestic supplies of natural gas and crude oil decrease, the United States must import more from exporting nations. The major exporters of oil and gas have formed an effective cartel known as the Organization of Petroleum Exporting Countries (OPEC). Member nations are Iran, Iraq, Kuwait, Saudi Arabia, Venezuela, Qatar, Libya, Indonesia, Abu Khabi, Algeria, and Nigeria.

\(^{8}\) Science, Feb. 9, 1973, at 549.
The problem is not met head on with a massive R&D and implementation program, perhaps not unlike the space program of the 1960’s, the options currently only being discussed may be lost and the United States may be faced with relatively narrow, inflexible choices. While it is not necessary to develop every exotic energy source and conversion process, the current reliance on fossil fuels is foolhardy. The situation calls for a comprehensive energy program which decreases reliance on fossil fuels and nuclear fission energy. Well defined, long range energy and resource policies need to be developed to meet future demands, simultaneously interim steps need to be taken to buy time until such long range programs can be put on line. Unfortunately, the present energy policy will make the United States increasingly dependent upon the relatively inflexible fossil fuel and nuclear fission technology.

ANALYSIS OF PRESENT ENERGY SOURCES AND POLICY

The United States presently has proven available reserves of coal that could supply its energy needs at 1970 levels for at least 500 years; of oil, perhaps 25 years; of uranium, thousands of years if the breeder concept proves feasible; of natural gas, perhaps 10 years; this excludes such sources as tar sands, oil shale, solar power, and geothermal energy. However, discovering, collecting, transporting, storing, converting, using, and disposing of each fuel impose economic and environmental constraints which limit each fuel’s potential to alleviate the energy shortage. Thus, in the short term (between now and 1985) and perhaps the medium term (1985 to 2000) all fuels will continue to play an integral part in meeting the United States’ energy demands. The effect and future of these fuels are analyzed hereafter.

A. Fossil fuels

1. Natural gas

Rising from the ignominious position of merely being burned at the mouth of the well head early in this century, natural gas has taken a commanding role today by supplying 33% of the United States’ energy requirement. Natural gas supplies approximately half of residential, commercial, and industrial needs and a fourth of steam-electric plant needs. In 1954 when gas was relatively plentiful and inexpensive, the Federal Power Commission placed controls on gas prices paid by interstate pipelines. Demand slowly increased until

gas became the fastest growing fuel with an average annual increase of 6.1% per year. This dramatic increase is primarily the result of the desirable burning characteristics of gas as well as its relative low cost. Its relative low cost, however, has discouraged outlays for exploration for more gas, has encouraged wasteful burning of gas by electric utilities, resulting in domestic reserves decreasing by one trillion cubic feet per year. The Department of Interior estimates that the demand for gaseous fuels, whether natural or synthetic, over the next 10 years will be approximately 275 trillion cubic feet. Total proven reserves reported by the American Gas Association were 291 trillion cubic feet at the end of 1970. Thus, if no further gas fields are discovered, domestic supplies would last approximately 10 more years at present rates.

On April 18, 1973, President Nixon announced in a message to Congress his proposals for alleviating the current energy problems. With respect to natural gas, the President acknowledged the failure of the Federal Power Commission’s regulation of the gas prices and suggested that:

... gas from new wells, gas newly-dedicated to interstate markets, and the continuing production of natural gas from expired contracts should no longer be subject to price regulation at the well head. At the same time, because increased prices on new unregulated gas would be averaged in with the prices for gas that is still regulated, the consumer should be protected against precipitous cost increases.

At the same time the President authorized the Secretary of the Interior to impose ceilings on the price of new natural gas should the circumstances warrant it. Finally, the President empowered the Secretary to triple the annual acreage leased on the Outer Continental Shelf from 8 to 24 million acres by 1979. This leasing estimates an increase of 1.5 billion barrels of oil and 5 trillion cubic feet of natural gas per year by 1985.

These alterations in the Administration’s policies were designed to raise the unreasonably low price of gas. Increased prices decrease demand in the long run as well as reduce wasteful use. The increase

10. Id.
11. One million BTUs of natural gas cost approximately 25 cents—equivalent energy derived from crude oil costs 60 cents; from heating oil, 80 cents; from coal, 35 cents. Business Week, Apr. 21, 1973, at 51.
13. These estimates are suspect because no one aside from the American Gas Association (which supplies this data to the government) has independently estimated the reserves of natural gas. J. Ridgeway, The Last Play 66-75 (1973).
in price in turn should stimulate industry to search for new gas (and oil) deposits. Once the gas and oil are found, the industry must still allocate the necessary capital to extract and distribute it.

While adequate in the short run, deregulation fails to significantly alter the medium and long term prospects of natural gas—its eventual depletion. Cumulative demand for gaseous fuels for the period 1970 to 2000 is estimated to be 1,200 trillion cubic feet (TCF), 275 TCF to be used within the next 10 years.\(^1\) While total undiscovered domestic gas reserves are estimated at 2,100 TCF (approximately 40% offshore),\(^2\) the greater part of this reserve will not be realized because of economic constraints.

2. Oil

Petroleum and related products were not extracted in significant amounts before 1880. Between 1880 and 1930 the petroleum industry grew slowly and finally flourished. During the Depression era the National Industrial Recovery Act\(^1\) initiated oil import quotas but subsequently the act was declared unconstitutional.\(^2\) Increased importation of cheap oil from the major finds in Venezuela and the Middle East caused the Office of Defense Mobilization to request voluntary import reductions in 1955. In 1959 the voluntary program was replaced by the Mandatory Oil Import Quota Program (MOIQP), which had a twofold purpose: decrease oil imports in order to increase the United States’ national security by making our economy less dependent upon foreign oil and encourage the domestic oil industry to locate and develop domestic supplies.\(^3\) Under this quota system, the nation’s refineries have been permitted to import certain allocations of crude oil (the 1970 quota was 30% of domestic production).\(^4\)

Because the percentage was not determined until after business plans were finalized, too few refineries were built. Thus, today United States’ refineries are running at over 90% of capacity (their practical limit), yet shortages exist in almost every refined product.\(^5\) In response to these problems, in his April speech President

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15. US ENERGY, supra note 9, at 21.
16. Hubbert, supra note 6, at 22.
17. 15 USC §§ 701-12, 48 Stat. 195 (1933).
20. For a more detailed study of oil quota policy, see Dam, Implementation of Import Quotas: The Case of Oil, 14 J. of Law and Econ. 1 (1971) and Cicchetti & Gillen, supra note 19.
Nixon abolished the MOIQP and substituted it with a license-fee quota system:

Under the new system, present holders of import licenses may import petroleum exempt from fees up to the level of their 1973 quota allocations. For imports in excess of the 1973 level, a fee must be paid by the importer.\(^2\)

Other aspects of the new policy allow unlimited imports in the short term but over the long term they encourage domestic exploration and discourage imports. Construction of refineries will be encouraged because fees are higher for refined products. Crude oil up to \(\frac{3}{4}\) of any new refining capacity may be imported without any fees. Thus, the system will have flexibility in changing fees to promote domestic production while keeping the costs at the lowest possible level. Furthermore, increased domestic production should strengthen national security, especially when incentives are introduced to increase domestic storage capacity.

There are an estimated 2.8 trillion barrels of crude oil in the earth. However, the United States can only obtain with current technology 171 billion barrels offshore and 246 billion onshore, if and when they are found. Proved reserves amount to only 39 billion barrels, of which 9 billion barrels are in Alaska’s North Slope. 1970 consumption rates were 5.36 billion barrels per year or 14.7 million barrels a day. Estimates project 1975’s consumption rates to be 6.55 billion barrels per year or about 18 million barrels a day.\(^2\)\(^3\) Thus in less than 10 years domestic reserves will be depleted if reliance is placed solely on domestic oil.

The present alternative to domestic oil is foreign oil—which is primarily Canadian and Mideast oil. Our major suppliers—Canada and Venezuela—have proven reserves of approximately 10 billion and 13 billion barrels respectively;\(^2\)\(^4\) this would only last several years if the United States would be allowed to buy all of it, which is improbable. But Mideast proven reserves are immense: 405 billion barrels.\(^2\)\(^5\) Even with the ever increasing demands of Western Europe and Japan, this reserve should last into the next century.

The answer to the oil problem does not lie in the Mideast, however, the problem merely begins there. The United States imported approximately 1 million barrels a day from the Mideast (6%) in 1972 with estimates projecting a rise to 6.6 million barrels a day (40%) in

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25. Id.
1975 as a matter of necessity, not choice.26 While the United States' demand increases, the supply is being limited by the Organization of Petroleum Exporting Countries (OPEC), the agency emerging as effectively dedicated to obtaining for its member countries the highest possible income from oil production and which generally follows the mercurial moves of Libyan ruler Colonel Muammar Kaddafi. In early September 1973 Kaddafi announced the take-over of 51% interest in foreign held oil industry and declared full tariff payment on each exported barrel. Subsequently, Prime Minister Abdel Jallud announced increased prices to keep up with inflation and stated that payment in dollars would no longer be acceptable. Similar shifts are expected from the remaining OPEC nations: already Kuwait is negotiating for immediate 51% control and Saudi Arabia is pressing for adjustments in the participation agreement and price structure of its oil industry.27

Having taken the Administration by surprise, these events prompted a top level meeting between President Nixon and energy policymakers at the White House for a review of the dismal energy outlook. Discussions resulted in a Presidential commitment to a crash energy program with the goal of energy self-sufficiency in three to five years. Included in this program is an all-out push for the Alaska pipeline, development of deep-water ports to handle supertankers, speeded up licensing of nuclear power plants, and the extraction of oil from military oil reserves in California.28 This crisis should be ample evidence of the lack of farsightedness in the United States' oil policy as well as of the ineffectiveness of the constant patchwork done to hold off the inevitable depletion of oil. Unless the United States is willing to risk an even more lopsided balance of payment deficit and sacrifice its national security, a potentially infinite substitute that has the essential characteristics of petroleum must be found and integrated into our society. Present stopgap measures can only delay the eventual depletion of oil and possibly aggravate the oil shortages in the medium and long term.29

28. Id., at 35.
29. Shortly before the finishing of this Note, hostilities between the Arabs and the Israelis broke out. While it is not clear what the final outcome of this conflict will be, the conflict has exacerbated the United States' energy problem. In some ways this may prove to be beneficial (even though burdening us presently) in that now the Administration and policy makers will be forced to consider the issues and make concrete decisions. Unfortunately, the decisions may be to increase the number of nuclear fission reactors and use more coal rather than begin use of solar energy. On the other hand, wasteful use of oil and gas will be sharply curtailed through increased prices together with whatever governmental energy saving programs are implemented.
3. Coal

No industry has a greater opportunity to capitalize on the energy problem than the coal industry. While the Middle East has the corner on oil, the United States has one-fifth of the world's coal. At the turn of the century coal had become the dominant fuel, accounting for over 70% of the total United States energy consumption. By 1970, however, coal accounted for only 20% of all energy consumed. Estimated United States coal reserves are at 3.2 trillion short tons—about half of which are at depths less than a thousand feet. About 390 billion tons of coal are recoverable under current technological and economic conditions. Of this 108 billion tons are low sulfur bituminous coal of metallurgical quality. At the 1970 production rate of 603 million tons, coal could last well over 500 years—if coal were to supply all our energy needs, it could do so for at least 100 years.

Several constraints tend to minimize coal's prospects however. In response to the poor health and accident record of the coal industry, Congress passed the Federal Coal Mine Health and Safety Act of 1969, setting new standards for mine maintenance and making employers responsible for the medical well-being of their workers. Critics charge that the standards are too low; industry counters that the laws have resulted in a 15% drop in productivity and have already cost them a billion dollars trying to meet minimum standards. Industry is therefore shifting from deep mining to strip mining, which is safer and cheaper (but stirs up vigorous opposition from environmentalists).

The President's Council on Environmental Quality has estimated strip mining has dug up 4 million acres, mostly in Appalachia, of which only half has been reclaimed; several thousand miles of streams have been polluted by strip mine wastes; 20,000 miles of "highwalls" have been exposed. At present several bills are being considered in Congress to create a permit system to regulate strip mining operators. Minimum environmental performance standards will probably be set, both in mining and in rehabilitating the land. The key issue is whether the federal government or the states will enforce the laws. Industry and the Administration heavily favor state control; environmentalists cite a notoriously poor enforcement rec-

30. US ENERGY, supra note 9, at 17.
32. Ridgeway, supra note 13, at 27-61.
34. Science, Aug. 10, 1973, at 524. A highwall is the almost vertical solid rock wall above the coal seam that faces the direction of mining advance.
ord of strip-mining laws in 30 states.\textsuperscript{35} No matter who administers these standards, coal production will become more costly.

To hasten the transition to a greater use of coal in the domestic energy production system, President Nixon in his April, 1973, speech indicated that he would delay the implementation of the secondary standards of the 1970 Clean Air Act for up to two years. His rationale was that:

If we insisted upon meeting both primary and secondary clean air standards by 1975, we could prevent the use of up to 155 million tons of coal per year. This would force an increase in demand for oil of 1.6 million barrels per day. This oil would have to be imported, with an adverse effect on our balance of payments of some $1.5 billion or more a year. Such a development would also threaten the loss of an estimated 26,000 coal mining jobs.\textsuperscript{36}

To balance the adverse effect of burning dirty coal, the President offered incentives for utilities to increase their use of pollution control equipment by asking state utility commissions to ensure that utilities receive a rapid and fair return on the expense of the pollution equipment. At the same time the President assured that primary, health-related standards would still have to be met.

While the coal may well be there, major technological and economical obstacles stand in the way of its clean use. It is doubtful that the President's reprieve will be sufficient time to develop present methods of cleaning coal to the point of economical sufficiency.\textsuperscript{37} Should these technological developments be achieved, however, the real battle will only begin: will the citizens of Wyoming, Montana, Iowa, Texas, and the other coal rich states permit their land to be stripmined in order to power the energy hungry East and California? Farmers and ranchers in Illinois and Iowa will have to decide whether to permit the destruction of their fertile fields for the immense coal deposit underneath that soil. Furthermore, as increasingly large power stations convert the coal to cheap electricity, the farmers and ranchers will have to give up part of their already limited water supply to cool the stations. A final drawback that local residents will have to bear is heavily increased mineralization of water.

Fossil fuels are the energy basis of our society but their use ranges

\textsuperscript{35} Id., at 525.

\textsuperscript{36} Nixon speech, \textit{supra} note 14, at 8.

\textsuperscript{37} Major contenders for the billion dollar coal clean-up market are stack-effluent scrubbers, conversion of coal to low BTU gas, conversion of high sulfur coal to sulfur free coal or oil, and gasification of coal into pipeline quality, high BTU gas. At present effluent scrubbers have advanced the farthest, but all will require important breakthroughs before they become commercially viable. \textit{Business Week}, \textit{supra} note 11, at 54-55.
beyond production of energy. Petroleum and coal are basic raw materials used in many products, including chemicals, paints, plastics, and synthetic textiles. Nitrogen and phosphate fertilizer use natural gas as a raw material. Viewed in the long term, the major importance of fossil fuels lies in chemical feedstock, not inefficient energy production. Accordingly, a rational energy policy must include steps to decrease the excessive use of this non-renewable resource.

B. Nuclear Energy

Nuclear energy has long been touted as the answer to all our energy problems. The first nuclear generating plant went into operation in 1959 and by 1972 29 more had been added, supplying about 16,000 megawatts (Mw) of electricity. By 1985 it is estimated that about 30% of all electrical production will come from nuclear power plants—saving approximately 2 million barrels of imported oil per day.38 However, the Administration's and the nuclear industry's optimism as to the future of nuclear energy has been severely shattered in light of current licensing delays, construction delays, and environmental concern. Nuclear facilities capable of generating 27,000 Mw by 1972 were not completed for the above reasons.

President Nixon reiterated his 1971 energy stance in his April 1973 speech, claiming that the United States' nuclear technology is an inestimable national asset which calls for increased, rapid, but safe development. To decrease the occurrence of unnecessary delays, the President stated that:

We need to streamline our governmental procedures for licensing and inspections, reduce overlapping jurisdictions and eliminate confusion generated by the government.

To achieve these ends . . . we will examine various possibilities to assure that all public and private interests are impartially and expeditiously weighed in all government proceedings for permits, licensing and inspections.39

Presumably, the scenario is that once licensed, nuclear reactors would soon be on line to start alleviating the energy crunch. For the long term breeder reactors would supply an almost limitless source of clean energy. The breeder reactor is integral in this scenario because it generates more fuel than it uses. Without the breeder reactor, the

38. Id. at 56.
domestic uranium supplies of approximately 850,000 tons could not meet the cumulative demand up to the year 2000 (1.4 million tons).\textsuperscript{40}

Despite the Administration's optimism there are major problems which have justified the present slow pace in further development of nuclear reactors. The most graphic problem is the possibility of the core melting. If the cooling system should malfunction, the possibility of the release of radioactive gases and materials into the biosphere would create an immense health hazard. Recent estimates place the possibility of one major accident happening by the year 2000 as virtually a certainty.\textsuperscript{41} The other major problem, and one to which no answer has been found, is finding a place to dispose of the radioactive wastes. Radioactive wastes from the ordinary nuclear reactor require a 500 year storage and observance period; wastes from the breeder reactor have a longer half-life and would require approximately a half million year custodianship.\textsuperscript{42} A once-for-all disposal method seems more appropriate than the lengthy custodianship but present proposals are inadequate. Any storage on earth must guarantee that the wastes do not re-enter the biosphere, which is an impossible guarantee. Non-earth disposal such as sending the wastes to the sun would require a Saturn V rocket to be launched every 6 hours at the estimated radioactive waste output of the year 2020.\textsuperscript{43} The final problem, coming especially with the advent of breeder reactors, will be the proliferation of the raw materials for nuclear weapons. To fuel the numerous breeder reactors at the turn of the century, daily shipments of plutonium to reactors and back to re-processing plants will not only be open to accidents but also to deliberate sabotage by such diverse groups as non-nuclear governments, terrorist groups, criminal organizations, and lunatics.

Despite these hurdles the Administration continues to heavily fund present research and development efforts of the conventional light water reactor (LWR) but more significantly the breeder reactors. In 1972, of $537 million allocated for energy R & D, $411 million (86%) went to nuclear energy and of that $236 million (44%) went to the liquid metal breeder reactor.\textsuperscript{44} Such funding in light of the above criticism is not only inappropriate but also extravagant at the expense of other promising energy sources.

\textsuperscript{40} US ENERGY, supra note 9, at 15.
\textsuperscript{41} One AEC report indicates that one accident each year may become a virtual certainty by the end of the century. Science, Jan. 26, 1973, at 360.
\textsuperscript{42} New Scientist, Mar. 1, 1973, at 474.
\textsuperscript{43} Id., at 475.
\textsuperscript{44} Science, Feb. 9, 1973, at 549.
The foregoing is an analysis of the status quo of the energy problem and the efforts of decision makers to alleviate that problem in the immediate and long term time frames. The multitudinous organizations grappling with energy problems today, the lack of concensus as to what should be done, and the ominous threat of immediate shortages of certain energy sources illustrate the lack of a clearly defined energy policy. Yet such a determination would be the starting point of a constructive solution to the problem. What should the United States' energy policy be?

Before reaching that question, one must come to grips with the concept of public policy. Public policy is derived from society, the body politic. Any society is fundamentally a system. According to systems analysis, the major elements of any system are: the components, their relationships, the goals, and the effects of components interacting in relation to the goals. Public policy is primarily concerned with the last two elements. One may define public policy as the on-going process to implement feasible solutions to more theoretical goals sought by the body politic.

A body politic seeks to achieve a set of objectives or goals. The need to ascertain and to clearly define the goals of the systems is paramount. System analysts provide for two types of goals: (1) stated goals, defined as abstract statements of the intentions of men and which are essentially qualitative, and (2) operational goals, defined as the pragmatic goals of the on-going actions and which are essentially quantitative. Stated and operational goals may easily conflict. For example, the energy system may be committed to enhancing mankind even though its products may damage the environment. Both man's good intentions and his actual behavior are necessary elements to identify and analyze the goals in the energy system.

Ascertaining whether a specific goal is part of a particular system may be difficult. For example, some people disagree that the development of breeder technology should be a goal of the United States' energy system. After the goals have been defined and categorized, the most difficult yet most crucial differentiation must be made: the ranking of importance or the priority scheduling of the goals. Almost any goal ranking will result in disagreement by some group or faction in the system. Only experience drawn from analoguous situations may provide the basis for resolving such conflicts. Although men will often disagree about these goals, they ultimately must resolve their differences of opinion. Once it is recognized that the goals and their
relative importance must be ascertained, the crucial first step in making a rational energy policy will have been taken.

The present lack of goal determination and ranking is evident in the diffused governmental agencies relating to energy. However, increased recognition of the energy problems has resulted in some constructive action for determining an energy policy. In the *Federal Energy Organization* prepared for the Senate National Fuels and Energy Policy Study by Senator Henry M. Jackson, the Senator stated:

> The well-publicized deficiencies of Federal organization in the energy field have become increasingly apparent in the course of the... study authorized by the 92nd Congress. Whether the subject is oil import policy, energy-resource management, or R & D programs, the lack of adequate and proper coordination is all too clear. And while no one suggests that better organization by itself will solve our energy problems, there appears to be general agreement that a revamped and strengthened energy organization is a necessary event to more rational energy policies.\(^4\)\(^5\)

Senator Jackson's recommendations for federal reorganization include: (1) high level surveillance of energy systems and provision for policy advice, (2) coordination and augmentation of federal operating programs, (3) energy data collection, analysis and dissemination, and (4) coordination and augmentation of federal regulatory functions.

At the same time the diffused governmental structure is overhauled the goals will have to be ranked by the body politic. The following are some of the numerous issues that will need resolution or compromise. At what point will environmental concern be balanced against energy use? Is government funding for energy research sufficient in comparison with, for example, the military budget or welfare expenditures? Are present research priorities in energy realistic? Should the recent trend of oil companies merging with coal companies and buying up uranium reserves create a situation in which greater governmental control is needed? Should energy prices be allowed to reach the market level rather than be supported by government subsidies or controlled by regulation? Should gas and electricity rates promote the use of these energy forms by discounts to large consumers as is now the case? Assuming the United States can still purchase it, should foreign oil be imported as much as pos-

\(^4\) IEEE Spectrum, June, 1973, at 36. This article examines in depth approaches to a national energy policy.
sible or should the United States' reserves be used first for national security?

PROPOSAL FOR AN ALTERNATIVE ENERGY PROGRAM

While the energy industry was nourished by protectionistic laws, the United States' energy policy corrected any problems on a patchwork basis without any long term program designed to meet the ever increasing energy needs and problems. Even until recently, most of the talk about energy has been about the problems that will arise in 1985 or later, effectively pigeonholing the matter in Congress. The concrete energy problem of 1973 is that the United States cannot afford the luxury of inaction for another twelve years—the time has come for the delineation and implementation of an energy program that will meet our near, medium, and long term needs.

A. Criteria

What are the essential criteria for an ideal energy program for the United States? Four major elements are (1) a potentially infinite primary energy source which is convertible into secondary fuels must be found and utilized; (2) the primary source and its byproducts must be environmentally clean, safe, and made readily available to consumers; (3) this primary energy source must be within reach of present technology and perhaps make use of present capital outlays (pipelines, electric networks, etc.); and (4) the United States must be able to domestically produce it in order to assure national security. These are not mutually exclusive criteria but rather interrelated.

Except for fusion research which fails the third criterion, the present governmental R & D programs fail to meet both the second and third criteria. The most heavily funded program—the breeder reactor—has not been proven feasible yet. The conventional nuclear reactor will run out of fuel at the turn of the century if the breeder fails. Both reactors pose two inherent dangers (radioactive wastes and melt down) that may cause them to be stopped altogether. Less heavily funded R & D areas are conventional fossil fuels which, except for coal, will run out at the turn of the century, are dirty, and have an increasingly adverse effect on people and the environment. While receiving the least amount of funding, solar energy has the greatest potential of all sources and satisfies all four criteria.

B. The Solar-Hydrogen Energy Program

Solar energy not only promises to fulfill the criteria for an infinite fuel but also is technologically feasible at the present time. The United States receives approximately $1.6 \times 10^{16}$ kilowatt-hours
(kWh) per year of sunshine (about 800 times our total energy consumption). This solar energy can be captured in several ways: through photosynthetic fuels, energy from organic wastes, solar cells, a solar heat-power cycle, and solar space and water heaters.

Solar cells are perhaps the best known solar energy converters and are very attractive: with their present 10% efficiency, silicon solar cells covering 100,000 square kilometers (equaling approximately 38,500 square miles or a third of Arizona or 6% of the area of the Southwest) could supply the entire energy needs of the United States. The major drawback is cost: presently solar cells cost $30,000 per kWh; to be competitive their cost must be reduced to $1,000 per kWh, which seems possible based on the current investigations of CdS cells. Solar cells can be mounted on roofs of homes to supply space and water heating.

By using what is known today, it would be technologically feasible to apply solar energy to space heating and water heating on a national scale; approximately 50 percent of the energy requirements (representing approximately 11 percent of the national energy consumption) could be met through local application of solar energy. The basic scientific requirements have already been satisfied and can be incorporated into designs for maintainability and low cost.

Dr. Berg calculates that capitalization of 1% of national fuel requirements through implementation of solar energy to provide low temperature heat would be approximately $3 billion. To get the same energy supply through gas liquefaction, he estimates the cost at approximately $10 billion. And if the electricity were generated by present means, the cost would be around $16 billion. While these figures could vary widely because of technological advancements, the possibility of economic savings through use of solar energy is dramatic. Furthermore, solar energy is non-polluting, is not subject to the whims of fossil fuel nations, would increase domestic jobs, would

47. Id., at 88.
48. Id. In early 1972 the Communication Satellite Corporation (COMSAT) announced the development of an improved solar cell, dubbed “violet cell,” which has a 14% energy conversion efficiency due to improvements in optical coatings, silicon diffusion, and advanced microcircuitry. Energy Digest, Jan. 15, 1972, at 1, 10-11. Dr. Joseph Lindmayer, director of the COMSAT research team that developed the violet cell, recently quit along with colleague Peter Varadi and formed Solarex Corporation. They claim their cells are now 18% efficient, moving closer to the 25% theoretical limit. Lindmayer is convinced that his corporation can produce even more efficient solar cells at one-tenth the present cost through cheaper production costs and less use of silicon. Electronics, Oct. 11, 1973, at 14.
be an exportable technology, and is ideal for national defense by decentralizing power supplies.

Another solar energy conversion method, the solar heat power cycle, which concentrates the solar heat on a steel tube containing liquid metal which in turn heats a secondary fluid that runs a steam turbine, claims an overall efficiency of 30%, reducing the area requirement to a third (33,334 km²). This cycle is available today—a pilot project could be started immediately. With cost estimates as low as $600 to $1000 per kW the solar-heat cycle is competitive with present day energy generating schemes.

The full ramifications of solar energy are not presently known because of the insignificant funding solar research has received from the government and the industry. Fiscal year 1974 saw a doubling in funding over 1973—up to $16 million—for solar research. Despite the lack of funding, results here and abroad have been impressive: existing devices include solar powered desalinization plants, turbines, water heaters, refrigerators, air conditioners, and pumps. This most promising source of energy still receives miniscule funding compared to nuclear reactors. A prestigious National Science Foundation panel has called for a $3.5 billion, 15 year federal solar energy development program. In conclusion, a rational energy policy for the United States would be to develop an effective, reliable, inexpensive solar collector for home space and water heating and large scale solar "farms" which would meet the remaining needs.

Alternatively or conjunctively, nuclear fusion might become another infinite primary energy source of the future. At the present time fusion has not been proven technologically feasible. Nevertheless, controlled thermonuclear fusion research is in a more optimistic state now than at any time in its 25 year history. Two concepts—laser-induced fusion and the migma cell—are the basis of this optimism. Should present research prove its theoretical promise, laser-induced fusion would provide large scale electrical power while the migma cell would probably be used primarily in homes. Fusion power would have all the advantages of solar energy—essentially non-polluting, limitless, readily available, could use present capital outlays—yet have the added advantage of not being dependent upon the sun. Excess electrical power produced during non-peak hours could be used to decompose water into hydrogen and oxygen, thereby contributing to secondary fuel manufacturing. Fusion nuclear plants would be safer than fission because few radioactive by-

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51. Dalal, supra note 46, at 88.
52. Id.
products result from the reaction and no explosion can occur.\textsuperscript{5, 5} Unlike solar energy, fusion energy is being supported more substantially by the government—approximately $88 million in fiscal year 1974.\textsuperscript{5, 6}

Finding a potentially infinite source of energy would meet a major criterion of a rational energy program. However, important modes of transportation (automobiles, planes) do not yet use electricity. Electricity furthermore cannot be efficiently stored. Thus, a secondary fuel that is plentiful and storable must be found. Hydrogen and perhaps methane seem to meet these requirements. Hydrogen can be decomposed from water, is therefore essentially limitless, and can be substituted for petroleum and coal in almost all industrial processes which require a reducing agent (i.e., steel manufacturing and other metallurgical operations). It is easily transformable into methanol, amonia, and hydrazine—other presently used fuels. The other by-product of the decomposition of water is oxygen which is also of industrial importance—it can be used to oxidize urban wastes for example. Finally, when hydrogen is burned in its various uses, the result is water and it does not leave pollutants such as hydrocarbons, carbon monoxide, sulfur dioxide behind, although there are small residues of oxides of nitrogen.\textsuperscript{5, 7}

An analysis of hydrogen shows that it meets most of the criteria of an ideal secondary fuel. First, hydrogen is readily available, stored in the form of water. The water would never be depleted because combustion of hydrogen results in water. The gaseous hydrogen can be transported and distributed to individual consumers in essentially the same pipelines used for natural gas, thus taking advantage of present capital outlays.\textsuperscript{5, 6} These pipelines in turn would be able to store large amounts of hydrogen to meet peak load demands. Furthermore, conversion to a solar-hydrogen economy would help maintain a favorable United States balance of payments as well as create domestic jobs. Perhaps the greatest plus would be increased national security, for little reliance would have to be placed on foreign fossil fuels.

A solar-hydrogen economy is feasible but only a vigorous engineering R & D program could implement such a system. A major hurdle is developing an acceptable non-gasoline engine to power the ubiquitous automobile or developing an alternative such as the electric car.

\textsuperscript{55} Dalal, \textit{ supra } note 46, at 87.
\textsuperscript{56} Science, Feb. 9, 1973, at 549.
\textsuperscript{57} New Scientist, Aug. 10, 1972, at 285-87.
\textsuperscript{58} Hydrogen used to be mixed with natural gas and supplied to home users. One problem currently under investigation is hydrogen's characteristic of making metals it comes into contact with brittle. For further analysis of hydrogen's potential, see \textit{Hydrogen: Its Future Role in the Nation's Energy Economy}, Science, June 29, 1973, at 1325-32, and New Scientist, \textit{ supra } note 57.
Possible fuels include hydrogen, methane (CH$_4$) and methanol (CH$_3$OH). The feasibility of operating an internal combustion engine on hydrogen fuel has been demonstrated—two hydrogen powered automobiles won the 1972 National Urban Vehicle Design Competition. However, storage of hydrogen in the family car remains the major problem; promising research into storing hydrogen in metal hydrides is being pursued. Methane requires liquefaction, thereby requiring heavy cooling equipment; methanol only has approximately half of gasoline’s energy content per gallon, thus a car would need a larger tank or require more frequent tanking. Non-gasoline powered cars will initially cause major changes in transportation (much slower) but the benefits of less pollution may offset this drawback.

The technology of solar power (and later fusion) and a hydrogen economy look more promising every day, despite a lack of research funds that would put their possibilities into greater perspective. Unfortunately, the present United States’ policies aim for a breeder reactor to supply the infinite primary energy source while continuing to rely on finite fossil fuels until they are depleted. This funding is extremely limited in scope. Once the domestic fossil fuels are depleted, the present program will leave the United States with a dangerous nuclear technology to provide the primary energy. If this technology should prove infeasible for whatever reason, the necessary lead time for switching to alternative energy sources will have been lost, placing the United States into a critical position.

The United States’ energy policy cannot be left for determination at some indefinite time in the future, for then there will be neither time nor opportunity to develop and utilize the various long-term alternatives. Because the health and welfare of all the present and future generations depend on decisions made today, vested interests, partisan politics, and the profit motive must not be allowed to dictate the course of our energy future. The present ad hoc policy has been illustrated, several criteria for a rational energy program have been suggested and discussed, and an alternative program has been described. The time has come for impartial decision makers to dictate a logical, clearly defined energy policy and program that will meet the ever increasing needs of our power dependent society.

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59. Recent developments at the Jet Propulsion Laboratory in California have renewed interest in a hydrogen powered car by developing a car engine partly powered by hydrogen that satisfies most of the strict 1976 pollution standards set by the government. International Materials Company of Burlington, Massachusetts, has spent more than $1 million to develop a car similar to the JPL car but they claim their car meets all 1976 emission requirements. New Scientist, Oct. 18, 1973, at 202-3.