13 Oct 1977

Dilemmas in Decision-Making Towards The Resolution of the Energy Crisis

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DILEMMAS IN DECISION-MAKING TOWARDS THE RESOLUTION OF THE ENERGY CRISIS

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Abstract

This paper discusses various solution approaches to solve our aggravating energy problem. It presents various dilemmas faced by the energy policy-makers of the United States, for each of the solution approaches. The factors involved are economic, environmental, technological, sociological, psychological, ethical, political,institutional, international, regulatory, managerial, futuristic, and systems-oriented. An approach to help the Congress and the President to formulate and implement an effective National Energy Plan is discussed.

1. INTRODUCTION

To the average American, the "Energy Crisis" existed only in the winter and summer of 1973-74, during and immediately following, the Mideast Oil Embargo. Most Americans measure the severity of the energy problem by the length of lines at the gas pumps or by the limited amount of gasoline purchasable. Hence, in the layman's eyes, the energy crisis ceased to exist after the summer of 1974. On the contrary, the problem has in fact remained severe and continually grown worse. This was evident in the winter of 1976-77 by the drastic shortage of natural gas for factories, schools and homes. Our report shall indicate that solutions to our invisible energy problem are neither easy nor quick. It will indicate how complex the energy problem presents itself to the energy policy-makers of the United States. It will also focus on how difficult it is to formulate and implement an effective National Energy Plan to solve our aggravating energy crisis.

This paper will discuss various solution approaches to solve our energy problem. It will present various dilemmas faced by the energy decision-makers of United States for each of the solution approaches. Implementing any of the solution approaches discussed involves significant societal and individual costs and benefits which can not be easily ignored.

Various dilemmas facing decision-makers in resolving our continuing energy problem require significant changes in the very fabric of our life style. Factors involved are economic, environmental, technological, social, psychological, informational, educational, etical, political, institutional, international, regulatory, managerial, futuristic, and systems-oriented. These factors, their inter-relationships, and their cumulative effects on our present and future life styles are discussed and a possible approach to aid our policy-makers in formulating and implementing a National Energy Plan that would be sound, effective and timely in resolving our continuing energy crisis is explained.

2. U.S. Energy Supply & Demand Situation

The United States currently consumes energy in the order of 80 quadrillion Btu. If the consumption growth rate is unchecked, U.S. will need about 200 quadrillion Btu. by the year 2000. At the present time about 75% of our energy needs are met by oil and natural gas. The production of oil and natural gas in the U.S. has either stabilized or declined. Further, about 50% of our oil needs are met by imports. Our energy supply-demand gap has been increasing and it will get worse. To meet our energy needs, we can follow one of the following solution approaches:

(1) Increase energy production in the

U.S.
(2) Import more energy from other countries.
(3) Conserve energy.
(4) A combination of the above three approaches.

All these approaches pose different dilemmas to the energy policy-makers of the United States. These are described below.

3. Increase Energy Production

One alternative to the energy crisis is to increase porduction of conventional energy resources and accelerate the development of alternative energy sources. Each individual energy source poses a unique set of dilemmas.

3.1 OIL AND NATURAL GAS

The U.S. recoverable reserves of petroleum and natural gas are finite. To increase production of petroleum and natural gas, incentives must exist for companies to increase exploration and drilling. The most obvious incentive is price. The market price must reflect the commodity's value. Higher oil and natural gas prices are needed to guarantee the companies a satisfactory return on their investments. Higher prices will inevitably result in a reduction of consumption in other parts of the economy. This may result in a slow down in the economy and greater unemployment. From a social standpoint, this may also result in some changes in lifestyle.

In order that themarket price of oil and natural gas reflect their market value, price regulations on inter-and intrastate shipments must be removed. Such a move poses the concern of price fixing by oil and natural gas companies. There are many who cite that oil companies are already becoming energy monopolies. The trend towards common ownership of fuel sources is one factor which has contributed to declining production. A subcommittee on special small business problems of the House Select Committee on Small Business in a report dated December 8, 1971 said that, "the growing fuel market concentration may result in the dwindling of available fuel supplies, the maintenance of artificially high price levels, and the eventual reduction in the number of competitors through merger, acquisition, or bankruptcy."

On the other hand, oil and natural gas companies contend that bureaucratic and legal red tape requiring impact studies are slowing down new exploration and drilling. Environmental regulations are hindering development on new reserves and adding to production costs. Another dilemma arises: environmental degradation and pollution vs. cheap, abundant energy. Although domestic production of oil and natural gas has declined since 1974, it is projected that future natural gas utilization will be limited due to the availablility of domestic gas supplies and oil will remain the largest source of energy through the end of the century. The problem still remains: the recoverable reserves of oil and natural gas are finite. Increased production of oil and natural gas will only accelerate the depletion of our already dwindling reserves.

3.2 COAL

The increased utilization of coal creates many environmental conflicts in terms of air pollution, water pollution, thermal pollution, and land desecration due to strip mining. Burning coal for heat and electric power generation causes air pollution by releasing solid particles of sulfur dioxide into the air. The processing of coal leaves waste material which are separated into "tailing piles." These piles are usually close to the processing plants. During periods of high rainfall, this waste material can become saturated and move as a mud slide. Underground mining can cause the overlaying layers to subside resulting in damage to surrounding property and buildings. Land subsidence also releases mining acid which is extremely detrimental to nearby watersheds. Flooding can also occur as a result of underground mining. As in all thermodynamic power production, the reinjection of waste heat into a body of water will cause thermal pollution. Strip mining removes trees and plants at the mining site, reducing soil productivity.

Transportation of coal presents a variety of problems. Approximately 75 percent of coal is transported by rail. The environmental impact of rail transport is difficult to determine because of the numberous uses in transport of other products. A by-product of transporting coal is coal dust blowing during loading and unloading. The pipeline method of transporting liquified and gasified coal has the least effect on the environment. Although coal liquification and gasification are attractive alternatives, both are still in the experimental stages and are not cost competitive. The majority of low-sulfur coal reserves are located in the Western U.S. It is costly to transport Western coal to Eastern markets, where the demand for low-sulfur coal is the highest.

Any substantial increase in coal production results in a greater concern for health and safety impacts. Although health and safety standards are specified in the Federal Coal Mine and Safety Act of 1969, at-

tention must be focused on mine ventilation, coal dust concentration levels (as it relates to black lung disease), and prevention of mining accidents. To increase coal consumption (in substitution of oil and natural gas), requires coal conversion of industrial and power plants. Coal conversion requires large capital expenditures. Conversion costs will most likely be passed onto consumers. Prices of a variety of manufactured goods would undoubtedly rise.

3.3 NUCLEAR

Nuclear energy is a controversial energy source for a number of reasons. Presently, there are no permanent means of disposing the radioactive wastes. Currently, radioactive wastes are sealed in a storage chamber and buried in a deep geological formation. These burial sites require continuous security and maintenance. Transportation of radioactive wastes by rail or truck poses the threat of accidents. Other prevalent environmental issues are accidental radiation emissions and thermal pollution.

Uranium enrichment capacity is limited by the finite sources of the fissionable isotope U^{235}. The costs of uranium and building reactor plants have soared. The cost to construct a 1 million kilowatt plant, approximately the size necessary to provide electricity for the state of Vermont, has risen from an original estimate of $250 million to an actual cost of $500 million. Costs are projected to approach $1 billion by 1985.

Development of nuclear energy requires a tremendous amount of research, development, and manpower such as nuclear engineers, specialized earth scientists, health physicists, radiation monitors, reactor operators, and nuclear welders. Further development of nuclear technology poses the threat of the spread of atomic defenses. This is both a political and international concern. Attention must also be focused on international regulation of nuclear energy and the long term effects on the world.

3.4 HYDROELECTRIC

Hydroelectric energy or hydropower is utilized almost exclusively for the generation of electricity. The growth potential of hydropower is limited because there are few economical and environmentally suitable new sites for hydroelectric facilities.

3.5 SOLAR

Solar energy is an attractive energy source because it is an infinite energy supply. Although it does not produce any obvious pollutants, the effects of thermal pollution are not conclusive at this time. Technical limitations in terms of auxiliary fossil fuel back-up systems and inefficient systems still render many applications of solar energy in experimental stages. Although there are many solar heating systems presently being marketed, consumer acceptance of these systems will probably continue to be slow due to the size of the systems and the problem of asthetics. Initial installation of such solar systems requires high capital expenditures. Presently, solar systems are not cost competitive because of limited production as opposed to mass production. Implementation of solar energy also poses legal (sun laws) and regulatory questions.

3.6 WIND

Wind energy is in a sense a form of solar energy. Presently wind technology is experiencing a second childhood, but there are numberous technical limitations to utilizing wind energy as a significant energy source. Like solar energy, wind energy systems require auxiliary fossil fuel systems for back-up. Wind energy is not reliable. To be effective there must be four times as many windmills as necessary to provide a full energy output. Wind energy systems are not asthetically appealing. Although wind energy does not produce any pollutants, there are currently a number of technical limitations. Wind energy is currently not cost competitive with other forms of energy.

3.7 GEOTHERMAL

Currently, geothermal energy is used only at geysers for producing electricity. The widespread application of geothermal energy from geysers, boiling pools of mud, fumeroles, hot springs, is limited by the geographic location of these resources. The majority of geothermal resource areas of promise in the United States are located in the Western and Rocky Mountain states. An economic advantage of geothermal energy is the reduction of requirements for plant equipment because there is no need for boilers, furnaces and storage tanks for fuel. However, there are numerous environmental disadvantages with the development and utilization of geothermal energy:

(1) Drilling operations in a geothermal field result in a considerable amount of noise,
(2) Land subsidence can occur in a geothermal field,
(3) Air pollution is produced as noxious gases are often a by-

product of geothermal wells (these gases include carbon dioxide, methane, hydrogen, nitrogen, ammonia, and hydrogen sulfide),
(4) Thermal pollution results from the reinjection of heat into a body of water (this is present in all thermodynamic power production).

From the perspectives of technical, economic, and resource potential, increased geothermal production of electricity could augment the total power supply of the western United States.

3.8 OCEAN THERMAL ENERGY

Ocean thermal energy utilizes the temperature difference between warm surface water and cold deep sea water. Application of this concept is limited by site locations of plants since a seawater temperature difference of at least 15 degrees Centigrade is necessary to operate proposed systems. Other limitations of such systems is the massive size of sea thermal power plants and themaximum thermodynamic efficiency is approximately 3.3 percent. The environmental impact of sea thermal power plants is not conclusive, although a major concern is thermal pollution of the oceans (construction of large numbers of sea thermal power plants). Production of electricity from ocean temperature differences is technically feasible, but the economical power production is still questionable.

3.9 HYDROGEN

Hydrogen possesses a lower boiling point and melting point than any other substance and is the lightest of all gases with the exception of helium. From an energy standpoint, it is an attractive fuel source but there is no economical method to extract the substance. The utilization of hydrogen has many advantages:

(1) It is essentially non-polluting,
(2) There is an unlimited supply as the hydrogen would be extracted from water,
(3) The short and direct cycle of hydrogen is produced during the combustion of its source i.e. the water utilized to produce hydrogen..

The technology of hydrogen utilization, in addition to methods for handling and transporting it, has been developed somewhat through industrial use. There are some disadvantages of various hydrogen applications:

(1) Hydrogen and air combustion result in the formation of nitric oxides,
(2) Gaseous hydrogen even in a pressurized state requires heavy containers (this storage system is too bulky for practical purposes),
(3) Liquid hydrogen is not cost competitive although technically feasible.

Other limitations of utilizing hydrogen power are high transportation costs and the high flammability of hydrogen storage.

3.10 OSMOSIS

Utilizing the chemical differences between sea water and fresh water through movement by semipermeable membranes, osmosis can be transformed into electrical energy by employing either kinetic energy or potential energy. Osmotic process has several environmental advantages:

(1) Ecological disturbances are minimal,
(2) It does not produce any air or water pollutants,
(3) The process does not result in any radioactivity.

Application of osmosis is not feasible at the present time due to both technical and economical limitations. An efficient conversion process has not been developed, thus the costs of osmosis cannot be estimated.

3.11 BIOFUELS AND WASTE MATERIALS

Biofuels (farm animal wastes) and waste materials are potential energy sources. The major limitations to utilizing these energy sources are both technical and economic. There may also be some environmental impact with the utilization of biofuels and waste materials in the form of water pollution (sewage to drinkable water)

4. IMPORT MORE ENERGY FROM FOREIGN COUNTRIES

The second possible alternative solution to our energy shortage problem is increased importation of energy from other countries. United States, in 1976 imported 7.8 million barrels of crude oil per day, an increase from the 6.5 million barrels per day imported in 1975.

Though U.S. imports oil from several countries the bulk of the imports comes from the middle eastern countries. Importing the oil from other countries is fine as long as it is dependable, there

are no strings attached to it, and the price is right. But unfortunately in the last few years the imports became very questionable and have created numerous problems. Imports are not dependable, as it became evident in 1973. The OPEC countries can at any time impose an embargo. The devastating effects of the embargo on our economy, social, and political areas was too clear during the 1973 embargo. These huge oil imports have created problems in economic, political, social, managerial, regulatory, international and various other areas.

4.1 ECONOMIC

Because of their virtual monopoly, the OPEC countries are charging higher and higher prices for their oil and are at liberty to increase the prices any time by any amount as they wish.

The OPEC countries are reaping billions of dollars as oil revenues. ($88 billion in 1976). The impact of these petro-dollars on U.S. is substantial. Currently several billions of petro-dollars are invested in the U.S. in the form of corporate securities, governmental securities, real estate, bank deposits, etc. A sudden withdrawal of these investments can throw the money markets and capital markets into total chaos. The OPEC nations have cash reserves of about $60 billion now against $9 billion in 1972, so when they move their deposits from one currency to another (or even if there is some rumor they are planning to do so) the exchange rates can move very sharply. By 1980 the U.S. State Department estimates that the OPEC's accumulation of financial assets could easily surpass $300 billions. Because of our huge payments for imported petroleum there is a significant dollar drain and our trade deficit is an all time high. The large amounts of oil imports have created higher demands for tankers and the costs of transporting the oil have gone up. We not only pay higher prices for the oil but also for the tanker. The embargo and higher prices of imported oil were also blamed for the 1974 recession, high inflation and the slow movement of economy. Throughout the world the economies are experiencing slower growth rates.

4.2 POLITICAL

Because of the oil, the OPEC countries are able to pressure the business and governments into making political decisions that are favorable to them. The Arab-owned (controlled) American companies may adopt anti-Jewish policies. The middle eastern oil-exporting countries were successful in forcing many of the world's most powerful nations to accept anti-Israeli political demands. Last year, the Commerce Department disclosed numerous incidents where U.S. companies were requested to boycott Israel. Later, U.S. government proposed numerous measures to curb U.S. firms from aiding the Arab boycott of Israel. This became a big political problem (issue). Opponents say that the proposal makes U.S. trade with Arab countries so difficult as to make it impossible. It will disrupt or terminate the U.S. business activity with the Arab world. When our trade deficit is increasing we really cannot afford to lose the trade with countries with abundant amount of money to buy our goods and services. Arabsand Israel maintain strong lobbyists to pressure the legislature and the government. Arabs boycott andmaintain a black list of American firms sympathetic to Israel.

4.3 INTERNATIONAL

On the international scene the middle east is like a time bomb. It hurts the U.S. image. OPEC's price rise and the lack of effective U.S. reaction to retaliate it have seriously weakened the political cohesion of the west and the prestige of the U.S. among the developing countries. OPEC now seems to enjoy enormous political power. Because the Arab and African oil producers are the major buyers of Italian plants andmachinery, they can get Italy's backing on virtually any political isssue. And while they do it with more grace, most European countries simply bow to OPEC. The oil-rich countries are buying huge amounts of arms from several countries. British AirCraft Corporation and Iranian government have agreed to swap weapons for oil. Carter administration is also moving towards selling arms to the Middle East. Similarly, Germany, Russia and several other countries are selling arms to the oil producing countries. The buildup of arms is a potentially dangerous situation.

Energy also became a cause of friction between several countries, mainly between the wealthy nations and the under-developed nations. Affluent countries like U.S. are importing oil thus supporting the monopoly prices at the expense of the poorer nations. The less affluent countries are forced to cut down their imports of oil with drastic effects on their economy, agricultural output, because of lack of fertilizers, loss of jobs, reduced economic growth, etc.

Further, the competition betweeen the countries for the scarce resources is much more thannormal. Though U.S. is still one of the world's largest oil producing

countries, in early 1970's it became the world's largest oil importer. The oil supply security of major industrial countries in Western Europe and Japan was not only threatened by U.S. competition for scarce supplies but also by the possibility of Arab embargo against the allies of U.S. in an effort to reach the U.S. indirectly. Thus the U.S. shift from self-sufficiency to dependence on foreign oil threatens the energy security of the very countries whose overall political and military security is guaranteed by the U.S. Further, the investments of the OPEC in U.S. are drawing the badly needed funds from IMF and less developed countries.

4.4 REGULATORY

Environmental problems seem to take a new twist with the increase of oil imports. The massive oil spills created by the tanker disasters have far reaching effects on the marine environment. The industrial countries as repositories of experience with environmental problems may be expected to take the lead in developing world-wide cooperation and international machinery. Currently there is no international regulatory body which can regulate world oil problems. There are no price regulations. Nothing can be done about price fixing and monopolies. The regulation of domestic prices also becomes somewhat more difficult with the unregulated imported oil. The tanker traffic needs regulations specifying the parties liable for damages in case of mishaps.

4.5 MANAGERIAL

Managerial decision-making will become more complicated. The uncertainties about prices and supplies can cause planning to become more difficult. The trade restrictions imposed by the Arab countries and the government regulations about the Arab boycott is another big problem for the managers. The multinational oil companies are faced with the uncertainties of possible nationalization.

4.6 SOCIAL AND ETHICAL

Currently the oil companies are acting as a cartel, a monopoly. By importing more and more oil from them is like accepting and supporting the monopoly. This is not the American system. What can we do to discourage the cartel? What will be the feeling of the domestic producers if we discourage higher prices on domestic oil and pay higher prices to outsiders? What about the billions of dollars going out of the country? As long as we keep importing, the public may not feel the effects of the real shortages and may not make the necessary adjustments in the consumption style. What about our national security? We are taking a large risk by depending upon the foreign oil. At war times and the similar extraordinary situations this risk is too much to take.

5. REDUCE ENERGY CONSUMPTION

A third alternative to our energy crisis is the reduction of energy consumption. Energy conservation in the long term is the most efficient utilization of energy resources and a subsequent reduction in energy demand. In the past, energy was cheap and abundant. Low energy prices stimulated demand while also inhibiting investment in energy-saving capital equipment or in energy-saving processes in transportation, industry, commerce, building design, community layout and residential-related energy use.

5.1 SOCIAL

Three attitudes prevalent in our society conflict with energy conservation. Firstly, the American lifestyle is one based on consumption. The lifestyle characterized by consumption is limiting any significant incorporation of individual energy conservation. A second attitude is that energy savings resulting from individual conservation are not significant, so "why make the effort?". Many of the conservation measures taken singularly do not produce any significant reduction in the overall demand, but these measures taken collectively can provide substantial energy savings. Thirdly, many Americans believe that the energy crisis is merely a contrived scheme of the oil and natural gas companies to force price increases. As a result, a "let others conserve" attitude emerges. These attitudes prevalent in our society are hindering a great potential for energy conservation and the elimination of individual wastefulness.

5.2 ECONOMIC

Economic output and energy consumption have been closely intertwined since World War II. A significant reduction in energy consumption may result in a reduction in the growth rate of the economy. As fossil fuel prices rise, consumer consumption in other areas of the economy may be reduced to compensate for higher energy prices. Higher energy prices will be passed on to consumers by industries. As a further consequence of an economic slow-down, unemployment may increase. Some economists are optomistic that a high growth rate can be obtained with a much reduced energy consumption rate. They cite that most industrialized nations maintain standards

of living similar to the U.S. on much less per capita energy consumption. Some changes in the American lifestyle are inevitable. Ultimately, increased energy prices will encourage the use of small cars, mass transit, recycling of materials, efficient production methods, conservation-oriented equipment, and better land-use planning. From an environmental standpoint, such changes would be positive and result in a better utilization of the nations's natural resources.

5.3 POLITICAL & REGULATORY

Energy conservation has become a political issue. Issues such as taxes on "gas guzzling" cars andmandatory beverage container deposits are highly controversial among self-interest groups such as consumers, environmentalists, and industrialists. Three main goals of Carter's national energy program are specified:

(1) To reduce the growth of U.S. energy demand to less than two percent annually by 1985 from the projected growth rate of three percent.
(2) By 1985 reduce gasoline consumption ten percent under this year's estimated level of 7.2 million barrels per day,
(3) To decrease petroleum imports to six million barrels per day by 1985.

The energy program does not rely on the supply and demand functions of a free economy. It involves a complex scheme of taxes and rebates. In essence, the program depends on a combination of penalties and subsidies to reduce consumption. From a financial perspective, tax incentives provided by Carter's energy policy to encourage energy conservation must be evaluated in terms of effectiveness. Loans must be made available for capital expenditures such as adequate insulation of homes and incorporation of energy-saving equipment and processes in commercial businesses and industry. In conclusion, the economic impact and legal implications of mandatory energy conservation must be carefully assessed prior to implementation.

5.4 TECHNOLOGICAL

It should be noted that in the short term there are some technical, financial, and resource limitation to the extensive implementation of effective energy management and the production of efficient cars, appliances, and other energy consuming goods. New markets have already begun to develop for energy-saving equipment and energy specialists. The necessary manpower for these markets is presently inadequate. New programs at universities should be established to develop energy technology and management. Public awareness of simple conservation measures should also be increased. Educational efforts should be directed to creating a more complete consumer awareness of government and industrial policies. Successful energy conservation requires the cooperation of all Americans.

6. ENERGY POLICY DECISION-MAKING

All the solution approaches discussed above pose many different types of dilemmas to the energy decision-makers of the U.S.A. The U.S. Congress and the President have the responsibility of developing a National Energy Plan that would provide us with adequate energy supplies in the short term (up to 1985), intermediate term (1985-2000), and the long term (beyond 2000) with the least amount of discomfort to the Nation. For the President and the Congress, to make the right kind of decisions, adequate and timely information about energy supplies, demands, technologies, societal attitudes, domestic and international politics, etc. must be available in an understandable way. Also, this kind of information should be available to the average citizen so that his views are made known to the senators and the congressmen of the respective districts.

Typically, the voting behavior of the members of the Congress depends upon the views of the respective constituents. As such, all the nation's citizenry should understand the various dilemmas posed by these different solution approaches so that the citizenry would make its informed views known to its repective members of Congress. Unless and until the Nation's population understands the various ramifications of the different energy solution approaches andmakes its views heard by the energy policy-makers, we will not have a solid, effective and timely energy plan.

To make the people well-informed, the public and private sectors and various consumer organizations must get involved in each of the Nation's communities. Since all of our life-styles are at stake, information that is made available should be as correct, truthful and timely as possible. If it is not, the common man would not have enough trust in the social organizations he is dealing with and would not be able to make his views known to his members of Congress who in turn would have a very significant part in energy decision-making.

In essence, communicating the right kind of information in a timely and truthful fashion to the general public is essential for the development of an effective National Energy Plan.

7. BIOGRAPHIES

Dr. Rao J. Tatikonda is currently Professor or Management and Coordinator of Decision Sciences at the Eastern Illinois University in Charleston. While his major interests are in Decision Sciences, he teaches also in the interdisciplinary baccalaureate degree program in Energy Management, the first of its kind in the Nation. He taught at the Indian Institute of Technology-Kharagpur, the University of Florida-Gainesville, and the Loyola University-New Orleans, in Engineering and Business programs. He worked with Central Water & Power Commission in India and Shell Oil Company in New Orleans on various engineering projects. His degrees include Ph.D. in Civil Engineering from the University of Texas-Austin, M.Tech., M.B.A., and B. Engg.

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