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INTRODUCTION

I am pleased to have this opportunity to participate in this conference and to speak to you. In keeping with the theme of this session, the bulk of my remarks will deal with the commercialization of synthetic fuels projects. But I will preface those comments with a brief review of the potential for synthetic fuels, and the important role that the government will have on the development of that potential.

Potential

As you would expect, our business planning at Exxon includes an intensive ongoing study of energy trends. Our United States energy outlook shows a continuing and significant dependence on imported oil. Domestic oil and gas production is forecast to decline about 2 million barrels per day of oil equivalent by the year 2000 even assuming an ambitious exploration and production effort. Despite voluntary and mandatory conservation efforts, United States energy demand is projected to increase about one percent per year as the economy grows. The chances that nuclear fusion, or solar, or some other renewable technology can be translated into usable energy supplies on a significant scale at a competitive cost in this century are remote. Direct-burned coal and nuclear fission are forecast to grow substantially over the next 20 years, but, there are some large segments of energy demand where coal and nuclear power have only limited application. Petrochemical feed stocks and almost all of the transportation demand can be met only by liquid and gaseous fuels. Therefore, a significant level of demand for these types of fuel will continue.

Our energy outlook shows the difference between projections of domestic petroleum demand and production to be in the league of 15 million barrels per day of oil equivalent early in the 21st Century.[3] This gap between demand and domestic supply for liquid and gaseous fuels has created the opportunity for development of synthetic fuels. The magnitude of the gap casts a sense of urgency on the opportunity since the only realistic alternative to synthetic fuels is a growing reliance on imported oil--an alternative that is not in the national interest. It is also noteworthy that production of synthetic fuels at a 15 million barrels per day rate could be sustained for 175 years on our presently known resources of oil shale and coal.

The Role of Government

The rate at which the potential for synthetic fuels is commercialized will be heavily influenced by governmental actions. Because of its concern with security of supply and the effect of oil imports on the nation's balance of payments, Congress created the Synthetic Fuels Corporation with initial funding of $17.2 billion. This legislation, designed to assist the initiation of a commercial synthetic fuels industry, was unquestionably significant, but many other governmental actions are needed to facilitate the development of synthetic fuels on a scale that would appreciably reduce the gap between domestic demand and production of liquid gaseous fuels. The potential of a large-scale synthetic fuels industry cannot be realized if, for example, environmental goals are not balanced with energy objectives, or if the federal leasing program is not modified to encourage rather than limit access to oil shale and coal resources.

In addition, one of the most important responsibilities of government is creating the economic and regulatory climate that will permit stable, long-range planning, and encourage investments in the new industry. Given the long lead times to design and construct synthetic fuel plants and the long payout time, this climate must not only be favorable now, but must hold out the expectation of remaining so for a considerable time. Government will also have to assume major responsibility for helping build the public awareness of the critical national need to begin development of a domestic synthetic fuels industry as rapidly as possible. My point is that unless the government assumes a leadership role, the potential for synthetic fuels will not be developed fully or on a timely basis.

The Economics and Technology

I would now like to discuss some aspects of the economics and technology of commercial synfuel projects. The security of a domestic synthetic fuels industry is certainly preferable to the insecurity of imported oil especially since crude oil prices have reached levels that make at least some synthetics economically competitive with petroleum products. Even after consideration of recent reductions in crude prices by OPEC members, several synthetic fuel processes are economically viable if we assume that OPEC prices will increase over the long term at least at the same rate as the cost of plant construction.

Shale oil is one of the lowest cost synthetic fuels and it can be refined into a wide range of conventional liquid petroleum products. Several oil shale retorting technologies now appear to be ready for commercialization. Based on our current estimates of project costs and our forecasts of future product prices, shale oil development, with the aid of presently available tax incentives, appears to be economically competitive with the cost of imported oil.

You probably are aware of Exxon's active involvement with a shale oil project. Last year we purchased Arco's 60 percent share of the Colony Project which is located on the rim of the Piceance Basin in northwest Colorado. Tosco owns the other 40 percent. As operator, Exxon is responsible for project engineering, construction, and operation of the plant and mine. It will require about 66,000 tons per day of raw shale to produce 47,000 barrels per day of shale oil. The engineering and site preparation work is underway and retort construction is scheduled to begin next year. We believe Colony will be the first commercial size shale oil project in operation in the United States.

Association with the Colony project is the development of a community called Battlement Mesa. When complete this will be a community of about 25 thousand people. This is, of course, an example of the magnitude of the task to develop a synthetic fuels industry. Development of a community of this size would in itself be a significant undertaking, yet in this case it is only a relatively small part of the overall project. Another competitive synthetic fuel option is gasification of low rank coals to generate intermediate BTU gas, or IBG, which is a mixture of carbon monoxide and hydrogen, with some methane. Several different gasification technologies are commercially demonstrated.

Sasol which uses the Lurgi technology is the most notable example. There are other technologies which are in the large pilot plant stage or ready for commercial size demonstration. We believe IBG is currently competitive with imported gas if the product market is close to the gasification plant. The heat content of IBG can be increased by methanation to produce substitute natural gas (SNG). This additional processing increases the cost but in some cases the process is still economically attractive.

The most economical method of obtaining liquid fuels from coal with today's technology appears to be an indirect process for producing methanol. The coal is first processed into IBG and then further processed to produce methanol. Methanol can serve many traditional fuel and chemical uses and offers promise for use as a transportation fuel if a market can be developed. Its cost under this production method is estimated to be competitive to slightly higher than imported crude oil, depending to some extent on location and the technology used. The technology for methanol production is, of course, well established. With further processing at additional cost, methanol could be converted into conventional gasoline using technology now under development. This produces a fungible product for which a market already exists.

As you may know, Exxon is considering construction of an IBG project based on East Texas lignite and later in my talk I will use this as an example of an approach to commercialization.

In addition to the indirect coal liquefaction processes, much research and development work is being done on technologies to convert coal directly to liquids by the addition of hydrogen. Today, all of these direct processes appear to be somewhat more expensive than the cost of imported crude oil. As these processes evolve, however, some will undoubtedly benefit from developments and that should bring costs down.

The Exxon Donor Solvent Process

There are three major direct liquefaction processes currently under development in the United States: the Exxon Donor Solvent process, the H-Coal process, and the Solvent Refined Coal process. I will briefly describe the EDS process and the outlook for its commercialization.

In the Exxon Donor Solvent or EDS Process, coal is mixed with a hydrogen-rich liquid solvent and gaseous hydrogen.

This mixture is then sent to a liquefaction reactor where the coal reacts with the solvent and hydrogen. The reactor product is then separated into hydrocarbon gases, naphtha, distillate, and fuel oil streams as well as heavy residual bottoms product. This bottoms product contains up to 50 percent of the energy in the original coal and consists of very heavy oils, unconverted coal, and coal mineral matter. It is not a saleable product. Bottoms can be recycled, however, to convert more material into lighter fractions, and the EDS Research and Development program includes work on this feature.

Exxon began the research and development work on the Exxon Donor Solvent process in 1966, and eleven years later in 1977 entered into a cooperative agreement with the U. S. Department of Energy, the Electric Power Research Institute, and several other domestic and foreign companies to fund the development effort. A comprehensive research and development program is being used which employs bench scale research, small plant operation, engineering/design studies, and a 250-ton-per-day liquefaction pilot plant operation.

In June of this year the EDS plant successfully completed the first phase of the pilot plant test operations on Illinois high sulfur bituminous coal. Over the next year we plan tests on a Wyoming subbituminous coal and on a Texas lignite. We had been planning large pilot plant tests on a bottoms conversion process called flexicoking, which was developed by Exxon several years ago for conventional petroleum processing. The EDS sponsors recently made a decision to discontinue the flexicoking program in favor of investigating other processes that have potential for more economic conversion of the residual material to useful products. Because of this decision, the development path and timing for a commercially-ready bottoms process is somewhat uncertain.

We will likely have the information needed to begin to assess commercial readiness for the liquefaction portion of EDS by the end of 1981 for Illinois coal and by the end of 1982 for Wyoming subbituminous and Texas lignite. However, as just mentioned, the path to commercial readiness on a bottoms process is less clear. The presently-approved program contemplates test work on partial oxidation of EDS residues and predevelopment work on a hybrid boiler concept. Details of these programs are still being developed, but it is not certain that the scope of work possible under the program will take one or both to full readiness.

Recognizing these uncertainties, the earliest timing for operation of a pioneer commercial EDS plant is sometime in the early 1990's. This assumes that development does continue and that R&D efforts result in a process with competitive economics.

I mentioned earlier that Exxon has under consideration a coal gasification project based on Lurgi Technology and a lignite feed source. In developing a synthetic fuel project a number of major considerations need to be addressed. I would like to examine these by using this project as an example.

Assuming one accepts the need for a synthetics industry and that preliminary economics indicate it is viable, one then needs to consider:

- Resource
- Technology Selection
- Product Mix and Market
- Environmental Issues
- Availability of Other Requirements; i.e., Water/Power
- Socioeconomic Constraints/Effects
- Public Attitudes
- Timeliness
- Economics

and finally,
- Competition for Resources within the Company

In developing an Exxon pioneer coal gasification project one of the first considerations was geographic location and market. The Gulf Coast offered clear advantages over other areas in terms of proximity to market and infrastructure considerations. Thus one of our first goals was to obtain a resource in the Gulf area of large enough size and quality to support a major investment. We were fortunate in acquiring upwards of 650 million tons of lignite suitable for recovery by surface mining - in East Texas about 200 miles from Houston. An early decision made with regard to technology selection was that only commercially proven processes would be considered. This was to avoid the added risk of an unproven technology on such a large investment. The Lurgi dry bottom process appeared to be most attractive for our resource and subsequent tests, including a test at Sasol in a commercial gasifier demonstrated to our satisfaction the suitability of this process. We tested this decision by assuming other processes currently under development achieved commercial readiness several years after our plant start up and that they had efficiencies as good as or better than Lurgi. These tests showed that proceeding now with Lurgi was still

attractive. I should add that as we learn more about the newer technologies we continue to test our selection.

A major issue we have not fully resolved is our product and our market, and of course the market value for the product. Initial discussions with chemical manufacturers indicate a strong interest in IBG for chemical feed stocks, and our own analysis indicates that this is a very attractive outlet assuming we can get the value we believe the product has. Yet we must consider if the plant output might not be better placed in the liquid fuel market by converting the IBG to methanol or to gasoline. Methanol is a very attractive transportation fuel and as I mentioned earlier this segment of the energy market is most critical for the next 30-40 years. Unfortunately there is no established methanol transportation fuel market, and it is not clear how rapidly one can develop. Synthetic gasoline, of course, has a ready market, but this product required two processing steps beyond IBG which adds to investment and product cost.

We are actively involved in these product/market questions and have had a number of discussions with potential customers. This area will require a continuing effort during the next year since the answers are critical to reaching a final decision on the project.

In parallel with this effort we are developing the environmental studies including an EIS, an extensive Socioeconomic assessment, and permits for mine and plant. So far we have not encountered or uncovered any major problems, and we have found the EPA, and state and local officials to be reasonable and helpful. This attitude was one we believed existed in the East Texas area and was another of the features that made it attractive to us. There appears to be an adequate infrastructure, so massive community development efforts will not be necessary. There is also access to a large labor pool which should help construction costs.

The area has ample water and electrical power supplies.

Preparation of process designs is well along with completion planned for early 1982. During 1982 a high quality cost estimate will be prepared for use in project evaluation and cost control. Our target is to reach a decision by 1983 on whether or not to construct. If the decision is positive it will

be about 4 years to build the first half of the plant -- the second half would come on stream two years later -- the entire plant would cost in excess of 4 billion dollars. Yet even at this level our current economics indicate it is attractive. The plant would produce the oil equivalent of 68 thousand barrels a day -- mainly IBG with some coproduced heavy liquids.

With all that is favorable you might reasonably ask why such a paced development schedule. This brings us back to two of the elements on our list. Timeliness -- i.e., are conditions favorable for the large investment required, and allocation of corporate resources -- manpower and capital. Earlier I mentioned the Colony project which is under construction and will cost several billion dollars. In addition, the next several years will place large demands on energy companies for technical and capital resources in the exploration and production areas, refinery modifications, and other areas of company interest. Deciding among these alternatives as to the pace of development and resource allocation is a very difficult task. Thus we have planned a paced development of the gasification project so the analysis can be done. I believe this is unavoidable when considering synthetic fuel projects because of the risks and heavy demands they impose on the organization.

The Timing of Commercialization

In summary -- I hope my example points out that while the need to reduce the nation's dependence on imported petroleum is clearly in the national interest, the commercialization of synthetic fuels production cannot be accomplished rapidly. Even after the technology has been satisfactorily demonstrated as with shale oil and IBG production, scaling up to commercial size involves several problems. The large multi-billion dollar capital requirement, for example, is a concern to many potential developers as attested to by the number of requests for financial assistance submitted to the SFC. Not only is there the problem of raising this large amount of capital, but the risks are also large especially with the long lead times and lengthy payout periods.

The plant facilities themselves are massive. The lead time for these large investments can span eight years from planning to plant start-up. Engineering and construction can take five years for many plants -- assuming no delays in environmental permitting.

The socioeconomic development associated with rapid

population growth that must accompany such large projects, many of which will be located in remote areas, poses another challenge and concern. Developers must cooperate with the local community and government to plan for the community development needs such as housing, roads, schools and public services. In some cases developers will have to assist in easing the impact mitigation burden. This is particularly so in that the impact on community services will usually precede the development of an adequate tax base by several years.

Some commercial plants are already in various stages of development. The Colony Shale Oil Project will startup in the mid-1980's. The first commercial production of IBG will probably come about the same time. The first commercial direct liquefaction of coal is not expected until the early 1990's.

The potential for commercial synthetic fuels in the United States energy future is large. Development of this potential, however, will be appreciably influenced by the extent to which the government assists by helping create a favorable business climate and the necessary sense of national resolve.