The Supply of Oil for Future U.S. Needs and the Subsequent Effects on the Environment

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Throughout most of this century, the United States has been self-sufficient in petroleum supply; however, since 1968 our rate of consumption of oil has been greater than our daily oil production capability. During the present decade, the gap between domestic petroleum demand and domestic production will increase. The gap is a result of several factors: First of all, a seriously insufficient exploration for, and development of, natural gas and crude oil; secondly, the disqualification, for environmental reasons, of much of our high sulfur coal from its normal industrial and utility markets; and finally, a lag in the construction and operation of nuclear electric power plants.

As shown in this first chart, domestic production of crude oil and natural gas liquids appears to be levelling off in this country at slightly over 11 million B/D. The levelling off may even be considered a slightly optimistic projection. Unless present finding and development rates are accelerated, production will soon begin to decline.

With U.S. petroleum demand constantly growing and domestic supply remaining relatively stable, it is proper to assume that this country will look increasingly to other countries for oil. An important question is, how much foreign oil will be needed and what area of the world will the oil come from? In the projection shown here, 6.5 million B/D will be needed in 1975, and about 10 million B/D in 1980.

There are four major exporting regions in the world: South America (Venezuela); Africa (Libya, Algeria, and Nigeria); Indonesia; and the Persian Gulf countries (Middle East). South American and Persian Gulf oil tend to be high sulfur oil, whereas African and Indonesian oils tend to be low in sulfur. Environmental constraints in this country as well as other countries will probably require most fuel oil to be of low sulfur content. This will probably mean low sulfur crude oil will be sold at a premium price, compared to high sulfur oil, reflecting a cost savings on desulfurization equipment.

It would be difficult to predict at this time exactly where all of our imported oil will come from. But as far as the environment is concerned, it should make little difference because most high sulfur crude oil used in the United States will be desulfurized. If European and Japanese environmental constraints lag behind U.S. criteria, domestic firms, anxious to save the cost of desulfurization, will outbid foreign firms for low sulfur crude. Of course this would accelerate environmental concerns in foreign developed areas since these countries would be left using increasing quantities of high sulfur oil. Therefore, it seems logical that other developed nations will adopt environmental regulations similar to those that are forthcoming in the United States, and low sulfur crude oil will be distributed throughout the world by other considerations, such as transportation and product yield slates.

There is one other aspect that should be noted at this point. The United States is in a unique and slightly advantageous position compared to other large oil-consuming countries. Much of our domestic crude oil production in East Texas and Louisiana is low in sulfur. This will afford our domestic refineries some additional flexibility in optimizing the use of low sulfur oil, high sulfur oil, and desulfurization facilities.

In the second figure crude oil producing areas of the world are depicted and the areas are drawn in proportion to their known reserves. The crude oil production in all regions except the Persian Gulf is committed for consumption, due either to proximity to a consuming area or qualify of the oil. The crude oil production in these areas is insufficient to meet world consumption needs; because of this, most of our additional imports, as well as the rest of the importing countries' crude oil, will come from the Persian Gulf.

Before leaving the subject of crude oil supply and demand, I am obligated to point out some problems concerned with projecting the quantity of oil that will be imported. Referring to the first figure that was discussed, an oil supply/demand balance was presented. The imports that are necessary for the country can be calculated by the difference in estimated oil demand and domestic oil supply. This sounds simple enough, but other factors affect and complicate the issue.

Figure 3 displays the total energy supply/demand balance for the United States for the present century. As can be seen, oil is a large part of the total energy picture. More importantly, it is also the alternate or "swing" source of energy. If there are shortfalls in the development and utilization of nuclear, gas, or coal, oil will be required to fill the gap.

Projections concerning the timing and quantity of coal, gas and nuclear development vary greatly. For instance, in figure 4, projections by Interior's Bureau of Mines, the Federal Power Commission and the National Petroleum Council, are given for domestic natural gas production. These gas projections appear on the surface to be quite different, but they are consistent with the bases and assumptions used by each group. The point here is that there are many things that can happen which will affect the development of our various sources of energy; several assumptions can be made; and a lot of personal judgment is involved in anticipating fuels usage. This results in a very clouded picture of the exact quantity of oil imports that will be needed for the future. Therefore, it is necessary that I caution against naive use of the oil import projection used in this presentation.

The next topic I wish to comment upon is the form in which the oil will be imported, that is crude oil or refined oil products. At the present time foreign residual fuel oil (a refined product) is, for all practical purposes, freely imported into District I (states on the Eastern Seaboard). However, the domestic refiner is not allowed freely imported foreign crude oil from which to manufacture residual fuel oil for District I. The domestic refiner has to use higher cost domestic crude oil or foreign crude oil imported pursuant to an oil import quota to manufacture residual fuel oil; this has caused domestically produced residual fuel oil to be at a higher cost and to be noncompetitive. In figure 5 the imports of foreign residual fuel oil over the past decade are shown in comparison with imports of foreign crude oil. As can be seen in the figure, imports of residual fuel oil which were once about 50% of crude oil imports have now exceeded crude oil imports.

Residual fuel oil is a natural and significant product of crude oil. A yield of 50% residual fuel oil can be derived from typical or average crudes and a yield of 25% remains after mild or moderate petroleum refining. The average residual fuel oil yield in U.S. refineries is 5 to 6%. The lack of residual fuel oil production in the United States is a result of high conversion or severe refinery processing in a complex refinery configuration. The utilization of high severity processing in the domestic petroleum industry, which has resulted in the destruction and conversion of resid, was originally attributed to the fact that the resid had to compete with low priced coal and natural gas as burner fuel. However, from the present time forward, due to the inadequate development of natural gas and disqualification of certain coal uses, the lack of domestic residual fuel oil production must be attributed to the import situation.

The import situation is subject to change, and one possible change would be to allow domestic refiners imports of foreign crude oil in proportion to the uncontrolled (freely imported) products that are manufactured in domestic facilities. This would have the beneficial effect of allowing refining facilities that may otherwise be built in foreign countries to be built domestically, and it would reduce the magnitude of high severity operations that are typical in the U.S. today. An important question at this point is what would be the effect on the environment from such an action?

As I see it, there would be two significant results of such an action and they would have a nil or possibly beneficial effect on the environment. First of all, there would be more crude oil imported and less products (resid); however, the total level of oil imported is unchanged. Oil that is imported and processed is handled and transferred a little more than oil that is imported and distributed directly to consumers, but this aspect probably has a nil effect on the environment. The second result is that there would probably be more crude oil refined in this country than would otherwise occur. This additional processing may possibly have a slight beneficial effect on the environment because it would reduce the need for extreme high severity processing.

The last point is most significant and can best be illustrated by observing the last three figures of this presentation. Figure 6 is a very simple schematic of a foreign refinery configuration. The process equipment is simple: a crude fractionation tower to separate the crude components, and a reformer to upgrade the naphtha cut into gasoline. A catalytic cracker is shown, but it is only partially colored in order to illustrate that it is not really typical for foreign refineries although there are some in existence. The desulfurizer depicts new equipment that will be going into many refineries.

The next figure illustrates a simple schematic for a U.S. refinery configuration. The contrast of the U.S. refinery to the foreign refinery is apparent; there is a massive amount of equipment (hydrocracker, coker, alkylation unit and cat cracker) that is dedicated to converting the residual fuel oil portion of the crude oil to light products. If, however, the increasing demand for residual fuel oil is considered, and the domestically produced resid is made competitive with foreign resid by a change in the oil import program, a greater yield of resid will be derived.

Figure 8 illustrates the change in refinery configuration which would result from increased resid production. There would be a larger crude oil feed rate, thus, a larger crude fractionating tower. However, many of the light products that were made in the previous configuration by severe cracking would be derived from distillation of crude oil. Furthermore, much of the resid produced by distillation would not be converted, but instead sold as a product. The net result is that more crude oil would be processed, but there would be much less processing of product streams. The type of processing that is reduced is the type that directionally has the most adverse effect on the environment. The high conversion operations generally operate at high temperatures which require significant quantities of fuel and cooling water. Also the processes produce unsaturate hydrocarbons (naphthalenes) and other organic compounds (phenols) that are resistant to biodegradability.

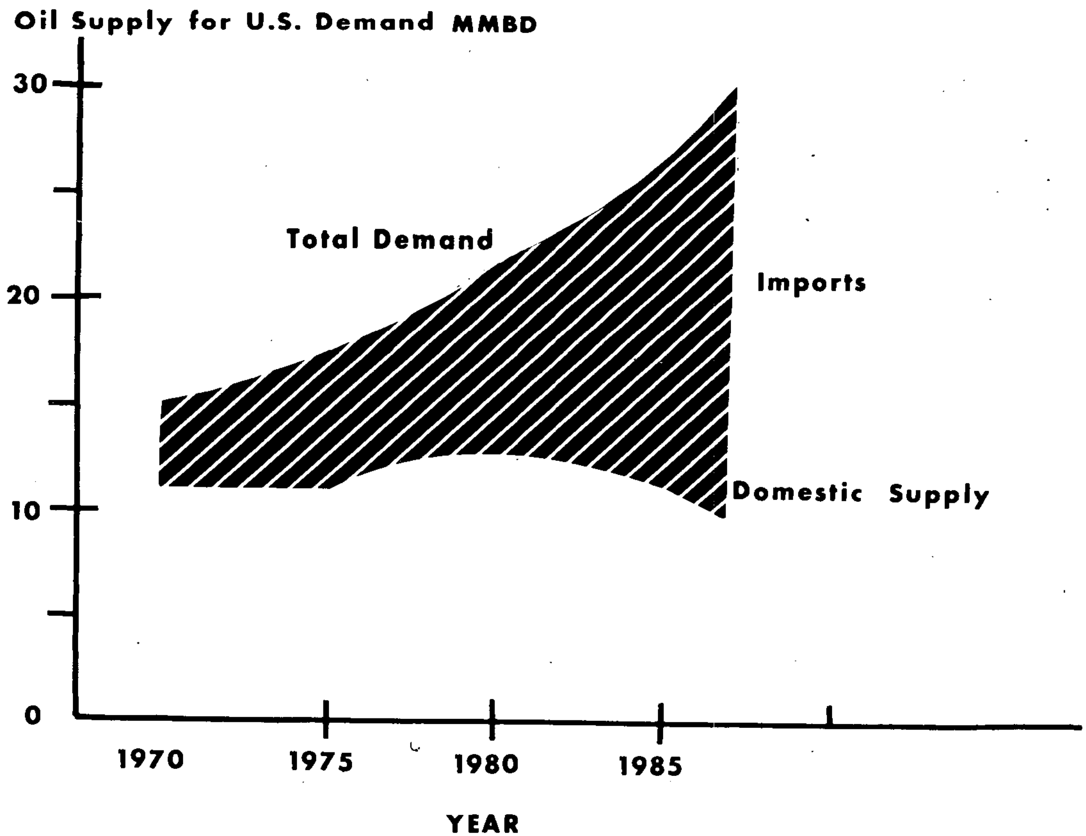
The ultimate refinery configuration would approach that of the foreign refinery. Existing refineries would probably find it advantageous to expand the crude fractionation sections and redistribute product streams to conversion units. The expected result would be a decreased percent conversion for the total crude oil feedstock.

To sum up, we see imports of foreign oil increasing rapidly in this decade. Much of the oil will probably be high sulfur crude oil from the Persian Gulf. We visualize modifications of the oil import program which will enable the refinery equipment, that will process the oil, to be located domestically. This would be beneficial to national security, trade balance, and the domestic economy. The ultimate effect such modifications in the oil import program would have on domestic refinery configurations would probably be slightly beneficial to the environment.

Earlier I referred to the interrelationships of oil, gas, coal and nuclear energy. All these energy sources and the "exotics," which are being developed, will be needed in the future. Yet, Government, as it is presently structured, does not encourage development of a unified energy policy. For example, about 61 Federal agencies are involved in some aspect of oil and gas decisions, and this fragmentation of responsibility can only result in inefficiency.

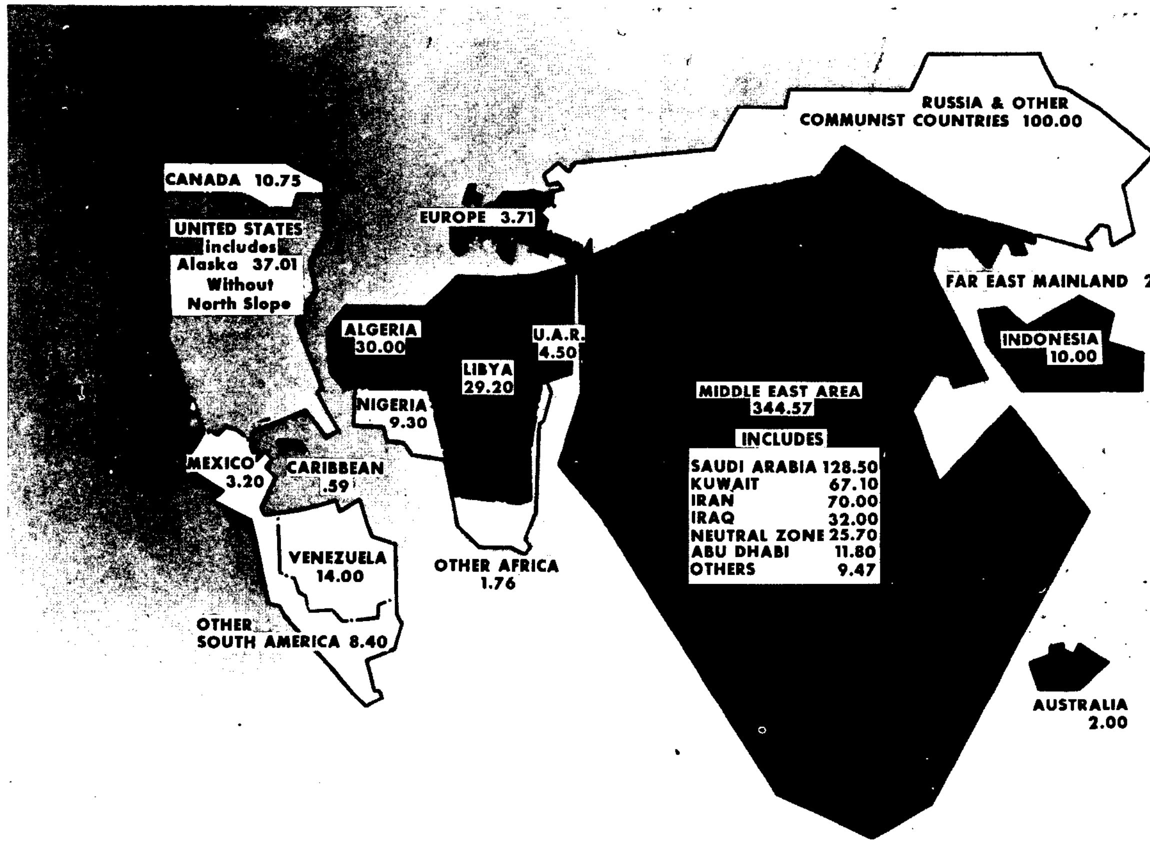
As a first step in overcoming this problem, President Nixon proposed to centralize major energy resource responsibilities in a new Department of Natural Resources. Passage of this legislation is essential if we are to integrate energy conservation and development efforts, and alleviate what more and more people are coming to realize is a serious energy supply problem.

OIL SUPPLY FOR U.S. DEMAND



WHERE THE OIL IS—

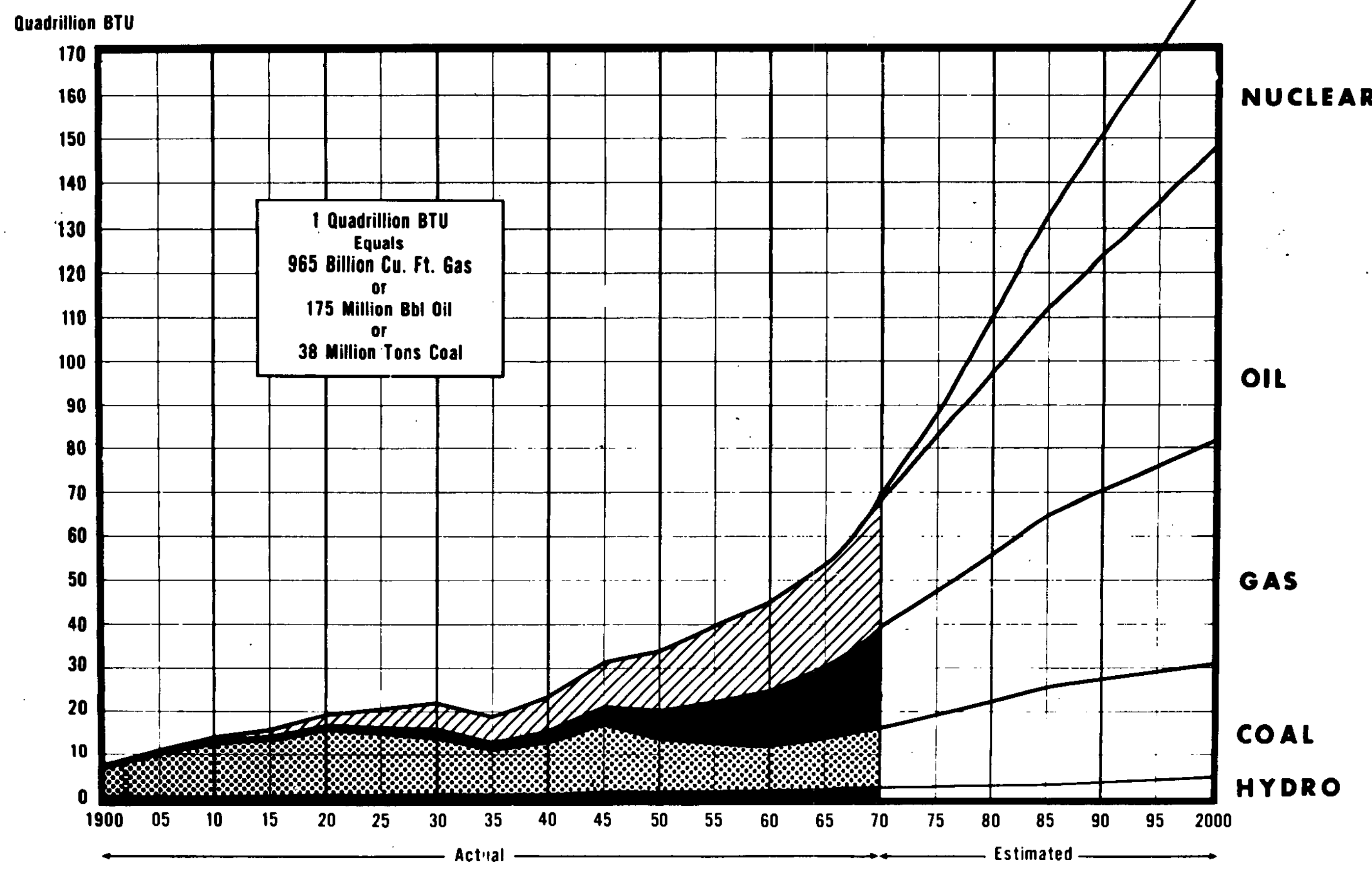
WORLD TOTAL 611.40 BILLION BBLS.
AS OF JANUARY 1, 1971



If geography reflected the reserves of oil in the ground, the map of the world would look like this.

Office of Oil and Gas
Department of the Interior
March 1971

U.S. ENERGY CONSUMPTION IN THE 20th CENTURY



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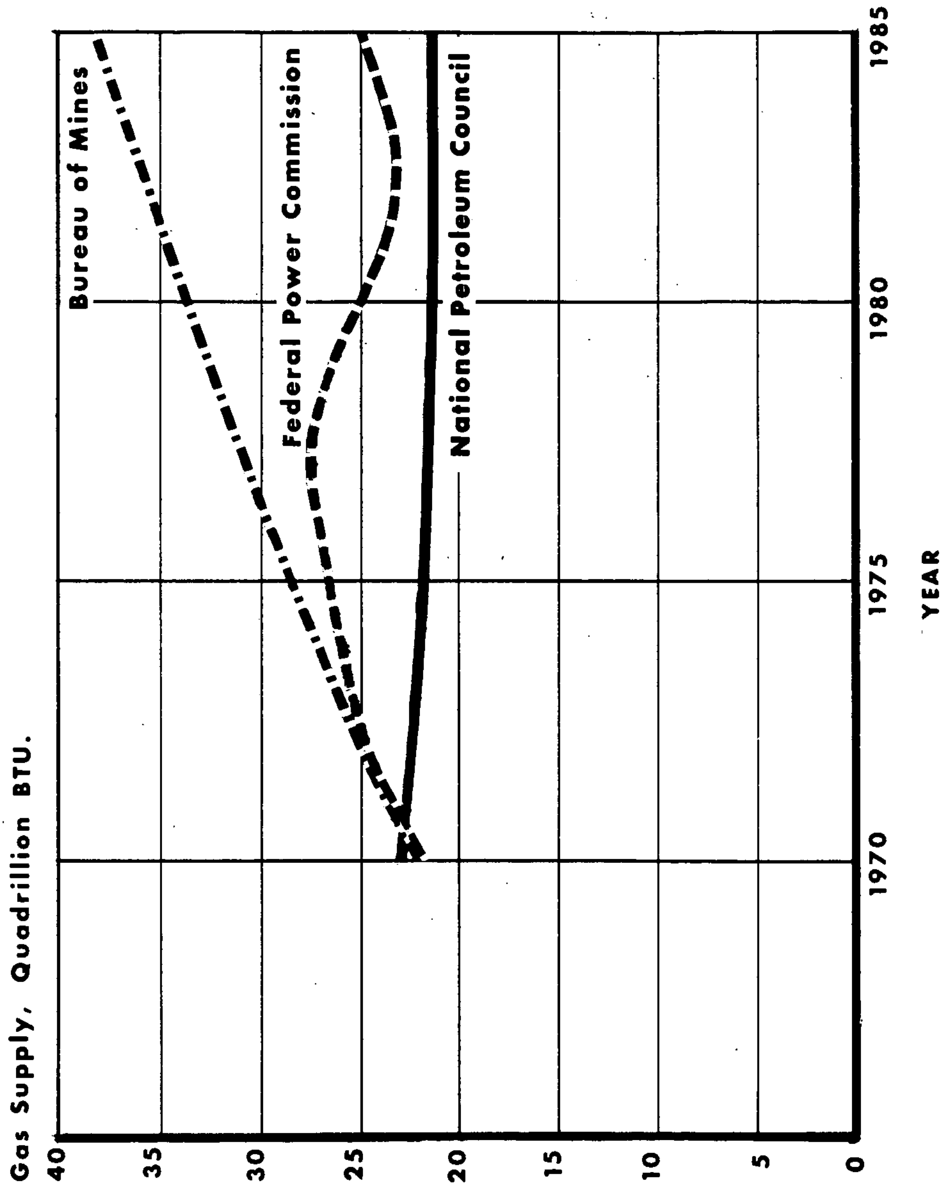
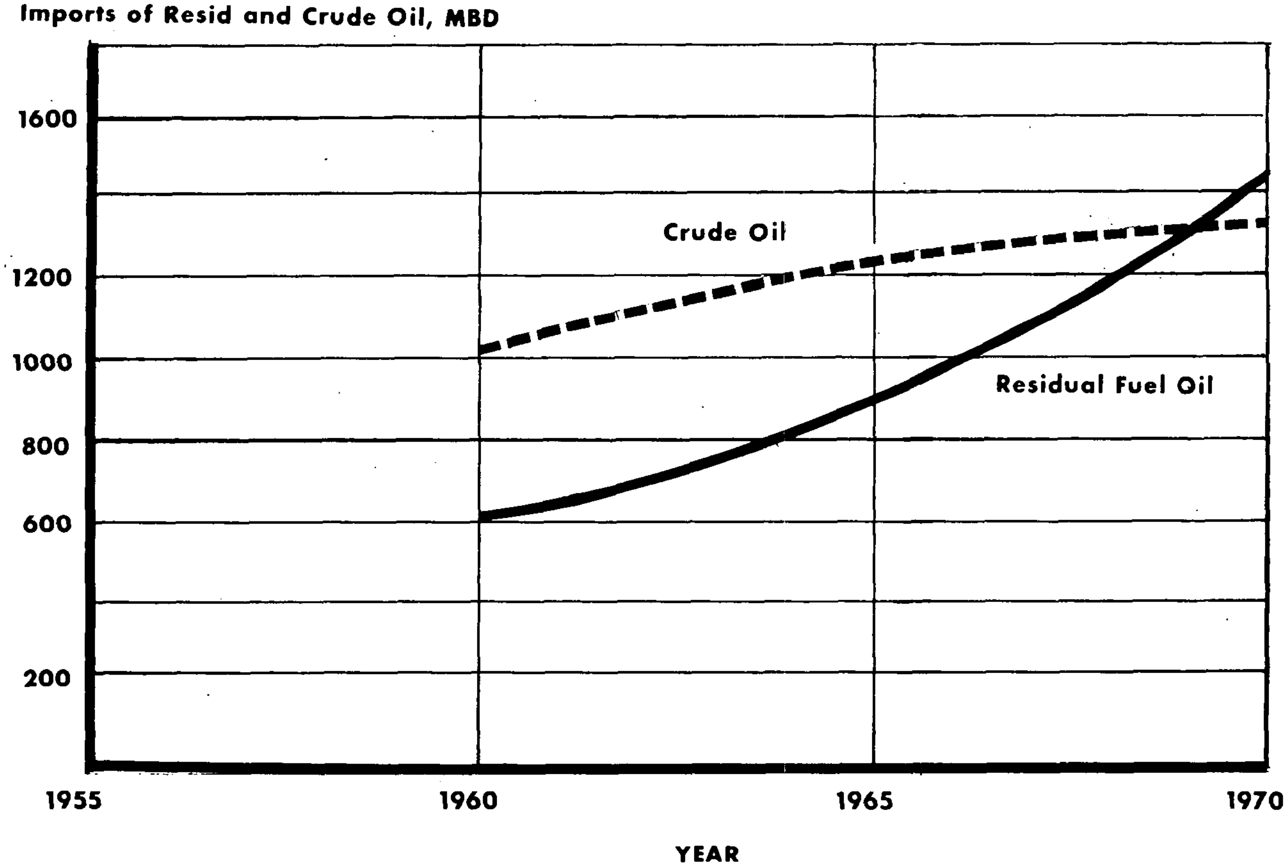
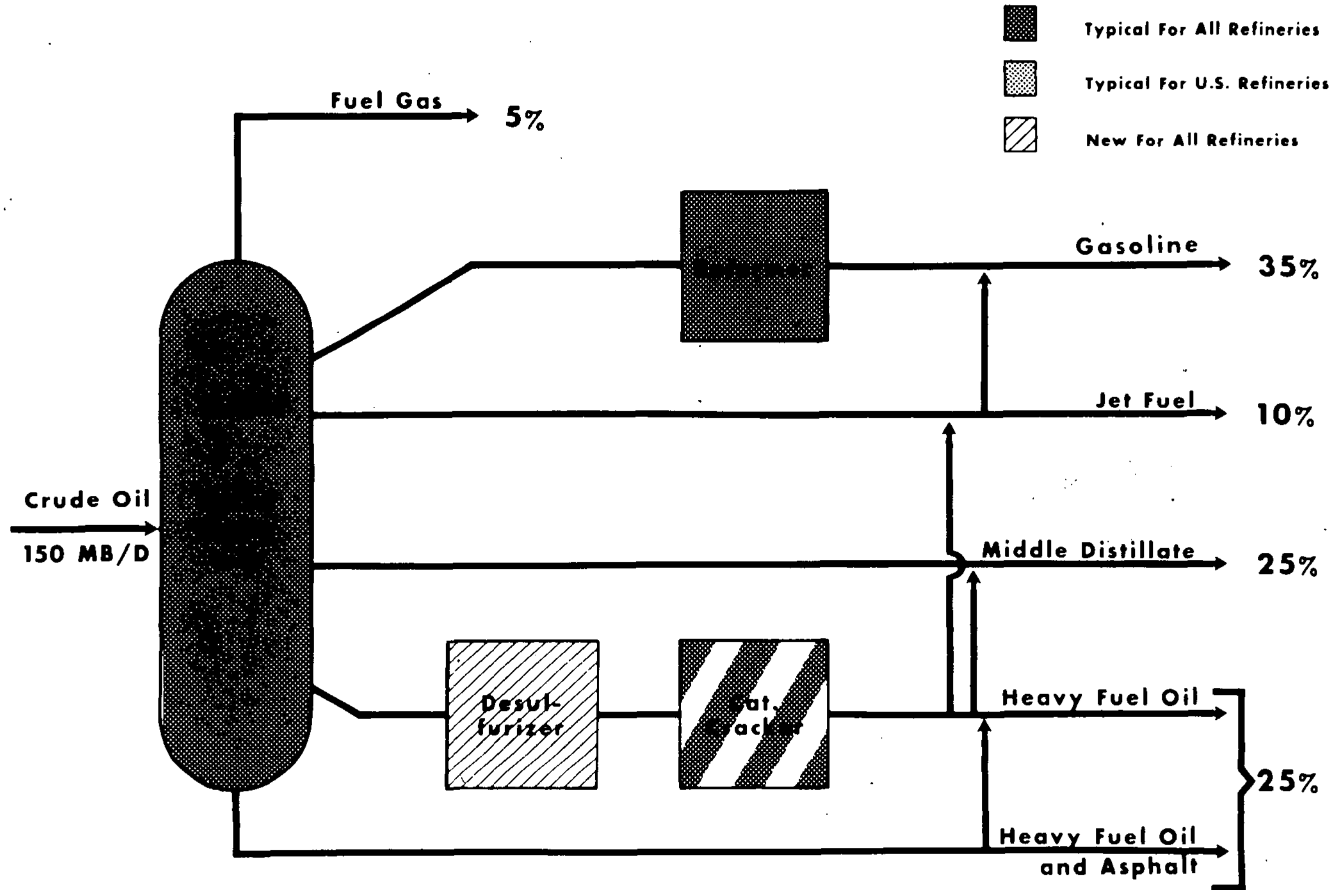
PROJECTED GAS SUPPLY



CRUDE OIL IMPORTS COMPARED TO RESIDUAL FUEL OIL IMPORTS



FOREIGN REFINERY



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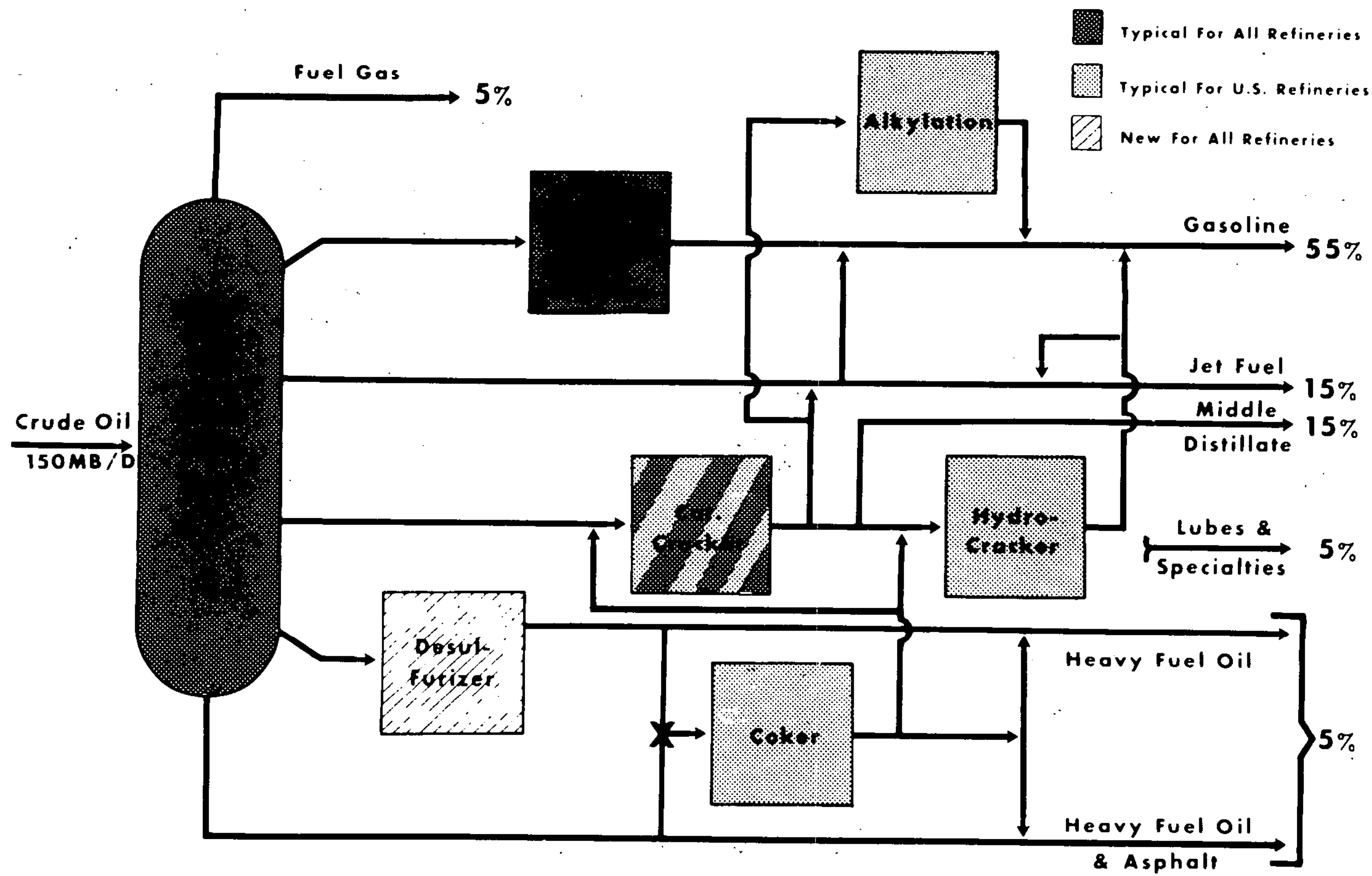
U. S. REFINERY



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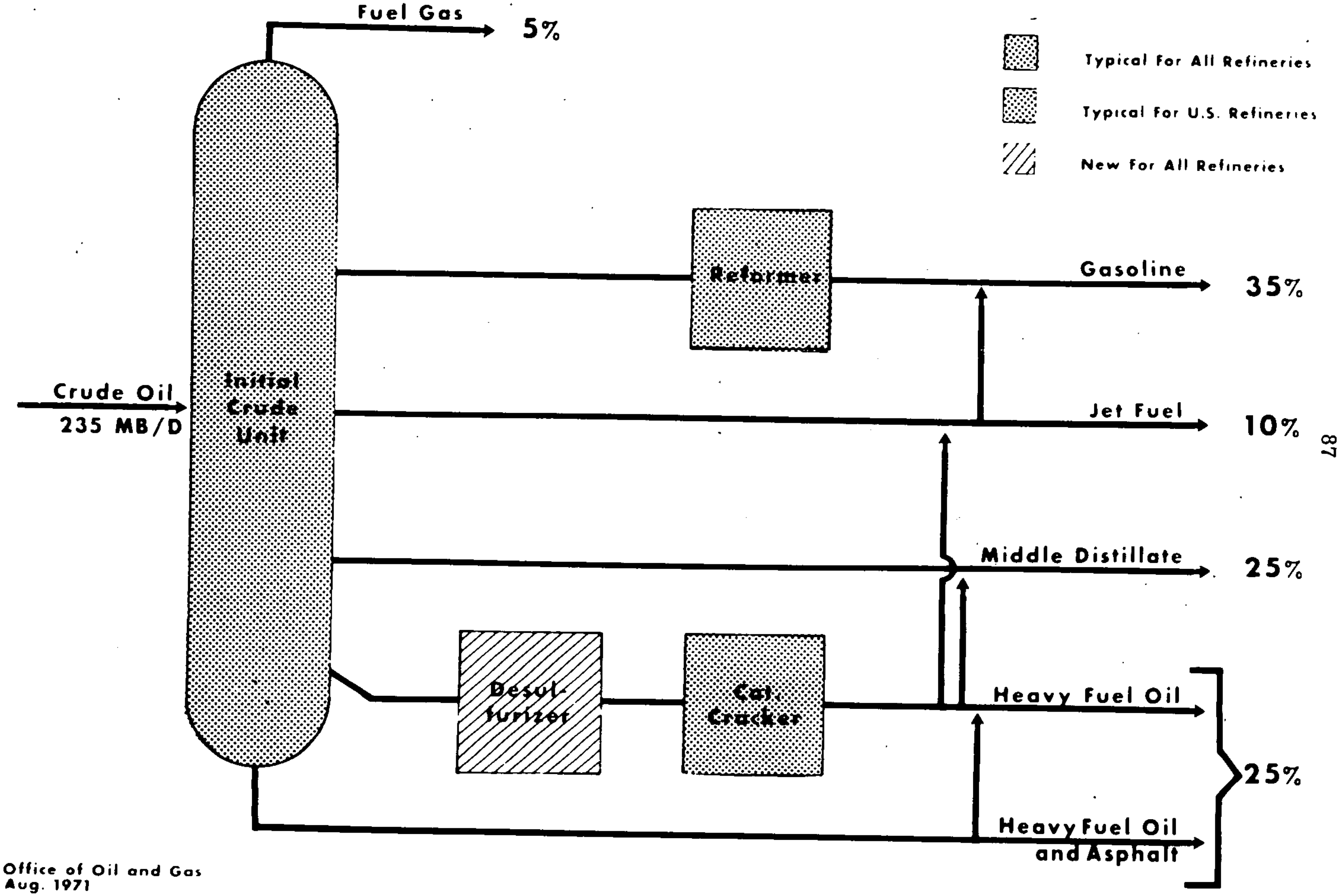
BALANCED REFINERY



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