THE SUPPLY SIDE OF THE ENERGY EQUATION

BY

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President Carter's energy program places heavy emphasis on conservation. That obviously affects the demand side of the market equation. Question: What are the implications for the supply side and can these implications be accommodated by public policy? This paper will review some of the possibilities.

Conservation Impact

First, let us review the impact of the projected conservation program. Table 1 displays expected United States energy consumption between now and 1985 under alternative conditions of annual growth -- a continuation of the current 4.6 percent rate, an immediate reduction to the 2.0 percent Presidential goal and a phased (linear) reduction to this same point by 1985. The values are instructive in that they show, by 1985, a 20 percent reduction in projected energy use if the growth path drops immediately to 2 percent and a 12 percent reduction if this goal is phased in. Since most observers question the ability to achieve the 2 percent rate by 1985, even the latter scenario appears to be an optimistic goal.

Note, however, that the 4.6 percent annual growth rate, although less than the 1976 rate of 4.9 percent, substantially exceeds the long-term trend of 3.7 percent. If the future growth rate corresponded to this lower value without conservation, the phased reduction to 2 percent would result in 94.9 quadrillion BTU's of consumption by 1985. Although falling between the two results displayed, the difference can be significant, as we will see at a later point.

Related Goals

In addition to an overall drop in the energy use growth rate to 2 percent by 1985, the President presented a series of related goals which will

Table 1.--Anticipated United States Energy Consumption (Quadrillion BTU)

Year	Current 4.6 Percent Annual Growth Rate	Immediate Drop to 2 Percent Annual Growth Rate	Linear Drop to 2 Percent Annual Growth Rate
1976	74.31	74.31	74.31
1977	77.73	75.80	77.51
1978	81.30	77.31	80.63
1979	85.04	78.86	83.64
1980	88.96	80.44	86.51
1981	93.05	82.04	89.24
1982	97.33	83.69	91.81
1983	101.80	85.36	94.17
1984	106.49	87.07	96.33
1985	111.39	88.81	98.26

bear on the mix of energy sources used in the future.

1. Gasoline consumption is to be cut 10 percent below the current level of approximately 7 million barrels per day by 1985.

2. Oil imports are to be reduced from 8 to 6 million barrels per day.

3. Domestic coal production is to be increased to 1 billion tons per year from the current level of 665,000,000 tons.

4. Solar home heating is to be expanded from its present state of invisibility to 2.5 million dwellings.

That leaves nuclear power, hydroelectric, petroleum and natural gas to take up whatever slack exists between the demand that results from conservation measures (including higher prices), stipulated import levels and supplies from coal and solar.

The Supply Picture

Certain assumptions must be made to clarify the supply side of the equation. For sake of discussion, assume the following:

1. Between now and 1985, the nuclear power industry increases its design capacity from the current 46,000 megawatts to 166,000 megawatts --

a 261 percent increase. This projection is based on a recent (October 1976) government forecast of the maximum production that could be obtained by 1985. The result, which is optimistic by almost any measure, is an increase in nuclear power consumption from the present 2.037 quadrillion BTU's to 7.35 quadrillion BTU's in 1985 (assuming similar operating conditions).

2. No major change will occur in hydroelectric production, reflecting the lack of qualified sites and the existence of environmental problems. Thus, hydro will maintain its current 3.119 quadrillion BTU share of the energy market.

3. Coal production will expand to reach the President's goal of 1 billion tons per year. However, as the focus on mining shifts to the west due to sulfur restrictions and lower production costs, the BTU content of a ton of coal will also fall. Eastern bituminous coal averages 24 million BTU's per ton while Northern Great Plains deposits only average 16 million BTU's. Production last year averaged around 23 million BTU's per ton. Assuming that this value will decline to 20 million BTU's per ton by 1985, coal would supply 20 quadrillion BTU's of our total energy consumption if the goal of 1 billion tons of annual production was met.

4. Converting or newly equiping 2.5 million homes for solar heat would save .3865 quadrillion BTU's of conventional energy annually by 1985. This assumes the average 1500 square foot home would otherwise be heated by electrical resistance heating and consume 251.3 million BTU's annually. Substitution of solar for heat pumps, oil or natural gas would substantially reduce these savings since use of these energy sources for home heating is more efficient than electrical resistance methods. However, to allow for other new energy sources, such as geothermal and windpower, assume that triple the BTU's estimated above will be saved by all new sources -- 1.160 quadrillion BTU's.

5. Natural gas production will remain constant at the 1976 level of 20.299 quadrillion BTU. Since production has exceeded new discoveries in each year beginning with 1970 (the difference exceeding 12 trillion cubic feet or 60 percent of consumption in 1976), this is also an optimistic assumption. Higher prices should stimulate greater discoveries but the time lags involved (especially for promising off-shore areas) may be as long as five years.

6. Finally, forecasts of domestic oil and natural gas liquids production from known reserves, including Prudhoe Bay, and projected extensions and revisions of these reserves indicate a decline to 5.85 million barrels per day by 1985 or 12.384 quadrillion BTU's.

Given these rather optimistic assumptions, Table 2 summarizes the supply side of the equation under the three growth rates used in Table 1 and shows the expected supply-demand balance. The conclusions are obvious. If imports are to be reduced to 6 million barrels of oil per day (12.702 quads), as sought by the President and shown in Table 2, anywhere from 5.5 to 16.2 million barrels per day of additional domestic oil equivalents will need to be produced by 1985. Clearly, continuation of the status quo is unacceptable. Total oil demand would soar to over 28 million barrels per day (an almost 6 percent annual growth rate) and import levels would be unacceptable for a world power (if, indeed, the oil would be available on the world market). But even conservation efforts leave a major short-fall. Growth rates in oil consumption range between one-half (to 17.5 million barrels per day) and 3 percent (to 21.9 million barrels per day) and domestic production continues to decline.

The President's conservation program and increased emphasis on coal and nuclear power cannot, alone, resolve the major imbalance in energy supply-

Table 2.--Anticipated 1985 United States Supply-Demand Balance (Quadrillion BTU)

		Current 4.6 Percent Annual Growth Rate	Immediate Drop to 2 Percent Annual Growth Rate	Linear Drop to 2 Percent Annual Growth Rate
1985 Consumption		111.39	88.81	98.26
1985 Supply				
Nuclear	7.350			
Hydro	3.119			
Coal	20.000			
Solar, etc.	1.160			
Natural Gas	20.299			
Oil (known reserves)	12.384			
TOTAL	64.312			
Required New Supplies/Imports		47.078	24.498	33.948
Import Goal		12.702	12.702	12.702
Required New Domestic Supply		34.376	11.796	21.246
Million Barrels/Day of Oil Equivalents		16.238	5.572	10.036

demand expected by 1985. Either the proposed conservation measures are inadequate, imports will need to rise and/or increased domestic supply will need to be developed. Moreover, note that all the estimates concerning a short-fall in domestic supply may be optimistic if our forecasts of future production from coal, nuclear, solar, and natural gas are inaccurate. Given the problems involved, some or all of these sources are not likely to meet the production goals stipulated.

Potential New Supply Sources

What is the potential for new domestic production that would fill the gap indicated above? In the time frame between 1977 and 1990, most experts hold out little hope for alternative sources of new supply from fusion, mag-

netohydrodynamics, coal liquefaction or oil shale. At best, such processes will add minor amounts of additional supply during this period. The question, then, is what can be expected from conventional sources? Little can be said with absolute certainty, since finding oil or gas requires actual drilling and producing it depends on the technology available. However, careful analysis using known data and appropriate statistical techniques can provide additional information for policy analysis.

The past pattern of hydrocarbon development in the United States has resulted in two potential sources of future production which could be substantial enough to assist in bridging the energy gap likely to develop by 1985. First, exploration activity has largely been excluded, by government policy, from our outer continental shelf (OCS) lands and those of Alaska. Little more than 6 percent of the available acreage has been actively explored even though the potential of these last undeveloped regions appears substantial. Second, through 1975, over 442 billion barrels of oil had been discovered in the United States, while only 109 billion had been produced and an additional 33 billion were deemed producible under current economic and technological conditions. The 300 billion barrels remaining is a target for enhanced oil recovery methods which are just now beginning to emerge.

What can be said of the potential for these two sources? Based upon studies sponsored by the National Science Foundation and carried out in conjunction with Executive and Congressional agencies, Cornell University researchers have developed some interesting projections. Since OCS development depends on government leasing activity and market economics, forecasts of OCS production depend on assumptions concerning these elements, as well as resource estimates. Using the new U.S. Geological Survey estimates of oil in place (which have resulted in greatly reduced values), Table 3

Table 3.--New Hydrocarbon Supply from OCS and EOR Production (Quadrillion BTU)

Source	1980	1985	1990
Petroleum			
OCS -- 10 Year Schedule	0	3.016	7.134
OCS -- 20 Year Schedule	0	1.682	4.408
EOR -- Low	.700	2.700	2.500
EOR -- High	1.300	4.700	5.400
Natural Gas			
OCS -- 10 Year Schedule	0	2.120	4.495
OCS -- 20 Year Schedule	0	1.116	3.011

displays potential oil and natural gas production from the OCS at $16.00 per barrel oil prices and $2.00 per Mcf gas prices. For gas, this is slightly above the price proposed by the President and, for new oil, slightly above delivered world oil price. Phased leasing schedules which would dispose of 75 percent of estimated resources in place over 10 and 20 year periods were also assumed.

Enhanced oil recovery is a group of largely unproven methods, using thermal, CO_2, polymer and surfactant injection materials, to improve oil recovery from known fields. Table 3 displays high and low forecasts of their potential between now and 1990 if production were priced at the current world market level. Achievement of the high forecast would require a substantial research and development investment by both government and industry, as well as the availability of massive quantities of injection material such as CO_2.

The Dilemma

Taking an optimistic outlook with regard to all these potential new sources of supply, 1985 production could expand by approximately 9.8 quads. The gap after all conservation measures and new supply from nuclear and coal

are accounted for, however, ranged between 11.8 and 21.3 quads (Table 2). This is roughly a 1 to 5 million barrel per day short-fall under the most favorable conservation and supply assumptions. This jumps to between 3 and 7.5 million barrels under less optimistic supply conditions, with the higher value being more likely given the pace of the President's conservation program. New on-shore oil discoveries are unlikely to significantly effect this result.

Economists are prone to argue that a gap of this magnitude would not develop if only prices were allowed to rise -- thereby dampening demand and calling forth new, more expensive, sources of supply. Although part of the conventional wisdom, this solution does not appear adequate for the energy problem developing in the 1980's. Its proponents ignore two basic economic factors. First, energy demand is highly inelastic (unresponsive to price) especially in the short run. Moreover, reduction in consumption growth to a 2 percent annual rate already factors in substantial price increases as one means of accomplishing that goal. Second, the lags involved in bringing new supply sources to market severely limit any response to price increases before the second half of the 1980's. Off-shore production requires a minimum of five years to reach the consumer after a government lease sale, as does new production from western coal mines. Power plant construction delays are well known. Perhaps of greater importance, new supply from domestic sources is not greatly limited by current world price levels. Although price increases would call forth some new production, the supply curve becomes inelastic beyond energy prices equivalent to $17.00 - $19.00 per barrel. The problem on the supply side is government regulation, delay and inaction. Witness the stop and start schedule for off-shore development, the lack

of a western coal leasing program, the nuclear bias to government research and development, and the often incompatible environmental regulations and supply goals. Substantially higher prices would only result in excess profits to energy producers. Until the government gets its energy house in order, reliance on purely market solutions to augment domestic supply will prove to be a seductive tease.

The bottom line appears to be an inextricable move toward higher import levels unless more stringent conservation measures are employed. Levels in the area of 60 to 70 percent of domestic oil consumption should be expected by 1985. The only other alternative appears to be a still further increase in production from coal and/or nuclear sources. However, the time lags involved and environmental constraints argue against these sources as a short-term solution. This places the United States in a market with a monopolistic seller and confronts us with all the uncertainties implicit in that situation. Failure to seek a balanced energy program, which includes both conservation and supply aspects, or failure of any important program element will exacerbate the import problem.

The United States, without sufficient public awareness, has reached a critical crossroads in its economic history. The question is whether time remains to implement adequate solutions and, if so, what mix of public-private responsibility should emerge for management purposes. Information about the magnitude of the overall problem, however, needs broader understanding before enlightened debate can commence about specific options.