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ENERGY POLICY: WHAT IS REALLY AT ISSUE

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## ENERGY POLICY: WHAT IS REALLY AT ISSUE

Mention energy policy and you will be offered a host of suggestions as to what such a policy should include: price decontrol, continued price control; increased leasing of federal lands, decreased leasing of federal lands; support for hard technologies, support for soft technologies; more stringent environmental regulations, more lenient environmental regulations; increased excise taxes on fuels, no excise taxes on fuels; break up the oil companies, don't break up the oil companies. It goes on and on. Yet, one may wonder why there is such disagreement on these various topics when there is little or no disagreement on the fact that we do need an energy policy.

Perhaps the very reason for this stalemate over energy policy is staring us right in the face. A closer look at these topics which receive so much attention will show that these are really "sub-issues" of the energy situation or, more accurately, policy options we might exercise to change our energy situation. But options can only be truly agreed upon when and if the real issues are first understood and agreed upon. It is suggested herein that not only have the basic issues of our energy situation been largely ignored, but also those which are addressed receive attention individually rather than as a part of the composite of related issues. Therefore, absent a common base of understanding, it has been impossible to delineate a consistent set of policy options.

This is not to discount basic differences in political or personal philosophies. However, the "real issues" suggested in this paper can, for the most part, be agreed upon regardless of varying philosophies.

To put it bluntly, energy policy is concerned with much more than prices and the structure of industry. We would be lucky if it were that simple. In the short term, these may appear to be the prime considerations; but in the long term, energy policy, perhaps more than any other national policy, will effect our lifestyles, standard of living, and perhaps our view of the world.

This study suggests that the real issues of our energy situation are more fundamental:

- Social equity, redistribution of income and wealth.
- The relationship between energy, the quantity and quality of GNP, employment, and commodity inflation.
- The social value of reduced dependence on OPEC.
- At what point (price) domestic supply could fulfill domestic demand.

It may not be possible to determine the absolute answers to these issues, but we must direct our attention much more seriously to them before setting out at a frantic pace to formulate national energy policy. To ignore these issues would be to ignore the real crux of the situation.

Given these issues, we must then ask two questions. These are crucial questions, the answers to which will markedly shape any energy policy. They are:

- Is the natural process of the marketplace too slow or too uncertain, especially during a transition period of say 30 years, to some "backstop technology" such as fusion, breeders, or solar?
- What are "proper" (i.e., mutually consistent and supportive) roles for the public and private sectors?

When these are resolved, as discussed further on, it will provide a "model" on which we can build and implement policies in an organized and reasoned method. Otherwise, we will continue to struggle over the merit of certain "sub-issues" which will at best only temporarily numb the pain of the disease.

The purpose of this paper, therefore, is to set forth a realistic view of our energy situation, define the true issues, and clarify decisions which need to be made. It is inaccurate to refer to our energy situation as our "energy problem." The word "problem" implies that there is a solution or cure which, when applied, will eliminate that problem. The energy situation is much broader and more complex than that. What we have in this country is an energy situation which is perceived as "not good" (and, therefore, to many it is a "problem"). What we want to do is change our "energy situation."

To do this it is first necessary to have an accurate view of the total energy situation. A clear view of the situation will then make it possible to identify the major concerns or "issues" involved that need to be addressed in order to change the situation. When the situation and the issues are clarified, policies which provide the ground rules for grappling with the issues in order to change the situation can be decided upon and implemented. This is the sequence this piece follows.

There is herein no attempt to define what specific policies should be implemented to change our energy situation. What is presented here is an overview of the energy situation, identification of the issues, a summary of the role of technology (including new energy sources), and the dimensions of the issues which will help mold the policies adopted. This piece attempts to provide the background necessary for sound policy decisions which will, in turn, change our energy situation.

It is important to note that we are not here considering an energy "problem" or an energy "crisis." The former implies that there is a solution which would permit a return to conditions essentially as they previously have been. The latter has short-term implications that lead to invalid analogies (e.g., winning World War II). As we will outline here, the energy situation in the future will forever be fundamentally different from what it has been in the past. That is, not a problem that has a solution, or a crisis through which we must pass; rather, it is a brand-new, long-term situation in which we must learn to live, and it raises issues which must be continually addressed. Coping with the energy situation is more nearly analogous to achieving world peace than it is to winning World War II. It is never really achieved, but rather grows (albeit, falteringly) as a result of wrestling with issues through the continual development of policy.

Since the beginning of the industrial revolution, that revolution and the societies it has impacted have been based largely on the premise of growing quantities of energy at declining costs. That world simply no longer exists. For reasons to be clarified later, the future holds prospects for only limited quantities of energy at rising costs--just the reverse of all of our experience. To describe an energy "problem" would imply a solution, which would permit a return to the former. To describe it as a "crisis" would imply that, through some massive effort, we could reverse the trend. We hold these to be invalid views.

What we have on our hands is a new situation. The "problem" is that we have not seen it as such, and we continue to bog down in trying to patch up old policies, forms, and structures. The call here is not for a "solution," but rather for an understanding of and agreement on the new situation so that the issues to be faced can be agreed upon, permitting the development of policy which will enable us to exist in our new situation and grapple creatively with the issues.

Therefore, the reader will not find here a recommendation for any particular policy. Rather, we argue here for the adoption of a framework in which policy can be built over the years, for surely a viable, authentic energy policy must be as dynamic and organic as, say, foreign policy (and, perhaps, at least for the rest of this century, second in importance only thereto).

#### Where We Are Coming From

The energy situation which has so many calling for a national energy policy did not evolve overnight. It is a logical outcome of trends in the world energy market over the past half-century. It does not reflect any sudden change in the relationship between man and his natural environment--although the trends may be building pressures for more substantial adjustments than in the past. The most fundamental and rapid changes appear to have been political (in the true sense of this

word)--representing basic changes in property rights and the incentives affecting the various actors in the petroleum marketplace.

Quite simply, what has happened is that the power over oil has shifted from home to abroad. Until the mid-1960s, domestic production of oil and gas could have satisfied domestic demand. The reason we were importing foreign oil long before domestic production declined was that until the winter of 1973-74, foreign oil was substantially cheaper than domestic oil. It made good economic sense (at least in the short run)--for the companies and the consumers--to import cheaper oil.

What brought the "energy crisis" to a head was the declining domestic production, which (in part) made possible the five-fold OPEC price hike in 1973-74. Now, foreign oil is no longer cheaper than domestic oil, but we must import it because domestic production cannot satisfy domestic demand at current prices.

It is necessary to accept the authenticity, seriousness, and long-term nature of our energy situation; otherwise, the urgency of the situation will be undermined and treated inappropriately. A statement of this energy situation is given below, in what is hoped to be a non-judgmental and comprehensive way.



COMMERICAL CONTEXT OF ENERGY IN THE U.S.

Due to our political/economic structure, geographic size, and resource wealth, the U.S. has an "energy system" which is different from that of nearly any other country in the world. Because of this, there are several basic points to keep in mind when considering energy policy for the U.S.

In the U.S., all dimensions of energy lie primarily in the private sector, whereas in most other countries, the government is significantly engaged in certain dimensions. As long as the situation was stable in the U.S., and the public's perception was that their needs were served, the energy sector had a low public profile, and the market mechanism was not questioned. However, when disruptions in supply and/or price occur, frustrating the consumer, then the public is likely to want to become involved in the decision-making process in ways other than through the marketplace. This is usually embodied in questions regarding industry structure and/or profit. Regardless of the validity of this reasoning, it is a very real, decisive force in a democratic society.

Along that same line, in the U.S., energy companies are almost entirely domestic companies. In most other countries, foreign companies play some role in providing and distributing energy to consumers. This leads to the perception that we (the U.S.) can "solve the problem" since

the firms are "ours." It also leads to tensions, even within the firms, when perceived market goals appear to be different from perceived national goals, especially in the short term.

Because of the size of the U.S., there exist very crucial regional differences with regard to need and supply, e.g., consuming New England, producing Gulf Coast, conservationist Rocky Mountains, and depressed Appalachia. Within most other countries, regional difference vis-a-vis energy are minimal. In looking into the "energy future," one cannot discount the significance of this. For example, why should a Texan be complacent about paying four times more for Texas natural gas than a New York resident pays? And why should a Colorado resident allow his land to be strip mined in order to provide fuel-hungry plants in Michigan coal to burn? These regional interests make it all the more necessary to arrive at a national consensus about the energy situation and issues. Otherwise, decisions made on regional bases may serve little towards bettering the nation as a whole.

Another point is that we currently have no "energy policy." This is not unique in that there is not U.S. policy in any sector where the government is not itself a supplier or consumer. For example, we are not surprised that there is no "clothing policy." There is a "Farm Policy," but there the government is a significant customer, through parity and stockpiling. There are also defense and highway policies.

In energy, however, the government is not the customer. This is significant because for the first time we are contemplating creating a national policy for a segment where the government is not a direct consumer. Therefore, we have no precedent to follow. (The "man-on-the-moon" analogy is totally invalid, since in that case the government was the only customer; in the energy sector, it very simply is not, to any significant degree.)

Finally there is in the U.S. no "energy industry" in the sense that there is a steel industry or an automobile industry. The various firms making up the energy sector are widely divergent as to function, regulation, perspectives, and interests. Producers, transmission companies, drillers, process equipment contractors, utilities, and retailers often have little in common. Therefore, a policy aimed at such diverse elements will have to take into account numerous considerations.

From this description of the "energy setting," one can further define several distinct characteristics of energy in the U.S. which display further the magnitude of concerns with which energy policy must deal.

In a broad sense, supply always equals demand (i.e., over any significant time period, absent price controls and rationing). But this happens in the energy sector only through a complex interplay among

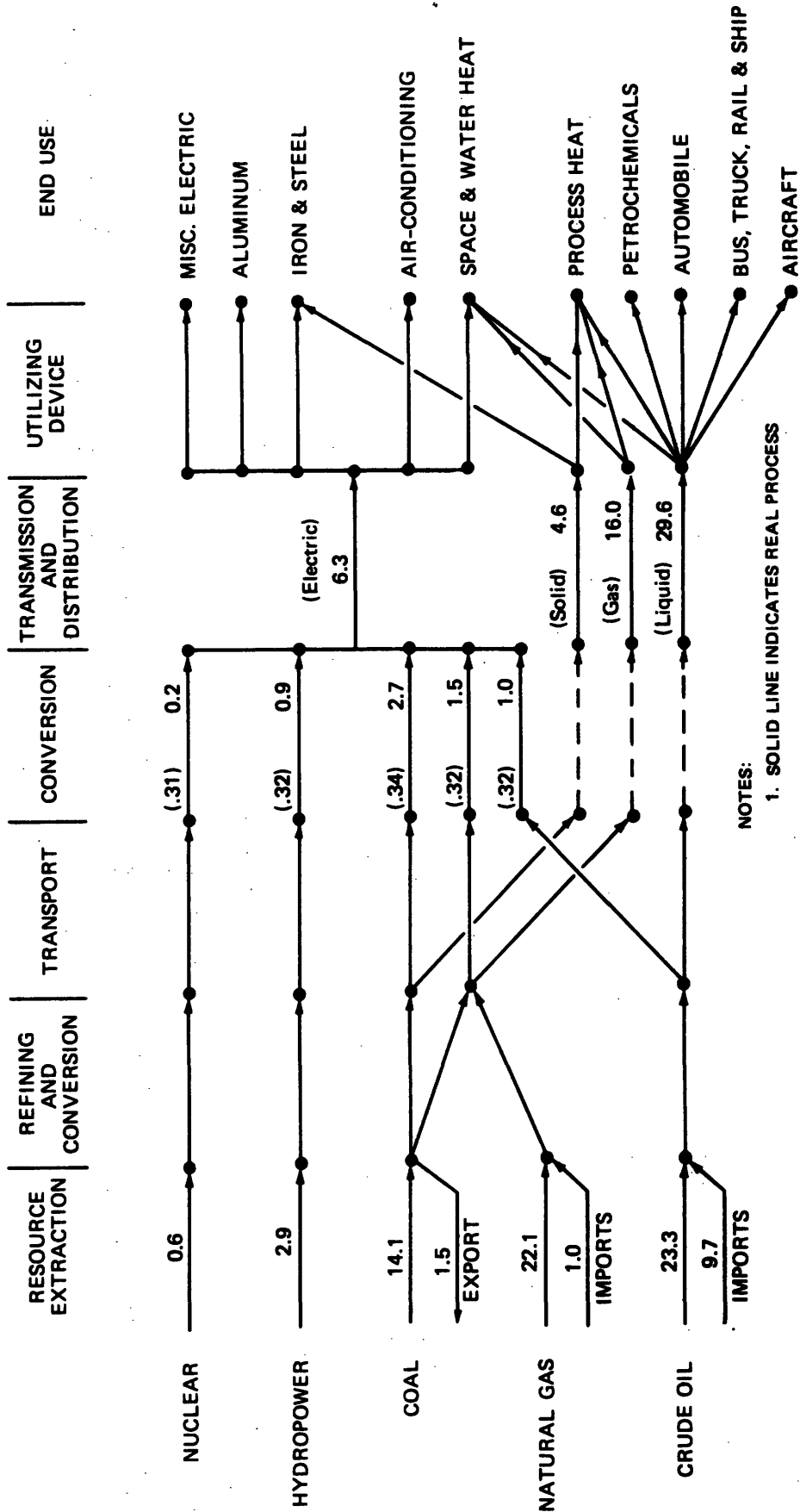
various factors as represented in Figure 1. The energy sector is highly capital-intensive at almost every point. Consider, for example, the investment involved in production, pipelines, ships, refineries, utilities. Even the consumption of energy is capital-intensive: boilers, automobiles, home heating, and cooking. This is one of the reasons that the short-term supply and demand functions are radically different from the long-term functions.

Also, energy is unique in that it is only a means to an end, never an end in itself. Ultimate demands are for private transportation, not gasoline; for a heated home, not for gas or oil or electricity. The consumer is usually not concerned over the type of fuel, as long as it fulfills his needs and is economical. Therefore, there is constant interfuel competition through a complex network. These interrelationships are not only complex but also dynamic. Often the implications of changing energy circumstances are not always obvious or understood because of the complexity of the system as well as the slow response to changing supply and changing prices caused by the capital intensity at every point.

#### Rising Prices and the Supply Curve

Given the complexity and characteristics of this system, now consider the impact of rising prices, which is one of the main concerns

Figure 1\*



NOTES:  
1. SOLID LINE INDICATES REAL PROCESS

TOTAL RESOURCE CONSUMPTION =  $73.7 \times 10^{15}$  BTU (INCLUDING  $1.5 \times 10^{15}$  BTU EXPORTS)

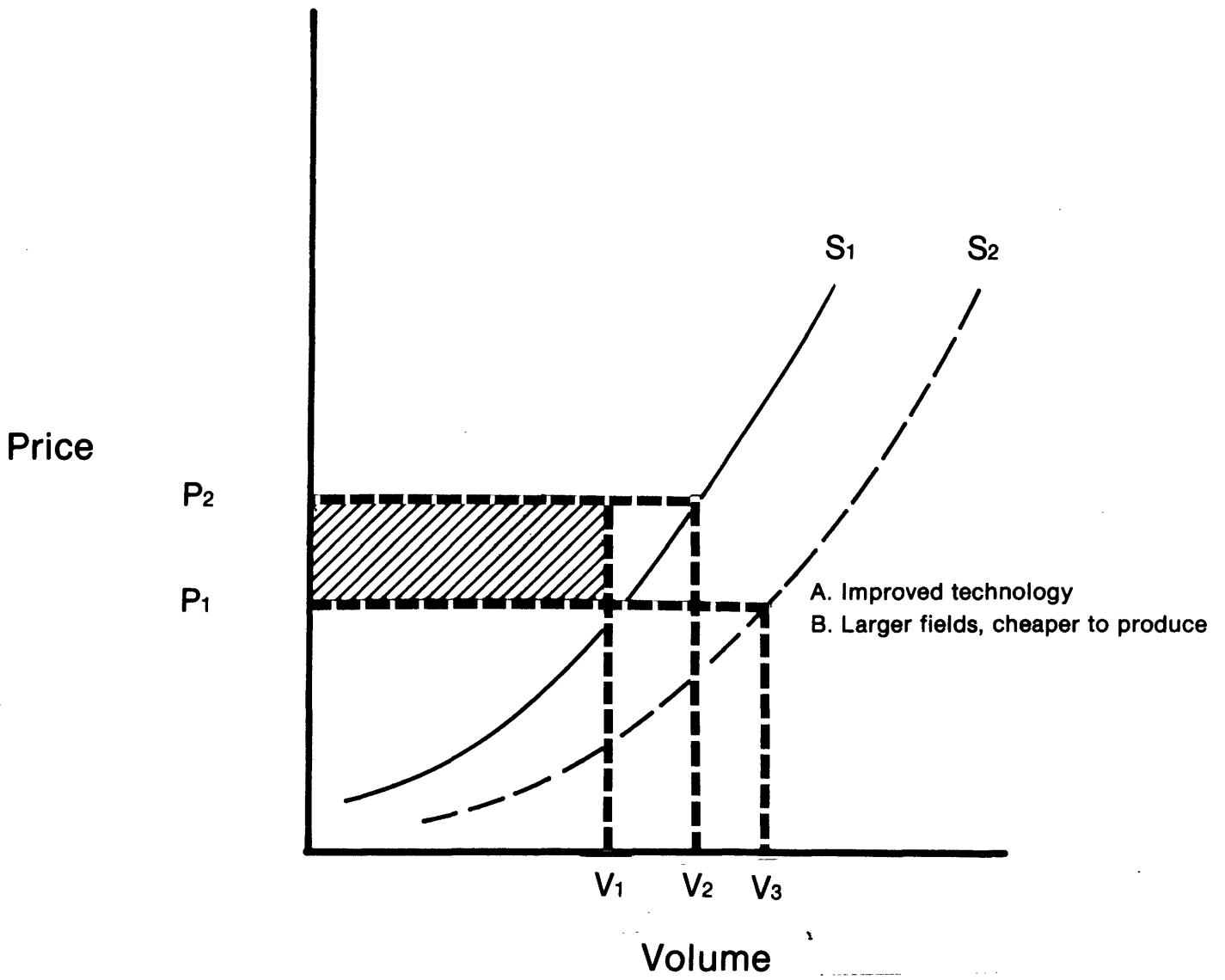
\*"A National Plan for Energy Research, Development & Demonstration: Creating Energy Choices for the Future," Volume I: "The Plan," Page IV-3 ERDA-48, Washington, D. C.

over our present energy situation. Figure 2 shows the supply curve.  $S_1$  represents the short term. As price increases from  $P_1$  to  $P_2$ , the total volume available to the market increases from  $V_1$  to  $V_2$ . When this occurs, marginally profitable supplies are attracted to the marketplace and supply, therefore, increases. Suppliers of  $V_1$  continue to supply this volume, but at the higher price,  $P_2$ , and therefore at increased profitability equal to  $V_1 (P_2 - P_1)$ , or the shaded area. This is referred to as "economic rent," and is a natural result of the operation of the marketplace.

However, over the long term, historically, this has not occurred because the supply curve has moved to the right ( $S_2$ ). This has happened for two reasons. The first is improved technology and increased productivity, such as better exploration techniques and improved production processes. The second is that major discoveries were made of progressively larger fields which were inherently cheaper to produce.

The effect of this moving of the supply curve continually to the right is that, at constant price  $P_1$ , increased volume  $V_3$  becomes available to the market. Figure 3 illustrates that, in fact, from 1920 until 1973, oil prices were declining. During the same period, supplies increased significantly. Thus, the "economic rent" described above did not in fact exist in the long term and the U.S. became accustomed during this period to ever declining energy costs, relative to other commodities.

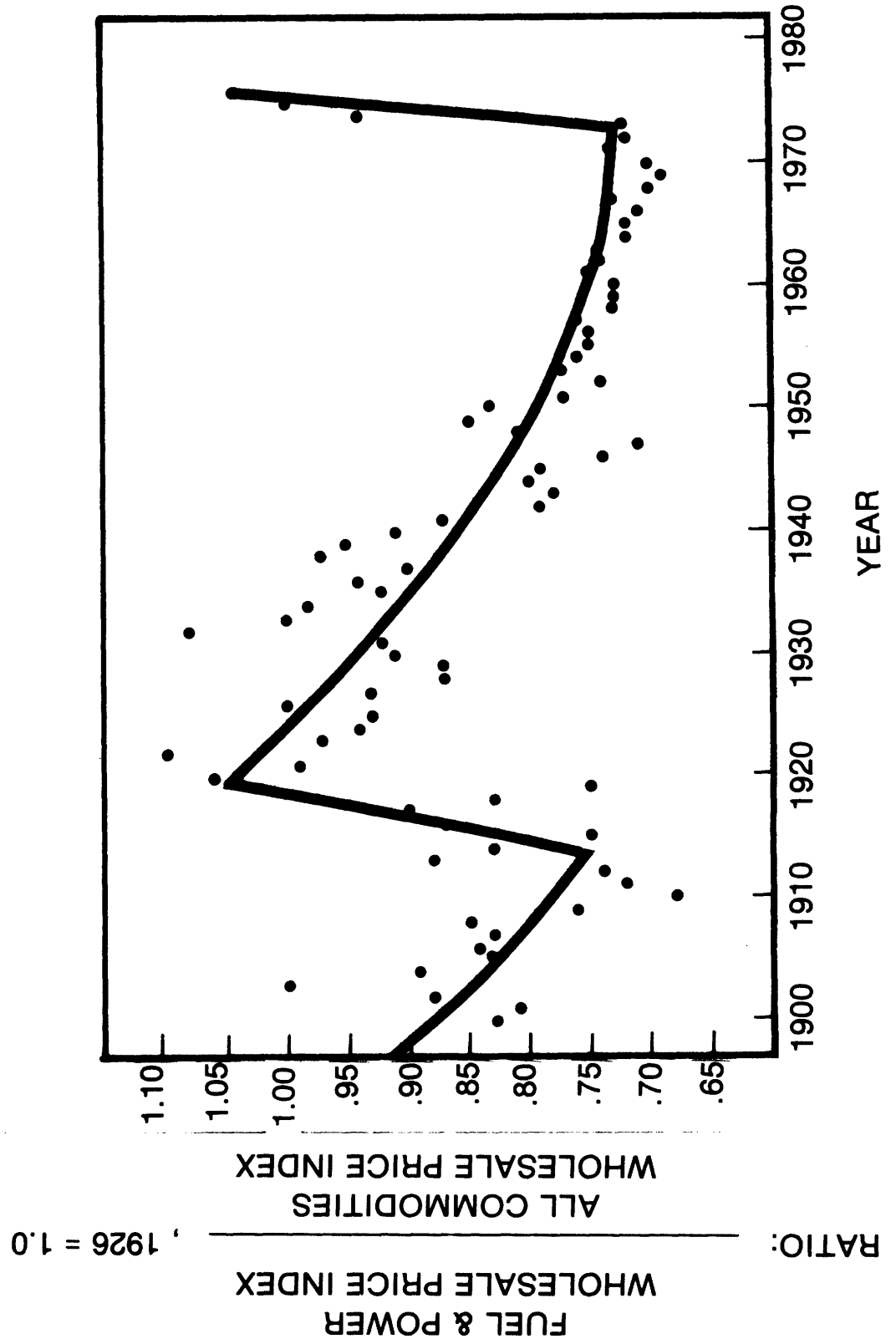
Figure 2



Relation of U.S. energy supply to price (short term,  $S_1$ ; and long term,  $S_1 \rightarrow S_2$ ) - past

Figure 3

RELATIVE PRICE OF ENERGY, 1900-1976





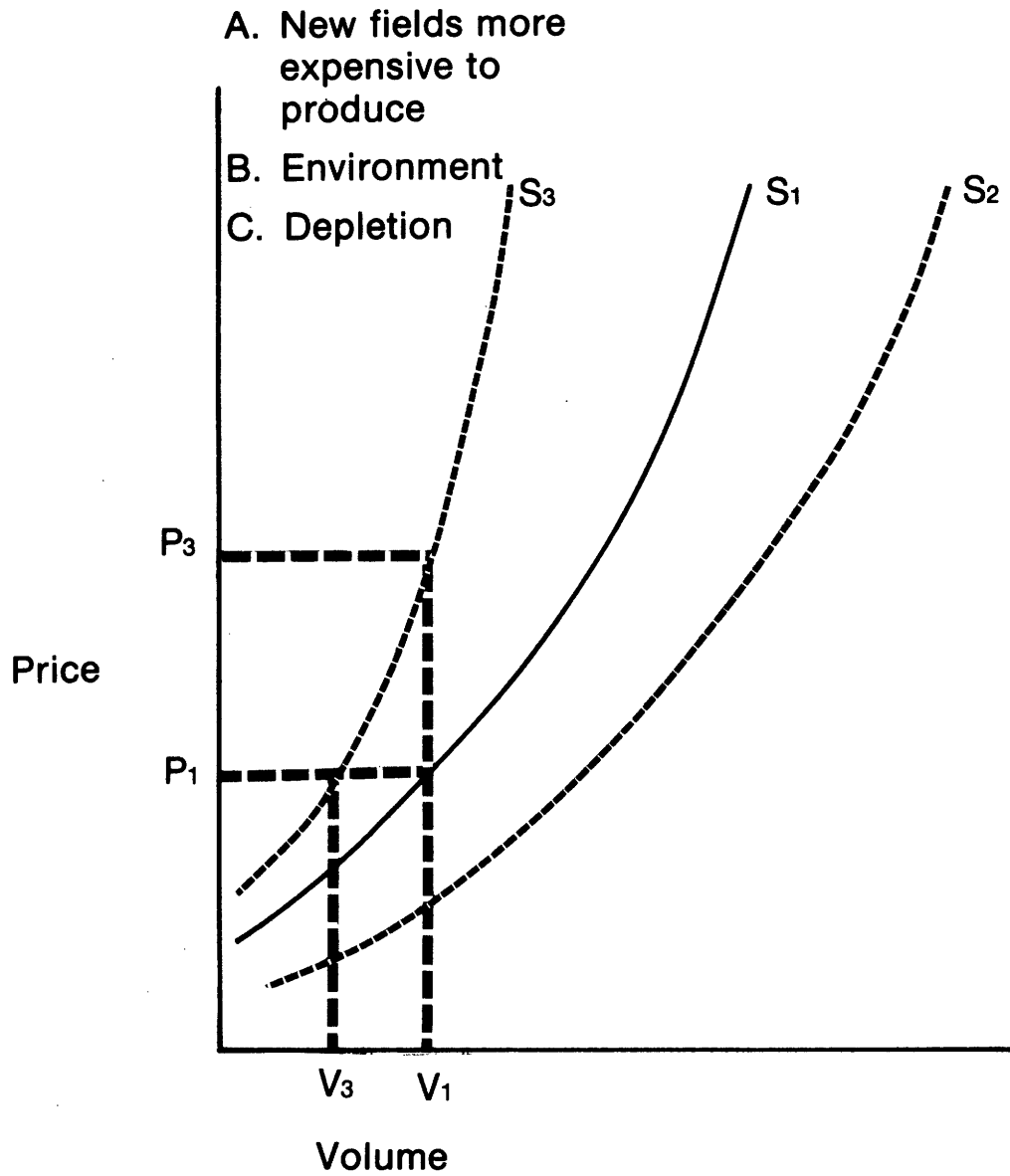
The sharp rise in this curve in 1973 was, of course, caused by the OPEC price increase, but additional factors were simultaneously coming into focus which accentuated the effect and made it seem to some that the so-called "energy crisis" happened overnight.

#### Other Factors Which Affect the Supply Curve

Figure 4 adds another dimension to the curve shown in Figure 2. As mentioned before, the supply curve has historically moved to the right ( $S_1$  to  $S_2$ ) as technology improved and new large, cheaply produced fields were found. This is no longer the case. By the early 1970s, technological progress had flattened out, most of our large fields had been discovered in conventional exploration areas, and OPEC's oil jumped from "cheap" to "expensive" from the U.S. perspective. New fields were increasingly expensive--oil from the North Sea and Alaska's North Slope, for example, is much more expensive to produce than oil from the U.S. Gulf Coast.

Thus, the supply curve instead of moving over the long term from  $S_1$  to  $S_2$ , began moving from  $S_1$  to  $S_3$ . At a constant price,  $P_1$ , the volume available to the marketplace would decline from  $V_1$  to  $V_3$ . Conversely, for a constant volume  $V_1$  to be available, the price would have to increase from  $P_1$  to  $P_3$ , creating an economic rent represented by  $(P_3 - P_1)(V_3)$ .

Figure 4 \*



Relation of U.S. energy supply to price (short term,  $S_1$  and long term,  $S_1 \rightarrow S_3$ ) - Future

Simultaneously, environmental concerns and awareness were becoming significant, so that the very nature of "energy" acceptable to the marketplace changed, at an increased cost for the same volume of energy. This too is reflected by a movement of the supply curve from  $S_1$  to  $S_3$ . Due to the increased cost associated with making it "clean, acceptable" energy, the price necessary for a given volume,  $V_1$ , of "old, dirty" energy increased from  $P_1$  to  $P_3$ . Or, at a given price  $P_1$ , a lower volume  $V_3$ , of clean energy is available than the volume of "dirty" energy,  $V_1$  than would have been.

Also, concerns and awareness over the depletability of natural resources became significant. The fact is, there is just so much there; and this also drives the supply function to the left. In the long term, the leftward movement of this curve is indeed a function of the volume removed.

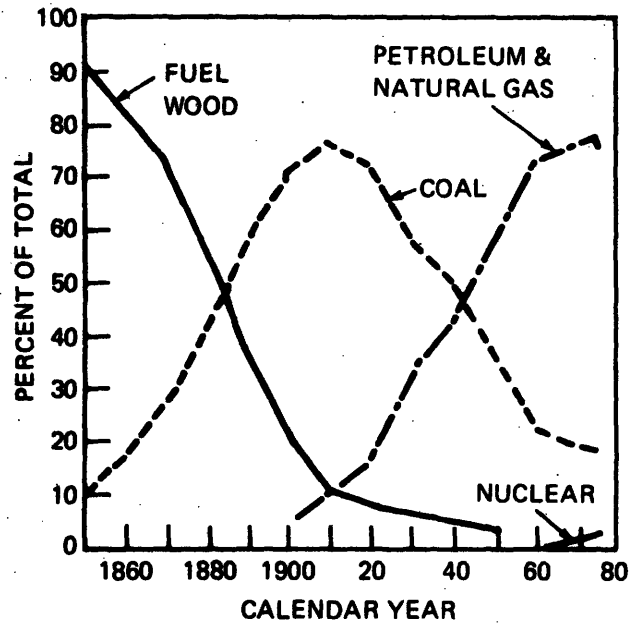
#### U.S. ENERGY SITUATION

In a situation where demand is increasing, it is deemed unacceptable for the supply curve to move leftward. However, this is what is now happening. A closer look at the U.S. energy market will further clarify the factors which effect our supply and demand curves and, consequently, our true energy situation.

Several other factors, external and internal, have altered the natural market process which, up until recently, supplied us with new, cheaper, more efficient forms of energy and kept the supply curve moving to the right. The history of primary energy sources in the U.S. is reflected in Figure 5. The replacement of wood with coal and of coal with oil occurred "naturally." That is, in the marketplace, each established source was replaced by a new, cheaper source. For the first time in our history the marketplace is not providing us a cheaper replacement fuel for oil and gas. Because new domestic oil sources are more expensive to produce and because new energy sources, such as oil from shale, oil and gas from coal and solar energy, are more expensive than OPEC oil (which is our marginal supply), we now find ourselves in a situation where if OPEC is to be displaced from U.S. supply, it must be displaced not by a cheaper source, but by a more expensive source. That is to say, for the first time in history, marginal costs exceed average costs. We simply have no experience at dealing with this kind of phenomenon. (There is also significant concern over the 50-60 year time period Figure 5 illustrates required to replace one energy source with another through the "natural" process.)

The implications of this can be further seen in Figure 6 which portrays the present U.S. market situation, and, in the most basic sense, outlines our energy situation.

Figure 5\*



SOURCE: HISTORICAL STATISTICS OF THE UNITED STATES BUREAU OF THE CENSUS; U.S. BUREAU OF MINES, 1974

**U.S. Energy Consumption Patterns**

\*"A National Plan for Energy Research, Development & Demonstration: Creating Energy Choices for the Future - 1976." Volume I: "The Plan," page 2, ERDA, 76-1, Washington, D. C.

When OPEC oil was cheaper than U.S. oil, it was imported (as limited by Federal quotas), but U.S. prices were determined largely by the U.S. supply/demand curves. After 1973, OPEC was the highest priced oil available and set the world price.

Let us assume that U.S. energy prices tend to follow world prices. Even now, world prices exert an upward pressure on the price of controlled "new" U.S. production. Then  $P_1$  is the world price, and  $V_1$  is the volume available from U.S. supply. However,  $V_2$  is the volume demanded at that price, so  $V_2 - V_1$  is the volume imported at that price. *There is considerable concern over the magnitude of this volume, and the concern is magnified by future expectations: In the long term, the U.S. supply curve will move from  $S_1$  to  $S_2$ , while the U.S. demand curve may well move from  $D_1$  to  $D_2$  because of increased population, increased GNP, and/or increased standard of living. The growing distance between the supply and demand curves (filled by imports at possibly rising prices) is the real crux of our energy situation.*

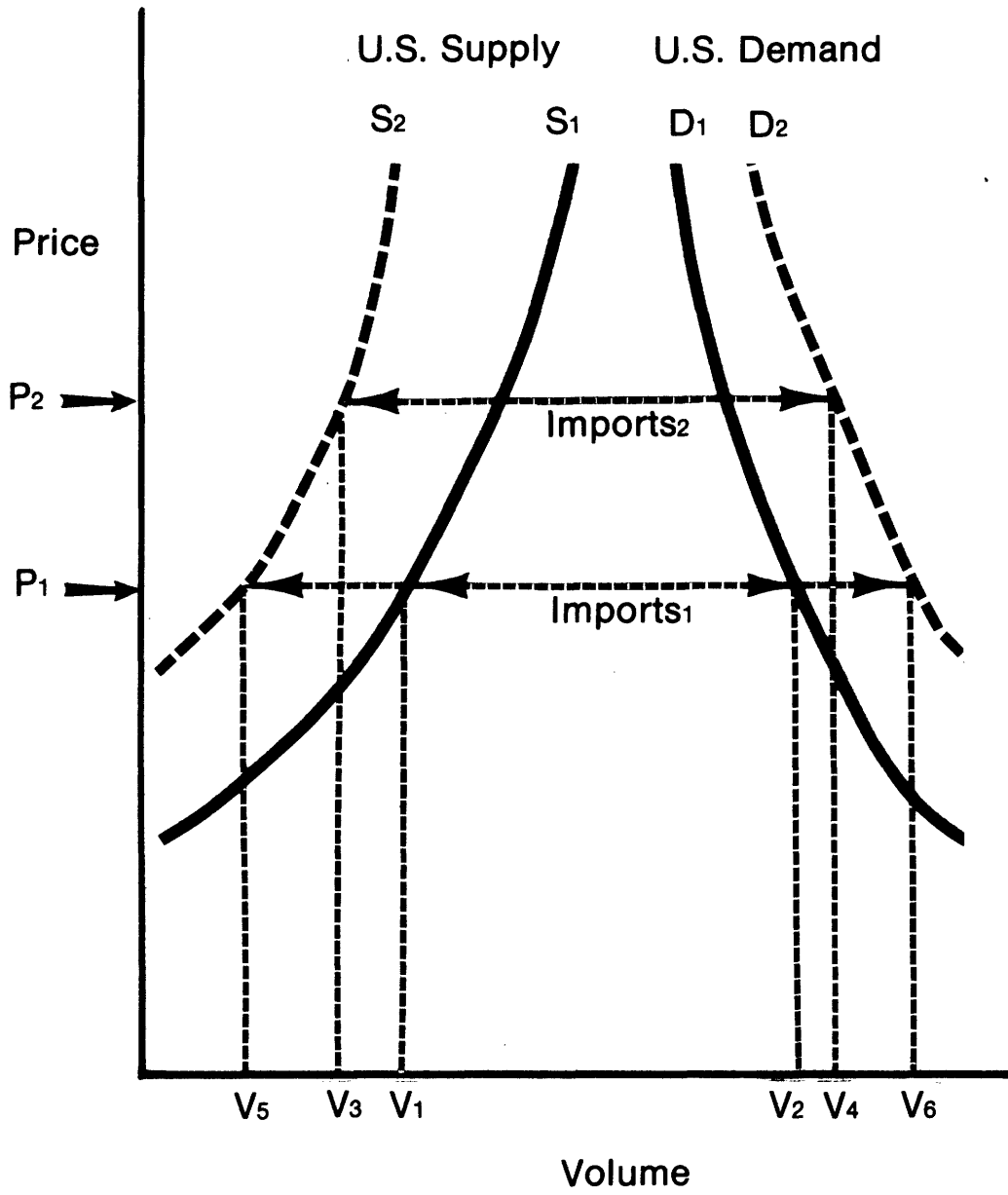
As can be seen, even if OPEC increases its price from  $P_1$  to  $P_2$ , imports could grow significantly to  $I_2$ . (It is interesting to note that U.S. volumetric dependency on OPEC would become even higher ( $V_6 - V_5$ ) if OPEC did not increase prices to  $P_2$ .)

There are several other factors which have influenced the U.S. supply and demand curves which are not apparent on Figure 6 and should be noted. When OPEC oil was cheaper than U.S. production, the U.S. had higher national energy costs than the other consuming countries. However, the other countries applied high taxes to imported oil, especially gasoline, so that the consumer saw higher prices than in the U.S.

Since 1973, the U.S. has not been the most expensive but rather the cheapest energy among consuming nations. However, U.S. price controls on domestic production work to reflect consumer prices lower than the cost of the marginal supply, OPEC oil. Also, interstate natural gas is regulated at average prices equivalent to about one-fourth the price of world oil.

The leftward movement of the supply curve and increasing regulation have had a serious impact on the utility industry which, in turn, has impacted on the total energy situation. Utilities are regulated on the basis of return on investment. Historically, this gave them incentives to give discounts to large, new users, since marginal costs in the long term were lower than average costs (the supply curve was moving to the right). In other words, the next plant would be cheaper to build than the last plant was. This encouraged new investment, which could be leveraged, resulting in increasing return on equity, even at a regulated return on investment.

Figure 6



What happens as the price of energy goes up.



But now, the situation is completely different. Because marginal costs are now higher than average costs, the next plant, and the next increment of fuel supply will be more expensive than the last. This is compounded by the fact that regulatory agencies are slow to grant increased rates resulting from increased investment. On the other hand, utilities can pass through the increased cost of feedstocks which drives the utilities to obtain feedstocks at almost any price but with great reluctance to add capacity. Reliability and continuity of supply has become a factor at least as important as price.

#### THE TRUE ISSUES OF OUR ENERGY SITUATION

This description of our energy situation now makes it possible to define and discuss those issues which need to be addressed in order to change our current energy situation. These issues include: the value of decreased reliance on imports; the shape of the supply and demand curves; and energy's impact on commodity inflation, income redistribution, the quality and quantity of GNP, and unemployment.

- As shown in Figure 6, the leftward movement of the U.S. supply curve (as well as possible rightward movement of the demand curve) is steadily increasing our level of imported oil. (21% of our total energy supply is now imported.) The structure of OPEC itself is a significant factor. Although

referred to as a cartel, it is internally heterogeneous in that some of the countries are wealthy and can afford to pursue long-term goals, while others are poor and are driven by short-term needs for cash. Nevertheless, it is certainly true that in a few months they were effective in increasing the world price of oil by a factor of five, and have maintained the new, higher level for several years since that rise. Such power raises valid questions about the U.S.'s economic risks relative to future price levels and fluctuations, continuity of supply, and the political questions involved.

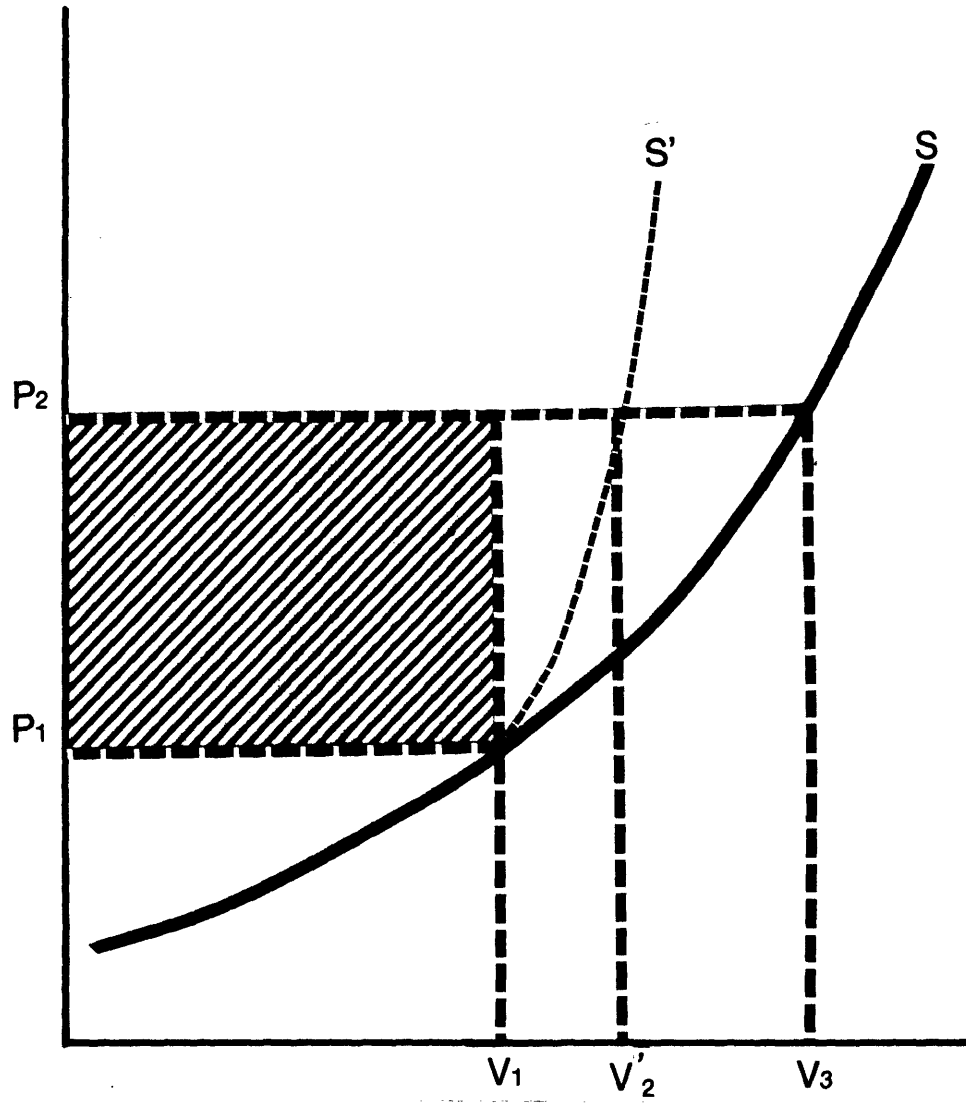
- At the same time, we do not know the shapes of the supply and demand curves (S and D), just as we don't know the speed of movement from  $S_1$  to  $S_3$  and from  $D_1$  to  $D_3$ . For example, we don't know at what price  $S_1$  intersects  $D_1$  or  $S_3$  intersects  $D_3$ . One of the reasons for this is that, as can be seen in Figure 3, since 1920, we simply have had no experience with significant changes in energy prices. Since most alternate energy sources cost considerably more than present world oil prices, it is feared that an arbitrary reduction in imports would result in a price "unacceptably high" from a social perspective. Thus, the energy situation could be stated as: We are uncomfortable with the uncertainty of OPEC supplies; however, economically, they are the best bargain around, and we can't afford to do without them.

Crucial, in this case, is the shape of the supply curve, particularly for oil and gas. If the supply curve for oil and gas is shaped like S on Figure 7, then an increase in price from  $P_1$  to  $P_2$  would result in a significant increase in volume from  $V_1$  to  $V_2$ , with the collection of economic rents indicated by  $(P_2 - P_1)(V_1)$ . In other words, the economy could possibly handle this price increase with few disruptions or dislocations.

If, on the other hand, there just isn't much left to be found, or if it is extremely expensive to find and produce remaining oil and gas reserves, then the supply curve might look like  $S'$ , and an increase in price would elicit an increased volume of only  $V_2' - V_1$ . In this case, the supply/demand balance would be maintained mostly through larger imports and/or reduced demand, despite the collection of the economic rents. This could possibly have an adverse effect on the economy.

Related to the above are other issues which have broad and significant implications for the economy and society as a whole. Specifically, a significant increase in prices has important effects on commodity inflation, and the economic rent results in considerable redistribution of wealth. Both of these have impact on the quantity of GNP, as well as its internal makeup, and they impact directly the unemployment level. Also, significant shifts will inevitably result in particular hardship cases. Stated in terms of Figure 6, a significant increase in the price

Figure 7 \*



High supply elasticity, S

vs.

Low supply elasticity, S'

can result in a leftward pressure on the demand curve as a result of its effects on commodity inflation, and on the size of the GNP and its makeup.

Because of the rapid increases in energy prices over the past several years, these issues are becoming a real concern in the U.S. As prices rise, those on fixed or low incomes feel the crunch first. Also, jobs which are eliminated because of higher fuel costs are usually jobs held by low income wage earners. While higher energy costs affect everyone, middle and upper income levels are better able to absorb higher energy costs than are low income levels. Therefore, the gap between the "rich" and the "poor" widens and the government is faced with the problem of income distribution. This forces the government to choose between allocating an increased portion of income to current consumption or to capital formation. The former is more socially responsive in the short run, but in the long run, inhibits more efficient consuming habits and capital formation, and therefore increased production, thus exacerbating the problem by driving prices even higher.

These are the issues that need to be addressed and carefully thought through prior to the implementation of any major policy options. And policy options need to be weighed against the impact they will have on these concerns. For example, if uncontrolled prices will not increase supply significantly, they may not be worth the economic disruptions and

dislocations that may occur with higher prices. At the same time, if higher prices increase supply substantially, we may still need policies to accommodate the disruptions that might occur.

In addressing these issues, one must consider the following questions:

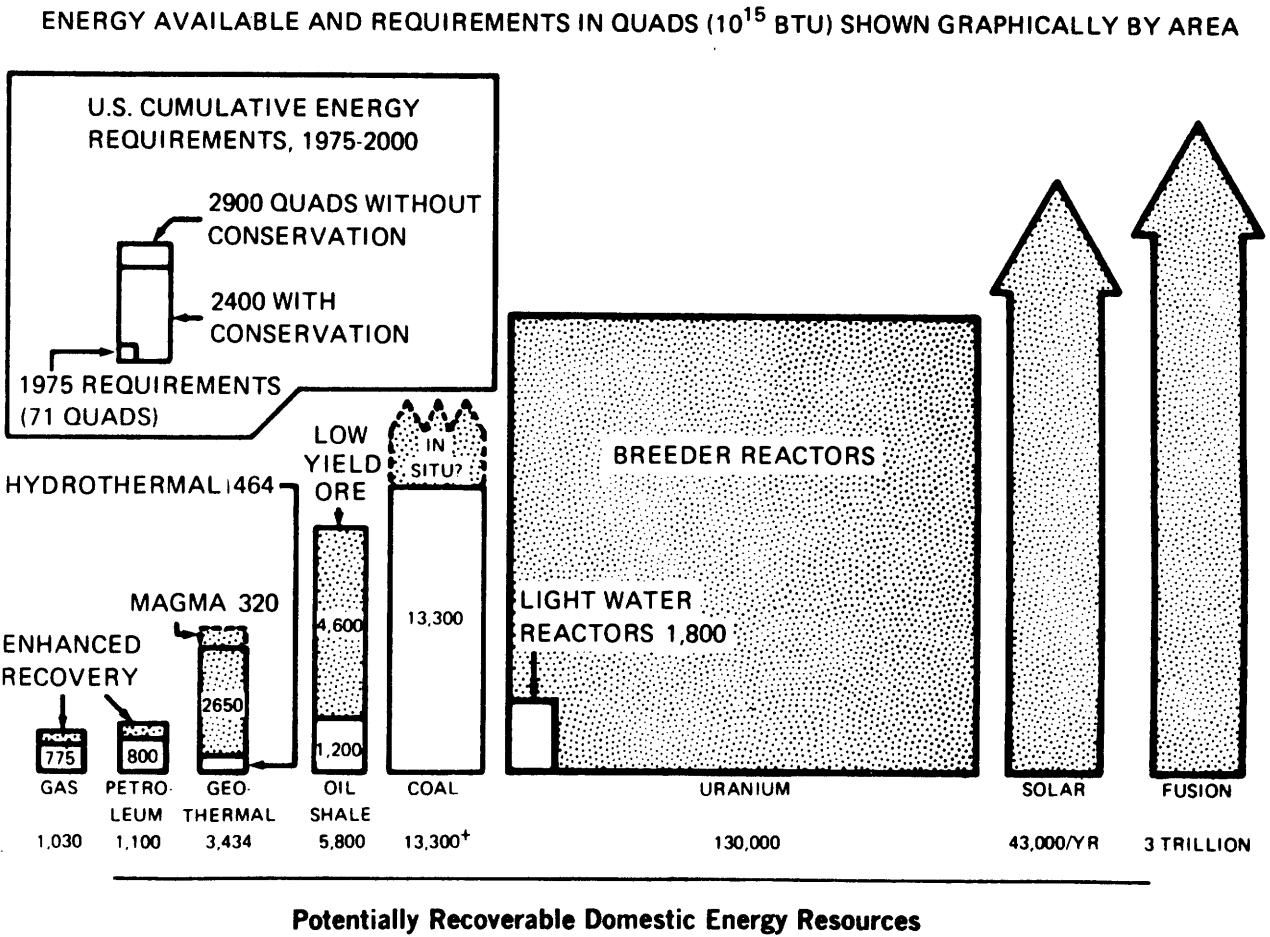
- Is the natural process of the marketplace too slow or too uncertain to provide our energy needs at a reasonable cost during a transition period of 30 years or so when renewable energy sources such as fusion, breeder reactors, and solar will become economically and technologically feasible? Or, have we entered into an era where traditional economic structures and occurrences will no longer be adequate to meet our needs?
- What are "proper" (i.e., mutually consistent and supportive) roles for the public and the private sectors? In other words, what functions should the government perform and what functions should the private sector perform in order to create the most practical system for handling our energy needs and related problems?

In order to address these two crucial questions, it is imperative to define the model or basic suppositions on which policies are formed and built. There are two specific viewpoints or approaches embraced today. So much misunderstanding and real difference of opinion stem from divergence on this issue that it is important to make a clear statement of the approach taken by the author of this study. Without the clear statement of the viewpoint taken by the author, the issues and philosophies contained in this study cannot be placed in their proper perspective.

On the one hand, much thought and analysis is focused on energy "needs," or "gaps" in energy supply, to be made good by the provision of particular fuels, or by conservation. The concentration is on physical flow. Technologies are rated according to how much can be brought onstream, and how soon, to cover the shortfalls or gaps.

An example of this approach can be seen by references to Figures 8 and 9, taken from "ERDE-76." Figure 8 is conceived as "requirements" (= needs) and "availabilities," without regard to or reference to prices or costs. The task is perceived here, then, to be matching "availabilities" with "requirements." A mismatch is then considered a "gap," e.g., to be filled by synthetics (Figure 9), imports, etc. The concept of supply, demand, and prices in the sense of the discussion throughout this paper simply does not exist in gap analysis. It is important to remember,

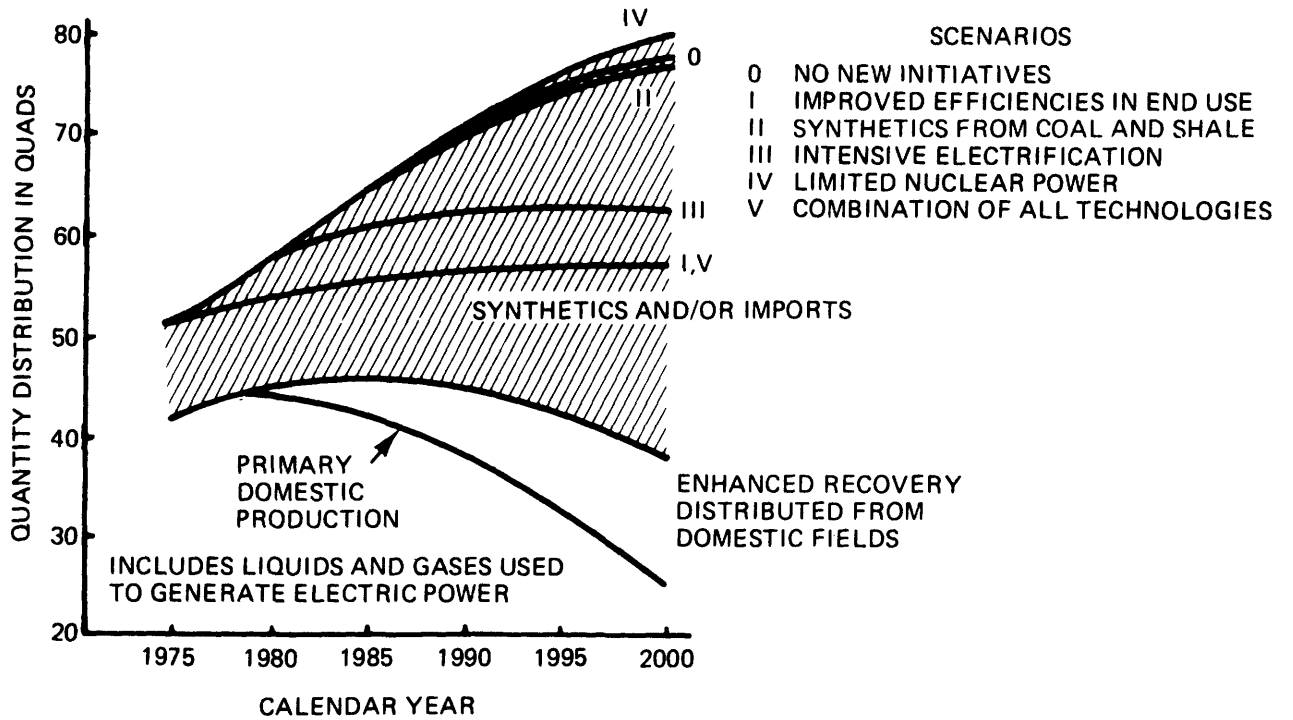
Figure 8 \*



\*"A National Plan for Energy Research, Development & Demonstration: Creating Energy Choices for the Future - 1976." Volume I: "The Plan," page 3, ERDA 76-1, Washington, D. C.



Figure 9 \*



SOURCE: ERDA-48, 1975.

Projected "Demand" for Liquids and Gases to be Met by Synthetic Fuels\*\*

\*\*A National Plan for Energy Research, Development & Demonstration: Creating Energy Choices for the Future - 1976." Volume I: "The Plan," page 55, ERDA 76-1, Washington, D. C.

\*\*Quotation marks added.

however, that excluding them from the analysis does not exclude real costs from the real world. In reality, these costs are paid somehow by the economy.

The other approach is to focus on energy prices as they operate in a market economy. In this view, there is no such thing as an energy "gap": Supply is always equal to demand (over any significant time period) absent price controls and rationing. Some kinds of supply may be less desirable because they are insecure or because they damage the environment. But in all cases the central question is the same: What price are we willing to pay to hold imports down or avoid environmental losses? From this viewpoint the most important fact about a technology is not the extent to which it may "close the gap" but its cost, for it is cost in relation to price that will determine whether it makes any contribution at all.

The difference in viewpoint is fundamental and is usually a difference in perception of how the U.S. economy actually operates, of the driving force behind changes in the energy sector, and about what policy tools are available and going to be applied. If the circumstance is formulated in terms of "needs" and the failure of assured supply, then the task of government is to find new supply and utilization technologies, design and build them, and ensure (somehow) that they are used.

This is the way energy is managed in the centrally-controlled economies (where the "needs" approach is called the method of "energy balances"). If the policy tools are available and the society wills to use them, then the view is perfectly appropriate. Many services are provided that way in this country--e.g., postal service, highways. Such an approach was successfully and appropriately used for the planning and subsequent provision of key commodities during World War II. For example, the "gap" left by Japanese control of natural rubber supplies was successfully closed by government-supported production, supplemented by detailed regulation of the importation, pricing, and utilization of available synthetic and natural rubber supplies.

The issue is whether the approach via "needs" and "gaps" is appropriate with regard to the U.S. over the next few decades. In the past, energy provision has been left to the workings of private markets--some regulated and some not. Energy prices and the relation of those prices to the costs of domestic supply and conservation measures have been the principal determinants of the magnitude and composition of the energy sector, and of energy imports. The driving force has been profits, with the government as one of the determinants of what was profitable. For example, while leaving most investment and operating choices to the private sector, public policy has had a pronounced effect on the oil sector through various financial incentives, such as the foreign tax credit and the depletion allowance.

Whether this should continue is a matter of some dispute. Perhaps the national security problem presented by oil dependence requires a drastic change. Perhaps the prices implied by a commitment to energy independence are socially intolerable because of the potential impact on lifestyle and on the income distribution. If so, technological change may relieve this squeeze by producing energy at costs lower than otherwise available. If the new technologies did not prove competitive, then they would need to be subsidized; and more government direction of energy markets would serve this end.

The hypothesis adopted here is that for the foreseeable future say, the next few decades, we are not likely to institute fundamental changes in the structure of the energy sector, or the U.S. Government, or move in a determined, decisive way to a more centrally-controlled energy economy. For better or worse, the market system will predominate in the U.S.

We are not talking here about some idealistic notion of a "free marketplace," but rather the de facto utilization of the marketplace as the operational decision-making mechanism. Pressures, constraints, and incentives can be brought to bear on the marketplace, i.e., by the government, that will influence the content of its resulting decisions, and still utilize the functioning of the marketplace as the decision-making process. For example, the government can have goals for unemployment and inflation, but does not control or direct them; rather, it

influences--through such tools as monetary and fiscal policy--the marketplace decisions which do in fact determine them.

If private markets will pervade in the energy sector, then "gap" analysis (which tends to ignore prices and profits) involves analytical and planning tools, and more importantly, policy prescriptions, that are inconsistent with the facts of our economic organization. For example, "commercial demonstration" of new technologies, either supply-augmenting or demand-diminishing, can lead to economically viable new industries only if the expected price regime which these technologies will face provides the incentives for investments to bring them forth. When the role of prices is ignored, the policy goals seem to be those of reducing uncertainties regarding costs of the new technologies. The implicit assumption is that when the new technologies are demonstrated as technically feasible and the uncertainties regarding costs and productivities are "eliminated," commercial penetration is assured. In fact, commercialization will only occur when prices are high enough to cover costs and investment risks, or when the government subsidizes the difference. Effective "demonstration" of new technologies can permit earlier commercialization if it reduces the risks or lower subsidies or provides more effective design.

It should also be pointed out here that we are assuming no drastic change in the context for decision-making in the international arena

over the next few decades. That is, on the whole, each nation will optimize for its own benefit, within its powers to exercise sovereignty. For example, we assume no massive movement toward a supranational "United States of the World," where global optimization might be imposed.

#### THE ROLE OF TECHNOLOGY

Technology will determine, to a great extent, how much energy we can obtain, from what energy resources, and at what cost to replace imported oil in our market. Therefore, a discussion of technology in the context of changing the U.S. energy situation significantly (say, adding five to ten million barrels per day of energy) at world prices in the next 20 to 30 years is an essential ingredient in any discussion of our energy future.

The basic problem with a "technological" solution is that, as outlined below, all new energy sources which might be available in significant quantities cost appreciably more than OPEC crude, even making reasonable assumptions for future technological progress. From the perspective of Figure 6, one might say that OPEC has not set world oil prices high enough for us to solve our problem technologically. (Viewing OPEC from a commercial viewpoint, this should not be surprising.)

From the outset, it must be understood that technology, like any other element, has its limitations and restrictions. Many Americans have the tendency to believe that technology, given the proper amounts of time, money, and brain power, can accomplish any feat and cure any ailment. Even if this were the case, we are confronted with a limited amount of time and, to only some extent the degree of which the reader accepts the previously defined "price" model, a limited amount of money. Therefore, technology does have restrictions and these must be kept in mind when considering the potential of all energy resources.

#### Oil and Gas

The U.S. has significant remaining oil and gas reserves. However, given the extensive exploration and production activities conducted domestically over the past 75 years, it is safe to say the large, cheaply produced onshore fields have for the most part, been discovered and tapped. The oil and gas that comprise our remaining reserves, then, basically lie in more remote or deeper formations onshore and in frontier regions such as the Outer Continental Shelf, deep offshore Gulf of Mexico, the Gulf of Alaska, the Atlantic offshore and the Beaufort Sea. Production costs in these areas will be an order of magnitude higher than that for most of the present production, which comes primarily from relatively accessible, conventional onshore and shallow offshore areas. Technological progress is expected in exploration methods, but again it

is unlikely that this will result in significant discoveries in conventional areas that have been overlooked during the past century.

Technological progress in enhanced recovery will produce some additional volumes but this will only delay the decline in production-- not permanently arrest it.

We currently rely on oil and gas for 75% of our total energy needs (21% of our total energy needs is imported). Given this outlook for oil and gas, it is obvious that we must begin now to consider and develop other possible forms of energy.

### Oil Shale

The cost of shale oil is expected to be between one and a half and two times present world oil prices. The economics of this process are limited by the inherent necessity of handling enormous quantities of inert solids and of hydrogenation of the oil. The most likely technological breakthrough which could make a significant supply of shale oil economically available is in the area of in-situ processing, which could significantly reduce either or both of these limitations.



Coal

Although the U.S. has substantial coal resources, there are definite limitations--man-made and natural--to its use. Coal utilization at costs competitive with world oil prices is limited primarily by the need for environmentally acceptable combustion. Stack-gas scrubbing is one attempt to deal with this need. It is now operational, and submarginally economical relative to world crude prices. In other words, electricity produced in a grassroots plant started now with stack-gas scrubbing for high-sulphur coal, is expensive relative to the world energy market. One cannot be optimistic about the likelihood of a significant breakthrough in stack-gas scrubbing technology.

The liquefaction and/or gasification of coal would permit coal to be burned in an environmentally acceptable manner. However, the cost of these products is expected to be two to three times present world oil prices. Improving the economics through technological breakthroughs is limited by the inherent need for massive hydrogenation. As in the case of shale oil, a technological breakthrough in the area of in-situ processing might reduce significantly or entirely this requirement, and therefore could make an appreciable supply of liquified/gasified coal economically available.

Incidentally, it is worth noting that a true order-of-magnitude breakthrough in enhanced recovery would probably lead to a similar revolution in in-situ processing of shale oil and coal and vice versa. They all involve a common problem, and that is one of controlling large quantities of fluids deep within the earth without the huge expense of mining in one form or another.

An additional possibility is the development of fluidized bed combustion technology to the point that emissions from "dirty" fuel would be controlled to acceptable levels within the combustion process itself, by preventing the formation of or removing pollutants within the fluidized combustion bed.

### Nuclear Fission

Fission offered the hope of cheap energy during the 1960s. However, since then, unit capital costs on nuclear power plants have increased about fivefold. This outpaces the general inflation rate in the construction industry. A substantial portion of this can be attributed to regulatory delays stemming from safety and environmental concerns. This has dramatically slowed down the building of additional nuclear facilities.

Since safety and environmental requirements change and become more severe with almost each new plant, not only does the absolute cost of each successive plant rise, but also "learning" takes place less effectively which will result in a slower future trend of downward costs. In addition, ultimate U.S. uranium supply at costs allowing electric generation competitive with OPEC oil is of some concern.

There seems little likelihood of economical technological breakthroughs in the foreseeable future that will deal with this situation.

Recently attention has been focussed directed at the "back end" of the fuel cycle because of potential nuclear weapons proliferation and radioactive waste disposal problems. Spent fuel from reactors may be reprocessed so that the remaining uranium and plutonium that has been produced are separated from the radioactive wastes. The uranium and plutonium can then be refabricated and returned to the reactor as fuel. The economics of nuclear power are improved by reprocessing, though the extent of improvement is highly dependent on uranium prices. The principal issue with regard to reprocessing is the separation of plutonium, which can be used in the manufacture of nuclear weapons. Whether or not the spent fuel is reprocessed, there is still an issue of how to dispose of wastes that will be radioactive for thousands of years.

### Hydroelectric

Hydroelectric power offers insignificant additional volumes of energy in the U.S. simply because most available damsights are already used up.

### Geothermal

Natural geothermal offers only small additional volumes of economical energy because there are only very limited sources of natural geothermal steam near the surface. Forced geothermal ("hot rocks") and subterranean hot water are expected to cost several times world crude prices, and cannot be expected to be a significant energy source in this century.

### "Backstop" Sources

Backstop sources are energy sources and processes such as the sun, breeder reactors, and fusion which, if perfected, offer renewable, virtually unlimited sources of energy. The technology for these, however, is essentially in its infancy and many economical, technological, and environmental hurdles must be leaped before we can see them reach fruition. None of these can be expected to make a significant contribution (e.g., five to ten million barrels/day of crude equivalent) to

our energy supply this century. However, it is essential that work be done on developing them now so that they will be available to us in the future.

As with fission reactors, breeders face economic, safety, and environmental constraints and are further complicated by the fact that fuel reprocessing is an integral part of the breeder concept. The fuel reprocessing issue is an unresolved problem. In addition, the capital cost of a breeder plant is inherently higher than that of a fission plant. Engineering research is needed for the process to become environmentally viable, and it will be decades before this process becomes economically viable.

Fusion is still in the basic research stage and offers little prospect of technological availability this century, much less commercial and economic availability. As with fission, the creation of some (although a smaller amount) radioactive wastes is an unresolved problem.

The use of sunlight, wind, tides, and hydrothermal seems most appropriate during this century in isolated, particularly, site-specific cases. Significant use of these forms is still in the research, as opposed to development, demonstration, or commercialization stage, and offers little prospect of availability this century.

Timber and biomass have the possibility of eventually becoming significant energy sources, through such mechanisms as "energy plantations." However, technological and infrastructure problems present significant economic blocks, and will most likely require decades to overcome before this possibility becomes a commercial reality.

### Conservation

Consistent with the kind of analysis conducted in this paper thus far, "conservation" is not a separate issue, but rather is the natural result of each energy consumer taking the logical steps in view of the price signals he receives. One of the most significant consequences of this would be a rational utilization of the various kinds of energy, e.g., liquid petroleum for transportation, gas for domestic and commercial, coal for industry, and coal and uranium for utilities. A shift from private cars and motor freight toward mass transit and rail freight might be added to this list. This rationalization could be the natural consequences of the decisions made through the operation of the marketplace. Educational and cultural pressures (e.g., preachments and posters) may be somewhat helpful but have little chance of making a significant difference when they run counter to the price signals. However, the marketplace can, if allowed, very effectively "fit the fuel to the job."

It is not intended here to dismiss conservation as a nonissue. But, it is important to see where the issue lies. We argue here that preachments of a moralistic nature ("you ought to turn off your lights") are essentially ineffective unless reinforced by the structure of prices. On the other hand, a more relevant price structure would lead to a shift in the context in which decisions are made. Before 1973, the price of energy was a negligible factor in most decisions at the consumer level, and even many at the commercial and industrial level, e.g., whether to go for a drive or watch TV, how much to insulate, incandescent vs. fluorescent lighting. With relevant prices, energy would become a part of those contexts. As an analogy, probably few menus are designed with the cost of table salt as a factor; however, if the price of salt were to increase significantly in a short period, it would become a part of the context in which menus were designed, but an educational process would be involved, including the changing of people's eating habits.

Perhaps it is necessary to point out explicitly that we cannot conserve our way out of the energy situation. For instance, new conservation technology (e.g., better insulation at lower prices) or more complete availability and utilization of life-cycle costs can, at best, move the demand curve of Figure 6 to the left or, more likely, slow its movement to the right.

### DIMENSIONS OF THE ENERGY ISSUES

Now that the energy situation, major issues, and the role of technology have been discussed, it is appropriate to identify and discuss the three major dimensions of the issues at hand: the role of the government relative to the marketplace, the importance of the energy situation, and the areas of policy research which are crucial to dealing effectively with the problem.

### THE ROLE OF THE GOVERNMENT RELATIVE TO THE MARKETPLACE

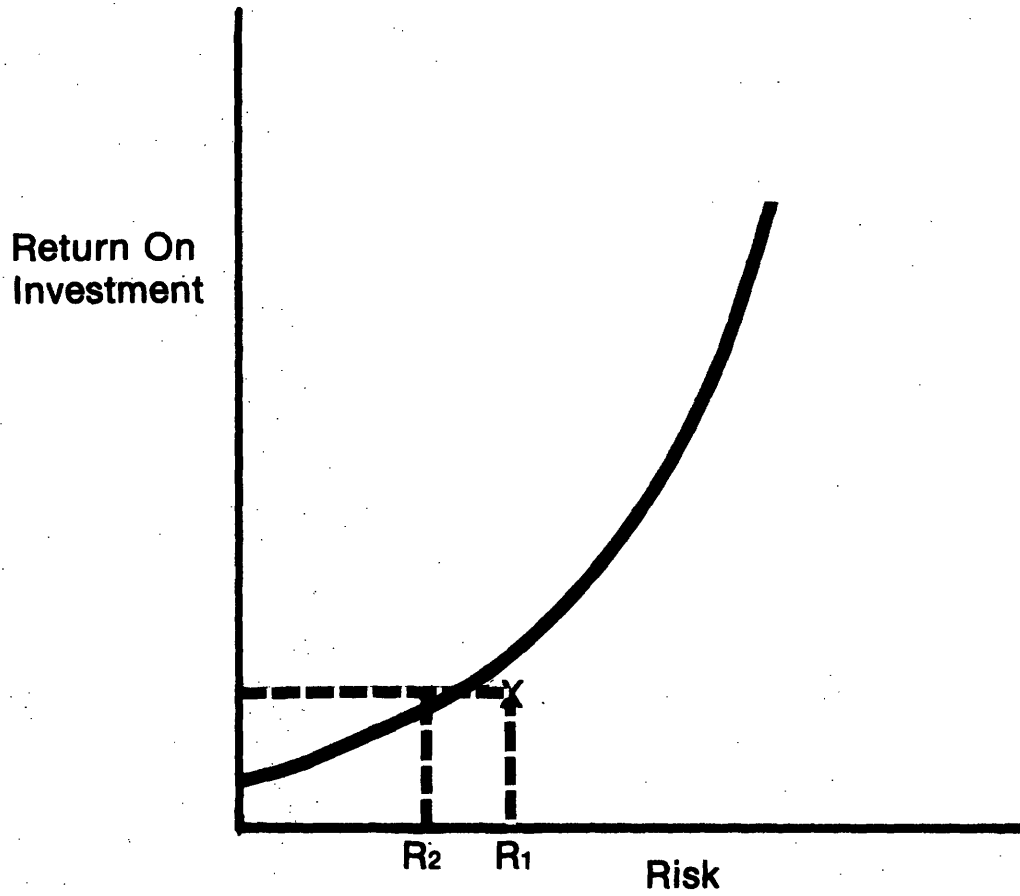
The operation of the marketplace in an economy such as ours is based on the premise that the sum of many individual decisions, each made in the context of what is best for the individual, results in patterns that are best for society as a whole. The traditional role of the private sector is to offer these choices and make those decisions, in that context.

Of course, there are instances where this premise does not hold. For example, a marketplace would presumably result in some degree of heroin traffic, but this is deemed not to be best for society as a whole. It is, therefore, termed a "market failure," and the role of the government is to step in and correct the failure. With regard to the energy situation, there exist more mundane but relevant market failures which call for government attention. These include:



- Failure of energy price to reflect the social value of a barrel of oil supplied or a BTU saved (e.g., world price plus the social value of reduced dependence on OPEC).
- Inability of a firm to appropriate as its own private property the results of its expenditures for research, innovation, or technical progress.
- Regulatory or other institutional barriers where otherwise socially desirable outlays would result.
- Inadequate structure of the market (e.g., monopoly).
- Higher degree of risk aversion in the private sector than appropriate to society at large. For example, with reference to Figure 10, a "socially desirable" project may lie at point "X." The market will not support it, since it lies below the curve. The government could correct this "failure" by spending public funds to reduce the risk from  $R_1$  to  $R_2$ , at which the market would support it. (This is a valid way of viewing ERDA's "commercialization" program.)
- Inadequate information (e.g., to decide on purchase of an automatic defrosting refrigerator on the basis of total life-cycle costs rather than first cost).

Figure 10



Example of "commercialization" by reduction of risk by the public sector.

- Sheer size of an endeavor can result in a market failure.

The traditional role of the government is to correct such failures. Often, the reason is unclear at the time or quickly forgotten, and the "correction" becomes "regulation" or "intervention" in perceptions, but we argue here that correction is the traditional role.

A second role of the government is to set the environment in which market decisions are made. Setting this environment influences without directing the market, through such policy tools as taxation. For instance, the government does not direct that each family buy a home, but the environment for this decision created by current income tax laws influence decisions toward this direction.

The third role of the government is to act as the "fireman." That is, deal with crises, which (by definition), are short term. (It is essential to note that the energy situation can, therefore, not be classed as a "crisis.") This fireman role calls for instant action, but implies that, following the fire, the fireman returns to the firehouse to await the next crisis.

The fourth role of the government is that of the "policeman," that is, the corrector of injustice. For example, the widow who can't afford gasoline to drive to her job, without which she would be on welfare.

THE IMPORTANCE OF THE ENERGY SITUATION

Energy is something upon which everyone depends. The energy situation will, therefore, affect everyone and virtually every aspect of our lifestyles.

Energy is a key to the development of industrial society, which is based on improving the standard of living, and increasing discretionary wealth and leisure time by replacing human effort with mechanical, electrical, chemical, and other nonhuman energy. Simply put, our lifestyles and our very "system" depend on energy for their continuation and perpetual improvement.

Because of the importance of energy, the public has taken an unprecedented interest in controlling the energy market as our energy situation has deteriorated. The thesis of the marketplace is that no one is in charge of understanding and directing it--it is self-directed by individual choices and by trial and error. Now questions are being raised as to the ability of the marketplace to cope adequately with the energy situation in a manner tolerable to consumers and the public. The government is experienced at influencing it indirectly, and at imposing rules of fair play, but is not structured for predetermining answers or distributing allocations. The difference between letting the market decide these things by trial and error and predetermining answers and

distributing allocations is as stark as the difference between natural selection and biological engineering.

Fundamental to this is that we do not have available the analytical tools and data for predetermining answers or distributing allocations within the required efficiency levels. Yet, there is a feeling among many that we need to do these very things if this nation is to manage its energy situation. Obviously, it would be foolhardy to embark upon these objectives knowing only what we know now.

Also, the time frame over which we are talking--several decades--is new. The problem is not only a lack of intellectual tools, but also a lack of accountability systems in both the public and private sectors over such a period. General problems, issues, and other elements which are of concern to the government and to the private sector are viewed in time frames of only a few years. While "long-range" plans are made in some areas, most specific planning and forecasts are made for only as long as five or ten years but rarely, if ever, has a time frame of 30 years or so been addressed in dealing with pertinent issues.

#### What We Know and Don't Know

The foregoing has provided a conceptual framework in which the "energy situation" is defined and the basic issues are listed. Also

derived therefrom, are a set of criteria by which to measure policy as to consistency and effectiveness. Surely other frameworks can be developed, perhaps equally valid, which would lead to different criteria. This should lead to a much more creative and helpful debate than the present alternative of debating the relative merits of various isolated policies on an adversarial basis.

Lacking such a framework, it is even conceivable that an energy policy based only on what is possible might be counterproductive. Dealing with short-term manifestations as if they were the problem raises the danger of effectively treating the symptoms but unwittingly increasing the severity of the disease. The classic picture of putting Band-Aids on Band-Aids comes to mind. Therefore, if only to illustrate by example, we refrain here from offering our favorite home remedy. There is no policy which will return us to the former times of plentiful, ever-cheaper energy, which is the premise on which our present systems rest. The first priority--before policy delineation--is in analyzing the new situation and the resulting issues which must be faced throughout the next one or two generations. Only then can creative and authentic policy formulation begin. We have not a problem to solve, but rather, the challenge of whether we can learn to adapt to the new situation in which we find ourselves. The latter requires policy, but of a different kind than the former.

However, there remains a great deal of policy research to be done to provide us with the information needed to formulate energy policy.

These include:

- More complete analysis of the domestic supply of primary energy. This requires integration of geologic information, engineering cost data, and studies of economic incentives in order to produce better estimates of future supplies of oil, gas, coal, and uranium.
- Studies of international markets for energy, including upgrading existing work on supply, demand, and price formation in the world market. Current understanding of the nuclear fuel cycle, including its relation to nuclear weapons proliferation, must be expanded.
- Development of improved methods for forecasting long-run energy demand and the effects of conservation measures. Analysis of energy demand on a 10- to 30-year horizon requires better methods of accounting for the introduction of new devices, and the consumer's response to them.
- Analysis of the structure and performance of the industries that develop and commercialize new energy technologies. Study

should focus on the processes that determine the growth of new energy industries, such as synfuels or solar collectors, and on federal measures intended to speed the rate of technology development and adoption.

- Study of the relationship between energy markets and overall economic growth and development. In order to form a basis for long-term energy sector planning, research should seek fundamental advances in understanding of the role of energy in economic growth, and its relation to capital and employment in various sectors.

This does not suggest in any way that formulation of an energy policy should await the needed research listed above. That is absurd as well as impractical and contrary to the immediate needs of the nation.

The point is that we will have an unsatisfactory energy situation for some time. Using a framework such as the one presented in this paper we need to go ahead and formulate an energy policy which, based on what we do know, will deal in the most constructive manner possible with all of the issues and problems of the energy situation. As we learn more through research and trial and error, we can adjust and improve upon the structure within which we operate.



Such an approach as the one proposed here would start with the situation, develop alternate approaches which would deal significantly with it, weigh the costs and risks against the benefits (on a macro basis) of each, and then lastly, consider what is judicious and practical in the world of politics and within the adversarial positions various actors will inevitably take. This should be far more effective than the present and opposite approach of starting to negotiate from the adversarial position (or, starting with "gimmick" solutions) and not really testing for macro costs, risks, and benefits, or even for the real significance vis-a-vis the situation being addressed.

Finally, we must not become complacent with whatever energy policy is adopted this year or next. However, since it is so vital that we make some tough policy decisions, while being faced with some significant "unknowns," it is imperative that these decisions address the real issues and not sub-issues or cosmetic appeals. We still have the time, the capacity, and the flexibility to adopt an energy policy which can be altered as we learn more. However, the longer we avoid facing the real issues on a comprehensive basis, the less flexibility we will have with which to face them.