WHEN SHOULD YOU BUILD A SYNTHETIC FUEL PLANT?

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The Timing Problem

Timing can be of paramount importance in the financial success of a venture. Conn cites the example of securing a new market with a totally new product[1]. If oil imports should be cut off or sharply reduced at the time a synthetic fuel plant came on stream, the allure of its product could exceed that of a brand new chemical.

Being number one with a synfuel plant on stream could capture easy markets, perhaps with "take or pay" contracts from eager customers, depending on demand for the product and whether it has any prospective problems in its use. In addition, being early would minimize escalation and shortages in manpower and equipment that are likely to develop. On the other hand, the first builder probably faces the greatest start-up difficulties, and being number one may mean "hurts," whereas number two may not have to try as hard. Number one in tar sands production accumulated a $90 million loss before start-up was complete[2]. However, number two was staggered by enormous escalation not encountered by number one. Nevertheless, both plants appear to be tremendous bargains today as construction costs have continued to escalate.

Thus the potential benefit to the second builder of learning from the mistakes of the first plant did not seem to apply to tar sand history. This is not uncommon for large projects because so much time is required to design and build the plant that the projects may be committed before the lessons of the earlier plant can be used. However, builder number two (or later builders) may benefit from development of communities and infrastructure in the synthetic fuel region and from development of new technology. In many cases the resources are in underdeveloped regions, and offsite investments can exceed onsites.

A corollary problem is the choice of technology. A synthetic fuels investor has the option of proceeding immediately with several commercially-proven processes applicable to particular resources. However, capital cost estimates, even those of the licensors, show that the projects are very expensive. In competition with these processes, near-commercial processes are also available. Coal-conversion processes have been demonstrated at less than commercial scale, but in some cases have operated with oil feed (rather than coal) at full commercial scale. Near-commercial processes on paper show appreciable advantages over the commercial processes. A synthetic fuels investor therefore has the additional options of delaying investment until a near-commercial process becomes commercial or, if he can arrange financing, choosing to commercialize the near-commercial process himself while accepting the increased technological and financial risks.

This paper does not analyze technology but notes that medium-Btu gas (MBG) could be produced by the commercial Koppers-Totzek (KBW or GKT) process or the near-commercial Texaco gasification process from large coal resources such as Illinois No. 6. Comparison of hypothetical cases are made by a "what if" approach designed to show the effects of several plausible assumptions on project selection and profitability.

Summary

The history of the progression of imported crude prices has been sudden large jumps separated by relatively long periods of moderate positive or negative real escalation. If a company believes that this pattern will continue and that synthetic fuel prices will behave similarly, the company should get such a plant under construction so it can be built before the inflation occurs that invariably follows the oil price jumps. Product price and capital cost are the two most important factors in the profitability. A jump in product price dramatically improves the profitability.

The second important factor in profitability, the capital cost, is subject to fairly sharp rises because of increased construction and financing costs. Costs increase after energy price increases through at least three mechanisms. Direct costs of materials, equipment and operations increase in proportion to their energy requirements. Investments in plants and equipment are stimulated to conserve fuel or provide or use alternative fuels, straining capacities and decreasing competitive pressures in the construction industry. And general inflation increases, e.g., by union demands for catch-up with the cost of living. If a plant is not already under construction at the time of an energy price jump, the chance to avoid the resulting capital cost increase is slim.

On paper, near-commercial processes show substantial advantages over proven commercial processes. Whether the advantages hold in practice depends on whether the plant can be constructed on budget and on schedule and operated as designed. Moderate cost and time overruns may eliminate the advantage of near-commercial processes, and process selection should be based on evaluation of risks. Waiting for complete demonstration of a process does not greatly reduce its profitability if two conditions apply: The plant is constructed on time and budget, and product price escalates faster than inflation. The lack of real escalation of product prices makes waiting less attractive. The happiest situation is to get a plant built before being hurt by plant capital cost escalation and in time to profit from increased product prices, using any practical technology.

Previous Studies and Experience

The startling experiences of previous synfuels projects may have left some potential investors in a state of shock, and it is worthwhile to examine the most important effects to determine whether they pose future hazards as well. The factors needing examination include:

- effects of inflation on process comparison and attractiveness
- constant-dollar escalation of cost components
- comparison of established projects with developmental or incompletely defined projects
- changing groundrules
- manpower and equipment shortages.

In this paper "inflation" means the increase of price levels in general, and "escalation" means the rate of rise of specific prices. Inflation may be expressed in terms of the GNP deflator or other appropriate index. In the current world energy situation, long-term real escalation of energy prices (the excess over the general inflation rate) is expected. Inflation affects the attractiveness of projects, but real escalation has more dramatic effects.

In previous work, the effect of inflation on process selection was studied by a public utility charged with supplying gas to its customers at minimum practical cost[3]. The study compared the economics of commercial Lurgi with five second-generation processes and concluded that inflation would more than counterbalance the estimated advantages of second generation plants if the time lag were greater than two years, whereas the estimated lag was seven to nine years. This study effectively showed the consequences of delay, but did not address the question of process selection to maximize the financial position of a company in the synfuels business, which is the main purpose of the present paper.

In another study, Louks and Gluckman argue convincingly that synfuel costs can be validly compared with each other and with petroleum product costs without consideration of inflation[4]. The most important assumption in their analysis is that the inflation rate affects interest rates and required rates of return in predictable ways:

$$(1 + x_0)\ (1 + \text{infl.}) = 1 + x \qquad (1)$$

$$(1 + i_0)\ (1 + \text{infl.}) = 1 + i \qquad (2)$$

in which x = interest rate (x_0 without inflation),
i = rate of return, DCF (i_0 without inflation), and
DCF = discounted cash flow.

By this analysis, zero inflation interest rates are estimated at 3 to 4 percent and rates of return about 4 points higher.

Their analysis derives levelized costs in the absence of inflation by discounting yearly receipts at rate i to give the present value of receipts. Also, they derive an "inflation independent price," IIP. In this case IIP is not a levelized cost, since it becomes smaller with positive real escalation, but it can be compared with current market prices of competing fuels. That is, real escalation of product prices makes a synthetic fuel plant more attractive. The Louks and Gluckman methodology does not provide for analysis of real escalation of components other than product price nor of the degree of risk of competing technologies.

Louks and Gluckman state that their "inflation independent price" is not rigorously independent but believe it is independent for practical comparisons. As shown by Griest[5], the return to a company is reduced by uniform inflation because effectively less is received from the depreciation allowance. Griest whimsically concludes, "Uncle Sam took the dollars." Perhaps more importantly, he demonstrates that ordinary DCF calculations show a falsely high rate of return unless inflation is properly handled, as is discussed further under Methodology.

It is hazardous to compare estimates of commercial processes with those still in the development stage or incompletely defined. For example, an increase of 100% in the Syncrude Canada Ltd. tar sands plant was attributed to design changes to use proven processes as construction became imminent[2]. Typically increasing conservatism is apparent when large sums are about to be spent, perhaps because of the need to convince financial institutions to loan the money. Merrow reportedly has developed a methodology to adjust cost estimates and plant capacities according to the stage of development[6]. His report is unavailable at the time of writing.

Changing groundrules have had a strong effect on plant costs in the past. For example, the requirement of wet scrubbers for pollution control can add 20% or more to the cost of a power plant. Because of the length of time the environmental movement has been around, sudden surprises are less likely in the future, and some slackening in requirements is possible because of the conflicts between energy and environmental goals.

Shortages of manpower and equipment, however, will have a dramatic effect on costs, and the companies that correctly anticipate this factor will gain significant competitive edge. Unpredictable increases in plant costs in the hyperinflationary period of 1974-1975 have been discussed, led by such factors as a sextupling of high-pressure casting prices in three years[7]. In the coming decade, building of synfuel plants seems likely to cause equipment shortages, particularly of compressors and heat exchangers. Several organizations have studied manpower requirements predicting up to 130,000 construction workers and 18,000 engineers needed for synfuel projects, peaking in 1985[8]. The building schedule of this maximum scenario is unrealistic, and construction worker demand does not appear burdensome in comparison with the total work force of over 3 million, but local shortages for specific skills will develop.

Recently the Bechtel Planning Model was applied to a synfuel scenario developed by Exxon Corporation[9]. This scenario, although controversial, shows much slower growth in the coming decade than proposed earlier by the Carter Administration. The model analysis showed generally manageable requirements. However, demand for heat exchangers in 1990 for synthetic fuel plants would be a large fraction (about 80%) of 1980 manufacturing capacity, and demand for process engineers would be a large fraction (almost half) of the total qualified personnel in major U.S. firms. Possible large military projects in the Rocky Mountain region in the same period could exacerbate shortages.

Methodology

For maximum flexibility, this paper uses a case study methodology. Cases are evaluated by the discounted cash flow (DCF) method with both inflation and escalation allowed for. The discount rate i may be used to compare alternatives in the same time frame, but it varies with the assumed inflation rate and is not suitable for other purposes. Therefore, the constant dollar discount rate is calculated by Equation 2.

Cooper and Davidson's parameter method is applied to derive additional information from DCF calculations by statistical analysis[10].

Base case conceptual designs were prepared for Koppers-Totzek and Texaco gasification of Illinois No. 6 coal to MBG according to the current state of the art. The costs to construct these plants in the five-year period from 1982 to 1986 were estimated (24.3¢ and 20.9¢ per Btu/hr, respectively, current dollars excluding interest). Many assumptions are required in a financial analysis, and all are likely to be arguable. The assumptions used in the base cases are listed in Table 1. Other cases were derived by variations of the assumptions, as described in the next section.

Table 1

Base Case Assumptions

Item	Assumptions
Financing	40% debt, 60% equity
Interest rate	11%
Depreciation	Double declining balance and straight lir
Investment tax credit	20%
Income tax total	50%
Escalation	10% for construction costs 8.5% for MBG (competes with No. 2 oil) 8.5% for labor and materials 6.0% for by-products, coal, general and administrative costs, and property tax and insurance
1987 values	$7.05/million Btu MBG By-products 13.5% of MBG Coal $1.40/million Btu Labor and materials $1.65/million Btu of MGB Property tax and insurance 1.2% General and administrative 0.5%
Capacity factor	330 days/yr

Table 2

DCF Rates of Return for Case Studies

Case	Texaco Current $	Texaco Const. $	K-T Current $	K-T Const. $
1. Build 1982-86, costs as estimated	22%	15%	18%	11%
2. Build and invest 1988-92, costs as escalated	21	14		
3. Loan money at interest now, build in 1988-92, costs as escalated	18	11		
4. Build and invest 1988-92, no real escalation of MBG		~8		
5. Build and invest 1982-86, no real escalation of MBG				~9
6. Build 1982-86, costs 17% above estimate	20	13		
7. Build 1988-92, costs 17% above estimate	18	11		
8. Build 1982-87 (one year overrun), cost 17% above estimate	18	11		
9. Build 1982-86, costs as estimated, price doubles in 1987			32	25

Results

Table 2 shows the results of case studies. Both current dollar and constant dollar rates of return are listed because both have been used in other studies. However, as noted earlier, the current dollar rate of return is not meaningful except for comparing alternatives at the same inflation rate, because it makes use of variable dollars.

The Case 1 base cases show an advantage to the Texaco technology, as expected, primarily because of the lower capital cost. Because the Texaco process has not been applied at as large a scale as K-T, Case 2 considers the effect of a six-year delay in the use of Texaco. The rate of return is only slightly reduced because the escalation in real terms of the MBG compensates for the escalation of plant costs. However, a company choosing this option would face the problem of what to do with its money in the interim. Case 3 shows the result of loaning the construction funds at interest until required for building a Texaco plant after a six-year delay. This option is no more attractive than building a K-T plant immediately.

MBG product price escalation increases the attractiveness. Cases 4 and 5 show that a lack of real (constant dollar) MBG escalation detracts more from the delayed Texaco than from the K-T because MBG value increases 15% in real terms during the six-year delay at 8.5% total escalation.

The next three cases show the effects of deviations from the estimates for Texaco plants. Case 6 shows the result of a 17% overrun in the same construction period. Such an overrun makes the capital equal to the capital for K-T, but Texaco remains favored because of higher process efficiency. Case 7 shows the result of a similar overrun for construction in 1988 to 1982. The result is now the same as for K-T (Case 1) because the delay balances the efficiency advantage. Case 8 assumes a one year overrun in time besides a 17% overrun in capital to get a Texaco plant operating at design in 1987. A time delay is likely to accompany a cost overrun. Case 8 also matches the attractiveness of Case 1. Any increase above 17% cost overrun or one-year time delay of Case 8 would make Texaco less attractive than K-T.

One theory circulating these days holds that synthetic fuel plants will never be profitable because the capital requirements escalates as fast as imported crude oil. Also, there are two factions on the analysis of profitability. One faction says that synthetic fuel plants built a few years ago would be profitable today, while the other faction says DCF analysis negates this profitability by its emphasis on returns in early years. Without confirming validity of the premises, case 9 addresses the possible implications. The price of MBG is assumed to double along with the price of imported crude in 1987. This change does wonders for the profitability, i.e., more than doubles it. The price jump comes just after the construction period and does not escalate the construction cost, but it greatly increases the subsequent income.

Most analyses, especially computer studies, assume that imported crude prices escalate uniformly in real terms. The history of the last decade does not bear out this assumption. We have had a quadrupling in one short period and more than doubling in another, separated by periods of moderate positive or negative real escalation. Some people are saying prices could not double again. We believe they could.

As to the premise that synthetic fuel plant costs increase in proportion to imported oil cost, the ultimate logical conclusion is not valid because it would require an infinite plant cost if all importing of oil were stopped (equivalent to infinite price). Three factors related to the price of imported oil do appear to increase in proportion to their energy requirements. The stimulation of equipment purchasing and plant building to conserve energy, use alternative fuels, or produce synthetic fuels strains construction capacity and reduces competition in the construction industries. Finally, general inflation increases, for example, because unions attempt to catch up with the cost of living. Some of these effects come after a time delay. Therefore it is worthwhile to examine the history of synthetic fuel plant costs.

Parker recently showed a sharp upward trend in SNG plant cost estimates through 1980 even after adjustment by the Chemical Engineering Index (11). The estimates are from various sources, and much of the apparent trend may be an artifact of the preliminary nature of estimates before 1975. Estimates usually increase as they become more definitive. The data for budget and definitive estimates after the hyperinflation of 1974-75 (following the oil shock of 1973-74) show only a slight uptrend, which may be related to the deflator of labor costs in the Chemical Engineering Index based on assumed increases in productivity. The Great Plains Plant may be an exception, showing a sharp increase (one third) in 1980. This may have resulted from the court battles and consequent delays for this plant. Sasol Two, which was completed on time, was within the estimate prepared in 1975.

Clearly, coming events may cause substantial increases in plant costs, even without great increases in indexes. Indexes are based on list prices, which do not increase as fast as contract prices when industries are close to capacity. Delays from shortag of equipment and personnel will also increase costs. Although plant costs for established synfuel processes may be expected to track general inflation when the industry is at a steady state, periods of fairly sharp escalation are to be expected at times as synfuel industries become established in the next decade. As in the case of imported crude prices, these periods will be difficult to predict. Because the total capital cost is crucial to profitability, it is important to have plant construction at least well advanced before a large oil price jump occurs.

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