Selected Technical and Economic Comparisons of Synfuel Options

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INCREASED AUTOMOBILE FUEL EFFICIENCY AND SYNTHETIC FUELS

Alternatives For Reducing Oil Imports

Background Paper #2

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Preface

This volume contains papers written for OTA to assist in preparation of the report ***Increased Automobile Fuel Efficiency and Synthetic Fuels: Alternatives for Reducing Oil Imports.*** OTA does not endorse these papers. In several instances, the OTA report reaches somewhat different conclusions because of additional information which was obtained later. These papers, however, may prove valuable for readers needing more detailed or specific information than could be accommodated in the final assessment report, and are being made available for such purposes.

SELECTED TECHNICAL AND ECONOMIC COMPARISONS OF SYNFUEL OPTIONS

FINAL REPORT

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NOTICE

EXECUTIVE SUMMARY

Study Scope and Content

This study is a comparative technical and economic assessment of selected synfuel technologies. It is a component part of a much larger study being conducted by the OTA on energy options. A key purpose of this study is to provide technical and economic comparisons among selected synfuel technologies which, to the extent possible, provides a background and basis which may assist the OTA in its policy deliberations. The synfuel technologies have been selected in consultation with and guidance from the OTA. They generically represent: oil shale production; direct and indirect coal liquefaction (including Mobil-M gasoline synthesis); and coal gasification (low, medium and high Btu) . The OTA Synfuels Advisory Board has been particularly helpful in providing for and reviewing information on these selected technologies, although by no means are they held accountable to or responsible for the study products.

The study effort built upon earlier work which attempted to the extent possible to standardize the engineering, planning, and estimating base of many processes. These efforts, as described in Chapters 2 through 4, were modified and extended to include additional concerns such as upgrading concerns and plant cost escalation concerns.

These standard or generic process units have been utilized, in conjunction with the assessment of site-specific planned/proposed synthetic fuel projects, to develop a set of alternate supply deployment scenarios. Two scenarios--a “business-as-usual” scenario, and an accelerated “pushing-the-limit”--have been developed in consultation with and direction from OTA staff.

Constraints and concerns affecting the scenario assessments have been discussed, as well as a discussion of the consequent labor needs. Supply site selection concerns, as well as end-use utilization concerns have also been identified.

As specified in the Introduction (Chapter 1), the study scope was confined to an assessment of the technical and economic comparisons of the selected synfuel technologies. On-line guidance and direction was provided by the OTA in making “mid-stream” technical and economic choices in the study effort. No assessment or interpretation of the policy implications was conducted as that was strictly considered outside of study scope, design, and performance. Such policy concerns were reserved for the OTA, with its well-established and defined review procedures.

Study Findings

The study analysis investigated numerous technical and economic aspects of the selected synfuel technologies. Because of the very complex nature of this topic--as well as the need for cautious and critical qualification of the findings--each chapter attempts to summarize its findings in its own setting.

In brief, a snapshot of the study findings are as follows:

1. There is a fairly consistent relationship between the cost of the synthetic fuel product and the "quality specifications" of the product, as it is used in current end uses. Criteria used to measure product quality specifications include hydrogen content; octane number, aromaticity, lubricity, and a host of physical and chemical parameters (discussed in Chapters 4 and 5) that affect specific end use technology performance.

2. Although perhaps an oversimplification, there appears to be a high correlation, in a cost dimension, with the product "quality specificity" and the amount of hydrogen content and/or the average range of distillation of the product. Both coal and oil shale contain a lower fraction of hydrogen than petroleum. Natural gas and crude oil having the highest percent; oil shale next; and coal with the lowest fraction. Crude oil is a broad range material, with a broad range of quality, in this sense, as well. If we are to upgrade coal and oil shale to a series of products, of varying quality and specifications, comparable to the average yield of petroleum products, we can expect that, in addition to the greater extraction cost of coal and shale, there will be a greater reforming, processing or upgrading cost. This cost reflects the necessary changes to be made in physical, chemical, and material properties of the primary synfuels products to make them equivalent in use to existing refined products. Going beyond that, the cost is proportional to the specific product yield quality or quality mix that is pursued. For example, it is <u>much</u> cheaper to produce a Low-Meal Btu gas from coal than a High Btu gas. Similarly, it is more costly to produce a low boiling, high hydrogen containing

fuels such as motor gasoline than to produce a higher boiling, lower hydrogen containing fuel such as home heating type fuel oil products.

3. Specific process differences disappear to a large degree under our analysis, and the cost of synthetic product is more dependent upon its composition than upon the particular process used. On the other hand, certain processes (or process approaches) may be more selective for certain type products or product-slates and hence more efficient and economical routes to those specific products.

   Our review and analysis of approaches to the process of upgrading raw (direct) liquid fuels to stable combustion fuels and subsequently refining them to transportation quality fuels shows us the following:

   (a) At present, indirect liquefaction technologies such as Fischer-Tropsch are known technologies. As such, there is limited technical risk. At present, however, these processes are relatively expensive because of the chemical nature of breaking down hydrocarbons and later resynthesizing them. Most of the initial coal liquids projects will be indirect liquefaction processes.

   (b) Certain resources favor certain product slates. Coal ravors the production of highly aromatic products, like high octane gasoline pool maphthas. Shale oil favors middle distillate products. Sour Crude contains many times the (high boiling) residual content as these resources and favors the production of boiler fuels, although it is certainly less expensive, at present, to produce gasoline and middle distillates from heavy and sour crudes than from coal or shale.

4. Cost Comparisons (in 1980 $)

   (a) Fully (risk) discounted cost estimates of representative or generic coal-conversion processes vary from $10.00 to $16.00 per MMBTU of product.

   (b) Future expectations of technology gains in the form of capital productivity may reduce these costs by over 30% (i.e., to about the $12.00 per MMBTU0.

(c) Upgraded costs add as much as $2.00-$2.50 per MMBTU (or $10.00-$15.00 per barrel) of product to the cost of oil shale liquids and-direct coal liquids.

(d) Refined transportation fuels are expected to have the following cost ranges:

(i) oil shale liquids - $60-70/barrel
(ii) indirect coal liquids - $70-80/barrel
(iii) direct coal liquids - $80-90/barrel

5. Transportation Concerns

(a) Transportation of synthetic liquids and gases are most likely to be transported by pipeline, with supplementary use of water borne carriers (where available), and unit tank train railcars.

(b) Patterns of synfuel plant and refinery siting are expected to be influenced by both resouce location as well as existing infrastructure (existing pipeline capacity; existing refinery capacity) .

6. Synfuel Deployment

(a) The development of reasonable scenarios of synfuel plant commercial deployment is extremely sensitive to the product role assigned to natural petroleum feedstocks, both domestic and imported.

(b) From the assessment of currently planned/ proposed commercial projects (described in Chapter 5), which provide the grassroot basis for our development of scenarios, we note that most commercial projects are directed toward the production of high grade fuels. Furthermore, due to the ever expanding cost of upgrading to meet increasingly stringent product user specifications, processes are being chosen to minimize these costs, and maximize high grade product yields. Oil shale, methanol, and Mobil-M gasoline are three examples of such product choices. A perceived outlook for natural crude supplies see higher volumes of lower grade crude oils available (sour crudes from Alaska and Saudi Arabia; heavy crudes with high viscosity from Venezuela and Bakersfield) . These crudes will require major refinery upgrading and consequent refinery investment, although this investment is considerably less than for synthetic fuels. Hence, redundant investment in the synthetics area may occur if an integrated view is not taken. We believe that an integrated view will most likely be taken by companies engaged in regions considered, although these views may represent a regional and company specific optimization.

(C) Synfuel development will require the resolution of numerous technical, economic, and socio-economic concerns. Key among these concerns are a provision of materials, as well as engineering and skilled labor requirements. Drag lines, air compressors, and large diameter reactor vessels are examples of material needs. Chemical engineers availability is an example of the latter needs. It is felt, however, that these needs can be met, even in the high scenario, with the early development of programmatic plans. Similarly, early planning can relieve or avoid potential socioeconomic and community disruption.