surge capacity which is brought on line whenever the spot price of coal increases sharply. The lead time for opening up new mine capacity, both surface and deep, ranges between three and five years. Since the construction of major synfuels plants takes the same length of time, adequate new coal supply can be brought on line in a timely fashion. Finally, the U.S. coal resource is so large that it is very unlikely that there would be supply shortages over the next century. For all these reasons, coal supply poses no constraint to synfuels development.

5.2.5 Water Supply

Chapter 2 has discussed water supply concerns. Also reference 31 discussed these in detail. In brief, while the U.S. has abundant water supplies in aggregate, there are certain specific geographic locations where water supply could become a constraint to development of a large synfuels program. This is particularly true in the semi-arid portions of the West where significant coal reserves are located.

> ". . . sufficient water physically exists to support a significant-sized synfuel industry in the Upper Missouri and Upper Colorado River Basins, the primary western fuel resource areas." (Reference No. 33)

The problems with water supply in these areas are institutional and highly political and often emotion-laded. Thus far energy developers have been able to purchase water rights from farmers or Federal and State water impoundments. As long as a relatively full market exists for the transfer of water rights, energy developers can afford to bid away the required water supply. In addition, corporate planners will need to consider water supplies for the construction/operating laborforce, their families, and the communities which-will support them.

5.2.6 Environmental Health and Safety

Standards and Requirements

The liquid synfuels technologies "appear to have no absolute environmental protection constraint that would universally limit or prohibit deployment." (Reference No. 33) However, the direct liquefaction processes have some potential to expose workers or the public to toxic and carcinogenic materials. Such risks could be judged politically and socially unacceptable and could become a development constraint. The Prevention of Significant Deterioration program under the Clean Air Act could pose absolute limits to the number of plants able to locate in a specific geographic area since the allowable increments of ambient air quality could be fully utilized. In the case of oil shale where the resource base is concentrated in a specific area in and adjacent to Northwest Colorado, PSD limits are very likely to constrain the number of facilities permitted. These limits, still to be developed, have not yet been set. Ranges of capacity vary, however, on what is possible. In addition,

> "Some yet-to-be-defined regulations, if promulgated in their stringent forms, appear capable of severely limiting a number of synfuel technologies. These regulations include air quality emission control measures for visibility, changes in the original prevention of significant deterioration (PSD) regulations, extension of PSD limiting increments to other pollutants, short-term nitrogen oxide ambient standards, development of hazardous waste tests and regulations and special waste regulations, toxic product regulations, and occupational safety standards." (Reference No. 33)

A detailed assessment of the environmental, health, and socio-economic impacts is found in reference no. 31.

Permits and Licenses

The permitting and licensing process is complicated and time consuming. However, it poses no direct constraint on the synthetic fuels deployment program. The process generates procedural delays and provides multiple access to various public interest groups opposed to specific projects, specific technologies, or specific sites. More importantly, the process can be used by local political jurisdictions to either force project relocation or extract concessions from the project developers. Permit considerations are specifically discussed in the project discussions to follow.

5.2.7 Siting

Siting constraints are discussed in detail by the author in reference 31. In brief, Physical availability of sites is not a constraint. However, optimal siting by industry using their objective function often conflicts with the goals of other interest groups. Since much of the synfuels development will occur in areas with low population density, "conflicts will arise between the rural social order which currently exists in the region and the new urbanized society which will accompany growth. Early planning is required to handle these impacts." (Reference No. 45)

To overcome the "locate your plant anywhere but not here" syndrome, corporate planners will have to work closely with state and local officials as well as with numerous civic associations. This requires full consideration of the secondary effects of development on the infrastructure of the immediate and surrounding areas. These by their very nature are site specific analyses. What new roads, schools, services, homes and institutions will be required? How will these requirements be funded? Can the community be protected against the worst features of the "boom" scenario and from the downside risk of bust? What does happen if the project fails and is abandoned? These are reasonable questions which often do not have reasonable answers. References 31 and 32 have discussed these key problems°

5.2.8 Transportation

Transportation constraints can be a key concern. They must be considered on a regional/site specific basis. Reference 18 has treated these concerns.

As discussed earlier in Chapter 4, transport costs can be a key part of delivered cost. As discussed later in this chapter, the availability of inexpensive bulk transportation is crucial to project development.

5.2.9 Tradeoffs

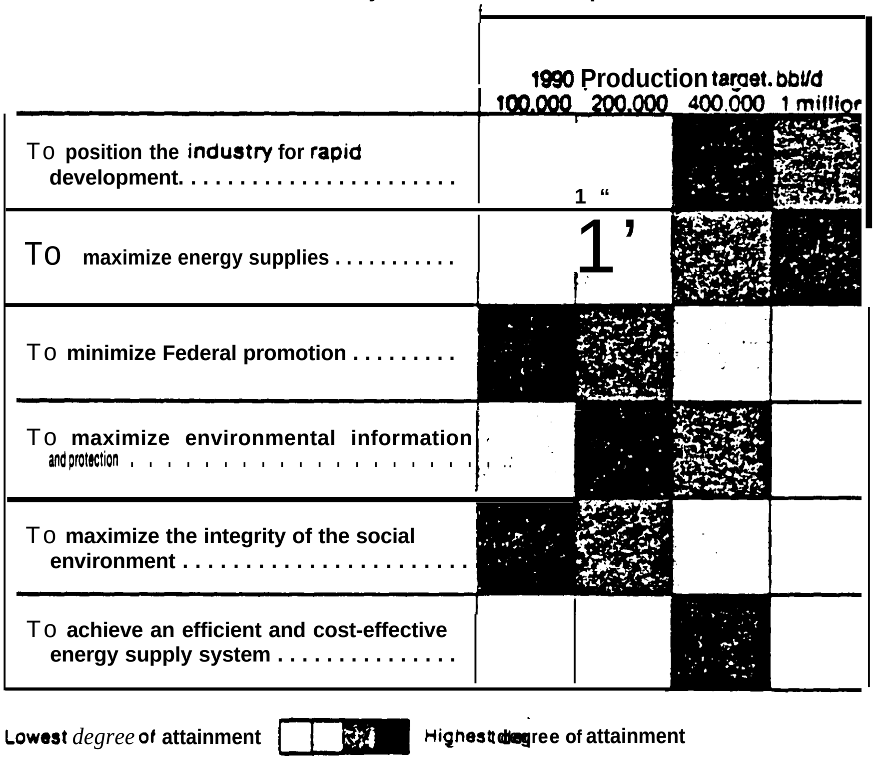
Hence, energy supply deployment will be affected by many competing constraining factors. Any specific project consideration must provide for a best optimum solution. This is clearly seen in Exhibit 5.6 in the variation to which oil shale targets would be achieved subject to different goals (Reference No. 8).

We will now look at our development of alternate supply scenarios.

EXHIBIT 5-6

ALTERNATE SHALE OIL PRODUCTION TARGETS (reference 8)*

-The Relative Degree to Which the Production Targets Would Attain the Objectives for Development



SOURCE Office of Tecnnology Assessment.

*Shale oil product ion targets are affected by many technical, environment al, and socioeconomic factors. As described in reference 8, the OTA has assessed the variation of 1990 production targets with regard to many of these key factors.

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5.3 Development of Supply Deployment Scenarios and Comparisons With Other Estimates

(A) Shale Oil

The oil shale industry*is in an advanced stage of development compared to other synfuel processes such as direct coal liquids. Design and construction (not including permiting) for an oil shale facility is typically in the 3-5 year time frame. Permiting requirements vary with two years being a typical time period. Most proposed/being developed projects are located in the West in the Green River Formation in Colorado, Utah, and Wyoming (Piceance, Uinta, Green River, Fossil, Great Divide, Washakie, and Sand Wash Basins) . Eastern shale development using promising new technical advances, discussed in Chapter 3, are likely to come on later. As discussed in the opening section, constraints center about resolution of land lease issues (the federal government owns over 80% of oil shale lands) , environmental and water availability issues, and availability of skilled labor, especially hard rock miners.

Table 5-1 lists the potential commercial scale projects, identifying their proposed location, process, estimated start up, and project scale (production). In addition, the Department of Energy is conducting above--ground and advanced retorting projects.** At present, permiting has been obtained for: Colony (final EIS, and a conditional PSD for 50,000, BPD complex), Union (final EIS for a 10,000 BPD commercial demonstration module unit) , Occidental (conditional PSD), Superior (final EIS) , and Paraho (draft EIS) . Based on the above projects planned, as well as individual surveys, scenario build-up rates are shown in Table 5-2. Comparisons of these rates with other estimates are shown in Table 5-3. This information is current as of 12/80.[p]

Initial production of shale, expected in the West, is expected to be treated (upgraded/refined) in the Rocky Mountain region, and will utilize existing spare refinery capacity. The next anticipated sequential market area is the Midwestern refinery region utilizing current in-place pipeline capacity (to the extent that anticipated new crude finds in the Overthrust Belt will not absorb pipeline capacity) . The key markets envisioned for shale oil is as refinery feedstocks producing a large middle distillate slate for anticipated growing middle distillate needs (such as diesel oil). Shale oil residuals have also been proposed for use in turbines (current tests being sponsored by EPRI at Long Island Lighting) . Using a typical refinery product slate, estimated shale-derived products are depicted in Table 5-4.

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*I.e., the industrial interests (oil, chemical, as identified in table 5-1) that are comprising the newly created shale industry.

**Private communication, DOE 12/80.

TABLE 5-1: POTENTIAL COMMERCIAL SCALE PROJECTS - SHALE OIL

PROJECT	SITE	PROCESS	PROJECT SIZE (1 OOOB/D)	EST START UP	APPROX. COST (B$)
COLONY DEVELOPMENT (Exxon, Tosco) STATUS: $75 million spent to-date; planning, detailed engineering design and costing completed; construction suspended; Exxon recently bought 60% share with contingencies tied to 1985 start-up; Tosco may seek Federal loan guarantee to raise its share of capital	co	Surf ace Retort	47	1985	1.7 (1980$)
UNION OIL STATUS: All permits received to construct and operate 9000B\D experimental retort which will be done with private financing (and $3 tax credit) ; 50,000B/D project depends on results of experimental retort.	co	Surface Retort	50	1983 (9000B/D)	
TOSCO SAND WASH STATUS: $2 million spent by end of 1978; planning exploration, and environmental analysis; TOSCO could use technology developed for Colony project, but would have to raise capital for both projects.	UT	Surface Retort	47	1988	
RIO BLANCO (GULF, STANDARD OF INDIANA) STATUS: $245 million spent to-date; shaft sinking & surface construction activities; further action pending Federal incentive programs.	co	Mod In Situ & Surface	76	1988	

TABLE 5-1 (Continued)

PROJECT	SITE	PROCESS	PROJECT SIZE (1000B/D)	EST START UP	APPROX. COST (B$)
OCCIDENTAL-TENNECO STATUS: Site preparation & shaft sinking; detailed development plan.	co	OXY Modified In-Situ	50	1986	
WHITE RIVER SHALE PROJECT (Phillips, Sun, Sohio) STATUS: Detailed development plan completed. Environmental monitoring continuing. $86 million spent to-date. Title status cleared by Supreme Court decision.	UT	Surface Retort	50 to 100		
SUPERIOR OIL STATUS: Pilot studies completed; environmental analysis . underway at BLM; feasibility studies underway; pending land exchange appears to be contrary to current DOI policy.	co	Surface Retort	13 + minerals		
PARAHO DEVELOPMENT STATUS: Beginning feasibility study (DOE funded) .	UT	Surface Retort	30	1984	
GEOKINETICS STATUS: Beginning DOE funded feasibility study.	UT	Surface Retort	2 to 8	1985	
TRANSCO ENERGY STATUS: Beginning DOE funded feasibility study.	KY	IGT Hytort	50	1984	
CHEVRON STATUS: Recently announced initiation of feasibility study.	co	Surface Retort	50		

SOURCE: E. J. Bentz & Associates

TABLE 5-2: SHALE OIL BUILD-UP SCENARIOS*
(in units of 50,000 MMBP)
OF CRUDE OIL EQUIVALENT

Scenario	1980	1985	1990	1995	2000
A Capacity added in period		.5	7.5	.5	0
Total Capacity		.5	8	9	9
B Capacity added in period		.5	9.5	8.5	.5
Total Capacity		.5	10	18.5	19

NOTE: Most shale plants are estimated to be sited in the Green River Formation (Colorado, Utah, Wyoming) .

* Shale oil build-up scenarios were constructed using interviews and referenced literature as cited in table 5-1, text, and footnote p.

SOURCE: E. J. Bentz & Associates

TABLE 5-3: OIL SHALE DEPLOYMENT SCENARIOS : 1980-2000
(thousands of barrels per day of crude oil equivalent)

Source	1980	1985	1987	1990	1992	1995	2000
U.S. DOE[1] (2/80)	--	80	225	400	450	450	450
Scenario A	--	25		400		450	450
DR1[2] (10/79)	--	185	350	700	800	925	950
National Energy Plan II (5/79)							900-1300
U.S. DOE[5] (11/80)	--	25	160	400-500	550-800		
Scenario B	--	25		500		925	950
OTA[4] (6/80)			400				
Shell[5]			150				

*NOTE: Most proposed shale projects are in the West, *in* the Green River Formation in Colorado, Utah, and Wyoming.

Interpreted from:

[1] U.S. DOE "Oil Shale Industrialization Action Plan," Feb. 1980.

[2] Denver Research Institute, 10/79.

[3] U.S. DOE Synfuel Corporation Planning Task Force, private communication, 11/80 and 12/80.

[4] OTA--An Assessment of Oil Shale Technologies, 6/80.

[5] U.S. National Energy Outlook 1980-1990, Shell Oil Co., 2/80. Shell--U.S. National Energy Outlook, Feb. 1980.

SOURCE: E. J. Bentz & Associates

TABLE 5-4: ESTIMATED TYPICAL SHALE OIL PRODUCT SLATE: * 1980-2000
(thousands of barrels per day of crude oil equivalent)

Scenario	Products	1980	1985	1990	1995	2000
A	Gasoline		4.25	68	77	77
	Jet Fuel		5.0	80	90	90
	Diesel Fuel	-	13.5	216	243	243
	Residues		2.25	36	41	41
B	Gasoline		4.25	85	157	162
	Jet Fuel		5.0	100	185	190
	Diesel Fuel	-	13.5	270	500	513
	Residues		2.25	45	83	86

* Table values derived using Table 5.2 values, and typical yield slates (Chevron Research, 1978 reference: "Refining and Upgrading of Synfuel From Coal and Oil Shale by Advanced Catalytic Processes") discussed in Chapter 4, Section 6.

Because of relatively higher hydrogen content and lower aromatic concentration (than in general to coal liquids) , a "natural" product slate from shale oil is a mixture of gasoline, diesel, and jet fuel.

SOURCE: E. J. Bentz & Associates

(B) Coal Gases

As shown in the accompanying project tables, there is a significant level of varied activity in the coal gases area. Key generic processes are low/medium Btu gas and pipeline quality H-Btu gas.

Low/Medium Btu Gas

As discussed in Chapter 3 and in the Appendix, leading technologies include the regular and slagging Lurgi gasifier (especially in earlier years) , Texaco, Westinghouse, Koppers, and Winkler gasifiers.

Since low/medium Btu gas offers industrial and utility users a relatively curtailment-free source of high quality fuel and chemical feedstock, it is expected that they will penetrate into the utility and chemical market. The Energy Security Act specifically exempts medium Btu gas from allocation and pricing regulations.

Low-Btu gas finds key market use as industrial fuels in such applications as kilns, small boilers, and chemical furnaces. At present it has been estimated that there are about 15-20 domestic facilities (Reference No. 48) that are beginning to use low Btu gas for these applications. These include chemical firms such as Dow Chemical as well as automotive giants such as General Motors.

The Glen Gery Corp. has itself four facilities gasifying coal to produce a fuel gas to fuel their brick kilns, while Caterpillar Tractor plant in York, Pennsylvania produces fuel gas for heat treating furnaces. NCA (8/80) estimates there are nine commercial plants (in operation, under construction, or in proposal/planning stage). It has been estimated (Reference No. 50) that low Btu gasifiers are feasible at approximately 3500 industrial plant sites. These plants are expected to be geographically located at coal/adjacent to available coal suppliers.

Medium Btu gas serves several markets. Among them are utilities and chemical feedstock markets. Medium-Btu gas could be used as a synthesis gas for producing chemical products (ammonia, fertilizers, plastics) , as well as utility power. Similarly, steel industry uses fuel for blast furnaces and annealing operations.

A potential co-product, methanol, could also be used as a utility peak showing fuel in turbines, or as an automotive fuel (Reference No. 51). Medium-Btu gas can also be used in utility use in a combined cycle power generation mode. NCA (Reference No. 48) estimates there are five commercial scale plants in the proposed/planning stage. Key demonstration plants at TVA, Memphis Industrial Fuel Use Plant, and Cool Water, California (Southern California Edison), are in advanced stages. It has been estimated (Reference No. 50) that there are approximately 350 potential sites for single user or limited distribution medium Btu gasifiers. In addition, there are combined-cycle markets (Reference No. 51). As shown on the accompanying tables (and NCA survey), likely locations for medium Btu facilities include Louisiana, Texas, Arkansas, Pennsylvania, New Mexico, California, Tennessee, Montana, Virginia, and Illinois. Table 5.5 lists the key proposed projects under way.

Table 5-7 gives the scenario deployments of medium Btu/L Btu gas. The rate build-up was estimated by review of the cited data tables, on-line surveys, and judgmental interpretation with alternate comparative estimates.

H-Btu Gas

As shown in the accompany table (Table 5-6), of proposed commercial scale projects most early H-Btu gas development will occur in the West, especially in the states of North Dakota, Wyoming, Utah, New Mexico, and Montana (Northern Great 'Plains Regions and Rocky Mountain Region). Construction is at present underway in North Dakota on the Great Plains Gasification project. As shown in the table, this plant could be producing by 1984, with a production of 138 mmscf/day, at which time a second plant would begin (an additional 138 mmscf/day). Later plants are expected to be deployed in the Southwest (Texas, Louisiana, Arkansas, Oklahoma), and in the East (Pennsylvania), and capture the use of existing transportation lines.

The predominant end use for H-Btu gas is space heating (industrial/commercial). Industrial use of the gas will be in the chemical, utility, and steel, iron and glass products industries (i.e., large current users of natural gas). Market penetration will be affected by the pricing treatment of gas (e.g., rolled-in pricing) over the estimation period (period of natural gas deregulation). Table 5-7 gives the scenario deployments of H-Btu gas over the estimation period. It is based on judgmental interpretation of the plant-specific build-up data cited, and on-line survey results. Table 5-8 gives the comparison of the scenario estimates with those of other sources.

TABLE 5-5 : POTENTIAL COMMERCIAL SCALE PROJECTS - LOW/MED BTU GAS

I. THE FOLLOWING PROJECTS ARE CURRENTLY UNDER DEVELOPMENT

(12/80)

PROJECT	SITE	PROCESS	PROJECT SIZE (1000BOE[D)	APPROX . COST (B$)
REYNOLDS ALUMINUM CO. APPLICATION: Power Generation for Aluminum Reduction	VA			
can-/do* APPLICATION: Industrial Gas	PA			
MUNICIPAL UTILITIES BOARD APPLICATION: Industrial Gas	AL			
PANHANDLE EASTERN APPLICATION: Industrial Gas	TX		8	
MEMPHAS GAS* APPLICATION: Utility\Feedstock (construction begins in 1982)	TN			0.3
SAN DIEGO P & L APPLICATION: Utility/Feedstock	CA			
ILLINOIS POWER COMPANY APPLICATION: Utility--Combined Cycle (1982 target)	IL		2	0.1
SOUTHERN CALIFORNIA EDISON APPLICATION: Utility--Combined cycle	CA		3	0.3
HOUSTON NATURAL GAS APPLICATION: Utility/Feedstock	LA			
COOLWATER APPLICATION: Utility-Combined Cycle (1984 target)	CA		100MW	0.2

*These projectsarecurrently funded as part of the Fossil Energy Technology Demonstration Program. (12/80)

TABLE 5-5: (I Continued)

PROJECT	SITE	PROCESS	PROJECT SIZE (10 00BOE/D)	APPROX. COST (B$)
MID-WEST ENERGY COAL ALTERNATIVE, INC. APPLICATION : Industrial Fuel/ Feedstock	IL			
CARTER OIL APPLICATION : Industrial Gas and Feedstock	TX			
ENERGY CONCEPTS APPLICATION: Electric Generation and/or Feedstock	OH			

SOURCE: E. J. Bentz & Associates

TABLE 5-5 (Continued)

II. THE FOLLOWING PROJECTS RECENTLY RECEIVED DOE FEASIBILITY GRANTS (PL-96-126)

PROJECT	SITE	PROCESS	PROJECT SIZE (1000B/D)	EST START UP
UNION CARBIDE APPLICATION: $MBG+H_2$ for fuel and feedstock	TX	Texaco	21.550	1988
GENERAL REFRACTORIES APPLICATION: LBG fuel to kiln for Pearlite Mfg.	KY	Wellman-Galusha	1.034	1983
CENTRAL MAINE APPLICATION: Combined cycle power- (new)	ME	Texaco	14.100	1987
FLORIDA POWER APPLICATION: Combined cycle repower	FL	BGC-Lurgi	7.458	1985
TRANSCO APPLICATION: MBG to existing power plants	TX	Lurgi	21.550	1985
PHILADELPHIA GASWORKS APPLICATION: MBG-fuel gas	PA	TBD	3.448	1985
EG&G APPLICATION: Combined cycle power & methanol	MA	Texaco	28.500	1986

NOTE: Over 40 proposals were received in response to 3/79 Notice of Program Interest. About 50 proposals were received in response to Feasibility and Cooperative Agreement Solicitations under P.L. 96-126. PL 96-304 programs are not listed due-to the funding uncertainty associated with the current recission order.

TABLE 5-6: POTENTIAL COMMERCIAL SCALE PROJECTS--HIGH BTU GAS

PROJECT	SITE	PROCESS	PROJECT SIZE (1000BOE\D)	EST START UP	APPROX. COST (B$)
GREAT PLAINS GASIFICATION STATUS: $40 million spent for project design and environmental work. All permits obtained but final FERC tariff to market the gas. DOE cooperative agreement & loan guarantee under P.L. 96-126. Plant could be producing by 1984. A second plant with additional 138 mmscf/day is contingent on the results of Phase 1.	ND	Lurgi	25 (138mmscf/d)	1984 earliest	1.5
WYCOAL GAS INC. STATUS: Recently received DOE cooperative agreement to develop definitive design, estimate costs, secure permits and approvals, obtain financing and identify long-lead delivery items; market is company owned pipeline to mid-West. Second phase would add a second 150 mmscf/d.	wy	Lurgi & Texaco	25 (150mmcf/d)		
EL PASO NATIONAL GAS STATUS: Initial 1972 application to FPC placed in abeyance. Coal commitment obtained; water lease expected; FERC tariff required before construction.	NM	Lurgi	13 (72mmscf\d)	earliest 1986	.6
TEXAS EASTERN/TEXACO STATUS: Water and coal from Texaco's Lake Desmet Reservoir property. Recently announced privately financed feasibility study.	WY	Lurgi	50 (275mmscf/d)	could be operative by 1990	

TABLE 5-6 (continued)

PROJECT	SITE	PROCESS	PROJECT SIZE (1000 BOE/D)	EST START UP	APPROX. COST (B$)
PANHANDLE EASTERN PIPELINE COMPANY STATUS: Coal and water commitments have been obtained. No filing yet before FERC. Second 135 mmscf/day stage if justified by first stage results.	WY	Lurgi	25		2.
MOUNTAIN FUEL COMPANY STATUS: Feasibility study under way. No filing before FERC to date.	UT	Lurgi	50 (275mmscf/d)	1990	
NATURAL GAS PIPELINE CO. OF AMERICA STATUS: Preliminary engineering design completed. No filing before FERC.	ND	Lurgi	50 (275mmscf/d)	late 1980s	
TEXAS EASTERN SYNFUELS STATUS: Beginning DOE funded feasibility study.	NM	Lurgi	43 (sng+MEOH)	late 1980s	
CROWE TRIBE OF INDIANS STATUS: Beginning DOE funded feasibility study.	MT	Lurgi	22	1987	

*Refers only to PL 96-126 feasibility and cooperative agreements. PL 96-304 project programs are not listed due to funding uncertainty associated with the current budget recission order.

SOURCE: E. J. Bentz & Associates

TABLE 5-7: SCENARIO DEPLOYMENT: H-Btu GAS AND MED/LOW Btu GAS

(EXPRESSED IN MMBD AND 50,000 BPD PLANT UNITS)

SCENARIO			1985	1990	1995	2000
H-Btu Gas (A)	Added Capacity in period (MMBD)	(# plants) (50,000 BPD)	.025 (.5)	.155 3.1	.20 (4)	.12 2.4
	Total Capacity	(# plants)	.025 .5)	.180 (3.6)	.380 (7.6)	.50 (10)
H-Btu Gas (B)	Added Capacity in period MMBD)	(# plants) (50,000 BPD)	.025 .5	.[illegible]5 (7.5)	.35[illegible] [illegible]7)	.250 (5)
	Total Capacity	(# plants)	.025 (.5)	.400 (8)	.750 (15)	1.0 (20
Med/Low Btu Gas (A)	Added Capacity in period (MMBD)	(E plants) (50,000 BPD)	.06 (1.2)	.115 (2.3)	.125 (2.5)	.10 (2)
	Total Capacity	(# plants	.06 (1.2)	.175 (3.5)	.30 (6	.40 (8)
Med/Low Btu Gas (B)	Added Capacity in period (MMBD)	(# plants) (50,000 BPD)	.06 (1.2)	.19 (3.8)	.15 (3)	.10 (2)
	Total Capacity	(# plants	.06 (1.2)	.25 (5)	.40 (8	.50 10)
Sum (A)	Total Capacity (MMBD)		.085 (1.7)	.355 (7.1)	.680 (13.6)	.90 (18)
SUM (B)	Total Capacity (MMBD)		.085 (1.7)	.65 (13)	1.15 (23)	1.50 (30)

SOURCE: E. J. Bentz & Associates; scenarios constructed using interviews and referenced literature cited in text, footnote q, at tables 5.5 and 5.6.

TABLE 5-8 : SYNTHETIC COAL GASES COMPARISONS

Source	1980	1985	1990	1992	1995	2000
National Energy Plan[1] (May 1979)						.8-1.0
Frost & Sullivan[2]			.8			2.2
Exxon[3]			.5			.7-1.5
U.S. DOE[4]		.05	.36	.63		
Shell[5]		.19	.49			
Scenario A		.085	.355		.680	.9
Scenario B		.085	.65		1.15	1.5

[1]U.S. National Energy Plan II.

[2]As reported in Synfuels, 2/80.

[3]Exxon Energy Outlook, 12/79.

[4]Private communication, DOE.

[5]Shell National Energy Outlook, 2/80.

SOURCE: E. J. Bentz & Associates

(c) Coal Liquids

As discussed in earlier chapters, coal liquids consist of indirect liquefaction of coal (Fischer-Tropsch liquids, methanol, methanol-gasoline) , and direct liquid processes (H-coal, EDS, SRCII) . As shown in the accompanying Table 5-9, all early (to 1990) commercial scale projects receiving current government support are in the indirect category, although several direct liquefaction proposals have been received. As such, indirect liquefaction liquids are expected to dominate coal liquids product in the later decades of the century. At present, the only commercially demonstrated coal liquefaction process is the Fischer-Tropsch process used in the SASOL plants in South Africa (described in Chapter 3) . This process technology, an indirect liquefaction technology, is being adopted and improved for use in the U.S. The other key indirect liquefaction processes are methanol production-- a well known commercial process technology, and Mobil-M methanol-to-gasoline process, which should be commercially demonstrated within several years. In addition to several U.S. funded domestic studies for M-gasoline (see Table 5-9), there is a pilot plant demonstration project in Germany (Reference-No. 48) , and a natural gas-methanol-M-gasoline commercial project scheduled for operation -in New Zealand by mid-80's (Reference No. 49). At present, there are no "commercially available direct liquefaction processes. The government has jointly (with industry) funded an SRC 1l demonstration plant and an EDS, and H-coal pilot plants for operation in mid-80's. Including the government sponsored study projects, there have been a total of 13 commercial plants, 4 demonstration plants, and 4 pilot plants are proposed/or in operation in the U.S. (Reference No. 18).

The anticipated deployment, based on judgmental interpretation of individual planned projects, current survey work, and individual project reviews, is depicted in the accompanying Table 5-9. As expected, indirect liquefaction processes dominate throughout, with direct liquefaction processes coming on stream late in the century. Early deployment is expected in the Northern Great Plains and Southwest region to capture existing product pipeline capacity (and water transport) and to fill energy product demands. Direct liquefaction developments are projected to come on in the 90's, and focus their activities in the Appalachian and Interior coal regions.

Direct liquid conversions naturally produce a high fraction of heavy oils. Since the traditional market for heavy oils (utility and industrial boilers) will probably convert to direct combustion of coal and medium Btu gas, upgrading of product slates into other market fuels is probable. Gulf's "Phase Zero Study" to DOE (also see Market Applications for SRC-11 products, Proceedings of the Sixth Annual International Conference on Coal Gasification, Liquefaction and Conversion of Electricity, Univ. of Pittsburgh, July 31-August 2, 1979) identified a substantial market where coal-derived liquid boiler fuels would have a distinct economic advantage over coal combustion with flue gas desulfurization primarily in congested areas of the Northeast where retrofitting to include flue gas desulfurization is expensive. As an example, projected EDS product slate usage could consist of stationary turbine fuels, special marine diesel fuels, and potentially home heating oils.

In general, direct coal liquefaction yields a high fraction of heavy fuel oil products. Current R&D work (at the laboratory stage) aims at upgrading this yield to the middle distillate, and naptha portion, thus minimizing the residual portion. However, this requires considerable upgrading by hydrogeneration or hydrotreating, as discussed in Chapter 4. In general, the products will be much more aromatic than equivalent petroleun-based products (private communication, Exxon Company, USA, 10/80) .

Indirect liquids such as Mobil-M gasoline and methanol have projected use in transportation, and transportation/utility peak usage respectively. These and other product slates (Fischer-Tropsch) have been identified and discussed in Chapters 3 and 4.

Tables 5-10 and 5-11 depict the scenarios constructed from this data. Table 5-12 compares the scenario with other data.

TABLE 5-9 : POTENTIAL COMMERCIAL SCALE PROJECTS--COAL LIQUIDS (12/80)
(SOURCE : E. J. Bentz & Associates; note feasibility study refers only to PL 96-126 programs)

PROJECT	SITE	PROCESS	PROJECT SIZE (1000BOE/D)	EST START UP	APPRQX. COST (B$)
W.R. GRACE STATUS: DOE cost shared demo; conceptual design near completion; construction scheduled for 1984.	TN	Texaco Methanol M-Gas	6		0.5
TEXAS EASTERN SYNFUELS STATUS: Feasibility study completed; entered into cooperative agreement with DOE.	KY	Fischer Tropsch	56		
HAMPSHIRE ENERGY STATUS: Beginning DOE funded feasibility study.	WY	Methanol M-Gas	18	1985	
NAKOTA CO. STATUS: Beginning DOE funded feasibility study.	ND	Methanol	40	1987	
W.R. GRACE STATUS: Beginning DOE funded feasibility study.	CO	Methanol	14	1986	
AMAX STATUS: Beginning DOE funded feasibility study.	MN	Methanol		1985	
HOUSTON NATURAL GAS/TEXACO STATUS: Beginning DOE funded feasibility study.	LA	Methanol	11	1987	
COOK INLET REGION STATUS: Beginning DOE funded feasibility study.	AK	Methanol	23	1987	
CELANESE STATUS: Beginning DOE funded feasibility study.	TX	Methanol	10	1986	
CLARK OIL & REFINING STATUS: Beginning DOE funded feasibility study.	IL	Methanol M-Gas	12	1987	

TABLE 5-lo: COAL LIQUIDS BUILD-UP RATE SCENARIOS : INDIRECT AND DIRECT*

(12/80) (In Plant Units of 50,000 BPD) of Crude Oil Equivalent

	SCENARIO		1980	1985	1987	1990	1995	2000
INDIRECT	A	Capacity added in period			3	3	3	5
		Total Capacity			3	6	9	14
	B	Capacity added in period			3	5	10	12
		Total Capacity			3	8	18	30
DIRECT	A	Capacity added in period				2	2	2
		Total Capacity				2	4	6
	B	Capacity added in period				2	8	10
		Total Capacity				2	10	20

*Coal liquids build-up scenarios were constructed using interviews and referenced information as cited in Table 5-9, text, and footnotes p and r.

SOURCE: E. J. Bentz & Associates

TABLE 5-11: COAL LIQUIDS BUILD-UP RATE SCENARIOS* (12/80)

(In plant Units of 50,000BPD)
of Crude Oil Equivalent

Scenario		1980	1985	1987	1990	1995	2000
A	Capacity added in period			3	5	5	7
	Total Capacity			3	8	13	20
B	Capacity added in period			3	7	18	22
	Total Capacity			3	10	28	50

*Values derived from Table 5-10.

SOURCE: E. J. Bentz & Associates

TABLE 5-12: <u>COAL LIQUIDS COMPARISONS</u>

(MMBD) of Crude Oil Equivalent

Source	1980	1985	1987	1990	1992	1995	2000
National Energy Plan[1]							.7-1.8
Frost & Sullivan*				1.0-1.5			9.5
U.S. DOE[3]			.14 .12	.5 .37	.8 .57		
She11[4]		.03		.25			
Scenario A			●15	.4		.65	1.0
Scenario B			.15	.5		1.4	2.5

[1]National Energy Plan II, 5/79.

[2]Synfuel Week reported 2/8/80.

[3]Private communication, DOE, 11/80.

[4]Shell National Energy Outlook, Preliminary Version, Feb. 1980.

SOURCE: E. J. Bentz & Associates

(D) Summary Tables and Comparisons

Table 5-13 depicts the summed synthetic fuel deployment schedules. Table 5-14 compares our "grass root" scenario build-up with other estimates developed by different approaches. As seen in Figure 5-1, the scenario brackets most estimates.[5]

Next we will look at the labor requirements associated with the scenarios, as well as identify other impacts and concerns associated with their synfuel deployment.

TABLE 5-13 : SUMMED SYNTHETIC FUEL DEPLOYMENT SCHEDULES*

(in plant units of 50,000 BPD)
of Crude Oil Equivalent

		1980	1985	1990	1995	2000
	Shale Oil	.-	**.5**	**8**	**9**	**9**
	Coal Liquids	--	--	8	13	20
A	Coal Gases	--	1.7	7.11	13.6	18
	Total	--	2.2	23.11	35.6	47
	(MMBD)	--	(.11)	(1.16)	(1.78)	(2.35)
	Shale Oil	--	**.5**	**10**	**18.5**	**19.0**
	Coal Liquids	--	--	10	28	50
B	Coal Gases	--	1.7	13.0	23	30
	Total	--	2.2	33.0	69.5	99
	(MMBD)	--	(.11)	(1.65)	(3.48)	(4.95)

*Derived from adding Tables 5-2, S-7, and 5-ll.

SOURCE: E. J. Bentz & Associates

TABLE 5-14 COMPARISON OF TOTAL SYNTHETIC FUEL PRODUCTION ESTIMATES (TARGET GOALS)

(MMBD)
of crude Oil Equivalent

Source	1985	1987	1990	1992	1995	2000
Energy Security Act[1]		.5		2.0		
Exxon Outlook[2]			1.2-1.5			4.0-6.1
Bankers Trust[3]			.5			
Mellon Institute[4]						2.1
Natl. Energy[5] Plan (II)						2.4-4.1
NTPSC[6]						
(Low-Meal)	0-.02		03-.18		.28-1.27	1.34-5.34
Shell[7] 2/80	.22		.89			
Scenario A	.11					
Scenario B	.11					

[1]Energy Security Act, PL 96-294 6/30/80, Sec. 100(a)(2).

[2]Exxon Energy Outlook, Dec. 1979.

[3]Bankers Trust Forecast--as reported in Synfuels, 8/15/80.

[4]Mellon Institute Forecast--as reported in Synfuels, 8/22/80.

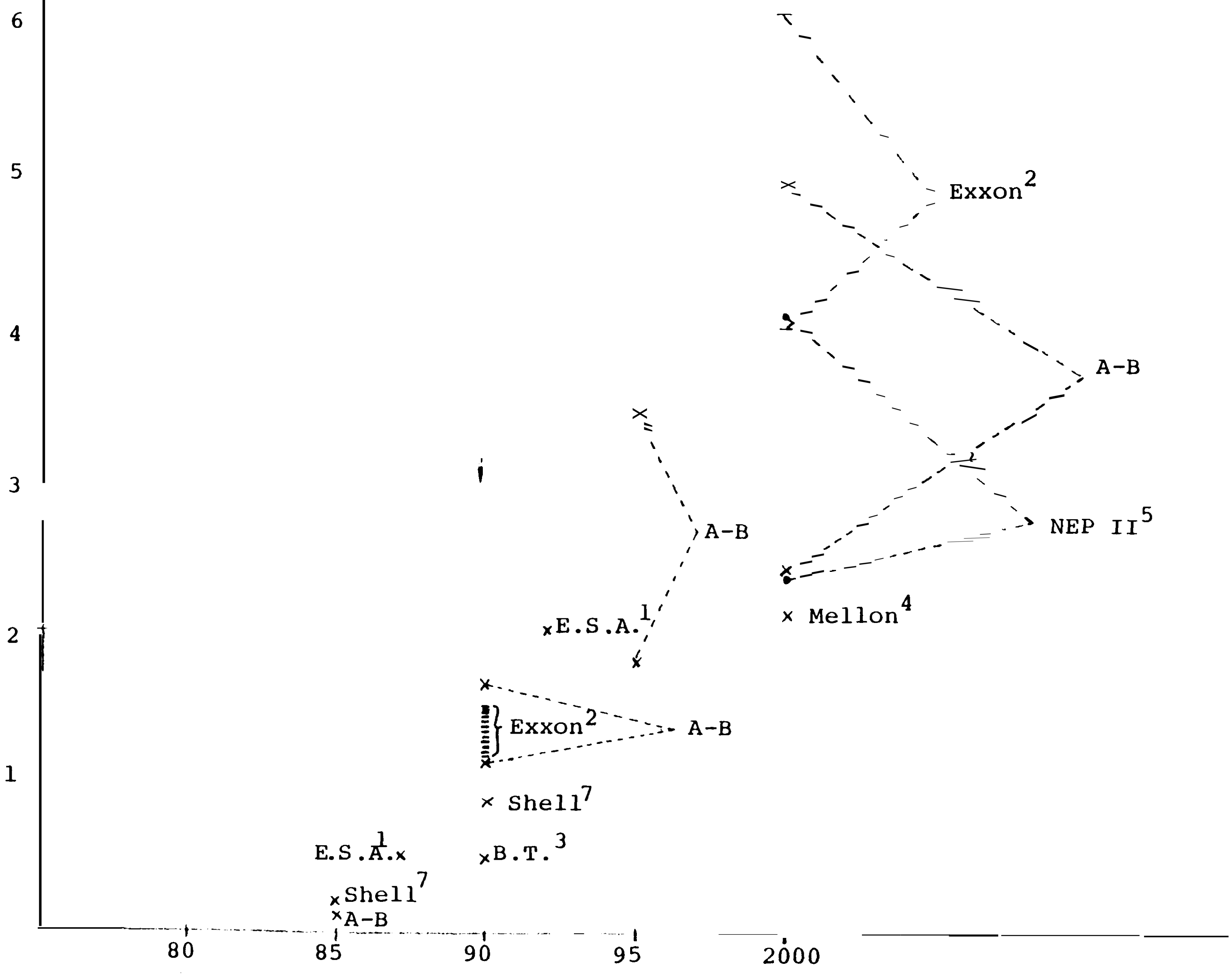
[5]National Energy Plan II, May 1979.

[6]National Transportation Policy Study Commission Report, July 1979.

[7]Shell National Energy Outlook, preliminary version, Feb. 19, 1980.

SOURCE: E. J. Bentz & Associates

Figure 5.1: Comparison of Synthetic Fuel Production Estimates



SOURCE: E. J. Bentz & Associates (derived from Table 5-14)

5.4 Labor Requirements Associated With The Scenarios

There are two categories of labor needs: construction labor and operations labor. As discussed in Chapters 2, 3 and 4, construction labor represents a peak employment situation whereas operations represents a steady-state labor requirement associated with the useful life of the facility. In addition, as discussed earlier, there are additional labor requirements in the geographical (and sectoral) area associated with provision of goods and services for the facility or for its labor force. The peak labor force is confined to a limited number of years (4-6) and often is several times the size of the resident population. This is especially so in the West. The impacts of this surge in peak labor can cause numerous community and environmental concerns in addition to severe strain on local infrastructure and even erosion of this infrastructure. Reference No. 52 discusses in detail some of these site impacts and their consequences. In addition, several studies, such as the Sec. 153a Studies of the 1976 Highway Bill, have looked at "Coal Roads" Issues, and the recently passed Energy Security Act mandates further studies to assess and hopefully suggest mitigation to energy impacted communities. The National Transportation Policy Study Commission in its final report (July 1979) specifically addressed the large and growing impacts of coal movement either in unbeneficiated or product form (pp. 141-149: The Commission forecast a large growth in the movement of coal. Associated with these movements will be: physical capacity concerns of a carrier nature; adequacy of service issues associated with carrier capabilities; and potential disruptions associated with these large scale movements) .

5.4.1 Operations Labor Needs

Based on Chapter 4 results, a typical labor composition for operation of a 50,000 barrel/day synthetic fuel facility is as follows:

Operations	120	people
Operator supervisors	25	people
Maintenance labor	150	people
Maintenance supervisors	30	people
Administrative	30	people
Total	355	people

Hence, upon applying this typical labor force participation to the scenario deployment estimates we arrive at the following aggregate estimate of needs: (See Table 5-15).

TABLE 5-15 AGGREGATE OPERATIONS LABOR NEEDS (WORKERS) *

Workers	1985 A	1985 B	1990 A	1990 B	1995 A	1995 B	2000 A	2000 B
Operators	264	264	2773	3960	4272	8340	5640	11,880
Operator Supervisors	55	55	578	825	890	1738	1175	2,475
Maintenance Labor	330	330	3465	4950	5340	10,425	7050	14,850
Maintenance Supervisors	66	66	693	990	1068	2085	1410	2,970
Administrative	66	66	693	990	1068	2085	1410	2,970
Totals	781	781	8202	11,715	12,638	24,673	16,685	35,145

* Table 5-15 entries derived upon applying Chapter 4 typical labor force estimate to values developed in Table 5-13. Operations labor needs skill mix utilized, Chapter 4, based on ESCOE process estimates.

SOURCE: E. J. Bentz & Associates