CHAPTER III LONG-RANGE (1975-2000) U.S. ENERGY OUTLOOK AND THE ROLE FOR SYNTHETIC FUELS

A. INTRODUCTION

This chapter presents a view of the possible energy futures of the United States and examines the issue of when synthetic fuels may be needed. Although specific forecasts are given, these forecasts are not sufficient by themselves to judge the need for the Synthetic Fuels Commercialization Program (SCP). The forecasts merely project the possible energy future of the United States under a variety of assumptions. The analysis discussed in Volume II and Chapter V of this volume focuses directly on the need for the program.

In spite of the interest that has recently been shown in synthetic fuel production, it is not commercially available at present and is not likely to be in the near future. Given uncertainty in future world oil prices and a high technical and economic risk, it is unlikely that private venture capital will be available to initiate significant commercial synthetic fuel production prior to 1985. Recent estimates of domestic oil and gas resources are significantly lower than previously predicted and imply the United States may need a fairly substantial start in a synthetic fuels industry before 1990. Thus, the crucial issues with respect to Federal involvement in accelerating synthetic fuels are (1) when synthetic fuels will be needed considering the lead times required to establish a synthetic fuels industry and (2) whether the investment climate will be stable enough to attract private sector investment and thus obviate the need for Federal intervention. This chapter addresses the first issue; the second is considered in Chapter IV.

B. METHODOLOGICAL AND OTHER ASSUMPTIONS

Projections of the long-range U.S. energy outlook were derived using the Stanford Research Institute (SRI) Energy Model. This methodological tool was selected because:

- it computes a long-term supply-demand balance through the year 2000,

- it incorporates all the major fuel types and specific regional demands,
- it incorporates dynamic effects such as delays in bringing new capacity on line or in changing demand patterns, and
- the domestic resource base is treated in an economically realistic manner in that extraction costs increase as the resource base is depleted.

A more explicit description of the SRI Energy Model is provided in Appendix A of Volume II of this report.

The nominal or base case projection has assumed that:

- natural gas and oil prices are not regulated,
- technologies are selected on the basis of the prices of their products,
- environmental costs are internalized in energy prices,
- there are no quotas or rationing of imports,
- world oil prices continue to rise slowly, and
- there are no restrictions on direct burning of western coal.

Included as input to the analysis are the size of domestic demand and the size of the conventional (oil and gas) U.S. resource base. The present analysis used a slightly modified version of the Ford Foundation forecasts. Table 2 shows a comparison of several different well-known demand forecasts as well as those used in the present analysis. The discrepancies between the different forecasts are due primarily to different assumptions about such variables as:

- state of the economy,
- population growth,
- response to changes in prices, and/or
- local and national energy policy.

TABLE 2. COMPARISON OF FUTURE U.S. DEMAND ESTIMATES
(QUADS)

	1972	1985	2000	Annual Growth Rate
SRI Energy Model				
High Demand	72.1	130.4	224.9	4.7%
Nominal Case	72.1	105.7	158.9	3.2%
Low Demand	72.1	95.0	129.5	2.4%
Ford Foundation				
High Case	72.1	116.1	186.7	3.7%
Low Case	72.1	91.3	124.0	2.0%
FEA ($11/bbl import price)	72.1	102.9	*	2.7%
FEA ($7/bbl import price)	72.1	109.1	*	3.2%

*Not Available

The analysis assumes that the marginal cost of extracting resources is proportional to the cumulative production from the conventional resource base. The price required to extract the next barrel of oil, for example, increases with the amount of oil that has been previously produced. Table 3 shows the comparison between various point values of the oil and gas resource curves used and other well-known resource estimates.

TABLE 3. ESTIMATES OF OIL AND GAS RESERVES

U.S. CRUDE OIL RESERVE ESTIMATES* (Billions of Barrels)			
	Proved Reserves	Remaining Potential Reserves	Cumulative Future Production
SRI Energy Model			
@ $6.03/bbl	34	26	60
@ $9.84/bbl	34	69	103
@ $25/bbl	34	161	195
FEA			
@ $5/bbl	34	64	98
@ $8.75/bbl	34	97	131
@ $13.75/bbl	34	122	156
U.S.G.S. (New)			
Low	34	50	84
High	34	130	164
U.S. NATURAL GAS RESOURCE ESTIMATES (Trillion cubic feet)**			
	Proved Reserves	Cumulative Future Production	Remaining Potential Reserves
SRI Energy Model			
@ $ .49/Mcf	236	99	335
@ $1.11/Mcf	236	579	815
@ $3.69/Mcf	236	1,037	1,273
@ $7.38/Mcf	236	1,145	1,381
FEA			
@ $ .50/Mcf, $8.75/bbl oil	236	105	341
@ $1.00/Mcf, $13.75/bbl oil	236	435	671
@ $2.38/Mcf, $13.75/bbl oil	236	466	702
USGS			
Low	236	324	560
High	236	663	899

*Cumulative Production to Date is 105 Billion Barrels.
**Cumulative Production to Date is 488 TCF.

C. THE NOMINAL LONG-RANGE FORECAST

The quantities of energy, by primary energy resource, that balance supply and demand are pictured in Figure 1. Implicit in these curves are the economics of primary resource production as well as energy conversion processes.[2] It is important to note that coal and nuclear fuel are expected to become increasingly important over time. Oil and gas including imports, increase steadily and shale oil production begins to increase after 1990. Production of domestic gas is expected to decline after 1983 and domestic crude oil after 1990. The projected growth in primary energy is from 72.1 quads in 1975 to 156.9 quads in 2000 which is equivalent to an annual growth rate in primary energy of approximately 3.2 percent.

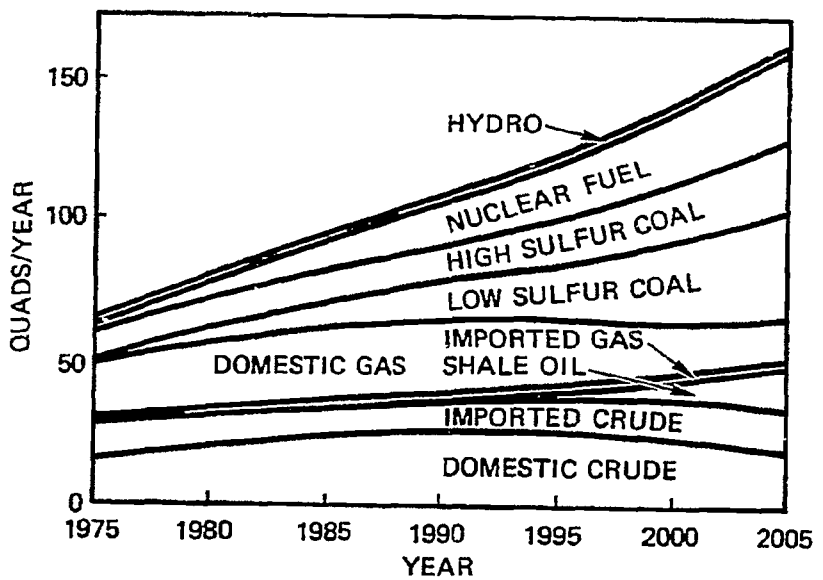

FIGURE 1. PRIMARY ENERGY RESOURCE PRODUCTION

[2] Economic data on process economics used in the nominal case are presented in Appendix A of Volume II of this report.

For the nominal case, eastern coal production in 1995 would be 15.9 quads or 660 million tons per year (approximately equal to the total tonnage of coal produced in 1975); western coal production in 1995 would be 19.8 quads or 1.2 billion tons. Finally, a total of 6.5 quads of electric power would be generated by nuclear power plants in 1980; at 70 percent loading, this would require 310 plants of 1000 MWe capacity.

To examine the contribution of synthetic fuels, the market must be considered on a more detailed level than the primary resource level. Synthetic fuels will compete with natural gas, crude oil, and refinery products. Although they indirectly affect all fuel types through interfuel substitution, synthetic fuels directly substitute for either liquid or gaseous fuels. To illustrate the substitution of synfuel for liquid and gaseous fuels, Figures 2 and 3 show the production and prices of aggregate liquid and gaseous fuel for the nominal case. This illustrates rising oil and gas prices due to depletion of domestic resources and the corresponding increase in synthetic fuels production as they begin to substitute for these primary gas and oil resources.

The average price of domestic energy, imported energy and synthetics, shown in Figure 3 includes both North Slope and Lower 48 well head prices. The curves in Figures 2 and 3 include the effects of interfuel competition among all fuels, not just gases and liquids.

The nominal case contains several important assumptions, which, if changed, can result in different estimates of synthetic fuel production than shown. One important assumption is that commercial synthetic fuels production will begin as market forces dictate. But without a stable investment environment or long-range energy policy this introduction might be significantly delayed.

Clearly, market forces will tend to favor the cheaper of imports or synthetics. However, if non-market factors force consumption of the more expensive of the two then the sum of synthetic fuels plus imports will decline, due partially to substitution of coal or nuclear and partially to lower demand due to higher prices.

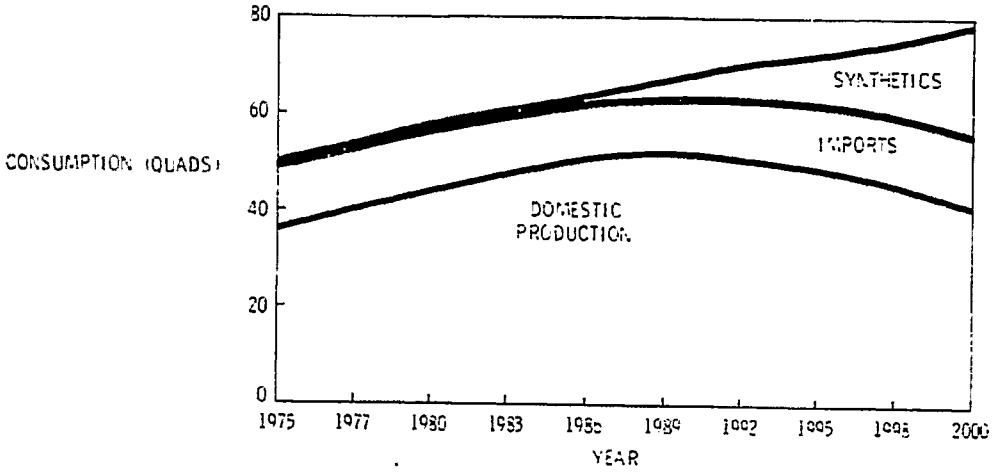

FIGURE 2. TOTAL CONSUMPTION OF LIQUIDS AND GASES

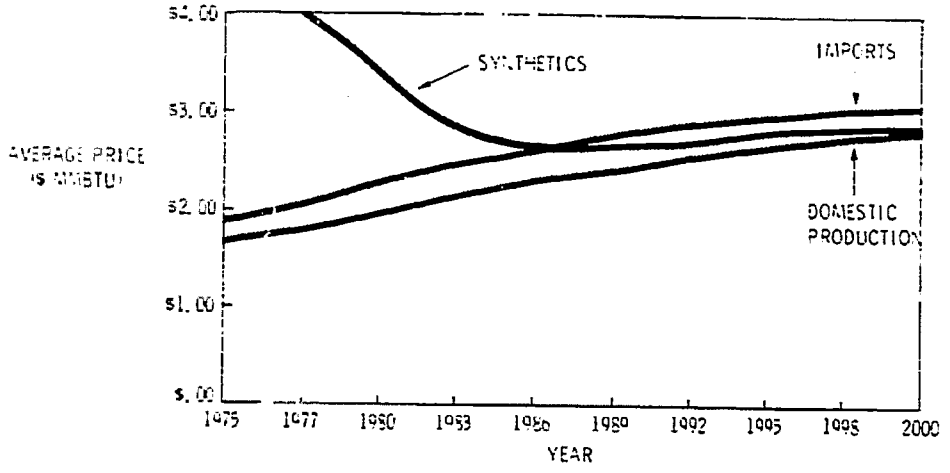

FIGURE 3. PRICES OF LIQUIDS AND GASES

For the nominal case, predictions of various types of synfuels production are displayed in Figure 4. Note that the most important contributions in the 1975-2000 time frame are projected to be from high Btu gas from coal and oil from shale. Synthetic high Btu gas production is estimated at .01 quads[3] in 1986 and 3.1 quads in 1995; shale oil production is estimated at .34 quads in 1986 and 2.5 quads in 1995. This corresponds to about 39 gas plants of 250 mmcf/day with a 90 percent stream factor (approximately equal to 40,000 bbl/day per plant of crude oil equivalent) and 26 shale oil plants of capacity 50,000 bbl/day with a 90 percent stream factor.

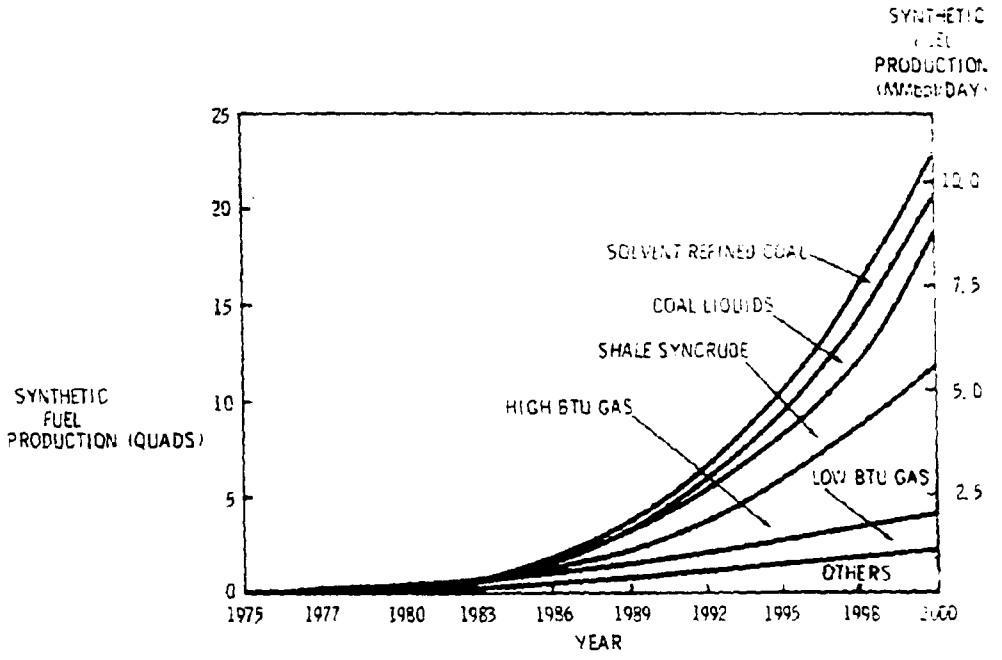

FIGURE 4. SYNTHETIC FUEL PRODUCTION - NOMINAL CASE

[3] 1 quad equals 180 million barrels of oil.

D. SENSITIVITY ANALYSIS

To examine the effects of alternative assumptions on the need for synthetic fuels and imports, the following factors were considered over a broad range of values:

- U.S. energy demand,
- supply of domestic oil and gas,
- price of imports, and
- cost of synthetic fuels.

Other sensitivities were considered in the analysis and are discussed in Volume II.

The eventual need for synthetic fuels is clear. The key issue is one of timing; determining the time when the prices of domestic oil, domestic gas, and imports will rise to the point where synthetic fuels become competitive. The operational decision with regard to the synthetic fuels commercialization program is whether synthetic fuels development should be encouraged so that production begins as soon as synthetics are competitive and/or whether development should be accelerated so that they are available earlier than would otherwise be expected. The following discussion of sensitivities (summarized in Table 4) is directed toward this timing issue.

1. Demand

To test the effects of successful energy conservation programs or continued high use of energy, a sensitivity to demand for usable energy

TABLE 4 SENSITIVITY OF SYNFUELS PRODUCTION AND IMPORT LEVELS TO VARIOUS ASSUMPTIONS

	VOLUMES (Millions b/d)					
	1985			1995		
	Total* Synthetics	Oil Imports	Imports & Synthetics	Total* Synthetics	Oil Imports	Imports & Synthetics
Nominal	0.9	4.4	5.8	5.4	5.4	10.8
Demand						
Low	0.8	3.5	4.3	4.4	3.5	7.9
High	1.2	8.6	9.8	8.3	11.1	19.4
Oil & Gas Reserves						
Low	1.3	7.3	8.6	7.5	8.2	15.7
High	1.3	2.1	3.4	2.8	1.8	4.6
Import Price						
High	1.3	2.2	3.5	8.0	1.4	9.4
Low	1.1	6.3	7.4	2.6	11.8	14.4
Synfuel Prices						
Low	3.0	4.1	7.1	8.8	2.8	11.6
High	0.4	5.4	5.8	1.9	7.5	9.4

*High & Low BTU gas, H_2, thermochemical H_2, shale syncrude, coal liquids, and SRC.

was examined. The low demand case corresponds to zero per capita growth in energy consumption; the high demand case is simply an extrapolation of the historical population and per capita energy growth. The high demand case reaches 224.9 quads by 2000 while the low case reaches 129.5 quads (shown in Table 2).

The sensitivity runs for high, nominal, and low demand indicate that imports are down 30 percent in 1995 for low demand but are up 95 percent for high demand. On the other hand, synthetic fuel production is down 18 percent in 1995 for low demand and up 54 percent for high demand.

2. Domestic Oil and Gas Supply

Synthetic fuels or imports will eventually supplement declining supplies of conventional domestic oil and gas. The time and rate of this replacement depends on the amount of domestic oil and gas available at or below the price of synthetic fuels and imports. Consequently, the sensitivity of synthetic fuels and imports to the availability of domestic oil and gas was examined. The low supply case assumed 20 percent less reserves than the nominal while the high supply case assumes 50 percent more reserves. (See Volume II for detailed assumptions.)

Table 4 illustrates that the quantities of both imports and synthetics are both expected to be quite sensitive to the availability of domestic oil and gas. In the high oil and gas availability case, synthetic fuels production is estimated to be 50 percent below nominal in 1995. Thus, the need for synthetic fuels could be markedly delayed by the increased availability of domestic oil and gas. However, if oil and gas supplies are more limited than in the nominal case, the demand for synthetic fuels is up 40 percent in 1995 over the nominal case.

3. Import Prices

The introduction of synthetic fuels will be determined by their cost relative to the cost of competing fuels. The most important competing fuel in the near-term is imported crude oil. Since the price of imported crude is set by a combination of cartel behavior, world energy demand, and to a lesser extent U.S. energy demand, the future price of imports will be uncertain. To test the effect of import prices, allow import price and a high import price scenario were examined.

The nominal case assumes all prices rise slowly from their current level of $11 to about $18 per barrel in 2000. The high case assumed that prices rise in the near future to $14 and then rise to about $21 per barrel in 2000; the low case has the import price dropping in the near-term as the cartel breaks but rising back to about current levels by 2000 due to resource depletion.

As might be expected, the future of synthetic fuels and imports is strongly affected by the price of imported crude oil. Although the production of synthetic fuels is projected to increase with high import prices, it is not entirely eliminated even assuming low import prices.

As shown in Table 4, if import prices are high, import volumes would be down 65 percent from the nominal case in 1995 and synthetic fuel production would be up 50 percent. If import prices are low through 1995, import volumes would be up 110 percent over the nominal case in 1995 but synthetic fuels production would be reduced to one-half the nominal projection.

4. Synthetic Fuels Cost

The cost to produce synthetic fuels determines their competitive position relative to imports and domestic production. Since synthetic fuels technologies remain undemonstrated on a commercial scale in the U.S., there is considerable uncertainty about their ultimate

cost. To study the sensitivity of synthetic fuels costs, high and low cost cases were examined. In the high cost case, capital and operating costs were increased by 50 percent; in the low cost case, capital and operating costs were reduced 20 percent. Table 4 illustrates the change in synthetic fuels production and imports for the two different synthetic fuels cost cases. The higher cost of synthetic fuels makes their competitive position much less favorable and delays their introduction 6 to 8 years. Specifically, synthetic fuels production is 65 percent below the nominal case in 1995 in the high cost case but 40 percent above the nominal in the low cost case. The implication is that most of the demand in the nominal case which is satisfied by synthetic fuels would be satisfied by imports if synthetic fuels turn out to be expensive to produce (as compared to the price of imports).

E. GENERAL CONCLUSIONS

The results of the analysis imply that under normal investment and risk circumstances, market forces are likely to cause the introduction of synthetic fuels in the 1985-1995 time period. With the right combination of prices and costs, production of synthetic fuels in 1995 might be as high as 9 million barrels per day although the expected average is 5 million barrels per day. If import prices fall and synthetic fuels are very costly, then it is estimated that there would be about 1 million barrels per day of synthetic fuels produced by 1995.

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