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CONSIDERATIONS IN THE FORMULATION
OF NATIONAL ENERGY POLICY

PREPARED AT THE REQUEST OF
HENRY M. JACKSON, Chairman
COMMITTEE ON INTERIOR AND
INSULAR AFFAIRS
UNITED STATES SENATE

PURSUANT TO

S. Res. 45

A NATIONAL FUELS AND ENERGY
POLICY STUDY

Serial No. 92-4



Printed for the use of the Committee on Interior and Insular Affairs

U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON : 1971

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MEMORANDUM OF THE CHAIRMAN

To: Members and ex-officio members of the Senate Interior and Insular Affairs Committee.

Senate Resolution 45, which directed the Senate Committee on Interior and Insular Affairs to undertake a study of national fuels and energy policy, provides a very broad mandate for the study. As the committee begins its study of the complex energy problems facing the Nation, it will be necessary to identify the major policy questions which must be considered.

This background report, "Considerations in the Formulation of National Energy Policy," was prepared at my request by Mr. Daniel Beard of the Environmental Policy Division of the Congressional Research Service. It provides a classification and a review of some of the important energy policy questions facing the Nation. I believe it will serve as a useful background document which will be of assistance to the committee in defining the scope of the national fuels and energy policy study authorized by Senate Resolution 45. I have directed that the report be reproduced as a committee print to make it readily available to the members and staff of the committee and to others.

HENRY M. JACKSON, *Chairman.*

(VII)

MEMORANDUM OF THE CHAIRMAN

To: Members and ex-officio members of the Senate Interior and Insular Affairs Committee.

Senate Resolution 45, which directed the Senate Committee on Interior and Insular Affairs to undertake a study of national lands and energy policy, provides a very broad mandate for the study. As the committee begins its study of the complex energy problems facing the Nation, it will be necessary to identify the major policy questions which must be considered.

The background report, "Constitutional Issues in the Development of National Energy Policy," was prepared at my request by Mr. Daniel Board of the Executive Council Policy Division of the General Accounting Office. It provides a classification and a review of some of the important energy policy questions facing the Nation. I believe it will serve as a useful background document which will be of assistance to the committee in defining the scope of the national lands and energy policy study authorized by Senate Resolution 45. I have directed that the report be reprinted as a committee print to make it readily available to the members and staff of the committee and to our friends.

Respectfully,
Thomas M. Anderson, Chairman

LETTER OF TRANSMITTAL

THE LIBRARY OF CONGRESS,
CONGRESSIONAL RESEARCH SERVICE,
Washington, D.C., September 15, 1971.

Hon. HENRY M. JACKSON,
Chairman, Committee on Interior and Insular Affairs,
U.S. Senate, Washington, D.C.

DEAR SENATOR JACKSON: In response to your recent request, I am pleased to submit a manuscript entitled "Considerations in the Formulation of a National Energy Policy." This report was prepared by Mr. Daniel Beard of our Environmental Policy Division under the direction of Mr. Richard Carpenter, Chief of the Division and Mr. Harry Perry, Senior Specialist in Environmental Policy.

The Congressional Research Service will be pleased to continue to assist you in any possible way in carrying out the broad study charter set forth in Senate Resolution 45.

Sincerely.

LESTER S. JAYSON, *Director.*

(IX)

LETTER OF TRANSMITTAL

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[Name]

Very truly yours,
[Name]

CONSIDERATIONS IN THE FORMULATION
OF
NATIONAL ENERGY POLICY

Prepared by

DANIEL BEARD

Environmental Policy Division
Congressional Research Service
Library of Congress

at the Request of

HENRY M. JACKSON, Chairman
Committee on Interior and Insular Affairs
United States Senate

September, 1971

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INTRODUCTION

Until recently, the adequacy of energy supplies in the United States was not a political or economic problem of major concern. Given the many alternate sources of energy that were available throughout the country, the productive capacity of energy industries was normally sufficient. Thus, industrial and household consumers grew to expect reliable, abundant energy supplies at reasonable prices. However, the Northeast blackout of 1965 awakened both producers and consumers to the realization that a reliable and sufficient supply of energy could not be taken for granted.

Following that blackout, other problems began to develop within the energy field. By 1969 it became obvious, both to industrial groups and Federal agencies concerned with the availability of energy resources, that natural gas might be in short supply locally during the winter of 1969-70. And shortages of interruptable gas did, in fact, occur for certain industrial users. In the spring of 1970 it appeared that electrical generating capacity in some areas would be inadequate to supply demand, and brownouts occurred on many utility systems during the days of peak summer temperatures. Stockpiles of coal were reduced at many plants as demand was greater than anticipated. Similar problems and shortages have been forecast for 1971 and 1972.

Prior to 1969, it was commonly accepted that a definitive and comprehensive national energy policy was unnecessary. Government decisions and actions with respect to energy were made on a fragmented basis which reflected narrow concerns to limited problems. Moreover, many government decisions in the energy field were in response to uncoordinated goals and objectives such as environmental management, national security, economic growth, or increased competition, instead of energy supply per se.

This "de facto" approach¹ to energy policy resulted in institutional conflicts and inconsistent policy directives. For example, State agencies were given the responsibility to regulate oil production while a Federal agency controlled natural gas field prices; one Federal agency was authorized to make low-interest loans to support small-scale electric cooperatives while another Federal agency's program was designed to promote the development of giant power generation and transmission systems to achieve economies of scale; one agency pressed for stricter standards for sulfur quality in fuels while another decided if imports of higher quality fuels were in the public interest. Thus, at present, a very large number of Federal, State, and local jurisdictions have overlapping responsibilities which are frequently incompatible and, in some respects, contradictory.

Recent shortages of supplies, transportation problems, conflicting regulations and the emergence of new national goals clearly indicated the necessity for a definitive and comprehensive national

¹ The best exposition of this "de facto" policy is presented in: U.S., Department of the Interior, *Observations and Remarks on United States Energy Policy*, Presentation before the OECD Energy Committee, Washington; Government Printing Office, 1967; see Appendix A.

energy policy. In response to this need, Senate Resolution 45 was passed on May 3, 1971. This resolution directs the Senate Committee on Interior and Insular Affairs to:

(a) make a full and complete investigation and study . . . of the current and prospective fuel and energy resources and requirements of the United States and the present and probable future alternative procedures and methods for meeting anticipated requirements, consistent with achieving other national goals . . . and

(b) make . . . a full and complete investigation and study of the existing and prospective governmental policies and laws affecting the fuels and energy industries with the view of determining what, if any, changes and implementation of these policies and laws may be advisable in order to simplify, coordinate, and provide effective and reasonable national policy to assure reliable and efficient sources of fuel and energy adequate for a balanced economy and for the security of the United States, taking into account: the Nation's environmental concerns, the investments by public and private enterprise for the maintenance of reliable, efficient, and adequate sources of energy and fuel and necessary related industries, and the need for maintenance of an adequate force of skilled workers.

The rationale for the proposed study was made clear in Senate Report 92-87:

Numerous energy studies have been and are being made by industry, various agencies and departments in the Executive Branch of the Federal Government, state regulatory agencies, many universities, private research foundations and by industry trade associations. These, however, are aimed at more specific and narrow problems which face these different groups. No previous attempt has been made to make a comprehensive analysis of existing energy policies or of identifying conflicting policies, of describing systematically the numerous energy problem areas, and, most important, to suggest an internally consistent set of alternative policies that lend to solutions of present problems and prevent future ones.

To facilitate a coordinated approach and also to garner the benefits of a wide variety of opinions and expertise, the chairman and ranking minority Members of the Committees on Commerce and Public Works and the ranking majority and minority Members of the Joint Committee on Atomic Energy have been invited to participate in the study. This unique organizational structure is designed to bring together the Members who can provide a well-balanced perspective to deal with the diverse jurisdictional issues in the energy field.

The development of a national energy policy touches on almost every facet of our society. Therefore, the Interior Committee has directed the preparation of a series of background reports on the multitude of interrelated aspects for its deliberation.

This paper is designed to identify broad policy issues and questions that should be considered in the formulation of national energy policy. The complexity of the considerations involved in understanding energy problems necessitated the grouping of major questions and issues under broad headings and into a workable framework which primarily recognizes economic, environmental, political and technological aspects.

The framework selected was based on a thorough review and analysis of the following literature on energy policy:

Jensen, W. G. *Energy and the Economy of Nations*. Cambridge: University Printing House, 1970.

Landsberg, H. H. and Schurr, S. H. *Energy in the United States*. New York: Random House, 1968.

Resources for the Future. *U.S. Energy Policies: An Agenda for Research, A Staff Report*. Baltimore: Johns Hopkins Press, 1968.

Organization for Economic Co-operation and Development (OECD). *Member Country Papers on Energy Policy*, Paris: (mimeograph), dated 1966-1970.²

Organization for Economic Co-operation and Development. *Energy Policy: Problems and Objectives*. Paris: OECD, 1966.

United Kingdom, Ministry of Power, *Fuel Policy*. London: Her Majesty's Stationery Office, 1965.

United Kingdom, Ministry of Power, *Fuel Policy*. London: Her Majesty's Stationery Office, 1967.

U.S., Executive Office of the President, Office of Science and Technology, Interdepartmental Energy Study Group, under direction of Ali Bulent Cambel, *Energy R&D and National Progress*, Washington: Government Printing Office, 1964.

U.S., Joint Economic Committee, *The Economy, Energy and the Environment*, Prepared by the Environmental Policy Division of the Legislative Reference Service, Library of Congress, Joint Committee Print, Washington: Government Printing Office, 1970.

U.S., Senate, Committee on Interior and Insular Affairs, Report of the National Fuels and Energy Study Group, *An Assessment of Available Information on Energy in the United States*. Washington: Government Printing Office, 1962.

Comments on, paraphrases and excerpts from these sources have been intermingled freely.

The report would be incomplete without supporting statistical material: each section contains selected tables and charts which emphasize and clarify the issues and questions presented in the text.

² The member country presentations given at this conference are restricted documents. The quotations from these documents, used in this report, have not identified the country from which the quote was taken in order to protect the restricted classification.

I. NATIONAL GOALS AND PRIORITIES

A. *What national goals and priorities should be examined in the formulation of national energy policy?*

The proper formulation of sound national energy policy cannot be divorced from the multitude of other goals and priorities of our society. Any limited policy is a partial expression of the total objectives toward which a society strives and an articulation of the manner in which these ends will be sought. In this sense, national energy policy is simply one of a family of policies which reflect overall national aspirations. It is essential, therefore, in formulating energy goals that an accurate understanding of the broader objectives and priorities of our society be obtained. The Organization for Economic Co-operation and Development (OECD) described this problem of goal coordination when it noted that, in practice, a country's energy policy:

* * * involves achieving a balance between different and sometimes conflicting objectives; and each country seeks to establish this balance in the light of its own resources and interests. The differences in the positions of * * * countries are naturally reflected in different solutions, and different instruments of policy. (OECD, *Energy Policy*, p. 103)¹

The first step to achieve this coordination is to identify those factors which must be weighed. The Senate energy policy study might first identify the present national goals and priorities which will have a bearing on the development of a national energy policy, then turn to the development of a working knowledge of the inter-relationships between the energy policy and these other goals.

B. *How do national goals and priorities affect the formulation of national energy policy?*

Decisions as to national goals and priorities can be expected to directly or indirectly affect the entire energy industry. For example, decisions to raise the standard of living implies greater use of gasoline and electricity as more use is made of motor cars and air conditioning. Decisions to reduce air and water pollution can require more energy to manufacture, install and use the necessary equipment and facilities for pollution control. In addition, a national energy policy could not draw any conclusions concerning the competitive nature of energy industries unless it first reflects the basic outlook of our society toward economic competition. Nor could an energy policy reflect a responsible position that has an impact on unemployment unless a thorough understanding of current employment goals were known.

The formulation of an energy policy does not involve a singular pronouncement; rather, it is an attempt to reconcile a number of different and conflicting factors:

The different objectives served are interrelated, and measures of policy designed to achieve one or other of them cannot be properly analysed in isolation. Encouragement of the search for

¹ Citations refer to documents listed in the Introduction.

indigenous resources, for instance, may contribute to obtaining adequate supplies and to reducing energy costs. On the other hand, efforts to attain greater security of supply can mean an increase in costs and prices, at least in the short term. Thus, measures taken to pursue one objective may have favourable or adverse repercussions on the attainment of others. Moreover, government policy need not always take the form of positive intervention. Certain aspect of government policy in the form of non-intervention, e.g., in permitting freedom of choice to the consumer, may be of equal significance. (OECD, *Energy Policy*, p. 105).

II. ECONOMIC AND SOCIAL CONSIDERATIONS

A. *Why is energy particularly significant in the U.S. economy?*

Energy is a fundamental necessity for our way of life. It is used both directly and indirectly by everyone, everyday.

Energy is the ability to do work. Power is the rate of doing work. For centuries the only sources of energy were the muscles of man and beast, supplemented slightly by energy that could be tapped from moving winds and waters. With the invention of the steam engine and the coming of the industrial revolution, modern man began to use large amounts of energy derived from burning fuels, and the power output of his machines increased.

A full-grown man is capable of an average power output of about $\frac{1}{20}$ th of a horsepower during an 8-hour working day, equivalent to an output of about 37 watts of electrical energy. Thus, when a child turns on a 150-watt television receiver, he commands electrical energy equivalent to the energy output of four grown men. As long as human progress depended mostly on the energy of human muscles, there could not be much physical change in the conditions of primitive life.

Today human labor provides energy for far less than 1 percent of the work performed in factories, refineries, and mills in the production of their products. Literally, our economy and our way of life could not continue without use of vast amounts of energy.

One measure of this situation is the increase in the total power for all engines, turbines, and work animals over the past 3 decades. Table [1] shows the increase from 2.7 billion horsepower available in the United States in 1940 to 17.9 billion for 1968. Of this, engines in trucks, buses and automobiles accounted for by far the largest part, increasing from 2.5 billion horsepower in 1940 to 16.9 billion horsepower in 1968. Over the same period, the power of electric generating stations increased from 53 million horsepower to 371 million horsepower.

Another way of looking at use of energy is to ask who is using it. Table [2] and Figure [1] show the consumption of energy resources by major consumer for the years 1963, 1965, and 1967. The use of energy is rather evenly divided between household and commercial use, industrial use, transportation, and generation of electricity. Industrial use accounts for almost one-third of the total. The British thermal unit is the standard unit for measuring

heat energy and represents the amount of heat that will increase the temperature of 1 pound of water 1° degree Fahrenheit. (*The Economy, Energy and the Environment*, pp. 1-2.)

Given the pervasive nature of energy, it is perhaps surprising to note that the share of the energy industries' component in national income is less than 4 percent. The economic dimensions of energy industries is shown in Table 3.

The energy industries are even less important, relatively speaking, as employers of manpower. Though one can argue over the definition of what types of business should be included in the energy category, a reasonable estimate is that the energy industries account for about 2 percent of all manpower employed in non-agricultural establishments.

TABLE 1.—TOTAL HORSEPOWER OF ALL PRIME MOVERS: 1940-68

[In thousands. As of January, except as noted. Prior to 1960, excludes Alaska and Hawaii, except as noted. Prime movers are mechanical engines and turbines, and work animals, which originally convert fuels or force (as wind or falling water) into work and power. Electric motors, which obtain their power from prime movers, are excluded to avoid duplication. See also Historical Statistics Colonial Times to 1957, series S 1-14]

Item	1940	1950	1955	1960	1965	1968 (preliminary)
Total horsepower.....	2,773,316	4,867,538	7,158,229	11,007,889	15,096,332	17,912,944
Work animals.....	12,510	7,040	4,141	2,790	2,000	1,460
Inanimate.....	2,760,806	4,860,498	7,154,088	11,005,099	15,094,332	17,910,684
Automotive ^{1 2}	2,511,312	4,403,617	6,632,121	10,366,880	14,306,300	16,937,725
Nonautomotive.....	249,494	456,881	521,967	638,219	788,032	972,959
Factories.....	21,768	32,921	35,579	42,000	48,400	52,000
Mines.....	7,332	22,000	30,768	34,700	40,300	43,400
Railroads ³	92,361	110,969	60,304	46,856	43,838	57,607
Merchant ships, powered.....	⁴ 9,408	⁴ 23,423	⁴ 24,155	23,890	24,015	20,413
Sailing vessels.....	⁴ 26	⁴ 11	⁴ 5	2	2	1
Farms.....	57,472	157,533	207,742	237,020	269,822	290,600
Windmills.....	130	59	59	44	30	24
Electrical central stations ²	53,542	87,965	137,576	217,173	307,025	371,756
Aircraft ^{3 5}	⁴ 7,455	⁴ 22,000	⁴ 25,779	36,534	54,600	137,158

¹ Includes passenger cars, trucks, buses, and motorcycles.

² As of July 1.

³ Beginning 1965, not strictly comparable with earlier years.

⁴ Includes Alaska and Hawaii.

⁵ Includes private planes and commercial airlines.

Source: *Economy, Energy and the Environment*, p. 2.

TABLE 2.—CONSUMPTION OF ENERGY RESOURCES, BY MAJOR CONSUMER GROUP: 1963, 1965, AND 1967

[In trillions of British thermal units, except percent]

Consumer group	Energy Inputs			Percent distribution		
	1963	1965	1967(prel.)	1963	1965	1967(prel.)
Total.....	49,649	53,785	58,853	100.0	100.0	100.0
Household and commercial.....	11,059	11,867	13,025	22.3	23.1	22.1
Industrial.....	16,225	17,550	18,634	32.7	32.6	31.7
Transportation ¹	11,964	12,715	14,021	24.0	23.6	23.8
Electrical generation, utilities ^{2 3}	9,663	11,104	12,875	19.5	20.6	21.9
Miscellaneous.....	738	549	298	1.5	1.1	0.5
Utility electricity purchased ³	3,128	3,600	4,134	(⁴)	(⁴)	(⁴)

¹ Includes bunkers and military transportation.

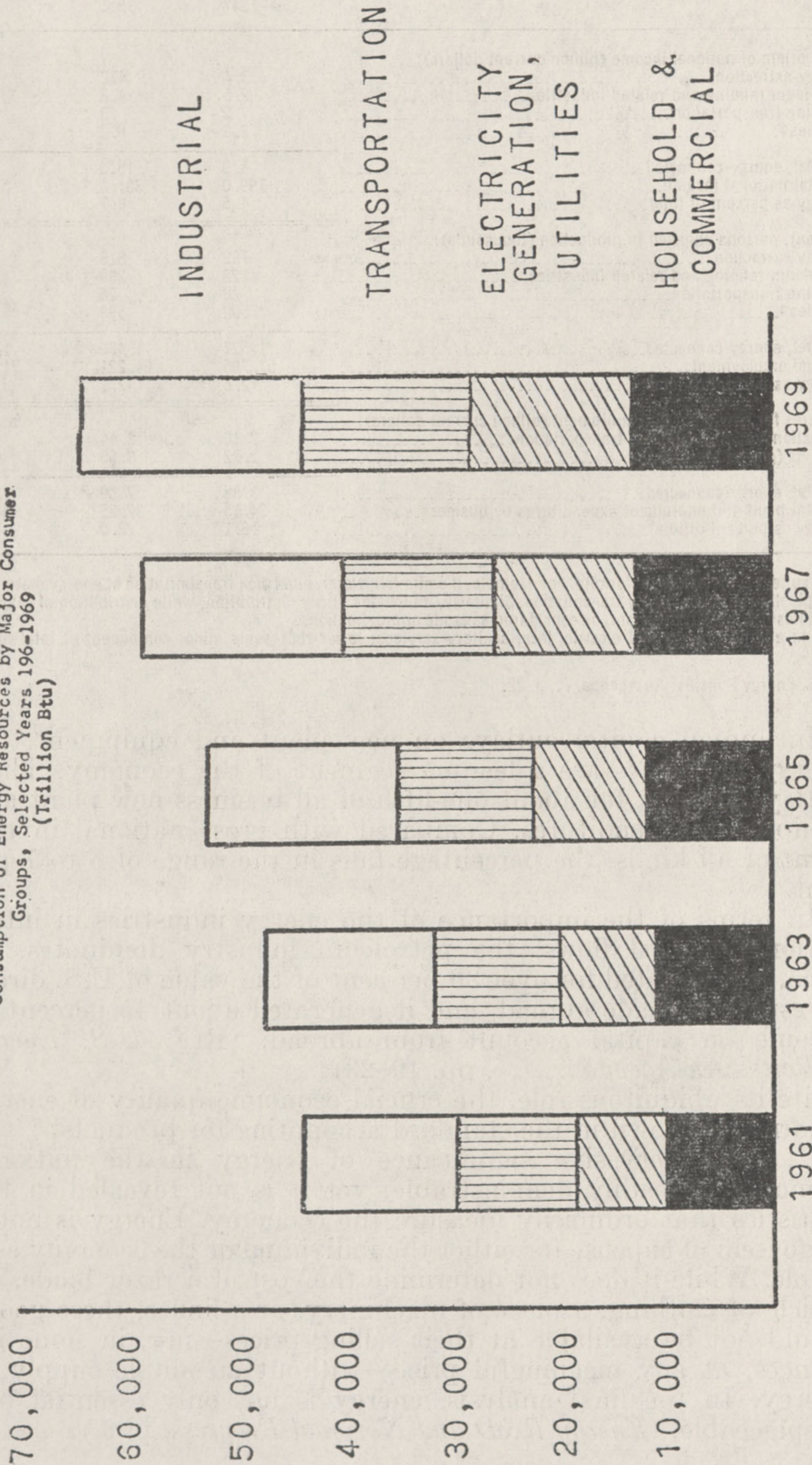
² Represents outputs of hydropower and nuclear power converted to theoretical energy inputs at prevailing rate of pounds of coal per kilowatt-hour at central electric stations using 12,000 Btu per pound coal. Excludes inputs for power generated by nonutility plants which are included within the other consuming sectors.

³ Electricity generated and imported.

⁴ Not applicable.

Source: *Economy, Energy and the Environment*, p. 2.

Figure 1
Consumption of Energy Resources by Major Consumer
Groups, Selected Years 1961-1969
(Trillion Btu)



Source: U.S., Department of the Interior, Bureau of Mines, Minerals Yearbook: 1964, Mineral Fuels, Washington: GPO, 1964, p. 8; U.S., Department of the Interior, Bureau of Mines, Minerals Yearbook: 1969, Volume I-II, Washington: GPO, 1969, p. 25.

TABLE 3.—SOME DIMENSIONS OF THE ENERGY INDUSTRIES,¹ 1947, 1955, 1965

	1947	1955	1965
A. Industrial origin of national income (billion current dollars):			
Energy extraction.....	3.4	4.2	4.1
Petroleum refining and related industries.....	2.5	4.8	5.1
Pipeline transportation.....	.2	.3	.5
Utilities ²	2.8	6.2	11.6
Total, energy-connected.....	8.9	15.5	21.3
Total national income.....	199.0	331.0	559.0
Energy as percent of total.....	4.5	4.7	3.8
B. Employment, persons engaged in production (thousands):			
Energy extraction.....	769	616	458
Petroleum refining and related industries.....	228	239	184
Pipeline transportation.....	28	26	19
Utilities ²	502	599	638
Total, energy-connected.....	1,527	1,480	1,299
Total employment.....	57,705	64,221	71,248
Energy as percent of total.....	2.6	2.3	1.8
C. Expenditures for new plant and equipment (billion current dollars):			
Extraction, refining, pipeline transportation.....	2.16	3.44	4.39
Utilities (gas and electric).....	1.72	3.65	6.72
Total, energy-connected.....	3.88	7.09	11.11
Total plant and equipment expenditures by business.....	24.15	32.25	57.32
Energy as percent of total.....	16.1	22.0	19.4

¹ The table suffers from lack of uniformity. For example, it omits rail, water, and truck transportation of energy materials, but includes pipelines and electricity transmission. Similarly, it includes utility distribution, while distribution of coal and oil is omitted. Results should, therefore, be considered as crude approximations.

² Includes, in addition to gas and electric, local sanitary services; latter represents minor component of total utility figure.

Source: U.S. Energy Policies: An Agenda. . . , p. 22.

In annual capital outlays on new plant and equipment, the energy industries are a leading segment of the economy. Their outlays account for about one-fifth of all business new plant and equipment expenditures. Compared with gross national investment of all kinds, the percentage falls in the range of 6 to 7 per cent.

In terms of the importance of the energy industries in international capital flows, the petroleum industry dominates. In 1965, it accounted for over 30 per cent of the value of U.S. direct investments made abroad, and it generated about 45 percent of income on capital account from abroad. (RfF, *U.S. Energy Policies: An Agenda* . . . , pp. 19-23)

Despite its ubiquitous role, the crucial economic quality of energy is not normally shown in the standard accounting for products:

. . . the pervasive significance of energy in the national economy is readily demonstrable, yet it is not revealed in the statistics that ordinarily measure the economy. Energy is not a large item of expense for either the individual or the economy as a whole. While it does not determine the cost of a razor blade, an article of clothing, a piece of machinery, or a house, these goods would not be available at their selling prices—nor, in some instances, at any meaningful price—without an ample supply of energy. In the final analysis, energy is not only essential but irreplaceable. (*Energy R&D and National Progress*, p. 6.)

B. What is the relationship between national energy policy and economic policy?

A national energy policy must be considered as intimately related to our over-all economic policies. A decision to increase industrial activity, for example, is also a decision to increase the use of energy. One participant in a recent OECD Conference on Energy Policy summarized this relationship in the following manner:

A country's energy policy cannot be disassociated from its general economic policy. Energy policy is made up of a combination of measures which are co-ordinated and lined up with decisions taken in respect of other raw materials, to facilitate the attainment of targets. Hence, the lowest immediate cost is not the only consideration. First of all, security of supplies must be assured with a view to economic independence. Other restricting factors and conditions are taken into consideration as well These include the optimum solutions for users from both the technical and the commercial standpoint, balance of trade, the need to plan the necessary adjustments and transitions both at regional level (in the framework of regional planning) and within the industries concerned. Limitations as regards the financing of new plant and equipment, which is a crucial problem in expanding industries, must be considered when deciding ways and means and setting targets. Likewise the constraints resulting from short-term variations are also taken into consideration.

This interrelationship of policies gives rise to a number of essential questions. What is the United States economic policy or policies? What constraints and/or responsibilities does our economic policy impose on the national energy policy? What role can an energy policy play in the attainment of our economic objectives? What is the role of energy in increasing the productivity of manufactured products? What are the energy demand implications of the increasing importance of the service sector in the economy?

While a national energy policy should reflect the relationship between energy goals and economic policy, it also should stress the proper steps to be taken toward their co-ordination. The OECD's examination of member energy policy's found:

that on the national level the energy sector should be seen as a whole and that measures affecting one part of it should be examined in the light of their repercussions on the rest of the sector and on other sectors of the economy. The recent past has often demonstrated the inter-relationships both between the different elements within the energy sector and between that sector as a whole and the rest of the economy; these inter-relationships will continue to develop.

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The choice of priorities must be determined against the background of long-term developments and prospects both within the sector and in the economy as a whole. Short-term measures should be designed not to hinder the attainment of the long-term objectives. Finally, it is important that policies should not be too rigid.

Changes in the energy situation can be—as they have been in the past—unexpected and can have far-reaching consequences. Long-term policies should be developed in a sufficiently flexible way to allow for the inevitable element of the uncertainty in all forward estimates. (p. 139–140).

Jensen, in *Energy and the Economy of Nations*, is even more succinct and direct:

It is manifestly impossible to separate or compartmentalize energy policy from wider economic (and, occasionally, strategic and political) considerations. There are continuous intimate points of contact with financial, social and economic policy, such as helping to finance the national budget, balancing foreign payments, stimulating national economic growth, protecting other resource values (i.e. no land damage), and regional development and retraining of labour. (p. 147)

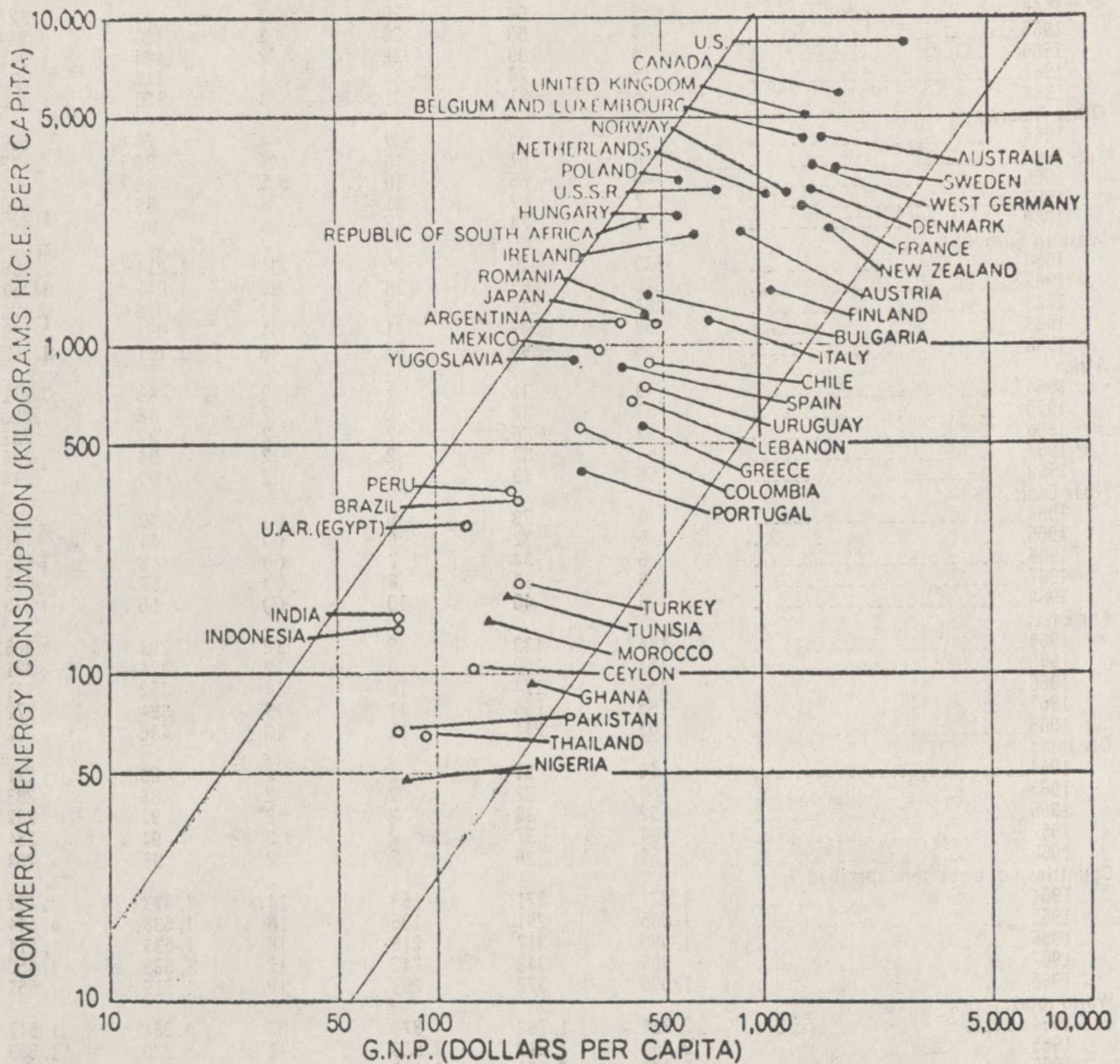
C. What impact does energy have on economic development?

Energy plays a vital role in the attainment of economic development objectives; indeed, there appears to be a direct correlation between energy consumption and economic development. The interrelationship is shown by Figure 2 where commercial energy consumption versus the gross national product of selected countries is graphed. Table 4 summarizes world energy consumption by fuel and continental area and Table 5 summarizes recent changes in the relationship between energy and gross national product. This relationship is even more enhanced when we note that without adequate supplies of energy:

our industrial world would soon be paralysed. We have only to reflect for a moment upon the part played by electricity, oil or coal in our daily lives at home, on the road, in the factories, offices or other places of work to realize the pervasive importance and significance of energy. Alternatively, we have only to cast back our minds to the situation that prevailed over much of Europe, including Britain, and Asia in 1945 to get a very clear picture of the grave problems that arose at that time from a situation of near universal energy shortage . . . (Jensen, *Energy and Economy of Nations*, pp. 7–8)

Figure 2

Energy Use Versus Gross National Product



● NORTH AMERICA, WESTERN
EUROPE AND OCEANIA

● EASTERN EUROPE AND U.S.S.R.

○ LATIN AMERICA

○ ASIA AND MIDDLE EAST

▲ AFRICA

Source: Sam H. Schurr, "Energy", Scientific American,
209:112, September, 1963.

TABLE 4.—WORLD ENERGY CONSUMPTION,¹ BY FUEL AND CONTINENTAL AREA

[Million metric tons of standard coal equivalent unless otherwise specified]

Area ² and year	Solid fuels	Liquid fuels	Natural and imported gas	Hydro, nuclear, and imported electricity	Total aggregate	Total per capita (kilograms)
North America:						
1964	424	758	630	37	1,849	8,743
1965	448	795	657	40	1,940	9,053
1966	471	834	707	42	2,053	9,460
1967	463	875	744	46	2,127	9,685
1968	481	929	799	47	2,255	10,155
Caribbean America:						
1964	5	64	25	2	95	922
1965	4	68	26	2	100	944
1966	4	69	28	2	104	945
1967	5	74	30	3	112	988
1968	5	81	31	3	120	1,032
Other America:						
1964	6	58	9	4	76	566
1965	6	61	10	4	80	578
1966	6	65	10	5	86	605
1967	7	67	11	5	89	610
1968	7	74	12	5	98	653
Western Europe:						
1964	539	416	25	34	1,014	2,986
1965	515	463	28	39	1,045	3,050
1966	486	516	33	43	1,078	3,120
1967	459	549	41	44	1,093	3,139
1968	458	599	58	46	1,161	3,312
Africa:						
1964	49	31	1	2	83	271
1965	53	32	2	2	88	283
1966	52	36	2	2	92	287
1967	54	37	2	2	94	284
1968	56	39	2	2	99	294
Near East:						
1964	6	28	6	(³)	40	456
1965	6	32	6	(³)	44	481
1966	6	34	7	(³)	48	515
1967	6	38	8	(³)	52	548
1968	6	40	10	(³)	56	575
Far East:						
1964	144	133	9	12	298	306
1965	151	152	10	12	324	321
1966	154	174	10	14	352	341
1967	165	206	11	13	394	372
1968	169	241	12	13	436	402
Oceania:						
1964	49	31	1	2	83	271
1965	53	32	2	2	88	283
1966	52	36	2	2	92	287
1967	54	37	2	2	94	284
1968	56	39	2	2	99	294
Countries not elsewhere specified: ⁴						
1964	1,021	271	168	14	1,473	1,402
1965	1,035	291	196	16	1,538	1,444
1966	1,080	317	218	18	1,633	1,514
1967	985	342	242	17	1,585	1,450
1968	1,066	372	263	19	1,719	1,553
World total:						
1964	2,224	1,782	871	107	4,984	1,547
1965	2,250	1,919	933	118	5,220	1,583
1966	2,293	2,074	1,015	128	5,510	1,641
1967	2,177	2,216	1,088	131	5,612	1,641
1968	2,284	2,408	1,185	138	6,016	1,727

¹ In most cases, data are aggregates of country figures representing apparent inland consumption—the purely arithmetic result of adding production and imports and subtracting from this sum the total of exports, bunker loadings, and additions to stocks (where the latter are known). All totals in this table are reported in source and may not represent the sum of listed parts owing to rounding and/or omission from detail in space of minor quantities not listed separately. A large number of the entries in this table have been revised from those appearing in previous editions of this chapter owing to revisions published in new edition of source; such revisions have not been identified as such by footnotes.

² Areas listed are those appearing in the source and have not been conformed in scope to standard terms used elsewhere in the Minerals Yearbook, except that the source term "Western Asia" has been converted to "Near East."

³ Nil or less than ½ unit.

⁴ The greatest part of the consumption listed under this heading is that of Eastern Europe—Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Rumania, and the U.S.S.R.

Source: U.S. Department of the Interior, Bureau of Mines, "Minerals Yearbook, Volume IV, Areas Reports: International," Washington: Government Printing Office, 1969, p. 31.

TABLE 5.—ENERGY CONSUMPTION, GROSS NATIONAL PRODUCT, AND THE ENERGY/GNP RATIO, 1947-70

Year	Aggregate energy consumption		GNP (1958 dollars)		Energy/GNP ratio	
	Amount (trillion B.t.u.'s)	Percent change from preceding year	Amount (billions)	Percent change from preceding year	Amount (thousands B.t.u.'s per dollar)	Percent change from preceding year
	(1)	(2)	(3)	(4)	(5)	(6)
1947	32,870		\$309.9		106.1	
1948	33,994	+2.5	323.7	+4.5	105.0	-1.0
1949	31,604	-7.0	324.1	+1.1	97.5	-7.1
1950	34,153	+8.1	355.3	+9.6	96.1	-1.4
1951	36,913	+8.1	383.4	+7.9	96.3	+2.2
1952	36,576	-9.9	395.1	+3.1	92.6	-3.8
1953	37,697	+3.1	412.8	+4.5	91.3	-1.4
1954	36,360	-3.5	407.0	-1.4	89.3	-2.2
1955	39,956	+9.9	438.0	+7.6	91.2	+2.1
1956	42,007	+5.1	446.1	+1.8	94.2	+3.3
1957	41,920	-2.2	452.5	+1.4	92.6	-1.7
1958	41,493	-1.0	447.3	-1.1	92.8	+2.2
1959	43,411	+4.6	475.9	+6.4	91.2	-1.7
1960	44,960	+3.6	487.7	+2.5	92.2	+1.0
1961	45,573	+1.4	497.2	+1.9	91.7	-5.5
1962	47,620	+4.5	529.8	+6.6	89.9	-2.0
1963	49,649	+4.3	551.0	+4.0	90.1	+2.2
1964	51,515	+3.8	581.1	+5.5	88.7	-1.6
1965	53,785	+4.4	617.8	+6.3	87.1	-1.8
1966	56,948	+5.9	658.1	+6.5	86.5	-7.7
1967	58,868	+3.4	675.2	+2.6	87.2	+8.8
1968	62,448	+6.1	707.2	+4.7	88.3	+1.3
1969	65,832	+5.4	727.1	+2.8	90.5	+2.5
1970 ¹	² 69,099	+5.0	724.3	-4.4	95.4	+5.4

¹ Preliminary.² Corrected from Bureau of Mines published values on the basis of Federal Power Commission data.

Source: Bruce C. Netschert, "Energy Consumption and Gross National Product in the United States: An Examination of a Recent Change in the Relationship," Congressional Record, daily edition, July 15, 1971, p. E7705.

This close relationship between energy requirements and level of economic growth has been well documented by the Common Market countries:

While the extent of the closeness of the relationship between industrial and economic growth on the one hand and energy demand on the other hand has become an accepted tenet of economic faith, nowhere has this fact been more amply illustrated than in the voluminous supporting documents prepared by the responsible agencies of the European Communities in the course of their attempts to formulate a common energy policy for the six Common Market countries.

The Community experts worked on the figures (1950-60) and assumptions (1961-75) with regard to annual percentage increases in Gross National Product, industrial production and energy consumption shown in Tables [6, 7 and 8].

A feature of the whole of the period between 1950 and 1975—and indeed as far ahead as existing projections permit one to see—in the Common Market countries as in other industrialized parts of the world, is the particularly rapid growth that has taken place and is expected to continue to do so in the demand for electric power. The extent of the difference in the relationship between increased Gross National Product and growth in demand for electricity and overall energy requirements is well illustrated in Figure [3]: whereas, taking the period from 1950 to 1975 as a whole, Gross National Product was expected to in-

crease nearly fourfold and total energy demand to rise by a factor of three, electricity requirements were expected to rise no less than sevenfold.

(Jensen, *Energy and the Economy of Nations*, pp 9-10)

TABLE 6.—PERCENT INCREASE IN GNP IN COMMON MARKET COUNTRIES, 1950-75

	Actual 1950-60	Estimated		
		1960-65	1965-70	1970-75
Belgium.....	2.7	3.8	3.9	3.9
France.....	4.3	5.2	4.7	4.6
Germany.....	7.4	4.4	4.0	4.2
Italy.....	5.9	5.95	5.75	5.3
Netherlands.....	4.9	4.3	4.9	4.3
Community.....	5.5	4.9	4.6	4.6

TABLE 7.—PERCENT INCREASE IN INDUSTRIAL PRODUCTION IN THE COMMON MARKET COUNTRIES, 1950-75

	Actual 1950-60	Estimated		
		1960-65	1965-70	1970-75
Belgium.....	3.0	4.8	4.8	4.8
France.....	6.4	6.5	5.9	5.5
Germany.....	9.1	5.5	5.0	5.0
Italy.....	8.1	8.8	7.8	6.5
Netherlands.....	5.8	5.4	6.0	5.6
Community.....	7.5	6.3	6.0	5.6

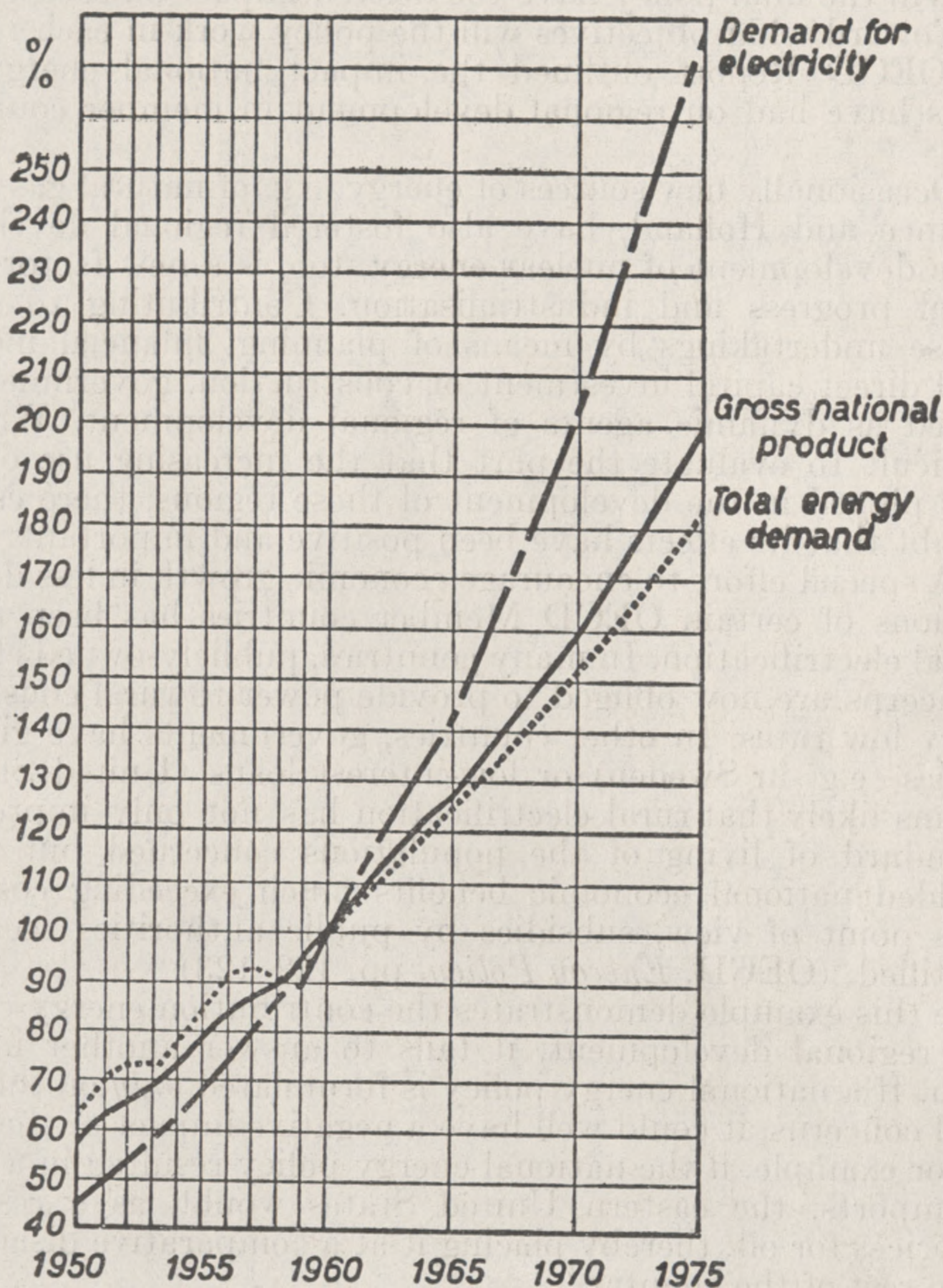
TABLE 8.—PERCENT INCREASE IN ENERGY CONSUMPTION IN THE COMMON MARKET COUNTRIES, 1950-75

	Actual		Anticipated		
	1950-60	1955-60	1960-65	1965-70	1970-75
Belgium.....	3.4	0.3	1.8	2.7	2.5
France.....	4.4	3.6	4.4	4.3	4.3
Germany.....	7.0	2.7	3.0	3.4	3.2
Italy.....	10.4	7.8	8.6	6.6	5.2
Netherlands.....	4.7	3.6	4.9	3.8	3.8
Community.....	6.1	3.5	4.3	4.2	4.2

Source: Jensen, "Energy and the Economy of Nations," p. 10.

Figure 3

Comparison of Growth in G.N.P., Overall Energy Requirements and Electricity Demand in the Six Common Market Countries, 1950-1975



Source: Jensen; Energy and the Economy of Nations, p. 11.

D. How can national energy policy reflect national and regional economic development objectives? What regional considerations should be examined in the formulation of national energy policy?

There are wide and deep-rooted differences in the structure and growth rates of regions in nearly every nation. The United States is no exception. Major questions concerning regional economic aspects of an energy policy could include a consideration of the following:

Should the national energy policy's impact on every region be the same, or, should the policy attempt to promote regional variations?

Should a uniform national energy policy work to the advantage of certain regions and to the disadvantage of others?

What will be the benefits and costs of the policy adopted on each region in the country?

If fuels must be rationed, how should they be allocated among regions?

Will the final policy have the desired impact on each region?

Toward what objectives will the policy work in each region?

The OECD Report outlined the impact national energy policy decisions have had on regional development in member countries as follows:

Occasionally new sources of energy, e.g. of natural gas in Italy, France and Holland, have also fostered regional development. The development of nuclear energy, too, is a new factor in technical progress and industrialisation. Contributing to some of these undertakings by means of planning, financial incentives, and direct capital investment or construction, governments have acted as dynamic agents of regional development. While it is difficult to evaluate the part that the increasing use of energy has played in the development of these regions, there can be no doubt that its effects have been positive and important.

A special effort to encourage economic growth in less developed regions of certain OECD Member countries has been made by rural electrification. In many countries, publicly-owned electricity concerns are now obliged to provide power to rural consumers at very low rates. In other countries, governments have given subsidies (e.g. in Sweden) or low-interest loans (United States). It seems likely that rural electrification has not only improved the standard of living of the populations concerned but has also yielded national economic benefits much exceeding cost. From this point of view, subsidies by public authorities seem to be justified. (OECD, *Energy Policy*, pp. 122-123)

While this example demonstrates the contribution energy can make toward regional development, it fails to answer another important question. If a national energy policy is formulated *only* on the basis of national concerns, it could well have a negative impact at the regional level. For example, if the national energy policy resulted in a decrease in oil imports, the eastern United States would, as a result, pay higher prices for oil; thereby placing it at a comparative disadvantage with the rest of the country.

By contrast, giving emphasis to a concern for the regional impact in formulating a national energy policy may, in turn, have negative national impacts. For example, it may be necessary to promote uneconomic practices in one region to preserve other values. A policy of preserving a viable rural population in one region could well mean higher energy costs for that region, and these costs would have to be borne by the country as a whole. Ireland appears to be one country which has recognized this relationship and initiated policies which, while meaning higher energy prices, have been justified on other social grounds. The Irish continue to rely on peat resources as a primary fuel source to maintain a viable rural population. Because peat is more costly than oil for the production of electricity, the use of peat increases the cost of electricity. The effect of using peat instead of oil is for the electricity consumer to subsidize domestic peat production.

Even though this subsidy amounts to over £1,000,000 a year, the government apparently feels it justified because peat provides employment in many rural areas which formerly were economically depressed.

E. What is the magnitude of employment in energy industries? What employment considerations should be addressed in the formulation of national energy policy?

Three separate, but interrelated, factors characterize employment in energy industries: (1) energy production, transportation and consumption are not labor-intensive; (2) the level of employment does not form a significant portion of the nation's labor force; and (3) total employment in the industry is declining, especially in the extraction and production sectors. Table 9 shows 1960 and 1969 employment figures for the energy industry (See also Table 3). It should be pointed out, however, that while total employment is decreasing, professionally trained people required by energy industries are in short supply. An excellent example is the rapid decline in mining engineering graduates in the United States over the last several decades. This has left a critical shortage of trained engineers to develop future resources.

TABLE 9.—EMPLOYMENT IN ENERGY-RELATED INDUSTRIES,¹ 1960 AND 1969

	1960		1969	
	Employment	Percent of total labor force	Employment	Percent of total labor force
Coal mining.....	188,451	0.35	130,832	0.19
Oil and gas extraction.....	309,000	.57	282,000	.40
Petroleum and coal products.....	212,000	.39	184,000	.26
Pipeline transportation.....	23,000	.04	19,000	.03
Electric and gas companies and systems.....	583,000	1.07	616,000	.88
Nuclear power.....	² 103,000	.19	155,000	.22
Total.....	1,418,451	2.62	1,386,832	1.98

¹ This table, like table 3, suffers a lack of uniformity. It also omits rail, water, and truck transportation of energy materials, but includes pipelines and electricity transmission. It includes utility distribution while distribution of coal and oil is omitted.

² Figure given is for 1961.

Sources: U.S., Department of Commerce, "Statistical Abstract of the United States, 1970," Washington: GPO, 1970, 220-222; U.S. Atomic Energy Commission, "Major Activities in the Atomic Energy Programs", Washington: GPO 1970, p. 19; and, U.S. Senate, Committee on Interior and Insular Affairs, report of the National Fuels and Energy Study Group, "An Assessment of Available Information on Energy in the United States," 1962 p. 133.

While energy industries are not labor-intensive, they do constitute significant portions of the total labor force in selected areas, especially the extractive sector. The decreasing employment in energy industries also indicates a role for intervention by the public sector to assist in re-training and relocation of workers being displaced in industries where mechanization is taking place.

The Dutch and British solutions to the decline in their coal industries presents an interesting contrast to the way in which this problem was handled in this country.

In the late 1950's, the drop in energy prices required a far-reaching adjustment in the costs of producing coal, an adjustment the Dutch were unable to make. As a result, coal was replaced by oil and natural gas and the maintenance of Dutch mines became less feasible. Immediate closure was impossible because of the severe employment repercussions. At the same time, the Dutch government realized that

their mines could never compete with cheaper foreign sources, especially as greater integration of the Common Market countries took place. Thus the government undertook a policy which was aimed at phasing out domestic coal mining. The method used to achieve this policy was a gradual one, intimately tied to the availability of alternative employment for displaced miners. In addition, measures were introduced to stimulate economic development of the former mining areas.

The British, on the other hand, have continued to operate their coal mines even though the price of British coal is above world averages. Rather than close the mines and switch to alternative energy forms or foreign sources of supply, the British Government has attempted to modernize the mines. While these measures were undertaken, a ban on all coal imports was imposed to preserve the domestic industry in the face of stiff foreign competition. While employment in the coal industry was held below 2 percent during the 1960's the British paid higher prices for their coal.

The Resources for the Future (RfF) report on energy policy re-capped the American case by noting that:

Throughout most of its history, the [coal] industry has been beset by problems of excess labor supply, chaotic competitive conditions, inefficient productive organization, and disturbed labor conditions. These conditions were exacerbated by the Great Depression and the competitive impact of petroleum. In the post-war years the industry has protected its competitive position by a cost-reducing program of mechanization with the collateral result of a drastic reduction of manpower requirements. *This has been an important element in the problems of Appalachia and has inspired programs for bringing new sources of livelihood to the region and for shifting the excess labor force.* (pp. 149-50)

These examples of the relationship between energy policy and social problems should not be limited to coal communities; and they are not.

There are ways in which a change of policy could raise welfare problems of importance for oil-producing communities. An example would be the elimination of radical relaxation of oil import restrictions. The price effects of this would make much oil production unprofitable. Traced back to the grassroots, this would mean that numberless communities and their members would be greatly damaged. In contrast to the coal country, where the fortunes of the participants have been left to the buffeting of competitive forces, the welfare of the oil communities has been a central consideration in state regulatory action. Nevertheless, in the broader context of policies concerned with national security and economic growth, it is possible that in time the issue of relaxation of import controls might arise. If so, the welfare issue might also arise. (RfF, *Energy Policy*, p. 151)

III. ENVIRONMENTAL CONSIDERATIONS

A. *What impact does the emergence of environmental quality as an issue of national concern have on the formulation of national energy policy?*

Increased concern for the environment, in both the public and private sectors, has resulted in many policy reconsiderations. At the Federal level, for example, new institutional arrangements have been

initiated, extensive environmental legislation has been enacted and Federally-supported studies undertaken to deal with a multitude of critical problems. Many of the actions which have been taken to improve environmental quality have also had an impact on energy production processes. There are direct constraints under which a national energy policy will have to operate because of recently enacted environmental legislation or recently initiated environmental programs. The report *The Economy, Energy and the Environment*, outlined several important areas of conflict between energy and the environment in the area of electric power production. Some examples from this report provide insight into the multitude of environment/energy inter-relationships:

①. *Control of sulfur dioxide*

Many local air pollution control agencies are restricting the use of fossil fuels that contain sulfur. Are fossil fuel supplies of low sulfur content available presently and in the future to meet federally recommended air quality standards for sulfur oxides?

If not, who has the responsibility for expediting development and demonstration of methods and equipment to remove sulfur oxides from stack gases of power plants? What priority should be given to this?

Concerning the effect upon fossil fuel supply of sulfur content limitations, what are their effects upon present import of residual fuel oil? What are the projected demands for low-sulfur oil from foreign sources—assuming no limitation of import by government action?

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③. *Comparison of nuclear and fossil fuels*

What definitive Government analysis of the comparative environmental effects of nuclear and fossil fuels for generation of electricity has been performed? Is one feasible? Who should do it? How would electricity generated from nuclear versus fossil fuels compare in cost if each system had to meet a "zero pollution" standard?

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⑤. *Evaluating environmental effects*

What reasons are there to develop a uniform method of evaluating environmental effects of major power projects, perhaps a method based upon cost-benefit analysis?

What weight should environmental considerations carry in decisions by utilities as to where and how to generate electricity and to transmit it, and associated review and decisions by Government agencies?

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⑦. *Protection of amenities*

Is there needed a national policy for amenity protection and supporting legislation so that the Federal Government would set standards and criteria to guide State, local, and regional agencies in deciding where power facilities and transmission lines should be located and their appearance? Who would apply and enforce such

standards? How can State governments cause zoning agencies to give special attention to siting of power generation and transmission facilities?

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9. Costs of "clean electricity"

How much will it cost to keep the environmental effects of generation and transmission of electricity, including effects of the fuel suppliers, within limits acceptable to society? How should these costs be divided between:

- (a) The taxpayers—Federal, State, and local.
- (b) The ratepayers.
- (c) The utilities, from income in excess of expenses.

How much agreement is there concerning costs of controlling environmental effects of generation and transmission of electricity for:

- (a) What capital and operating costs should be recognized by State public utility commissions in the setting of rates?
- (b) The amount of those costs. (pp. 15-16)

But the problems identified for electricity generation offer only a sample of the problems which are to be found in the "interface" between environment and energy. Other interface problems include:

The development of energy resources which will decrease pollution potential, either through new sources (solar energy or tidal power), or through conversion of existing sources (magnetohydrodynamics or coal gasification).

The prevention and cleanup of oil spills in navigable waters and on the continental shelf.

The elimination of acid mine drainage.

The control of carbon monoxide, hydro carbons, and oxides of nitrogen from internal combustion sources.

The safe perpetual storage of radioactive waste, perhaps through international agreements that will provide that the practices of one nation will not threaten the public health and safety of another.

The preservation of landscape values, especially with regard to the siting of electric power generating and transmitting facilities.

The preservation of aesthetic, ecological and wilderness values while at the same time, meeting energy demands.

The multitude of conflicts which can develop between environmental values and the supply of energy have been brought into focus by the "Four Corners" controversy recently examined by the Senate Committee on Interior and Insular Affairs.

To summarize briefly, in 1964, 23 public and private utilities representing electric power concerns in California, Nevada, New Mexico, Arizona, Utah and Colorado, formed a consortium to develop coal-fired electric power plants sufficient to meet long-range needs of their respective states. The consortium, the Western Energy Supply and Transmission Association (WEST), projected a doubling of electric power demands every decade. In response, they have planned the construction of six power plants across the Southwest. The plants are to be built near the Four Corners area and fueled by low-rank coal found near the surface in New Mexico and Arizona. Most of it will be strip mined and slurried or railed to the plants. Transmission lines

will supply markets in Phoenix, Las Vegas, Tucson, Albuquerque and Los Angeles.

The first of these plants, located in Farmington, New Mexico, is now in operation. But operation of the plant has generated considerable controversy. Some of the problems disclosed at the recent Interior Committee hearing, included:

Air Pollution.—Critics have cited the volume of stack emissions from the existing and proposed plants, drawing parallels with the total emissions of cities such as New York and Los Angeles. Opponents also noted that California regulations would not permit similar coal-fired plants in the Los Angeles Basin, thus maintaining that Los Angeles, in effect, was exporting its air pollution. Proponents of the project, on the other hand, maintain that both stack emission restrictions and ambient air quality standards are included in the Clean Air Act. They have also announced the proposed installation of several pollution control facilities and that an area-wide monitoring program to determine the nature and extent of atmospheric pollution from the plants would be initiated.

Water Pollution.—Opponents of the project contended that leaks had occurred from the coal slurry pipeline, polluting nearby drainages, and in the future slurry water would be disposed of by running it into nearby rivers. Another complaint was that the removal of water from the Colorado River would result in an increase in salinity of the remaining water. This was seen as a problem in fulfilling treaty requirements for delivery of usable Colorado River water to Mexico. Company officials acknowledged that pipeline leaks or discharges had occurred but that steps were now being taken to prevent their reoccurrence.

Strip Mining.—Critics maintained that the strip mining techniques used to procure coal for the Farmington plant were comparable to the detrimental effects of strip mining in Appalachia. Proponents countered that the comparison is unjustified. They pointed out that rainfall in Farmington is about 5 inches annually, compared to nearly 10 times that amount for Appalachia; whereas the Farmington area is sparsely vegetated, Appalachia is heavily forested; and, finally, the topography of the Southwest consists of table-like mesas and interspersed lowlands, while Appalachia consists of steeply sloping hills.

Mercury Contamination.—This problem was raised with regard to both air pollution and strip mining. Contradictory figures were presented by State and private witnesses. Further study will have to detail the magnitude of the problem.

Indian Affairs.—Two problems associated with Indian control over their land holdings were disclosed at the hearings. The first involved the contracts signed by the Indians with the various companies for use of tribal lands. The primary issue involved how the contract terms compare with other non-Indian contracts for similar services. The second problem involved a preservation versus development conflict within the tribes. "Traditional" segments of the tribes oppose the mining operations and other development activity. "Progressives", however, promoted the power plants, viewing them as a source of economic development which could aid the welfare of the tribe.

B. Can a national energy policy be formulated which would sustain economic growth and enhance environmental quality?

Meeting energy requirements, while at the same time preserving environmental values, presents a paradox. On the one hand, energy is a major contributor to pollution, but environmental improvement generally is difficult without adequate energy supplies. In addition, energy is needed in the economic development process. Thus, more energy supplies will be needed both to promote growth and to assist in restoring the environment, but the energy forms used must not contribute greater pollution.

To resolve this difficulty, additional Federal funding might be expended to assist in the research and development of non-polluting energy sources. Additional Federal funding for research and development, as well as other pollution control programs, usually means funds must be diverted from other sources. Some people maintain, however, that the resources of the Federal Government are almost fully committed through 1975 because of maturing programs already in force and because of the expected impact of new initiatives whose adoption appears to be well underway. State and local governments also will be hard-pressed to raise the revenue necessary to finance an expanding demand for public services in the environmental area.

Under these circumstances, we must face squarely an inescapable fact: there is a fundamental conflict between our efforts to maximize the growth of our gross national product (GNP) as traditionally defined and our efforts to devote a substantial share of our real resources to pollution control.

While activities to check pollution and to improve our environment will undoubtedly take many forms, above all they will require a significant increase in the level of investment in pollution abatement equipment. This will mean a drastic change in the pattern of investment spending in both the private and public sectors. Historically, the vast proportion of the new investment in private industry has been made to increase production capacity, and only a modest share has been devoted to suppressing the pollutants generated as a by-product of industrial activity. To get a firm grip on the pollution problem will require a considerable reordering of investment priorities: a much larger share of new investment will have to be devoted to making production processes themselves far cleaner and to repairing the environmental damages suffered in the past.

And here we encounter the toughest choice of all: the rate of growth of real output in the United States—as in any other advanced industrial society—depends heavily on the pace of investment in plant and equipment to expand productive capacity. With much more of our net investment being channeled into pollution abatement, the rate of expansion of the American economy as a whole will probably slow down perceptibly. So, with our population continuing to grow, we would be faced with the likelihood of a slower growth in real per capita income—and in our standard of living as traditionally defined. Some of us, of course, would accept such an outcome as a reasonable price to pay to halt the deterioration of our environment. Others would decry it as an unwarranted penalty to be paid primarily by those segments of society least able to bear it—under-developed regions

of the country, the poor and disadvantaged, hard-pressed urban communities—all of which may benefit considerably from a high level of sustained economic growth. And, finally, still other observers would hope and search for a viable means of reconciling these conflicting goals.

* * * * *

Thus, the fundamental question that must be asked is this: are we prepared to pay these real costs? Only the American people as a whole can answer.

(Andrew F. Brimmer, "Economic Impact of Pollution Abatement," Speech at University of Miami, Coral Gables, Fla., June 6, 1971, *Congressional Record*, Daily Edition, August 3, 1971, pp. E8717-8718)

IV. DEMAND CONSIDERATIONS

A. What are the current trends in energy demand?

Since the end of World War II there has been a continued rise in the demand for energy in the United States. Between 1947 and 1965 consumption of energy in this country:

* * * rose by an annual average of 2.8 per cent compounded just a shade below the long-term growth rate of about 3 per cent. Although it rose in all but five of these eighteen years, the rate of increase was markedly below the 2.8 per cent average in the first few years of the period (which followed an expansion in energy use unprecedented since the beginning of the century) and especially fast in the first half of the 1960's.

* * * * *

Steady growth in energy consumption was accompanied by significant changes in the energy mix, as expressed calorically and shown in Table [10]. Coal ceased to be the dominant source of energy, being surpassed at the beginning of the 1950's by oil and, less than a decade later, by natural gas.

By the mid-1960's these changes seemed to be leveling off, and an approximate pattern had emerged in which oil held 40 per cent, gas 30 percent, and coal a little over 20 per cent of the domestic energy market—a far cry from 1947 when the corresponding figures were 33, 14, and 44.

* * * * *

These broad compositional changes in energy use are reflected also in data on trends in the value and volume of fuels output (hydro excluded) over the postwar period, shown in Table [11]

* * *

Mineral fuels are also seen to make a dominant, though declining, contribution to the value of *total* minerals production.

Whether the reversals of the declining coal and the rising oil trend, and the flattening of the rising gas trend—all in terms of market shares—are steps leading to another radical change in the energy mix is a subject of legitimate controversy, made the more intriguing by the advent of commercial nuclear energy and the approach to competitiveness of other hitherto unused energy sources.

* * * * *

The growth in the volume of energy consumed in the American economy and changes in the mix have been associated with changes in the importance of various energy-consuming sectors and, within these sectors, by changes in the mix of fuels consumed in them.

In order to bring out one of the outstanding changes during the two decades, it is convenient to treat electric power generation as a separate economic sector rather than as a processing stage prior to final consumption. The results are shown in Table [12], in which the relative rise in energy use by the electric utility industry is seen to be the steepest of all * * *

TABLE 10.—U.S. ENERGY CONSUMPTION BY PRIMARY FUEL, SELECTED YEARS, 1900-65

Year	Total	Bitumi- nous coal ¹	Anthra- cite	Crude oil ²	Natural gas	Natural gas liquids	Hydro- electric power ³
A. Trillion B.t.u.:							
1900.....	7,572	5,431	1,410	229	252	-----	250
1910.....	14,800	10,654	2,060	1,007	540	-----	539
1920.....	19,782	13,325	2,179	2,634	827	42	775
1925.....	20,899	13,079	1,627	4,156	1,212	124	701
1930.....	22,288	11,921	1,718	5,652	1,969	246	785
1940.....	23,908	11,290	1,245	7,487	2,726	294	917
1945.....	31,541	14,661	1,311	9,619	3,973	491	1,486
1947.....	32,870	14,302	1,224	10,803	4,518	564	1,459
1950.....	34,153	11,900	1,013	12,706	6,150	783	1,601
1955.....	39,956	11,104	599	16,328	9,232	1,196	1,497
1960.....	44,816	9,967	447	18,608	12,736	1,427	1,631
1961.....	45,573	9,809	404	18,989	13,228	1,498	1,645
1962.....	47,620	10,160	363	19,662	14,027	1,605	1,803
1963.....	49,649	10,722	361	20,282	14,843	1,668	1,773
1964.....	51,515	11,295	365	20,617	15,562	1,769	1,907
1965.....	53,791	12,030	328	21,337	16,136	1,872	2,088
B. Percentage distribution:							
1900.....	100.0	71.7	18.6	3.0	3.3	-----	3.3
1910.....	100.0	72.0	13.9	6.8	3.7	-----	3.6
1920.....	100.0	67.4	11.0	13.3	4.2	0.2	3.9
1925.....	100.0	62.6	7.8	19.9	5.8	.6	3.3
1930.....	100.0	53.5	7.7	25.4	8.8	1.1	3.5
1940.....	100.0	47.2	5.2	31.4	11.4	1.0	3.8
1945.....	100.0	46.5	4.2	30.5	12.6	1.5	4.7
1947.....	100.0	43.5	3.7	32.9	13.8	1.7	4.4
1950.....	100.0	34.8	3.0	37.2	18.0	2.3	4.7
1955.....	100.0	27.8	1.5	40.8	23.1	3.0	3.8
1960.....	100.0	22.0	1.0	41.6	28.4	3.2	3.6
1961.....	100.0	21.5	.9	41.6	29.0	3.3	3.7
1962.....	100.0	21.3	.8	41.3	29.4	3.4	3.8
1963.....	100.0	21.6	.7	40.8	29.9	3.4	3.6
1964.....	100.0	21.9	.7	40.0	30.2	3.5	3.7
1965.....	100.0	22.4	.6	39.6	30.0	3.5	3.9

¹ Includes lignite.

² Includes net imports of petroleum products.

³ Includes nuclear for 1960-65 (never exceeding 0.1 percent).

Source: RfF, "U.S. Energy Policies: An Agenda," p. 7.

TABLE II.—U.S. PRODUCTION OF FUEL AND NONFUEL MINERALS (QUANTITIES AND VALUE), 1947, 1955, 1965

Item	1947			1955			1965					
	Value			Value			Value					
	As percent of—			As percent of—			As percent of—					
	Quantity	Dollars (million)	All minerals	Fuels only	Quantity	Dollars (million)	All minerals	Fuels only	Quantity	Dollars (million)	All minerals	Fuels only
Coal, total (million short tons)-----	687	3,034	31.6	42.2	490	2,295	14.5	21.3	528	2,404	11.2	17.1
Bituminous coal and lignite-----	630	2,620	27.3	36.5	464	2,087	13.2	19.4	512	2,276	10.6	16.2
Pennsylvania anthracite-----	57	413	4.3	5.7	26	206	1.3	1.0	15	122	.6	.9
Peat-----	.1	1	(1)	(1)	.3	2	(1)	(1)	.6	6	(1)	(1)
Natural gas, wet (billion cubic feet)-----	4,582	275	2.9	3.9	9,405	978	6.2	9.1	16,040	2,495	11.6	17.8
Natural gas liquids (million gallons)-----	132	295	3.1	4.1	11,818	619	3.9	5.8	18,545	911	4.3	6.5
Natural gasoline and cycle products-----	87	228	2.4	3.2	5,845	424	2.7	4.0	7,288	494	2.3	3.5
L-P gases-----	45	67	.7	.9	5,973	195	1.2	1.8	11,257	417	2.0	3.0
Petroleum, crude (million barrels)-----	1,857	3,578	37.2	49.8	2,484	6,871	43.6	63.8	2,848	8,158	38.1	58.1
Total, fuels ² -----	(3)	7,188	74.8	100.0	(3)	10,774	68.3	100.0	(3)	14,015	65.5	100.0
Total, nonfuel minerals-----	(3)	2,422	25.2	-----	(3)	5,003	31.7	-----	(3)	7,388	34.5	-----
Metals-----	(3)	1,084	11.3	-----	(3)	2,044	13.0	-----	(3)	2,472	11.5	-----
Nonmetals-----	(3)	1,338	13.9	-----	(3)	2,959	18.7	-----	(3)	4,916	23.0	-----
All minerals-----	(3)	9,610	100.0	-----	(3)	15,777	100.0	-----	(3)	21,433	100.0	-----

¹ Negligible.² Excluding hydro and nuclear power. Data for 1955 and 1965 include small amounts of other mineral energy resources, not shown separately above.³ Common weight or volume measure not meaningful.

Source: RfF, "U.S. Energy Policies: An Agenda * * *," p. 8.

TABLE 12.—U.S. CONSUMPTION OF ENERGY RESOURCES BY MAJOR SOURCES AND CONSUMING SECTORS, 1947, 1955, 1965

A. TRILLION B.T.U.

Consuming sectors	Primary energy sources					Total primary energy inputs ³	Utility electricity purchased ⁴	Total sector energy inputs ⁵
	Anthracite	Bituminous coal	Natural gas	Petroleum ¹	Hydro and nuclear power ²			
Household and commercial:								
1947	813	2,586	1,125	2,251	(6)	6,774	393	7,167
1955	331	1,444	2,850	4,001	(6)	8,625	837	9,462
1965	79	546	5,534	5,634	(6)	11,793	1,937	13,730
Industrial:								
1947	285	7,014	2,875	2,490	(6)	12,663	452	13,115
1955	53	5,796	4,675	3,329	(6)	13,853	1,000	14,853
1965	49	5,640	7,685	4,141	(6)	17,515	1,634	19,149
Transportation: ⁷								
1947	24	3,006	—	5,760	(6)	8,791	24	8,815
1955	12	462	254	9,109	(6)	9,837	20	9,857
1965	—	19	518	12,184	(6)	12,721	21	12,742
Electric utilities: ⁸								
1947	90	1,994	386	468	1,459	4,397	—	—
1955	82	3,402	1,194	512	1,497	6,686	—	—
1965	55	5,825	2,399	743	2,088	11,110	—	—
Miscellaneous and unaccounted for:								
1947	13	—	133	398	(6)	544	—	—
1955	123	—	260	572	(6)	955	—	—
1965	145	—	—	507	(6)	652	—	—
Total primary energy inputs:								
1947	1,224	14,600	4,518	11,367	1,459	33,168	—	—
1955	599	11,104	9,232	17,524	1,497	39,956	—	—
1965	328	12,030	16,136	23,209	2,088	53,791	—	—

B. PERCENTAGE DISTRIBUTION: CONSUMING SECTORS BY PRIMARY ENERGY SOURCES

Household and commercial:								
1947	12.0	38.2	16.6	33.2	(6)	100.0	—	—
1955	3.8	16.8	33.0	46.4	(6)	100.0	—	—
1965	.7	4.6	46.9	47.8	(6)	100.0	—	—
Industrial:								
1947	2.2	55.4	22.7	19.7	(6)	100.0	—	—
1955	.4	41.8	33.7	24.1	(6)	100.0	—	—
1965	.3	32.2	43.9	23.6	(6)	100.0	—	—
Transportation: ⁷								
1947	.3	34.2	—	65.5	(6)	100.0	—	—
1955	.1	4.7	2.6	92.6	(6)	100.0	—	—
1965	—	.1	4.1	95.8	(6)	100.0	—	—
Electric utilities: ⁸								
1947	2.1	45.3	8.8	10.6	33.2	100.0	—	—
1955	1.2	50.9	17.8	7.7	22.4	100.0	—	—
1965	.5	52.4	21.6	6.7	18.8	100.0	—	—
Miscellaneous and unaccounted for:								
1947	2.4	—	24.4	73.2	(6)	100.0	—	—
1955	12.9	—	27.2	59.9	(6)	100.0	—	—
1965	22.2	—	—	77.8	(6)	100.0	—	—
Total primary energy inputs:								
1947	3.7	44.0	13.6	34.3	4.4	100.0	—	—
1955	1.5	27.8	23.1	43.9	3.7	100.0	—	—
1965	.6	22.4	30.0	43.1	3.9	100.0	—	—

See footnotes at end of table, p. 29.

TABLE 12.—U.S. CONSUMPTION OF ENERGY RESOURCES BY MAJOR SOURCES AND CONSUMING SECTORS, 1947, 1955, 1965—Continued

C. PERCENTAGE DISTRIBUTION: PRIMARY ENERGY SOURCES BY CONSUMING SECTORS

Consuming sectors	Primary energy sources					Total primary energy inputs ³	Utility electricity purchased ⁴	Total sector energy inputs ⁵
	Anthracite	Bituminous coal	Natural gas	Petroleum ¹	Hydro- and nuclear power ²			
Household and commercial:								
1947.....	66.4	17.7	24.9	19.8	(6)	20.4	-----	-----
1955.....	55.2	13.0	30.9	22.8	(6)	21.6	-----	-----
1965.....	24.1	4.5	34.3	24.3	(6)	21.9	-----	-----
Industrial:								
1947.....	23.3	48.0	63.6	21.9	(6)	38.2	-----	-----
1955.....	8.7	52.2	50.6	19.0	(6)	34.7	-----	-----
1965.....	14.9	46.9	47.6	17.8	(6)	32.6	-----	-----
Transportation: ⁷								
1947.....	1.9	20.6	—	50.7	(6)	26.5	-----	-----
1955.....	2.0	4.2	2.8	52.0	(6)	24.6	-----	-----
1965.....	—	.2	3.2	52.5	(6)	23.6	-----	-----
Electric utilities: ⁸								
1947.....	7.4	13.7	8.6	4.1	100.0	13.3	-----	-----
1955.....	13.6	30.6	12.9	2.9	100.0	16.7	-----	-----
1965.....	16.8	48.4	14.9	3.2	100.0	20.7	-----	-----
Miscellaneous and unaccounted for:								
1947.....	1.0	—	2.9	3.5	(6)	1.6	-----	-----
1955.....	20.5	—	2.8	3.3	(6)	2.4	-----	-----
1965.....	44.2	—	—	2.2	(6)	1.2	-----	-----
Total primary energy inputs:								
1947.....	100.0	100.0	100.0	100.0	100.0	100.0	-----	-----
1955.....	100.0	100.0	100.0	100.0	100.0	100.0	-----	-----
1965.....	100.0	100.0	100.0	100.0	100.0	100.0	-----	-----

¹ Including natural gas liquids.² Includes nuclear for 1965 only (negligible).³ Represents energy content of all primary energy sources and their derivatives (domestic and imported) at time it is incorporated in the indicated consuming sectors of the economy. Hydro and nuclear power, where entered, are converted at their theoretical primary energy equivalent (see footnote 8, below).⁴ Represents utility electricity distributed to the indicated consuming sectors, computed at 3,412 B.t.u. per kilowatt-hour, the direct calorific value of electricity.⁵ Energy resource inputs by sector, including direct fuels and electricity purchases.⁶ Not shown, since only aggregate electric energy purchases can be allocated to end uses.⁷ Comprises all transportation, including commercial transport services, passenger cars, bunkers, and military.⁸ The hydro and nuclear power components of this panel are converted to theoretical inputs at the prevailing average rate of pounds of coal per kilowatt-hour at central electric stations.

Note: A dash signifies "nil," "not applicable," or "negligible."

Source: RfF, "U.S. Energy Policies: An Agenda," pp. 10-13.

When input into power generation is allocated to final consumers rather than considered as an end-use in itself industry remains the largest consumer, but because transportation is for all practical purposes out of the electric power market, it falls considerably below the household and commercial segment as a destination of energy use . . . (RfF, *U.S. Energy Policies: An Agenda* . . . , pp. 7-14)

In the last five years, even more profound changes have occurred in the character of energy demand. Table 5 (p. 15) presents the ratio of aggregate energy consumption per dollar of (constant dollar) gross national product (GNP). During the period 1947-1966, this ratio showed a decline and, as long as it did so, economic growth resulted in a less than proportionate increase in energy consumption. Between 1966-1970, however, this ratio increased which implies that as GNP increased, energy consumption was increasing at a greater rate than

GNP. If the trend prior to 1966 had persisted, energy consumption in 1970 would have been lower by an amount greater than the total electric utility consumption of coal in that year.

One can obtain a measure of the significance of the trend reversal by assuming that it did not occur and calculating what aggregate energy consumption would have been on that basis in 1970. The actual level of the ratio in 1970 was 85,400 Btu per dollar of GNP. Projecting the 1947-1966 trend in the ratio to that year, the ratio would have been 84,000 Btu per dollar of GNP, or 12 per cent less. When this ratio is applied to the 1970 GNP figure, we find that aggregate energy consumption in that year would have been 8,258 trillion Btu, or 12 per cent, less than actual consumption . . . *it seems fair to conclude that in the absence of the trend reversal in the energy/GNP ratio, the energy supply crisis of 1970 would have been far less severe or would not have occurred at all.*

There is, then, more than academic interest in questioning what the statistical phenomenon really signifies. Is the trend reversal real or is it only a statistical illusion? Has the economy crossed a watershed in the energy/GNP relationship in the past five years, and if so, what is the explanation? Is the reversal, if it is real, something that can be expected to persist indefinitely or is it only temporary? (Bruce C. Netschert, "Energy Consumption and Gross National Product in the United States: An Examination of a Recent Change in the Relationship," *Congressional Record*, Daily Edition, July 15, 1971, p. E7702)

An analysis of the possible reasons for this trend reversal indicates that it cannot be ascribed to any single cause; however, several factors might be influencing this trend: (1) the increasing relative importance of non-energy uses of the fuels; (2) a tapering off in the year-to-year improvement in thermal efficiency at central power stations; and (3) the increasing importance of air conditioning and electric heating.

B. At what rate can the demand for energy be expected to increase? What is the validity of demand projections which have been made to date? Do they provide sufficient information upon which national energy policy can be formulated?

There is no doubt that demand forecasts are a necessity to formulate reliable energy policies. While the demand for energy can be expected to increase in the future, the rate of increase and our ability to predict that rate will encounter major difficulties. Projections can provide a guide by assessing the prospects of future consumption and also bring into focus the energy supplies required to meet rising demand.

The report, *Energy R&D and National Progress*, indicated several problems inherent in projections:

The purpose of the projection, the time available for its preparation, and the sophistication and personal preference of the author cause the many differences in methods of projecting energy requirements. No one method is clearly more accurate than others, although some provide more useful results. All projection methods recognize to varying degrees and in varying ways the basic determinants of energy requirements, one of which is population. However, the acceptance of population as an

independent parameter is based on the premise that energy resources are so plentiful and inexpensive that there are no serious problems in providing enough energy to meet per capita needs, regardless of whether predicted population is high or low. Such conditions have existed in the United States in the past and may well exist in the future, and one purpose of energy planning is to assure that such conditions continue to exist. (In countries with limits on the total energy supply, different population projections imply the same total consumption but different per capita levels of consumption.) Hence the acceptance of population as a determinant of energy requirements carries no judgment of its relative importance as a determinant.

Energy consumption is highly dependent on standards of living, changes in which are intimately related to economic growth, the prediction of which, in turn, is a major art in itself. For projection purposes, it is also significant that the standard of living is partly determined by the supply of energy; that is, the quantities available at various costs.

Another determinant, the efficiency with which energy input into the economy is converted to useful energy output, is largely a matter of technology, although there are elements of consumer preference . . .

Consumer preference in this country has steadily emphasized the use of energy in more highly refined or processed form, which generally implies less useful output per unit of primary-energy input. As an example, a consumer preference for electric space heating ignores the fact that the total energy for heating a house electrically normally requires more total energy than using fuel directly in an efficient household furnace. (p. 15)

The procedural difficulties noted in this report can result in strikingly different estimates. In March, 1970 the Office of Science and Technology² released a report which analyzed the adequacy of existing, published energy forecasts for public policy purposes. Nineteen energy forecasts published by private organizations, government agencies and individuals were collected and studied. Not surprisingly, differences in terminology, coverage, assumptions, and intent were found to exist. Moreover, most of the forecasts were prepared prior to the recent concern for environmental quality and did not reflect the possible effects of developing environmental policies on energy supply and demand. The widely divergent results presented in the OST report are shown in Table 13.

The OST report also made an assessment of the most realistic demand projections:

According to the forecasts examined in this report, energy consumption in the year 2000, including non-fuel uses, is expected to be about 170,000 trillion British thermal units if real gross national product grows at about 4 percent per year. Consumption in 1968 was slightly over 62,000 trillion Btu. The average annual indicated growth rate is about 3.2 percent.

Although a figure of 170,000 trillion Btu in the year 2000 is certainly reasonable, on the basis of extrapolating current trends,

² U.S., Executive Office of the President, Office of Science and Technology, Energy Policy Staff, *A Review and Comparison of Selected United States Energy Forecasts*, Prepared by Battelle Memorial Institute, December, 1969.

it does not reflect an analysis of new factors which are already emerging, the most important of which is the growing concern for protecting the environment. It is also by no means clear that it adequately reflects possible changes in efficiency of energy conversion and changes in the structure of consumption, especially the larger share going into electric power production. (OST, *A Review and Comparison of Selected United States Energy Forecasts*, 1969, pp. viii-ix)

TABLE 13.—FORECASTS OF TOTAL ENERGY REQUIREMENTS

[Trillions of B.t.u.'s]

Source document ⁷	Date of publication	Base years	Base value	1970	1975	1980	1985	2000
CGAEM ¹	1968	1947-65	30,838	64,444	79,611	97,825	119,597	
EUS ^{1,2}	Sept. 1967	1960-65	52,350 41,453	60,827	79,944	93,374	118,126	
N.F. & E.S.	Sept. 1962	1961	50,314 44,064			³ 82,000		
RAF	Sept. 1962	1960	45,250	60,190		79,200		135,200
PEC	Dec. 1968	1947 1962	33,168 47,897			85,934		
ER	Dec. 1962	1907-60	14,600 44,900			⁴ 61,000		
OEUS	Oct. 1968	1950-65				⁵ 97,000		
USP	July 1968	1965	54,000			88,100		
EMUS	July 1968	1947-65	33,168 53,791	64,276	75,605	88,075 ² 83,900		168,600 ² 158,951
PCCP ²	May 1968	1948-65	54,000			91,000		155,000
FFF	October 1960	1953	41,000		73,000	86,200		170,000
TCUSEC ⁶	1968	1960	48,200			93,000 (99,700)		174,000 (213,000)

¹ Hydro accounted for at kw.-hr. energy equivalent.

² Excludes nonfuel uses.

³ Consensus of 11 forecasts.

⁴ Minimum.

⁵ Converting their 17,000 million barrels of oil equivalent to B.t.u. 5,800,000 B.t.u. per barrel.

⁶ GNP growth rate at 3.5 percent per year and (4.0 percent per year).

⁷ The studies examined were the following:

CGAEM—Competition and Growth in American Energy Markets, 1947-85, Texas Eastern Transmission Corp., 1968.

EUS—Energy in the United States, 1960-85; Michael C. Cook, Sartorius & Co., September 1967.

NF&ES—Report of the National Fuels and Energy Study Group on Assessment of Available Information on Energy in the United States, Committee on Interior and Insular Affairs, U.S. Senate, September 1962.

RAF—Resources in America's Future, Landsberg, Fischman, & Fisher, Resources for the Future, Inc., John Hopkins Press, 1963.

PEC—Patterns of Energy Consumption in the United States, William A. Vogely, Division of Economic Analysis, Bureau of Mines, U.S. Department of the Interior, 1962.

ER—Energy Resources, a report to the Committee on Natural Resources, M. K. Hubbert, National Academy of Sciences, Publication 1000-D, National Research Council, 1962.

OEUS—Outlook for Energy in the United States, Energy Division, The Chase Manhattan Bank, N.A., October 1968.

USP—United States Petroleum Through 1980, U.S. Department of the Interior, Office of Oil and Gas, July 1968.

EMUS—An Energy Model for the United States Featuring Energy Balances for the Years 1947-65 and Projections and Forecasts to the Years 1980 and 2000, Bureau of Mines, IC 8384, July 1968, U.S. Department of the Interior.

PCCP—Projections of the Consumption of Commodities Produable on the Public Lands of the United States 1980-2000, prepared for the Public Land Law Review Commission, Rogert R. Nathan Associates, Inc., Washington, D.C., May 1968.

FFF—Fossil Fuels in the Future, Office of Operations Analysis and Forecasting, U.S. Atomic Energy Commission, Milton F. Searl, 1960.

TCUSEC—Technological Change and United States Energy Consumption, 1939-54, Alan M. Strout (unpublished thesis) (energy projection portion of the thesis). University of Chicago.

Source: U.S., Executive Office of the President, Office of Science and Technology, Energy Policy Staff, *A Review and Comparison of Selected United States Energy Forecasts*, Prepared by Battelle Memorial Institute, December, 1969, p. 12.

Even with these precautionary comments, the figures for energy demand given in the report are large. A projected demand of 170,000 trillion Btu means an increase of 274 percent over 1968. Given the present shortage now experienced with many energy fuels, meeting this demand will present a formidable task.

The Office of Science and Technology's study is only one of the many studies on energy projections that will have to be examined. The Resources for the Future report offered a suggestion to assist in this task:

To avoid becoming a source of intellectual confusion, projections need to be drawn to clearly defined specifications and accompanied by a precise statement of their meaning and limitations. Today they emanate from many sources and are of different quality, drawn to different specifications, with different coverage; and not infrequently they are designed to promote some particular interest. (RFF, *U.S. Energy Policies: An Agenda . . .*, p. 130)

C. To what extent should a national energy policy provide for supplying all future energy demand regardless of the amount?

Although the rate at which energy demand will increase in the future is open to question, it is certain that an increase will occur. Our ability to meet this demand will depend on the availability of future supplies and the level of demand. However, another fundamental question must be asked: Should the national energy policy formulate the position that all energy demand should be fulfilled?

If the above question is answered affirmatively, the availability of future supplies must be carefully examined to ensure that attainment of this goal is possible. Would this decision conflict with proposed environmental, economic and social policies? What trade-offs will have to be made in order to ensure the fulfillment of the demand for energy? The supply of reliable electric power, for example, has produced widespread concern in recent years. If solutions are sought to overcome present-day shortages, without consideration of the long-term consequences of such actions, even greater problems may be encountered. The same may hold true for other supplies as well.

If, on the other hand, it becomes apparent that future energy demand cannot be satisfied, even more difficult questions arise. What types of energy demands will be left "unsupplied"? Which geographic areas, energy forms, or markets could be left unfulfilled with the least economic and social dislocations? Should priorities be established to delineate those consumers which should be supplied in case of shortages?

Many people have taken an opposing position on the need for meeting future energy demands. They argue that the important question is not whether we can meet energy demands, but whether we really need increased energy:

The more fundamental question, then, cannot be avoided: Do we really *need* twice as much electricity every ten years and twice as much energy of all kinds every fourteen? Industry spokesmen claim that the only alternative is a return to a more primitive existence. The persistent repetition of this fallacy, in forums from newspaper editorials to Congressional hearings, does not make it any more plausible. Obviously, our options are more varied than the two choices the industrialists are offering. For example, a great deal of energy is used frivolously and wastefully in the United States partly because energy is so cheap. Most of us live in poorly insulated homes and apartments and work in poorly insulated buildings, all of which require vast quantities of energy to heat and air-condition (more than 10 percent of U.S. energy

consumption). For the most part, individuals commute alone in two-ton automobiles (13 percent of our energy consumption is in the form of gasoline for private cars). And we pour countless kilowatt-hours into the night sky from garish flashing signs.

* * * * *

[T]here is ample reason to believe that a "crisis" in supply and demand can be met by manipulating demand as well as supply, and the power lobby has produced no evidence that doing so would necessarily cripple the economy or further disadvantage the poor. The mounting—and in some degree unavoidable—environmental consequences of energy use require that the question of moderating demand now be seriously addressed. It will not be made to vanish by pious rhetoric about a "healthy economy." (Paul R. Ehrlich and John P. Holden, "The Energy Crisis," *Saturday Review*, August 7, 1971, pp. 50–51.)

V. SUPPLY CONSIDERATIONS

A. What are the current trends in energy supply?

The sources of energy supplies have changed markedly over the last 100 years. Since the middle of the last century, the energy economy of the United States has undergone supply substitutions illustrated in Figure 4.

During the years when fuelwood was the principal source of energy, household use was its principal destination. An early estimate of the use of fuelwood puts total consumption in 1879 at about 146 million cords of which less than 4 per cent went to uses other than in homes. Coal by that time was *the* industrial fuel. In the middle eighties the railroads had become the most important single user of coal, followed by coke ovens, with the balance burned by industry and in domestic use. Anthracite was preferred for household application.

* * * * *

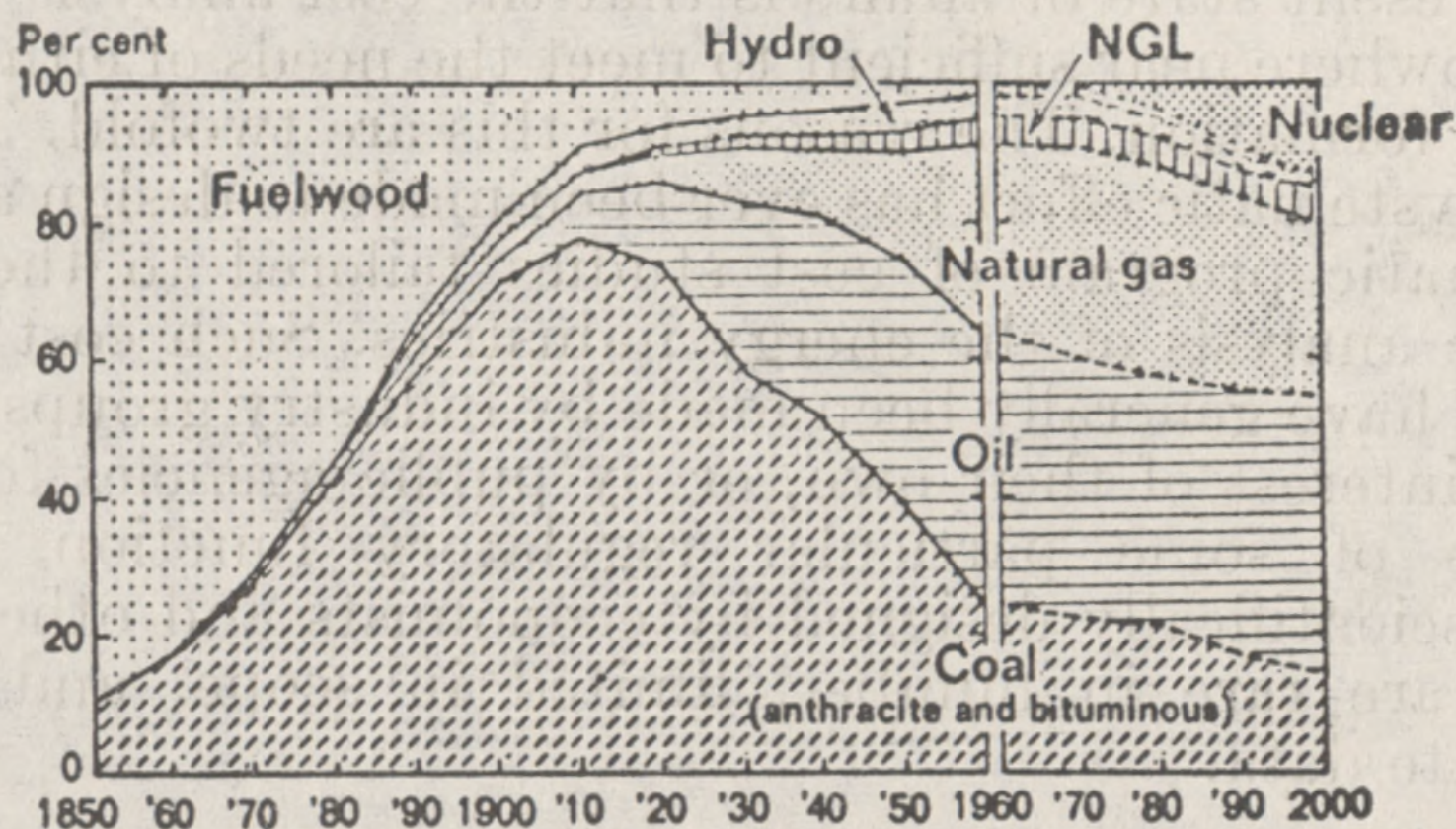
By 1910 the picture was almost a mirror image of 1850. Fuelwood accounted for little more than 10 per cent, and coal for the bulk, of energy consumption. There were also three newcomers: oil, natural gas, and hydropower. Fuelwood, though on the decline, still outranked oil and gas jointly.

World War I was a turning point. By 1920, oil and gas together were twice as important as fuelwood, but coal consumption was still $4\frac{1}{2}$ times as large as oil and gas. The petroleum fuels caught up with coal in 1946. By 1960 oil and gas between them accounted for some 70 per cent of total energy consumption. Thus the second cycle was completed. One important difference between the two eras, however, is the fact that coal has never ceased to be the preferred source of fuel in important segments of the economy, above all in the production of ferrous metal and in the generation of electricity.

(Landsberg & Schurr, *Energy in the United States*, pp. 30–31)

Figure 4

Changing Sources of Energy, 1850-1960, with Projections to 2000



Source: Landsberg and Schurr, Energy in the United States, p. 30.

Energy supplies in the years ahead will be determined by the interaction of many factors; including, other national priorities and goals, future demand, transportation patterns and technology, pricing policies, regulatory policies, research and development, foreign trade and foreign policy considerations, and the national energy policy itself. Thus energy supply forecasts will involve the consideration of a multitude of variables and parameters. Even though the problems are large, estimates have been made. Table 14 presents estimates of how much of the demand is expected to be supplied by oil and gas (see also Table 13, p. 32).

There are several other items which must be considered in future energy supply forecasts. Current supply estimates, like those for demand, present a confusing array of analytical procedures. While uniformity among all forecasts is not to be expected, there is a need to bring various studies into juxtaposition with one another.

In principle, the most important knowledge relevant to the future availability of energy, if it could be obtained, would be a knowledge of the supply functions of the various fuels—that is to say, a schedule of the amounts that would be brought to market at various prices. The nature of the analysis of supply functions is the tracing of the expected course of marginal and average costs, thus defining the prices which would elicit varying volumes of production. . . .

Comparative cost analysis, whatever the difficulties and however unsatisfactory the data to support it, is an essential underpinning to any effort to assess the future outlook for energy supply and demand.

Cost problems cast their shadow over every sphere, whether in analysis or public action. Fixing the field prices of natural gas is based upon cost analysis. Restrictions on crude oil imports are related to the costs of domestic production. The costs of uranium

and coal will partly determine their use in electrical generation. The costs of oil from shale or of synthetic fuels from coal will condition the terms of their competition with conventional fuels. And so on into every corner of the energy problems with which public policy is concerned.

The present state of affairs is that the cost analysis now available is nowhere near sufficient to meet the needs of either analysis or policy formation. The reasons for this are twofold. The first is that no systematic effort has ever been made to design and pursue a systematic program of cost studies tailored to the needs of economic analysis of the energy industries. Such cost studies as there are have generally been made by industry groups in pursuit of some interest of their own, or by public agencies for the performance of some particular regulatory function. Objective studies, scientifically designed by economists and other industry experts, are rare in number, limited in scope, and based on inadequate data.

TABLE 14.—U.S. ENERGY AND PETROLEUM REQUIREMENTS FOR 1980¹

Source	Date	Total energy quad. B.t.u.	Oil		Gas	
			Million barrels per day	Percent total	Trillion cubic feet	Percent of total
National Fuels and Energy Study Group ²	1962	82.0	16.7	41	21.2	28
Department of Interior.....	1965	85.9	17.5	40	25.6	31
Pan American Petroleum Corp. ²	1966	87.0	18.6	43	28.0	33
American Gas Association ²	1966				27.2	
Stanford Research Institute ²	1967	92.0	18.2	39	27.9	31
The Gas Industry Committee.....	1967				28.6	
First National City Bank of New York ²	1967	87.2	17.2	38	23.6	28
The Petroleum Industry Research Foundation.....	1968	92.0	18.0	39	28.0	31
Texas Eastern Transmission Corp.....	1968	97.8	18.9	41	30.8	33
Humble Oil & Refining Co.....	1968	97.3	18.2	37	29.8	32
Department of Interior (current survey).....	1968	88.1	18.2	41	24.6	29

¹ Explanation provided by the Department of the Interior included: "Energy projection claims the attention of many in government and industry alike. Shown below are extracts from 10 recent studies by various sources giving estimates of the 1980 requirements of the United States for oil, gas, and total energy. Totals arrived at in this survey are shown as the last item for purposes of comparison. Although not directly comparable because of differing assumptions used, the estimates do provide a useful guide to current opinion on the energy outlook."

² Oil and gas consumption obtained by converting B.t.u. to barrels and cubic feet at the rate of 5,400,000 B.t.u. per barrel and 1,035 B.t.u. per cubic foot.

Source: "The Economy, Energy and the Environment," p. 27.

The other reason for the deficiency is inherent in the nature of the problem of cost analysis. What is needed is supply functions for the various fuels running some distance into the future. But the future supply conditions of all energy fuels are clouded by a high degree of uncertainty, because what is involved is a probing of the unknown—the costs related to the finding and development of new reserves. This difficulty cannot, however, serve as an excuse for failure to establish a program of cost studies. Some hypotheses concerning the relation between future costs and supplies provide the only economic basis for assessing the outlook for the future of the different energy sources. The proper grounding for these hypotheses is the marshalling of all available evidence. The problems of method break down into stages, moving from short-run to long-run analysis. (RFF, *U.S. Energy Policies: An Agenda . . .*, pp. 135–136)

B. Are sufficient supplies of energy available to meet future requirements?

The review of energy policy studies uncovered a wide difference of opinion concerning the security of future energy supplies. Two major studies expressed a degree of optimism:

The survey of conventional resources . . . shows that North America's³ reserves of coal, oil and natural gas are more than sufficient to meet home requirements. North America is not, therefore, forced to look to overseas countries either to make up an overall shortage or to meet an absolute deficiency of a particular fuel for which there is no alternative. Indigenous oil, however, tends to be more expensive than that from some overseas sources, and imports can therefore find a place in the market . . . In total, imports of all fuels provide about 7 percent of the region's requirements. (OECD, *Energy Policy*, p. 73.)

* * * * *

A review of recent estimates of future energy demands and of the resources available to meet them yields several conclusions: (1) Projections of demand for total energy tend to cluster in a range of 80 to 90 per cent increase for 1960 to 1980 and in the order of 200 per cent from 1960 to the year 2000. (2) There is a widespread belief that energy requirements for the next twenty years or more can be met without serious upward pressure on real costs . . . (4) The prospects for growth in specific energy sources are subject to much greater differences of opinion than in total energy.

(RFF, *U.S. Energy Policies: An Agenda* . . . , p. 23)

However, the review of selected energy forecasts undertaken for the Office of Science and Technology and the findings of *The Economy, Energy and the Environment* both expressed a pessimistic note:

In the case of individual fuels, most of the forecasts made several convenient but questionable assumptions. A major assumption is that overall relative prices for energy will be such that price need not be explicitly considered in the forecasts. A second and related assumption is that there will be no limit on the availability of any fuel or energy form. The assumption of unlimited availability at no change in relative prices is of questionable validity for even the next decade, let alone the remainder of the century. It is, of course, very difficult to consider price and resource availability in energy forecasts, but it appears to be increasingly necessary to do so.

(Office of Science and Technology, *Energy Forecasts*, pp. xi-xiii.)

In response to the question "Is there an energy gap?", *The Economy, Energy and the Environment* noted:

Until quite recently it was assumed that because the United States had large reserves of fuels in the form of coal and oil shales and nuclear fuels—provided the breeder reactor can be perfected, there was little prospective shortage of available, useful energy. Recently warnings are heard that the United States may be passing from a situation of energy abundance into one of energy scarcity. If so, this would have grave implications for prospects of further increasing the standard of living and also increasing the productivity of labor. The imports of residual fuel oil to the

³ "North America" includes Canada and the United States.

northeastern United States, present plans to import it into the Midwest, and future plans to import liquified natural gas may reflect a decrease in availability of energy from domestic sources to meet rising demands. (p. 18)

In its assessment of several energy sources, the same report also cautioned about future shortages:

Coal.—It should first of all be noted as regards these materials that there is no near-term U.S. shortage of resources in nature. Coal is, so to speak, along with atomic power, our probable ace in the hole for the next several centuries. Total U.S. coal production in 1968 was 556,044,000 tons, very nearly the same as the 560,388,000 tons of 1950 If by the year 2000, U.S. production possibly should be increased to 2 billion tons per year, with half of that total supplying the 1-billion-ton demand projected for generation of electricity, coal resources in the ground appear to be fully adequate for many decades. Capital, labor, and technology for economic removal of coal from its geologic formation appear more likely to constitute possible bottlenecks than the availability of the raw resource itself. (p. 33)

* * * * *

But if the total coal resource is fully adequate for the present and for decades in the future, the geographical distribution is significantly unbalanced The principal highly developed coalfields at present are in three regions—the northern Appalachians, centering on Pennsylvania and the northern part of the West Virginia, a southern field mostly found in West Virginia and Virginia and a north-central field centering on Kentucky and Illinois. (p. 35)

* * * * *

Natural Gas.—But there can be little question that the ratio of proved reserves to production did decline in 1968 and again in 1969, creating more than a little alarm in some quarters. Others argue that such reserve data as published can be extremely misleading. At the same time it is evident from the exploration statistics that emphasis on new discoveries has for one or several reasons been deemphasized.

According to the Chairman of the Federal Power Commission, discernible trends of supply and demand indicate a developing natural gas shortage in the United States.

Short-range effects appear to be that some pipeline suppliers in parts of the United States may be unable to meet demands of the gas distribution companies for new service in the winter of 1970–71. Over the longer term, assuming that the present annual growth in demand continues for natural gas and that additions to the supply do not correspondingly increase from new discoveries in the lower 48 States or supplementary sources, it is manifest to the FPC that total gas energy demands will not be met by the natural gas industry.

The Chairman of the Federal Power Commission cautions that there is no immediate solution to the gas supply problem. No single factor is determinative in assuring new domestic gas supplies to meet growing demands, including those of the electricity industry. (pp. 60–62)

Accurate information on the availability of each energy source and their cost is a necessary prerequisite to the formulation of national energy policy. With the lack of unanimity among available sources, the formulation of a policy will be difficult.

C. What geographical sources and energy forms should be used to meet future demand?

The geographical sources and energy forms to be used to meet future demands are important considerations in the formulation of a national energy policy.

Should domestic or foreign sources be used to supply domestic demand? At present, energy from many foreign sources could be imported and sold at a lower price than domestic supplies, thereby benefiting consumers. Should a national energy policy encourage the use of foreign energy supplies? If it did, the stability of domestic energy industries could be seriously threatened. In addition, other complex questions arise; including, foreign policy considerations, balance of payments deficits or surpluses, and national security objectives.

Questions surrounding the geographical source of future supplies within the United States are also important. At present, numerous regions hold comparative advantages with respect to energy prices and supplies. Should a national energy policy promote a continuation of this policy? If it did, some areas of the country will continue to pay higher prices for some energy supplies while others would pay lower prices. If, on the other hand, an energy policy sought to equalize prices between regions, the comparative advantage of many areas might disappear.

The questions surrounding the types of energy forms that will be used to meet future demand are equally complex. Should an energy policy favor one type of energy source over another, e.g., nuclear power plants vs. coal-fired power plants? In many countries this is an essential component of energy policy. Nearly every country at the Organization for Economic Co-operation and Development has taken steps to favor one energy source over another. One country noted, for example:

Since the beginning of the present century Federal legislation has been directed at helping the exploitation of domestic water power and the construction of electric supply lines to distribute current to most isolated villages and even farms.

With the same purpose of developing the country's own resources. Another country commented that their:

* * * energy policy is centered around the electricity industry in order to achieve a very important reduction of the investments devoted to the sector. The aim is that of increasing the investment effort in installations for transmissions and distribution in order to reduce transmission losses to more optimised values.

Still another country explained that:

* * * an interrupted supply of energy is of greater importance and more difficult to ensure [for it] than in many other countries. Since indigenous fuels . . . cannot be utilized economically in normal times, no particular efforts have been made by the government to support their use. Even though . . . firewood and

peat resources are sufficient, a fast shift to these fuels is not feasible in the event of a crisis. In consequence, sufficient stocks of imported fuels must be built * * *

By emphasizing one energy form over another, problems do arise. For example, unemployment in "non-emphasized" industries could increase; higher energy prices could result; and national security objectives could be compromised.

D. Will security of supplies have a significant effect on national energy policy?

Security of energy supplies is a fundamental element in any national energy policy. In the past, "security of supplies" was synonymous with encouraging the exploration and development of indigenous energy resources and conversion industries.

. . . North America, for example, could, at a price, cover all its energy requirements from its own resources; large available reserves of coal, oil and gas, and the low cost at which many of these can be extracted, have traditionally led to policies which encourage indigenous energy production. Certain European countries, on the other hand, have to import virtually all of their supplies and their policies are accordingly very different. Different again are the policies of other European countries and Japan, where indigenous energy still provides a considerable proportion of total supplies, but where imports both supplement and compete with indigenous sources. Those countries with the resource potential have encouraged its development in the following principal ways.

Fiscal measures are widely used to encourage indigenous exploration and production. Typical are the depletion allowances of the United States to stimulate exploration for oil and natural gas. In one of its forms, "percentage depletion" allows a producer to deduct up to a stated percentage of gross income from oil and gas production from Federal taxable income. Similar but lower allowances apply to coal and lignite, oil shale and fissile materials. Another important tax provision allows drilling and development costs in oil and gas exploration to be charged against current income.

The French system of depletion allowances for oil and gas exploration resembles that of the United States, but requires in addition that exempted profits be reinvested in exploration. Similar systems exist, for instance, in Spain and Turkey.

Some countries, e.g. Germany and Austria, give tax privileges to encourage the development of hydro-power. In many Member countries, the energy industries enjoy financial or fiscal privileges because they are public utilities or are nationalised or otherwise publicly-owned. In a number of countries, certain tax privileges are granted because of geographical location.

Some member governments, Germany and France for example, have given direct financial support to exploration companies or given special loans or other financial aids for exploration. In the United States such financial aids, plus a guaranteed market, were used to stimulate exploration for uranium; and in Portugal, France and the United States, substantial amounts of the same commodity have been discovered as a result of exploration by government bodies.

A number of other government measures have the effect of increasing the amount of energy available from indigenous resources or facilitating the development of indigenous industries. Conservation measures, particularly in North America, have been introduced to prevent waste of oil and gas as well as of coal. Their main purpose is not always to increase the amount of energy available but that is, nonetheless, one result. The terms of the leases of government land, and of licenses to explore and exploit oil resources on land and sea, are often designed to encourage exploration and development. All countries encourage, and support in varying degrees, facilities for internal energy transport. Governments often help too in establishing oil refining industries in their own countries. There are also examples of governments sponsoring the construction of plants for enriching uranium.

Scientific research and development can also help considerably to increase the amount of energy available and reduce its cost. For example, improvements in production methods can increase the quantities of oil and coal that can be recovered; and new sources of energy, such as nuclear power, can be developed. (OECD, *Energy Policy*, pp. 108-109.)

Security of supplies has been encouraged through protection of domestic energy production. As the OECD report on energy policy noted: "Until relatively recently such protection was not needed in Europe and North America because imports presented no challenge to indigenous supplies." (p. 109) The protection which presently exists has resulted in recent years because of a decline in the competitive nature of some industries. This protection can take many forms including, direct and indirect subsidies, import restrictions and duties, taxation of competing forms of energy and indirect protection such as preferential transport rates. In addition, security of supplies can also involve the diversification of the sources of supplies, stockpiling and maintaining domestic reserve capacities.

Thus, there are a multiplicity of techniques available to influence the security of supplies. What measures is the United States presently employing? Toward what objectives are these measures working? Are these goals relevant to today's needs? Which energy supplies should be secure? What are the economic and social costs of present and future policies toward security of energy supplies? What foreign policy and balance of payments implications are involved in these questions?

VI. INDUSTRY CONSIDERATIONS

A. *What impact do present public policies have on the economic efficiency of energy industries?*

A basic tenet of U.S. economic policies has been the promotion of economic efficiency in all sectors of the economy consistent with maintaining effective competition. It is instructive to examine the ways in which economic efficiency could be approached for the purpose of formulating national energy policy.

The central economic desideratum with respect to energy, in common with all other lines of production, is that whatever the amounts to be supplied they should be supplied at the lowest costs that practical circumstances permit. This principle is applicable in the first instance to the separate supplies of the indi-

vidual forms of energy. In the end, it applies to achieving the lower-cost "mix" among the interchangeable forms. This principle of economical operation will not in all circumstances provide a definitive norm for policy. Other considerations, such as national security and concern for the quality of the environment, may provide reasons for deviating from it. But the economic norm needs always to be available; the reasons for deviations from it need always to be subjected to critical examination, in particular the claims of interested groups for preferential treatment.

Our concern is with the manner in which existing public policy affects the efficiency with which the energy industries perform, and with the potentialities for improving efficiency implied by possible changes in public policy.

* * * * *

The problems of encouraging industrial cost-efficiency will carry over to the newer energy industries, shale oil and nuclear energy, where government will necessarily play a central role in determining the structure of the industries. Along the competitive margins of all the energy industries, the cost prospects will be a factor in influencing judgment concerning the character and degree of government intervention to stimulate the various potential sources of energy supply. . . .

(RfF, *U.S. Energy Policies: An Agenda . . .*, pp. 138-39)

B. How does intra- and inter-industry competition bear on national energy policy?

Competition is one mechanism which can promote economic efficiency, lower costs and also provide consumers with the widest range of choices. Competition has always been a cornerstone of U.S. economic and energy policies.

Competition provides a powerful incentive to reduce costs whether through advances in technology, or increased efficiency in production and distribution. Other things being equal, competitive forces are strongest in a free-enterprise system which comes close to the theoretical concept of "free competition". These conditions do not prevail entirely in the energy market. But even where the State controls some of the industries, there is, against a background of freedom of choice for the consumer, competition between the fuel industries, both publicly and privately owned; also, even if protected, the fuel industries are to some extent subject to the pressure of the world market. Diversification normally encourages competition by increasing the number of sources of supply and of suppliers; other measures are outlined in the following paragraphs. As in other areas of energy policy, there is often a conflict here, as broader economic or social objectives may at times call for protectionist policies which blunt competition both between fuels and between suppliers.

The authorities in most countries allow consumers a substantial degree of freedom to choose between competing fuels; but that freedom is hardly ever absolute. Legislation inhibiting the consumer's freedom of choice is rare, but nearly all countries adopt some measures—for example, the various forms of protection of indigenous industries—which affect the balance of competition

between different sources of energy and so prevent the consumer choosing between fuels competing strictly on their merits. Thus freedom of choice is normally qualified for the sake of broader economic or social requirements, or for considerations of public health.

Some countries have taken steps to ensure that there is effective competition. Several of them have legislation designed to prevent any undesirable accumulation of market power by industrial groups. The growing dependence on oil imports seems to have prompted a number of countries to give particular attention to ensuring a satisfactory degree of competition between different oil suppliers and between other fuel producers.

* * * * *

All oil consuming countries have a strong interest in maintaining a reasonable level of oil prices on a long-term basis and preventing wide fluctuations in prices. Both the private oil companies and the exporting countries also have an interest in achieving these objectives, although of course the latter are seeking higher returns and conflicts in this, as in every other field, are sometimes inevitable. As pointed out in the last report by the OECD Special Committee for Oil, Member countries are "vitally concerned with the maintenance of good relations between oil producing countries and the oil companies". They are further concerned with the maintenance of good relations between themselves and both exporting countries and oil companies. But this is a subject which goes well beyond the field of energy policy.

A competitive market structure serves the interests of both producing and consuming countries, for its existence tends to ensure that supplies are made available at prices which reflect the economic conditions of supply and demand. It further helps to ensure that neither producing countries nor oil companies nor for that matter importing countries, acquire a dominant position that could be abused. The principles in this and the preceding paragraphs are generally accepted, although it must be recognized that, as in most cases in real life, the actual situation within energy markets does not fully correspond to the theoretical ideal.

The United States actions in this field illustrate the efforts of governments to develop a competitive structure. It has encouraged the development not only of indigenous oil and natural gas resources, but also the development of access by American companies and associates to foreign resources. At the same time the authorities have encouraged the development and progress of independent companies in both domestic and overseas oil activities as a means of balancing what might otherwise be a controlling position of a few major groups

Some governments aim to encourage competition by rendering the energy markets more transparent. For example, the High Authority of the ECSC, in accordance with the Treaty, obliges enterprises to publish prices and other data for coal regularly. There are also examples of rules which protect the consumer by prohibiting unfair discrimination in transport and other charges. (OECD, *Energy Policy*, pp. 116-118)

Competition within and between energy industries has recently emerged as an issue of some concern. The report by the Senate Committee on Interior and Insular Affairs (1962) on energy information provides an excellent background to the present controversy by detailing the genesis of the present problem:

In tune with industrial development throughout the country, a relatively small number of coal, oil, and gas companies account for most of the production . . .

A similar corporate concentration exists in the electric generating industry. Electric power is generated relatively close to where it is needed . . . so that the corporate concentration that exists is related more to population and industrial concentration and to facts of Nature than . . . to business decision.

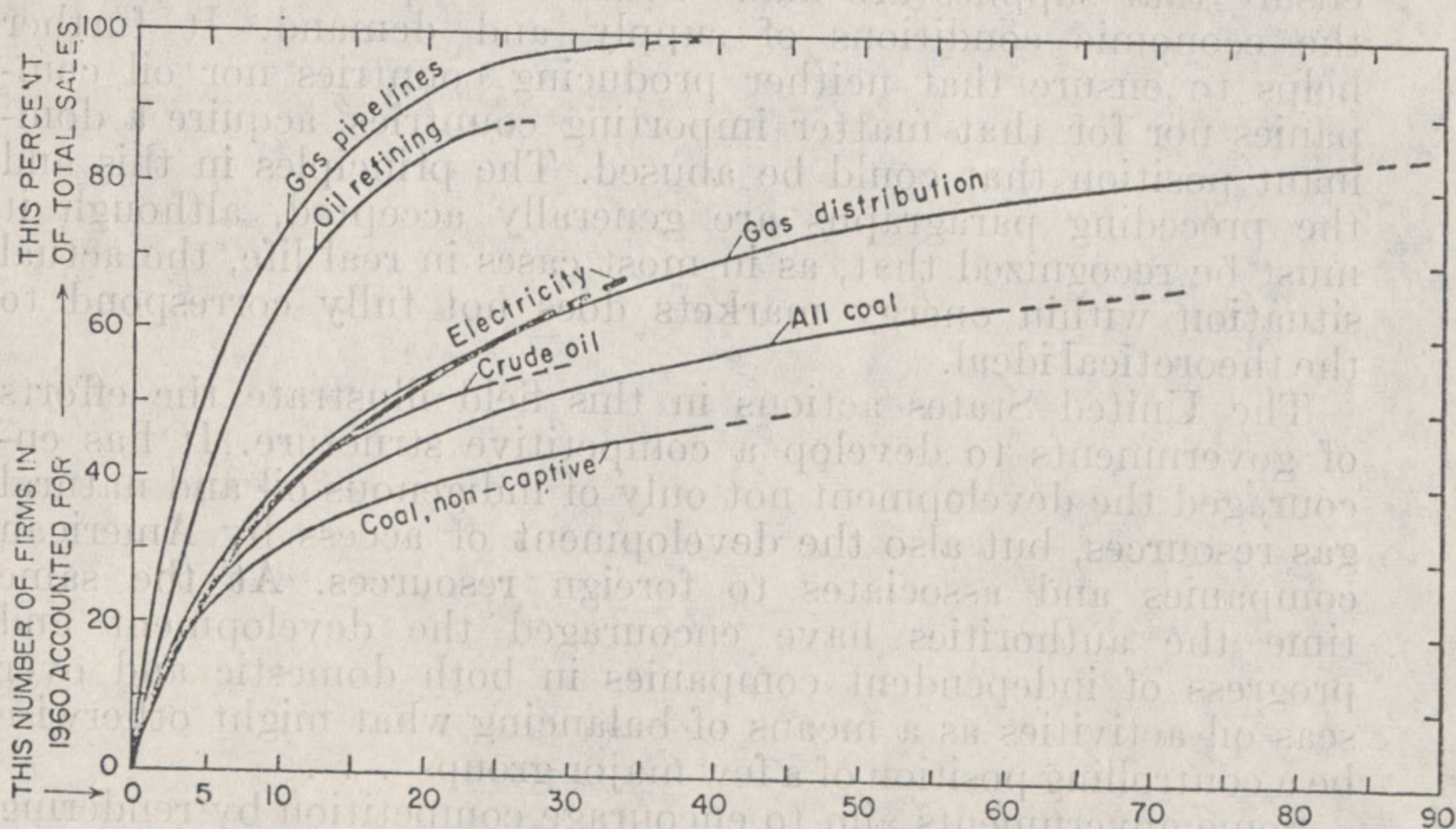
Yet, while there is this corporate concentration in the energy industries, these industries are not as concentrated as many other industrial segments in America.

COAL

The 5 ranking coal companies in 1960, out of a total of around 7,500 (0.07 percent), produced almost an even fourth of the year's total output. The top 10 companies produced an even third, and the top 25 produced half. The other half was produced by the remaining 7,400 and more. See figure [5].

Figure 5

Comparison of Total Energy Sales and Number of Companies in Each Industry, 1960



Source: U.S., Senate, Interior and Insular Affairs Committee, An Assessment of Available Information on Energy, p. 209.

Figure [6] compares the situation in 1960 with that in 1910 when coal production was on the way up and total output was the same as in 1960, at 416 million tons. Although there were a third fewer mines at that time, they were more uniform size.

OIL

In crude oil production (again see fig. 5) a fourth of the output (1959) is by the five ranking companies. The top 10 companies produced 37 percent, and the top 15 companies 44.

In refinery operations four-tenths of the output (1959) is by the first five companies. The top 10 companies produced more than six-tenths, and the top 15 companies three-fourths.

GAS

Because of the large investment required, few companies can afford to get into the gas transmission business. Moreover, the economics of scale favors large firms. As a consequence, corporate concentration is high, the highest, in fact, among this group of industries, 15 companies out of 106 (14 percent) in 1960 accounting for 84 percent of the industry's total gas sales. In gas distribution, in contrast, 84 companies (out of 1,324) accounted for this same 84 percent of the sales.

The only figures available on corporate concentration in gas production are for 1954. According to them, and by strange coincidence, concentration in this industry—as measured by number of firms and percent of output or sales—is almost precisely the same as in the gas distribution industry. Gas distribution is much the more concentrated of the two as measured by percentage of firms.

ELECTRIC GENERATION

Concentration among companies and systems generating electricity closely parallels, up to about half of total output, corporate concentration in gas distribution and crude oil production. The top 5 companies or integrated systems accounted for nearly a fourth (23 percent in 1960) of the kilowatt-hours sold, and the top 20 account for more than half (53 percent).

* * * * *

Table [15] assists the chart in bringing the statistics into comparative focus (pp. 207-210).

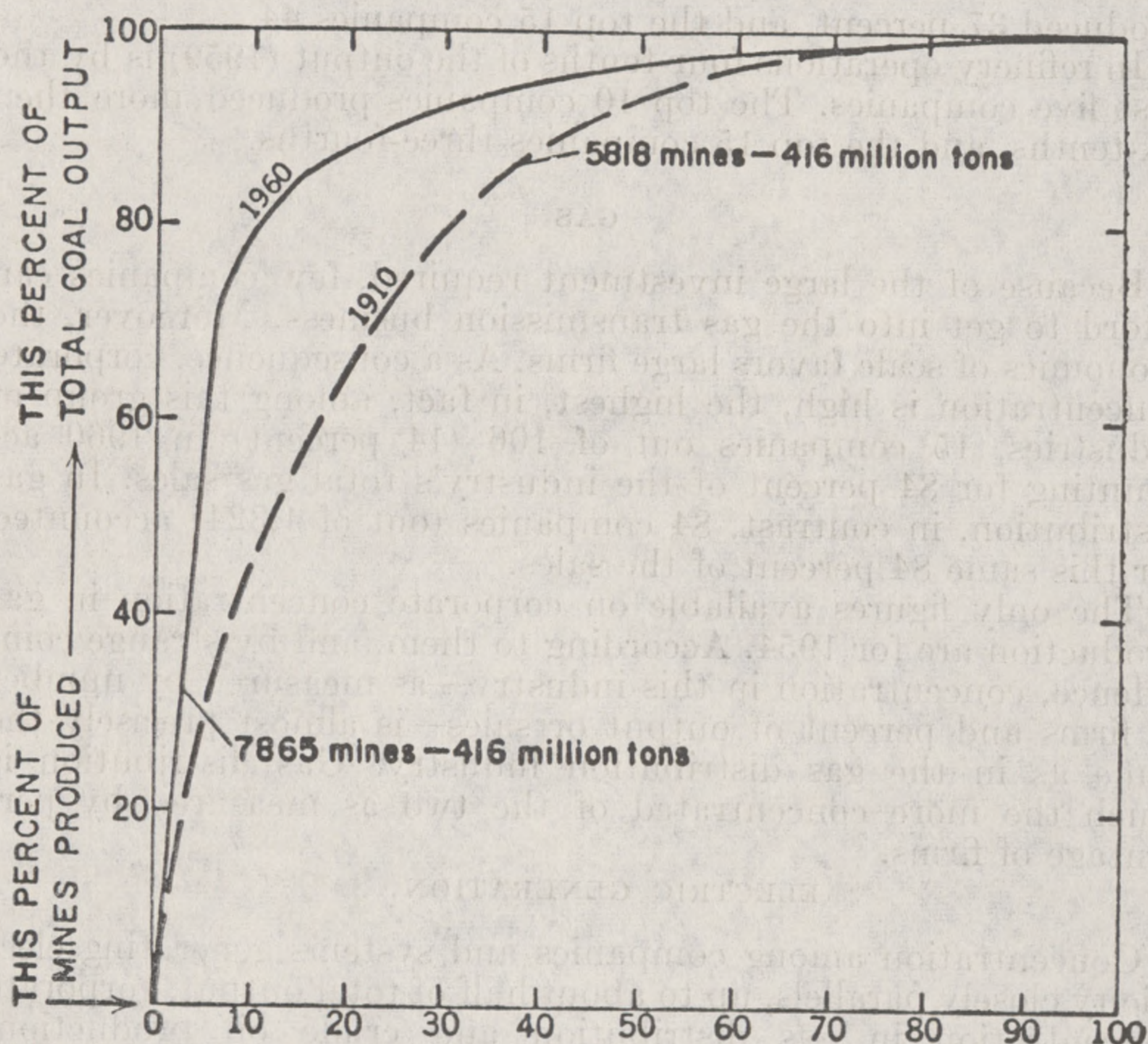
Table 15
Corporate Concentration Among Energy Industries
in the United States

Number of firms.....	Percent of total sales			Total firms
	5	15	25	
Gas transmission.....	50.9	84.2	96.1	106.
Oil refining.....	39.4	75.1	87.3	172.
Gas distribution.....	23.4	46.6	58.8	1,324.
Gas production.....	23.0	47.0	59.0	About 11,000.
Electric generation.....	23.2	45.7	58.7	3,600.
Crude oil production.....	25.0	44.3	52.5	About 11,000.
Coal production.....	24.8	39.8	49.0	1,112. ¹

¹ Producing 100 tons or more a day. Total number of companies is 7,500.

Figure 6

Concentration of Coal Production by Mines, 1960 and 1910



Source for Figure 6 and Table 15: U.S. Senate, Interior and Insular Affairs Committee, *An Assessment of Available Information on Energy*, p. 210.

The same report also described the interfuel competition and detailed the problems involved in examining competition in energy industries:

Competition among fuels is a complex of economic, technologic, and political forces. The three fuels—coal, oil, and gas—compete with one another for the electric energy, space heating, and process-heat markets; electric energy (including hydropower) then competes with coal, oil, and gas for parts of these same markets. The subject is complex technologically because of the many areas in which it operates As technology changes, so do costs and competitive relationships. The joint technologic-economic complexity is compounded by atomic energy. The subject is politically complex because it is involved with problems of trade, utility and transportation regulation, conservation, public versus private power, and such social problems as unemployment and public fears regarding disposal of atomic wastes. (p. 274)

Competition is changed by the ability and willingness of the customer to shift from one product or supplier to another. When, in an economic sense, consumers of fuel are able to shift freely from one fuel to another, there is intense competition among the

fuels, and the degree of competition increases or decreases as this freedom of choice expands or contracts.

Many factors influence this freedom of choice. In part of the energy market, the consumer has equipment that enables him to switch at will from one fuel—coal, oil, or gas—to another; freedom of choice is wide, and competition is keen. In other parts of the market, more than one of the fuels could serve the purpose, but some added investment in the way of new equipment may be needed; the economic choice is less free and competition, accordingly less keen. In still other parts of the market, one fuel may satisfy the consumer's wants in a way that no other fuel can, in which case he really has no practical choice, except as to which supplier he selects.

Where more than one fuel may be used, the choice is approached initially on the basis of cost. Other factors are convenience and simple preference, and particularly reliability of supply. However cheap a fuel may be, it may not be selected if the user cannot be certain, within the dictates of his needs, that he can get it in any quantity he wants whenever he wants it and at a price he can afford. There are also political factors, which may circumscribe all the others and that operate in a manner not always immediately obvious. At any particular time, Congress or other authorized public institution may determine that the public welfare requires some interference with market economics, in which case a whole chain of consequences may ensue.

The situation at any given time represents an economic equilibrium, but the equilibrium is both fragile and fleeting. (pp. 276-277.)

Since this report was published, a decline in competition in energy markets has occurred because of the creation of "energy companies." Since 1965, for example, a growing number of oil companies have taken positions of one sort or another in other fuels. Of the 25 largest oil companies (all of which, of course, are in natural gas), 18 have positions in oil shale; 11 have positions in coal, 18 are in uranium and 7 in tar sands. These positions took several forms: the acquisition of existing companies in other fuels industries; the acquisition of reserves holdings; the establishment of new ventures, either alone or jointly with other companies within or outside the petroleum industry; and participation in research and development ventures, either alone or jointly with other companies.⁴ This growing concentration has given rise to considerable interest both in and out of Congress.

The changing character of energy competition will have a direct influence on the energy policy. Are these developments conducive to the fulfillment of future energy demand? Do they indicate a decline in energy employment, thus necessitating the need for greater assistance to displaced workers? Are "energy companies" compatible with present anti-trust laws? How will Federal regulatory policies be revised to meet the development of "energy companies"?

C. What incentives are presently employed by the Federal Government to assist energy industries? Will these measures be consistent with the evolving national energy policy?

The Federal Government influences energy production through a variety of measures. Grants, loans, contracts, subsidies, tax write-

⁴ U.S., Senate, Committee on the Judiciary, Subcommittee on Antitrust and Monopoly, *Hearings on the Competitive Aspects of the Energy Industry*, 91st Cong., 2nd Sess., May 5, 6, and 7, 1970, p. 186.

offs and incentives, and other measures are presently employed. Do these tools actually promote the efficient production, distribution and consumption of energy?

The widest range of elements affecting incentives is to be found in the policies affecting crude oil; but the exact cumulative consequences are difficult to unravel. Two federal policies, special tax treatment and import restriction, are specifically designed to stimulate investment in the discovery of new reserves, although their effectiveness in this regard needs study. Such positive results as they may have in that direction may be neutralized, to a degree difficult to ascertain, by state proration systems. Restrictions on output and inducements to overinvestment in reservoir development seem likely to undermine the incentives for exploration.

In one respect, federal policy affects the profitability of natural gas production in the same way as in the case of crude oil, through the percentage depletion tax allowance. In another respect, however, federal policy acts in the opposite direction to limit profitability, through fixing the field price of natural gas. The result of these two factors upon the long-run supply functions for natural gas is highly obscure. The obscurity is increased by the facts (1) that exploration expenditures for oil and for gas are closely associated, (2) that the profits from production in the two fuels largely accrue to the same companies, and (3) that the joint profits may take many other investment directions than exploration for new reserves

In sharp contrast to oil and gas, public policies relating to bituminous coal have little effect upon private incentives, though there is a low federal percentage depletion tax benefit. One reason for this difference, on the side of federal policies, may be that the findings of new reserves is the central concern in the case of petroleum, while great reserves of coal are taken for granted. *The main way in which public policies affect incentives in the coal industry is indirectly, through policies relating to other industries but which affect the position of coal in interfuel competition*

The roadway to private enterprise in the nuclear field has been provided by the government, through its support of R&D programs. Incentives to discover uranium, and subsidies to nuclear power stations⁵ The future of the coal industry will be deeply affected by the results of these policies and the scope and intensity of their continuation in the future. A critical question of policy will be, as in the past, in connection with government programs in energy R&D.

In the case of shale oil, the pattern of incentives for private operators has yet to be established by government policies with respect to R&D, leasing, taxation, and other decisions which will determine the structure of the industry. If in the end a highly profitable industry for large-scale output emerges, there will be important consequences for the incentive structure in petroleum; and the development of the plentiful coal deposits of the West might be greatly affected.

(RfF, *U.S. Energy Policies: An Agenda*, pp. 139-41)

⁵ Those generating stations constructed under the power demonstration reactor program [editor's note].

At the present time, a myraid of regulatory and administrative regulations control various aspects of the energy field. Do the present Federal regulations assist or detract from industry's ability to achieve national energy objectives? Are these regulations consistent with today's needs? Should the national energy policy provide for the promotion of energy-related industries which might be slow in developing were it not for support by the public sector? While such a policy could achieve economic development and security of supply objectives, would it promote a beneficial response in other energy fields? Should national energy policy promote the substitutability of energy sources? What impact would this have on existing energy industries?

VII. FEDERAL ROLE AS AN ENERGY PRODUCER

A. What is the present role of the Federal Government as a leaser of energy resources and as an energy producer?

The Federal Government is in a position of peculiar responsibility for future energy supplies because of the vast sources located in areas under Federal ownership and control. This is especially true, for example, with respect to oil and gas in the Outer Continental Shelf and on Western public lands.

In principle the federal government has the power to regulate production (or not to regulate it) in whatever way it wishes. In practice, it has made producers on the public domain subject to the rules of the states in which the lands are located. While there is no evidence of an intention to abandon this practice, at the instance of the Department of Justice, the Department of the Interior in 1967 made a public statement concerning its exclusive jurisdiction. The states have since then been urging that they be granted legal authority to include oil from the Outer Continental Shelf within their proration system.

With respect to the petroleum resources of the public lands, other than the Outer Continental Shelf, there appear to be good reasons for a critical review of the whole framework of present leasing policy. Questions have been raised concerning it that deserve answers: about how far it serves as a vehicle for speculative trading in leases; how far it encourages the postponement of exploratory effort; and how far it fails to require the most efficient methods of reservoir development. These and other questions relating to leasing policy will presumably come within the purview of the Public Land Law Review Commission, but such consideration needs the benefit of participation by persons with a broad interest in energy policies. Special questions relating to leasing policy for the Outer Continental Shelf also require study.

In another direction . . . ways in which oil on public lands, including the Outer Continental Shelf, could be fitted into plans for national security [could be examined]. A problem of the future may be foreshadowed by the declining reserves-production ratio. The government could, by its own enterprise or by incentives to private enterprise, stimulate the discovery and partial development of fields, but hold them out of production. *Some part of the present reserves and a larger part of the new reserves could be kept under wraps and set aside as a national stockpile. The consideration of any such plan would have to be in the broader context of*

alternative measures for assuring energy supplies in the interest of national security. (RfF, *U.S. Energy Policies: An Agenda . . .*, pp. 47-49)

In addition, the Government maintains four naval petroleum reserves on public lands which total approximately 23,766,000 acres and contain at least 11 billion barrels of proved reserves, and three naval oil shale reserves totaling 150,632 acres and containing an estimated 16 billion barrels of recoverable oil shale.

The national policy with respect to these is to retain, in the ground within the United States, a reserved supply of fuel for military and industrial requirements in an emergency. The reserves are administered by the Secretary of the Navy, subject to consultation with the Armed Services Committees of Congress and to approval by the President. (U.S. Senate, Interior and Insular Affairs Committee, *An Assessment of Available Information on Energy*, p. 314.)

The Federal Government is also active in other areas of energy production. Several agencies are directly involved with the production of electricity:

Department of the Interior.—The Department of the Interior produces and sells hydroelectric power through the Bureau of Reclamation, the Bonneville Power Administration, the Southeastern Power Administration, and the Southwestern Power Administration . . .

Tennessee Valley Authority.—The Tennessee Valley Authority was created in 1933 as a means of controlling floods and of promoting navigation on the Tennessee River and its tributaries. Accomplishment of these goals required the construction of dams and other facilities that had hydroelectric potential. Some of this electric energy was needed for operational purposes, but the act specified that surplus power could be marketed and also authorized the necessary transmission and related facilities.

Rural Electrification Administration.—Under the Rural Electrification Act of 1938, the Rural Electrification Administration makes self-liquidating, interest-bearing loans to finance the construction and operation of generating plants and of electric transmission and distribution lines to serve persons in rural areas who are not receiving central station service. The Rural Electrification Administration does not own or operate any electric facilities.

Atomic Energy Commission.—The development and use of nuclear energy in all its aspects is controlled by the Federal Government. The Atomic Energy Act of 1946 and now the Atomic Energy Act of 1954, as amended, establish the policies and programs of the Government in this field and certify the Atomic Energy Commission as the responsible executive agency.

The Atomic Energy Commission regulates the design, location, and operation of nuclear powerplants, the fuel used, the materials produced, and disposal of the radioactive waste resulting from the operation. It has jurisdiction over the possession and use of

source materials (uranium and thorium), nuclear fuel, and radioactive byproduct materials (isotopes).

* * * * *

Investor-owned utilities—Federal Power Commission

The Federal Power Act provides for the licensing of hydroelectric power developments located on streams over which Congress has jurisdiction and on Federal public lands, and for the comprehensive regulation of the interstate operations of the electric power industry. (Committee on Interior and Insular Affairs, *An Assessment of Available Information on Energy*, pp. 315-17)

The development of oil shale is also affected by Federal policies:

The federal government's predominant ownership role and its refusal hitherto to permit exploration or development of its land for shale oil production have frequently been represented as the principal block to the emergence of a profitable shale oil industry. Whether such a view is prompted by hopes of developing an industry or by the desire to control valuable pieces of mineral land, it stands in urgent need of dispassionate scrutiny. It must be assessed, for example, against the fact that in Colorado alone private companies are known to hold 168,000 acres of oil shale land; or that all land privately owned is estimated to contain 150 billion to 200 billion barrels of oil equivalent. This does not mean that all of this land is easily exploited. Shape, size, or other characteristics may make commercial working costly or otherwise inadvisable. But more than assertion seems called for in support of the thesis that the insufficiency of prime oil shale land in private hands prevents the development of the industry. (RFF, *U.S. Energy Policies: An Agenda . . .*, pp. 116-117)

B. How do existing Federal policies affect energy production in the public and private sectors?

An investigation of the Federal Government's impact on energy production should be a prime consideration to the Committee because of the multi-faceted nature of Federal involvement. The report of the Public Land Law Review Commission offers a good beginning in this task by outlining the Federal role in energy production on public lands and it also offers suggestions for the reshaping of Federal involvement. However, the Commission's report is only a beginning; there are a large number of other questions which should also receive the Committee's attention. Is there an over-all policy which presently guides Federal actions in energy production? If not, what should be the objectives of such a policy? Is the Federal role excessive, or should Federal involvement be increased? In which energy fields? In which geographic areas? Should the Federal Government limit its activities only to exploration and or development of new sources? Should it undertake additional cooperation with private industry? What impact do Federal energy production practices have on private industry? What impact do they have on maintaining uninterrupted energy supplies?

VIII. REGULATORY CONSIDERATIONS

A. *What is the present distribution of authority among Federal, State and local governments in the regulation of energy production?*

While energy industries are in competition with one another, they are subject to widely divergent types of regulation.

In the production of *crude oil*, various state governments regulate the amount of production in the state and prorate the total into production quotas for individual producers. In sum, these state regulatory practices fix the total supply of oil produced in the nation and tend to dampen price fluctuations. Through its control of the Continental Shelf, the federal government is involved in leasing lands for development of the oil and gas provinces there located. In addition, on the ground that an undue increase would endanger security, the federal government has since 1959 limited oil imports, thereby reinforcing the controls exercised by the states.

In the case of *natural gas*, in addition to a degree of special state regulation the industry is regulated at a series of levels by state and federal agencies. At the local consumer level, prices and services are regulated by state public utility commissions. At the level of interstate transmission, the wholesale prices and services of the pipeline companies are regulated by the federal government. At the level of primary production, the field prices paid by interstate pipelines to producers are regulated by the federal government.

In the case of *coal*, there is no direct public regulation; prices and production are left to the forces of the competitive market. But the costs of delivered coal are substantially affected by railroad rates which are regulated by the federal government and have an important effect on the terms of competitive entrance of producers into local markets. A rather special type of agreement with the union also strongly affects the competitive situation. The federal government provides some assistance through support of a program of market and technical research.

In the case of *electricity*, local rates and services of private companies are regulated by public utility commissions in most states. Under federal law, the wholesale price of electricity in interstate commerce is subject to federal regulation. The federal government is a direct producer and wholesaler of electricity from numerous hydroelectric installations in multipurpose river basin development programs; and through the Tennessee Valley Authority it is the sole supplier to a wide geographical region. It licenses private companies to use interstate rivers for hydroelectric projects. Some states operate hydroelectric projects. The federal government also supports rural electric co-operatives through low-interest loans and assists them in other ways. Many municipalities own and operate their own generating facilities, and in the state of Nebraska only publicly and co-operatively owned utility systems are allowed. (RFF, *U.S. Energy Policies: An Agenda . . .* pp. 3-4)

Nuclear energy is also regulated by extensive licensing requirements both with respect to plant design and operating procedures.

B. Do existing regulatory mechanisms promote efficient cooperation and coordination between different levels of government? Can sound national energy policy objectives be achieved under the present system of energy regulation?

The present system of regulating energy industries is a complex web of separate yet highly interrelated policies undertaken at many levels of government. The fundamental bases upon which regulatory efforts have been founded might receive careful attention, beginning with the basic reasons for Federal involvement. What should be the extent of Federal involvement in the regulation of energy industries? Two European countries had widely divergent views on this issue. One country feels it is:

... justified and is generally accepted that the government should take steps to guide producers and consumers. Such intervention may be directed towards quantities or prices, and moreover action on one will inevitably affect the other. In practice, both methods are used ... acting either at the supply stage or at the level of the consumers. Insofar as users are concerned, and they are very numerous, government intervention is mainly directed towards prices and the desired orientation is given to final consumer in this way.

At the other extreme was a country which stated:

Freedom for trade and industry is guaranteed by the ... Constitution. This guarantee equally applies to the energy sector. For this reason [this country] is among those countries in which the energy industry has the greatest freedom. Anyone is free to import and sell any source of energy: coal, petroleum products, gas or electricity. In the case of fuel it is sufficient to comply with the legal requirement to constitute stocks in case of possible international conflict. (Trade in nuclear fuels is clearly subject to the authorisation procedure provided for in international treaties.) The result is very brisk competition, both between various industries in the energy sector and within each of them, which explains why prices are comparatively low.

The question of "how much" Federal involvement in energy regulation is desirable cannot be answered without first addressing the question of "why" Federal involvement is necessary. The present system of Federal regulation has evolved in response to problems which emerged at different periods and under varying circumstances in the development of different energy resources. With time, these regulatory efforts have become entrenched. Are all the regulatory mechanisms which now affect energy industries needed? Does the present system meet needs which are as valid today as they were when they were instituted?

Both the direct and indirect controls presently employed in the energy industries will have to be examined. What specific regulatory functions are carried out by Federal agencies? State agencies? Local agencies? Do the existing administrative procedures of Federal regulatory agencies achieve the desired objectives? Do present regulatory arrangements preclude achievement of national energy policy objectives? Do all Federal agencies regulating energy work toward the same goals, or are their missions contradictory? Do the State and local governments work toward the same goals as the

Federal government in regulating energy industries? Should regulatory policies favor one industry over another? Or, should regulatory policies treat each industry equally? If regulatory policies should be consistent from industry to industry, how can we justify the present arrangement where coal, for example, is essentially unregulated but natural gas is regulated from the field to the consumer? Is such a difference justified? Is such a policy working against the competitive advantage of natural gas and other industries? Under such a system, is the consumer provided with the widest range of choices and the lowest price for energy?

At the present time, there is no regulation of "energy"; rather, each energy form is regulated by a different institutional framework which seeks to attain different goals. One purpose of a national energy policy is to guide each of these divergent institutions toward a common goal. Achieving this commonality among regulatory agencies at all levels of government may prove difficult. The national energy policy will have to delineate the objectives toward which the regulators should be working and this will involve the establishment of priorities among an assortment of competing institutions and ideals.

IX. PRICING CONSIDERATIONS

A. *What effects do prices have on production and consumption of energy?*

The price system in our economy is the mechanism by which scarce resources are allocated among competing consumers. As such, it plays a key role in guiding and organizing economic activity. The importance of energy prices differs between consumers and among industries. To the average household, for example, the price of electricity is of no great concern. The same may hold true for some industries. But to other industries (e.g., electrochemical and aluminum) it represents a significant portion of total production costs.

It is, however, not only the direct costs of energy for given industrial consumers that determines the full extent of the influences of variations in fuel prices. Of equal . . . influence, is the effect increases in energy prices may have upon other energy intensive products required by the industries in question. These so-called secondary results have to be added to the immediate or primary effects of a change in energy prices if the latter's full effects are to be accurately calculated. (Jensen, *Energy and the Economy of Nations*, pp. 29-30)

The price of energy is determined by the interaction of many factors; including, consumer preference, transportation costs, production and recovery costs, and government regulatory policies and procedures. The impact of production costs were detailed by a Common Market report which placed special reference on exporting industries:

It was found that direct energy costs played a much more important role in the production of goods earmarked for export than in those destined for general internal consumption. When the value of energy exports was added to the direct energy costs incurred in the manufacture of industrial goods sold on the export market, a figure of about 10 per cent was obtained. Even when real energy exports were omitted from the calculation, energy costs still represented a proportion of 4 to 6 per cent,

according to country, of the total costs of export goods, i.e. marginally above the figure for direct energy costs for total industrial output. This was explained by the fact that the more energy intensive industries are generally to be found among the main exporting industries. Thus, industries for which energy costs represent 10 percent or more of the total value of their production accounted for 22 per cent of all exports, while those for which energy costs represented more than 5 per cent of the value of their production contributed 39 per cent. (Jensen, *Energy and the Economy of Nations*, pp. 30-31)

The price of energy can also affect a wide variety of other components within the economy. Jensen provided two examples when he discussed the influence of prices on industrial location and regional development:

Industrial Location.—If for the producers of energy, access to raw materials remains a determining factor, consumer location preference is subject mainly to market proximity and manpower availability. Clearly, however, no assessment can be made without knowing exactly those industries for which energy costs are a determining, or major, factor in the choice of location. In some countries, of course, there are only minor differences from one area to another. In these cases other factors will determine the issue. In fact, energy costs normally have an important bearing on choice of location when they exceed 5 percent of total costs. In cases where energy costs represent less than 5 percent of total costs their influence becomes so slight that even big regional fluctuations do not affect the fundamental choice. Clearly, however, even for industries for which energy costs represent more than 5 percent of total cost it is far from being the sole or even major determining factor—the final choice of location normally being that combination of all the factors concerned which is considered to be the most favourable from the firm's point of view. (p. 33)

* * * * *

Regional Development.—Economic history provides a number of examples of the importance of the price of energy in regional development. This applies with particular force to the iron and steel industry which has a remarkable record of industrial mobility through the ages. It was, for instance, lack of timber and its consequent rise in price (coal did not conquer this market till the next century) that led to the decline of iron production in eighteenth-century England; at the same time there was a big rise in Sweden where both iron ore deposits and wood from the forests for the charcoal ovens were plentiful. In the next century, the development of the blast furnace burning coke and the elimination of the old charcoal ovens had a profoundly modifying effect on the economic geography of Europe. The traditional ironworks of Wallonia, in eastern Belgium, Lorraine, and the north of France were obliged to move out of the plains to new sites near the coalfields or iron ore mines and near to water. Even so, these changes were not fundamental as the industry tended to remain within the same broad economic area. (p. 40)

Price also has an impact on the development of the energy resource. One European country, in their presentation to an OECD conference on energy policy, presented a good example of the effect of pricing policy on the development of natural gas.

The integration and the rapidity of penetration of natural gas are mainly dependent on the price. If the price is set too high it becomes difficult to fit the new product into the existing pattern, and the penetration takes too long, so that the economic advantages to be gained are reduced by the time taken, and by the arrival of other even newer sources of energy. Too low a price, however, would dislocate the energy market.

The natural gas policy, therefore, aims at achieving an important and complicated goal of energy policy viz. the harmonious introduction of this source of energy on the energy market, dislocation of the market being avoided and penetration into this market being effected at such a rate that maximum benefit accrues to the economy.

B. What measures of public policy have an impact on energy prices?

The objective of governmental intervention in the pricing of energy is to ensure that energy requirements are met in the way that best suits the interests of society. It would be impracticable, for example, to aim at achieving the lowest possible current cost or the lowest possible price at any one time for energy because they may be attained only at the expense of higher long-term costs or at considerable sacrifice of social or national security requirements.

Government policies can result from a wide variety of direct and indirect actions. Actions taken to decrease energy prices in a particular market or for certain consumers does not have the same effect throughout the country. The effect of some measures is only to shift costs between different consumers while other measures may actually contribute to lower the basic cost of energy. Special tax privileges and price fixing are direct government actions; encouragement of improved industrial technology to reduce costs and government-sponsored research are examples of indirect actions. The OECD report on energy policy described direct governmental actions in the following manner:

1. *General Intervention.*—Prices may be controlled in many different ways. During World War II or during the early period of post-war reconstruction, some governments assumed complete control over all energy prices. Today, even the fixing of prices of individual products is rare.

Public utilities, such as the electricity and gas industries, are often a special case. In return for the special powers that their status gives them, they are generally subject to some form of price control. In some countries, in fact, and for certain consumer groups, gas and electricity prices are fully controlled, whether the utilities are largely privately-owned, nationalised or otherwise publicly-owned * * * In most OECD countries, however, the prices charged by public utilities are controlled with some degree of flexibility. In the United States, for instance, the gas and electricity industries are partly under the control of the Federal Power Commission which exerts its influence through the regulation of interstate operations and partly under the control of State governments. In addition, the Interstate Commerce

Commission controls the charges for the transport of other forms of energy.

Outside the public utilities, however, direct control of prices has become increasingly less frequent, probably owing to the absence of major crises and to the improvements in the energy supply conditions throughout the world. No doubt, the desire to avoid excessive price fluctuations has been one of the reasons why governments have for a long time given particular attention to prices of imported energy * * *

Countries without indigenous production of primary energy are now taking advantage of the low level of world prices, but the energy producing countries are faced with very complex problems. Completely free competition, with no government influence on prices, might help to stabilize or reduce energy prices. But this might also bring about an over-rapid decline of many of the indigenous energy industries which are not fully competitive, thus giving rise to serious social and economic problems, both national and regional, and create risks to the security of supply * * *

In practice, price control has normally taken the form of setting maximum prices. These have the effect of limiting the consequences of import restrictions, and competition usually leads to lower prices than the maximum set. Minimum price fixing is virtually no longer practiced by the authorities of Member countries but, to a certain extent, discriminatory taxation of certain forms of energy or of energy from certain sources helps to fix a minimum price level, sometimes to the benefit of other forms or sources of energy.

Although direct government control of energy prices is much less common than before, the formation of energy prices in many countries is subject to what may be called a system of "controlled freedom". Under such a system, producers are free to fix their own prices but must notify the authorities of any changes. In some countries, oil and natural gas prices must be authorised in advance by the appropriate authorities * * *

2. Specific Measures Affecting Particular Consumer Groups.—For the "energy intensive" industries, energy prices are naturally of very great importance. This is, for instance, the case in the steel industry. Particularly in view of the substantial quantities of coal and coke needed for steel-making, the steel industries in the coal producing countries of Europe and Japan are vitally concerned with the effects of the measures of protection for indigenous coal, since their competitive position could be jeopardised by high energy costs. Other "energy intensive" industries, such as the electrometallurgical and petrochemical industries have received some form of tax relief in some of the OECD countries. The secondary fuel industries occupy a special position and usually enjoy a number of advantages, although in some cases, the electricity industries are persuaded to use indigenous fuels when others would be more economic.

In the transport sector, taxation of motor fuels, beyond that required to support highway construction, may considerably increase the cost to the transport user and affect the structure of motor vehicle utilisation. Taxation is sometimes used more selec-

tively to affect prices to some consumer groups—for example, lower taxation of diesel oil compared with motor spirit, or complete tax remission for agriculture or fishing.

Such action on energy prices, whether directed at certain markets or special consumer groups, does little or nothing to reduce costs to the community as a whole. Rather it is designed to grant special price advantages which do not result normal functioning of the market.

(OECD, *Energy Policy*, pp. 113–116)

C. What is the present governmental involvement in energy pricing?

An examination of present governmental involvement in energy pricing could be undertaken along two lines. First, the direct controls on energy prices could be examined. The Federal Power Commission, the Atomic Energy Commission and other Federal as well as State agencies all have a direct influence on the price of most energy fuels. The direct controls employed could be catalogued and their inter-relationships examined. Secondly, an examination of the indirect controls on energy prices might be undertaken. This investigation could include an appraisal of the impact of related regulatory agencies (e.g., ICC), leasing policies, tax and investment incentives, foreign policy considerations and others.

These investigations could also attempt to make an assessment of the objectives of Federal influence on energy prices. Are the objectives of present day Federal actions valid in light of today's condition? Is there an over-all *energy* pricing objective or goal toward which these various actions work? Or, is each energy fuel working toward a separate objective? Can the present objectives for pricing energy fuels be integrated with the national energy policy?

D. What should be the objectives of future Federal energy pricing policies?

The major question to be addressed in the assessment of Federal energy pricing objectives is: Should the "lowest possible price" or "lowest cost" be the prime determinant of the national energy policy? If it attempts to achieve the former, households and other purchasers of energy will benefit. On the other hand, if the latter is emphasized, the producers will benefit. If some type of middleground is sought the ultimate solution will have benefits and costs to each group.

How much regional variation in the price of energy should be allowed? Should one region be favored over another? Or, should the price remain constant in all areas of the country? Should the energy policy encourage one energy source to be priced at a lower level than another to stimulate or support that energy source? Does our present policy give an unfair competitive advantage to one type of energy over another?

Finally, three constraints will have to be kept in mind as these questions are addressed. First, should one over-all objective be formulated for all energy fuels, or should a separate policy be maintained for each energy fuel? Secondly, can the different pricing policies which govern each energy fuel be integrated into one over-all objective? Finally, can the separate influences of State, local and Federal agencies be guided in the direction formulated by the national energy policy?

X. INVESTMENT CONSIDERATIONS

A. What is the present magnitude of investment in energy production and distribution?

Table 3 (p. 10) presents the expenditures for new plant and equipment by private firms in the energy industry. While these figures are only rough approximations, it can be seen that nearly 20 percent of all investment takes place in energy industries. Table 3 also indicates the capital intensive nature of energy industries. Comparative statistics to those presented in Table 3 for public investment in energy production are not available.

While the magnitude of energy investments is important, the timing of investments is equally significant. In energy, as well as other industries, investments must be available not only in the proper amounts but also at the proper time. The role which timing can play was presented by the British in their fuel policy:

The growth in sales foreseen implies a very high level of investment . . . The requirements of the capital-intensive electricity industry will be particularly heavy. The industry's total capital expenditure at present throughout Great Britain is estimated to be about 10 per cent. of the country's gross fixed capital formation. It does not follow from the scale of the industry's investment and of its borrowing from the Exchequer that its growth should be curbed. Because the continuous rapid increase in demand for the product soon overtakes any over-provision of capacity, it offers a relatively safe, as well as profitable, field for investment. However, there is clearly a need to guard, as far as practicable, against the possibility of over-investing. Premature investment, especially at a time of strain on capital resources, is a real burden, and avoidance of it is a function of the annual capital investment reviews. Over-stimulation of demand through un-economic pricing provides another possible cause of misallocation of the country's resources. Against this danger, insistence that the return on the industry's capital should be adequate, and that the prices for any service should cover the full cost, including full capital charges of providing it, should provide sufficient safeguards. Hence the importance of financial objectives and of proper criteria for new investment for the nationalised industries.

If any restrictions were to be placed on the industry's growth, they should impinge on the growth of demand as well as of supply, and should avoid prolonging or worsening present strains on generating and distributing capacity. (U.K., *Fuel Policy*, 1965, pp. 29-30)

B. Will sufficient investment capital be available to meet future energy demands?

One essential question with respect to energy investment is the sufficiency of investment capital to meet future energy demands. The growing demand for energy means that decisions will have to be made now about the availability of investment capital for future production because of the long lead-time involved in most energy production industries. In addition, there are the problems of providing investment capital: (1) to finance new exploration for energy sources; (2) for the

development of new energy sources; (3) for the research and development to improve the efficiency of existing sources; and (4) to reconvert or develop sources to meet environmental quality objectives.

A recent report by the National Petroleum Council ⁶ gives an insight into some of the future investment problems to be faced. The Council forecast an average increase in energy consumption of 4.2 percent per year during the period 1971-1985. In order to achieve the initial appraisal of energy balance envisioned by the study, the Council estimated that capital outlays for resource development, manufacturing facilities and primary distribution in the United States would have to total approximately \$374 billion over the 1971-1985 period. Not included in this estimate were other major sums for petroleum marketing, gas and electricity distribution, and the development of overseas natural resources needed to satisfy U.S. import requirements. The breakdown of capital requirements for each energy source are given in Table 16.

TABLE 16.—*Capital requirements to meet U.S. energy needs, 1971-85*

[In billions of 1970 dollars]	
Oil and gas production*	\$92. 0
Oil refining*	20. 0
Oil transportation (marine and domestic pipelines)	18. 0
Gas transportation	21. 0
Coal production	9. 0
Coal transportation	6. 0
Nuclear production and processing	5. 0
Oil from shale	. 5
Syngas plants	2. 5
Subtotal	174. 0
Electric powerplants and transmission lines	200. 0
Total	374. 0

*Excludes foreign facilities.

Source: National Petroleum Council, *U.S. Energy Outlook*, 1971, p. 12.

The report also carried detailed capital requirements for oil production and natural gas transportation.

Oil.—Construction of 10 million B/D of refinery crude throughput capacity in the United States during the next 15 years would require capital expenditures estimated at \$18 billion (1970 dollars). The replacement of obsolescent refinery capacity would add approximately another \$2 billion to this sum for a combined requirement of \$20 billion. Adding the 5 million B/D refinery capacity needed to supply heavy fuel oil could, if built by U.S. companies, calls for another \$5-8 billion, at least half of which could be considered dedicated to meeting U.S. needs. In sum, the 15-year refinery investment would be \$25-28 billion.

A fleet of 367 (250,000 DWT) foreign-flag tankers was estimated as needed to accommodate incremental waterborne imports (both long and short haul) over the next 15 years. Thus, at

⁶ National Petroleum Council, *U.S. Energy Outlook: An Initial Appraisal 1971-1985*, Washington: National Petroleum Council, 1971.

\$37 million per vessel (current price quoted for 1975 delivery), the capital need for foreign-flag tankers would amount to \$13.5 billion. The estimated initial investment in the Trans-Alaskan pipeline from Prudhoe Bay to Valdez was expected to be in the order of \$3 billion. Alternatively, a Trans-Canadian pipeline from Prudhoe Bay to Chicago might require an investment of \$4 billion or more. The required capital for three large-scale, deep-water terminal facilities, one each for the East Coast, Gulf Coast and West Coast, would be in the order of \$1 billion.

Added together, the indicated capital required to meet U.S. needs for oil refining and transportation facilities is set at \$40-43 billion . . .

No estimate can be made of capital requirements for Alaskan North Slope exploration and development, other than the estimated pipeline investment cost mentioned earlier, since this area as yet has no history of capital expenditures. It is safe to say, however, the developing this area to a point where it is capable of producing 2.0 million B/D by 1980-1985 will add considerably to capital requirements.

Summed up for the 15 years through 1985, the investment to meet U.S. needs in oil and gas production, oil refining and oil transportation could aggregate close to \$140 billion. (pp. 29-30)

* * * * *

Natural Gas.—Total capital requirements during the 15-year study period for the movement of gas are estimated at \$21.0 billion, in 1970 dollars. . .

Approximately 49 percent of the capital required would be used to provide for transport capacity from Alaska, Canada and overseas LPG sources, to replace pipeline capacity in the "lower 48" states, and to transport synthetic gas from coal. The remaining 51 percent would be needed to build LNG plants, ships, terminals and storage facilities. The location of new sources of supply would require the construction of new facilities, while continuing production from existing sources would require replacement of old facilities. Therefore, substantial investment would be required to transport gas even though annual volumes of gas production are projected to decline. Furthermore, unit costs for new and replacement facilities are expected to increase above historical levels because of environmental restrictions, higher financing costs, the more removed location of sources of supply to be transported and stricter government regulation. (p. 36)

The Council's report clearly indicates that very large sums will have to be expended in the next decade and one-half to balance energy supply and demand. The question remains, however, whether these funds will be forthcoming. If private sources cannot supply these needs, will government participation be required? If so, what form will this participation take? Subsidies? Tax incentives? Tax deductions? Tax write-offs? Depletion allowances? Or, do the large sums required indicate a need for new institutional arrangements to meet future investment needs? What form might these arrangements take? Will public-private ventures in energy production develop?

XI. FOREIGN TRADE CONSIDERATIONS

A. What is the nature and extent of U.S. foreign trade in energy goods?

Shortly after the end of World War II, the United States became a net importer of energy resources. Since that time the deficit in the country's energy trade has steadily risen, in spite of the restrictions imposed by oil imports. By 1965, net imports of energy resources had risen to 7.6 percent of energy consumption, compared with an export surplus of 6 percent in 1947. This is shown by Table 17. Mineral fuel imports constituted over 10 percent of total imports in 1965 with petroleum representing about 90 percent of energy imports and natural gas the remainder.

Exports of energy consist almost solely of coal and refined petroleum products. The value of gross mineral energy exports was nearly 3½ percent of total exports in 1965. Coal exports have remained substantial, with the United States being the largest coal exporter in the world in 1969. Total exports rose to 56.2 million tons, valued at \$585 million in 1969. Nearly 95 percent of U.S. coal exports were shipped to Japan, Canada and Europe. While exports of coal fluctuated widely prior to 1961 because of various emergencies abroad, since that time, exports have increased steadily. There is reason to believe that because of its high quality and competitive price, U.S. coal will continue to provide an important part of the coal supply abroad.

U.S. energy imports are linked in varying degrees with other regions and nations; Table 18 shows the distribution of foreign trade in 1965. Trade has been dominated by crude oil and petroleum products imported from Canada, Venezuela, and the Netherlands Antilles. In 1965 about 80 percent of the value of U.S. imports of energy minerals came from these countries. Total imports of crude oil and refined products in 1969 were 1,154.5 million barrels compared with 1,039.4 million in 1968. Crude oil imports increased 41.5 million barrels for the year and 33.9 million of this represented additional imports from Canada.

TABLE 17.—U.S. NET ENERGY IMPORTS¹ RELATED TO ENERGY CONSUMPTION, 1947, 1955, 1965

[Trillion B.t.u.]

	1947	1955	1965
Crude oil.....	292	1,529	2,517
Petroleum products.....	-262	372	2,452
Natural gas.....	-19	-21	437
Bituminous coal and lignite.....	-1,791	-1,335	-1,310
Anthracite.....	+218	-81	-22
Total net imports.....	-1,998	464	4,074
Total consumption.....	32,870	39,956	53,791
Net imports as percent of consumption.....	² -6.1	1.2	7.6

¹ Net exports denoted by (-). Excluding exchanges of electric power.

² 1947 happened to be a year of peak coal exports. Substituting 1948 exports would reduce this percentage to -4.3 percent; substituting 1949 exports, to roughly -2 percent. But whatever year was chosen, it would not affect the U.S. position as a net exporter in the early postwar era.

Source: RfF, "U.S. Energy Policies: An Agenda . . .," p. 18.

TABLE 18.—DISTRIBUTION OF U.S. FOREIGN TRADE IN SELECTED ¹ MINERAL ENERGY SOURCES, BY REGION,² 1965
[In millions of dollars]

	North America	South America	Europe	Asia	Africa	Oceania	Com- munist countries	Total
Coal and other solid fuels:								
Imports.....	13.4		1.4				0.2	15.1
Exports.....	157.4	21.8	229.2	77.3	0.1	0.2	8.0	494.0
Net imports.....	-144.0	-21.8	-227.8	-77.3	-.1	-.2	-7.8	-478.9
Crude petroleum:								
Imports.....	335.2	507.6	.7	293.8	50.4			1,187.7
Exports.....	1.5		2.3	1.1				4.9
Net imports.....	333.7	507.6	-1.6	292.7	50.4			1,182.8
Petroleum products:								
Imports.....	416.8	431.7	3.9	10.8	.6		.4	864.1
Exports.....	99.2	33.0	108.5	128.6	22.2	14.8	2.3	408.5
Net imports.....	317.6	398.7	-104.6	-117.7	-21.6	-14.8	-1.9	455.6
Natural and manufactured gas: ³								
Imports.....	113.1	.6	.1	.1				113.8
Exports.....	27.3	.6	6.3	.3				34.5
Net imports.....	85.8		-6.2	-.2				79.4
Total, selected ¹ mineral fuels:								
Imports.....	878.6	939.9	6.1	304.7	51.0		.6	2,180.8
Exports.....	285.4	55.4	346.3	207.2	22.3	15.0	10.3	941.9
Net imports.....	593.2	884.5	-340.3	97.5	28.7	-15.0	-9.7	1,238.9

¹ The table excludes electric power exchanges, trade in lubricants, and a few other minor items. Total 1965 imports and exports of SITC code 3 ("Mineral fuels, lubricants, related materials") amounted to \$2,222,000,000 and \$947,000,000, respectively.

² North America includes Trinidad and Netherlands Antilles; South America includes Cuba; and Communist countries (as defined by the U.S. Bureau of Mines) cover the European Communist countries (including Yugoslavia) and the Asiatic Communist countries.

³ Includes liquid petroleum gas.

Source: RfF, "U.S. Energy Policies: An Agenda," p. 20.

Projections of future petroleum demand and supply indicate a greatly accelerated dependence of U.S. petroleum imports from the Middle East. What are the national security implications of such a shift in supply? What competitive problems are raised with other countries depending on the same resources?

Imports of natural gas have increased steadily in the last decade. During 1969, imports reached a record high of 726.9 billion cubic feet which was 11.5 percent higher than in 1968, although still only 3 percent of total demand. Imports from Canada account for 85.5 percent of natural gas imports. Exports of natural gas, similar to the pattern for imports, involves both Canada and Mexico. Future imports by pipeline from Canada and LNG from North Africa are expected to increase the percentage of natural gas imported into the United States in the years ahead.

B. Do present trade patterns reflect an unnecessary reliance on foreign sources?

In 1965, total energy imports accounted for 7.6 percent of all energy consumption (Table 17). While this figure may not appear excessive, the changing pattern of imports over the last two decades may be of concern. If the trends which have been developing continue, the U.S. would become heavily dependent on foreign sources for energy in the years ahead.

The National Petroleum Council made the following observations concerning this trend when it examined the supply of petroleum and natural gas for the period 1970–1985:

Petroleum Liquids.—* * * in order to meet growing demands for petroleum liquids, imports would have to increase more than fourfold by 1985 [over 1970], reaching a rate of 14.8 million B/D in that year. Assuming the availability of foreign supply, oil imports would then account for 57 percent of total petroleum supplies and would represent 25 percent of total energy consumption. Most of the imports would have to originate in the Eastern Hemisphere because of the limited potential for increased imports from Western Hemisphere sources.

Natural Gas.—In the absence of supply limitations, potential gas demand would approximately double between 1970 and 1985, reaching a level of about 38.9 trillion cubic feet (TCF) per annum . . . Taking all of these sources into account, 1985 supplies would total only 21.49 TCF, or 1.25 TCF less than 1970 supplies of 22.74 TCF. Dependency on imports would rise from 4 percent of gas supplies in 1970 to more than 28 percent in 1985, assuming the availability of foreign supply. The shortfall in energy supply between potential gas demand and available gas supplies would have to be made up from increased supplies of other fuels. (National Petroleum Council, *U.S. Energy Outlook*, 1971, pp. 4–5).

If the Council's observations are correct, the U.S. could come to rely quite heavily on foreign sources in the next decade. Would such reliance be in the best interests of the United States? What foreign policy, national security, transportation, balance of payments or domestic employment considerations could be affected by a greater reliance on foreign resources? What international trade problems would be raised? Does this trend indicate the decline of competitive domestic oil and gas industries? If foreign imports are curtailed to maintain domestic production, can future demands be met at reasonable prices? Indeed, will we be able to meet demand at all? If a national energy policy takes the position that energy demand should be satisfied, at reasonable prices, will trade barriers have to be lowered to meet that policy goal?

The present trend toward greater imports of basic energy sources will ultimately lead to a consideration of the fundamental question of free trade versus protectionism. Should the national energy policy promote free trade in all aspects of energy industries? Our policy presently reflects both free trade (coal) and protection (oil imports). Should this policy be continued or is a change desirable? Can certain fuels continue to operate under free trade, while others operate under quotas or tariffs? Does the present mix of free trade and protectionism accurately reflect energy priorities of the future?

The increasing demand for imported energy fuels may also cause the reconsideration of the oil import program:

To the extent that national security is the basis for policies it is important to know the cost to the economy of this security. As economists have pointed out, to achieve absolute security might require devoting a large share of the nation's resources to security purposes, at the cost of a much lower rate of economic growth and standard of living. It is necessary to determine the trade-off points between higher cost and higher risks. But today

scarcely even a framework exists within which to analyze this problem. Moreover, since there are alternative ways of achieving a security goal, the costs of the alternatives need to be analyzed if the national security cost is to be minimized. Cost-benefit analysis has been used in defense systems appraisal. Such an approach is not free from error, but it might well be adapted to studying the security ramifications of alternative energy policies. (RFF, *U.S. Energy Policies. An Agenda . . .*, p. 45)

The oil import program is not the only Federal program which may have to be re-examined and scrutinized in light of a growing reliance on foreign energy sources. Federal lands, both on and offshore, offer great potential for future energy supplies. Should these lands be developed at a faster rate to increase domestic production and lessen reliance on foreign energy sources? Would a positive response to this question be in line with present and future environmental quality control considerations? Naval petroleum reserves also offer a source of future supply. Do these lands still need to be preserved for national security purposes? The percentage depletion allowance and other tax incentives are intended to stimulate exploration and development of domestic energy fuels (as well as other minerals). Are these provisions achieving their intended purposes? Should other methods be instituted to promote domestic production? The leasing of Federal lands, of naval petroleum reserves and various tax incentives all offer a viable alternative to increased importation of petroleum.

C. What constraints should balance of payments considerations play in the attainment of national energy policy objectives?

The projected increase in energy imports could make balance of payments an important consideration in a national energy policy. A continuation of the present trends in energy imports could result in larger balance of payments deficits. However, if imports are limited to prevent deficits, this action could result in a failure to meet future demands or higher energy prices for domestic consumers.

In the past, the U.S. policy has been to encourage private investment abroad, and to maintain equality of commercial opportunity between American and foreign producers. The present U.S. investment in energy production abroad is concentrated solely in petroleum and natural gas production. The nearly \$19 billion invested by private petroleum industries in 1968 represents a \$1.4 billion increase over the previous year. Table 19 presents increases in total foreign investment since 1964, and those made by the petroleum industries. The expected increase in petroleum imports, plus the figures in Table 19, indicate that serious balance of payments difficulties could arise in the future.

A number of countries have confronted the problems resulting from balance of payments deficits due to or aggravated by increased energy imports and they have sought various solutions. For example, one European country noted that:

One of the principal points of our policy in the petroleum industry is to increase petroleum production so that the national demand for petroleum can be met * * * The main goals of our long-term policy for petroleum are stated below:

- (a) Raise the local refinery capacity to a level such that no importation of petroleum products shall be required;

(b) Increase the local production of crude oil so that no importation will be necessary for national uses and thus secure hard currency savings * * *

TABLE 19.—DIRECT PRIVATE INVESTMENT OF U.S. COMPANIES IN FOREIGN PETROLEUM INDUSTRIES, 1964, 1968
[Millions; net inflows to the United States designated by]

	Petroleum							
	Book value beginning of year		Net capital outflows		Undistributed earnings of subsidiaries		Book value end of year	
	1964	1968	1964	1968	1964	1968	1964	1968
Canada.....	3,134	3,819	30	163	54	107	3,228	4,088
Latin American Republics, all.....	3,095	2,903	4	59	3	25	3,142	2,976
Other Western Hemisphere.....	541	569	31	81	-1	17	569	667
Europe.....	2,776	4,423	389	321	-87	-112	3,086	4,640
Africa.....	702	1,219	97	313	4	15	830	1,567
Middle East.....	1,206	1,608	25	39	8	13	1,238	1,654
Far East.....	714	992	74	123	-20	31	775	1,146
Oceania.....	496	592	30	36	-1	19	444	646
International ¹	988	1,279	60	46	-9	124	1,038	1,451
Total ²	13,652	17,404	739	1,181	-49	239	14,350	18,835
	All industries							
	Book value beginning of year		Net capital outflows		Undistributed earnings of subsidiaries		Book value end of year	
	1964	1968	1964	1968	1964	1968	1964	1968
Canada.....	13,044	18,097	250	594	498	762	13,820	19,488
Latin American Republics, all.....	8,662	10,265	156	461	219	297	9,085	11,010
Other Western Hemisphere.....	1,229	1,779	134	111	34	59	1,386	1,979
Europe.....	10,340	17,926	1,342	995	410	442	12,067	19,386
Africa.....	1,426	2,273	135	308	40	71	1,629	2,673
Middle East.....	1,277	1,749	42	37	11	23	1,331	1,803
Far East.....	1,515	2,540	146	197	47	160	1,731	2,891
Oceania.....	1,460	2,520	115	164	80	132	1,582	2,821
International ¹	1,733	2,336	56	158	79	196	1,865	2,705
Total ²	40,686	59,486	2,376	3,025	1,417	2,142	44,496	64,756

¹ Comprised of international trading and shipping companies.

² Data may not add to totals shown because of independent rounding.

Sources: U.S., Department of the Interior, Bureau of Mines, "Minerals Yearbook: 1964, Mineral Fuels," Washington: GPO, 1964, p. 30; U.S., Department of the Interior, Bureau of Mines, "Minerals Yearbook: 1969, Metals, Minerals, and Fuels," Washington: GPO, 1969, p. 50.

Foreign trade and balance of payments considerations are also vital to the British; the following discussion indicates the many factors which the British have to consider:

All fuels except indigenous coal involve some direct cost in foreign exchange. In general this will be highest for oil, intermediate for natural gas, and lowest for nuclear power. Virtually all our oil comes from overseas in the first instance. Its cost in foreign exchanges varies according to its source, whether it is refined here or overseas, whether the suppliers are British or foreign and whether it is transported in British or foreign ships. An indication of the net balance of payments costs of oil and of some of the factors which enter into the calculation is given [elsewhere in this report]: the estimated average foreign exchange content of retained oil imports in 1965 was £4.1 per ton. Both North Sea natural gas and nuclear power also have some foreign exchange content, although rather lower than for oil * * *

In the case of nuclear power, the uranium fuel for the reactors all comes in the first instance from overseas. Current requirements are being met from the substantial stock already held in this country, but this will have to be replaced in time and it is appropriate to regard all incremental requirements for uranium as involving a cost in foreign exchange. For AGR stations this

cost would appear to be in the region of 10s. a ton of coal equivalent. The present oil tax represents an average loading of about 40 percent. On the delivered pre-tax price of fuel oil to large industrial users and, as a measure of protection for indigenous fuels, this is a much higher level of protection than applies in most other sectors of the economy. In reaching a view about the appropriate rate it is important that weight should be given to the indirect effects on the balance of payments of the availability of cheap fuels in making British goods more competitive for exports or import-substitution. (U.K., *Fuel Policy*, 1967, p. 38)

XII. OTHER FOREIGN POLICY CONSIDERATIONS

A. Are there foreign policy considerations, other than trade, that should be examined in the formulation of national energy policy?

The major considerations which could have an impact on national energy policy include: the impact of our foreign policy on national energy policy; and, the impact of our energy policy on our relations with other countries. These questions must be examined in light of changing foreign and domestic events.

Our foreign policy is a significant factor in determining the source and nature of U.S. energy supplies. But as the demand for and trade in energy resources increases, will changes in our foreign policy be required? Does our foreign policy place unnecessary constraints on trading with other energy producing nations?

The formulation of national energy policy must also consider the impact it has on our relations with foreign nations. What impact will the policy have on our allies? Will the policy continue to encourage existing sources of supply? Or, should the policy attempt to change the existing pattern? Will the policy cause reciprocal adjustments to be made by other nations? What arrangements (alliances, trade routes) might the energy policy influence? Can the energy policy achieve domestic objectives, while at the same time, avoid severe repercussions on the economy, balance of payments and energy policies of our allies?

Should the role of energy in developing nations be an element in national energy policy since energy is a necessary ingredient in the development process? Should contingency be made in the national energy policy to initiate means and measures to provide energy resource to developing countries? This could be done by providing energy resources or by assisting in the development of indigenous supplies.

B. What contingency should national energy policy make for international cooperation in energy-related activities?

The need for international cooperation was highlighted by the Organization for Economic Cooperation and Development when it noted that many of the problems in the energy field:

* * * particularly those related to research and to the development of facilities for the transport and distribution of both primary and secondary forms of energy, may be tackled effectively by international co-operation. There is nothing new in this concept, for there are countless precedents for such co-operative ventures both in the public and private sectors. (OECD, *Energy Policy*, p. 137)

The value of the exchange of energy policy information toward the development of individual energy policies was described in the following manner:

The regular confrontations of national energy policy which already take place in the OECD Energy Committee are designed to bring individual countries' problems and policies to the attention of the other Member governments. Considerable benefits can result from comparing the ways in which different countries solve similar problems. Our conclusion is that these confrontations will continue to be of value in tackling the problems that lie ahead, and should be developed to include discussions and mutual exchange of information bearing on the development and modification of policy.

These confrontations and discussions should be increasingly orientated towards the basic principles of energy policy particularly those with repercussions on international trade and on the pattern of allocation of energy resources.

Within the framework of broad economic and social objectives, energy policies could be tested and balanced against the following principles:

1. The realisation in the long term of the lowest energy costs for the community as a whole and of reasonable and stable prices for each consumer.
2. Secure and regular supply.
3. Competition and transparency in energy markets.
4. Consumers' freedom of choice between competing fuels, on the basis of prices which reflect costs of supply.
5. Safeguarding public health and preserving other resources.

Even if in some cases subsidies or other protection have to be maintained over a relatively long period, they should not be regarded as permanent but contribute towards efforts to remedy the underlying difficulties.

When temporary protection measures are necessary, it is preferable to apply those which permit:

Rationalisation, and avoid penalising efficient producers;
Assessment of any burden to the public purse and the cost to the community including the effect on regional and employment problems;

Rapid changes in the light of improvements or deterioration in the competitive position of the protected sector.

The principles given above are generally acceptable within the economic philosophy of most OECD Member countries. Their pursuit in an energy economy of rapidly changing size and

structure will, however, create difficulties and conflicts in most Member countries, especially in those which are presently protecting their indigenous production.

Confrontations and discussions between governments in the OECD can help to ease these difficulties, possibly resolve certain conflicts and increase every individual country's understanding of the interdependence within the area and with other countries. (OECD, *Energy Policy* p. 141.)

XIII. TRANSPORTATION CONSIDERATIONS

A. *What is the impact of transportation on energy consumption and production?*

The cost of transporting energy resources is an important, and sometimes critical, element in the structure of energy markets. Transportation costs can account for a significant share of total costs for energy resources at the point of final consumption and they can also influence the timing and distribution of the final product. While technological improvements in transport systems have helped to decrease the costs of shipping energy, transportation still forms an important element for consideration in a national energy policy.

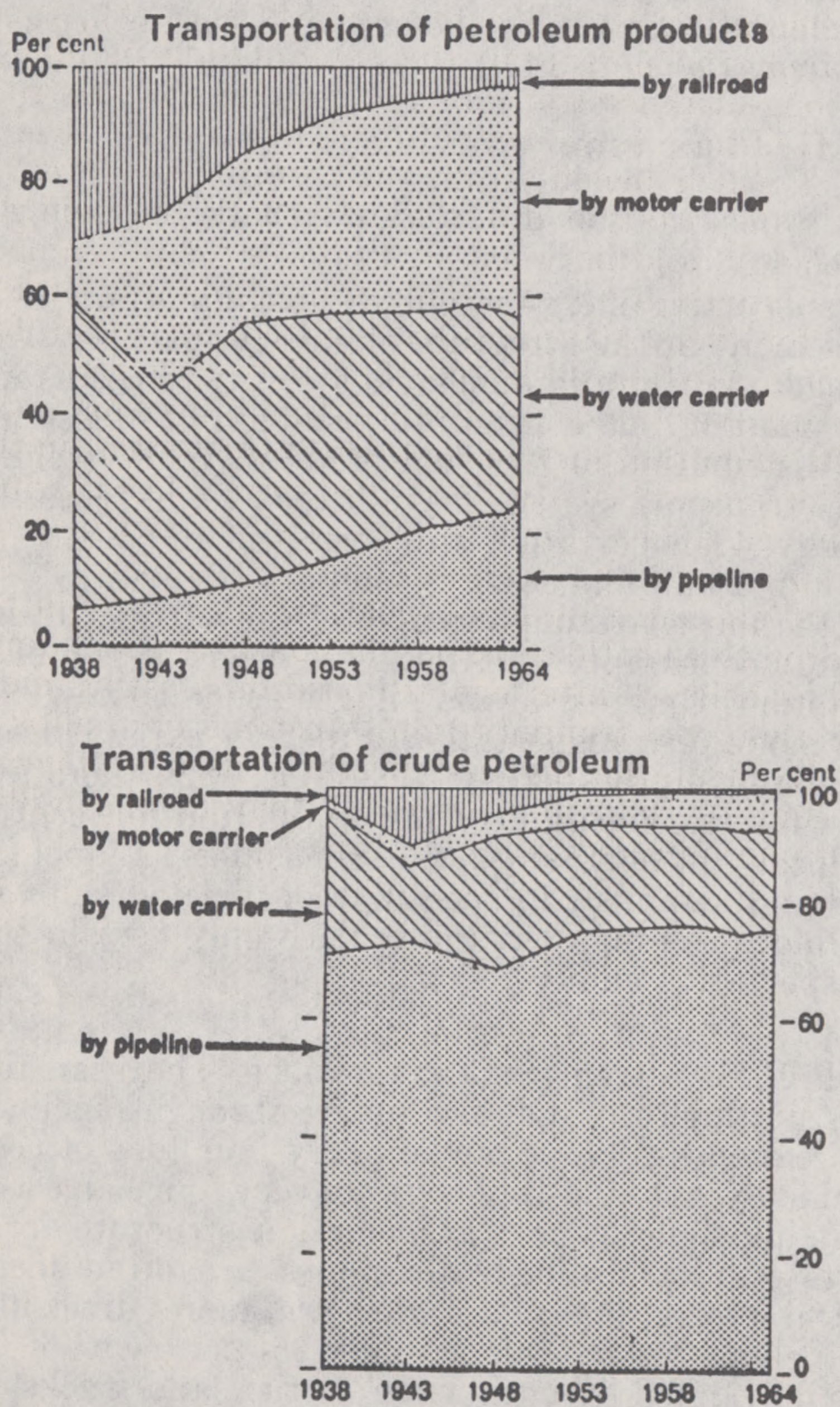
Perhaps the most striking example of the effect of transportation on energy consumption patterns has been the rise of natural gas consumption. Unlike coal and oil, gas has until now depended on a single mode of transportation. Pipelines carry it from wells to relatively simple processing installations, from there to pumping stations for transmission to major distribution centers, and finally to local gas companies and consumers. Liquefaction of natural gas and shipment in specially constructed ships is likely to become more common but can replace only certain segments of the transportation chain.

* * * * *

Coal and oil have transportation options. They can travel by water, rail, and highway. Oil also moves through pipelines. Still, there are preferences. Three out of every four tons of coal move from the mine by rail; and three out of every four barrels of crude oil travel in pipelines. The transportation structure for refined oil products is less lopsided. Refineries are often located on principal waterways, and deliveries are more diversified and smaller; pipelines, which move only 25 per cent of refinery output, are outranked by both water carriers and trucks, with 30 and 40 percent of traffic, respectively. [Figure 7.]

Figure 7

Transportation of Petroleum Products, and Crude Petroleum, 1938-1964

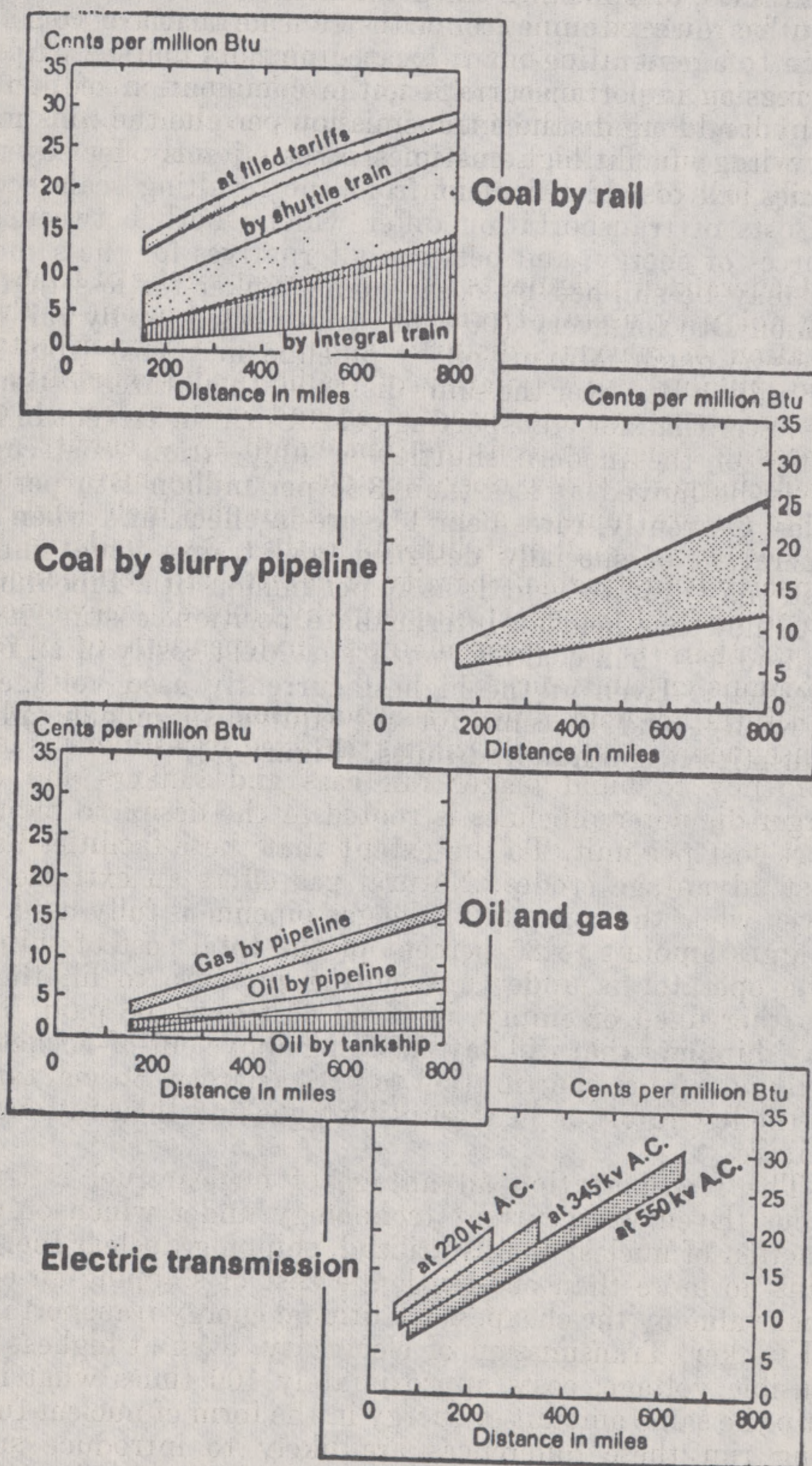


Source: Landsberg and Schurr, Energy in the United States, p. 19.

In competition with all of these carriers are transmission lines that carry electric energy from generating plants to consumers. Their effective radius is continuously lengthening, bringing distant hydro developments into competition with local generation from fuels, and making the generation of electricity at the mine mouth a direct competitor with transportation of coal from the mine to a generating plant located near its markets. Apart from savings in fuel transportation, the combination of mine-mouth plants and long-distance transmission permits the construction of very large facilities, sometimes owned jointly by several companies, all of which benefit from the resulting scale economies.

Costs of transportation differ widely, both between different sources of energy, and between alternatives for the same source. Oil may be shipped by ocean-going tanker for less than $\frac{1}{2}\text{¢}$ per million Btu for every 100 miles transported, or by rail for three times as much. Moving oil by pipeline may cost from 1 to $1\frac{1}{2}\text{¢}$ per million Btu over the same distance. In all three instances costs are lower than for transporting coal. Until the advent in the early sixties of the modern shuttle—or unit—train, coal could only rarely be moved at less than $3\frac{1}{2}\text{¢}$ per million Btu per hundred miles. Currently, rates near $1\frac{3}{4}\text{¢}$ are in effect, and when the next generation of specially designed coal trains comes into being, costs may drop to as little as 1¢ per million Btu. Pipelining of gas until now has held an intermediate position, costing more than oil, and less than coal transportation. Most costly of all is moving electricity. Even at the highest currently used voltage it runs between 4 and 10 cents for the equivalent of one million Btu transmitted one hundred miles. [Figure 8.]

Figure 8
Costs of Transporting Selected Energy Fuels, 1964



Source: Landsberg and Schurr,
Energy in the United States, p. 21.

Important as they are, rates alone do not determine competitiveness. Each form of transportation has advantages under certain conditions. For example, when electricity rather than fuel is transported, the transmission and distribution systems permit the electricity to be drawn upon for markets along the way. Flows may be reversed; and economies of scale that are possible at the point of generation but not consumption, can be exploited. Of increasing importance, pollution problems are eased. In the case of hydroelectricity the fixed site allows no choice but transmission by wire, but the high cost of transmission is offset by the ordinarily low cost of generation.

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Generalized judgments as to preferred modes of transportation are not very useful. Decisions vary with location of the source, location of markets, distance and type of terrain between the two, volume and regularity of traffic, and availability of other factors that enter into production and consumption. Pronounced seasonal swings in consumption handicap a carrier with high fixed charges and low operating cost. Where there is uncertainty as to future market growth, a medium which lends itself to expansion in small installments rather than in large blocks of capacity is preferable. Scarcity of capital and abundance of labor would counsel transport of energy by labor-extensive methods. In short, there is no "best method" independent of physical and economic circumstances.

Efforts to hold down transportation cost have far-reaching consequences, especially where the fixed investment is large. The tendency to build bigger rail cars and tankers and construct larger-diameter pipelines is rooted in the desire to reduce transport cost per unit. To the extent that these facilities lie idle the cost advantage erodes. Natural gas offers an extreme example. Even when the capacity of the gas pipeline is fully used, the fixed charges amount to 80 percent of the total cost of shipping gas. The operator is under unrelenting pressure to fill the line, for whether filled or empty, its fixed cost must be paid. Therefore, any shipment that will pay anything above out-of-pocket expenses will make a net contribution to fixed charges. Special tariffs, such as the low rates for "interruptible" gas find their rationale in this feature.

The transportation advantage of nuclear fuel is truly enormous. Even with current technology under which only a small fraction of nuclear fuel is utilized, shipping nuclear fuel probably runs no more than one-tenth the cost of shipping an equivalent heat value by the cheapest traditional energy transportation—the oil tanker. Transmission of electricity, even at highest currently feasible voltage, costs approximately 100 times what it costs to ship the same amount of energy in the form of nuclear fuel. In the long run these differences are likely to introduce substantial changes into national patterns of energy production and transportation. (Landsberg and Schurr, *Energy in the United States*, pp. 18–23)

B. What impact might recent technological developments in transportation have on energy consumption and production?

In the last ten to fifteen years, tremendous developments have taken place in the field of energy transportation, most of which have originated in the private sector. The fundamental importance of these developments has been to decrease the per unit cost of energy transportation which, in turn, has radically altered the world's energy situation. The many developments which have taken place include: the growth and spread of pipeline systems; the building of larger ships to carry oil and coal; the growing use of unit trains for coal transportation; the construction of ultra-high voltage electric transmission lines; and, the introduction of new methods of transporting natural gas in a liquid state.

In 1945 there were only a few pipelines in operation outside the United States. Even by the early 1950s such schemes as the Bechtel plan to bring crude oil by pipeline from the Middle East to Europe were considered excessively ambitious. Today, Western Europe, in particular, has developed a dense network of pipelines for crude oil, refined oil products and natural gas * * *

The costs of construction are often high, but these are rapidly offset by the subsequent reductions in transport costs. More recently, work has been progressing at an impressive pace to lay pipes to enable the natural gas deposits of the British North Sea area to be brought ashore and connected to the national grid.

Even more spectacular, perhaps, than the development of the European pipeline network has been the increase in size of oil tankers and, on a more modest scale, in coal-carrying ships. In the immediate post-war years the largest available tankers were of the order of 15 to 20,000 tons * * * .

Today, some twenty ships of 200,000 tons are either afloat or under construction. The Gulf Oil Company's Bantry Bay project envisaged the construction and chartering of six tankers of some 300,000 tons capacity—some of which are already in service * * *

Some idea of the savings achieved by the introduction of these giant vessels and terminal facilities was given by Mr. Binsted, the Gulf Oil Company's worldwide co-ordinator of transportation * * * "Although * * * it will be some time before we are able to chronicle the precise economics, we certainly are confident that the cost per barrel of bringing oil from Kuwait by the mammoth tankers is roughly one half as much as Gulf's cost of moving the oil through the Suez Canal in the largest vessels that could transit the Canal prior to its closure."

One major result of these developments has, of course, been to throw serious doubts on the future economic and financial viability of the Suez Canal when it is eventually reopened. In 1966, its last full year of operation, 166.7 million tons of oil passed through the Suez Canal on its way to Europe and only about 10 percent of Europe's oil supplies from the Middle East took the long route round the Cape. Today, it has been estimated by Shell that some 45 per cent of world tanker capacity would be unable to pass, when laden, through the Canal at its present depth, and this proportion is expected to rise to nearly 60 per cent by 1971. While it would be physically and technically possible to deepen the Suez Canal so as to give it sufficient draft to take tankers of up to

250,000 tons at least when they are in ballast, such an operation would inevitably require a great deal of capital expenditure * * *

This trend towards ever larger ships has also been applied, although on a significantly smaller scale, in the coal-carrying trade, where the French, in particular, have recently constructed two vessels of 65,000 and 80,000 tons respectively, to carry coal from Hampton Roads in the United States to the new Le Havre power station and the Dunkirk steelworks. It is noteworthy also that both the United Kingdom and Poland are at present engaged in the process of constructing new coal-loading terminals * * * which will be able to handle colliers for the European coastal trade of up to some 60,000 tons. (Jensen, *Energy and the Economy of Nations*, pp. 19-20)

In the past, wide variations in the price of energy fuels could be anticipated from country-to-country or even region-to-region. Improved transportation has tended to narrow these differences and may eventually lead to an equalization of prices. In addition to changes in price, improved transport of energy has changed the consumption pattern of energy resources. With the ready availability of oil and natural gas in many countries, and especially Europe, coal production has suffered heavily. With some of the best seams exhausted, with an industrial structure that is still basically labor-intensive, and obliged to operate in difficult geological conditions, the coal industry of Western Europe has been burdened with high production costs.

While improved transportation technology can decrease prices and costs, and improve security of supplies, the continuation of these improvements could be influenced by many government programs. Is the Federal Government providing sufficient incentives to seek new methods for transporting energy sources? What form could new assistance take? The coal-slurry pipeline, for example, has long been considered technically feasible. But objections from the railroad industry (including labor) and small coal operators have been raised to its widespread use. In addition, pipeline companies have had difficulties in obtaining right-of-ways for coal pipelines. Should the Federal Government initiate measures or provide mechanisms by which eminent domain rights can be obtained for coal pipelines? Should such measures be considered in order to decrease costs to the consumer and to increase the security of supply to major coal users?

C. Are existing mechanisms adequate to ensure the effective transmission and distribution of energy resources to meet future demand?

The availability of uninterrupted energy supplies is another problem which has recently developed. In order to meet future demands, supplies must be available at the point of consumption, in the required amounts and at the required times. In many cases, these conditions have not been met. Many blackouts and brownouts, for example, have resulted from either a breakdown in the transportation of electricity (i.e., transmission difficulties) or because of insufficient supply of resources to generate power. In the latter case, a major breakdown has been in the transportation of coal to power plants.

In order to avert serious transportation difficulties in the face of rising energy demand, many firms have taken steps to increase transportation reliability. Coal-mouth generating plants, nuclear power plants, vertical integration of many firms (i.e., energy companies)

and unit trains all represent partial solutions to meet isolated problems connected with energy transportation reliability.

Should a national electric power grid be established to ensure the supply of electricity at all times and in all areas? Could electric power reliability be enhanced by the creation of more regional inter-ties? Should administrative and regulatory measures be undertaken to coordinate the transportation of energy fuels to ensure their supply when needed? Could this be achieved with the present administrative and regulatory mechanisms or should new arrangements be created to ensure the supply of energy resources?

One solution to the difficulties surrounding the reliability of energy supplies could lie in the effective coordination of the national energy policy and the national transportation policy. The present U.S. transportation policy was adopted in 1940 (54 Stat. 895) and up-dated by the Federal-Aid Highway Act of 1968 (82 Stat. 815). The Airport and Airways Development Act of 1970 (84 Stat. 219) called on the Secretary of Transportation to formulate a national transportation policy by May, 1970. The new policy has been announced and it should be carefully examined in the formulation of the energy policy.

XIV. RESEARCH AND DEVELOPMENT CONSIDERATIONS

A. *What is the structure and magnitude of energy research and development?*

The funding of energy R&D is a composite of public and private efforts. The last comprehensive analysis of energy R&D, *Energy R & D and National Progress*, estimated the public-private ratio of R&D funding to be one-third, two-thirds (Table 20). More recent figures on the public-private mix are not available, but Table 21 does give an insight into the level of Federal funding over the last seven years.

The figures in Tables 20 and 21 refer only to civilian energy R&D and do not account for "scientific fallout" from military and space programs:

The transfer of R&D findings from defense and space programs into the civilian economy—generally called "scientific fallout"—has been a long-debated subject on which there is little general agreement. However, experience suggests that the energy sector has profited from defense research and likely will do so in future. Since paucity of statistics makes quantitative assessment difficult, several specific examples relating to energy must serve to show the general pattern.

Improvements in military aircraft piston engines have been widely adapted for commercial aircraft and automobiles. Gas turbines, initially developed for military aircraft, are used extensively in commercial aviation, in stationary powerplants, and in portable electric power generators. (They are being considered by the automobile industry as a possible advance over conventional piston engines.) The vigorous growth in power pooling in high-voltage, intertie systems would not be possible without the high-speed electronic computers that were born of the defense efforts. Civilian energy applications of the research associated with nuclear weapons have by no means been exhausted. However, the fact that \$1,275 million already has been expended in developing civilian nuclear power points is an outstanding characteristic of scientific fallout. Some research from defense and space projects

is not immediately applicable, and extensive adaptive R&D often is necessary before a useful transfer can be effected. In extrapolating to the future, it must be recognized that defense and space research programs are becoming increasingly specialized, which means that the needs of such projects may diverge from commercial requirements. Furthermore, as such research becomes more directional, the more it loses its generality and its wide range of potential applicability. (Energy R&D and National Progress, pp 32-33)

TABLE 20.—ESTIMATED EXPENDITURES FOR ENERGY RESEARCH AND DEVELOPMENT, 1963

[In thousands of dollars]

	Government		Industry	
	Amount	Percent of total	Amount	Percent of total
Coal.....	11, 000	3.3	11, 000	1.8
Oil and gas.....	40, 000	12.2	336, 000	54.8
Nuclear (fission).....	210, 000	63.6	90, 000	14.7
Electricity:				
Generation.....	1, 000	.3	94, 000	15.3
Transmission.....	250	-----	62, 000	10.1
Solar.....	3, 000	.9	500	-----
Magnetohydrodynamics.....	9, 000	2.7	4, 000	.6
Fuel cells.....	8, 200	2.5	9, 000	1.5
Thermionics.....	11, 000	3.3	2, 000	.3
Thermoelectricity.....	11, 000	3.3	2, 600	.4
Thermonuclear fusion.....	26, 000	7.9	3, 000	.5
Total.....	330, 450	100.0	¹ 614, 100	100.0

¹ Industry figures are "order-of-magnitude" expenditures.

Source: Interdepartmental Energy Study, "Energy R. & D. and National Progress," p. 30.

TABLE 21.—FEDERAL RESEARCH AND DEVELOPMENT FOR CIVILIAN ENERGY,¹ FISCAL YEARS 1966-72
OPERATING COSTS

[Dollar amounts in millions]

Department or agency	Fiscal year						
	1966	1967	1968	1969	1970	1971	1972
Department of the Interior:							
Bureau of Mines:							
Coal.....	\$6.3	\$6.6	\$6.9	\$6.9	\$6.8	\$8.8	² \$8.8
Petroleum.....	2.3	2.2	2.4	2.6	2.7	2.7	² 3.0
Oil shale.....	1.0	1.3	1.5	2.5	2.4	2.5	² 2.5
Explosives.....	.5	.6	.6	.6	.7	.7	² .7
Office of Coal Research.....	7.4	10.0	10.6	8.7	16.1	19.2	² 21.0
Office of Oil and Gas.....	0	0	0	0	0	0	0
Health and Safety Research.....	2.0	2.0	2.1	2.3	3.7	20.8	² 32.6
Total Interior.....	19.0	22.7	24.1	23.6	32.4	54.7	68.6
Percent of expenditures.....	7.1	8.0	7.0	6.0	8.1	13.0	15.7
U.S. Atomic Energy Commission:							
Civilian power reactors.....	\$89.8	\$102.4	\$121.5	\$125.2	\$124.5	\$129.6	³ \$144.8
Cooperative power demonstration reactor program.....	13.5	11.6	30.6	8.8	6.7	11.6	³ 13.1
Cooperative program with Euratom.....	3.4	2.7	2.5	1.9	0	0	³ 0
Terrestrial electric power development.....	1.7	4.6	6.6	4.2	3.5	.9	³ 1.0
General reactor technology.....	46.9	49.8	47.2	49.1	45.6	42.0	³ 38.5
Advanced systems research and development.....	18.1	10.4	7.6	0	0	0	0
Nuclear safety.....	21.6	28.6	32.8	33.7	37.1	35.9	³ 35.9
Controlled thermonuclear research.....	21.7	22.4	24.7	26.5	27.7	28.4	³ 28.0
Environmental research and development.....	(4)	(4)	(4)	70.7	71.2	71.2	⁵ 72.0
Total AEC.....	216.7	232.5	273.5	320.1	316.3	319.6	333.3
Percent of expenditures.....	81.1	81.9	79.1	81.6	79.6	76.4	76.4

See footnotes at end of table, p. 78.

TABLE 21.—FEDERAL RESEARCH AND DEVELOPMENT FOR CIVILIAN ENERGY,¹ FISCAL YEARS 1966-72
OPERATING COSTS—Continued

[Dollar amounts in millions]

Department or agency	Fiscal year						
	1966	1967	1968	1969	1970	1971	197
Environmental Protection Agency:							
Air pollution: removal of sulfur and nitrogen oxides from stack gases..	(4)	(4)	⁶ \$10.0	⁶ \$16.0	⁶ \$19.0	⁷ \$14.5	⁷ \$27.5
Radiation control.....	(4)	(4)	(4)	(4)	(4)	2.3	⁷ 2.8
Water pollution: waste heat disposal..	.5	.5	.5	.5	.5	.5	⁸ .5
Total EPA.....	.5	.5	10.5	16.5	19.5	17.3	30.8
Percent of expenditures.....	.1	.1	3.0	4.2	5.0	4.1	7.1
Federal Power Commission.....	0	0	0	0	0	0	0
National Aeronautics and Space Administration:							
Nuclear electric power.....	14.0	13.1	21.1	17.4	16.6	16.1	(4 ⁹)
Solar power.....	9.0	7.5	8.2	6.5	5.2	2.8	(4 ⁹)
Chemical power.....	5.1	5.0	4.9	4.4	4.0	3.1	(4 ⁹)
Total NASA.....	28.1	25.6	34.2	28.3	25.8	22.0	(4 ⁹)
Percent of expenditures.....	10.5	9.0	10.0	7.2	6.5	5.3	-----
National Science Foundation Engineering energetics.....	¹⁰ 3.2	¹⁰ 3.1	¹⁰ 3.1	¹¹ 2.9	¹¹ 2.6	¹⁰ 2.9	¹⁰ 4.2
Percent of expenditures.....	1.2	1.0	.9	.7	.6	.6	.8
Tennessee Valley Authority.....				1.1	.9	1.9	(4)
Percent of expenditures.....				.3	.2	.6	-----
Total for all departments and agencies.....	267.5	284.4	345.4	392.5	397.5	418.4	436.0
Total expenditures (percent).....	100.0	100.0	100.0	100.0	100.0	100.0	100.0

¹ The table does not include military spending on energy R. & D., or the funding for the Atomic Energy Commission's isotopic separation processes for production of U-235.

² Appendices to the Budget of the United States, fiscal years 1966-72.

³ Annual hearings of the Joint Committee on Atomic Energy for AEC authorizing legislation, fiscal years 1966-71, from program justification statements of the AEC.

⁴ Not available.

⁵ For fiscal years 1969-71, "AEC Authorizing Legislation Fiscal Year 1971." Hearings before the Joint Committee on Atomic Energy, 1970, pt. 1, p. 292. Fiscal year 1972 information from USAEC.

⁶ OST report on expenditures for civilian energy production, conversion and transmission. Sept. 8, 1969.

⁷ Information from EPA.

⁸ Personal estimate based upon inquiry from the Environmental Protection Agency.

⁹ NASA budget estimates, fiscal years 1968-71. Comparable information did not appear in the budget estimate for fiscal year 1972.

¹⁰ Information from NSF.

¹¹ NSF annual report for 1970, p. 10.

Source: Prepared by Warren H. Donnelly, Specialist, Science Policy Research Division, Congressional Research Service Library of Congress.

The institutional aspects of U.S. research and development in energy are among the largest and most diverse in the world. R&D programs are handled by a wide variety of organizations ranging from completely private groups to public institutions.

No one, so far, has been able to decide which type—Government bureau, industrial establishment, National laboratory, academic institution, nonprofit organization, or foundation—is most effective in a particular type of research program. Nor is there yet sufficient information to provide the basis for an analytical answer. Nevertheless, each type of R&D institution, because of both history and current conditions, has certain advantages and limitations. Many industrial laboratories operate under severe, self-imposed, time-horizon constraints which, while consistent with the economic objectives of the parent firms, may preclude the undertaking of long-term projects with uncertain

outcomes. In contrast, many university and Government laboratories operate in a milieu that provides no "test of the market place" by which the ultimate worth of a new discovery can be judged.

As table [20] indicated, private industry supports appreciable programs in energy R&D; but the difference in the amounts spent on coal and petroleum R&D, respectively, showed that there are wide variations between expenditures by different parts of the energy sector. Certain energy industries have had a lengthy history of research consciousness; others are becoming aware of the potential benefits of R&D, while others are relatively unawakened to conceivable gains from R&D undertakings. However, even in the research-centered and mature industries, too much R&D is practically oriented, and there is a discernible reluctance to undertake forward-looking programs without categorical indications that the proposed activity will pay off. While an industry's concern for its obligations to stockholders is understandable, companies must be shown that they lose vitality, growth potential, opportunities for diversification, and the services of the most fertile minds unless they provide environments that encourage intellectual curiosity and technological accomplishment.

* * * * *

Table [20] also showed that the Government is financing sizable programs in all parts of the energy sector; many of these are carefully formulated and well handled, although the approach and objectives tend, as to rule, to be less competitive than those that industry sponsors. The Government supports research in several ways: through in-house activities by certain agencies; by contracts to college and industrial laboratories from agencies directly concerned with the research; or by basic-research grants from nonoperating agencies. R&D in some segments of the energy sector is under Government sponsorship by only one agency, which is not surprising where the agency concerned has been assigned specific missions or applications. In such cases, a research worker with a meritorious program in basic energy research faces the need to "sell" his project to a single agency, since there are no alternative sources of Government support. This possible danger or threat of Government control of research might be ameliorated by competition among agencies. Such diversity need not entail undesirable duplication of effort but could have the salutary effect of curtailing those R&D programs that could not meet the vigorous test of a competitive system.

In some agencies with in-house research facilities, there could be a tendency to reserve the most promising programs for themselves, a practice that could be readjusted if these agencies allocated a certain portion of the budget for work in academic, nonprofit, or industrial institutions.

Conversely, several Government agencies and bureaus having a fine tradition for R&D related to energy problems have lost ground. Further, new agencies, created to have jurisdiction over new scientific areas in the last 20 years, have absorbed some of the R&D that otherwise would have been the responsibility of

the older organizations (typically, the National Bureau of Standards and the Bureau of Mines). These older groups could be revitalized by assigning to them, whenever possible, cognizance over new or expanded energy R&D programs. Finally, the staff in agencies with no in-house programs can become detached from the research it is sponsoring elsewhere. The situation could be improved if staffs of these agencies were given opportunities to establish intimate contacts with neighboring universities and research establishments. (*Energy R&D and National Progress*, pp. 34-36).

B. What areas of energy research and development should be examined in the formulation of national energy policy?

The last comprehensive review of energy R&D was completed in 1964. Thus, more recent data should be available to formulate positions on how energy R&D expenditures could be improved. This observation is supported when it is considered that the complexion of energy industries has changed radically since 1964. We have moved from a position of energy surplus to scarcity; demand for many fuels has risen greatly; and, environmental considerations have placed additional responsibilities on the industry.

To formulate a more workable position in energy policy regarding R&D, up-to-date information must be available. This would include information on: the level of financing (both public and private) for energy R&D; the returns available for different programs; and, the prospects for new technologies and an assessment of the commercial feasibility.

The mix of public and private R&D funding demonstrated in Table 20 leads to several policy questions. Since two-thirds of the entire R&D effort is in private industry, much of the leadership in the years ahead will have to come from the private sector. This point is especially germane when it is considered that, in the future, many major research efforts could take years before they become commercially profitable. Research and development on some of these projects must be undertaken on a large scale and at high costs and risks. As a result, many private firms have found it impossible to assume the risks involved with present management limitations and financial capabilities. Anti-trust laws, non-patentability of processes and the difficulty of maintaining exclusive positions and proprietary knowledge also compound the problem. Do these problems indicate the need for new Federal institutional arrangements or programs to assist private industries in energy R&D? What innovative approaches might be utilized to solve these problems?

Tables 20 and 21 also indicate that the Federal priorities in energy R&D have been directed toward the development of nuclear fission processes. From FY1966 through FY1972, the Atomic Energy Commission averaged nearly 80 percent of all civilian energy R&D funds. Does this emphasis on nuclear fission mean that our future energy priorities have already been established? Have we neglected the development of alternative sources of energy? Should more funds be allocated to the development of new sources of energy (e.g. solar)? Should more funds be allocated for the re-conversion of existing sources (e.g. coal gasification)?

This examination of Federal funding naturally leads to the following questions: What should be the objective of the Federal Government in energy R&D? Should it attempt to emphasize the development of new energy sources? Or should it attempt to re-vitalize existing sources, seeking new applications and new technologies? Should it limit its role only to those instances where the R&D costs and risks are too high for private industry to assume? The development of new energy sources will require greater time to implement and greater costs in R&D funds. In light of our pressing energy needs, can we afford the luxury of developing new energy sources? Or, is the need for new energy sources so great that their development can no longer be viewed as a luxury? Are the time limits too short to afford the development of new sources? Should, therefore, projects be funded that seek new uses for existing sources? The choice which is made between new sources or re-vitalizing old ones must be examined from both the long and short-runs. In the short-run, faster pay-offs can be obtained by funding new uses for existing sources, but is this in the best interests of the long-term supply of energy?

The diverse nature of both government and industry R&D efforts indicates, on the surface at least, a need for some type of coordinating mechanism to guide the development of energy R&D in the years ahead. Does this mean there is a lack of leadership in the energy R&D effort? Should some type of leadership be provided? What type of leadership could be provided? What type of institutional arrangements could provide this leadership?

XV. NATIONAL SECURITY CONSIDERATIONS

A. What basic national security questions must be examined in the development of a national energy policy?

Because it affects every aspect of American life, the national security policies of the United States will have a very large influence on the formation and success of the national energy policy.

One central question which should be addressed is the security of energy supplies. Without a reliable source of energy supplies, the national security objectives of any country cannot be assured. In the United States, for example, imported petroleum is relied on very heavily; this reliance raises several questions: to what degree should the United States allow itself to become dependent upon foreign sources, or foreign transporters? Will such dependence affect the development and reliability of domestic sources? To find answers to these questions, the U.S. oil import program may have to be examined with special emphasis on its national security considerations.

Over and above the issues involving individual energy fuels, the entire concept of national security and its relationship to energy production and consumption must be examined. What are the basic national security questions which relate to a national energy policy? Have these questions been detailed so that they can be considered in the formulation of the policy? Are national security objectives concerned only with fuels for military purposes or is the basic question fuels for the domestic economy in time of war or national emergency? What are the military and civilian energy requirements during these periods? What measures are appropriate for meeting what situations? What risks are to be met by which means?

When examining the many complex questions involved with energy and national security, three additional items might be kept in mind.

First, an inquiry into the national security rationale calls for clarification of the concept itself. A whole congeries of security concepts now invade the sphere of public discussion—a war contingency concept (for different kinds of wars), a national self-sufficiency concept, a Western Hemisphere self-sufficiency concept, a Western Alliance self-sufficiency concept, a good foreign relations concept, and finally, though without exhausting the list, a wholeheartedly protectionist concept that what is good for the domestic oil producers is good for national security. These concepts swirl around in the controversial discussion of import policy, creating a general obfuscation of what is being talked about. As a subject for special study, however, national security considerations can be limited to kinds of precautions to be taken to assure energy supplies in a variety of contingencies that might arise in the international situation.

Second, we must ask, what measures are appropriate for meeting what situations? What risks are to be met by what means? This is a subject at present obscured in a fog of undefined ends and means. Several federal, and even state, policies have rested part of their justifications on security considerations. Oil import controls, special tax treatment for oil and gas, federal leasing policy on off-shore oil and gas provinces, programs for coal research, programs for nuclear energy research, and even state conservation regulation have all invoked the national security argument. But no systematic assessment of the security role of energy policies has ever been attempted.

Third, to the extent that national security is the basis for some policies, it is important to know the cost to the economy of this security. As economists have pointed out, to achieve absolute security might require devoting a large share of the nation's resources to security purposes, at the cost of a much lower rate of economic growth and standard of living. It is necessary to determine the trade-off points between higher cost and higher risks. But today scarcely even a framework exists within which to analyze this problem. Moreover, since there are alternative ways of achieving a security goal, the costs of the alternatives need to be analyzed if the national security cost is to be minimized. Cost-benefit analysis has been used in defense systems appraisal. Such an approach is not free from error, but it might well be adapted to studying the security ramifications of alternative energy policies. (RfF, U.S. Energy Policies: An Agenda . . . , pp. 143-44)

APPENDIX A

PART I: OBSERVATIONS ON UNITED STATES ENERGY POLICY

Presented to the Energy Committee
Organization for Economic Cooperation and Development

by Assistant Secretary
J. CORDELL MOORE
U.S. Department of the Interior

November 1, 1966

As background for a confrontation on United States energy policy

January 26-27, 1967

INTRODUCTION

Few words so innocently incorporate into their basic meaning as much simplifying illusion as does the word policy. It means a settled, definite course of action, and yet by its very nature, policy only needs to be formulated when there are complex, uncertain alternatives so difficult to analyze and resolve that it is almost impossible to settle on a single, definite course. The illusory qualities of the word have merit, however, for once the compromising, hedging judgments have been made, choosing, chances are, not one but several somewhat indefinite and conflicting courses, it is comforting to be able to describe them by a word implying such wisdom, certainty, and singleness of purpose.

You who represent your government in the energy policy field have no illusions, I am sure, about the complexity of energy policy, either in the United States or in your own country. Because energy policy is so complex, and is in fact composed of many policies formed in many parts of the Federal Government, and in the State and local governments as well, there has never been a fully comprehensive official declaration of energy policy in the United States and I doubt that it would ever be possible to prepare one. As with foreign and economic policy, the problems, goals, and measures of energy policy are so numerous, diverse, conflicting, and mercurial as to defy comprehensive treatment at any given time. My remarks here and

in our subsequent discussion will, I hope, be informed and useful, but I must caution you that they may not in all instances represent the official position of the various governmental bodies of the United States.

Since our purpose in this Committee is not to reach signatory agreements but to enlarge our understanding of each other's situations and problems, my inability to give you a comprehensive declaration of policy will prove to be an advantage rather than a handicap, for it will permit me to substitute some meaningful generalizations for what would otherwise have to be a tedious and confusing stream of reservations, qualifications, and exceptions. Even so, it will be difficult to cover the topic adequately, but I will do my best to give you the highlights of the philosophies, goals, and problems that guide the formulation of energy policies, the mechanisms by which they are shaped, their objectives and current components, and the problems that may require modification in policy in the near future. I will be both frank and speculative in my remarks about problems and weaknesses in our energy policy and I hope you in turn will be penetrating in your questions, comments, and suggestions. This process of confrontation in the energy policy field will be useful only if it helps to broaden mutual understanding of each other's problems and policies, and to achieve this we must be open and frank in our discussions.

THE DE FACTO NATURE OF UNITED STATES ENERGY POLICIES AND THEIR PHILOSOPHICAL BACKGROUND

It is sometimes observed that it is easier to talk about energy policy than to say what it is, and perhaps that comes close to explaining why there has never been a comprehensive statement of it. But the lack of such a declaration doesn't mean that there is no policy. On the contrary, there is the continually operating de facto policy made up of a myriad of laws and regulations that affect energy, and made up not only of actions taken to accomplish some specific purpose but of studied inactions, of deliberate decisions to accomplish something by doing nothing for the time being. Most of these actions and inactions are taken on an ad hoc basis, but even though they may give the appearance of being unrelated to one another, in the aggregate they constitute the checks and balances--the channelways, levies, and dams--necessary to effect and improve the flow of energy in the economy.

There are, of course, broad objectives concerning the flow of energy in the economy, but they arise from still broader national goals and philosophies that are the base from which policy is laid in nearly all fields. These are so fundamental to an understanding of United States policies that they deserve enumeration. Briefly, they are as follows:

1. National security is a fundamental aim and responsibility of government.
2. Preservation of personal freedom and continued improvement of the health, economic welfare, dignity, and intellectual well-being of the individual are cardinal national objectives, and are prime responsibilities of government.
3. Continued economic growth, balanced by economic stability, are two of the essentials for these national and individual goals and are in themselves, therefore, prime objectives of social and economic policy.
4. Individual and corporate initiative are both a right and a consequence of freedom, and private enterprise is the most efficacious means of producing and marketing most of the goods and services required by American consumers. A major responsibility of govern-

ment is to create a climate that stimulates private initiative and enterprise. Premeditated inaction is often an important means of achieving this purpose.

5. Competition must be preserved as a stimulant to initiative and a safeguard against monopoly.

6. While the private sector is responsible for most production and distribution of goods and services, government bears responsibility for maintaining and improving many services and engineering works that are required for the public welfare but are not readily or efficiently marketable by the private sector.

7. The natural resources and physical environment of the United States are to be used wisely and constructively and are not to be hoarded without purpose. The nonrenewable resources, however, are wasting assets, and action is justified to save them when their loss is avoidable and would be injurious to the economy over the long term. Some of the renewable resources are spoilable and must be safeguarded against contamination and damage. Wise-use conservation practices are essential for near-term and long-term public interests.

8. Free trade, consistent with other objectives, is the most efficient and equitable means of international exchange of raw materials and finished products, and is in itself conducive to economic growth.

9. For both humanistic and economic reasons, peaceful relations are sought with the other nations of the world, and the aims for human dignity, personal freedom, social equality, economic betterment, and personal well-being held for the United States are held for the peoples of the world also.

These national goals and philosophies have been held throughout our history with little basic change. Conflicting, ad hoc, diverse, and complex as our actions and inactions in the energy field may seem to be, I believe you will find that all of them are rooted in our deep concern over these basic goals and values.

THE ORGANIZATIONS THAT SHAPE AND IMPLEMENT ENERGY POLICY

Before discussing energy policy per se, it may be of interest to you to know something about who shapes and implements it. Three broad groups may be distinguished: 1) the private sector; 2) the Federal Government; and 3) the State and local governments.

The private sector

The private sector is not usually identified as a force in policy making, but in the United States it plays an important part in both shaping and implementing policy. Because our governments--Federal, State, and local--are by and for the people, they attempt generally to solicit and reflect the views of the general public. From the grass roots, the public contributes its views through all available means of communication, and diverse opinions are thoroughly discussed in the news media as well. Any elected or appointed public official in the United States will testify that the extent of this communication from the general public is wide indeed, and that its influence on policy is substantial.

Beyond the initiative of individuals there is also an important contribution from both profit- and non-profit making organizations in the private sector, for companies, trade associations, learned societies, trade unions, and other informed and concerned organizations all make known to government their views on policy issues. It is common place also for the government to seek advice from the private sector via the formation of various advisory groups. The National Petroleum Council is an example of an industry advisory group formed at the request of the Secretary of the Interior to advise on policy and investigate problems that bear on policy. In preparing its National Power Survey, a comprehensive report on the electric utilities industry issued in 1964, the Federal Power Commission was aided by 13 specialized advisory committees drawn largely from industry. Similar examples of the role of advisory committees could be cited for almost every agency in the Federal establishment. Governments synthesize views, strike the balance among them necessary to crystallize policy, pass laws, and set and enforce regulations,

but in the United States the private sector plays a vital part in shaping policy.

The private sector also plays an important part in implementing policy in the United States, particularly policy of the inaction and indirect type. If the government levies a tax, its own agents collect and enforce it, but if the government attempts by indirect means to encourage some activity in the private sector, it is the response of the private sector that implements the policy. For example, the public purpose of stimulating economic growth has been aided by a variety of policies--many of a hands-off type--but implemented through private initiative in production and marketing.

As the United States population and economy increase in magnitude and complexity, government intervention necessarily broadens, deepens, diversifies, and multiplies; most of what I will say here will relate to the nature of government's role, and the emphasis called for by the topic assigned to me will appear to magnify government's role relative to that of the private sector in the energy field. These trends and appearances to the contrary, I cannot overemphasize the role the private sector plays in shaping policy and in implementing the most fundamental aspects of it. Government applies checks and balances, stimuli and constraints, some of which, particularly in the regulatory field, attract far more notice than they deserve. But it is generally the response and initiative of the private sector that implements policy and accomplishes its purpose. To a major degree, ours is a do-it-yourself economy, advancing through the enterprise of the private sector in a climate that encourages its initiative.

Federal Government organizations

A quick look at the branches of the Federal Government that are concerned with some aspect of the energy field would tempt one to conclude that there is hardly a single office that is not involved in some way or other. Such a conclusion would have only fractional validity, of course, but even if it were true it would be worthwhile to review the functions

of the organizations concerned to see the breadth and complexity of government involvement in the energy field.

As you know, the United States Government is divided into three branches--the Executive branch, Legislative branch, and Judicial branch. The Judicial branch may play a decisive role in fixing energy policy, for its court decisions are the final test of whether or not a given policy is constitutional, and its rulings on the interpretation of law may have far-reaching effects on policy. An entirely new phase of the Federal Power Commission's regulation of the natural gas industry was thus initiated by the Phillips decision of 1954, which interpreted the scope and coverage of the National Gas Act as extending to production. The courts do not take direct initiative in setting policy, however, and I will not discuss their role further.

The Legislative Branch--The two houses of Congress--the Senate and House of Representatives--are the immediate source of the laws that affect energy. Congress is partly guided and stimulated in its actions by the general public and the Executive Branch, but it does much of its own investigative and formulative work, particularly through committees that hold formal hearings and receive and publish testimony from both public and private sources.

Nearly all of the Congressional committees affect one or another aspect of energy policy, but a glance at the following list of those involved gives a clue to the complexity of the subject.

Senate

Aeronautical and Space Sciences
Agriculture and Forestry
Appropriations
Armed Services
Banking and Currency
Commerce
Finance
Foreign Relations
Government Operations
Interior and Insular Affairs
Judiciary
Labor and Public Welfare
Public Works

House of Representatives

Science and Astronautics
Agriculture
Appropriations
Armed Services
Banking and Currency
Interstate and Foreign Commerce
Merchant Marine and Fisheries
Foreign Affairs
Ways and Means
Interior and Insular Affairs
Judiciary
Education and Labor
Public Works

Joint Committees

Atomic Energy
Defense Production
Internal Revenue Taxation
Economic

In addition, both houses have Select Committees on the problems of small business, and a Public Land Law Review Commission, composed of members of both houses and the general public, has recently been formed that will, among other matters, study problems and make recommendations related to laws concerning energy resources on public lands.

The Executive Branch--The wide dispersion of responsibility for problems in the energy field seen in the Congressional Committees is even more prominent in the Executive Branch, where there are some 85 bureau-level organizations that have substantial concern with one or another aspect of the energy field. They are distributed in every one of the Executive Departments except the Post Office, and include also about 15 independent agencies, among which are the Atomic Energy Commission and the Federal Power Commission. In addition, there are about 10 special boards, committees, and quasi-official agencies, such as the National Academy of Sciences, that are in some way concerned with energy. Space will not permit me to even name all these organizations, much less describe their respective roles, but I will group them by function, and mention some of those most directly concerned with energy.

Security and economic policy are, of course, the parents of energy policy, and these policies are laid by the President, acting with the advice of his Cabinet and the Congress and with the aid of several specialized organizations attached directly to his own office, including the Bureau of the Budget, the Council of Economic Advisors, the National Security Council, the Office of Emergency Planning, and the Special Representative for Trade Negotiations.

Most of the Federal functions directly concerned with the appraisal and development of energy resources are performed by bureaus in the Department of Interior, among the larger of which are the Geological Survey, the Bureau of Mines, Office of Coal Research, Office of Oil and Gas, Bureau of Land Management, and the Bureau of Reclamation. The Atomic Energy Commission, which has broad responsibility for the development, use, and control of nuclear energy for military and peaceful purposes, is also concerned with resources of radioactive minerals. The Corps of Engineers in the Department of the Army shares with the Bureau of Reclamation in responsibility for development of some publicly-owned hydroelectric projects. The Tennessee Valley Authority, an independent agency, develops and generates power in the Tennessee Valley, the Federal Power Commission licenses construction of hydroelectric projects on Federal lands or navigable waters, and the Office of Naval Petroleum and Oil Shale Reserves in the Navy Department manages the Naval petroleum and oil shale reserves. The concern of a few of these agencies is entirely with the management of publicly-owned resources, but most have responsibility also for scientific, technologic, or economic problems related to development and use.

Research and development in the field of energy are undertaken or sponsored by several of the agencies I mentioned, particularly those in the Department of the Interior and the Atomic Energy Commission. In addition, energy R&D is undertaken or sponsored by the National Science Foundation, the Bureau of Standards, several organizations in the Department of Defense, Army, Navy, and Air Force, and the National Aeronautics and Space Administration. The defense agencies and

NASA are especially heavy contributors to R&D on exotic fuels, fuel systems, and energy uses. The National Academy of Sciences performs an advisory function on scientific and technologic problems. The Office of Science and Technology was created in 1962 in the President's office to help coordinate scientific research, and in this capacity, of course, it also influences energy policy.

Although the Federal Government owns and leases to the private sector much oil, gas, and coal land, and has certain riparian rights on many major rivers, it produces itself only about 3 percent of the Nation's requirement for energy, almost entirely in the form of electric power. TVA produces and markets power from both thermal and hydro sources, and the Corps of Engineers produces electric power which is marketed by four agencies within the Department of the Interior, including the Bureau of Reclamation, the Bonneville Power Administration, the Southeastern Power Administration, and the Southwestern Power Administration. The Bureau of Reclamation produces as well as markets hydropower.

In the area of transport and marketing of energy, the Federal Power Commission issues certificates authorizing interstate gas pipelines, controls the sale of gas moving in interstate commerce, regulates the wholesale rates of gas and electric power moving in interstate commerce, and encourages the broad coordination and interconnection of electric systems. The Rural Electrification Administration in the Department of Agriculture administers loan programs for the generation, transmission, and distribution of electricity to rural consumers. The Corps of Engineers develops and maintains the inland waterways for barge transport. The Interstate Commerce Commission has certain responsibilities for land surface transport and oil pipelines. The Maritime Administration in the Department of Commerce administers the Federal subsidy programs to U.S. merchant shipping, and has jurisdiction over the National Defense Reserve Fleet, which includes some tankers. The Atomic Energy Commission controls the import and export of thorium, uranium, and other fissionable materials, and also manufactures and markets nuclear fuel and unique reactor materials. The Federal

Trade Commission and the Department of Justice are responsible for maintaining free and fair competition in interstate trade and for the administration of the antitrust laws. The President's Special Representative for Trade Negotiations, with the advice of seven other Executive Departments, is responsible for trade agreement negotiations and for advising the President on foreign trade policy. Within these Executive Departments, the Bureau of International Commerce and the Business and Defense Services Administration in the Department of Commerce; the Bureaus of Economic Affairs, of International Organization Affairs, and the various regional Bureaus in the Department of State; and the Oil Import Administration in the Department of the Interior are particularly concerned with foreign trade in the energy field. The Department of State has primary responsibility for advising the President on the foreign relations of the United States, including those aspects of energy policy which impinge on our relations abroad. The United States Tariff Commission, an independent agency, investigates and reports on the effects of tariffs and foreign trade.

International monetary and balance of payments problems, which always have potential bearing on trade in fuels, are primarily in the domain of the Treasury and Commerce Departments. The Treasury Department, particularly the Internal Revenue Service, also enforces and advises on tax laws and regulations.

Stimuli and aids to economic growth and development, which often directly involve energy or energy industries, are offered in many ways by the Federal Government, but several organizations have rather direct responsibilities in this area, including the Business and Defense Services Administration and the Economic Development Administration in the Department of Commerce, and the Appalachian Regional Commission and the Small Business Administration, both independent agencies.

In the broad area of social policy relating to energy, safety regulations in coal mines are administered by the Bureau of Mines, and labor regulations affecting all the energy industries are administered by the Department of Labor. The U.S. Public Health Service is

responsible for research and control programs on environmental health (including air pollution), the newly formed Federal Water Pollution Control Administration in the Department of the Interior has similar responsibilities for water pollution control, and the Atomic Energy Commission has jurisdiction over the safety of nuclear installations and the control of radioactive wastes. The Coast Guard in the Treasury Department and the Corps of Engineers enforce domestic statutes implementing responsibilities agreed to in the International Convention On The Prevention Of The Pollution Of The Sea By Oil, 1954, as amended in 1962.

The United States Government is itself a large user of energy, particularly in its military services, and its procurement and use policies are often of considerable importance in the national picture. The Departments of Defense, Army, Navy, and Air Force, the General Services Administration, and TVA, which is the Nation's largest coal customer, are the agencies most concerned in this area.

As a last function in the energy field, let me name one of the most important--the collection of statistics and other information on all aspects of energy. Many of the agencies I have mentioned collect and publish statistics on various aspects of energy, but those most directly involved are the Bureau of the Census in the Department of Commerce, the Bureau of Mines in the Department of the Interior, the Federal Power Commission, and the Interstate Commerce Commission. The Bureau of the Budget is responsible for coordinating Federal statistical services.

State and local governments

State and local governments also exercise considerable authority over the energy-producing industries in the United States, particularly in the areas of conservation, utilities, taxation, and air and water pollution. Their procedures and policies are not uniform, of course, and I cannot attempt to name individual organizations. But I will describe briefly their principal functions.

Nearly all states have conservation laws that limit the spacing and rate of production of oil and gas wells in the interest of maximum and most efficient recovery. In addition,

many states attempt to prevent above-ground waste and to stabilize prices by limiting production to market demand. The Interstate Oil Compact Commission, composed of the Governors of nearly all of the producing States, attempts to promote conservation of oil and gas and cooperation between the states in the solution of mutual problems.

Many states have commissions authorized to license the development of hydroelectric projects, and nearly all states have commissions to regulate rates for the sale of gas and electricity. Many local governments, particularly in the few states that do not have power commissions, also control electricity and gas rates, and they also are generally responsible for construction codes and zoning ordinances that control many aspects of local energy manufacturing and distribution systems.

State and local governments obtain a significant portion of their tax revenue from the energy industries, generally through property and gasoline taxes, but in some cases also through some type of direct severance tax on extractive industries or on the product.

State and local control over air and water pollution and other potential damages to health and environment varies greatly but is increasing in the overall. Many of these regulations

are direct in their control of noxious wastes, but zoning and construction codes also are sometimes designed to minimize damage to health or environment.

Many states, particularly those in the west, own land and mineral rights and hence have laws and regulations governing their lease or sale. Some hydropower is produced by the States. Numerous municipalities own and operate power distribution systems and some generate their own electric power as well.

While some overlap between Federal, State, and local authority is inevitable in the energy field, there is some attempt to coordinate the two. The Connally Hot Oil Act, prohibiting interstate shipment of oil produced in violation of State conservation laws, is an example of a Federal law that underpins many State policies in the field of conservation and provides a basis for some coordination of Federal and State policies. And section 274 of the Atomic Energy Act, authorizing the AEC to enter into agreement with the States to transfer its regulatory authority with respect to byproduct materials, source materials, and special nuclear materials in quantities insufficient to form a critical mass, is an example of legislation providing for a division of responsibility in the regulatory field.

BROAD OBJECTIVES OF ENERGY POLICY

These various Federal, State, and local government organizations often act independently and on an ad hoc basis in setting or influencing policy in their respective parts of the energy field, but their actions are motivated by the broad philosophies I have already described. More particularly, they are motivated by objectives that, although not set forth in law or any official manifesto, are broadly held and understood throughout government. These objectives are essentially those outlined in the OECD Energy Committee's 1966 report on Energy Policy: Problems and objectives, as follows:

1. To assure adequate and diverse supplies of energy--sufficient for continued economic growth, dependable under emergency and non-emergency conditions, and diverse in both source and form.

2. To assure the lowest possible costs and prices consistent with sound business, labor, and conservation practices, with health requirements, and with national security and fiscal needs.

3. To manage wisely and productively publicly-owned energy resources.

4. To operate efficiently public businesses that involve the production or use of energy.

5. To help meet broader economic and social objectives, including achievement of internal and external budgetary objectives and the protection of health, environment, and other resources from damage resulting from the production and the use of energy.

Similar objectives are held by all OECD countries, but the measures and instruments of policy adopted by each country are a

response to its specific situation and problems, and these differ greatly from one country to another. Our own energy situation is different in many respects from most other OECD

countries, and although some of its elements are well known to you, it is desirable to outline it briefly as background for the description of policy measures to follow.

THE U.S. ENERGY SITUATION AND ITS PROBLEM-POSEING ELEMENTS

The principal trends in demand, use, supply, price and other features of the U.S. energy picture may be quickly sketched, as follows:

1. Energy consumption has increased during recent decades at an average rate of about 3 percent per year, and continued increase at a slightly higher rate will be required to support anticipated economic growth of at least 4 percent per year. Consumption of electric energy will increase at a faster rate than other forms--probably 6-7 percent per year.

2. The energy mix has diversified substantially in recent years and is still broadening. Twenty years ago about half our energy came from coal, about 34 percent from oil, and 14 percent from gas; now only about 23 percent comes from coal, 43 percent comes from oil, and 30 percent comes from gas. Nuclear energy barely furnishes 0.1 percent of our total requirements now, but about half the new generating capacity ordered this year by electric utilities has gone to nuclear plants, and nuclear energy will soon be an important contributor. By 1980 the generating capacity of nuclear stations will probably be 100,000 MW or more, 17-18 percent of the total generating capacity. In parallel with increasing diversification in source, there has been a marked increase in the interchangeability of energy, with the result that both primary and secondary forms compete with one another in nearly all of their markets except transportation, which is almost entirely supplied by liquid fuels.

3. The use of energy also has diversified and continues to do so. Whereas a century ago inanimate energy was used mainly for home heating, cooking, smelting, brick making and a few other purposes, its use now extends to every industry, and its availability has made possible whole industries that did not exist before. New uses are still coming, and, of

course, the extent of mechanization and automation is still broadening in most industries.

4. During this century the average price of energy in constant dollars has decreased substantially, but in the last two decades only electric power, coal and nuclear energy have decreased in price; crude oil has risen about 23 percent, and natural gas has nearly doubled. The price increase for natural gas largely reflects its shift from a by-product disposed of locally to a principal product distributed and marketed nationally.

5. Increased production, decreased prices, and diversification in source and use have been made possible by steady technologic advance, one of the net effects of which has been to increase the invested capital and decrease employment throughout the energy industry. This effect has been particularly pronounced in coal mining, an industry that in 1920 employed about 875,000 workers and now employs only about 150,000 to produce very nearly the same amount of coal. At times unemployment has been widespread, but growth in other industries--construction, for example--has helped to absorb displaced workers, and Federally supported regional development and assistance programs have helped bring about the necessary readjustments.

6. The geologic terrane of the United States is diverse, and known and potential resources of all of the mineral fuels are extensive. Reserves of low-cost uranium ores are expected to be adequate to meet presently foreseen requirements. The development of advanced reactors, including the breeders expected to be available in the late 1970's, will unlock the essentially limitless energy from the enormous uranium and thorium minable at higher but still acceptable costs. Known minable resources of coal are more than adequate for foreseeable needs. Potential resources of oil and gas are believed

to be adequate for several decades, but proved reserves, as estimated by the American Petroleum Institute, are more limited and represent only 10 and 17 year supplies respectively at current rates of consumption. Presently, however, crude oil is available from several foreign sources at prices lower than it can be marketed from many domestic sources. In Venezuela, for example, crude prices are of the order of \$1.80 a barrel, compared to U.S. prices of around \$2.90 a barrel.

In addition to these conventional sources of energy, the United States possesses enormous deposits of oil shale, which can be processed to yield either oil or gas, and there are also potentially significant deposits of oil in bituminous rocks, smaller but similar to the Canadian tar sands. Shale-oil production is not yet economic, but it is likely to become so within a decade. In addition, processes for the manufacture of hydrocarbons from coal are under development; a pilot plant is under construction and there are good prospects for producing gasoline in the price range of 11 to 13 cents a gallon, which probably will be competitive in some areas.

7. As previously mentioned, all but a small percentage of the production and marketing of energy in the United States is undertaken by private enterprise. The energy industries are large and vigorous, both in terms of companies and sectors. Three of the energy industries--electric power, oil, and gas--are among the six U.S. industries with the largest gross capital assets. Generally, the companies are structured around a single commodity--oil, electric power, coal, etc.--but there is a tendency now for the larger oil companies to diversify into other fuels, other minerals, and other chemicals. As is often the case in industries of all kinds, there are numerous small companies in nearly every phase of the energy industry, but a much smaller number do the bulk of the business. There are about 10,000 oil companies, for example, but 30 produce about 65 percent of the total and account for 85 percent of refining and marketing; the others, however, are responsible for about 70 percent of the well completions. Many of the larger oil companies

are also active in world exploration and production.

8. Science and technology, of course, are the foundation for the industrial society in general and the modern energy industry in particular, and here again we are fortunate to have numerous and vigorous research and development establishments in the academic world, in private industry, and in the Federal Government.

9. The Federal and to a lesser extent State Governments also are large land-holders. Approximately 34 percent of the total land area of the United States is Federally owned, and the mineral rights to an even larger area, including the outer continental shelves, are also under Federal control. Under the mining laws, many mineral deposits, including uranium, can be claimed by the discoverer, but oil, gas, oil shale, and coal are among the so-called leasable minerals that are leased to entrepreneurs, often under competitive bidding. Many waterpower sites are also publicly controlled. Publicly-owned energy resources are a substantial part of the total, and although government is seldom a producer, in its role as a landlord it is an important part of the energy industry.

10. The production and use of energy in the United States have become so large that they are modifying our total environment in ways that adversely affect other resource values and public health as well. Air pollution from unburned carbon, hydrocarbons, and sulfur dioxide is substantial in many industrial areas. Thermal pollution from power production is becoming a problem in some areas, and stream pollution and damage to land and scenery from mining are substantial in the eastern part of the country.

These, then, are the highlights of the current energy situation in the United States. To a considerable extent it is the product of policies long in effect, but it also is the soil in which are germinating problems for future policy development. In discussing policy measures, I will describe first those already in effect, but I will return later to the problem-posing elements of the present situation that may require action in the near future.

CURRENT MEASURES AND INSTRUMENTS OF ENERGY POLICY AND THEIR EFFECTS

Current measures and instruments of policy may be described in terms of the broad objectives already outlined.

Actions to assure adequate and diverse supplies

The Federal Government acts in many ways to assure that adequate and diverse supplies of energy will be available for both present and future needs. With regard to indigenous sources, its basic mining law, permitting private ownership of minerals, is designed to reward those who discover and produce minerals, and the Federal leasing regulations are generally designed also to encourage and reward private initiative in mineral exploration and production.

Regulations and laws that permit the expensing of exploration costs in Federal income-tax returns are specific encouragements, and even more specific were the bonuses offered a few years ago for the discovery of uranium deposits. Depletion allowances, which permit the producers to deduct from taxable income a percentage of current income as representing the early amortization of a wasting asset, are substantial for oil and gas and for fissionable materials (27-1/2 and 23 percent, respectively, of gross revenue but limited to 50 percent of net revenue). One of their indirect effects is to encourage exploration, and they provide the means to regenerate quickly the capital required to find and develop new reserves. Another major incentive offered to the petroleum industry--and one somewhat greater in its total effect than the depletion allowance--is the deduction for intangibles, which permits the producer to write-off in a single year drilling and development costs that would otherwise have to be capitalized. Both the depletion allowance and the deduction for intangibles are controversial provisions that have been challenged many times, and doubtless will continue to undergo review.

Through its geological surveys and minerals research, the Federal Government for nearly a century has attempted to facilitate exploration and aid in mineral development by making available to the public knowl-

edge about the distribution of rocks and minerals, and by helping to develop principles, tools, and methods useful in prospecting, mining, processing, and utilization. In times of emergency, the Federal Government itself has also undertaken exploration for certain minerals, notably uranium, making the results available for private initiative to pursue. This form of Government support is insignificant now, but Government supported R&D directly focused on energy currently amounts to about \$350 million annually out of a total for both Government and industry of about \$1 billion. Even larger amounts are spent by both Government and industry on R&D that bears indirectly on energy development and use. Most of the Government expenditure is for nuclear energy and for some of the new forms of conversion and uses, such as magnetohydrodynamics, thermionics, and the fuel cell--all of which will add to efficiency of energy utilization. But about \$50 million is for R&D that will assist the conventional fuel industries. In recent years, for example, Federally-supported coal research has been much stepped up to help keep the domestic coal industry viable in the face of mounting competition from other sources.

There is no fixed policy governing the focus of Government-sponsored R&D, but in practice it adheres pretty much to the philosophy expressed by President Lincoln to the effect that Government should do for the people what the people cannot do for themselves. Most of it is directed toward problems that are too large, complex, and costly for private enterprise to attack, or that industry would be unable to surmount with sufficient rapidity, or that provide no profit incentive for industry in the near term. In the field of nuclear energy, for example, the initial R&D on the light water reactors was largely sponsored by the Federal Government. Now that they are being installed commercially, Government-sponsored R&D on nuclear reactors has shifted to the advanced converters and to the breeder reactor.

In the field of conservation, the Federal and to an even greater extent the State Governments attempt through both research and

regulation to extend indigenous resources by preventing waste in mining and improving the percentage of recovery of minerals in mining and processing. Nearly all states, for example, have statutes that control the spacing of oil wells, are attempting to encourage unitization, make provision to limit production to the most efficient rate, and make every effort to reduce the volume of gas flared or vented to the atmosphere. These measures have had considerable effect in reducing waste, but there is room for further improvement. The scope of field unitization, for example, is still small and although efforts to unitize are on the increase, it is difficult to accomplish in old fields.

Generally, the Federal Government has chosen profit incentives and capability development through R&D as the means of encouraging domestic industry, rather than straight regulatory treatment. As many of you know, the decline of the coal industry in the decade and a half after World War II was painful, and was accompanied by a substantial social cost that might have been reduced had direct protective measures been adopted. But there is no question but that the American consumer and the coal industry itself are both better off as a result of the adjustments and efforts to help it stand on its own feet.

The notable exception to this generalization about protective measures are the import restrictions applied since 1959 to petroleum and its products. Oil transported by overland means from the country of origin is now included in the permissible level of imports, although it does not need to be licensed. Presidential approval is required for pipelines that cross our international boundaries. In District V--which includes Hawaii, Alaska, Washington, Oregon, California, Nevada, and Arizona--imports are limited to a level estimated to represent the difference between domestic supply and demand; east of the Rockies, in Districts I-IV, they are limited to a level of 12.2 percent of estimated production of oil and natural gas liquids in those areas. Products other than residual fuel oil are included within the respective levels in both Districts V and I-IV and are restricted to the quantities imported in 1957. On April 1, 1966, the regulations governing the allocations of residual

fuel oil were modified, with the practical effect of eliminating the restrictions on imports on the East Coast, the area in which virtually all of the imported residual fuel oil is consumed.

The restriction on imports was imposed by the President under the Trade Agreements Act of 1955 and extended in the Trade Expansion Act, which authorizes him to impose quantitative restraints on imports if they threaten to impair national security; his decision followed a finding to that effect by the Office of Civil Defense Mobilization (now Office of Emergency Planning). Although the measure is protective, its intent is not to protect the industry for economic or social reasons, but to protect production capacity for security reasons. You may recall that President Eisenhower remarked when he issued Proclamation 3279 that it was not only the security of the U.S. but of the Free World at large that was at issue; this observation is still germane.

There is also a small duty imposed on oil, and a rather substantial one on products other than residual fuel oil. Neither have had any appreciable effect in discouraging imports.

While foreign oil currently poses a problem because it can be imported at considerably lower costs than oil can be produced from some domestic sources, it is interesting to note that its availability is in part a consequence of Federal policies. United States oil companies have been energetic in foreign exploration for many years. The Federal Government has encouraged their activities by attempting to maintain and develop mutually beneficial trade and investment relations with oil-producing countries. There are strong advantages--national security and otherwise--to having a viable domestic industry, but important economic and security benefits stem also from a well-developed foreign supply, particularly one that is well diversified in source and ownership. The other sources of oil in both hemispheres--distributed in many friendly countries and produced by many different companies, most of which also have holdings in more than one area--add much to the security of supply for the United States. The diversity of these same sources also helps create security of supply for all the nations of the Free World. In spite of the,

thorny problems involved, our security and yours is strengthened by the double-barrelled support of a United States and a world petroleum industry.

Stockpiling is an important security measure in some countries, but because each of the industries producing conventional fuels in the United States has much excess capacity, with the exception of uranium the U.S. Government itself does not possess a stockpile of fuels. Because of its military significance, private ownership of nuclear fuel was initially forbidden and the Federal Government purchased all ores produced. Legislative modifications now permit private ownership of all types of nuclear materials. The Federal buying program will cease in 1970, and leasing of enriched uranium will be terminated in 1973. Beginning in 1969, the Federal Government will enrich uranium on a toll basis, but domestic industry will be required to furnish its own supply of raw material from domestic sources. The service will also be available to foreign industry furnishing supplies from either U.S. or foreign sources.

Private industry maintains some stocks of the other fuels, but more important is its excess production capacity. It is a conservative generalization to say that the installed facilities are capable of producing 25 to 30 percent more oil, gas, and coal than are being produced now. Excess delivery capacity is normally in a lower range, of course, but diversion of facilities from other uses would provide flexibility for rapid expansion under emergency requirements. Both domestic production and transport capacity for oil are adequate to support refinery operation at full capacity.

Standby petroleum producing capacity is also maintained by the U.S. Navy for both military and civilian emergency use. The Navy holds title to four petroleum reserves and three oil shale reserves. The petroleum reserves contain 1.2 billion barrels in the proved category, and one of them--Elk Hills, California--has 1,055 existing wells capable of producing about 175,000 barrels a day.

The problem of future producing capacity is of continuing interest and concern to the Federal Government, and through periodic analyses of production capacity made at its request by the National Petroleum Council,

and through its own studies, the Government tries to anticipate problems that may call for action some years in advance. There is some ground for concern now, for example, about future petroleum-producing capacity and Secretary Udall has called for an analysis of future supply that, depending on its outcome, may lead to the formulation of some new policies. Also underway is a study of ways and means to improve petroleum statistics--to make them serve more fully the needs of both government and industry in analysis and planning--and both production capacity and reserves are among the kinds of information we hope to improve.

An essential element of supply is to have it where it is needed, and an adequate transportation system is therefore a prerequisite for security of supply. As in other fields, the Federal Government leaves to private industry the operational function, but it takes responsibility for preparatory functions that are too complex, too costly, or too diffuse in their benefits for industry to undertake. For example, it prepares and maintains the inland and coastal waterways, and State and Federal Governments jointly or separately construct the highway system, and provide for rights of eminent domain for most railroad, pipeline, and power transmission facilities. Through land grants, the Federal Government stimulated the early development of the transcontinental railway system. The Federal Government also has made important contributions to maritime transport through subsidies, protection, and R&D, and its R&D contributions to electric-power transmission have been highly important. Congress recently passed legislation authorizing R&D on highspeed rail passenger transportation that may pave the way for improved freight transport also. Its current recognition of the importance of efficient transportation facilities of all kinds is manifested in the recent establishment of a Department of Transportation.

Actions to reduce costs and prices

Measures to increase security of supply often increase rather than decrease costs, but those that increase supplies by increasing the sources and the usable forms of energy by advancing fuels technology work also to

decrease costs and prices, for they broaden and intensify competition and take the pressure of scarcity out of the energy market. The abundance and relatively wide geographic production of oil, gas, and coal resulting from vigorous exploration, for example, have kept natural scarcity from being a major factor in price in the United States, and have helped to keep down transport as an element of cost. The development of technology to transport gas, and hence to use it effectively, not only added to supply but added a competitor to the market, and of course the R&D that has brought nuclear power to the energy market has not only much increased energy supplies, but will also reduce costs of electric power. And countless advances in all aspects of fuels technology--improved efficiency of mining, drilling, thermal power generation, and so on--have both enlarged supplies and reduced costs.

Primarily these are benefits from the advance of technology, but they are translated into reduced prices to the consumer by competition, and competition in turn acts to stimulate R&D. Three kinds of competition may be distinguished: one is interarea competition, another interfuel competition, and the third intrafuel or, more properly, interorganizational competition. All three have been extremely valuable in the United States, and under the aggressive initiative of private enterprise they have interacted to yield some notable reductions in prices. Most of the gain has come as the result of the work of industry, but the Government has contributed by creating a climate favorable for private initiative and by its support of R&D, much of which is specifically designed to reduce costs. For example, the purpose of developing the breeder reactor is to extend the low-cost supply of energy from nuclear fuels, thereby assuring the continuing availability of low cost energy, as well as conserving supply.

Once competition develops, the problem is to maintain it, and this has been done in the United States in intrafuel competition by anti-trust legislation and regulation to prevent monopoly. The anti-trust laws apply to industry in general, and not just the energy industry, but it is interesting to note that one of their first major applications was to early practices in the oil industry.

In addition to maintaining intrafuel competition through anti-trust measures, the Federal Government has added some competition of its own in the field of electric power production and transmission through the operations of the Tennessee Valley Authority, the Corps of Engineers, the Department of the Interior, and the Rural Electrification Administration. Their product is only a small part of the industry's total, but they are efficiently operated and have had an important effect in providing competition by comparison.

Anti-trust regulation has less scope in maintaining interfuel competition, and for this either protection, which is self-defeating, or technologic advance is required. As already indicated we have chosen the R&D route to help the coal industry remain a viable competitor, and it is this approach, of course, that the coal industry itself is using. Because coal is the largest single source of revenue for the railroads, the railroad industry also has an important stake in helping to maintain the competitive status of coal. Its recent development of the unit train was a spectacular response to the threat of competition from the coal pipeline, and the railroad industry is attempting to further improve its position by similar means.

Although most of the long term progress in reducing energy costs and prices has come from the advance of science and technology in a climate favoring vigorous free enterprise, Federal, State, and local governments also regulate prices of products and services provided by industries operated as public utilities to protect the consumer against unfair pricing where this cannot be guaranteed by competition. The Federal Power Commission regulates wholesale rates of electric power and natural gas in interstate commerce, and State and local governments also regulate utility rates in areas of their jurisdictions. The Interstate Commerce Commission regulates transport rates for some forms of energy and because transport is an important element of final cost, it thus influences final prices. The objectives of all these organizations in controlling rates are to provide the consumers with a high standard of service at the lowest rates sufficient to attract the necessary investment capital and allow a fair return on it.

During World War II the Federal Government controlled prices throughout the economy as an emergency measure to prevent inflation. Such widespread controls are painful to our free enterprise philosophy and are avoided in peace-time. The Federal Government attempts to control inflation, however, through its influence on interest rates, as well as through taxes and Federal spending. There is another important instrument of policy that is brought to bear on this problem, namely persuasion. It has been used effectively by President Johnson in helping prevent or delay price increases in steel and other basic commodities, and is sure to play an important continuing role in the Administration's efforts to control inflation.

The well-spacing and unitization regulations of many states have helped to reduce costs of oil and gas production and have had some indirect but nevertheless beneficial affect on prices. Unitization, if it could be achieved on a broad scale, could bring about a further substantial reduction in costs, with attendant affects on prices.

In discussing policies intended to reduce costs and prices, it is only fair to report measures that have the opposite effect. The most common, of course, are above average taxes, but I am glad to say that in the United States energy is not generally heavily taxed. Motor fuel taxes might seem at first glance to be an exception, for the tax is nearly equal to the wholesale price, but inasmuch as 93 percent of the revenue so obtained is used to support highway construction and maintenance such taxes are essentially a user charge. Other kinds of taxes, of course, add to costs and prices but because of the depletion and expensing allowances their net effect is somewhat less than the effect of taxes on other kinds of products.

Of more importance in the United States than taxes in influencing costs and prices, are various protective measures that chiefly affect crude oil. It is not possible to estimate their combined effect accurately, for there are offsetting and counterbalancing effects, many of which are intangible.

One of these measures is intended to protect shipping, but it has the effect of increasing costs and prices of oil moving from Gulf to East Coast ports by requiring that it

be carried in relatively high-cost American Flag tankers.

The two protective measures applied directly to oil are prorationing and import restrictions, and their main effects in raising costs and prices are to introduce an element of scarcity into the market and to allow high-cost wells and fields to remain in production. There are in the United States, for example, about 400,000 stripper wells that produce less than 10 barrels a day each, and average less than 4 b/d. They supply 20 percent of the total production, and tap pools estimated to contain about 23 percent of the total proved reserve. Not all of them are costly to operate, but in the aggregate they represent much of our higher-cost production.

Prorationing, practiced in several states, limits production to market demand. Although new fields are allowed some production, production from older and perhaps now higher-cost wells is maintained at the expense of what might be more efficient and less costly production. Prorationing supports prices at a higher level than they would otherwise be, and because it reduces the rate of return on investment, it also tends to increase prices. It is sometimes argued, however, that prorationing will prevent price increases in the long run because of its effect in conserving supply. This view is premised, of course, on an eventual shortage of oil from other sources, which we hope will not materialize.

The restriction on imports did not increase U.S. prices when it was imposed and prices have decreased slightly since. Nevertheless, the import program is holding prices at a higher level than they would otherwise be by protecting some high-cost production that would be displaced in a more open market.

It is difficult to assess accurately the consumer cost of both prorationing and import restrictions, for their effects are difficult to unravel and balance. For example, whereas economic benefits are sometimes cited as the result of the activities and taxes pyramided on a local and national industry that is larger than it would be if there were no restrictions on imports, the benefits from employment of the same capital and labor in other enterprise might be even greater. Difficult as it may be to determine the exact cost, however, it is certain that there is a substantial net cost.

and it is the price the Nation pays for this part of its conservation and security program. It is fair to say, incidentally, that while the import quota costs us something, it is of direct benefit to other OECD countries as well as the United States. We count this as one of its intangible benefits, for our own security is enhanced by the availability to other countries of an adequate supply of energy at reasonable prices.

In addition to policies that add to costs and prices, it is worth identifying another category of things that also have the same net effect, namely, things that we know how to do but are not doing. My predecessor, Mr. John Kelly, well known to many of you from his active participation in this Committee, use to say that we could much reduce costs in nearly all fields if we would only use fully the knowledge we already have. In the competitive world of most of our energy industries, usable knowledge isn't exactly buried in dust, but most producers admit that there is room for increased efficiency in their operations. The unit train, which brought startling reductions in the cost of coal transport, didn't require fundamental technical innovations, for example, and could have been introduced many years earlier; and now that we have the concept we have been slow in adopting it, for only a third of our coal is being moved by this means now. In another area, we know that substantial savings in costs remain to be achieved through unitization. There are many obstacles to attempting it on a wide scale, and both the Federal Government and the States have been reluctant to press for forced-pooling, particularly in older fields. But the potential savings are there nevertheless and no doubt we could realize more of them. Without multiplying examples, it is fair to say that by streamlining and improving policy measures and practices we could substantially reduce costs and prices in each of the energy industries.

Even though ground is still to be gained, the net effect of the policies and other factors that influence energy prices has been to give the U.S. consumer reasonable prices, lower, in fact, than prevail in most other industrialized nations.

Management of publicly-owned resources

The Federal Government's role as a landlord is a large and important one for all sources of energy. About 10 percent of total oil and gas production comes from public land, and with the growing importance of the outer continental shelf the percentage is increasing. Production of coal from public land is a lower percentage of the total, but a substantial part of the U.S. coal resources, particularly in the West, is on public land. The Federal Government also controls about 80 percent of the oil shale reserves.

Development and production of mineral fuels from the public land is controlled by leasing laws and regulations, under which acreage is offered for competitive bidding on a lump sum payment or bonus for control of the lease, or is leased non-competitively, depending on the extent of knowledge of the deposit involved. The lessee pays a royalty on production. Production is supervised by the Geological Survey to conform with good conservation and safety practices. Where state regulations are applicable they are generally enforced also.

Generally, the leasing laws and regulations favor exploitation of minerals on the public land under the stimulus of market forces, and under conditions that encourage private exploration and development. The Secretary of the Interior, however, exercises discretion in offering lands for lease, and may refuse a request to offer a given tract for lease if he finds it is not mineral bearing or if the lease would interfere in some other way with higher public interest. He may withdraw lands from entry if he believes that leasing would prejudice wise development and use in the future. Revenues from lease sales and royalties are substantial--in fiscal year 1965 those from oil, gas, and coal amounted to \$249 million. Under the mineral leasing acts, 37.5 percent of the revenues are allocated to the State in which the lands are located, 52.5 percent to the Federal Reclamation Fund, and 10 percent to the Federal Treasury; in Alaska 90 percent goes to the State. All lease receipts from Federally-owned offshore oil and gas go to the Federal

Treasury. In some areas there is dispute over the exact position of the boundary between the inner continental shelf, title to which lies in the State, and the outer continental shelf, controlled by the Federal Government; revenues from the disputed lands are being held in escrow pending the outcome of litigation.

In spite of the size of the revenues, stewardship of the public lands is guided by broader or longer range considerations than desire for direct revenue. It has been recognized from the start that the most important contribution of public resources is to general economic development and growth, and although leases are sold and royalties collected, direct revenue is secondary to more important considerations relating to national economic welfare.

Operation of other public business involving production and use of energy

The management of the public land is public business of a substantial order of magnitude, but there are three other kinds of business in which the government is engaged that involve energy: in one, it is an energy producer and wholesaler, in the second it is an investor, and in the third it is an energy consumer.

Aside from minor production of oil from the Naval petroleum reserves, the Federal Government's activity as an energy producer is in the generation of electric power, mainly from hydroelectric projects, but in the Tennessee Valley also from thermal plants. There are about 125 Federal power-producing projects, but nearly all of the product is marketed by TVA and the four power agencies of the Department of the Interior. Although about 40 percent of the Nation's hydroelectric power is generated by the Federal Government, the Federal Government produces only about 13 percent of the total electric power and only about 3 percent of the total energy requirement.

In nearly every field, the Federal Government attempts to undertake only those projects that are in the public interest, but that are too long range, too large, or too complex for private enterprise, and in the main it is

this principle that guides the Federal Government in its participation in the power field. Most Federal power projects are multipurpose ones in which the generation of power itself may be secondary to a combination of other objectives, such as navigation, flood control, conservation, recreation, or, more broadly, basin development. Government performs a highly important local and sometimes regional service in its power generation and transmission and an important nation-wide service in its competition by comparison, but its purpose is to complement private enterprise in multipurpose water development projects rather than replace private enterprise in the electric power field. Moreover, in 1959 it reduced Congressional responsibility for its largest electric power system--TVA--by putting it on a self-financing basis, and authorizing it to obtain funds in private capital markets by issuing revenue bonds; TVA is required to pay a return on the Federal appropriation investment at a rate equivalent to the average rate of interest paid by the United States on its outstanding marketable debt, is required to repay the bulk of the appropriated investment, and makes payments in lieu of taxes to State and county governments. It is thus essentially in transition to a public cooperation.

The Federal Government is, of course, a large investor in its own power operations, but through its rural electrification program it is also an investor in other power systems through low-interest loans (2 percent per annum) to cooperatives, investor-owned utilities, and public systems willing to serve the rural market. The REA program has been highly successful; there are now about 1,000 consumer-owned cooperatives participating in its program, and they serve nearly 8 percent of the Nation's retail customers for electricity. Initially, loans were restricted to communities of not more than 1,500 people without central station service, and although some cooperatives now serve larger communities, they still have a comparatively low customer density.

Many state and local governments also produce and/or market electric power. They have about 10 percent of the Nation's generating capacity and serve nearly 14 percent of its total retail customers. Some are very large, but number-wise they are decreasing--whereas there were more than 3,000 non-Federal

but public systems in the early 1920's, there are only about 2,100 now.

With a current annual budget of about \$135 billion for purchase of goods and services, the Federal Government is naturally a large consumer of energy, and is, in fact, the Nation's largest customer. In most of its operations, it functions as any large concern--buying energy from the lowest bidder, using it by the most efficient practicable means, and by reason of its dispersion not influencing energy policy or the energy market to any appreciable extent. Some of the Government's consumer requirements for energy, however, are large enough to influence market forces and to serve as an instrument of policy if necessary. Thus, the purchase program of the Department of Defense has been influenced recently by balance of payments problems, and TVA's coal purchasing program has had a substantial influence on the price of coal and the structure of the coal industry.

In all of its business functions in the energy field--ranging from management of public resources to the generation and transmission of electricity and the development of military logistic and weapons systems--the Federal Government must develop and apply the most efficient technology possible. Aside from its motivation to support R&D for the public good, its own business functions require it to be aggressive in its pursuit of science and technology. Many of the most significant developments in the field of energy have come as a result of R&D applied to government's specific problems. Nuclear energy is perhaps the most spectacular example, but it is only one of many.

Energy policies designed to help achieve broader social and economic objectives

Energy policy is the servant of broader economic and social objectives. Apart from policies designed to provide an adequate and secure supply of energy at reasonable prices, and apart also from Government's concern with energy in the operation of the public business, there are many energy policies that serve these broader economic and social objectives.

Financing the national budget is one of these broader objectives, and inasmuch as the energy industries are among the Nation's giants, it is natural that they should provide a substantial tax revenue. This they do on an essentially proportionate basis with other industry, but, as pointed out earlier, energy is not selectively taxed to any significant extent in the United States as a commodity subject to an inelastic demand; in fact, the depletion and expensing allowances give the fuel production industries a lower tax rate on the whole than most other industries. The policy not to tax energy selectively is a traditional one in the United States, and it fits well with the philosophy of the Administration in recent years to tax at a low enough rate to stimulate the growth of taxable income. Energy is one of the geese that lay the golden eggs of industrial expansion and we have no intention of discouraging its growth.

Balance of payments problems also plague the United States now, as they do many other countries, but even though oil imports are substantial we have resisted pressures to restrict them further, and indeed recently relaxed restrictions on residual oil imports. Considering the returns from foreign investments in petroleum, the export of petroleum equipment and products, and the major export earnings of the U.S. petrochemical industry, our trade in oil makes an important contribution to our balance of payments.

Rather than attacking balance of payments problems by reducing energy imports, we are placing more emphasis on exports. Manufactured petroleum products, coal, and nuclear power plants accounted for exports valued in 1965 at \$413, \$494, and \$40 million respectively, and we hope that the return from all of these exports, and especially coal, will continue to increase. The nuclear fuel enrichment service to be offered soon should also provide a growing source of foreign payments. Some of you have questioned our ability to sustain increased exports of coal over a long period, but let me assure you that we can meet expanding requirements for both internal consumption and export far into the future. As shown by a recent survey, producers have in their areas of current mining and development 20 billion tons of high quality coal marketable at present prices. Known deposits in the

same cost and quality range contain about 200 billion tons, and total coal resources are more than 3 trillion tons. The industry now has excess annual mine production capacity of about 125-150 million tons a year. We exported 50 million tons in 1965 and believe there would be no difficulty in expanding our export capability to 300 million tons a year by 1980, assuming there are the long-term contracts needed to justify expansion of mine and transport capacity. With the pressure on the coal industry to increase its efficiency, prices should go down further, and the same may be said about nuclear plants.

Continued economic growth is another broad economic objective of the United States Government. As with tax policy, energy policies have long been geared to this goal--exploration, development, and use of energy have all been encouraged, and these policies are continuing. Regional economic development is receiving special attention now in depressed areas, such as Appalachia, and it is recognized that the development of some of them may be quickened by industrialization based in large part on the use of indigenous resources of minerals and fuels. The Office of Regional Economic Development in the Commerce Department has recently been formed to spearhead development in these areas, and means of stimulating the use of local fuels as a platform for industrial growth are under review.

Whereas energy policies that aid in achieving most of the broader economic objectives have been developed for many years, policies to support some of the broader social objectives--particularly those of safeguarding public health and protecting the aesthetic qualities of the environment--are undergoing rapid development. Concern over health and safety in direct connection with mine and plant operation and with the transportation and use of energy, of course, has long been reflected in Federal, State, and local regulations and codes. But this traditional concern with health and safety for the individual immediately involved is now being much broadened to include concern for damage to other resources and to the health of the local or national population as a whole. For some problems--air pollution, for example--this timing reflects their late development and

recognition, for it is only in recent years that they have become significant. For others, however, the delay in concern represents a shift in values. In developing a new land from a raw frontier over a relatively short period, the prime concern of the American people was for material values, for economic betterment. Our efforts went toward building a good house and acquiring a good livelihood, and we gave little thought to our effect on the environment as a whole. Now that the house has been built, and perhaps even abandoned for an apartment, we see that we have created a bit of shambles in our rush for material advance. We are therefore setting about the task of cleaning up, and we are trying also to reach a balance in the use of our resources and environment that will enable us to continue to progress economically without destroying the quality of our environment.

During the last few years the Federal Government has passed a Clean Air Act, a Water Pollution Control Act, and a Solid Waste Disposal Act, and recently Congress passed a \$3.6 billion appropriation to assist cities and States in reducing water pollution. Nearly all of the States now have some legislation regulating the discharge of air and water pollutants, including thermal pollution. Some States also have or are developing regulations regarding restoration of the surface of land mined by open-cut methods and the Federal Government has underway several programs directed toward means of preserving land and scenery. Private industry is responding to the need for pollution abatement by attempting to develop means not only to reduce damage to the environment, but to do so at a cost that does not raise the price of its products. As I will indicate later, however, much remains to be done to develop a technology that makes it possible to use our resources and environment effectively and efficiently without damage to other values.

As I mentioned previously, the Atomic Energy Commission is responsible for enforcement of safety regulations governing nuclear materials and facilities, and the Federal Government is also backstopping the reactor insurance program. The first \$74 million of the insurance required on a given facility is handled through a pool of insurance companies, and further indemnity for an

additional amount, up to a total of \$560 million, is provided by the U.S. Government. Even though the ceiling figure of \$560 million limits specific Government obligation, the Federal

Government characteristically provides various forms of disaster relief and presumably would do so in the event of larger catastrophe.

FUTURE POLICY PROBLEMS

Although the de facto U.S. energy policies must be judged, de facto, to be highly successful on the whole, almost every part of the energy field is alive with problems and issues, and it would be difficult to find an area in which existing policies or regulations are considered wholly satisfactory. For commodities that play a dynamic role in a dynamic economy in a democratic nation, it is inevitable that this be so. Change in general is both the cause and effect of economic growth, and the same may be said of changes in policies.

Some of these unresolved problems have been identified in the preceding description of energy policy, but many of them are inter-related, and it is desirable to put them into perspective. For this purpose, five groups of problems deserve summary: 1) maintaining the viability of the domestic energy supply industries; 2) public lands; 3) environmental pollution; 4) transportation and marketing problems; and 5) need for improvement in the means to develop and coordinate energy policy.

Maintaining viability of domestic supply industries

In the area of supply, our problem is not how to obtain adequate or diverse supplies, but how to maintain the viability of the domestic production industries--how to have the benefits of continuing interfuel and interarea competition without defeating any of the competitors. Depending as we do on these forms of competition, this is a problem that we bring on ourselves, for if the competition is vigorous enough to accomplish its purpose, some of the competitors are bound to be pressed hard, and may lose out. There is no value in a pseudo competitor, propped up like a dummy by artificial supports, and we have no interest in maintaining obsolete industries. There is great value, however, in maintaining a full field of viable domestic energy industries,

and this we are anxious to do. For the next decade or so it appears that each one of the domestic energy industries may be faced with some difficulties in maintaining its competitive status, and the problem of maintaining their viability is therefore one of the principal ones confronting energy policy. Let me review briefly the status and prospects of the domestic supply industries, beginning with oil.

There is little question but that there are ample resources of oil in the ground to meet our needs for the next several decades, and at the present time there is much excess production capacity in the domestic oil industry. Nevertheless, the amount of exploration has been diminishing for several years, and the National Petroleum Council recently predicted that the annual rate of net additions to production capacity will diminish to about 50,000 barrels daily by 1970, compared to a recent average rate of increase of about 375,000 b/d. These trends are puzzling and may have one or more of several possible explanations. For example, they may stem from a desire on the part of the domestic industry to relieve itself of burdensome excess production capacity, or they may reflect a growing reluctance on the part of the domestic industry to invest in exploration in many parts of the country in the face of the availability of low-cost supplies from foreign sources, in the face of prospects for lower cost production from the outer continental shelf in the Gulf of Mexico, and in the face of possibly rising exploration costs.

Of less immediate concern to the oil industry but plainly on the horizon are good prospects for competitive production of gasoline from coal and of oil from shale; they will enter the market only gradually, of course, but when they materialize they will reduce still further the incentives for domestic petroleum exploration in many areas.

There is no likelihood, of course, that the domestic petroleum industry will be wiped out in the foreseeable future. Production costs

in many fields are low enough to meet any competition, and with discovery costs already incurred, advances in secondary recovery techniques are making it possible to greatly extend reserves without the necessity for additional exploration. The competitive elements and trends I mentioned, however, do pose the question as to whether or not the industry will continue exploration at a rate adequate to meet future needs.

As I indicated previously, oil imports benefit our security and trade, and it should be particularly stated that we are not seeking full self-sufficiency. Similarly, development of synthetic processes would also have many benefits, and we hope they will become competitive soon. At the same time, there are several valid reasons for wanting to maintain a vigorous domestic petroleum industry. For one thing, we wish to avoid the substantial social costs that trail the precipitous decline of a large industry. This in itself is not the prime consideration, however, for traditionally we have chosen to bear these costs in other industries that have declined as the result of technologic advance. Of more concern are the objectives of maintaining security of supply and maintaining domestic oil as a competitive string in the bow, even if some new synthetic strings should be added.

Natural gas is in a strong competitive position now, and, as with oil, its known and potential resources are large. Nevertheless, there are some clouds on the horizon also, for because much gas is associated with oil a decline in oil exploration probably would lead to a decline in natural gas exploration. Imports do not pose a problem now, but conceivably liquified gas from North Africa, Venezuela, or other areas where it is surplus to local markets, might be competitive eventually, and there is the strong prospect also that gas from shale or coal will become competitive in some areas within a decade or so. Intense competition is developing between gas and electric power in home heating and other markets, and this could be a limiting factor in the growth of the industry. As with oil, the concern is not with an immediate decline in the industry or even with the loss of gas as a commodity in the market, but with the possible future decline of the domestic natural gas industry.

The coal industry is also healthy and expanding now, but the rapidly developing nuclear power industry is challenging its long term future in electric power generation. As with oil, there is much low-cost coal that can be mined in the face of intensified competition, and successful development of the electrogas dynamic (EGD) process, in which a high temperature ionized gas operates in an electrostatic field to generate electricity with no moving parts, would help coal also. But nuclear costs are not going to remain fixed, and successful development of the breeder reactor--expected within a couple of decades--will bring them to an even lower level. Moreover, coal has an increasing burden to bear in the form of pollution abatement costs, and unless they can be brought to a very low range they will weaken further its competitive position. With the prospects for development of processes for synthesizing gas, gasoline, and other hydrocarbons and petro-chemicals from coal, there is not much reason to fear that the coal industry itself will seriously decline, at least over the long term, and even if the nuclear industry grows as rapidly as appears likely now, the consumption of coal in power production will increase for a decade or two--in fact, the nuclear industry itself estimates that coal consumption for power generation will increase from about 245 million tons a year now to about 500 million by 1980. But beyond some such period, coal may start to lose its competitive position in the power field.

To look now at the other side of the power-generation coin, the Federal Government has made strong efforts to bring nuclear energy to the market, and as just indicated its position and prospects appear to be firm and bright. Operations of installed nuclear power plants of the types now being sold have been very successful, but the economic expectations for the much larger plants on order remain to be proved in actual operation. If they should not be borne out, or if intensified competition from the coal and railroad industries should rapidly reduce the cost of coal, or if the EGD or other new processes in prospect for cheap power manufacture from coal should develop rapidly, it is possible that the growth of the nuclear industry would be less spectacular than now generally projected. Nuclear energy, as a spectre alone, has.

already served nobly as a competitor and has done much to reduce power costs in the stimulus it has provided the coal industry from the wings, but we want it on the stage itself as a full-fledged competitor in the energy market.

The future of hydropower also has its uncertainties. Only about 4 percent of our total energy requirements are met from hydropower now, and the prospects are that this percentage will drop substantially--perhaps to 2 percent or less--by 1980. Whereas hydropower is now both an important baseload and peaking source, it probably will be used mainly for peaking purposes in integrated systems within a decade or two, and for this purpose the demand for it will increase. Our potential hydro capacity is only about 30 percent developed now, but there is growing resistance toward the construction of dams in some regions, and only the more costly of the remaining hydropower sites are available for development. There is some question, therefore, as to whether or not the hydropower developments will keep pace with demand. Development of pumped-storage facilities and redevelopment of existing hydropower projects will help. For example, a third power plant is being installed at Grand Coulee which will increase the total installed project capacity from 1,974,000 kw to over 5,500,000 kw. Increases in the million kw range can also be obtained by development of pumped storage at many sites. But installations where changes of this magnitude are possible are limited, and a growing proportion of the peaking capacity may have to be provided from other sources, such as the gas turbine and older, less efficient steam plants.

Now, among all of these uncertainties concerning the future status of the domestic energy industries are many that could not be clearly foretold with the proverbial crystal ball, even if a good one were available. But the outcome of many others will depend on policies of the Federal Government. Specifically, the actions the Federal Government takes on oil shale, on offshore leasing, on research, on breeder development, on pollution abatement, on the disposal or development of hydropower sites, on import regulations, and other problems, will strongly influence

if not determine the outcome of many of these questions.

A strong case is sometimes made to permit questions such as these to be resolved by normal market forces, and the Federal Government has traditionally leaned in that direction. But the industries themselves do not favor this as a flat policy--the various oil producer associations, for example, favor the import quota and the depletion allowances. As has been amply documented in the description of current policies, the Federal Government has played an extremely important role in all of these matters in the past, and it certainly will play an important part in the future.

I will not attempt to predict what specific policies will be devised to cope with these problems in the future, except to say that as in the past we will probably depend as much as possible on the interactions of competition and technologic advance and as little as possible on protective measures.

Certainly there are still many opportunities for reducing costs through technologic advance in the exploration and recovery of oil, gas, and uranium, in mining and transport of coal, in abatement of environmental pollution, and in power plant design for both nuclear and fossil fuel operation. And improvement in prorationing and other regulatory procedures may also help maintain the viability of the domestic industries.

One of the prime objectives of energy policy as applied to the future is to maintain a high degree of flexibility in the way in which the Nation's needs for energy can best be met. Maintaining the viability of all the domestic industries for the next few decades will help preserve flexibility during the period when the effects of new developments are difficult to evaluate. There may come a time, however, when diversity in either source or form of primary energy is not so important as it is now. If, for example, technologic advances should make the breeder reactor the cheapest source of electric power, and if other advances were to make possible a nearly-all electric energy system, policies would change enormously. Inasmuch as the breeder would permit the use of thorium and of higher-cost but plentiful uranium ore, it would solve the security of supply problem. Air pollution.

problems would be eliminated or vastly reduced. And instead of placing so much emphasis on interarea and interfuel competition, attention would focus more on interorganizational competition and regulatory procedures.

How far off such an energy system may be is difficult to say now. The breeder reactor is expected to reach the commercial stage sometime in the 1970's, and the recent development of the air-metal battery, which may permit storage rates of 50 watt-hours or more per pound, rekindles hope in the practicality of the electric automobile, another key component in such a system. Two of the leading automobile manufacturers recently announced that they have prototypes, and there are bills pending in Congress now to authorize Federal research on it also.

More important than the questions of whether or when such an energy system might be developed, however, is the fact that its development and others that are conceivable are all permitted by the flexibility provided for in current policy.

Public lands

The Federal Government through its Public Land Law Review Commission is undertaking an extensive review now of its policies with respect to the public lands. There are some 5,000 to 15,000 laws that affect the public lands, and no doubt the work underway will result in a badly needed revision of public land legislation and policies.

Among the specific problems concerning fuels on the public lands, that relating to oil shale is perhaps the most difficult. The Federal oil shale lands were withdrawn from entry in 1930 to prevent speculative leasing that might complicate development or add to its cost, and this withdrawal has never been rescinded. Inasmuch as the privately held lands contain 150-200 billion barrels of shale oil, Federal land is not needed immediately to support development. In view of the enormous size of the Federal holdings, however, delay in decision as to how to handle them may introduce a factor of uncertainty that could affect investment decisions. There is no doubt that Federal land will be made available to support development of the oil shale

industry, but many difficult problems concerning lease size and procedure, and protection of other resources must be resolved before action can be taken.

One of the problems encountered on the oil shale land is illustrative of a broader and much more complex problem, namely the multiple use of resources. Some of the oil shale deposits have been found to contain dawsonite and other valuable saline minerals, and some of the oil shale lands also contain oil and gas at other horizons, recovery of which might be jeopardized by oil-shale mining. Similarly, some mineral-bearing lands also have non-mineral values--recreational or scenic resources, for example, that may be damaged in mining. There is a conflict of use also in some areas on the outer continental shelf, where shipping, fishing, and drilling may be mutually interfering. Some of these problems will no doubt have to be solved in different ways, but the basic challenge to the Federal Government is to find means to permit the multiple development and use of its lands and mineral resources without significant loss or damage to any of the component values.

Environmental pollution

The problem of environmental pollution is another one that poses difficult questions to government in the energy field, for the production, transportation, and use of all forms of energy causes many kinds of damage to other resources and to the environment in general. Laws and regulations controlling air, stream, land, and aesthetic pollution are developing rapidly and every one of the energy industries is faced with the need to modify some phases of its operation.

There are two problems here that are of particular concern to the Federal Government. One is to learn more about the origin and consequences of the hazards and damage to environment and health, to provide the understanding necessary to set standards. The other is to assist in finding abatement methods that do not increase the cost or restrict the use of energy. There is a temptation for those responsible for pollution control to simply shut down offensive sources, or to assume that the cost of abatement, if it is physically

possible, is wholly the producer's problem. It is much more than this, however, for if the other objectives of energy policy in particular, and of economic and social policy in general, are to be achieved we must continue to increase our consumption of diverse forms of energy, and have it at reasonable cost. Economic growth is a public goal. It will be the public that pays if the costs of the raw materials of growth increase, or if their availability is restricted, and it is in the public interest, therefore, to help find means of protecting environment and health that do not add to cost or restrict use.

There are rich opportunities here. Not only has it been possible to eliminate some sources of pollution and damage but in some cases to capture another product of economic value in the process. Sulfur dioxide in smelter gas and in sour gas is a classic example of a liability transformed to an asset, and there are several others that show that this type of solution is well worth the effort required to find it.

Transportation and marketing of energy

Problems in the transport and marketing of energy are often at the forefront in debates on energy policy, for it is in this area that government controls are often the most specific. The electric-power industry, the gas-marketing industry and some of the transportation industries must operate as public utilities, and government already controls rates and several other aspects of their operations. Several years ago, Government control in rate-making in the gas industry was extended to cover prices at the well head, and there is some possibility that the extent of government control may broaden still further in several directions.

The Northeast power blackout of November 1965 raised the question about the need for some kind of supervision of interconnected power grids. As their extent increases, it is certain that means will have to be found to protect the public from crippling failures. Federal systems are involved in the interties, and the Federal Government has played an important part in stimulating their development. The Federal Power Commission is currently sponsoring a wide range of studies

of the reliability of bulk power supply, and will issue its findings and recommendations shortly. Several legislative proposals are pending that would grant certification authority to the Commission for extra-high-voltage transmission lines. There is a considerable range of possibilities in the magnitude and character of the role of the Federal Government in the operation of interconnected grids and the problem of selecting the most appropriate one must be resolved in the near future.

The questions about interruptible gas and end-use control are also live issues. The Federal Power Commission has authority now to certify pipeline and other facilities to serve the interruptible customer--the user willing to shift to other sources of energy during periods of peak demand--and a recent Supreme Court decision also gave it the authority to consider the use to which gas is intended as a factor in authorizing or denying the construction of transport facilities. With the growth of the nuclear power industry, based on a much less limited supply of energy, and the competitive pressure that may come to bear on coal, it is possible that the arguments for more control of interruptible gas and end use may become stronger, particularly if exploration for gas should decline. Bearing on the question of end use, the Federal Power Commission recently refused to issue a certificate for the construction of a new pipeline designed for the single use of supplying gas to replace other forms of fuels for electric power generation in southern California as a means to reduce the smog problem. What policies will be developed regarding end use remain to be seen, but certainly the issue will widen as time goes on.

The question of pipeline safety has recently become an issue, and represents another area in which Government control may broaden. The Interstate Commerce Commission already has authority with respect to oil-pipeline safety, and legislation is now pending to give similar responsibility to the Federal Power Commission for gas pipelines.

The Federal Government is also taking an interest in gasoline marketing practices, and the Federal Trade Commission is reviewing them. Gasoline price wars have been costly to the industry as a whole at times, but individual dealers have suffered even

more. Government control does not seem likely in this area, but there certainly will be some attempt to give the dealers more protection than they have now.

Government has considerable responsibility in the general area of transportation, and considering the importance of transport costs in the final cost of energy, there is a strong challenge here to Government to assist in the development of means to reduce transportation costs, both through its regulatory functions and by support of R&D on new and improved methods. The extent of Government activity in this area is likely to increase considerably in the near future.

In most of its regulatory activities government acts on proposals submitted to it, rather than taking the initiative itself in proposing changes. Meddlesome interference surely would not be helpful, but there is both scope and legislative authority for Government to take more constructive initiative, using not only R&D but also the vehicles of analysis and persuasion to help improve rates and services in the industries under its surveillance.

Need for improved means to develop and coordinate energy policy

The breadth and range of problems in the energy policy area is almost overpowering, and it is no wonder that the responsibility for energy policy is widely dispersed in an organizational structure that has grown pretty much like Topsy. Understandable as its origins may be, however, the intertwining nature of energy policy problems requires a degree of coordination that is difficult to achieve now. As mentioned in the discussion of the viability of the energy industries, a wide range of government actions--which originate now in different Departments and come under the review of different Congressional committees--can all influence the outcome of a given objective. Policies dealing with the management of the public lands, with the allocation of funds for research, with environmental pollution, with transportation, with end use, with fiscal problems, and with foreign trade all influence the competitive status of the energy supply industries, and the need to coordinate policies in these areas is steadily increasing as the

sources and uses of energy continue to diversify. And the problem is not confined to the Federal establishment. There is great variation now among the policies of State and local governments in their treatment of problems in the energy field and there is need for better coordination among them and with the Federal Government also.

As shown previously, the responsibility for energy in the Federal Government is widely dispersed. We have no single department or bureau with the chief responsibility for energy policy, although the Interior Department, with some 15 bureaus and offices spread in function across a fair part of the board--from resource appraisal to oil-import control and water pollution--is perhaps a reasonably close analogue to the Ministry of Energy and Power that some countries have. No doubt we can improve our organizational structure, but we cannot reduce the dispersion of function to any appreciable extent, much less weld into a single organization all of the functions relating to energy. Energy problems are so closely intertwined with broader security, economic, and social problems that responsibility for policy cannot be isolated under the control of a single body. Even if we had a Department of Energy and Power, embracing functions more or less directly related to energy, we would still find that much critical energy policy would have to be laid and implemented in many other branches of government. Energy policies related to security, balance of payments, trade, taxation, transportation, and public welfare are among the most important in their effect on the production and consumption of energy, but because of their broader origins and effects, it is inevitable that they be laid in branches of government not primarily concerned with energy. I dare say this is just as true with your governments as it is with mine.

The main need, then, is to find a better means for coordinating policy, for developing strategy to cope with both short term and long term problems in the full context of broader objectives, and this is a problem that very much deserves our attention in the future.

Parallel to the need for a better and more fully coordinated organizational structure or mechanism for formulating energy

policies is a need for better information on all phases of the energy field as a base from which to appraise and understand the problems to which policy must be addressed. As I mentioned earlier, we go to considerable lengths now to acquire statistics on the production, consumption, transport, marketing, etc. of various forms of energy, and we have underway an extensive effort, in cooperation with industry organizations, to improve our petroleum statistics; if we are successful in this and can make similar gains in other areas, we will have a far better basis for appraising our problems and planning on ways to meet them than we have now.

But beyond statistical data as such, we need more and better information of other kinds also. Statisticians don't consider estimates to be statistics, and they confine their efforts to things that can be accurately counted, weighed, or measured. For similar reasons, the petroleum industry reports only proved reserves--the amount of oil and gas that has been accurately estimated and is known to be economically recoverable under present conditions. Proved reserves are essentially the industry's inventory--its stocks on hand--and they generally represent a 12-13 year supply at present rates of production; to cope with policy problems, however, we need to know much more about our future supplies than the magnitude of the stock on the shelf. For ex-

ample, we need to know how much more oil and gas probably occur in unproved acreage in pools already discovered and how much more can be recovered from these same pools by improved methods of secondary recovery. These probable reserves, as we might call them, are the reserves that will be developed with little or no exploratory drilling. We also need to know something of the magnitude of the oil and gas in reservoirs as yet undiscovered, and for all of these categories we need to have some understanding of the exploration and production costs involved. Knowledge such as this would tell us whether or not incentives to exploration are likely to yield the production we need and tell us also how much of a cost barrier we must expect to overcome.

This same kind of information is needed for all resources. The magnitude of low-cost uranium resources, for example, bears on the planning for the development of the breeder reactor, and is a question of much interest now. For all resources we attempt to make estimates of these kinds now, but the factual basis for them is weak. To provide a sound basis for formulating policy, then, we need better knowledge about the extent, distribution, and character of our potential resources, and a better understanding of the problems and costs of exploiting them.

SUMMARY AND CONCLUSIONS

Having amply fulfilled my obligation to show how complex U.S. energy policies are, perhaps I can now summarize them in a nutshell, albeit one of coconut size. Our prime objectives are to assure an adequate supply of cheap energy, diverse in form and geographic source but drawn largely from domestic sources--produced and used in ways that cause no permanent damage to either health or environment. We try to achieve these purposes by stimulating initiative in the private sector, by encouraging and trying to maintain interarea, interfuel, and interorganizational competition, by regulating standards of service and rates of public utilities and similar enterprises where competition is impractical, by using public resources wisely and working

with the States to avoid waste and reduce production costs, by helping to advance technology through R&D, and by avoiding as much as possible protective measures and selective excise taxes that would add to cost.

Much has been said about the inherent conflicts in energy policy--the incompatibility of the goals of security, diversity of supply, low cost, fiscal solvency, and pollution abatement. In view of these conflicts, one of my colleagues once observed that energy policy is necessarily a compromise, and that a good test of its wisdom be that it satisfy no one. In my experience in administering the oil imports program, I found this test most comforting on many occasions.

Certainly the main difficulty in formulating energy policy is often that of balancing opposing forces, but in spite of the conflicts in objectives and forces, impressive progress has been achieved over the long term on all the objectives of energy policy. Their conflicting aspects have made the problem difficult but they have not precluded solutions that made it possible to advance several purposes simultaneously. In surveying the means by which this has been accomplished in the United States, and in other countries as well, technologic advance appears again and again as the common denominator, the universal solvent so to speak, capable of solving almost simultaneously many of the problems of supply, cost, and protection of environment and health. Outside the strict area of technology, new techniques and new approaches have also proved valuable. The better-mousetrap solution to policy problems has held us in good stead in the past and it is one well worth seeking in the future.

Not only is the usefulness of technologic advance impressive, but its power is also. In view of the accomplishments to date, I think we must work from the hypothesis that R&D can be a massive factor in determining the course of events in almost every aspect of the energy field. We are already several decades removed from the time when technologic advances came largely from the chance tinkering of the backyard mechanic, or the independently aroused curiosity of the garret scientist. We still value their initiative, and perhaps they still contribute more than their proportionate share of the true innovations of science and technology. But for many years now scientific research and development have been deliberately employed as problem-solving tools by both industry and government. And as R&D have become prime instruments of policy, research strategy has become one of the prime components of policy strategy. In planning for the future, it is

essential, therefore, that plans for government R&D be fully coordinated with the objectives of energy policy, and with other mechanisms for achieving it.

In emphasizing the high importance of R&D as an instrument of energy policy I am sure I am correctly identifying the means by which we in the United States, and many of your countries also, can obtain abundant supplies of diverse forms of energy at low cost without damage to health or environment. But I do not wish to over-emphasize it to the neglect of other components of policy and policy strategy.

In fact, as scientific and technologic advance have helped us solve the problems of scarcity and high cost, they have created the equally difficult problems of abundance and low cost. Unquestionably, discovery of means to make available low-cost inanimate energy was the spark of the industrial revolution. Increased consumption of energy has supported the subsequent growth in population, and continued increase in the availability of energy invites continued population growth, with attendant problems that we are beginning to see all too clearly. In spite of increased demand, however, the abundance created by science and technology is even greater, and excess production capacity, with its attendant problems that we also know all too well, is a recurring phenomenon. An economic and social strategy to cope with the fruits of technological progress is becoming a pressing need.

These observations on energy policies in the United States have, I believe, touched the surface of most of their facets, and if you would like to pursue any of them further I shall be glad to try to answer your questions. To enable you to pursue the subject at your leisure, we are supplying several publications, which, together with those distributed at our last meeting, describe much more fully our energy situation and policies.

ACCOMPANYING PUBLICATIONS

(*Identifies those distributed at the 10th session)

- Cambel, A. B., et al, 1966, Energy R&D and national progress.
- Interdepartmental Energy Committee, 1966, Energy R&D and national progress: findings and conclusions.
- *Petroleum Statistics Study Group, 1965, Petroleum statistics report.
- *Duncan, D. C. and Swanson, V. E., 1965, Organic-rich shale of the United States and World land areas: U.S. Geol. Survey Circular 523.
- *Hendricks, T. A., 1965, Resources of oil, gas, and natural gas liquids in the United States and the world: U.S. Geol. Survey Circular 522.
- Department of Interior, 1966, Petroleum production, drilling, and leasing on the outer continental shelf--a summary.
- National Fuels and Energy Study Group, 1962, Report on assessment of available information on energy in the United States: Committee on Interior and Insular Affairs, United States Senate.
- *Oil Shale Advisory Board, 1965, Interim report to the Secretary of the Interior.
- Rural Electrification Administration, 1963, The REA pattern. REA Bull. 1-8.
- Tennessee Valley Authority, 1965 TVA Facts.
- Federal Power Commission, 1964, National Power Survey, guidelines for the growth of the electric power industry, Vol. 1.
- Federal Power Commission, 1966, Informal explanation of organization and work.
- *Federal Power Commission, 1965, Northeast power blackout.

APPENDIX A

PART II: SOME DISTINGUISHING FEATURES OF UNITED STATES ENERGY POLICY

Opening remarks of Assistant Secretary J. Cordell Moore

U.S. Department of the Interior

at the Confrontation on U.S. Energy Policy

11th Session of the Energy Committee

Organization of Economic Cooperation and Development

Paris, France

January 26, 1967

Mr. Chairman and fellow delegates: It is pleasant to be with all of you again. In spite of the fact that the very intent of this confrontation is to put us on the spot, to poke our ribs in search of broken bones or other weaknesses, I am looking forward to our discussion of U.S. energy policy. In its total aspects we are satisfied that U.S. energy policy has been extremely effective and has many strengths. We are also aware that it has some weaknesses, and you may help us to identify others that we don't appreciate fully ourselves. If you are as searching in your questions as I hope you will be, I may wince from time to time, but I hope that will not deter you from a probing examination, any more than it does my dentist when he is searching for cavities.

You will be relieved to know that I do not propose to repeat here the long statement on U.S. energy policy submitted for your review in November. Instead, I suggest we devote this session entirely to discussion, beginning with the questions submitted to us by the German and Italian delegations. I believe we touched on most of them in our written statement, but a generalized response to some groups of questions may help to bring out more clearly the essence of U.S. energy policy.

Several of the written questions asked for forecasts of future production of various forms of energy; some pointed to discrepancies among the forecasts already available; and one asked whether the composition of the energy mix predicted for 1980 in a recent paper by two Bureau of Mines authorities corresponds to the United States Government's directives on energy policy. Our written statement gives our best estimates of future production, but there is a general point that is worth emphasizing to you. The United States Government does not issue official forecasts of energy production, nor does it issue directives of any kind to the energy industries regarding their future development. The Administration adopts general goals concerning economic growth and other national objectives, of course, and it attempts in the various ways we have indicated in our written statement to encourage the development and progress of the energy industries. But it does not adopt a plan for future development similar to those issued by many other countries. De-

pending as we do on competition among the energy industries to achieve some of our goals, a specific plan for the development of individual industries would defeat part of our purpose.

As indicated in our written statement, the Administration for some years had held as a national goal economic growth of about 4 percent a year, and to attain this we expect that our total energy consumption will increase at a slightly lower rate. But how much of our requirement will be met by nuclear energy, coal, petroleum and other fuels will depend mainly on the outcome of competition among these various sources. Forecasts prepared by various government agencies or various individuals are based on assumptions judged to be reasonable at the time, but they are estimates rather than plans, they may differ from one another, and they have no official status. They may influence policy and other official actions but they do not constitute official plans or goals.

Some of the written questions asked about plans to expand production capacity, future investment costs, future prices, and other future developments within the individual energy industries. Here again, the basic relation between Government and industry in the United States makes it impossible for us to answer such questions authoritatively. The very core of U.S. energy policy is that industry is responsible for production, distribution, marketing, and pricing, except in markets where fair prices cannot be guaranteed by competition, such as, for example, gas and electricity in interstate commerce. The Federal Government attempts to establish a climate favorable for the growth of the energy industries. It tries to stimulate initiative, to help advance technology, and to encourage and maintain competition. It monitors the overall energy situation to be sure that the national security and the broad interests of the public are protected, it applies constraints to the operations of the private sector where the public interest so requires, and it makes liberal use of the instrument of persuasion at times to influence the course followed by the private sector. But the Federal Government does not control production, it does not direct the efforts of industry, and it does not involve itself in company affairs. Even in the

regulatory field its posture is mainly reactive rather than positive. Information on costs, reserves, processes, and plans is generally closely guarded by the companies and they are not required to divulge it. Of course, we can and do make informed judgments about all of these matters, particularly on an industry-wide and nation-wide basis, and we sometimes seek and receive privileged information from companies on a confidential basis. But I stress our lack of authoritative knowledge concerning these matters because it is a basic part of our policy, and contrasts, I am sure, with the situation in nations in which the energy industries are nationalized.

A number of the questions submitted to us in advance refer to the future status of the coal industry. Some of these questions are tangent to the subject of energy policy, and some of them refer to information of the type I have just described about which the United States Government cannot speak authoritatively. Nevertheless, I will attempt some general statements about the status and outlook of the coal industry that I hope may answer most of your questions.

As we have said many times previously, our reserves and resources of coal minable at or near present costs in the Appalachian region are extremely large, so large, in fact, that we do not undertake the exploration necessary to determine their exact magnitude. Perhaps I can explain this best by discussing briefly the interesting contrast in the kinds of resource estimates made for coal and oil that result from the difference in their mode of occurrence and geologic characteristics. Oil occurs in relatively small reservoirs that are concealed beneath the surface and that do not have closely predictable distribution or continuity. Consequently, when oil is discovered it is necessary to test its extent and continuity by rather closely spaced drilling; only the amount that is found to exist on the basis of such drilling can be considered producible. The quantity that can be recovered from fields found and tested by such exploration is reported as the proved reserve; it represents only a small part of what may be discovered ultimately, but the figure itself is a rather accurate estimate of what is currently economically available for production. Because proved reserves in the aggregate represent

only a 12-13 year supply, the industry, through the American Petroleum Institute, collects and publishes data on proved reserves annually, and trends in the rate of addition of proved reserves are watched closely by all concerned with the industry. No such accurate information, however, is available on potential resources, for the unpredictable nature of the distribution and continuity of oil makes it impossible to arrive at an accurate estimate of the total amount that actually occurs in the ground and that will eventually be discovered. So for oil, we have an accurate estimate of what is essentially the industry's producible inventory, and a very poor estimate of the total that awaits future discovery.

The situation for coal is exactly the opposite. Coal beds characteristically have great lateral continuity. A few measurements from outcrops or widely spaced drill holes, coupled with geologic mapping and stratigraphic studies, make it possible to determine with fair reliability the approximate amount of coal that occurs in the ground. Because the amount of coal so estimated is extremely large, the magnitude of closely explored and developed reserves is of little interest to either industry or government, and no periodic attempt is made to compile national estimates of proved reserves. Neither is any continuing attempt made to enlarge the national proved reserve by exploration, for exploration undertaken to prove the existence and detailed distribution of something long before it is needed represents a foolish use of capital. As mentioned in my written statement, a recent incomplete survey showed that deposits being mined or developed by coal producers contain about 20 billion tons. Inasmuch as this represents a 40 year supply at present rates of consumption, it would be unwise for coal producers to spend now the money necessary to prove a larger reserve. And it would be a waste of money and effort to attempt a more refined annual inventory of proved reserves.

The fact, then, that there are not larger proved reserves does not by any means indicate that the coal is not there to be developed; it is simply that the coal under development is more than sufficient for foreseeable needs and that the total resources are so large as to leave no doubt but that additional reserves can be proved up as needed.

In Virginia, West Virginia, and Pennsylvania--the areas of the Appalachians that are contiguous to the principal East Coast ports--there are presently known to be minable at present costs about 7 billion tons of low volatile coal (i.e. 22 percent or less volatile matter) in the vicinity of producing mines or properties under development, and there is a similar recoverable reserve of anthracite coal in eastern Pennsylvania. This is not by any means the full potential, for more coal of the same qualities remains to be discovered and more lies at greater depths. For example, 500 million tons of Pocahontas coal was discovered only a few years ago in Virginia at a depth of about 1500 feet and a new mine there has only recently been brought into production. Reserves of medium and high volatile coals in the Appalachians, many of which are suitable for coking, are several times larger than the low volatile coals in the region, and they are eminently suited for most uses. There is no question but that Appalachian resources of low cost coal are sufficient to support both domestic consumption and exports far beyond the period relevant to either your plans or ours.

Some excess mine and transport capacity is available now in the Appalachian region to support additional exports, but new facilities would have to be added for substantial expansion. Some of you have asked about government plans to maintain future prices at reasonable levels. Here again, it is appropriate to point out that these problems are in the domain of private industry, and are not under the control of government. We can draw your attention, however, to the fact that the trends in costs and prices have been downward over the years because of greatly increased efficiency resulting from technologic advance in both mining and transportation. The real cost of coal at the pit head, for example, has declined 15 percent since 1957. By the means described in our written statement we are attempting to help the industries continue to improve their efficiency and to lower costs. But we do not have accurate information on industry's projected costs and plans.

How then, you may ask, can you determine whether or not low-cost American coal would be available for your continuing need? The answer is simple; attempt to negotiate long

term contracts with American companies on terms that you would consider suitable. There are, as you know, no regulations limiting the export of coal, and none are contemplated. The coal exporters and producers are free to negotiate long term contracts, and I am confident you will find them eager to reach agreements under mutually satisfactory terms. I may point out also that you are free to invest in American coal properties and production facilities, if you wish to develop sources that are under your direct control. Most of the coal in the Appalachians is privately owned, and there are no restrictions against foreign ownership. Even coal land that is owned by the Federal Government is available to you under the same leasing arrangements that apply to American citizens. Only American citizens or American corporations are allowed to hold such leases, but foreign ownership of the stock of such corporations is permitted by nationals of countries with whom we have reciprocal agreements, as I believe we do with all of you. Thus, if you were interested in captive production, not subject to the effects of competition from other markets, your own producers could, at a modest investment, acquire title to reserves that would satisfy your needs for any period you might wish.

Some of you have asked how the American coal industry will be affected by the rapid growth of the nuclear power industry. The construction of a nuclear plant in the heart of the Illinois coal field, and the two recent contracts let by TVA for nuclear plants have been impressive indications of the growth in the competitiveness of nuclear power. Frankly, we do not know what will be the effects of this competition on the coal industry, but as I indicated in our written statement, it is generally believed that coal production will continue to increase for a couple of decades and perhaps longer. Even if nuclear power were to gain a distinct cost advantage over coal, it is doubtful that the nuclear industry could supply all of the new generating capacity that we anticipate will be needed at competitive costs. Keep in mind that our demands for electricity are increasing at more than double the rate of increase of our demands for energy. Beyond the ceiling on the growth of nuclear power imposed by the limits of the manufacturing industry--and here again, we don't know

what these limits are exactly--we fully expect that the coal and railroad industries will redouble their efforts to maintain coal as a vigorous competitor. If they are successful, it is possible that the nuclear industry will grow at a less spectacular rate than is now expected. As indicated in our written statement, our best guess now is that coal production for domestic electric power generation will double by 1980 and that nuclear power by that time will be furnishing of the order of 17 or 18 percent of our total generating capacity.

You have asked also about the significance of the entrance of some of the petroleum companies into the coal field. Here also we are not privy to company plans, but our understanding is that the companies involved have merely wished to broaden their base as energy producers. Many oil companies have large oil shale holdings, some have been active in uranium exploration, and many have important chemical and petrochemical production and manufacturing facilities. In view of the bright prospects for the manufacture of synthetic fuels and chemicals from coal, it is natural that some of the petroleum companies want to acquire reserves of that commodity also to protect their position as energy and chemical producers. We do not anticipate that their interests and activities will adversely affect the availability or price of coal for other uses. Again, with recoverable resources, minable at present costs, of the order of 200 billion tons, and many times that amount in marginal resources that probably can be brought within economic reach by further technologic advance, we have enough coal for all conceivable uses far beyond the foreseeable future.

During the last few months I understand that some European coal importers have had grounds for complaint about the failure of U.S. suppliers to meet commitment in either quality or time of delivery or both. The delays apparently originated in strikes last spring, and they hurt U.S. consumers just as much as they did exports. Only a relatively small amount of the total volume was affected, but no doubt the failures were aggravating to the importers

concerned, and they may give you cause to ask whether American coal exporters are dependable. In view of the generally reliable record of American coal producers over the years, I think the few recent difficulties are insignificant, but here again far better than my opinion are the standard business procedures you can take to determine the reliability of exporters and to guarantee your contracts. Investigate your dealers as you would in any other business. Deal with firms of proven reputation or verifiable capability to meet contract specifications. Negotiate contracts with suitable guarantees of delivery or with compensating penalties for failure. And seek long-term contracts that will enable suppliers to give you the benefit of economies gained from the ability to plan and develop the most efficient operations. The three long term contracts recently negotiated between Japanese and U.S. firms are examples of the mutually advantageous arrangements that can be worked out in this way.

In stressing, in my response to these several questions, the lack of direct U.S. Government control over many aspects of our energy situation, I am outlining the essence of American energy policy and strategy. We try to achieve our objectives in the energy field by stimulating initiative in the private sector rather than by directing it or doing the work ourselves. We limit regulatory measures to areas where our objectives cannot be achieved by competition. And we attempt to avoid protective and other measures that add to cost, seeking instead to solve long-range problems of security of supply, cost, and other objectives through technologic advance.

Brigham Young once said that "as Latter Day Saints we oppose tobacco but as Mormons we use quite a bit". I might say the same with regard to the policies I just outlined, for there are indeed exceptions to them. But in judging the nature of energy policy, and particularly its future course, it is the rule rather than the exception that is the best guide.

Mr. Chairman and fellow delegates, I now invite your questions and comments on U.S. energy policy.

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