CF 77-14

STATUS OF KANSAS INDIGINEOUS PREFERRED FUELS AND COAL - 1976

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Status of Kansas Indigenous Preferred Fuels: 1976

The per capita use of energy can serve as a bench mark to measure trends in energy usage. Increases in population, conservation or the use of alternate fuels will be reflected in per capita use.

Table (1) shows the trend of per capita use (or production) of natural gas, crude oil, coal and electric power in Kansas from 1950 to 1975. The trend is expressed in both absolute units and converted to BTU. It can be noted that per capita energy use in BTU has increased from about 254.4 million in 1950 to 531 million in 1975.

The natural gas consumed is based on the quantity of natural gas available after allowing for exported quantities, gas to storage, repressuring and flaring, and an unaccounted quantity. Crude oil consumed is that oil required to be converted to the gasoline and distillate fuel oil which are in turn consumed in Kansas. The coal is the tons of coal mined in Kansas. The electric power is the net generated in Kansas.

As of 1975 the per capita mix of the above energy was 45% natural gas, 48% crude oil, 1% coal and 5% electricity. This is in contrast to the 1950 figure of 52% natural gas, 35% crude oil, 11% coal, 2% electricity.

The per capita growth in consumable natural gas between 1950 and 1970 was 4.0% compounded annually; the crude oil equivalent to the gasoline and distillate used in Kansas had a 4.0% growth compounded annually; and between 1950-1970 growth of the net per capita electric power generated was 7.0%. After 1970 the per capita rate of growth in consumed natural gas began to decline, gasoline and distillate crude oil equivalent use continued to grow at a lower rate, and electric power seems to have reached a plateau.

Table 2 outlines the 1976 use pattern for Kansas natural gas. From a gross production of 846,164 million cu. ft., 284,953 million cu. ft. or 33.7% was exported; 19,721 million cu. ft. or 2.3% went to storage and as losses and the remaining 541,490 cu. ft. or 64.0% was utilized by final consumers. Note that some 96,454 million cu. ft. was required by the gas industry itself to produce and transport the natural gas. This is 11.4% of gross production.

Table 3 summarizes the Kansas crude oil production for 1975 as well as the products from refining this crude. It is to be noted that 59.5% of the crude oil entering the Kansas crude oil system was imported and 3.7% exported, with 96.3 or 140,488,953 bbls run to refinery stills. Crude oil production from Kansas fields was 59,106,104 bbls.

Product output from crude oil is also listed in Table 3. Total motor gasoline produced was 88,765,000 bbls or 0.63 bbls of gasoline per barrel of crude oil run to stills. Similarly, total distillates produced was 39,726,000 bbls or 0.28 bbls per barrel of crude oil run to stills. Of these quantities 36,500,000 bbls of gasoline or 41% was used in Kansas, the remainder of the gasoline being exported. 13,413,000 bbls of distillate were used in Kansas.

This all leads to the crucial question, i.e., what sort of life expectancy is ahead for supplies of Kansas natural gas, crude oil and coal. As of January 1, 1976, Kansas reserves were reported to be:

Natural gas (million cu. ft.)	12,661,181
Crude oil (1000 bbls)	364,294
Coal-strippable, measured and indicated (million tons)	526

TABLE 1: Annual Per Capita Energy Consumption[2] in Kansas 1950, 1960, 1965, 1970, 1974 and 1975

	1950	1960	1965	1970	1974	1975	1976
Population	1,905,299	2,130,579	2,200,171	2,249,071	2,299,220	2,314,479	
Natural Gas Consumed CF per capita	127,331	174,742	211,046	273,240	265,227	233,958	
Crude oil[1] required bbls per capita	16.1	25.8	29.0	36.0	43.9	45.8	
Coal produced[2] tons per capita	1.126	0.417	0.595	0.723	0.304	0.223	
Net electricity generated KWH per capita	1747	3859	5137	7082	8263	8254	
Natural gas consumed in BTU[3] per capita	52% 131,278,300	52 180,159,000	53 217,588,000	54 281,710,000	49 273,449,000	45 240,977,000	
Crude oil required in BTU[3] per capita	35 90,146,000	42 144,457,000	39 162,374,000	38 201,568,000	44 245,800,000	48 256,439,000	
Coal produced in BTU[3] per capita	11 27,024,000	3 10,008,000	3 14,280,000	3 17,352,000	1 7,296,000	1 5,352,000	
Electricity generated in BTU[3] per capita	2 5,964,000	4 13,175,000	4 17,538,000	5 24,178,000	5 28,210,000	5 28,179,000	
Total BTU per capita	254,412,300	347,799,000	411,780,000	524,808,000	554,755,000	530,974,000	

[1]Crude oil derived from the quantities of gasoline and distillate oils used in Kansas.

[2]In-state coal consumption data not available; therefore used total production.

[3]BTU contents:

	Natural gas	1031 BTU per cu. ft.
	Crude Oil	5,599,100 BTU per 42 gal bbl
	Coal	24,000,000 BTU per ton
	Electricity	3414 BTU per KWH

Table 2

Natural Gas-Production and Use-1975

	Million Cu. Ft.
Gross Production	846,164
Imported (Total)	1,852,575
Total	2,698,739
Exported	1,852,575
Kansas Nat Gas Exported	284,953
Total Exported	2,137,528
Net Remaining (from Gross Production)	561,211
Repressuring, Venting & Flared	2,539
Gas to Storage	13,968
Unaccounted	3,214
	19,721
Net Remaining for Consumption	541,490
Utilization	
To Produce and Transport Natural Gas	96,454
Extracted in NG Liquids	42,763
Electric Utilities	127,818
Residential	98,372
Commercial	48,714
Ammonia Plants	27,000
All Other Industry	97,378
Misc.	2,991
	541,490

Table 3

Crude Oil Production and Conversion-1975

Gross Production	59,106,104
Imported	86,787,860
Total	145,899,964
Exported	5,405,011
Runs to Stills	140,488,953
Products from Runs to Stills	
Motor Gasoline	88,765,000
Distillates Fuel Oil	39,726,000
Residual Fuel Oil	5,241,000
Jet Fuel	3,708,000

The life expectancy of Kansas natural gas supplies based on current data calculates out as follows:

Current annual rate of production	835 billion cu. ft.
Reserves	12,661 " "

Percent Annual Growth	Resource Life Expectancy (Years)
zero	15.2
1	14.0
2	13.0
3	12.3
4	11.9
5	11.3

Thus, with zero growth in natural gas usage the current life expectancy of supplies is only 15 years.

A natural follow-up question is what quantity of reserves, at the current annual rate of production, 835 billion cu. ft., would be required for another 20 year span. Calculations give the following:

Percent Annual Growth Rate	Reserves Required, billion cu. ft.
zero	16,700
1	18,370
3	22,823
5	28,557

Based on current data, the life expectancy of Kansas crude oil supplies is indicated to be as follows:

Current annual rate of production: 58 million bbl.

Reserves in Kansas 364.4 " "

Percent Annual Growth	Resource Life Expectancy (years)
zero	6.3
1	5.8
2	5.7
3	5.6
4	5.6
5	5.4

With zero growth in crude oil usage the current life expectancy of supplies is only a short 6 plus years.

At a current crude oil production of 58 million barrels annually, the reserves required for another 20 years span are as follows:

Percent Annual Growth Rate	Reserves Required Million Bbl
zero	1160
1	1276
3	1585
5	1983

When the present reported reserves of 364 bbls are compared with the preceding figures, the short fall is cause for concern.

It is almost certain that Kansas coals along with other Mid-western coals will receive increased attention as energy sources. Although these coals, in general, have high sulfur contents, improved anti-polluting techniques should make them amenable to direct firing or gasification.

Kansas coal reserves can be classified as follows:

30:1 stripping ratio million tons		100 ft. overburden or less million tons	
Demonstrated	Inferred	Demonstrated	Inferred
527	789	999	1816
Total demonstrated and inferred 1,316		Total demonstrated and inferred 2,815	

At current stripping practice of 30:1 ratio the reserves then are 527 million tons.

Coal production rose rapidly in Kansas between 1865 and 1919 to a maximum of about 7 million tons annually. After that production declined almost as rapidly until at present production is less than 1 million tons annually.

Assuming that all Kansas electric power generating stations were to convert from oil and gas to coal in some form, approximately 138×10^{12} BTU of energy would be required annually, or 8-1/4 million tons of coal at 70 percent efficiency. The annual potential for coal use in Kansas could easily exceed any previous annual production.

The life span of the 527 million tons of strippable coal reserves would be as follows:

Current use rate - 0.560 million tons annually

Strippable reserves - 526 million tons

Percent annual use growth rate	Resource Life Yrs
zero	939
5	123
10	68
15	33
20	26
30	19

To achieve a Kansas coal production rate of 8-1/4 million tons annually within a time frame of 10 years would require an annual production increase of approproximately 35%. To state this in another way, the use of coal in Kansas would need to have a growth rate of 35% annually to achieve 8-1/4 million tons use in 10 years.

The estimated scheduled growth from 0.560 million tons annually at a 35% rate is as follows:

Year	Million Tons
1	0.56
2	1.18
3	1.37
4	1.86
5	2.51
6	3.39
7	4.57
8	6.18
9	8.34
10	11.25
Total	41.21

Total reserves 527 less 41 = 486 million tons of reserves and with no further growth the life expectancy at 11.25 million tons annually would be approximately 43 years.

Population in Kansas increased by 1.2 times from 1950 to 1974; however the per capita energy based on the data described above increased 2.2 times. Figures for 1975 seem to indicate a standstill or a small overall decline in energy consumption.

Nevertheless, even at zero growth rate in production of Kansas indigenous natural gas and crude oil, the evidence points strongly to rapidly diminishing supplies. Crude oil can be imported--at a price--to offset declining indigenous supplies, but it is not clear how the short-fall in natural gas supplies will be made up.

The Kansas energy problem (and also the U.S. national energy problem) is a declining supply of indigenous preferred fuels and feed-stocks, a growing dependence on foreign imports to bridge the gap between demand and supply; and lack of any coordinated plan to solve the problem. The solution to this problem requires that we pursue: (1) reduction in energy demand growth rate, (2) development of energy alternatives and (3) utilization of available oil and gas in the most efficient and economic manner.

How well this mix is fashioned will depend upon the acumen of our leaders in government, industry, and science.

APPENDIX

When a quantity (such as the rate r(t) of consumption of a resource) grows a fixed percent, the growth is exponential

$$r(t) = r_0 e^{kt}$$

when r_0 is the current rate of consumption (at t = 0), e is the base of natural logarithms, and k is the fractional growth per year. Kansas energy use has shown this type of growth (see Fig: 1 where the data are plotted on semi-logarithmic paper).

The projected life spans of crude oil, natural gas and coal were calculated on the assumption that their rates of consumption grow exponentially using the following relationship:

$$Te = 1/k \ln [KR/r_0 + 1]$$

Te = time resource will expire

k = fractional growth per year

R = size of resource

r_0 = current rate of consumption

basis natural logarithms

Figure 2 shows the growth in Kansas population as a semi-logarithmic plot. From 1890 to 1975 the rate of growth compounded annually is .60% and at that rate the Kansas population would double in 122 years.

Figure 3 shows the crude oil production and reserves from 1956 to 1973, while figure 4 shows the same for natural gas.

FIG: 1 RATES OF ENERGY USE IN KANSAS

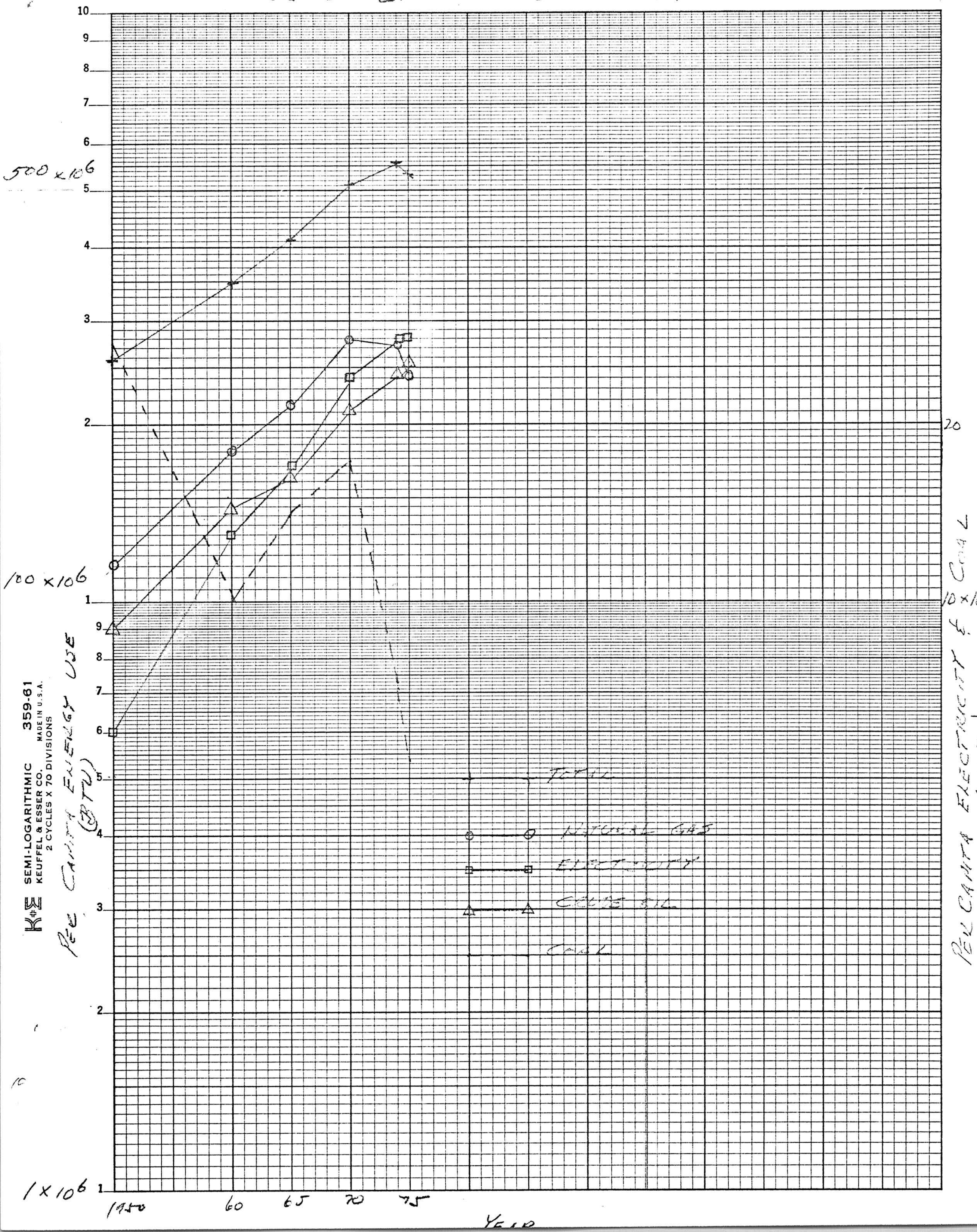
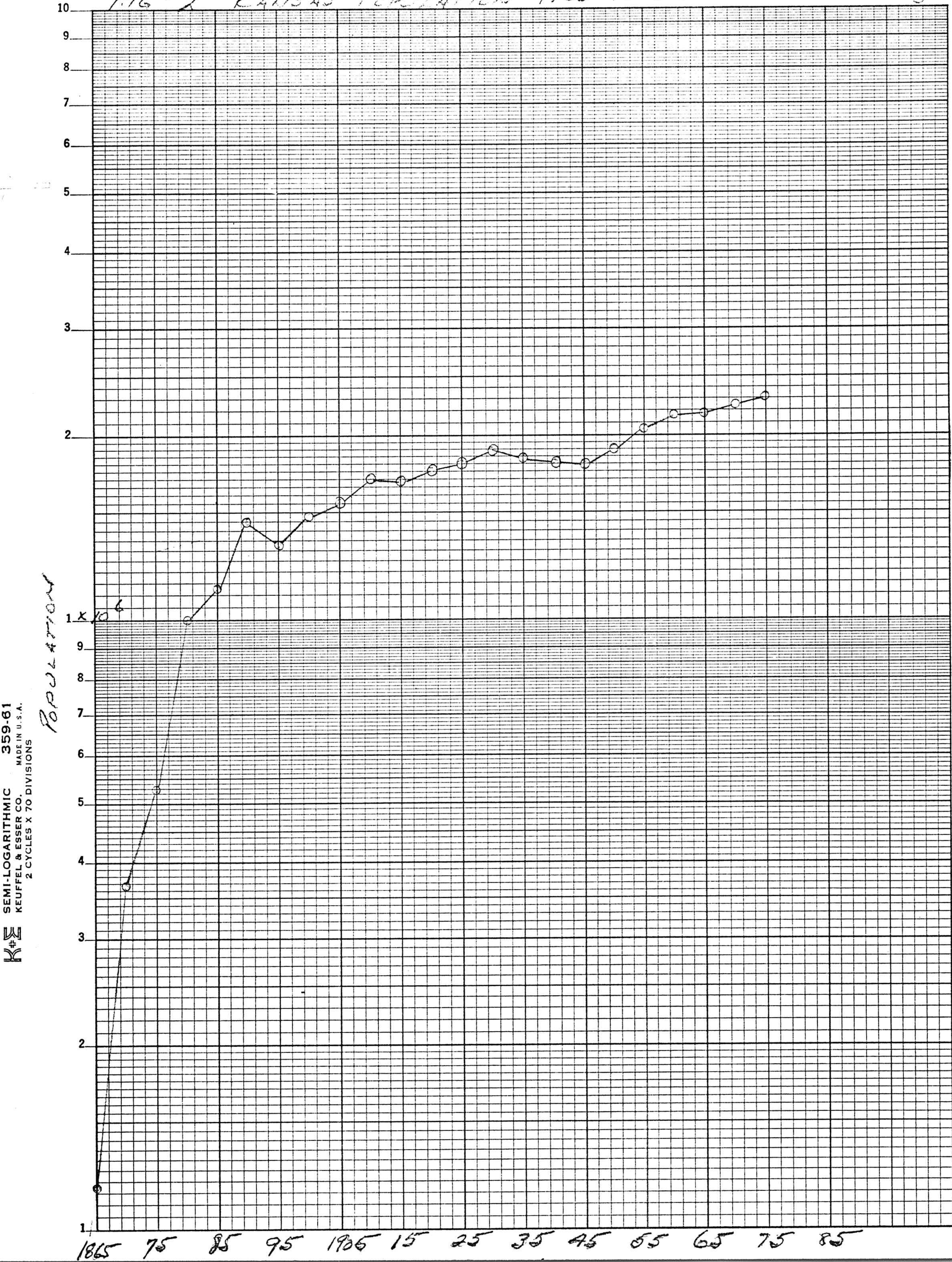


FIG. 2 KANSAS POPULATION 1865-1975 (5 YEAR INTERVALS)



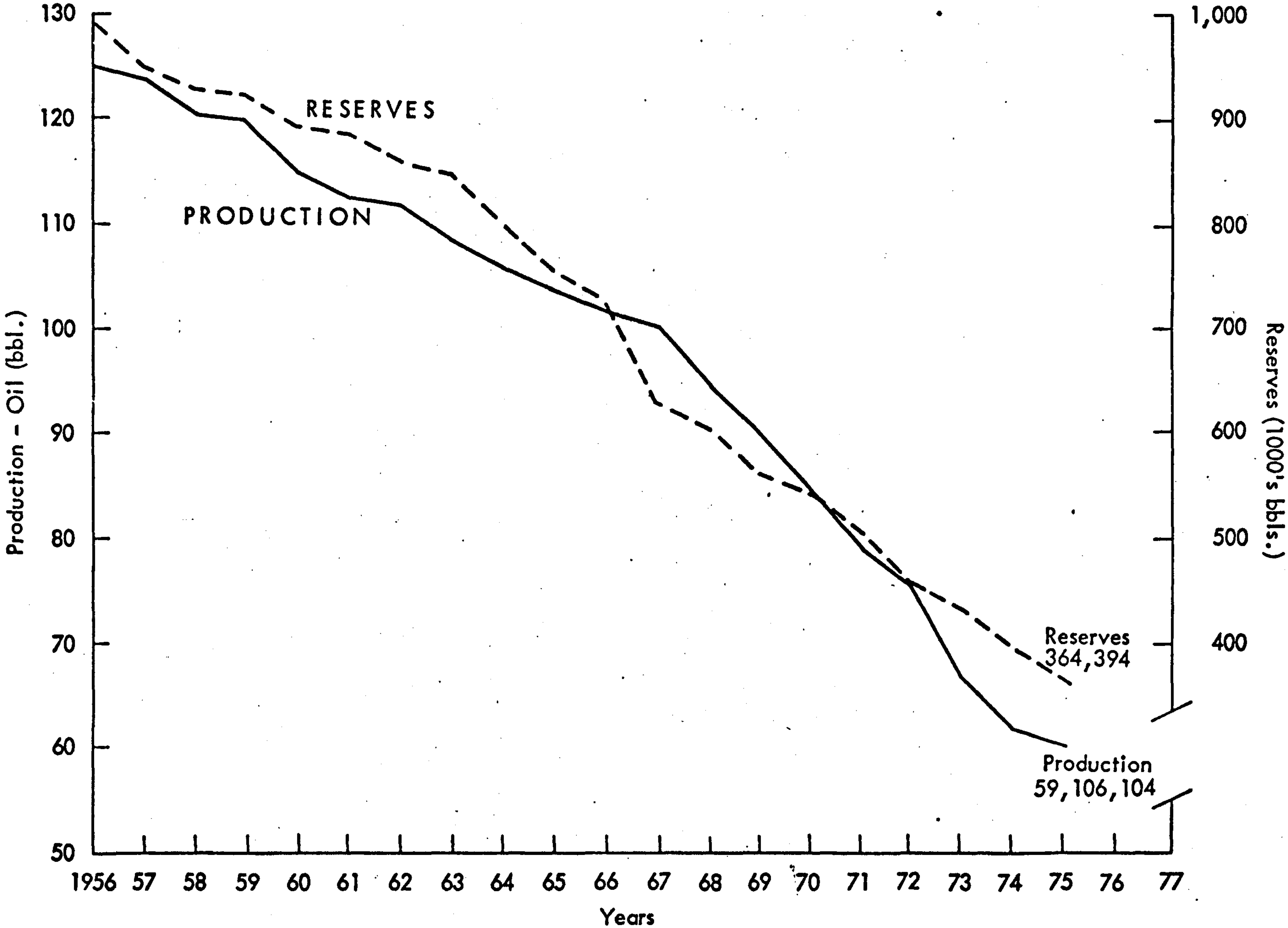


Figure 3 - Crude Oil Production and Reserves in Kansas, 1956-75.

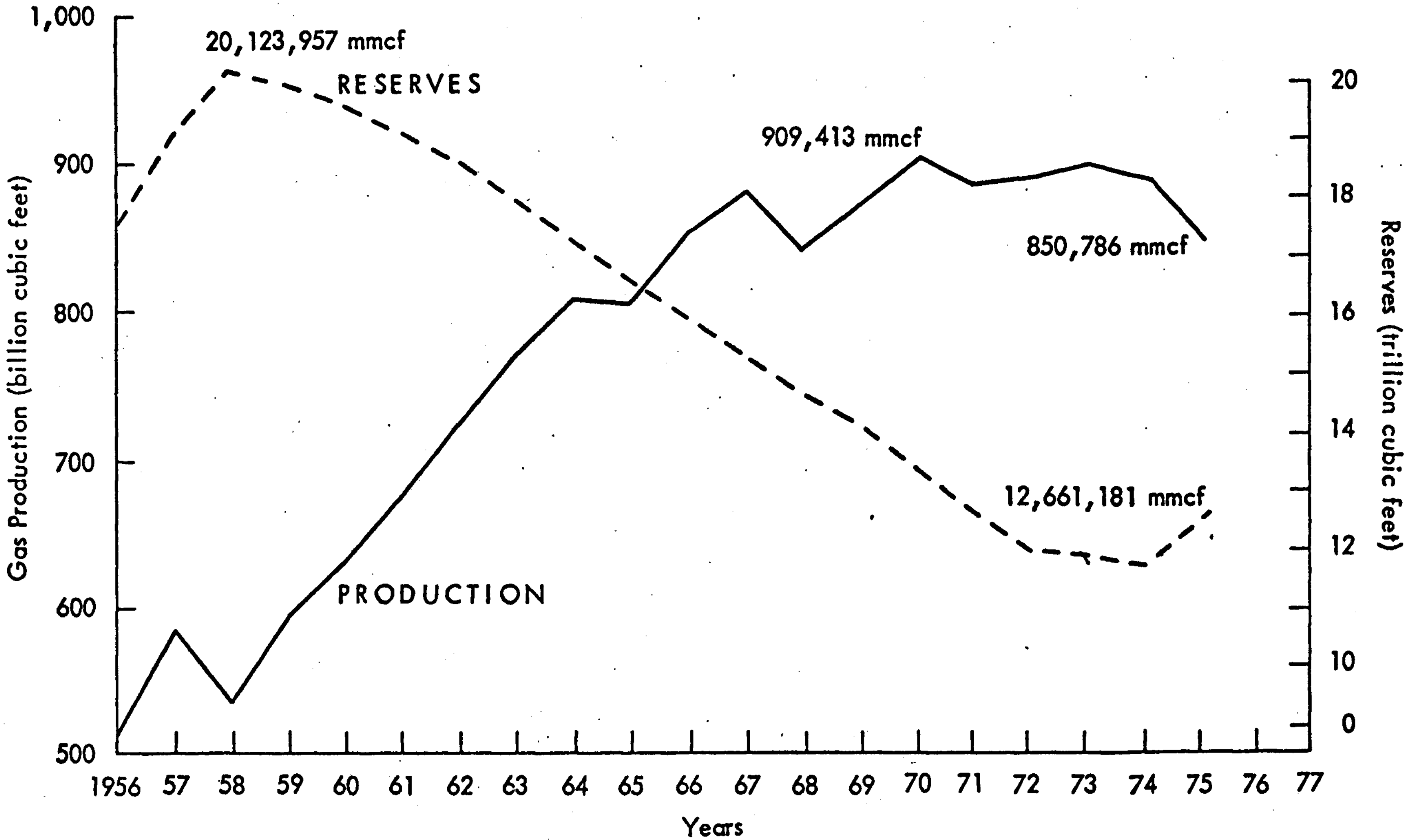


Figure 4 - Natural Gas Production and Reserves in Kansas, 1956-1975.

Energy Report from CHASE

May, 1977

TOWARDS A NEW ENERGY POLICY

It is more than a month now since President Carter delivered his energy message to Congress. Some of the detail has been filled in, and several Congressional committees have begun the complex task of translating the proposals into specific pieces of legislation. As the President predicted, special interest groups all over the country have begun attacking some of the individual proposals, and the debate over how to accomplish the program is likely to wax hot and heavy for most of the summer. Why we need an energy program, and what kind of energy program we need may be lost sight of during the arguments over the details.

Simply stated, the United States needs a comprehensive energy program because we are beginning to run out of the most readily available sources of energy – oil and natural gas. These sources increased their share of the energy mix between the end of World War II and the present from one-half to three-quarters because they could be delivered to consumers more cheaply than other sources. This era is drawing to a close. The cheapest, most accessible sources of oil and natural gas have already been found and are at various stages of their productive life. Although substantial reserves still remain in the ground, they will become progressively more expensive to locate and develop. Depending upon the incentives that exist either through market action or government planning, the search for these remaining reserves will continue for awhile at varying rates, and will ultimately be virtually abandoned. The share of oil and gas in the energy mix will inevitably decline as we approach the end of the twentieth century.

In formulating an energy program, we need to look far beyond the year 1985 to which the President has attached his energy goals. The lead time required to change the sources and uses of energy make 1985 a very short term perspective indeed. We need to plan now for at least a generation ahead. What choices exist and how should they be used to change the energy mix?

Energy sources consist broadly of two types, those that are finite in quantity and for practical purposes non-renewable, and those that are infinite or continually renewed. Examples of the latter that are in current use are water power and geothermal steam. Other renewable forms of energy that may be part of our future energy mix include solar, geothermal hot rocks, and atmospheric electricity. Solar energy as a source may be available either directly or in a derivative form, such as tidal, wind, ocean thermal gradients, or wave action. These forms of energy are almost surely at least a generation away from commercial use, but they will never be any closer until an active, well financed research and development program is undertaken.

For economic and technological reasons, the finite, or non-renewable, resources have been developed first. These include oil, natural gas, coal and uranium. For other finite resources such as oil shale and tar sands, the technology exists but the economics are not yet ready. It is of interest that when these finite resources are converted to Btu's, the worldwide oil resources account for only 4 percent of the total, and Middle East oil resources only 1 percent. But that 1 percent is the most accessible economically.

Coal and uranium resources are sufficient to last for many generations, but the same cannot be said about oil and natural gas. At historical growth rates, oil production in the non-Communist world will peak in about five years, based on existing reserves. Even if new reserves are discovered at the rate of about 20 billion barrels a year, production will peak in ten years. Clearly, the growth rate of oil consumption will soon begin to slow automatically.

The United States has an additional problem. Production of domestic energy resources, taken together, are at a standstill. Any increase in energy use must, therefore, be satisfied by imports, mainly oil imports. These have increased from about a quarter of total oil use just prior to the 1973 embargo, to almost a half. Our vulnerability in the event of a future embargo is much greater than it was in 1973. Our immediate energy problem is, in fact, an oil problem.

These facts were recognized in the goals that the President included in his energy program, several of which are interlocking. For example, a 10 percent reduction in gasoline use will go a long way to containing any further increase in oil use, which in turn will help limit the growth of total energy use to about 2 percent a year. The growth curve between now and 1985 is not likely to be a straight line, of course. Built in momentum will carry existing trends upward for awhile, before a decline sets in. The resulting configuration will be more like an inverted saucer.

Assuming that the 1985 oil demand can be held to the present level, the goal of reducing oil imports to 6 million barrels a day will only be possible if domestic production increases by about 2-1/2 million barrels a day. That is the difference between current imports and the goal of 6 million barrels a day. By 1985, production from the North Slope of Alaska should provide about 2 million barrels a day, leaving an additional half million from the rest of the country. This task is more difficult than it may appear at first sight. Production from existing fields is declining steadily, and by 1985 will amount to about half the present level. Thus, the gap to be filled by production from reserves yet to be discovered, or developed through additional recovery of known reserves, is about 4½ million barrels a day.

Similar problems affect the supply of natural gas. Production from existing fields is declining to the extent that even an active exploration and development program is unlikely to do more than hold total production at about the present level through 1985. If the incentive and opportunity to invest is not present, then production in 1985 will be far below the current level. Throughout this period domestic production will be supplemented by modest imports by pipeline from Canada and in liquid form from other areas of the world.

It is apparent that any increase in United States energy consumption will have to rely on coal or nuclear electric power. The alternative is higher oil imports. This is recognized in the President's energy program which supports existing nuclear electric power plans and which lays great emphasis on increasing reliance on coal. The goal is to produce 1 billion tons of coal by 1985 – 400 million tons more than the current level. This is a very ambitious goal even if the roadblocks in the way of mining and burning coal are removed.

In our judgment, the President's goals are attainable, but only if existing barriers are removed. Considerable political courage will be required to translate these goals into specific pieces of legislation.

The President's program contains his recommendations concerning the implementation of the goals. As might be expected, it is in this area that the greatest disagreements arise. The proposals relating to gasoline taxes and purchase taxes on "gas-guzzling" cars are very complex and cumbersome to administrate, and accomplish very little relative to the much more powerful provisions on mileage that are already law. In fact, if these provisions are strictly enforced, it is unlikely that the proposed standby gasoline tax would be triggered.

Under the Energy Policy and Conservation Act of 1975, automobile manufacturers are required to raise the average performance of their product lines to 20 miles per gallon in 1980 and 27.5 miles per gallon in 1985. This compares with 18.6 miles per gallon this year. Assuming that the nation's car fleet turns over at the rate of 8½ percent a year, and allowing for the fact that EPA ratings overstate the actual miles per gallon obtained, we have calculated that the performance of the automobile fleet will increase from less than 14 miles per gallon today to almost 19 miles per gallon by 1985. The number of cars on the road will increase modestly, but the miles driven per year will probably remain stable at the same level as during the past thirty years. Under these circumstances the consumption of gasoline by passenger cars would be a million barrels a day lower in 1985 than at present. Consumption of gasoline by other vehicles – mainly trucks and buses – may not change much as increases in the number is offset by a greater proportion of diesel powered vehicles.

From the point of view of conservation, among the most powerful parts of the program are the proposals to raise crude oil and natural gas prices. These measures would bring United States energy prices much closer to the world level and also to the cost of replacement. If spread evenly across the barrel, the cost of oil products to consumers would increase by about 7 cents a gallon. As instruments of demand management, the proposals are unobjectionable, but as instruments of supply management they leave much to be desired.

Oil prices are to be increased through taxation. Several categories of oil production are defined, each with its own price and tax provisions. Thus, a potential investor can calculate with a fair degree of precision whether the oil production business is likely to offer him as good a return on his funds as an alternative investment in some other field. Many may decide it does not. Deregulating oil and gas prices, while not guaranteeing an adequate return on new investments, offers investors the hope of making a return commensurate with the risk, and is more likely to stimulate investment.

Returning the various taxes that form part of the energy program to the public as rebates will at best lessen the conservation incentive of higher prices or will represent another dose of income redistribution. Perhaps the worst feature of the plan, however, is that the rebated taxes will tend to be used for consumption rather than investment. If the incentives and opportunities to invest are provided, the petroleum industry will continue the search. Granted the resource base is finite, but production could be increased substantially before the limits are reached. But if the industry does not receive sufficient encouragement, the oil and gas era will come to an end that much sooner.

John D. Emerson