CHAPTER V COST AND BENEFITS OF ALTERNATIVE PROGRAMS

A. INTRODUCTION

The cost of a synthetic fuels commercialization program must be considered in light of the expected benefit to the Nation for such a program. A synthetic fuels program could provide additional long-term flexibility as traditional energy sources are depleted, may reduce the need for imports, and could enhance our knowledge of the technical, economic, environmental and social aspects of the conversion of coal and oil shale. It could also help develop the industry infrastructure needed to support a significant expansion of synthetic fuels by the end of this century if this becomes desirable. Further, a commitment to provide for this capability could strengthen the U.S. international bargaining position and could place the U.S. in a position of leadership with respect to the other consuming nations.

Synthetic fuels are not competitive at current prices of imported oil. Shale oil, high Btu gas, low Btu gas, and synthetic crude from coal all cost $12 or more per barrel to yield an adequate return on investment. Under these conditions, and with the uncertainty attached to the future price of world oil, industry has not been willing to make the substantial investments needed for synthetic fuel plants. Government incentives may be needed to bring these plants to the commercial phase if early introduction is desired. The cost of subsidizing synthetic fuels which could replace lower priced energy and the diversion of labor, capital, and materials from other important national projects, must be measured against the benefits.

The net benefits and costs from a synthetic fuels commercialization

program that have been quantitatively considered in this analysis are:

- Economic Benefits and Costs. Economic benefits include consumer surplus (the difference between what a commodity is worth to each consumer in the U.S. economy and what is paid for it) and producer surplus (the difference between what producers receive for the commodity and what they would have been willing to sell it for). Government intervention is justified when producers would not find it profitable to invest, but the net benefit is positive (consumer surplus exceeds producer loss).

- Embargo Protection. In addition to economic benefit under ordinary market conditions, any reduction in the economic consequences of an embargo is an added benefit.

- Environmental and Socio-Economic Costs. Besides the cost of pollution control that is included in the producers' costs, the generally noninternalized cost of environmental and other socio-economic impacts has also been included.

Some benefits may appear ignored, but have been included as economic benefits (such as demonstrating U.S. resolve to OPEC which may actually reduce import prices or the probability of embargo). Also included are such benefits as information gained from the program which would be reflected as learning cost reductions and reduced uncertainty in future costs of synthetic fuels.

There are a number of possible benefits that are difficult to assess and were not quantitatively considered in the analysis. These include:

- international leverage associated with positive U.S. leadership in developing alternative fuel sources (improved bargaining position);

- resolution of uncertainty with regard to government policy which may speed development of synthetic fuels

by the private sector;

- the value of a potential decrease in world oil prices paid by other importing nations;
- possible weakening of the cartel strength (this was assessed as negligible); and
- value of reduced balance of payments (this was assessed as negligible).

Additional international benefits which may accrue from a program include:

- potentially large inflows of foreign capital to supplement U.S. financial resources.
- strengthened cooperation with the International Energy Agency to develop synthetic fuels and to reach our long-term goal of becoming a net energy exporter.
- creation of energy development possibilities for energy-poor International Energy Agency countries as they perceive an opportunity to participate in the U.S. synthetic fuels program.

To evaluate the expected net benefit (benefit minus cost) a decision analysis model was developed (see Figure 5 for the structure of the model). This procedure permits consideration of uncertainty, future decisions, and economic benefits and costs. The model was used to assess four levels of synthetic fuel programs: no program; information (350,000 barrels/day by 1985); medium (1,000,000 b/d); and a maximum (1,700,000 b/d) program under varying conditions of imported oil prices, state of the cartel, and forecasts of synthetic fuels costs. The analysis considered several thousand possible outcomes, and while its results are not precise, it provides important insights for making decisions.

TABLE 8 COMPONENTS OF EXPECTED DISCOUNTED NET BENEFIT

	Expected Discounted Net Benefit (billions of 1975 dollars)				
Program Alternative	Consumer Surplus	Producer Surplus	Embargo Protection	Environmental and Socioeconomic	Total
No Program	0	0	0	0	0
Information Program	1.07	-2.71	0.43	-0.44	-1.65
Maximum Program	3.29	-8.74	1.18	-1.14	-5.41
Large Program	4.55	-15.77	2.23	-1.99	-10.98

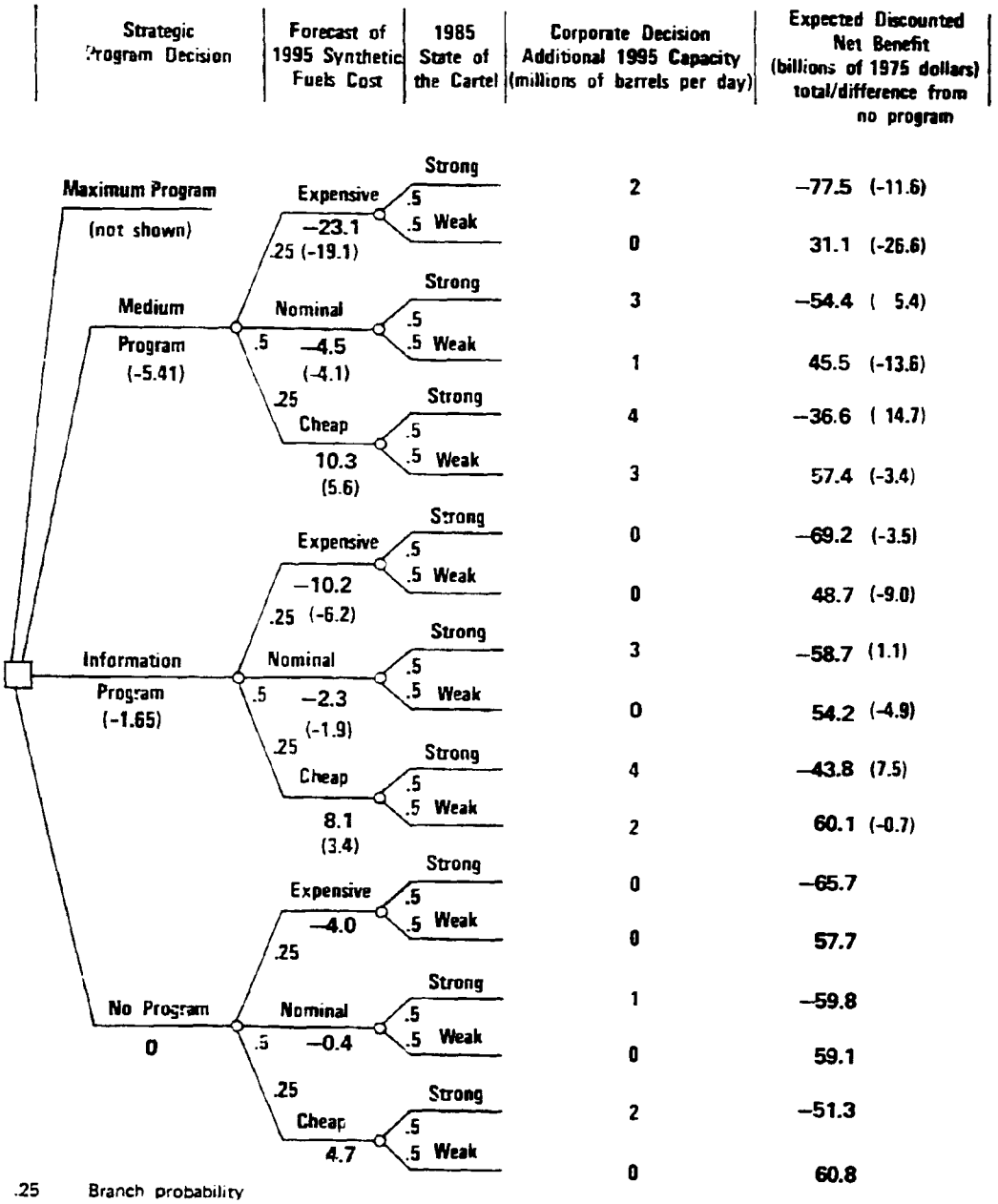
program by $0.4 billion.

A closer look at the range of results illustrates some important trends. The highest expected net benefits from the information program would occur when synthetic fuels are forecast to be cheap and the cartel is assumed strong (see Figure 6). This follows because a strong cartel has been defined to be one which can maintain high prices for world oil. Thus, cheaper synthetic fuels lead to savings in direct energy costs and create some downward pressure on world oil prices. The worst outcome for the information program occurs when synthetic fuel costs are high and the cartel is weak. The weak cartel leads to higher total benefits to the Nation assuming there are no restrictions on imports, but is a less beneficial result for the synthetic fuels program. Clearly, then, the commercialization program is most desirable in adverse macroeconomic situations.

C. SENSITIVITY ANALYSIS

The results of the cost-benefit analysis are particularly meaningful when viewed in relation to variations from the "expected" outcome. Each decision-maker has a different perception of the future state of the cartel, world oil prices, and the expected cost in 1985 of synthetic fuels. While expected results can be displayed, an understanding of the sensitivity of these results to varying world conditions is vital to making a choice about the need for and size of the most appropriate program.

For example, while the expected net benefit of the information program is $-1.6 billion, this is based upon an assumption that there is a 50 percent chance that the cartel will exist and therefore set high world oil prices through the period to 1985. If the cartel remains strong through 1985 and



.25 Branch probability

( ) Figures below branch indicate expected discounted net benefit (Difference from no program for branch shown in parenthesis)

FIGURE 6 PARTIAL DECISION TREE DISPLAY OF RESULTS

thereafter, the expected benefit is $2.7 billion for the information program and $6.5 billion for the medium program, (see Table 9). If the threat of a persistent cartel presents a strong enough risk that the U. S. is willing to bear the $1.6 billion cost of the expected case, the information program may be chosen. Since the existence of the cartel has foreign policy impacts that have not been quantified in this analysis, and since the country would be far better off if the cartel did not exist, the U.S. may be willing to accept an expected $1.6 billion loss. On the other hand, if the cartel will weaken or collapse before 1985, the synthetic fuel program will have a considerably greater negative effect, although the Nation as a whole would benefit.

The major economic factors affecting the synthetic fuel decision are the expected strength of the cartel, the cost of synthetic fuels, and the domestic energy position in 1985 with respect to imports. This is particularly well-illustrated with the information program, where a strong cartel combined with high import demand and a low synthetic fuel cost would lead to a net benefit of almost $10 billion (see Table 10). A weak cartel, low U.S. energy demand, and high priced synthetic fuels would result in a discounted cost due to the program of almost $10 billion. Similarly, for the one million barrel per day program, Table 11 shows that expected benefits could be as high as $19 billion and losses as high as $28 billion.

The strength of the producers' cartel, through its effects on foreign oil price, has a major impact on the expected benefits of a program. As indicated in Figure 7, even the 1.7 MMB/D program would have a positive value if it is assumed the cartel has a 90 percent probability of being strong in 1985 with an 80 percent persistence in 1995. The information program becomes economically beneficial if the probability of a strong cartel is about 0.75, assuming the potential benefits not quantified are taken as zero. This analysis

TABLE 9. SENSITIVITY ANALYSIS (BILLION 1975 DOLLARS)

	No Program	Information Program	Nominal Two Phase Program (Medium Program)
Base Case	0	-1.6	- 5.4
Sensitivity to Information			
1. Strong cartel throughout	-68	2.7	6.5
2. Weak cartel throughout	69	-5.6	-16.6
3. Import quota 6 MMB/D	-44	4.9	9.7
4. Storage program	11	-1.6	- 5.4
5. Environmental cost			
None	-1	-1.2	- 4.3
$1/barrel	-0.1	-2.3	- 7.1
6. Synthetic capacity expansion			
None	-0.2	-2.6	- 7.7
Minimum expansion (2 MM bbls/d)	-4	0.5	- 1.8
7. Reduction in synthetic fuel cost by $1/barrel	1	-0.5	- 2.0

TABLE 10

CONDITIONAL NET BENEFIT OF INFORMATION
(350,000 BARRELS PER DAY) PROGRAM

		Expected Discounted Net Benefit (billions of 1975 dollars)					
		-1.65					
		1985 Cartel					
		Weak			Strong		
		-4.86			1.55		
		Synthetic Fuel Cost (1985 Forecast)			Synthetic Fuel Cost (1985 Forecast)		
		Low	Medium	High	Low	Medium	High
		-0.75	-4.87	-8.92	7.52	1.09	-3.49
1995 U.S. Energy Position Supply Relative to Demand	Ample	-1.37	-5.05	-9.29	5.30	0.00	-4.90
	Moderate	-0.77	-4.89	-8.96	7.52	1.15	-3.65
	Limited	-0.08	-4.67	-8.47	9.75	2.07	-1.76

TABLE 11

CONDITIONAL NET BENEFIT OF MEDIUM LEVEL
(1 MILLION BARRELS PER DAY) PROGRAM

		Expected Discounted Net Benefit (billions of 1975 dollars)					
		-5.41					
		1985 Cartel					
		Weak			Strong		
		-14.30			3.48		
		Synthetic Fuel Cost (1985 Forecast)			Synthetic Fuel Cost (1985 Forecast)		
		Low	Medium	High	Low	Medium	High
		-3.36	-13.60	-26.63	14.68	5.46	-11.56
1995 U.S. Energy Position: Supply Relative to Demand	Ample	-4.52	-14.57	-27.50	10.98	1.43	-15.33
	Moderate	-3.48	-13.66	-26.71	14.54	5.33	-11.76
	Limited	-2.11	-12.53	-25.60	18.69	9.51	-7.41

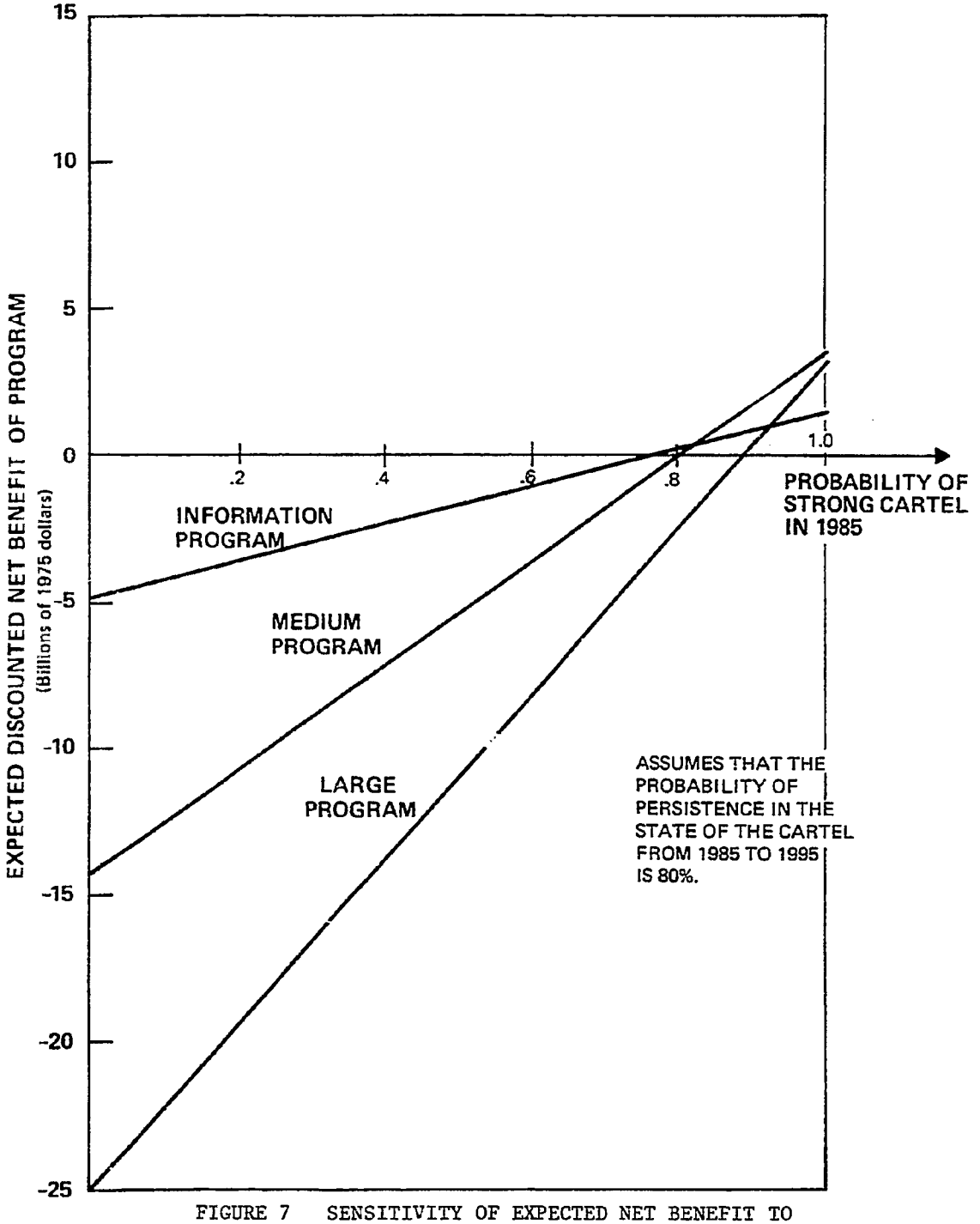


FIGURE 7 SENSITIVITY OF EXPECTED NET BENEFIT TO THE PROBABILITY OF A STRONG CARTEL IN 1985

assumes that if there is a strong cartel in 1985, the price of imported oil is equally likely to be greater or less than $15 a barrel (in 1975 dollars), with a 10 percent chance of being greater than $19 a barrel and a 10 percent chance of being less than $11 a barrel.

The future expected cost of synthetic fuels has a major impact upon the benefit of the program. Assuming low synthetic fuel costs (about $10 per barrel or $2.25 per million Btu for gas), the information program has an expected net benefit of $3.4 billion; at moderate costs ($14 per barrel), the expected loss is $1.9 billion; while at high costs ($20 per barrel), the expected loss is more than $6 billion. The learning effects of the program may be substantial. The larger the program, the more the synthetic fuel costs are expected to decline as the less expensive technologies are developed and used in second generation facilities.

The U.S. energy position with respect to supply, demand, and imports has an important, but less critical effect on the benefits of the program. Obviously, the greater the demand for high priced imports, the more favorable the program appears.

There are a number of additional factors that affect the synthetic fuels decision. If an import quota of six million barrels per day were to be imposed for the rest of the century and no major new conservation or domestic supply initiatives were taken, the effect on the overall economy would be significantly negative. The information program would have an expected benefit of $5 billion, but the Nation would lose about $45 billion as a result of the import restriction. Obviously, an import quota with unsatisfied demand would place severe strains on the U.S. economy. Under these conditions any synthetic fuels program would be better than no program.

Although the focus of this analysis was on the relative merits of various levels of synthetic fuels commercialization, the implications of

an oil storage program were also considered. It was determined that a storage program would have very little effect on the merits of a synthetic fuels program. Each program impacts the energy situation differently. Synthetic fuels would represent new productive capacity functionally equivalent to new oil or gas wells whereas storage provides a mechanism for rapidly increasing supplies should an embargo occur. A storage program of between 0.6 and 1.0 billion barrels would yield a net benefit to the Nation of about $9 billion assuming an embargo probability of 10 percent per year and an expected length of five months.

If, in 1985, corporate planners decide to forego additional synthetic fuels expansion, any synthetic fuels program will have a larger expected cost than no program. This is mainly because the economic benefits of learning (reduced cost to produce) are eliminated. Even with a minimum expansion program beyond 1985, the benefit of the synthetic fuels program increases.

Environmental Costs

There are two basic kinds of environmental costs -- the cost of pollution control that is internalized in the cost of production and the cost to society of the environmental impact of air, water, and land pollution. The costs of pollution control vary depending upon the process being considered. For example, the cost to control air pollution from a high Btu gas plant may be four times as great as for a low Btu gas plant, because the sulfur oxide emissions are greater as are water requirements.

One of the most difficult costs to measure is the cost of environmental impact. While some of these costs may be relatively straightforward (e.g., cost of painting houses more frequently), others may depend upon local values (e.g., loss of natural undisturbed areas). Unlike the costs of raw materials or pollution control equipment, these externalities are not reflected in the price of the product.

The external environmental cost of synthetic fuels is approximated by computing a cost for each major pollutant emitted. For example, the cost of oil shale may range from 12 to 56 cents per barrel, with the major costs being sulfur oxide and nitrogen oxide emissions. Also included is the accident rate for shale mining which could be as much as 10 cents per ton mined.

In this analysis, changes in the non-internalized environmental costs, which were assumed to be $.40 per barrel in the base case, have very little effect on the expected net benefit. Thus, environmental control is not a significant economic factor for the decision, although it is an important social issue.

Socioeconomic Costs

The labor requirements for synthetic fuel production will necessitate population shifts and a program would result in rapid rates of growth in those rural areas where mining and processing facilities are located. Such rapid growth would probably be accompanied by the short-run adverse costs of housing shortages, inflation, and disruption of local labor markets. However, it would also lead to benefits over time from general economic development.

In general, the adverse impacts are more serious:

- the smaller the original population base,
- the greater the rate of growth,
- the lower the rate of local unemployment,
- the lower the excess carrying capacity of local infrastructure, and
- the more geographically concentrated is the energy resource development.

Consequently, adverse impacts of synthetic fuel commercialization could be expected to be more severe in the sparsely populated and more concentrated energy areas of the Northern Great Plains, Rocky Mountains, and Four Corners regions than in the Appalachian and Eastern Interior regions.

The estimated cost of developing public infrastructure for the three production scenarios varies from about $340 million for the information program to $1.9 billion for the high program (see Table 12). The labor requirements under peak construction range from 300 man-years for low Btu gas to 2400 for high Btu gas whereas labor needs in an operational situation are 60 for low Btu gas to 1400 for shale oil. The population impact of a shale oil plant will be as high as 10,700 during operations while a high Btu gas plant will create a total population of 18,000.

The social costs of rapid growth can be substantially mitigated by planning and developing public infrastructure prior to the population influx. The major financing problems in developing infrastructure in a timely manner occur from:

- revenue lag (collection of tax revenues from new industry and resident lags expenditures by 2-5 years),
- statutory constraints (prohibitions against bonding, conservative debt limits, etc.),
- performance of tax exempt bond market (high risk, poor marketability, high cost, etc.),
- exposure to risk after bonding (project delay or failure), and
- special problems on Indian reservation (lack of access to traditional sources of funding, strong opposition).

To relieve these financing problems the Federal government could require industry to help plan for developing infrastructure, and/or provide loan guaranties to support local bond issues required for front end support of infrastructure development. For the 350,000 barrel per day program, these options have Federal costs ranging from $44 million to $340 million.

TABLE 12

TOTAL COST OF PUBLIC INTRASTRUCTURE DEVELOPMENT

	Information Program (Million $)	Two-Phase Nominal Program (Million $)	Maximum Program (Million $)
Shale Oil	$ 98	$ 295	$ 490
Syncrude	0	115	115
High Btu	198	470	810
Low Btu	47	145	280
Total without any new towns:	242	1025	1695
Additional cost of Public Infrastructure for 4, 6, or 10 new towns:	68	135	225
TOTAL	$ 411	$ 1160	$ 1920

Resource Constraints

The synthetic fuels commercialization program could place a substantial burden on the Nation's demand for coal, transportation facilities and capital goods, as well as a number of other resources.

Coal requirements for the program will vary according to the production level achieved. Under the information program, coal requirements for syncrude, high Btu gasification, and low and medium Btu gas will range from 40 to 60 million tons per year. For the 1 million bbl/d and 1.7 million bbl/d programs, coal consumption is estimated to range from 90-150 million and from 160-270 million tons per year, respectively. These requirements will generally impact beginning in the early 1980's.

In addition to these demands are increased coal consumption from converting oil and gas burning utilities to coal (could add 40-50 million tons by 1980); industrial conversion (40-60 million tons by the early 1980's); and the construction of an estimated 70,000 MWe of new coal fired capacity planned to come on line prior to 1981 (would require about 190 million tons per year of coal).

Rail transportation also faces a number of difficulties which may inhibit coal development. Coal transported by rail in 1973 totaled 591 million tons. Coal transported by rail in 1973, amounted to approximately 380 million tons with the resulting earnings constituting 10% of total rail freight revenues for 1973. By 1985, the United States may double coal production to 1.2 billion tons, with 700 to 750 million tons to be transported by rail or about double the existing capacity. Expanded railroad service is thus essential to the development of coal over the 1975-1985 period. However, the ability of the railroad industry to double coal traffic is questionable because of inadequate rail bed conditions; railroad abandonments; shortage of hopper cars; and poor utilization of rolling stock. In particular, 40,000 new hopper car deliveries may be needed each year to meet expected

1985 demand, as contrasted to 1974 deliveries of about 7200 units.

Further, the current backlog for most coal-mining equipment (as much as a four-year backlog for draglines used in surface mining) could contribute to significant delays. Immediate delivery on most mining equipment is impossible, and capital good expansion is limited in the short-term. An intensive coal development program could lead to shortages and higher equipment prices and could diminish the purchasing power of mining firms.

Expansion of the Nation's coal production will intensify the need for labor, the distribution of which will depend on the location of the synthetic fuels plants. For example, coal conversion facilities to provide utility and industrial fuels would probably be located in the East. Conversely, high Btu gas from coal plants and oil shale development are largely Western developments. Labor required to support the information program option should not represent a major impact on the mining labor pool, but expansion beyond this level may cause serious labor shortages, particularly for underground coal mine development in the East.

Uncertainty concerning industry expansion to satisfy future demands is also inhibited by surface mining regulations, oil import levels and prices, natural gas prices and availability and air quality standards. In this environment, coal prices could continue it's inflationary spiral as a result of shortages.

Conclusions

The cost-benefit analysis provides an understanding of the desirability of certain levels of synthetic fuels program. It is highly unlikely under present circumstances, that the 1.7 million bbl/d program for 1985 could be beneficial and may, in fact, be infeasible due to resource and institutional constraints. The 1 million barrel per day program also has substantial expected economic costs, although it would probably be beneficial if the cartel remains strong throughout the period. The imme-

diate choice appears to lie between the 350,000 barrel per day program and no program at all.

If no program is undertaken, the knowledge that would be gained concerning the technical, economic, environmental, social, and institutional problems in the development of each of the various processes would be delayed. More importantly, the U.S. would also lose the flexibility needed for the future as the nation's conventional energy resources continue to deplete.

The 350,000 barrel per day program represents a relatively small risk, with the possibility of large tangible plus unquantified benefits. This nation's energy policy planning has been based upon the threat of a continued strong cartel with an ability to embargo our imported oil, to raise prices at will, and to use the oil weapon to attempt to gain foreign policy advantages. If there is at least a 75 percent chance that the cartel will remain strong, the information program benefits this country even assuming the unquantified potential benefits are zero. If the cartel breaks, while the synthetics program could cost several billion dollars, the Nation would have much higher revenues and the loss from the synthetics program would be easily overcome. Other benefits such as the demonstration of our resolve to lead the way to alternative sources of energy, may enhance the posture of the oil consuming nations.

Given the small risk of the information program, its international leverage, learning benefits, and its moderate cost, this program is recommended. Further, it is recommended that increasing the size of the program be reevaluated in 3-4 years when there will be a better understanding of the persistence of the cartel, the impacts of our domestic energy policy, and additional results from the energy research and development program. At that time, a decision can be made to maintain the existing schedule or accelerate towards a 1985 goal of 1 million b/d.

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