CHAPTER 1

INTRODUCTION AND SUMMARY

The purpose of this report is to provide some background information for determining a role for methanol in a U.S. synfuel strategy. To that end and as instructed by the National Alcohol Fuels Commission, ICF compared methanol from coal with other, selected coal-based synthetic liquids as fuels for automobiles and electric utilities. In addition, methanol from coal is considered as a substitute for the methanol from natural gas now used by the petrochemical industry.

In the first section of this chapter, the plantgate product cost estimates used throughout the report are presented and explained. Each of the next three sections consider one of the energy uses studied herein: automobile fuels; fuels for electric utilities; and petrochemical feedstocks. A final section in this chapter outlines the remainder of the report.

PRODUCT COST ESTIMATES

This report compares costs of synthetic fuels over the entire fuel cycle, but the first step was to estimate the cost of producing the selected synthetic fuels. Several estimates of product costs were developed for five liquid fuels derived from coal: methanol; gasoline from methanol with the Mobil-M process; and the gasoline, distillate, or residual oil made with direct liquefaction technologies. Except for the methanol estimate marked Koppers-Totzek, all of the estimates involve second-generation technologies. That is, technologies which have not yet been demonstrated on a commercial scale.

Table 1-1 displays the product cost estimates in terms of 1980 dollars per million Btu (MMBtu). The range of estimates in 1990 are as follows:

- Methanol - about $6 to $9 per MMBtu. Excluding the only first-generation technology, Koppers-Totzek, the range is about $6 to $7 per MMBtu.

- Direct Liquefaction Gasoline - the range is about $8 to $9 per MMBtu.

- Mobil-M Gasoline - the single relevant estimate is about $9 per MMBtu.

- Direct Liquefaction Distillate or Residual Oil - $6 to $7 per MMBtu.

Notice that two numbers are listed for all the direct liquefaction technologies. The top number is the total product cost estimate while the bracketed number is the refining cost embodied in the total.

TABLE 1-1

PRODUCT COST ESTIMATES a/
(in $1980 per Million Btu)

Technology/Estimate	Year Construction Completed			
	1990	1995	2000	2010
Methanol				
Koppers-Totzek	8.94	9.62	10.36	12.06
Badger	7.02	7.52	8.09	9.33
Texaco	7.10	7.62	8.19	9.50
BGC/LURGI	6.16	6.61	7.10	8.20
Direct Liquefaction-Gasoline b/				
SRC-II	9.15 (2.23)	10.17 (2.74)	11.12 (3.11)	13.09 (3.78)
EDS	8.58 (1.72)	9.43 (2.09)	10.26 (2.37)	11.97 (2.85)
H-COAL	7.71 (1.36)	8.41 (1.58)	9.16 (1.82)	10.69 (2.17)
Mobil M				
Badger	9.15	9.81	10.54	12.19
Direct Liquefaction-Distillate, Resid b/				
SRC-II-RESID	7.04 (1.72)	7.83 (2.11)	8.56 (2.40)	10.08 (2.91)
EDS-RESID	6.60 (1.32)	7.26 (1.61)	7.90 (1.82)	9.22 (2.19)
H-COAL-RESID	5.94 (1.05)	6.47 (1.22)	7.05 (1.40)	8.23 (1.67)
-DISTILLATE	6.32 (1.12)	6.89 (1.30)	7.51 (1.50)	8.77 (1.78)

a/ The report displays other cost estimates in Chapter 4. Shown here are the estimates used for all cost comparisons in Parts 3, 4, and 5. Some of the key assumptions, as detailed in chapter 2, are a 15 percent capital charge rate, no construction delays, and a 90 percent utilization rate.

b/ Numbers in brackets are the estimated refinery cost already embodied in the total product cost.

Since the prime motive for pursuing synfuels is to reduce crude oil imports, it is also useful to display these product cost estimates in terms of crude oil equivalents. Table 1-2 presents such estimates. It's very important to understand the notion of crude oil equivalent used here. The figures shown here are the costs per barrel of average crude oil that, by ICF estimates, would yield gasoline, distillate, or residual oil at the product costs shown in the previous table. For example, in Table 1-1 methanol with the Koppers-Totzek estimate has a product cost estimate of $8.94 per MMBtu in 1990. In Table 1-2, a crude oil cost of $40.52 is shown because crude oil at this price would have yielded gasoline at a price of $8.94 per MMBtu.

The range of estimates in 1990 is as follows:

- For methanol, the range is about $27 to $41 per barrel. Excluding the Koppers-Totzek estimate, the range is $27 to $32 per barrel.

- For direct liquefaction gasoline the range is $35 to $42 per barrel.

- For Mobil-M gasoline the single comparable estimate is $42 per barrel.

- For direct liquefaction distillate or residual oil, the range is again $35 to $42.

It is also essential to remember these are crude equivalents at the plantgate. That is, they do not take into account costs of delivering and using these synthetic fuels. Costs at these later stages of the fuel cycle are substantial and they can affect significantly the cost comparisons among these fuels. As will be seen, methanol's delivery charges can be double those of gasoline while its costs of use can be much lower than gasoline because of its superior fuel efficiency.

Finally, there is a fundamental difference between the indirect and direct liquefaction technologies that should be stated here because it causes considerable uncertainty when estimating product costs for direct liquefaction and because it could become a key criterion for choosing between these two broad classes of synthetic fuels. The difference is that the indirect processes yield a single principal product while the direct liquefaction processes, which are assumed to include refining, yield an array of products.

Uncertainty arises for product cost estimation when several products are produced because one cannot easily allocate total annual costs among them. In other words, there are common and joint costs; one piece of equipment can be used in the production of all the products (common costs) and in some cases, one piece of equipment produces the products simulatenously (joint costs). For this report, total annual costs have been allocated among the direct liquefaction products by assuming a fixed relationship among four product prices. In other words, with the direct liquefaction processes the total, annual cost is assumed to be recovered by selling four petroleum products at

TABLE 1-2

CRUDE OIL EQUIVALENT COSTS[a/]
(In $1980 Per Barrel)

Technology/Estimate	Year Construction Completed			
	1990	1995	2000	2010
Methanol				
Koppers-Totzek	40.52	43.79	47.35	55.52
Badger	31.29	33.69	36.43	42.39
Texaco	31.67	34.17	36.91	43.21
BGC/LURGI	27.15	29.32	31.67	36.96
Direct Liquefaction-Gasoline				
SRC-II	41.53	46.43	51.00	60.47
EDS	38.79	42.88	46.87	55.09
H-Coal	34.61	37.97	41.58	48.93
Mobil-M				
Badger	41.53	44.70	48.21	56.14
DIRECT LIQUEFACTION-				
SRC II - RESID	41.27	46.09	50.54	59.80
EDS - RESID	38.59	42.61	46.51	54.56
H-COAL - RESID	34.56	37.79	41.33	48.52
DISTILLATE	34.54	37.87	41.50	48.87

a/ These are estimates of the crude oil costs that would yield the product costs shown in Table 1-1.

prices which have a fixed relationship. Since this same problem of cost allocation occurs with the production of conventional petroleum products, the assumed price relationship represents ICF's estimate of the way crude oil and associated refining costs would be allocated across conventional gasoline, distillate, and residual oil.1/ While ICF's approach is judged to be best suited for this report, there are other allocation schemes which would alter significantly the product cost estimates.

With respect to a choice between the two classes of technologies, it seems that a decision on methanol's role in the nation's synfuel strategy is indeed closely tied to a decision on the desired split between indirect and direct liquefaction technologies. That broad decision depends, in turn, on the intended role for synthetic fuels in the U.S. energy future. For example, if liquid synfuels are intended solely as a transportation fuel, it must be noted that the entire output from a methanol or a Mobil-M plant could, if demand warrants, be used for automobiles. In contrast, only a portion of the product yield from the direct processes is gasoline; Table 1-3 displays the assumed yields of the three direct liquefaction technologies studies herein.

TABLE 1-3

PRODUCT YIELDS FOR
DIRECT LIQUEFACTION TECHNOLOGIES
WITH REFINING
(barrels per stream day)

	SRC-II	EDS	H-Coal
Gasoline	8,963	18,511	15,070
Distillate	-	-	19,436
Resid	41,024	27,001	10,689
LPG	4,500	6,690	6,506

Product mix is, of course, a matter of a choice. The distillate and residual oil could, for example, be more severely refined and thereby, made suitable for gasoline blends; product costs would increase, however, with the considerably increased refining expense. But the central point remains. The indirect liquefaction technologies studied here yield a single primary product intended as a transportation fuel while the direct liquefaction processes yield a full product slate. If a full range of synthetic liquids is sought, perhaps it is appropriate to view the indirect and direct technologies as complementary rather than competitive. Products from the indirect, with some help from the direct, would serve as transportation fuels while the direct would serve primarily other important energy users.

1/ The assumed price relationship is as follows: Distillate's price is 82 percent of the estimated gasoline price while the price for residual oil (and liquid petroleum gases) is 77 percent of the gasoline price.

SYNTHETIC FUELS FOR AUTOMOBILES

Methanol is most often proposed as a fuel for automobiles. This report first compares methanol and the synthetic gasolines in terms of technical and environmental performance and then a comparison is made in terms of the costs of owning and operating a methanol-powered and a synthetic gasoline-powered car. Finally, a rough projection is presented for fuel consumption by automobile fleets; fleets are considered the most likely users of methanol in the early stages of its development.

Technical and Environmental Performance

The relationship between fuel and engine design is critical. Today's spark-ignition engines have been designed to maximize performance for gasoline blends with respect to fuel economy, environmental impact, vehicle operation costs and other factors. Since methanol has distinctly different physical and chemical characteristics when compared to conventional gasoline, certain modifications must be made by automobile manufacturers to current engine designs and fuel delivery systems.

Although all the problems facing the automobile manufacturer are solveable with currently available technologies, it is worth noting the two biggest--cold starts and lubricity difficulties.

- Cold Starts - Methanol engines are difficult to start in cold climates. Fuel modification, fuel heating and/or a dual fuel system are available techniques for overcoming this cold start problem.

- Lubricity - Today's lubrication oils have been developed primarily for hydrocarbon fuels and do not work as well with methanol. The development of new compatible oils and/or the use of corrosion inhibitors to reduce engine wear may be needed for methanol.

A methanol fueled spark-ignition engine can be designed which is superior to a gasoline fueled engine in terms of fuel economy and environmental performance.

With respect to energy efficiency, there is evidence that a methanol engine can be designed to get 15 to 25 percent more miles per Btu than a gasoline engine depending on the extent of engine modification. Equivalent increases in specific power are produced by the methanol engine as well.

In terms of environmental performance, methanol exhaust is generally cleaner than gasoline's.

- Nitrogen oxide emissions are reported to be lower (8% to 50% reductions are commonly reported by investigators).

- Carbon monixide emissions are as low, if not lower.
- No lead, sulfur and soot containing emissions are produced.
- A slight reduction in total hydrocarbons (by mass) can be achieved via methanol use.
- Aldehydes emissions, primarily formaldehyde with methanol, increase, but can apparently be held down to acceptable levels with engine modification and/or an oxidation catalyst.
- Subsequent ozone formation from methanol exhaust is less than gasoline's. This suggests that methanol fueled cars could have a beneficial impact on urban atmospheres.

Cost Comparisons

Costs over the entire fuel cycle are compared for three alternative automobile fuels: methanol; gasoline from the direct liquefaction processes; and Mobil-M gasoline. These cost comparisons could be shown to vary for several reasons. The two most important variations explored here concern the extent or scale of methanol use and the methods of pricing retail service and setting excise taxes.

Also seen within this report is the variation in cost due to type of use. As requested by the National Alcohol Fuels Commission, the two classes of users studied here are termed fleet and non-fleet. For these auto cost comparisons, note that both classes of cars are assumed to meet and maintain the 1985 average fuel economy standard for new cars--27.5 miles per gallon, according to the EPA estimate, which is the equivalent of about 22.5 miles per gallon on-the-road. The annual mileage of these two classes, however, is assumed to be quite different--23,000 miles per year for fleet cars and 12,000 miles for non-fleet cars. Fleet cars also differ here because they are assumed to avoid retail costs and excise taxes.

When examining methanol, the most important cost variation is caused by the extent or scale of methanol use. With limited use, several cost "penalties" may be associated with methanol. In this analyses, the cost penalties are assumed to be as follows:

- The cost of modifying a car for methanol use is $350. With large scale consumption, methanol-powered cars could be mass produced and the difference between constructing a methanol and a gasoline-powered car is assumed to be negligible.1/ (That cost of modification is assumed to be depreciated over three years with a straight-line method).

1/ Estimates based on information from the staff and Commissioners of the National Alcohol Fuels Commission.

- As explained before, methanol-powered cars are likely to be more fuel efficient than gasoline-powered cars. With small scale methanol use, that improvement is assumed to be 15 percent. When methanol-powered cars are mass produced, however, they can be optimized for this fuel and even greater improvements may be realized; the large scale case assumes a 25 percent advantage in fuel efficiency. (In both cases, the fuel efficiency improvement is measured in terms of miles per million Btu, not miles per gallon, and then put in terms of million Btu per mile for use in the cost comparison tables).

- In the small scale case, all fuels are assumed to be shipped by rail. With larger scale use, all the synfuels are assumed to take advantage of the lower rates of pipeline transport. Because of methanol's lower Btu content, about half that of gasoline, the change to pipeline transport lowers its cost more than the cost of the other synthetic fuels.

In the initial cost comparisons shown herein it was assumed that the charges for retailing and excise taxes are the same per gallon of methanol and synthetic gasoline. Since methanol has fewer Btu's per gallon than gasoline, these charges are higher per Btu of methanol.

To illustrate the uncertainty surrounding this topic, consider the difference between a gasoline and a methanol service station. Assume the stations would serve the same customers; that is, they would supply the fuel for the same number of miles of travel. Obviously, the methanol station would sell a greater number of gallons; with 25 percent superior fuel efficiency for methanol and 50 percent fewer Btu per gallon, sales in terms of gallons of methanol would be 60 percent higher.

The central question here is whether the service station's cost would rise commensurately. If the station's cost increase by 60 percent it is appropriate to set retailing cost equal per gallon. That is, it would be assumed new land, fuel tanks, and attendants would be added to handle the increased volume. For the cost comparisons this is termed high retail.

In contrast, one might assume the increased volume would be handled without added expense. Since the service station could spread its fixed costs over a greater number of gallons, the cost per gallon of methanol would be lower than for gasoline. For the cost comparisons, this is termed low retail.

Table 1-4 summarizes the many cost comparisons by showing the estimated differences in annual cost of a methanol-powered and a synthetic gasoline-powered car. For each situation, twelve comparisons are made in total because three estimates of production costs were used for methanol and four were used for synthetic gasoline (only the Koppers-Totzek estimates was excluded because it is a proven or first-generation system while all the others are second-generation.) It is the use of so many production costs estimates that cause the range shown in the Table. Notice these comparisons cover costs over the entire fuel cycle. That is, they include the cost of producing, delivering, and using these alternative auto fuels. (Bracketed numbers indicate a cost disadvantage for methanol.) For perspective on the significance of these differences, remember that the total annual cost of owning and operating a car will be several thousand dollars.

TABLE 1-4

METHANOL AND SYNTHETIC GASOLINE POWERED CARS:
RANGE OF DIFFERENCES IN
ANNUAL OPERATION COST
(dollar differences in annual cost per car) a/

	1990		2000	
	Fleet	Non-Fleet	Fleet	Non-Fleet
Small Scale, High Retail	(22) to 269	(200) to (47)	42 to 417	NA b/
Large Scale, High Retail	197 to 479	(4) to 143	271 to 635	NA b/
Small Scale, Low Retail	NA b/	(68) to 84	NA b/	(35) to 161
Large Scale, Low Retail	NA b/	102 to 249	NA b/	140 to 331

a/ Estimates represent the difference in cost of using a methanol and a synthetic gasoline automobile. Bracketed numbers indicate a cost disadvantage for methanol.

b/ NA means these comparisons were not made.

The comparisons can be summarized as follows:

- With the small scale situation for fleet cars in 1990, methanol has a cost advantage in ten of the twelve cases and the advantage is up to $269 per car per year; in the other two cases the disadvantage is up to $22. By 2000, methanol has an advantage in all twelve cases which ranges from $42 to $417.

- With the large scale situation for fleet cars in 1990, methanol has a cost advantage in all twelve cases which ranges from $197 to $479 per car per year. By 2000 the range of advantage increases; the range is $271 to $635 per car per year.

- For non-fleet cars in 1990 assuming small scale distribution and high retail costs, methanol is at a cost disadvantage in all twelve cases ranging from $47 to $200.

- For non-fleet cars in 1990 assuming large scale distribution and high retail costs, methanol has a cost advantage in ten of twelve cases which can be as high as $143. In the other two cases, the disadvantage is negligible.

- Using what has been termed low retail costs for 1990, the cost comparisons for non-fleet uses change in favor of methanol. In the small scale cases, methanol now has a cost advantage in seven of the comparisons; the advantage can be up to $84. In the large scale cases, methanol has a cost advantage in all twelve cases and the range is $102 to $249 per car per year. By 2000, that range of advantage in large scale increases; it is $140 to $331.

Automotive Fleets and Fuel Use

It is likely that methanol will first be used as a fuel by automotive fleets. As illustrated above methanol use can be cheaper for this class of operators because they can avoid the cost of retail distribution and excise taxes. But more important is the possibility that some fleets will not be concerned with methanol's limited availability. That is, some fleet cars will be used in a narrow geographic area and can return for refueling to the fleet's central methanol storage area. Methanol use would not be precluded, as it might be for nonfleet or "family" cars, by the fact that it cannot be found in a number of service stations in most cities.

However, even for fleets which find an operating cost savings with methanol and, in addition, are not bothered by limited availability, there is at least one more disincentive for methanol use in the early stages of its development. The disincentive concerns the fact that many fleets consider resale value to be a primary criterion for an auto purchase and further, fleet cars are most often resold to used car dealers who in turn sell to the general public. If methanol is not available widely and non-fleet use is thereby precluded, resale value will fall to zero for many fleets when methanol-powered cars are used. This would raise considerably the cost estimates for methanol since the results presented in Table 1-4 assume the resale values are the same for methanol and gasoline powered cars. Inability to resell is an obvious and a very important disincentive to methanol use in automotive fleets.

Despite this important disincentive, automotive fleets are still the most likely first-round market for methanol. They are also a likely target for many other new auto fuels or technologies. For example, the federal government already has programs encouraging, through subsidies, the use of methane in cars as well as the introduction of electric vehicles and may mandate the use of gasohol in federal fleets.

Table 1-5 displays a projection of total fuel use by automotive fleets in terms of methanol consumption. A distinction is made in the table between two sizes of fleets--those with ten or more cars and those with 4 to 9 cars. The larger fleets are better targets for methanol use in the early stages of its development, but only a fraction of these might be suitable. For example, in 1979, 25 percent of the cars were in "lease" fleets; that is, the cars were purchased in mass, but then leased to individuals for unspecified uses. Another 45 percent of the cars were in business fleets and these may be likely candidates, but only limited information is available on their driving practices such as ability to refuel at a central location. The fleets for which methanol use clearly seems appropriate are those owned by state and local governments, utilities, and taxi operations. Even in these cases, which accounted for 20 percent of fleet cars in 1979, there would be exceptions.

TABLE 1-5

TOTAL FUEL USE BY FLEET CARS
IN TERMS OF METHANOL CONSUMPTION[a/]
(trillion Btu of methanol)

Year	Fleets of 10 or More	Fleets of 4 to 9	Total
1985	1,048	462	1,510
1990	1,161	428	1,589
2000	1,443	428	1,871

a/ To translate to barrels of methanol remember there are 2.65 MMBtu per barrel. In contrast, there are 5.3 MMBtu per barrel of gasoline.

Source: ICF Incorporated

ELECTRIC UTILITIES

With respect to technical performance, only limited testing has been done with methanol by utilities. These tests, however, have shown that, with minor equipment modifications, methanol can perform on a par with oil and natural gas in combustion efficiency and power production capabilities. There can, however, be some problems which can be traced to the same physical and chemical properties as were the problems encountered with cars; corrosion of certain metals and the need to double the fuel flow rate are good examples.

As with automobiles, methanol's environmental performance in utility technologies can be superior to that of conventional fuels. Sulfur dioxide, particulates, and nitrogen oxides are the prime environmental concerns with utilities. As noted before, methanol combustion would not produce any sulfur dioxide or particulate emissions and NO_x emissions could be very low.

It is assumed for the purposes of the cost comparisons in this report that methanol as well as the residual and distillate oil from direct liquefaction can be used without significant equipment modifications in both new and existing gas turbines, combined cycle facilities, and in conventional oil and gas-fired boilers. With this assumption a cost comparison among competing fuels is reduced to a simple comparison of delivered fuel prices; that is, equipment operation and maintenance costs will not vary by fuel type.

Table 1-6 summarizes the cost comparisons. The only distinction between the large and small scale cases is the means of transport; for small scale all fuels travel by rail, but in the large scale cases methanol and distillate use pipelines. The range of estimates is caused by using the range of plantgate costs shown earlier. (Again, the Koppers-Totzek estimate is excluded because it is the only first-generation technology.)

- For the small scale cases in 1990, methanol is at a fuel cost disadvantage in eleven of the twelve comparisons; that disadvantage could be up to $1.99 per MMBtu. By 2000 there is little change, methanol has an advantage in only one case.
- For the large scale cases in 1990, methanol has an advantage in only two of the cases. The disadvantage is up to $1.57 per MMBtu. By 2000, the situation does not change significantly, methanol still has an advantage in these two cases.

TABLE 1-6

METHANOL AND SYNTHETIC DISTILLATE AND RESIDUAL OIL: Differences in Delivered Fuel Cost a/
(differences in $ 1980 per MMBtu)

	1990	2000
Small Scale	(1.99) to .05	(1.97) to .63
Large Scale	(1.57) to .47	(1.55) to 1.05

a/ Estimates represent the difference in delivered fuel prices between methanol and synthetic distillate and residual oil. Bracketed numbers mean methanol is at a cost disadvantage.

In these comparisons then, the direct liquefaction technologies seem to have a cost advantage. The advantage could be lessened or eliminated, however, if the distillate or resid require further upgrading. Further tests are required to resolve this issue.

In the post-1990 period, the use of any liquid fuel in any significant quantities will probably be limited to daily and seasonal peak-load service in electric utilities. Liquid Fuel use will be limited to peak service because direct coal use seems to be the cheapest means of generating electricity in intermediate and base-load. For 1990, 2000, and 2010, demand for liquid fuels in daily peak-load service could amount to .34, .49, and .71 quadrillion Btu. Liquids may also be a low cost fuel for existing oil-fired units which serve seasonal peaks; that market could amount to about 1 quad or more in each of these years. Table 1-7 displays projected demand for liquid or gaseous fuels in daily and seasonal peak service.

TABLE 1-7

PROJECTIONS OF UTILITY DEMAND FOR
LIQUID FUELS IN PEAK-LOAD SERVICE
(in quadrillion Btu)

Year	Daily Peak	Seasonal Peak	Total
1990	.341	.894	1.236
1995	.406	.964	1.370
2000	.490	1.039	1.529
2010	.710	1.206	1.916

Some oil and gas is now used in both intermediate and base load service. That market should decline over time, however, as these units are retired, dropped to lower capacity factors, and replaced by coal or other fuels in 2000 and after. It is doubtful that methanol plants would be built to serve such a temporary market because direct coal use is the cheapest alternative.

Unlike most fuels, methanol use could actually be encouraged by very strict environmental rules because it emits lesser amounts of key utility pollutants. As example of such rules, consider the following:

- Acid Rain Control: Methanol's zero emissions of SO_2 and low emission of NO_x may make it the preferred utility fuel for control of acid rain if very strict regulations are adopted by EPA and Congress. This is particularly true in the Northeast and Middle Atlantic areas.

- New Facilities in "Non-Attainment" Areas: Utilities that want to expand facilities in an area which has not attained the national standards for SO_2, TSP, or NO_x may turn to methanol to avoid the need for costly "offsets" (i.e. emissions reductions in existing facilities).

- Tighter New Source Performance Standards: If the EPA were to declare tighter emission standards for SO_2 or NO_x, methanol could become the prime fossil-fuel for new powerplants. This potentially represents the largest utility market for methanol, and could conceivably replace coal if the standards were set low enough. There is little likelihood in the short-run of such a change in regulations especially since coal fuel systems can be made clean with flue gas desulfurization.

PETROCHEMICALS

Methanol, now produced from natural gas rather than coal, is an important chemical. With the impetus of rising natural gas prices and uncertain supply, the petrochemical industry is in search of a new raw material for methanol production. Although far from definitive, the cost comparisons presented here indicate coal-based methanol can be produced at a lower cost than that made from natural gas.

The key assumption for that comparison is that natural gas prices are deregulated in 1985 and, at that time, begin to track the oil prices assumed here. Since natural gas price is so key, Table 1-8 displays what can be termed breakeven natural gas prices. That is, the gas price at which coal-based methanol starts to be cheaper. As can be seen, the breakeven gas prices are far below the projected gas prices in each of the two years. Gas prices would have to be 30 to 40 percent lower than projected in 1990 in order to find gas-based methanol to be cheaper; by 2000 the gas prices would have to be 50 to 60 percent lower than projected.

The market for methanol as a chemical, rather than as a fuel for automobiles or utilities, might grow in the years 1990, 2000, and 2010 to .121, .208, .366 quadrillion Btu respectively.

The petrochemical market for methanol could be considerably larger than noted above if and when that industry decides to look for new and less expensive ways to manufacture the principal petrochemical building blocks. Some of the new ways to do this involve methanol. If the methanol-using routes prove cheaper and more reliable, methanol could become one of the foremost chemical intermediates and the demand for coal-based methanol could grow rapidly.

TABLE 1-8

NATURAL GAS PRICES NECESSARY TO MAKE
GAS-BASED METHANOL AND COAL-BASED METHANOL
EQUAL IN COST
($ 1980 per MMBtu)

	Year	
	1990	2000
Projected Gas Price	5.39	8.45
Breakeven Gas Prices		
Badger Methanol		
Rail Shipment	4.34	4.69
Pipeline	3.34	3.68
BGC-Lurgi Methanol		
Rail Shipment	3.80	4.05
Pipeline	2.79	3.05
Texaco		
Rail Shipment	4.39	4.75
Pipeline	3.39	3.74
Average		
Rail Shipment	4.18	4.50
Pipeline	3.17	3.49

OUTLINE OF THE REPORT

The remainder of the report is outlined as follows.

- Part 2 contains chapters 2, 3, and 4. The purpose is to present and explain the product cost estimates used throughout the report. Key assumptions are listed and the effect of changing some of those assumptions is explored.

- Part 3 contains chapters 5, 6, 7 and 8. The purpose is to discuss methanol as an auto fuel. Chapter 6 deals with the technical and environmental performance of methanol-powered cars. Chapter 7 presents the cost comparisons of methanol and the synthetic gasolines. Finally, chapter 8 considers fleet car fuel use.

- Part 4 contains chapters 9, 10, 11, and 12. The topic is methanol use in electric utilities. Chapter 10 considers technical and environmental performance while chapter 11 presents the cost comparison. Projections of utility fuel use are dealt with in Chapter 12.

- Part 5 contains chapters 13, 14, 15 which all deal with methanol use in the petrochemical industry. Chapter 13 considers current methanol use. Chapter 14 shows the cost comparisons while chapter 15 discusses the possible level of demand for methanol as a chemical feedstock.