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Petroleum ✓

Wright

1974

AAEA, 1974

Petroleum for U. S. Agriculture

Robert R. Wilson

The 1970's and 80's have been recognized by many as an era of raw material commodity shortages. The optimism of the 1950's and 1960's that technological advance would ameliorate the alledged paucity of resources on the planet has not been realized in the 1970's. The growthmen and technological fundamentalists have been replaced with quixotics who tilt with the windmills of environmental and commodity crises. The quixotics, of course, also tilt among themselves whenever windmills are scarce. Many feel that public and private investments in technology have not kept pace with the need while others feel that seeking the bananza in advanced technology may result in just another dry hole.

During the past year, critical shortages and/or substantial fluctuations in prices have occured in tin, pig iron, lead, zinc, mercury, antimony, tungsten, silver, magnesium, bismuth, palladium, gold, phosphate, coal, petroleum and petroleum products. Each of these commodities has experienced a price change of more than 50 percent during the past 12 months.

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Serious shortages of natural gas are expected to occur again this year and a scheduled national coal strike could have a more substantial impact on energy supplies this fall and winter than the Arab oil embargo of the previous year.

During the last eighteen months fossil fuels have experienced at least a doubling in price.

The average prices of petroleum products have more than doubled. During the past winter, spot prices of oil reached levels of more than four times their magnitudes of eighteen to twenty-four months ago.

Imports of these critical commodities constitute a significant component of U. S. consumption and most may be subject to actions of international cartels seeking political or monetary gains. The recent Arab oil embargo is sometimes recognized to be an international cartel action to achieve both political and monetary concessions.

The Energy Crisis and the Arab Oil Embargo

The recent energy crisis was apparently a case in which the dynamic market mechanisms failed to attract a level of investment in new domestic petroleum discoveries and refinery capacity sufficient to maintain a relatively stable relationship between domestic consumption and production. Domestic real prices of both crude petroleum and finished petroleum products had declined over the period from World War II to 1972 as a result of competition from lower priced imported

products. As a result of the stable low prices, demands for energy in the United States grew at a phenomenal rate in recent years. By autumn of 1973 the U. S. was importing around thirty-six percent of its petroleum consumption. Most of the imported petroleum came from Arab countries and domestic crude petroleum production had begun to decline.

Throughout 1973 there was a growing apprehension that the U. S. might neither be able to produce nor to import enough petroleum products at existing market prices to avert a major disaster during the winter of 1973-74. There had long been discontent about low petroleum prices among the members of Organization of Petroleum Exporting Countries. The October, 1973 Mid East War precipitated increasing pressures for political sanctions against the U. S. The resultant Arab oil embargo compounded an existing energy crisis in the U. S.

Prices of crude petroleum and products rose rapidly during the months of the Arab embargo. Domestically, prices have stabilized at around double their levels of a year ago.

There is evidence that a market clearing solution has been reached. There are now reports that prices of petroleum products in the U. S., particularly gasoline, have fallen slightly from their levels in June 1974. In addition, the Treasury Department has estimated an international oil surplus of 1.5 to 2 million barrels per day at current prices.^{1/} The American Petroleum Institute has reported 7745 new oil and

^{1/}This estimate was for July 1974. By September 1974 the estimated international oil surplus had doubled.

gas well completions in the U. S. during the second quarter of 1974, an increase of 34.2 percent over the second quarter of 1973, foretelling increased domestic supplies of crude oil.

Supplies of petroleum products are expected to meet demands during the remainder of 1974 and possibly into 1975, provided that no new embargo or similar action occurs and limited conservation and price induced changes in demand prevail (12). An extended coal strike in the fall of 1974 could cause serious shortages in the industrial sector and in electric power generation. Steel production could be substantially effected by a strike of more than thirty days, and electric power shortages are expected with a slightly longer strike.

From the market disequilibrium standpoint the petroleum component of the energy crisis would appear to be solved.^{2/} The market solution is highly dependent, however, on imports of foreign oil, which leaves the market strategically vulnerable to international cartel actions including oil interruptions or price increases.

In the next sections, U. S. demands for petroleum products of importance to the agricultural sector and agricultural demands for these products will be considered.

F.E.A. Petroleum Forecasting Equations

In late 1973 after the imposition of the Arab oil embargo

^{2/}Balance of payments and international financial problems may become almost as critical as energy shortfalls.

it became desirable for the Federal Energy Office to develop monthly forecasting relationships with which to predict shortages of major petroleum products. The author was assigned to develop several of these relationships including forecasting equations for motor gasoline, aviation gasoline, and liquefied petroleum gases. These relationships covered the major areas of agricultural demand with the exception of diesel fuel which was classified under the distillate oil demand in the F.E.O. forecasting model.^{3/}

The forecasting equations are assumed to be reduced from equations of market consumption. No hypotheses about the structure of supply and demand are suggested. Though price appears in the motor gasoline equation, it was assumed that price was an exogenous variable in the short run. All consumption data were taken from monthly petroleum statements of the Bureau of Mines. Although these relationships were developed in an on-rush of a great crisis in November and December of 1973 and subject to massive subsequent improvements, they remained the official short term forecasting instruments of the Federal Energy Administration throughout the oil embargo and past mid-summer of 1974.

^{3/} The distillate oil equation was developed by Dr. Frank J. Alessio. These relationships were reported in detail in Technical Report 74-2 of the Federal Energy Office(12).

A. The Forecasting Equation

The forecasting equations are as follows:

1. Motor Gasoline: The forecasts of the annual domestic demand for motor gasoline are based on the following monthly equation:

$$\begin{aligned}
 \text{DMG} = & 59.418 - 114.69 * \text{PMG} \\
 & (5.26220) \quad (-2.70527) \\
 & + .00095993 * \text{PY} - .011088 * \text{DD} \\
 & (5.88119) \quad (-4.02857) \\
 & - 4.2310 * \text{S02} + 2.5410 * \text{S03} \\
 & (-1.92947) \quad (1.49715) \\
 & - 5.0821 * \text{S09} + 4.8020 * \text{S12} \\
 & (-2.44418) \quad (2.04327) \\
 & + .51089 * \text{DMG} (-12) \\
 & (+4.69341) \\
 & (\text{RHOG}^{\text{K1}}) * (\text{GACT} - \text{GSTAR}) \\
 & (2.73478)
 \end{aligned}$$

$$\begin{aligned}
 & -2 \\
 \text{R} & = .9660; \text{DW} = 2.1666; \text{SE} = 3.88266; \text{RHOG} = 0.312165;
 \end{aligned}$$

where DMG $\equiv$ domestic demand for motor gasoline, millions of barrels per month, PMG $\equiv$ monthly average price (in dollars per gallon) at 55 cities for major brandname, regular gasoline excluding taxes; PY $\equiv$ monthly total personal income in millions of current dollars, DD $\equiv$ national monthly degree days; GACT $\equiv$ actual domestic monthly total demand for motor

^{4/}The numbers in parentheses are t statistics.

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gasoline in July 1973; GSTAR $\equiv$ the forecast from the above equation omitting $(RHOG^{K1}) * (GACT - GSTAR)$ for July 1973; $K1 = 6, 7, \dots, 17$ for January through December respectively; $S02, S03, S09$, and $S12$ are seasonal dummy variables for February, March, September, and December respectively. DMG was obtained from the Bureau of Mines Monthly Petroleum statements (11); PMG was obtained from Data Resources Inc.; and PY was obtained from the McGraw-Hill Survey of Personal Income (9).

2. Aviation Gasoline: The forecasts of the annual domestic demand for aviation gasoline are based on the following monthly equation:

$$\begin{aligned} DAG = & 8.0027 + .00004409 * PY \\ & (.4.42716) (2.02243) \\ & - .00027596 * DD - 0.03409 * T \\ & (-3.59753) (-3.21016) \\ & + .31531 * DAG (-12) \\ & (3.18226) \end{aligned}$$

$\bar{R}^2 = .8733$; $DW = 1.80$; $SE = .252689$; where DAG $\equiv$ domestic total demand for aviation gasoline, millions of barrels per month, T $\equiv$ a linear time trend and the remaining variable as defined above. DAG was obtained from the Bureau of Mines Monthly Petroleum Statements (11).

3. Distillate Oil: The forecasts of the annual demand for distillate fuel are based on the following monthly equation:

$$\begin{aligned} \text{DDO} = & 12.294 + .00036228 * \text{PY} \\ & (6.93173) \quad (10.1312) \\ & + 0.0000000033 * \text{BNT} * \text{DD} \\ & (12.6486) \\ & + .30357 * \text{DDO}(-12) \\ & (5.52326) \end{aligned}$$

⁻²
 $R = .9739$; $DW = 1.8901$; $SE = 3.64352$; where DDO = domestic total demand for distillate fuel oil, millions of barrels per month, BNT = number of oil burner tips in use at end of month, and the remaining variables as defined above. DDO was obtained from the Bureau of Mines, Monthly Petroleum Statements (11) and BNT was obtained from Fuel Oil and Oil Heat Magazine (4).

4. Liquefied Petroleum Gases: The forecasts of the annual domestic demand for liquefied petroleum gases are based on the following monthly equation:

$$\begin{aligned} \text{LG} = & -1.0417 + .0060598 * \text{DD} \\ & (-0.300991) \quad (4.11148) \\ & + 7.1578 * \text{FRBC} + .68081 * \text{DLG}(-12) \\ & (2.52202) \quad (7.61227) \\ & - (\text{RHOLG}^{\text{K}2}) * (\text{LGACT} - \text{LGSTAR}) \\ & (5.65390) \end{aligned}$$

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$R = .9254$; $DW = 2.0077$; $SE = 2.0528$; $RHOLG = .54556$;

where LG = domestic total demand for liquefied gases, millions of barrels per month. $FRBC$ = FRB production index of chemicals and products; $DLG (-12)$ = domestic total demand for liquefied gases, lagged 12 months; $LGACT$ = actual domestic monthly demand for liquefied gases in September 1973; $LGSTAR$ = the forecast from the above equation omitting $(RHOLG^{K2}) * (LGACT - LGSTAR)$ for September 1973; $K2 = 4, 5, \dots, 15$ for January through December 1974 respectively. DLG was obtained from the Bureau of Mines Monthly Petroleum Statements (11) and $FRBC$ was obtained from the Federal Reserve Bulletin (3).

The aviation gasoline and distillate oil equations were estimated using ordinary least squares. The motor gasoline and liquefied petroleum gases equations were estimated using the ~~Cochrane-Orcutt~~ method for a first order autoregressive process (7). By extending a result given in Johnston (7) it can be shown that the statement of the autoregressive equations given provides best linear unbiased forecasts.

The reporting of t-statistics rather than standard errors is subject to criticism. Generally, the exact distribution of least squares parameter estimates from distributed lag or autoregressive models is not known. In addition, if the price in the motor gasoline equation is truly endogenous then the parameter estimates in the gasoline equation are not consistent.

Forecasts of Petroleum Consumption

Forecasts of U. S. consumption during 1974 and 1975 of motor gasoline, aviation gasoline, distillate oil and liquefied petroleum gases were based on the F.E.A. short term forecasting equations.^{5/} Agricultural consumption for these products was forecasted using methods developed during a study of end use demands for petroleum products conducted for F.E.A. (21), and modified as noted in the following sections.

Motor Gasoline: Forecasts of U. S. total consumption of motor gasoline were based on the April 26, 1974 unconstrained F.E.A. forecasts adjusted for changes in prices(12). The F.E.A. forecasts assumed a constant average price of

^{5/} The F.E.A. short term forecasts were revised in August 1974 after this paper was prepared(13).

30 cents per gallon exclusive of taxes throughout 1974. (Table 1). The prices employed in the present forecast were the actual average prices, 39 cents, 41 cents, and 43.5 cents per gallon for the first and second quarters and July 1974. The 43.5 cent price was assumed to prevail for the remainder of 1974 and 1975. By late July 1974, prices were reported to be falling slightly (22). The present forecast is also given in Table 1. Consumption in 1974 is forecasted at 2,391 million barrels and in 1975 at 2,446 million barrels, the difference arising from growth in personal income similar to that in 1974.

The apparent price effect is ^{the} difference between the actual price in the period and the 30 cent pre-embargo price assumed in the F.E.O. unconstrained demand forecast, weighted with the price coefficient from the equation, converted to thousands of barrels per day. During the first two quarters of 1974, mandatory conservation, including reduced speed limits, long lines and uncertainty about the availability of gasoline apparently accounted for considerable reductions in demand. There is considerable risk in interpreting

Table 1.

Motor Gasoline Consumption and Forecasts - 1974 and 1975.

	<u>Forecast</u>		Apparent	FEO Forecast	Apparent	Apparent
	FEO Uncon-	Present	Con-	Less	Price	Conservation
	strained	Analysis	sumption	-Apparent	Effect	Effect
	<u>Pre Embargo</u>	<u>Analysis</u>	<u> </u>	<u>Consumption</u>	<u> </u>	<u> </u>
1974	Thousands of Barrels					
QTR						
I	6500	6100	5800	700	400	300
II	7100	6700	6500	600	400	200
July	7300	6800	6800	500	500	0
III	7300	6800			500	
IV	7100	6600			500	
1974 Annual	7000	6550				
		2391	million barrels			
1975 Annual		6700				
		2446	million barrels			

the price coefficient as representing a price effect since the forecasting equation does not represent a structural demand hypothesis and the data are extrapolated far beyond the range of estimation. It would appear that in the July 1974 forecast the apparent price effect is overstated because some mandatory conservation (lowered speed limits) remain in effect but there is no apparent conservation effect.

Although the motor gasoline equation is not structural, price elasticity estimates were developed. At the end of the data series for estimation (July 1973) the price was 26.78 cents per gallon and consumption was about 7100 barrels per day. The short and long run price elasticity estimates in July 1973 were $-.140$ and $-.285$, respectively. Extrapolating the price coefficient well beyond the range of the data, the short and long run price elasticity estimates in July 1974 were $-.237$ and $-.485$, respectively. Structural relationships, however, should be developed covering more recent data with substantial price changes for reliable estimation of price elasticities.

Agricultural consumption of motor gasoline was forecasted for 1974 and 1975 based on the total motor gasoline consumption forecasts for the period and a study of end use demands for all petroleum products prepared for F.E.A. (21). These forecasts of agricultural consumption of motor gasoline along with an unpublished 1974 forecast by the U.S. Department of Agriculture are given in Table 2.

In that study, it was estimated that 3.1 percent of total motor gasoline consumption was for off-highway purposes. This would imply off-highway consumption of 203 thousand barrels per day or 74 million barrels per year for 1974. For 1975 off-highway consumption is forecasted at 208 thousand barrels per day or 76 million barrels per year.

Agricultural consumption of motor gasoline for off-highway use was estimated at 60 percent of total off-highway consumption, based on Federal Highway Administration tax refund data (6). The 60 percent figure implies forecasted agricultural consumption for which tax refunds were claimed of 122 thousand barrels per day or 45 million barrels per year in 1974 and in 1975, 125 thousand barrels per day or 46 million barrels per year.

Based on unpublished results of the 1971 Farm Expenditure Survey, some 54.9 percent of motor gasoline purchases by farmers were delivered to the farm.(17) The remaining 45.1 percent was purchased at service stations. Assuming that only 54.9 percent of farm use of motor gasoline was claimed for tax exemptions the forecasts of agricultural consumption becomes 222 thousand barrels per day, or 81 million barrels for 1974 and 228 thousand barrels per day, or 84 million for 1975.

Table 2
Forecasted Agricultural Consumption of Petroleum Products

<u>Product</u>	<u>1974 Forecast</u>		<u>1975</u>
	<u>Present</u>	<u>U. S. D. A.*</u> (Million Barrels Per Year)	<u>Present Forecast</u>
1. Motor Gasoline	81	95	84
2. Aviation Gasoline	1	-	1
3. Diesel Fuel	51	66	61
4. L. P. Gas	18	36	19

* Unpublished Forecasts of the U. S. Department of Agriculture

Aviation Gasoline: The F.E.A. forecasting relationship yielded 31, 40, 40 and 36 thousand barrels per day for the first, second, third and fourth quarters of 1974, respectively, or an average of 36.75 thousand barrels per day. (12). Extrapolating the same increase in personal income in 1975 as forecasted for 1974 and accounting for the time trend the forecasted average daily consumption for 1975 is 37.65 thousand barrels per day. Annual forecasts of consumption of aviation gasoline are 13.4 million barrels and 13.7 million barrels for 1974 and 1975.

The 1975 figure would imply a reversal in the downward trend in aviation gasoline consumption as evidenced in the data for the past several years. Since there would appear to be no circumstance to warrant an increase, the 1975 forecast should be treated with caution and the forecasting relationship re-estimated using more recent data.

Based on the F.E.A. end use study (21), business and personal use of aviation gasoline is about 28.4 percent of total aviation gasoline consumption. Forecasts for the business and personal use categories for 1974 and 1975 are 3.8 and 3.9 million barrels, respectively.

Agricultural use of aviation gasoline in 1971 was 920 thousand barrels (5). Based on a 3 percent long term growth rate in agricultural use, agricultural use of aviation gasoline is forecasted at about 1 million barrels both for 1974 and 1975, or about 25 percent of business and personal use (Table 2).

Distillate Oil and Diesel Fuel: Based on the F.E.A. forecasting relationships (12) total U. S. demand for distillate oil in 1974 is forecasted at 4366, 2513, 2345, and 3551 thousand barrels per day. For July 1974, apparent consumption was 2247 thousand barrels per day, 42 thousand barrels per day higher than the F.E.A. forecast.

It is significant that the F.E.A. forecasting relationships and unconstrained forecasts are based on time series ending in January 1972. Prices of distillate oil have increased more than 100 percent at wholesale during the subsequent 19 months. Consumption does not appear to be highly sensitive to price effects.

Based on this apparent lack of price sensitivity, and that conservation effects are largely voluntary, the 1974 F.E.A. unconstrained consumption forecast of 3190 thousand barrels per day, or 1164 million barrels, was assumed.

The effect of a change in numbers of burnertips of the magnitude of the 1973 to 1974 change is forecasted to change consumption by less than a thousand barrels per day. A constant rate of growth in income over the 1973-1975 period implies an increase in the consumption forecast for 1975 over 1974 by 634 thousand barrels per day, to 3824 thousand barrels per day. Annually, such a 1975 forecast would amount to 1396 million barrels.

Agricultural consumption of distillate oil is a portion of off-highway diesel use. Off-highway diesel use was projected at 4.4 percent of the total consumption of distillate oil in the F.E.A. study of end uses of petroleum (21). Applying this fraction to the 1974 and 1975 consumption forecasts, off-highway use of diesel is forecasted at 51.2 million barrels in 1974 and 61.4 million barrels in 1975. The off-highway portion of distillate oil demand was based on Bureau of Mines Sales Survey data (21).

The U. S. Department of Agriculture put 1973 farm use of diesel fuel at 60 million barrels and forecasted a 66 million barrel usage in 1974. Both figures exceed the F.E.A. off-highway diesel use estimate. In this paper it is assumed that the 51 million barrels for 1974 and the

61.4 million barrels for 1975 of off-highway diesel consumption constitute agricultural consumption (Table 2).

Liquefied Petroleum Gases: The unconstrained F.E.A. forecast of consumption of liquefied petroleum gas was adopted in the present analysis (12). This forecast is 1556, 1041, 1018, and 1508 thousand barrels during the first, second, third and fourth quarters of 1974, or an average of 1281 thousand barrels per day. Based on a Data Resources Inc. forecast of the growth in the Federal Reserve Board Index of Chemicals and Products of .173 points for 1975 (3), the 1975 forecast of consumption of liquefied petroleum gases is 1302 thousand barrels per day. The forecasts of annual liquefied petroleum gas consumption for 1974 and 1975 are 468 and 475 million barrels, respectively.

Based on the F.E.A. end use demand study (21), agricultural use of liquefied petroleum gases falls into the end use categories of internal combustion engines and in other uses. According to the Bureau of Mines sales survey definitions it is assumed that all of the other use category is agricultural (21). Based on 1.8 percent of total liquefied gas consumption from the F.E.A. end use study, 8.4 million

barrels of other (agricultural) use is forecasted for 1974. By applying the 1.8 percent to the 1975 forecast, a consumption of 8.6 million barrels is forecasted for other use in 1975. The U. S. Department of Agriculture estimated that 1973 use of liquefied petroleum gases for drying corn and tobacco totaled 18.6 million barrels. Based on the 1971 Farm Production Expenditure Survey 46 percent of agricultural use was other uses (8). Applying the 46 percent figure to the 8.4 and 8.6 million barrel figures, total agricultural consumption forecasts would be 18.3 and 18.7 million barrels in 1974 and 1975, respectively (Table 2).

Agricultural production use was forecasted as 35.7 million barrels by the U. S. Department of Agriculture for 1974. Total consumption on farms including home heating should total more than 70 million barrels in 1974 based on a 1971 figure of 55 percent of farm use as home heating (8). The comparison of U. S. Department of Agriculture and Bureau of Mines based data on agricultural consumption implies serious discrepancies between the two data sources. Doubt is cast that meaningful forecasts of agricultural consumption of liquefied petroleum gases can be based on the F.E.A. end use demand study and the Bureau of Mines sales survey(21).

Other Energy Consumption: Gavett (5) reports that the fertilizer industry consumes about 2 percent of the U. S. natural gas consumption or about 375 billion cubic feet on an annual basis. Most of the natural gas, 325 billion cubic feet, is used in the production of ammonia, the remainder being used in the drying of other fertilizer elements.

Gavett also estimates that around 40 billion kilowatt hours are consumed on farms, or about 2 percent of the total. About 15 percent of this electric power, nationally, is generated with petroleum. In addition, an estimated 81 million barrels of diesel fuel and 9 million barrels of gasoline are used to move agricultural products to markets (5).

In 1974, U. S. petroleum consumption is expected to be around 6.2 billion barrels of oil (12). Agricultural consumption of petroleum will total around 260 million barrels, including transport to market. Thus agriculture is expected to consume around 4 percent of U. S. petroleum in 1974 and 1975. Beyond 1975, growth rates of agricultural consumption of petroleum are not expected to exceed 2 or 3 percent in the absence of substantial changes in agricultural technology or demands for agricultural products.

Future U. S. Petroleum Supplies

Domestic production of crude petroleum reached an all time peak of 9.8 million barrels per day in April, 1971 and has declined since that time except for limited oscillations. Imports of crude oil reached a peak level of 3.8 million barrels in October of 1973, dropped sharply during the Arab oil embargo and had resumed their previous peak levels by May of 1974. Imports of finished petroleum products peaked in February 1973 at 3.6 million barrels per day and were at 3.0 million barrels per day in May 1974 (10).

The U. S. has only two options if it is to satisfy its petroleum demands at existing prices: supplies of petroleum can be either produced domestically or imported.

Existing productive capacity is relatively fixed; but can be changed somewhat in the future. According to the latest estimates of the Geological Survey (19), the sum of measured and inferred reserves range from 62.7 to 79.2 billion barrels for the onshore coterminous states and Alaska. Offshore measured and inferred reserves range from 10.6 to 14.1 billion barrels. Except for the Gulf of Mexico and offshore California areas, the offshore areas are essentially unexplored. Total cumulative production to the present time has been about 120 billion barrels for the U. S. Thus, more than half of

all measured and inferred reserves ever discovered in the U. S. have been produced.

The Geological Survey also estimates that from 135 to 270 billion barrels of undiscovered recoverable resources (not necessarily economically producible) remain in Alaska and coterminous states onshore. An additional 65 to 130 billion barrels of undiscovered recoverable resources are estimated for the offshore areas. These undiscovered recoverable resources of 200 to 400 billion barrels are inferred from seismic and other geological and geophysical data and are not, of course, based on exploratory drilling. The offshore areas, particularly, have received little exploration.^{6/}

If the Geological Survey estimates are correct there is from 3 to 5 times as much petroleum remaining to be produced in the U. S. as has been produced to date. The oil industry has challenged the Geological Survey estimates indicating that they may be 2 to 5 times too high, with most of the remaining undiscovered recoverable oil in the offshore areas(14).

Newly discovered oil now brings a market price of between \$10 and \$11 per barrel in the U. S. Economic costs of

^{6/} The one-third of the undiscovered recoverable petroleum resources estimated to lie on the outer continental shelf cannot receive exploratory drilling until the submerged lands are leased by the federal government. It is now the policy of the Secretary of the Interior to accelerate the leasing of these submerged lands to 10 million acres per year for the next five years.

exploration, development and producing new oil are escalating rapidly because of the increased demand for oil field equipment and manpower at oil prices triple those of two years ago. At rates of return of 10 to 15 percent, the oil industry may not find it attractive to explore and develop much of the small and difficult to find onshore resources estimated by the Geological Survey. In the offshore areas exploration, development and production costs are much greater than onshore, particularly for offshore Alaska. Oil in some areas might not be producible at real prices per barrel under \$30, an order of magnitude greater than 1972 prices. On the other hand, the best offshore areas in the Atlantic Ocean and offshore Alaska might be able to yield oil for \$2 to \$3 per barrel. Lead times for the development and production of these resources is more than ten years in many cases. The magnitude of the remaining resources and the prices at which such resources could be developed are highly uncertain at the present time. These uncertainties make any plans currently being laid to achieve energy independence at some future date highly speculative at best.^{2/}

At new crude oil prices of more than \$10 per barrel there are also rather open ended possibilities for the production of synthetic crude oil from tar sands, oilshale and coal. Estimated threshold prices for the development of synthetic crudes range from \$7 to \$9 per barrel according to unpublished

^{2/}The "Project Independence Blueprint" exercise of F.E.A. has a cast of thousands from the best available talent but its petroleum projections depend on uncertain and unexplored resources being actually discovered in the future.

information from the Bureau of Mines. Lead times are again in the neighborhood of ten years before such petroleum can become available.

Given the lead times required to develop new natural and synthetic petroleum resources there are severe limitations on the ability of the U. S. to increase its domestic supply of petroleum in the near future. It would appear that it will be necessary for the U. S. to rely heavily on imports of petroleum for the next several years.

Conclusions

The consumption of energy in the U. S. has been growing at from 3 to 4 percent per year (2 , 17) with growth in petroleum consumption at around 5 percent per year(12). The consumption of motor gasoline, aviation gasoline, distillate oil and liquefied petroleum gases for the U. S. and for the U. S. agricultural sector was forecasted for 1974 and 1975. Agricultural consumption of petroleum products constitutes about 4 percent of total U. S. petroleum consumption and is anticipated to grow in the future at a relatively limited rate.

Growth in the domestic supply of petroleum is expected to be limited for up to ten years because of uncertainty about resources and costs and long lead times for development. Given the 36 percent existing deficit in domestic supply

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and the expected slow rate of development of petroleum resources, it is expected that imported petroleum will be important in the satisfaction of U. S. demand for a great many years to come.

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