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The usefulness of resource and reserve estimates of the Nation's primary energy fuels, including oil, gas, coal, and uranium, can be greatly improved. These estimates are prepared and reported on by Federal agencies. Findings/Conclusions: The estimates prepared have been an attempt to measure the potential short- and long-term domestic supplies of these fuels. Review of the reported energy resource and reserve estimates demonstrates that there is a need for more data to assess resources and reserves and a need for more reliable resource and reserve estimates. In order to increase the usefulness of reserve estimates for decisionmaking purposes, information is needed on the effects of cost-price relationships on energy source recoverability. Recommendations: The Secretary of the Interior should direct a geological exploration program which would provide for the development and implementation of a systematic plan for appraising Outer Continental Shelf oil and gas resources. The Energy Research and Development Administration should expedite the work and report of its National Uranium Resource Evaluation Program. The Administrator of the Federal Energy Administration should obtain additional information concerning the effects of cost-price relationships on the recovery of energy resources, the quantities of recoverable coal reserves, and the ownership and control over energy resources.

**(Author/SC)**

# REPORT TO THE CONGRESS



BY THE COMPTROLLER GENERAL  
OF THE UNITED STATES

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## Domestic Energy Resource And Reserve Estimates--Uses, Limitations, And Needed Data

This report examines the Government's data on domestic resources and reserves of crude oil, natural gas, uranium, and coal. Estimates of resources and reserves of these fuels can be greatly improved.

Additional information should be obtained concerning

- the oil and gas in Outer Continental Shelf areas,
- the availability of economically recoverable U.S. uranium resources,
- the effects of cost-price relationships on the recovery of energy resources,
- the quantities of recoverable coal reserves, and
- the ownership and control over energy sources.



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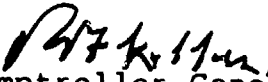
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To the President of the Senate and the  
Speaker of the House of Representatives

This report focuses on the usefulness of resource and reserve estimates of the Nation's primary energy fuels--oil, gas, coal, and uranium. The estimates examined are being prepared and reported on by Federal agencies.

The examination was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67) and because of the importance of energy resource and reserve estimates in planning for the Nation's energy future.

Copies of this report are being sent to the Director, Office of Management and Budget; the Secretary of the Interior; the Administrator, Federal Energy Administration; the Administrator, Energy Research and Development Administration; the Chairman, the Federal Power Commission; the Chairman, Senate Committee on Energy and Natural Resources; and the Chairman, House Committee on Interior and Insular Affairs.

  
ACTING Comptroller General  
of the United States

D I G E S T

As the oil embargo in late 1973 showed, our Nation depends on petroleum product as a primary energy source. Domestic energy supplies are declining--annual estimates of oil and gas reserves have decreased since 1970, and studies show that our petroleum production is declining. Our Nation is faced with dependence on potentially unreliable foreign sources of oil unless development of U.S. energy sources is escalated and/or an aggressive energy conservation program is pursued. (See p. 1.)

The future energy demand, the combination of fuels which will best meet that demand, and the possible impact of energy conservation efforts are uncertain. However, the Government can effectively plan for and shape the Nation's energy future. In doing so, decisions concerning various supply options must be based on a better understanding of the potential future supplies of domestic fuels, who owns and controls them, and the costs associated with developing each fuel. (See p. 4.)

Resources, in general, are quantities of a substance estimated to exist and be recoverable either now or in the future. A reserve, on the other hand, is that portion of resources which is estimated to be recoverable based on current technology and economic conditions. Estimates of our Nation's domestic resources and reserves of the primary energy fuels--crude oil, natural gas, coal, and uranium--are important in assessing the current energy situation and planning for our energy future. (See p. 5.)

The comments expressed in this report by Executive branch agencies were obtained by GAO under the previous Administration. It is uncertain as to what the current Administration's views and judgments may be on the issues discussed in this report.

## DOMESTIC RESOURCES

The potential availability of oil and gas in the Outer Continental Shelf could be determined better if a systematic plan to assess Outer Continental Shelf resources was developed and implemented by the Federal Government. The plan should include a timetable for providing minimum levels of stratigraphic test drilling. The data obtained would provide a better basis for continually assessing the role of the Outer Continental Shelf in supplying future energy needs and giving precedence to major areas for future leasing.

In implementing the resource appraisal plan, private industry should be encouraged to conduct the stratigraphic test drilling called for in the plan. However, to insure full implementation of the plan, GAO believes the Federal Government should finance stratigraphic tests in areas where private industry does not plan to drill. (See p. 20.)

In an earlier report, "Outer Continental Shelf Oil and Gas Development--Improvements Needed in Determining Where to Lease and at What Dollar Value" (RED-75-359, June 30, 1975), GAO recommended that the Secretary of the Interior direct a geological exploration program, which included stratigraphic drilling, in Outer Continental Shelf areas. At that time the Secretary of the Interior stated that the recommendation did not consider the cost effectiveness of such a program and questioned the use of a Government financed drilling program. (See pp. 20 and 21.)

In commenting on this report, the Department of the Interior said that it

--had promptly made difficult and necessary decisions using the best information available,

--considered data coverage in areas offered for lease to be sufficient for a technically sound determination of fair market value, and

--considered ongoing industry-financed stratigraphic tests to be generally

well placed and adequately tested to furnish valuable data. (See p. 21.)

The Federal Energy Administration, in commenting on this issue, stated, in essence, that stratigraphic drilling is a major expense of any exploration effort whether carried out by the Government or by private industry and that the amount of drilling necessary to provide information to adequately evaluate tracts before they are leased to insure that the public receives a reasonable return could be extensive. The Federal Energy Administration pointed out that the minimum levels of exploratory coverage recommended may not coincide with the coverage necessary to adequately evaluate tracts before leasing. (See p. 21.)

Concerning the Department of the Interior's comment that it considered its data coverage in areas offered for lease to be sufficient for a technically sound determination of fair market value and considered the industry-financed stratigraphic tests to furnish valuable data, it was not within the scope of this report to address tract evaluation. (See p. 21.)

Concerning the amount of stratigraphic drilling, GAO agrees with the Federal Energy Administration that the minimum level of drilling necessary for adequate resource appraisal may not coincide with the coverage necessary to adequately evaluate tracts before leasing. The amount of stratigraphic drilling GAO is proposing, as part of a systematic resource appraisal program, would be much less extensive than that required for comprehensive tract evaluation and should be that level of drilling which the Department of the Interior determines is needed to provide minimum levels of subsurface data coverage in major Outer Continental Shelf geologic basin areas. (See p. 22.)

Concerning the financing of stratigraphic drilling, GAO concurs with the Department of the Interior's comment that a totally Government-financed drilling program may not be

appropriate. GAO is proposing that a plan for a systematic appraisal of the Outer Continental Shelf's resource potential be developed which would identify, among other things, those specific areas where the Department of the Interior determined stratigraphic drilling should be performed. GAO believes that private industry should then be encouraged to perform the planned stratigraphic testing to the extent that it is willing to do so. However, GAO believes that the Government should finance any additional drilling needed to fully carry out the resource appraisal plan. This approach will provide better information to more realistically assess the oil and gas potential of Outer Continental Shelf areas. (See p. 22.)

Concerning the cost effectiveness of such a program, the cost cannot be determined until the Department of the Interior develops a resource appraisal plan, identifies the levels of stratigraphic drilling needed to assess major Outer Continental Shelf areas, and determines the extent to which private industry is willing to perform such drilling. The benefits of stratigraphic drilling, although difficult to quantify, could be measured by industry's willingness to undertake such efforts under a positive comprehensive program developed by the Department of the Interior. In addition, benefits from such a program include obtaining information to enable policy makers to formulate broad energy policy and giving precedence to Outer Continental Shelf areas for leasing purposes. (See p. 22.)

The Government has limited knowledge of its uranium resources. An aggressive, accelerated effort is needed to define the availability of economically recoverable U.S. uranium resources.

GAO believes that the Energy Research and Development Administration's National Uranium Resource Evaluation program should be expedited to the extent practicable. GAO also believes that the costs and benefits of an exploratory drilling program, including suitable levels of private and Government financing, should be thoroughly evaluated. (See p. 24.)



The Energy Research and Development Administration agreed that its National Uranium Resource Evaluation program should be expedited to the extent practicable and believed this approach would result in a better appraisal than an extensive drilling program. (See p. 24.)

The Department of the Interior stated that an intensified drilling program would lead to a more accurate assessment of undiscovered uranium resources. However, the Interior believes that the costs and benefits of an exploratory drilling program should be evaluated. (See p. 24.)

In view of the differing points of view regarding the uranium exploratory drilling program, GAO believes the Energy Research and Development Administration and the Department of the Interior, under the general direction of the Federal Energy Administration should undertake a joint effort designed to identify the costs and benefits of such a program, including suitable levels of private industry and Government financing, and report the results of that effort, with appropriate recommendations, to the Congress. (See p. 25.)

#### DOMESTIC RESERVES

Estimates of reserves of certain energy sources can be greatly improved, not only for explicit Federal leasing decisions but also for energy policy formulation involving choices and timing among alternative sources of supply. Specifically, information is needed on (1) the effects of cost-price relationships on the recovery of fuels, (2) the quantities of recoverable coal reserves, and (3) the ownership and control over energy sources. (See pp. 25 through 32.)

The Federal Energy Administration, and the Department of the Interior generally agreed that information on the effects of cost and price on reserve estimates is desirable and important. The Federal Power Commission pointed out that obtaining this information is complicated and time consuming. The Federal Energy Administration pointed out that ways

of developing such information would be quite uncertain. (See p. 27.)

The Energy Research and Development Administration also suggested that information on chemical composition and washability of coal be included in any additional analysis of coal seams. (See p. 29.)

The Federal Energy Administration and the Federal Power Commission believe information on ownership and control over energy sources is important. According to the Federal Energy Administration, an analysis of ownership would be difficult and complex but could be manageable by developing data from major companies owning or controlling significant quantities of resources. (See pp. 31 and 32.)

GAO recognizes that the effects of cost-price relationships on energy source recoverability and the question of ownership of energy sources are complex issues. However, because of the importance of this information in planning for the Nation's energy future, GAO believes that this information should be obtained by the Federal Government.

#### RECOMMENDATIONS

In its June 30, 1975, report, "Outer Continental Shelf Oil and Gas Development--Improvements Needed in Determining Where to Lease and at What Dollar Value" (RED-75-359), GAO recommended that the Secretary of the Interior direct a geological exploration program. This program would provide for the development and implementation of a systematic plan for appraising Outer Continental Shelf oil and gas resources, including selective stratigraphic test drilling. GAO continues to endorse this recommendation and believes the plan should identify the level of stratigraphic drilling necessary to provide a minimal level of data coverage for major Outer Continental Shelf areas. After the plan has been developed, the Department of the Interior should encourage private industry to conduct the drilling identified in the plan. After the extent of industry participation is known, if any data gaps still exist, the Department

of the Interior should take the necessary actions, including public financing of stratigraphic drilling, to obtain the needed data.

GAO also recommended in its July 31, 1975, issue paper, "The Liquid Metal Fast Breeder Reactor: Promises and Uncertainties" (OSP-76-1), that the Energy Research and Development Administration expedite the work and final report of its National Uranium Resource Evaluation program currently scheduled for completion in 1981. GAO continues to endorse this recommendation and also recommends that the Energy Research and Development Administration and the Department of the Interior, under the general direction of the Federal Energy Administration, undertake a joint effort designed to identify the costs and benefits of a uranium exploratory drilling program, including suitable levels of private industry and Government financing, and report the results of that effort, with appropriate recommendations, to the Congress.

In addition, GAO recommends that the Administrator, Federal Energy Administration:

- Determine the ownership and/or control over domestic energy fuels by major companies.
- Obtain from coal producers estimates of recoverable domestic coal reserves, using appropriate verification techniques, and develop plans to regularly update these results, including the effects of cost-price relationships on recoverability.
- Work with the appropriate Federal departments and agencies to fulfill the informational requirements of section 13(f) of the Federal Energy Administration Act of 1974, 15 U.S.C. 761 (Supp. V, 1975), including close monitoring of the Department of the Interior's implementation of the comprehensive exploratory program authorized under the Federal Coal Leasing Amendments Act of 1975.

--Update regularly the estimates of oil and gas reserves, including the effects of cost-price relationships on recoverability.

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**ABBREVIATIONS**

AGA	American Gas Association
API	American Petroleum Institute
BOM	Bureau of Mines
ERDA	Energy Research and Development Administration
FEA	Federal Energy Administration
FPC	Federal Power Commission
FTC	Federal Trade Commission
GAO	General Accounting Office
IOCC	Interstate Oil Compact Commission
NURE	National Uranium Resource Evaluation
OCS	Outer Continental Shelf
LMFBR	liquid metal fast breeder reactor

## CHAPTER 1

### INTRODUCTION

During 1973 the United States was obtaining its principal energy needs from the following sources: crude oil and natural gas, about 77 percent; coal, about 18 percent; uranium, about 1 percent; and hydropower, about 4 percent. About 35 percent of the oil being consumed was obtained from foreign sources.

The oil embargo in late 1973 demonstrated the importance of the Nation's dependence on petroleum products as a primary energy source. Coupled with this realization is the additional threat of apparently declining domestic supplies of oil and gas; this is indicated by decreases in annual estimates of oil and gas reserves since 1970 and studies which show that the Nation is in the decline phase of oil and gas production. Thus the Nation is faced with a continued high level of dependence on potentially unreliable foreign sources for oil unless development of U.S. energy sources is escalated and/or an aggressive energy conservation program is pursued.

The President and the Congress have initiated actions in the past 2 years in response to the 1973 embargo. Major actions have included the establishment of the Federal Energy Administration (FEA) and the Energy Research and Development Administration (ERDA), the preparation of the Project Independence report and its revision (1976 National Energy Outlook), various national energy plan proposals, enactment of the Energy Policy and Conservation Act, 42 U.S.C. 6201, (Supp. V, 1975), and the Energy Conservation and Production Act, (Public Law No. 94-385). Despite these actions, in March 1976 the United States imported, for the first time, more than 50 percent of its petroleum requirements.

Within this framework national energy goals and supporting energy policy objectives have been identified. Former President Gerald Ford, in his 1975 State of the Union message and his 1976 energy message, stated the following three goals:

- To halt our growing dependence on imported oil during the next few critical years.
- To attain energy independence by 1985 by achieving invulnerability to disruptions caused by oil import embargoes, specifically, by reducing oil imports to 3 to 5 million barrels a day, with an accompanying ability to offset any future embargo with stored petroleum reserves and emergency standby measures.

--To mobilize technology and resources to supply a large share of the free world's energy needs beyond 1985.

These broad goals are supported by, and to be realized through, seven national energy policy objectives or principles:

--Reduced dependence on imported energy.

--Reduced growth in energy demand.

--Adequate energy supplies.

--Increased domestic energy production with protection of the environment.

--A smooth transition to commercial availability of advanced technologies.

--Stable energy prices.

--Federal, State, and local cooperation to attain these objectives.

The Nation's energy goals and policy objectives can only be realized if appropriate actions are taken by the Federal Government in conjunction with the private sector. The decisions necessary to implement this process must be based on a clear understanding of (1) the Nation's potential domestic supplies of the primary energy fuels--crude oil, natural gas, coal, and uranium--and (2) how this energy will be used.

There have been numerous studies<sup>1/</sup> on the future domestic energy supply and demand picture and scenarios on the mix of energy sources necessary to meet future demand. These studies demonstrate the type of analysis that must be made if the Nation is to adequately meet its energy needs in the future. The results of these studies differ depending on the various assumptions made (e.g., to hold imports to 10 percent of energy consumption). However, two points are clear.

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<sup>1/</sup>These studies include FEA's "1976 National Energy Outlook"; ERDA-48 "A National Plan for Energy Research, Development & Demonstration: Creating Energy Choices for the Future"; "A Time to Choose: America's Energy Future" by the Ford Foundation; "Achieving Energy Independence" by the Research and Policy Committee on the Committee for Economic Development; and the Bureau of Mines' "United States Energy Through the Year 2000 (Revised)."



First, even with a reduction in the growth rate, U.S. energy demand will increase significantly between now and the year 2000. Second, there will have to be an increase in the role of coal and uranium (nuclear) relative to oil and gas. To illustrate, ERDA in its Scenario I forecasted a growth in energy demand of about 29 percent between 1973 and 1985 (from 75 to 97 quads <sup>1/</sup> and a growth of over 63 percent between 1973 and the year 2000 (to 122.4 quads). To meet these increases in demand, the relative role played by oil, gas, coal, and nuclear power would greatly change.

Oil would play a less important role in meeting future energy demands of the Nation. According to ERDA's projection for the years 1985 and 2000, the oil demand in 1985 would increase 2 percent over 1973's demand, and an increase of 18.5 percent over 1973's demand is projected for the year 2000. Projections of the role of natural gas by the years 1985 and 2000 indicate an increase in gas demand of 10.4 percent by 1985 and a decrease from 1973 demand levels of 5 percent by the year 2000.

Coal has played a less important role in supplying energy for the Nation in recent years. However, because of the domestic oil and gas situation, coal consumption is expected to increase greatly. In ERDA's Scenario I projection, domestic coal consumption would have to increase over 1973 by more than 42 percent in 1985 and over 76 percent for the year 2000.

The use of uranium as a domestic fuel source has increased in recent years and has accounted for about 2.4 percent of the total domestic energy consumption in 1975. In the next 25 years, the use of nuclear fuel is projected to increase considerably to about 17 percent of total energy consumption by the year 2000, according to ERDA's Scenario I. However, because of uncertainties concerning the development and commercialization of new technologies expected to use uranium much more efficiently, such as the liquid metal fast breeder reactor, the availability of uranium for use in conventional reactors becomes a critical variable.

The role of other potential energy sources, such as solar and geothermal, is expected to become increasingly important by the year 2000. ERDA's Scenario I estimates that these two sources would provide 5.9 quads of energy by the year 2000. However, projections as to their future impact are particularly

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<sup>1/</sup>A quad is equal to 1 quadrillion British thermal units (Btu's) or the amount of energy produced by 180 million barrels of oil.

uncertain because of technological, environmental, and economic questions that must be overcome.

The role of energy conservation in closing the gap between domestic energy supplies and projected demand will be crucial in years to come. Eliminating energy waste and inefficiencies in energy use should be an integral part of any national approach in meeting future energy needs because such elimination is necessary to alleviate shortages, preserve the environment, and stretch out the supply of finite resources. ERDA's Scenario I projected a savings from energy conservation of 10.3 quads by 1985 and 43 quads by the year 2000.

In summary there is a great deal of uncertainty with respect to future energy demand, the mix of fuels which will best meet that demand, and the possible impact of energy conservation efforts. However, the Federal Government can effectively plan for and shape the Nation's energy future. The decisions the Government makes concerning various supply options must be based on a better understanding of potential future supplies of domestic energy sources, who owns and controls these fuels, and the costs associated with development of each fuel.

#### DEFINITIONS OF RESOURCES AND RESERVES

The terms "resources" and "reserves" have been defined in a number of ways to provide a measurement of the certainty with which quantities of energy fuels are known to exist. In recent years various estimates of resources and reserves of the Nation's primary energy fuels have been prepared and publicized by Government and private concerns and individuals which have been considerably different. This situation has highlighted differences of opinion in estimating such quantities and has raised questions concerning the Federal Government's knowledge about the future availability of domestic energy sources. An understanding of the definitions used is essential in analyzing this issue. To maintain consistency in this report, the Department of the Interior's U.S. Geological Survey and Bureau of Mines' definitions of resources and reserves will be used.

Resources are concentrations of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust in such form that economic extraction of a commodity is currently or potentially feasible. A resource is either identified or undiscovered. An identified resource is a specific accumulation of economic resources whose quality and quantity are estimated from geologic evidence supported, in part, by engineering measurements. An undiscovered resource is a

quantity of a resource estimated to exist outside of known fields on the basis of broad geologic knowledge and theory.

A reserve is defined as that portion of an identified resource which can be economically extracted. A critical element in estimating a reserve is economics (the cost to extract the fuel and the market price of the fuel).

Much information is available on the quantities of resources and reserves of crude oil, natural gas, coal, and uranium. This report focuses on the usefulness of such resource and reserve estimates being prepared by the Federal Government as a basis for decisions on the Nation's energy future. Chapters 2 and 3 are essentially descriptions of the Federal agencies and private organizations involved in making resource and reserve estimates and the methodologies used by them. Chapter 4 highlights the problems and data gaps in Federal resource and reserve estimates. Chapter 5 contains our conclusions and recommendations.

### SCOPE OF REVIEW

Because of the importance of the primary energy fuels-- crude oil, natural gas, coal, and uranium--in meeting the Nation's future energy demands, we examined the data existing in the Federal Government on the resources and reserves of these energy sources. Although oil shale is also expected to play an important role in meeting the Nation's future energy demands, we have not discussed oil shale in this report because of uncertainties about its economic and technological recoverability.

The comments in this report by Executive branch agencies were obtained by GAO under the previous Administration. It is uncertain as to what the current Administration's views and judgments may be on the issues discussed in this report.

We made our examination at the following Federal agencies located in Washington, D.C., and various field locations in the United States:

- Bureau of Mines (BOM), Department of the Interior.
- U.S. Geological Survey, Department of the Interior.
- ERDA.
- FEA.
- Federal Power Commission (FPC).

At each of these organizations, we interviewed officials and reviewed selected documents, reports, maps, and data files related to energy resource and reserve data. Additional visits were made to the offices of energy companies and various State organizations.

## CHAPTER 2

### GOVERNMENT AND PRIVATE INVOLVEMENT IN

#### ESTIMATING RESOURCES AND RESERVES

Federal agencies which have been involved in developing resource and reserve estimates of crude oil, natural gas, coal, and uranium include the Department of the Interior's Geological Survey and BOM, ERDA, FEA, and FPC. In addition to the Federal effort, many other institutions have developed and reported resource and reserve estimates of some of these fuels.<sup>1/</sup> However, the Federal Government has placed particular reliance over the years on petroleum reserve estimates prepared by the American Petroleum Institute (API) and the American Gas Association (AGA).

A description of each organization's activities relating to energy resource and reserve estimates is discussed in the following paragraphs.

#### U.S. GEOLOGICAL SURVEY

The Geological Survey was established by the act of March 3, 1879 (43 U.S.C. 31). This act charged the Survey with the responsibility for classifying public lands and examining the geological structure, mineral resources, and products of the national domain. As part of its functions, the Survey makes geological surveys and investigations to determine and appraise the mineral and mineral fuel resources of the United States.

The Survey is involved in activities to determine the domestic resources of current and potential energy sources. The Survey's Office of Energy Resources, as part of its functions, prepares resource estimates for oil, natural gas, coal, and, to a lesser extent, uranium. The Survey estimates resources from raw geological data obtained from private companies, State geological surveys, and geological surveys performed by its own geologists. These estimates may be limited to selected geographic areas or may include the entire United States.

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<sup>1/</sup>Potential Gas Committee, Potential Supply of Natural Gas in the United States (as of Dec. 31, 1972); National Academy of Sciences, Mineral Resources and the Environment, Washington, D.C., 1975; and M. King Hubbert, (personal estimate) U.S. Energy Resources, a review as of 1972, pt. 1, in a national fuels and energy policy study, 1974.

The Survey is also responsible for obtaining reserve data on Federal leases.

#### BUREAU OF MINES

BOM was established by an act of Congress on May 16, 1910 (30 U.S.C. 1). A more recent act, the Mining and Minerals Policy Act of 1970 (30 U.S.C. 21a), states that the Federal Government has a role in fostering and encouraging private enterprise in the orderly economic development of domestic mineral resources and reserves. It requires the Secretary of the Interior to include in his annual report to the Congress a statement of the trend in using and depleting mineral resources but it does not refer specifically to a mineral fuel reserve assessment function.

BOM compiles and publishes reserve estimates from data supplied by the mineral and energy materials industry and by the Survey and other governmental agencies. Although BOM has been primarily involved in compiling estimates of coal reserves, it does maintain information on crude oil and natural gas reserves.

#### ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

ERDA was established pursuant to the Energy Reorganization Act of 1974, 42 U.S.C. 5801 (Supp. V, 1975). Under the act, certain functions of selected Federal agencies were transferred to ERDA. Among the transferred functions was the Atomic Energy Commission's responsibility to assess the uranium supply situation in the United States.

ERDA's activities include the development and reporting of U.S. uranium resource and reserve estimates. These estimates result from information supplied principally by private companies and special geological studies that ERDA undertakes.

#### FEDERAL ENERGY ADMINISTRATION

FEA was established pursuant to the Federal Energy Administration Act of 1974, 15 U.S.C. 761 (Supp. V, 1975). Under the act, FEA is to assess the adequacy of energy resources to meet demands in the immediate and long-range future for all sectors of the economy and for the general public. Additionally, as provided in section 15(b) of the act, FEA is to

"\* \* \* provide a complete and independent analysis of actual oil and gas reserves and resources in the United States and its Outer Continental Shelf\* \* \*."

In November 1975, FEA released the final results of its study of oil and gas resources and reserves. The resource portion of the report was developed from information obtained from the Survey and the reserve portion was developed from information obtained from an oil and gas industry questionnaire and independent analyses of selected oil and gas fields.

FEA is also charged, under the Energy Supply and Environmental Coordination Act of 1974 (Public Law 93-319), with developing quarterly reports of energy information, including information on domestic reserves and production of crude oil, natural gas, and coal. These reports have been prepared and published by FEA since the third quarter of 1974. The Energy Policy and Conservation Act extended this responsibility until December 31, 1975.

### FEDERAL POWER COMMISSION

The Federal Power Commission (FPC) was established in 1920 by the Federal Water Power Act (16 U.S.C. 791). The Natural Gas Act (15 U.S.C. 717), passed in 1938, expanded FPC's responsibilities to include jurisdiction over companies which transport and sell natural gas interstate.

FPC is vested with broad information gathering powers and obtains natural gas reserve data from interstate pipelines and gas producers. In addition, FPC made an appraisal of the proven gas reserves of the United States during 1972.

The National Gas Reserve Study was undertaken because FPC believed it would help accomplish the objectives of the Natural Gas Act. FPC was assisted in its study by other Federal agencies. The results of the study were released in a May 1973 report and was revised in September 1973.

### AMERICAN PETROLEUM INSTITUTE AND AMERICAN GAS ASSOCIATION

The American Petroleum Institute (API) and the American Gas Association (AGA)--industry trade associations--report aggregate oil and gas reserves data. Estimates for individual reservoirs or fields were kept confidential until 1975 when API and AGA published reserve estimates for the 100 largest oil fields and the 50 largest gas fields.

API has published annual estimates of domestic crude oil reserves since 1946. The API committee responsible for preparing such estimates is basically composed of representatives from U.S. oil companies.

The AGA has published annual estimates of domestic natural gas reserves since 1945. The AGA committee responsible for preparing such estimates is composed mainly of individuals from natural gas production and transmission companies.

API and AGA have been the recognized sources of nationwide crude oil and natural gas reserve statistics. Industry, Government, and the general public have relied on the statistical information prepared by these organizations. The reserve estimates are developed by geologists and engineers who (1) represent various segments of the producing industry, (2) have broad experience in estimating reserves, and (3) have an intimate knowledge of the areas assigned to them.

## CHAPTER 3

### DEVELOPMENT OF ENERGY RESOURCE AND RESERVE ESTIMATES

Federal agencies have developed specific procedures and methods for preparing estimates of domestic energy resources and reserves. The procedures and methods developed attempt to account for the lack of complete knowledge about the occurrence and distribution of domestic energy sources. As will be shown, assumptions and geologic inference are crucial factors in the methodologies used for assessing domestic energy resources and, to a lesser extent, reserves and have been primarily responsible for differences in estimates for the same energy source.

The following sections will describe, in general terms, how resource and reserve estimates are developed by Federal agencies for coal, crude oil, natural gas, and uranium.

#### COAL

The Survey, through its Branch of Coal Resources, prepares estimates of the coal resources of the United States. BOM prepares estimates of domestic coal reserves. Such estimates have been developed and revised from time to time and have been reported in bulletins, circulars, and other papers.

Estimates reported in 1975 are 3,968 billion tons of resources and a reserve base of 437 billion tons. Domestic coal production in 1974 amounted to 611 million tons.

#### Resource estimates

The current estimate of domestic coal resources prepared by the Survey includes quantities based on mapping and exploration (identified resources) and on geologic inference (hypothetical resources). The quantities included in these categories have been limited by thickness and depth restrictions. The restrictions are used so that only coal which is believed to be potentially recoverable would be included in the resource estimate. For example, coal existing in beds less than 14 inches thick or existing more than 6,000 feet below the surface is not included in the resource estimate.

The quality of coal may also limit its inclusion in a resource estimate. For example, coal with an ash content greater than 33 percent generally is not included in modern estimates.

The Survey's coal resource estimates have resulted from data supplied by State geological surveys, maps and drill



records from mining companies and others, private records of individuals, and the Survey's own studies of coal-bearing areas.

The estimate of identified resources is made by determining, from physical observations or subsurface drilling information, the thickness of coal beds, the area (in acres) the coal encompasses, and the approximate weight of the coal. In estimating identified resources, generally only coal that is believed to exist within 3 miles of a physical observation is considered. Once the three factors are determined, the thickness of the coal is multiplied by the number of acres the coal encompasses, which, in turn, is multiplied by the weight of the coal; the result is the identified resource. This procedure has been followed for all geographic areas where there are physical observations of coal. The sum of the coal in all such areas is the total identified resource.

Hypothetical resources are estimated by a process of extrapolation from nearby areas of identified resources. They are made because in most States many areas of coal-bearing rock were omitted from the estimate of identified resources due to the lack of specific information about the occurrence and thickness of the coal. These estimates are based on an understanding of regional geology sufficient to project resources beyond those already identified.

### Reserve estimates

There are no Federal estimates of total recoverable domestic coal reserves because recoverability, which is normally estimated by considering existing economic conditions and technology, is not included in existing Federal coal reserve estimates. BOM, however, does estimate the demonstrated reserve base of domestic coal by reclassifying coal resource estimates. The demonstrated reserve base reflects the quantity in relatively thick beds near enough to the surface to mine by conventional surface or underground methods. However, the demonstrated reserve base also includes coal which, because of economic or legal restrictions, may not be recoverable. For example, coal which meets the thickness and depth criteria, but exists under manmade features (such as roads) or natural features (such as lakes), is included in the reserve base.

According to BOM, the proportion of coal that can be recovered from an individual deposit (the reserve) varies from 40 to 90 percent according to the characteristics of the coal-bed, the mining method, legal restraints, and the restriction placed on mining because of natural and manmade features. Mining experience in the United States has indicated that, on a national basis, at least half of the in-place coal can be recovered.

Raw data from which demonstrated reserve base estimates are derived are resource estimates classified by the thickness of coalbeds, depth beneath the surface, and reliability of estimate. The demonstrated reserve base estimate is developed after certain restrictions are placed on these resource classifications. For example, coal is not classified as a reserve by BOM if its depth beneath the surface is greater than 1,000 feet (except at an operating mining site where coal is being recovered at greater depths).

### CRUDE OIL AND NATURAL GAS

The Survey's Branch of Oil and Gas Resources prepares estimates of crude oil and natural gas resources. Recent estimates of the Survey, which were prepared for FEA, were part of a continuing resource appraisal program. FEA, as required by section 15(b) of the Federal Energy Administration Act of 1974, recently prepared independent estimates of crude oil and natural gas reserves.

Recent Survey estimates of oil and gas resources (as a range) and FEA estimates of reserves of oil and gas are shown in the following table.

	<u>Reporting date</u>	<u>Crude oil</u> (billions of barrels)	<u>Natural gas</u> (trillions of cubic feet)
Identified resources (note a)	1975	182-202	529-554
Undiscovered resources (Survey)	1975	<u>94-238</u>	<u>362-737</u>
Total resources		<u>276-440</u>	<u>891-1291</u>
Reserves (FEA)	1975	<u>b/42.1</u>	240.2

a/Includes reserve estimates of the API and AGA.

b/Includes 4.1 billion barrels believed to be economically recoverable when additional recovery methods are installed in some fields.

Oil consumption during 1975 was about 6 billion barrels whereas natural gas consumption in 1975 was about 20 trillion cubic feet.

## Resource estimates

Although the Survey prepares estimates of the total domestic resources of oil and gas (as shown above), its estimates of the undiscovered recoverable resources of these materials have been given the greatest level of attention. Such estimates attempt to measure that quantity of a fuel which has not been discovered but which is assumed to be discoverable and recoverable under conditions represented by price-cost relationships and technological trends prevailing at the time of the estimate. As such the estimates are made on the basis of relevant experience concerning recovery factors, geology which has, historically, been favorable to the occurrence of producible materials, and the size and type of deposits which have previously been found, developed, and produced.

Resource estimates reported in 1975 were developed after a detailed analysis by the Survey of 102 individually appraised geologic petroleum provinces. Data for the appraisals was obtained from three main sources: verbal and written contributions from Survey geologists; published references consisting of geological information, exploration, and production history data and maps; and unpublished Survey materials. The appraisals involved an estimate of the value of potentially prospective rock, generally to depths of 30,000 feet. Following the appraisal specific resource estimation techniques were used to arrive at an estimate of the oil and gas resources. Specific techniques included an extrapolation of information from substantially tested areas into untested areas with similar geology, comprehensive comparisons of all known published estimates for each area being appraised, and the use of subjective probabilities. Recovery factors of 32 percent for oil and 80 percent for gas--national averages for actual recovery of these fuels--were used to arrive at estimates of the amount of oil and gas which would be recoverable.

The Survey prepared four estimates of undiscovered recoverable oil and gas resources in the last 12 years; in 1965, 1972, 1974, and 1975.

<u>Year</u>	<u>Crude oil and natural gas liquids</u>	<u>Natural gas</u>
	(billions of barrels)	(trillion cubic feet)
1965	264	1,080
1972	450	2,100
1974 (as a range)	200 to 400	1,000 to 2,000
1975 (as a range)	61 to 149	322 to 655

The above table reflects the great uncertainties associated with recent resource estimates and also raises questions concerning estimating techniques. The above estimates differed noticeably in (1) geographic areas being measured, (2) estimating techniques, and (3) quantity and quality of available raw data.

The method used for the 1965 estimate involved classifying adequately explored geographic areas into categories of oil and gas potential in terms of barrels for each 1,000 square miles. The categories were then applied to the inadequately explored areas to arrive at an estimate of the undiscovered recoverable oil and gas resources. Much of this procedure was based on available factual data, but the geologic analyses of the explored and inadequately explored areas are very subjective, as is what constitutes adequate exploration.

The 1972 estimates reported by the Survey were prepared using the same basic methodology used in the 1965 estimates. However, the 1972 estimates included analyses of offshore areas to water depths of 8,200 feet, whereas the 1965 estimate included offshore areas to depths of 660 feet. The 1972 estimate was over 70 percent greater than the 1965 estimate.

The 1974 estimates were made using new raw data to supplement existing data and a modified geologic analysis approach that was previously used. The concept of a range of estimates was introduced to account for the possibility that unexplored areas may contain less oil and gas than explored areas with similar geology. The analysis also included the assumption that an oil recovery factor of 30 percent for the conterminous United States and 40 percent for offshore areas and Alaska were reasonable. Offshore areas were included to water depths of 660 feet.

In reviewing past Survey estimates, it should be noted that, as the quality and quantity of raw data increased over the years, the resource estimates apparently became more refined. In addition, the potential exists for increased future supplies of crude oil through technological advances in secondary and tertiary recovery methods as evidenced by the general recovery rate for oil. Furthermore, limiting offshore areas considered in resource estimates to those with water depths less than 660 feet may have resulted in a considerable lowering of resource estimates.

#### Reserve estimates

FEA completed the first comprehensive Federal analysis of domestic oil and gas reserves in October 1975 and released the final results of its analysis in November 1975. FEA's

reserve study consisted of two parts; a survey of all oil and gas field operators and engineering analyses of a selected sample of major oil and gas fields.

For the survey over 22,000 questionnaires were mailed asking the operators for, among other things, their estimates of the oil and gas reserves for each of the properties where they were the operator. Operators were not required to report reserves for those fields in which they produced less than 20,000 barrels of oil or 100 million cubic feet of gas in 1974. Final results from the survey were adjusted to account for the operators who did not respond or who failed to respond adequately. Of the 22,000 questionnaires mailed, about 10,000 were not used because potential respondents (1) were out of business, (2) did not respond, (3) could not be located, or (4) returned unusable information. The nearly 12,000 responses used represented 97 percent of oil and 95 percent of natural gas production in the Nation for 1973.

The engineering analyses of a selected sample of major oil and gas fields were undertaken as a check on the operator survey results. The sample was drawn from a list of the 125 largest oil fields and the 25 largest gas fields in the United States in terms of 1973 production. A total of 59 oil and gas fields were selected for analysis representing half the Nation's proved crude oil reserves and about 30 percent of U.S. natural gas reserves. The engineering analyses of these fields were made by the Survey, BOM, FEA, and private contractors.

FEA directed the contractors to select the method of reserve estimation they believed to be most appropriate for each individual field. They were also responsible for selecting the data and the data sources used in their analysis. In most cases the field studies were prepared after reviews of available interpretive information. In only some cases was additional interpretative information obtained from operators although in most cases additional factual information was obtained. Both the respondents to the operator survey and the field study teams based their answers and analyses on the oil and gas prices and the recovery methods being used as of December 31, 1974.

The results of FEA's reserves study were reasonably compatible with the information reported by API and AGA. The FEA estimate for oil was 11 percent higher than the API estimate, whereas FEA's natural gas estimate was 3 percent higher than the AGA estimates.

In summary, FEA's approach in carrying out its study included a direct survey of oil and gas field operators and

an independent analysis of reserves in selected oil and gas fields. This approach offered FEA the opportunity to obtain reserve estimates from those responsible for producing the oil and gas while also obtaining independent assessments of raw data to arrive at reserve estimates in selected fields. In view of the nature of the study and the relatively short time in which to complete the study (1 year), we believe FEA's approach was reasonable.

In May 1976, at FEA's initiation, the Ad Hoc Committee on Oil and Gas Reserves Survey was established. The Committee comprises representatives of FPC, the Interior, FEA, and the Office of Management and Budget. The purpose of the Committee is to address petroleum reserve data needs of the Federal Government and data collection alternatives. One of the issues to be studied is how often oil and gas reserve data should be collected.

We believe the Committee's efforts to develop a plan for obtaining useful oil and gas reserve information to meet the needs of the Federal Government is appropriate and necessary. We also believe that any plan developed by the Committee should require that oil and gas reserve data be updated on a regular and recurring basis.

#### URANIUM

Both ERDA and the Survey have prepared estimates of domestic uranium resources. However, in December 1975 the two agencies agreed that the Survey would provide raw data to ERDA and prepare uranium resource reports only on specific areas. Thus, the Survey no longer makes estimates of total domestic uranium resources. In the past these agencies generally limited their estimate to geographic areas in the Western United States. The last Survey estimate, made in 1965, was reviewed during 1974, and no changes were made.

ERDA also develops estimates of domestic uranium reserves and reports them annually. The recent domestic uranium resource and reserve estimates reported by ERDA in April 1976, were 2.92 million tons of resources and 640 thousand tons of reserves. These estimates are based on a cutoff cost of \$30 a pound or less. The cutoff cost includes estimated operating costs and those capital costs not yet incurred. Profit and costs already incurred, such as expenditures for property acquisition, exploration, and mine development, are not included. Domestic uranium production during 1975 was 11,600 tons.

## ERDA resource estimates

The National Uranium Resource Evaluation (NURE) program, initiated in 1973 and conducted by ERDA, is intended to expand the coverage of previous estimates by assessing total domestic uranium resources. The first comprehensive report is scheduled for 1981. Preliminary results reported in July 1975 and June 1976 indicated that the United States possesses more uranium resources than previously estimated.

ERDA obtains basic data used to estimate uranium resources from private companies (on a voluntary basis); the Survey; private contractors; universities; BOM; State geological surveys; and, to a lesser extent, ERDA's own exploratory work. The basic data includes information from industry drill holes, drill-hole maps, and geologic studies.

ERDA's computation of uranium resources is based on the assumption that the uranium potential of a geographic area could be comparable to a thoroughly explored area if certain key favorability characteristics are similar. Judgment is used in assigning values to the favorability characteristics. Values are assigned based on the similarity of the unexplored area to an area where a uranium deposit is known to exist.

## Reserve estimates

ERDA prepares uranium reserve estimates from data supplied voluntarily from private companies. The majority of this information is subsurface information obtained from analyses of drill holes.

The procedure used to arrive at the reserve estimates is to (1) convert the raw data to computer readable information, (2) analyze the data using computer programs to determine the size and grade of the uranium deposit, and (3) perform an economic analysis to determine the forward cost for recovery. Economic analyses are made possible because many of the major uranium producers voluntarily provide cost data to ERDA.

## CHAPTER 4

### ANALYSIS OF FEDERAL ENERGY RESOURCE

#### AND RESERVE ESTIMATES

The concepts of energy resources and reserves have received much attention in recent years, especially since the oil embargo in late 1973. Since that time, various estimates have been made of the domestic resources and reserves of coal, oil, natural gas, and uranium. The estimates prepared have been an attempt to measure the potential short- and long-term domestic supplies of these fuels.

In conjunction with and as a result of reported energy resource and reserve estimates, opinions have been formed about (1) the need for more reliable resource and reserve estimates, (2) the need for more data to assess resources and reserves, and (3) the role such estimates can and should play in decisions relevant to the domestic energy situation. The following sections put the concepts of resources and reserves in perspective and identify problems in the current Federal data base for energy resources and reserves.

#### RESOURCE ESTIMATES

Resource estimates include components which are estimated from various degrees of knowledge about a material's existence and recoverability. The component based on the most knowledge is the reserve. Beyond this the identified subeconomic resource is the next most certain component. This component can be reclassified as a reserve based on favorable economic or technological changes in recovery operations.

The remaining major resource component, based on the least amount of information, is the undiscovered resource. This component is further subdivided between undiscovered recoverable resources and undiscovered subeconomic resources. Increased knowledge about a material's existence can cause these resources to be reclassified as identified.

Estimating undiscovered resources can result from a wide range of basic data. For example, an estimate of such resources can be based entirely on geologic judgment and inference or on a considerable amount of subsurface information (such as seismic readings and, particularly, subsurface drilling information), which may not prove that a material exists but which greatly increases the level of certainty about the material's existence.

Projections of serious limitations in the future availability of crude oil and natural gas and indications of potential



limitations in the future availability of uranium to provide nuclear energy without advanced breeder reactors have focused attention on estimates of undiscovered recoverable resources of oil and gas and potential resources of uranium. These estimates indicate that great quantities of these fuels can be discovered and recovered. Consequently, major actions have been initiated and/or continued to increase future supplies of these energy sources. For example, the Interior recently offered and received bids on tracts to be leased on the Atlantic OCS for oil and gas. Furthermore, ERDA is pursuing its program to develop and commercialize advanced fast breeder reactors which have the potential to use uranium resources much more efficiently than is currently done.

These decisions, however, have been partly based on estimates of undiscovered recoverable resources of oil and gas and potential resources of uranium which were prepared without the benefit of subsurface data in many potentially favorable areas. Such data would greatly increase the level of certainty concerning the likelihood that these materials exist and provide a better basis for analyzing future energy supply options.

#### Need for data on oil and gas potential of OCS areas

In the past we have reviewed a number of issues concerning the oil and gas development of offshore areas. These efforts were designed to help illuminate both the issues and opportunities associated with implementing a national energy policy. A major problem identified in two previous reports <sup>1/</sup> was the need for better data on which to base Federal leasing decisions. An additional problem, which is discussed below, is the need for an adequate assessment of the potential of oil and gas resources in many offshore areas. Currently, data concerning the subsurface geology of certain OCS areas, including Alaska, is limited. However, these areas--the Atlantic and Pacific OCS and the Alaskan OCS--are estimated to contain about 26 percent and 12 percent, respectively, of domestic undiscovered recoverable oil and gas resources. These estimates were prepared, for the most part, without the benefit of data obtained from drilling.

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<sup>1/</sup>"Outlook for Federal Goals to Accelerate Leasing of Oil and Gas Resources on the Outer Continental Shelf" (RED-75-343, Mar. 19, 1975); "Outer Continental Shelf Oil and Gas Development--Improvements Needed in Determining Where to Lease and at What Dollar Value" (RED-75-359, June 30, 1975).

Both Government and industry officials agree that drilling stratigraphic holes would greatly improve the geologic knowledge about potential petroleum accumulation. From deep stratigraphic test results, scientists can determine the nature of various rock layers and the ability of the rocks to transmit and retain oil and gas.

In 1974 the Department of the Interior established a program to afford private industry an opportunity to obtain permits to drill stratigraphic holes in OCS areas and Alaska. Since the program started two such wells have been drilled off Texas--one has been drilled on the Alaska OCS, a fourth was drilled off Southern California--and deep stratigraphic testing is being carried out in the Atlantic. The Survey obtains the data from test wells as they are drilled. The data is made available to the public after 5 years or 60 days after the issuance of the first Federal lease within 50 miles of the well, whichever is earlier.

The program is aimed at obtaining scientific data about the geology of the OCS to provide better and more complete information to evaluate potential resources. In addition, the test wells provide useful geologic information as an aid in evaluating tracts to be offered in tentatively scheduled lease sales. According to the Interior, the program helps the Federal Government to respond to the need for fundamental scientific data prior to any decision concerning leasing. Under this program drilling has been done for the most part at private industry's preference without Federal involvement or direction to insure adequacy of data coverage.

We pointed out in our June 30, 1975, report, "Outer Continental Shelf Oil and Gas Development--Improvements Needed in Determining Where to Lease and at What Dollar Value," that the Government should initiate the development and implementation of a systematic exploration plan for resource appraisal, including a timetable for providing minimum levels of exploratory coverage in Shelf areas and the collection, analysis, and mapping of resource data. We stated that the Interior should encourage industry to conduct additional stratigraphic drilling tests similar to those off south Texas, as part of implementing such a plan. However, to insure that the plan is fully implemented, the Federal Government should finance stratigraphic tests in those areas where private industry does not plan to drill.

In commenting on a recommendation in that report to implement a geological exploration program including stratigraphic drilling, the Interior stated that the recommendation did not consider the cost effectiveness of such a program and questioned the use of a Government-financed drilling program.

The Interior, commenting on a draft of this report, stated that it had made difficult and necessary decisions in a timely fashion using the best information available. In addition, the Interior said that it considered its data coverage in areas offered for lease to be sufficient for a technically sound determination of fair market value and considered the industry-financed stratigraphic tests generally to be well placed and adequately tested to furnish valuable data.

FEA, in commenting on this issue, stated that the concept that more and better data would enable better resource appraisal is correct, but the procedures suggested to develop such data are questionable. According to FEA, stratigraphic drilling is a major expense of any exploration effort whether executed by the Government or private industry, and the amount of drilling necessary to provide information to adequately evaluate tracts before they are leased to insure that the public receives a reasonable return could be extensive. FEA pointed out that the minimum levels of exploratory coverage in OCS areas recommended may not coincide with coverage necessary to adequately evaluate tracts before leasing. FEA also stated that the concept of establishing minimum levels of exploration in a given area is a good one but that granting exclusive exploration rights to any single entity is dangerous.

Concerning the Interior's comment that it considered its data coverage in areas offered for lease to be sufficient for a technically sound determination of fair market value and considered the industry-financed stratigraphic tests to furnish valuable data, it was not within the scope of this report to address tract evaluation. However, in our review of the Interior's OCS Sale #35, we found that the data available to the Interior in 211 of 231 tracts appeared to be less than adequate to determine the fair market value.

In considering other agency comments on this section, we believe further clarification of our views on this issue is warranted. We believe that existing resource appraisals of the oil and gas potential in many OCS areas can be greatly improved by developing and implementing a systematic resource appraisal program which includes minimum levels of stratigraphic drilling. We believe also that data obtained from stratigraphic drilling is essential because it provides specific information on various rock layers and the ability of the rocks to transmit and retain oil and gas. Seismic information does not provide this information.

Agency comments on this issue centered on three basic points; the amount of stratigraphic drilling that would be

needed, the financing of that drilling, and the costs and benefits of such a program.

Concerning the amount of stratigraphic drilling, we agree with FEA that the minimum level of drilling necessary for adequate resource appraisal may not coincide with coverage necessary to adequately evaluate tracts before leasing. The amount of stratigraphic drilling we are proposing, as part of a systematic resource appraisal program, would be much less extensive than that required for comprehensive tract evaluation; and it should be that level of drilling which the Interior determines is needed to provide minimum levels of subsurface data coverage in major OCS geologic basin areas.

With regard to financing stratigraphic drilling, we concur with the Department of the Interior's comment that a totally Government-financed drilling program may not be appropriate. We are proposing that a plan for a systematic appraisal of OCS resource potential be developed which would identify, among other things, those specific areas where the Interior determined that stratigraphic drilling should be performed. Private industry should then be encouraged to perform the planned stratigraphic testing to the extent it is willing to do so, and the Government should take the necessary actions, including the financing of any additional drilling needed to fully carry out the resource appraisal plan. Such an approach will provide better information to more realistically assess the oil and gas potential of OCS areas.

Concerning the cost effectiveness of such a program, the cost to the Federal Government cannot be determined until the Department of the Interior develops a resource appraisal plan, identifies the levels of stratigraphic drilling needed to assess major OCS areas, and determines the extent to which private industry is willing to perform such drilling. The benefits of stratigraphic drilling, although difficult to quantify, could be measured, to some extent, by industry's willingness to undertake such efforts under a positive comprehensive program developed by the Interior. In addition, benefits to be realized from such a program include information to enable policymakers to formulate broad energy policy and to give precedence to OCS areas for leasing purposes.

We believe that a program for resource appraisal of OCS areas as described above is necessary to provide a more reasonable basis to evaluate the role of the OCS in supplying future energy needs. In addition, the information obtained, if used in conjunction with the results of available environmental information involving the same geologic areas, would

provide a better basis than now exists for evaluating resource development potential and potential environmental impacts both within and between geologic areas.

One way to initiate a drilling program could be through a notice in the Federal Register encouraging industry to conduct the needed drilling to the greatest possible extent; the information developed should be shared with the Interior on a confidential basis. After the extent of industry participation was known, if any gaps then existed, the Interior should take the necessary actions, including public financing of stratigraphic drilling, to obtain the needed data.

This seems to us to be at least one possible version of a positive drilling program, initiated and directed by the Interior, with the potential for major public benefits. The Department of the Interior has never undertaken such a program for the purpose of assessing the OCS resource potential. Although this report does not address the issue of track evaluation to determine the fair market value in the Federal leasing program, the information gathered from the program we recommend would be useful in such evaluations.

#### Need for a more complete appraisal of uranium resources

Projections of the role of uranium in providing nuclear fuel to the Nation in the future indicate that nuclear fuel can provide a greater source of energy through the introduction of advanced breeder reactors and an expansion of the use of light water reactors. If breeder reactors are not introduced when projected, it becomes questionable whether the Nation can provide uranium to meet projections, beyond the year 2000, using commercially available reactors and based on uranium currently known to be available.

ERDA is attempting to resolve problems in its development and commercialization of the liquid metal fast breeder reactor (LMFBR), its priority breeder program. In our July 31, 1975, issue paper, "The Liquid Metal Fast Breeder Reactor: Promises and Uncertainties" (OSP-76-1), we pointed out that problems involving development and commercialization of the LMFBR, such as safety, safeguards, and environmental impacts, have not been adequately resolved. A key concern surrounding whether LMFBR or other breeder technology will be needed before the year 2000 and, if so, how soon, is the amount of economically recoverable uranium which the United States possesses.

The Federal Government has not completely assessed U.S. uranium resources. Recent uranium resource estimates have generally been limited to appraisals of the uranium potential in the Western United States, although a preliminary evaluation of the potential for uranium deposits in areas other than the Rocky Mountain area was released by ERDA in June 1976.

In June 1974 the Survey estimated that thoroughly appraising the U.S. uranium resource base would take from 5 to 10 years and would probably cost about \$523 million. Virtually all of the cost--\$500 million--would be for exploratory drilling and supporting services. Because much of this work would not yield a direct dollar return in a short time, the Survey noted that it probably would have to be done by the Federal Government.

We believe that an aggressive, accelerated effort is needed to define the availability of economically recoverable U.S. uranium resources. Consideration should be given to expediting the work and final report of ERDA's NURE program and to the Survey's alternative approach of thoroughly appraising the U.S. uranium resource base through extensive exploratory drilling by the Federal Government. Obtaining such information in a shorter time frame would be useful for decisions on commercializing new breeder reactors and on the future role of nuclear energy as a supply option.

ERDA, in commenting on a draft of this report, agreed that the NURE program should be expedited to the extent practicable. ERDA pointed out that the program is being rapidly expanded and should provide adequate information for more long-term planning. Concerning a Federal Government sponsored exploratory drilling program, ERDA believes its approach will result in a better appraisal than an extensive drilling program carried out in relatively few selected areas.

The Interior stated that an intensified uranium drilling program would lead to a more accurate assessment of undiscovered uranium resources. The Interior also said that even if the results of such a program were largely negative, that in itself would be useful information. However, the Interior felt that the costs and benefits of this program should be evaluated before recommending such a program.

We continue to believe that the Federal Government should eliminate significant data gaps in its knowledge of uranium resources so it can realistically determine when new technologies, such as the fast breeder reactors, will be needed. Such knowledge will also provide a basis for analyzing future energy supply alternatives.

In view of the differing points of view regarding a uranium exploratory drilling program, we believe ERDA and the Interior, under the general direction of FEA, should undertake a joint effort to identify the costs and benefits of such a program, including suitable levels of private industry and Government financing and report the results of that effort, with appropriate recommendations to the Congress.

### RESERVE ESTIMATES

In general a reserve is that portion of an identified resource which can be economically extracted. Important factors which differentiate a reserve estimate from identified subeconomic resource estimates are economic conditions and existing technology at the time of the estimate. Therefore, reserve estimates are likely to change as economic conditions change or as new technologies for recovery are introduced. The change would result from reclassifying subeconomic resources.

We believe the usefulness of reserve estimates of certain energy sources which have been reported by Federal agencies can be greatly improved not only for explicit Federal leasing decisions but also in terms of energy policy formulation involving choices and timing among alternative sources of supply. To assess the future availability of different energy fuels, additional information is needed (1) concerning the effect of cost-price relationships on the recovery of fuels, (2) on the quantities of recoverable coal reserves, and (3) on energy sources in the public domain and in the control of individual private companies.

### Need for cost and price information on reserves

Generally a measured reserve is an assessment of expected ultimate recovery of a fuel under economic and technological conditions prevailing at the time of the estimate. Thus a change in economic conditions or a technological advance would necessarily change the assessment of expected ultimate recovery. In order to increase the usefulness of reserve estimates for decisionmaking purposes, information is needed on the effects

of cost-price relationships on energy source recoverability. Such information would provide a basis for assessing such things as the desirability of Federal research and development into new recovery techniques and the feasibility of realizing various energy supply options to meet future needs.

Cost-price relationships have generally been excluded from reserve estimates of fuels, although reserve estimates for uranium include assessments indicating the general quantity of uranium expected to be available under different cost conditions. Specific studies have also attempted to analyze the effects of price on energy source recoverability. For example the Interstate Oil Compact Commission (IOCC), under contract with FEA's Office of Energy Resource Development, analyzed the effect that price increases would have on ultimate recovery of oil from wells using enhanced recovery techniques. This study, dated February 1975, indicated the effect of various pricing levels on expected ultimate recovery of fuels. It concluded, among other things, that decontrolling the selling price of oil produced by enhanced recovery methods could result in a projected increase in ultimate recovery of 10 billion barrels. In addition Lewin and Associates, Inc., under contract with FEA, also studied the effects of price on oil recovery for major fields in three States. Their report, dated April 1976, concluded that with prices at \$11.28 per barrel, 30.5 billion barrels would be economical to recover through enhanced recovery techniques; with prices at \$5.25 per barrel, only 5.2 billion barrels would be economical to recover.

The FEA Act required FEA to submit a report to the Congress on domestic oil and gas reserves and resources within 1 year. The Congress desired information on the extent that reserves would fluctuate under various cost-price relationships; however, FEA did not obtain such information. Although FEA recognized the need for this information, FEA officials believed that obtaining cost-price information from respondents would have delayed the survey. In addition FEA believed that many respondents, particularly smaller ones, would not have the expertise to provide accurate information. According to the IOCC engineer in charge of its study, however, oil well and gas well operators are the best source to provide reserve estimates under various cost-price relationships.

Ultimate recovery of an energy source may fluctuate considerably because of changes in cost-price relationships. Therefore, we believe that economically sound policy decisions with respect to development of domestic energy sources



and assessments of the relative importance and timing of various supply options can only be made by assessing the availability of various fuels under different cost-price relationships. In addition we believe that FEA should take the necessary actions to obtain information on the effects of cost-price relationships on the recoverability of oil, gas, and coal.

FEA, in commenting on this issue, stated that developing accurate reserve estimates to reflect cost and price relationships is desirable and important but complicated. Developing such estimates based on future governmental regulations and environmental constraints would also be desirable. FEA pointed out that estimates of the effect of such variables would have a high degree of uncertainty. We believe that uncertain data is better than no data at all. We realize that work dealing with future actions or alternatives other than existing actions are, by necessity, uncertain.

The Interior, which is studying the economics of fuel availability, pointed out that BOM has done considerable costing work in the energy field.

FPC chose not to debate GAO's position on the need for cost and price information on reserves. FPC pointed out, however, that estimating resource availability under various economic conditions would be complicated and time consuming. According to FPC, the degree of uncertainty dramatically increases as alternate economic criteria are specified. In addition, since the commonly accepted definition of proved reserves does not include variable economic and operating conditions, new estimation procedures would have to be developed and their testing would require several years. Thus, FPC believes the procedures would remain highly controversial, limiting their usefulness as policy inputs for some time. Although we do not disagree that estimating reserves under various economic conditions may be complicated and time consuming, in our view, this should not preclude obtaining the information.

ERDA pointed out that in order to plan its enhanced oil and gas recovery programs, detailed knowledge of the magnitude and characteristics of identified oil and gas resources is required. According to ERDA, this information would contribute greatly towards the need to better assess the availability of various energy fuels under different economic conditions. In addition ERDA pointed out that confidentiality of information collected by other Federal agencies has been a problem in carrying out these programs.

While this report does not address the issues of confidentiality of information, we did discuss this problem in earlier reports. <sup>1/</sup> In essence we believe that the terms "confidential" and "proprietary," as related to energy information, have been overused and that steps should be taken to restrict confidential data to the absolute minimum. Our general view is that the burden of proof should be on those who argue that energy-related information is proprietary and should be withheld from the public.

### Need for information on the availability of coal

As pointed out previously BOM prepares estimates of the demonstrated reserve base of coal. This base is simply an assessment of those domestic coals estimated to exist in physical settings which are minable by conventional methods. These estimates are based principally on resource estimates prepared by the Survey and State geological surveys. While BOM has a useful way for identifying physical amounts of coal, until economic factors and technology are related to its recoverability, such estimates have limited usefulness for assessing the need for Federal actions to meet goals of increased coal production.

Demonstrated coal reserve base estimates do not take into account important factors which will limit ultimate recovery. Of the coal included in the demonstrated reserve base, large tonnages are unavailable for mining because removal would conflict with other land uses, such as coal beneath towns or highways and under rivers or railroads. Other portions of coal are not minable because they are in beds closely overlying mined-out coalbeds and, therefore, are dangerous and expensive to mine.

FEA is charged, under the Energy Supply and Environmental Coordination Act of 1974, with preparing, on a quarterly basis, an energy information report which includes information on domestic reserves and production of coal. Yet the quarterly reports issued through the fourth quarter of 1975 did not include an estimate of domestic

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<sup>1/</sup>"Actions Needed to Improve Federal Efforts In Collecting, Analyzing, and Reporting Energy Data," B-178205, February 6, 1974; "Improvements Still Needed In Federal Energy Data Collection, Analyses, and Reporting," OSP-76-21, June 15, 1976.

coal reserves. FEA was intending to rely on information on coal reserves being collected by the Federal Trade Commission (FTC). However, the FTC survey is limited in scope and will not provide a complete assessment of domestic coal reserves.

In its quarterly report for the first quarter of 1976, FEA included an estimate of remaining coal reserves as of March 1976. However, this estimate was derived from the BOM-demonstrated coal reserve base estimate by applying standard recovery factors of 50 percent for deep-mined coal and 80 percent for surface-mined coal and by adjusting these figures for coal production for 1974, 1975, and the first quarter of 1976.

We believe information on those quantities of coal currently considered recoverable should be obtained from coal producers by FEA. This information is important for determining the need for additional coal leasing by the Federal Government and for assessing the need for Federal actions to initiate production of coal on Federal lands already leased but where coal development and production is not taking place.

The Interior, in commenting on this issue, stated that efforts should be made to update coal reserve information. It said that there is no great sense of urgency for national updating because coal reserves and resources are obviously many times greater than production requires now and for the next 10 to 15 years. It believes that canvassing coal producers for reserves on a national basis would yield uneven results due to local variations in development practice and the amount of coal that operators feel is necessary to keep in front of the working area.

On this issue, FPC suggested that information on Btu and sulfur content be included in any effort to obtain coal reserve information from coal producers. ERDA generally agreed that there is a need for better estimates of economically recoverable coal reserves and suggested that information on chemical composition and washability of coal be included in any additional analyses of coal seams.

ERDA also pointed out that consideration should be given to developing a coal resource and reserve data base that would classify coal suitable for in situ processing.

We believe that information on coal reserves obtained from coal producers is necessary to evaluate the quantities of coal expected to be produced from existing mines. This information will allow the Federal Government to assess further actions which may be needed to meet goals of increased coal production, including the need for further leasing of Federal coal lands. We believe also that information on Btu and sulfur content and chemical composition and washability of coal should be included in such an effort, as suggested by FPC and ERDA.

#### NEED FOR INFORMATION ON OWNER- SHIP OF ENERGY SOURCES

The Federal Government has limited information about ownership and control of domestic energy sources and, therefore, has incomplete information on (1) the extent of energy sources currently under the control of private industry with potential for early development and (2) those energy sources which the Federal Government owns or controls and for which direct action would be needed by the Federal Government to initiate development. Although some assessments are made of specific Federal land areas, no special effort is made to isolate and assess all Federal land.

Section 13(f) of the Federal Energy Administration Act of 1974, 15 U.S.C. 772 (f) (Supp. V, 1975), states that:

"The Administrator shall collect from departments, agencies and instrumentalities of the executive branch of the Government (including independent agencies), and each such department, agency, and instrumentality is authorized and directed to furnish, upon his request, information concerning energy resources on lands owned by the Government of the United States. Such information shall include, but not be limited to, quantities of reserves, current or proposed leasing agreements, environmental considerations, and economic impact analyses."

Concerning this legislative requirement the FEA Administrator has stated that information on the quantities of energy resources on Federal lands is unavailable and that evaluations of energy reserves on Federal lands are usually made before offering tracts for lease.

Adequate knowledge about the ownership and control of U.S. energy sources is important in developing appropriate

policies and programs to foster the orderly development and use of all energy fuels. This information would aid the Federal Government in its assessment of the need for and effectiveness of Federal leasing programs to increase the domestic supply of energy fuels.

As we pointed out in our report on, "Role Of Federal Coal Resources In Meeting National Energy Goals Needs To Be Determined And The Leasing Process Improved" (RED-76-79, April 1, 1976), the Department of the Interior had given little attention to adequately valuing coal lands and has leased coal under conditions of great uncertainty about the quantity and quality of coal resources. We recommended that the Secretary of the Interior direct a coal-drilling program which would provide data for developing and implementing a systematic plan for appraising coal resources (on Federal lands).

Beyond the public/private distinction, additional information should be obtained concerning large quantities of energy sources controlled or owned by individual companies or industries and which may not be available to the general domestic supply of energy. As stated in a report prepared by Federal Trade Commission staff in March 1974, such information is necessary if Government agencies are to estimate the price and availability of fuels in the future and if antitrust agencies are to evaluate the competitive impact of an actual or proposed interfuel merger. We believe the FEA, using information gathering authorities granted to it under the Energy Supply and Environmental Coordination Act and the Federal Energy Administration Act of 1974, should obtain such information.

The Interior, in responding to a draft of this report, stated that although no effort was being made to access all Federal lands, the Survey has an ongoing program to define those areas in western coal basins where workable coal units are definitely known to exist. In addition the Survey is compiling all available data on those lands and supplementing that data with drilling.

FEA, in commenting on a draft of this report, stated that data on ownership is important but that an analysis of ownership would be difficult and complex. According to FEA the royalty owners throughout the United States own about 15 percent of these resources and many have no means of determining their reserves. FEA stated that the task could be more manageable by developing the data for major

companies owning or controlling significant quantities of resources.

FPC said that it was in the advanced stages of implementing a data collection program, applicable to jurisdictional companies and their affiliates, which will provide an annual reporting, by owner, of a large portion of the Nation's proved reserves of natural gas; and any effort to obtain oil and gas reserve data on an ownership basis should take advantage of FPC's natural gas reserves reporting program. FPC concluded that this body of information would assist in the meaningful and important analyses necessary to support national energy policy formulation and implementation.

We agree that FPC's program to obtain natural gas reserve ownership information should be relied on, to the greatest extent, in developing and implementing a program to obtain ownership information for all energy sources.

On August 4, 1976, the Federal Coal Leasing Amendments Act of 1975, Public Law No. 94-377, was enacted. Under the act the Secretary of the Interior is authorized and directed to conduct a comprehensive exploratory program, including stratigraphic drilling, to evaluate the extent, location, and potential for developing coal resources on Federal lands. This legislation, if effectively implemented, should provide the data necessary to adequately appraise the coal resources on Federal lands.

#### ENERGY CONSERVATION AND PRODUCTION ACT

On August 14, 1976, the Energy Conservation and Production Act, Public Law No. 94-385, was enacted. This act, among other things, established a National Energy Information System in the newly created Office of Energy Information and Analysis within FEA. The System is required to contain information to provide a description of and facilitate analysis of energy supply and consumption within and affecting the United States.

According to the act, the System is to include energy information necessary to define and analyze

--the institutional structure of the energy supply system, including patterns of ownership and control of mineral fuel and nonmineral energy resources; and the production, distribution, and marketing of mineral fuels and electricity; and

--the sensitivity of energy resource reserves, exploration, development, production, transportation, and consumption to economic factors; environmental constraints, technological improvements, and substitutability of alternate energy sources.

To meet partial requirements of the System, information will be necessary on (1) the effects of cost-price relationships on the recoverability of oil, gas, and coal; (2) the availability of coal; and (3) the ownership and control of energy sources. We believe it is imperative that FEA obtain such information and also monitor the Interior's implementation of the comprehensive exploratory program authorized under the Federal Coal Leasing Amendments Act of 1975.

## CHAPTER 5

### CONCLUSION AND RECOMMENDATIONS

In recent years there has been an increased awareness of the need for better information on domestic energy resources and reserves. As a result certain Federal agencies have taken actions to improve the Federal Government's knowledge in this area. However, our examination of Federal data on resources and reserves of oil, gas, coal, and uranium has indicated that certain information is missing which should be obtained to strengthen the basis for decisions about the United States' energy future. Specifically, we found that

- data on the oil and gas potential of certain OCS areas is severely limited,
- a complete appraisal of domestic uranium resources is needed to better assess ongoing research and development programs,
- information to better assess the availability of various energy fuels under different economic conditions is lacking for most energy fuels,
- information on quantities of coal currently considered recoverable is lacking, and
- information on ownership and/or control of domestic energy resources and reserves is severely limited.

In our June 30, 1975, report entitled "Outer Continental Shelf Oil and Gas Development--Improvements Needed in Determining Where to Lease and at What Dollar Value" (RED-75-359), we recommended that the Secretary of the Interior direct a geological exploration program which would provide for the development and implementation of a systematic plan for appraising OCS oil and gas resources, including selective stratigraphic test drilling.

We continue to endorse this recommendation and believe that the plan should identify the level of stratigraphic drilling necessary to provide a minimal level of data coverage for major OCS areas. After the plan has been developed, the Department of the Interior should encourage private industry to conduct the drilling identified in the plan. After the extent of industry participation is known, if any data gaps still exist, the Department of the Interior should take the necessary actions, including



public financing of stratigraphic drilling, to obtain the needed data.

We also recommended in our July 31, 1975, issue paper, "The Liquid Metal Fast Breeder Reactor: Promises and Uncertainties" (OSP-76-1), that ERDA expedite the work and final report of its National Uranium Resource Evaluation program currently scheduled for completion in 1981. We continue to endorse this recommendation and also recommend that ERDA and the Department of the Interior, under the general direction of FEA, undertake a joint effort designed to identify the costs and benefits of a uranium exploratory drilling program, including suitable levels of private industry and Government financing, and report the results of that effort, with appropriate recommendations, to the Congress.

The establishment of an Office of Energy Information and Analysis within FEA has placed additional responsibilities on that agency in the area of energy data collection and analysis. To effectively carry out the requirements of that office, as set forth in the Energy Conservation and Production Act, it will be necessary for FEA to obtain additional information on domestic energy resources and reserves. Based on our examination and this new requirement, we recommend that the Administrator, Federal Energy Administration:

- Determine the ownership and/or control over domestic energy fuels by major companies.
- Obtain from coal producers estimates of recoverable domestic coal reserves using appropriate verification techniques and develop plans to update the results of this effort on a regular and recurring basis, including the effects of cost-price relationships on recoverability.
- Work with the appropriate Federal departments and agencies to fulfill the informational requirements of section 13(f) of the Federal Energy Administration Act of 1974, including monitoring of the Department of the Interior's implementation of the comprehensive exploratory program authorized under the Federal Coal Leasing Amendments Act of 1975.
- Update on a regular and recurring basis, estimates of oil and gas reserves, including the effects of cost-price relationships on recoverability.

FEDERAL INTER-AGENCY COUNCIL ON ENERGY INFORMATION  
C/O NATIONAL ENERGY INFORMATION CENTER  
1200 PENNSYLVANIA AVENUE, N.W.  
WASHINGTON, D.C. 20461

AUG 13 1976

Mr. James Duffus III  
Assistant Director  
United States General  
Accounting Office  
Washington, D.C. 20548

Dear Mr. Duffus:

Thank you for the opportunity extended to the Federal Inter-Agency Council on Energy Information (FICEI) to comment on your draft report to the Congress on "Federal Energy Resource and Reserve Estimates -- Uses, Limitations, and Data Gaps." Since four of the most energy-intensive agencies which are members of the Council are commenting on the draft report and the available time is inadequate to provide detailed comments fully representative of Council viewpoints, an ad hoc task group of six Council members is providing the following general comments. These comments should not be interpreted as being the personal viewpoints of any individual Council member or his organization. The corporate comments of the Council Ad Hoc Task Group follow:

o Your report will be an extremely important document with a major influence on critically important and essential energy legislation over the next few years. Developed by your independent organization, it will enjoy credibility not associated with documents from the Federal Energy Office or any other agency. Accordingly, the final product should be a superior document.

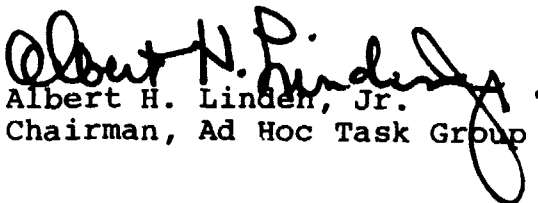
o The Council is particularly active in the area of standardization and is especially sensitive to the need for absolute precision in defining such terms as "resources," "reserves," and related classifying terms. Your choice of the Department of Interior terms as a standard is an excellent one, but we recommend adherence to exact definitions rather than the close paraphrase used in the draft report. Each following reference to resources and reserves or their subclassifications should rigorously adhere to precise definitions.

[See GAO note.]

o It must be recognized that reserves and production are not immediately responsive to price/cost changes and that the lead time to stabilize the relationships must be taken into consideration. Accordingly time is an important parameter. Factors such as policy stability, corporate decision time, capitalization, and the like would have to be analyzed in each case to determine the appropriate lead time for stabilization of the effect to be measured.

We trust that your finished report will be an authoritative document reflecting the objectivity, accuracy, and precision needed to support positively the development of energy policy and legislation. Please do not hesitate to call on the Council if we can be of further service in reaching that goal.

Sincerely,

  
Albert H. Linden, Jr.  
Chairman, Ad Hoc Task Group

GAO note: Deleted comments, which refer to the draft report, have been considered in this report.



OFFICE  
FEDERAL ENERGY ADMINISTRATION  
WASHINGTON, D.C. 20461

DEPUTY ADMINISTRATOR

**AUG 13 1976**

Mr. Monte Canfield, Jr.  
Director, Energy and Minerals Division  
United States General Accounting Office  
Washington, D. C. 20548

Dear Mr. Canfield:

Mr. Zarb has asked me to respond to your letter of June 11, 1976, requesting our review of and comments on your draft report entitled "Federal Energy Resource and Reserve Estimates--Uses, Limitations, and Data Gaps."

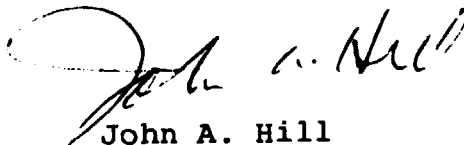
In general, the Federal Energy Office agrees that much can and should be done in the area of assessing our reserves and resources of primary energy supplies. In fact, the Federal Energy Administration initiated an Ad Hoc interagency task force, chaired by the Office of Management and Budget, to address issues in regard to oil and gas reserves data. Representatives of the General Accounting Office have been involved in all stages of this planning effort, and were in attendance at public meetings held on May 27, and July 22, 1976, to solicit comments from the public. This task force is developing a plan for the continued collection and analysis of oil and gas reserves information which will incorporate the requirements of all agencies and the public to the extent which is justifiable and cost prudent. Your suggestions and comments will be an important contribution to this effort and will be carefully considered in developing the plan.

With respect to your report, I would like to make the following additional points:

1. The energy supply situation in the country continues to deteriorate, and our vulnerability to a supply disruption continues to worsen. While we need to obtain better information on which to base our policies, we also must create and implement a sound energy policy which addresses the national energy problems we are now facing.
2. It would be a mistake to have a single government agency explore and condemn Outer Continental Shelf acreage. A program that encourages a variety of interpretations and technologies (both public and private) is desirable to assure active participation of the market mechanism and the full utilization of the best talents available.
3. Developing accurate reserve estimates to reflect cost and price relationships is desirable and important but complicated. Developing such estimates based on future governmental regulations and environmental constraints would also be desirable. Of course, estimates of the effect of these variables would have a high degree of uncertainty.
4. Acquiring data on ownership of resources is also important but complex. The task could be more manageable by developing the data for major companies owning or controlling significant quantities of these resources.

I am enclosing a copy of my comments which discuss these and several other areas of concern. Again, I wish to emphasize the report is timely and helpful to our planning efforts.

Sincerely,



John A. Hill  
Deputy Administrator

Enclosure [See GAO note.]

GAO note: The deleted material contained general and technical comments on our draft report which have been incorporated into this report where appropriate.



## United States Department of the Interior

OFFICE OF THE SECRETARY  
WASHINGTON, D.C. 20240

JUL 20 1976

Mr. Monte Canfield, Jr.  
Director, Energy and Minerals Division  
United States General Accounting Office  
Washington, DC 20548

Dear Mr. Canfield:

This letter is in response to your proposed report to the Congress on "Federal Energy Resource and Reserve Estimates--Uses, Limitations and Data Gaps." The Department is in general agreement with the main theme of the report -- that more and better information on reserves and resources is desirable. However, the development of detailed information on the physical and economic availability of resources which lie beneath the surface of the earth and the ocean is a long, tedious and expensive process. This process has been accelerated by the Department of the Interior, ERDA and FEA. The cost of further acceleration, as suggested by GAO, would be great and the amount of information added would be small relative to the substantial body of data which is now available for the formulation of long-term energy policy.

Several general issues and the GAO recommendations are discussed in more detail in the enclosed statement. Also specific comments listed by chapter and page are given.

Sincerely yours,

*Kent Drizzell*  
Under Secretary

Enclosure

DEPARTMENT OF THE INTERIOR STATEMENT  
ON  
GAO REPORT TO THE CONGRESS  
ENTITLED

"Federal Energy Resources and Reserve Estimates--Uses, Limitations and Data Gaps."

I. General Issues

1. A misunderstanding of the nature of the terms "resource" and "reserve".

The report states that resource and reserve estimates are inadequate because 1) there are data gaps (SEE GAO NOTE 1, P. 47) the economic criteria used in the estimates are not varied with time (SEE GAO NOTE 1) they show considerable change over time (as in estimates of oil and gas resources cited on pg 28).

There always will be data gaps. A major part of resources are undiscovered. Estimation of either resources or reserves is a predictive process, not a counting process. Reserves, which are apparently viewed by GAO as solid numbers subject to change only due to economic forces, are subject to a variety of other factors, especially production rates, multiple-use decisions, and not the least of all, chance, as seen in equipment failure, or mine explosion or fire. A view of reserves moving up and down in direct relationship with price is too simplistic.

Estimation of resources must consider these factors and a different set of geotechnological data than used in reserves. The evaluation of resources has shown considerable change over the last several decades. It should be stressed that this reflects a continual closing of data gaps and increasing awareness of the economic aspects of exploration and production. The high cost of exploration and production of deep reservoirs or remote OCS areas renders large amounts of oil and gas subeconomic. In all commodities we now can assess change in association with ongoing exploration.

We agree that resource and reserve data are inadequate for firm and detailed long-range planning, but they are adequate to tell policymakers some very important things. For oil and gas, for example, all the estimates--high and low--show that a lot more oil is to be found if exploration is encouraged. Frontier areas have great promise, oil remaining in the ground now is a very important target for improved recovery, and yet no matter how lucky we are in all these potentials we will have to shift to other sources for our major supplies of energy in a matter of two or three decades.

2. Obsolescence of the report in terms of what actions have already been taken or at what stages various programs are in.

[See GAO note 2, p. 47.]

[See GAO note 2, p. 47.]

**3. Lack of documentation of cost and effectiveness of recommendations.**

The recommendations offered by GAO which affect the Geological Survey programs have been considered before by several levels of Government, including the Congress. Partial implementation of the recommendations is meeting the immediate needs of the Federal leasing program at an acceptable funding level. The Geological Survey is presently spending about \$10 million a year on geophysical data collection for oil and gas in the OCS, and a million dollars for coal drilling.

[See GAO note 2, p. 47.]

Analysis of the cost of each recommendation has shown that filling data gaps by drilling is quite expensive. The cost estimates for various bills proposed in Congress are as follows:

H.R. 6721 (passed both houses and forwarded to White House on June 22, 1976, for signature). The cost for 160-acre systematic and comprehensive coal drilling program with updated maps covering 6.5 million acres of Federal coal lands would be \$190 per acre. The total cost would be \$1.235 billion. The speed at which the program would be implemented would determine the annual budget.

H.R. 6218 in an early version would require the Secretary to implement an exploration plan to determine the presence of oil fields, the extent of each field and determine the reserves. The cost based on 475 wells, geophysics and personnel costs, is estimated to be about \$10.7 billion per year.

Other programs have been suggested, but these are largely variations on the two just outlined. Basic problems such as the availability of rigs for these massive programs have not been investigated.



**II. GAO Recommendations:**

That the Administrator, Federal Energy Administration

- A. --take the necessary actions to obtain information on the effects of cost/price relationships on the recoverability of oil, gas, and coal.

**Comment**

The use of the terms "Price-Cost Relationships" is not clear. If the authors of the report mean to give economic content to the "McKelvey Box," then what they desire is a supply function for the various fuels-- and this is a difficult concept to quantify. There are limitations in the available statistical data and much data required is not available. More precision in defining "Price-Cost Relationships" is required, as is more detail in explaining what is sought from these relationships.

The Bureau of Mines has done considerable costing work in the energy field. A few of the publications in this area are:

**Petroleum**

- IC 8557. Offshore Petroleum Studies, composition of the Offshore U.S. Petroleum Industry and Estimated Costs of Producing Petroleum in the Gulf of Mexico.
- IC 8561. Engineering Cost Study of Development Wells and Profitability Analysis of Crude Oil Production.
- IC 8593. Determining Discounted Gas Flow Rate of Return and Payout Time for Onshore Development Wells.
- IC 8652. Profitability Analysis of Producing Crude Oil by Waterflooding Using a Simulation Technique.

**Coal**

- IC 8535. Cost Analysis of Model Mines for Strip Mining of Coal in the United States, 1972.
- IC 8641. Basic Estimated Capital Investment and Operation Costs for Underground Bituminous Coal Mines, Mines with annual production of 1.03 to 3.09 million tons from 48 inch coal beds, 1974.
- IC 8689. Same title as above, revised 1975.
- IC 8682. Basic Estimated Capital Investment and Operating Costs for Underground Bituminous Coal Mines, Mines with annual production of 1.06 to 4.99 million tons from a 72 inch coal bed, 1976.
- IC 8703. Basic Estimated Capital Investment and Operating Cost for Coal Strip Mines, 1976.

The Geological Survey is currently initiating studies directed toward the relationship of cost/price ratios to oil and gas resource assessments. The first necessary step is the development of price/cost ratios with respect to each of the commodities, in a time series extending back to a least 1960 and projected into the future to at least 1990.

That the Administrator, Federal Energy Administration

- B. --determine the ownership and/or control over domestic energy fuels by individual companies.

Comment

The Federal Energy Administration has developed adequate data on oil reserves by ownership within U.S. during the last year. FPC has developed data on reserves of natural gas in interstate commerce trade and has maintained these for many years.

That the Administrator, Federal Energy Administration

- C. --obtain from coal producers, as soon as possible, estimates of domestic coal reserves using appropriate verification techniques, and develop plans to update the results of this effort on a regular and recurring basis.

Comment

Efforts should certainly be made to update coal reserve information. There is no great sense of urgency for national updating, however, because coal reserves and resources obviously are many times present production requirements and indeed many times any level of coal production foreseeable for the next 10 to 15 years.

The GAO recommendation should also consider noneconomic factors. However, the legal and environmental problems of coal development are extremely complex. It is dubious that any appreciable understanding of multiple-use problems of coal could be developed on a national scale without an extremely manpower-intensive study including reviews of State, county, and municipal environmental and land use and development laws, and an extensive survey of private landowners controlling coal rights.

Canvassing coal producers for reserves on a national basis would yield uneven results due to local variations in development practice and the amount of coal operators feel necessary to keep in front of the working area. It should be stressed that this type of survey would represent only reserves under operators control and would not include unleased reserves.

It should be pointed out that the Geological Survey has responsibility for obtaining reserve data on Federal leases under the 211 regulations (section 211.20) and that FEA's effort should be confined to obtaining reserve data for non-Federal sources to avoid unnecessary duplication of effort.

That the Administrator, Federal Energy Administration

- D. --update on a regular and recurring basis estimates of oil and gas reserves.

Comment

The development of reserves data useful to all involved agencies and the public is now being discussed by the Oil and Gas Reserves Working Committee chaired by OMB. The Geological Survey is the only organization having sufficient data to estimate and update reserves on Federal OCS lands. The proposed FY 1977 budget includes an expansion of the OCS Reserve Inventory. The Geological Survey plans to continue its cooperation with FEA or other agencies in providing aid in this area.

Oil and gas reserve estimates are currently prepared by industry on an annual basis. Adequate means can be developed for auditing such reserve estimates and for conducting operator surveys to further assess their reliability. There is no obvious reason why oil and gas reserve estimates should be made more frequently than is done at present.

- E. That the Secretary of the Interior develop and implement a systematic plan for resource appraisal on Outer Continental Shelf areas which would include sufficient drilling of stratigraphic tests to develop data on the geology of these areas for the purposes of pre-sale tract evaluation and to fill data gaps.

Comment

Deep stratigraphic drilling, as now done before frontier area lease sales, facilitates the basic appraisal of each general area under consideration, and does permit the development of a more rational long-range leasing program. Stratigraphic drilling can increase or decrease the discovery prospects of certain sectors of the OCS, but it does not provide definitive information on either reserves or resources. Considerable exploratory drilling is required to determine roughly the amount of recoverable oil or gas in a given field. Extensive production data are necessary to determine recovery factors.

The Geological Survey has just signed a contract for a limited amount of drilling to 1,000 feet to supplement existing deep stratigraphic data and geophysical data on the Atlantic OCS. However, in view of industry's willingness to undertake deep stratigraphic drilling it has no plans to duplicate that effort.

The basic question posed by the GAO report is whether the Federal Government should assume the responsibilities of a petroleum exploration company operating on its own lands. This is not a scientific or even a technological problem. It is political in nature and the ultimate decision rests with the Congress and the American people.

[See GAO note 2, p. 47.]

- G. ... "That ERDA expedite the work and final report of its National Uranium Resource Evaluation Program," ... "and that the Congress explore with ERDA, the Geological Survey, and the Federal Energy Administration the feasibility of establishing a program to thoroughly appraise the U.S. uranium resource base by having the Federal Government conduct or sponsor extensive exploratory drilling, including such program and financing authorizations as may be needed."

Comment

The Geological Survey maintains a close relationship with ERDA in the development of uranium resource data and will continue to support their work as our expertise is applicable and available.

With respect to uranium it is true that an intensified drilling program would lead to a more accurate assessment of undiscovered uranium resources. Even if the results of such a program were largely negative, that in itself would be useful information. But GAO fails to consider explicitly in its recommendations for uranium drilling programs the high cost and the probable near impossibility of getting the Congress to approve sufficient funding for a comprehensive drilling program. Before making such recommendations, the GAO should carefully evaluate the cost and benefits of the program, something it apparently has not done.

It takes time, not solely money, to develop resource estimates that have value. Further, resource estimates are dynamic in nature and ERDA's 1981 estimate will be only the estimate as of that date and will need to be kept up to date after 1981. Input from other agencies probably would speed and improve ERDA's work. Annual estimates incorporating new data could be made between now and 1981 and would prove useful if it is understood that the estimation procedure is an ongoing process.

[See GAO note 2]

GAO notes:

1. Deleted page references refer to a draft of this report.
2. Deleted comments, which refer to the draft report, have been considered in this report.



UNITED STATES  
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION  
WASHINGTON, D.C. 20546

JUL 27 1976

Mr. Monte Canfield, Jr., Director  
Energy and Minerals Division  
U. S. General Accounting Office  
Washington, DC 20548

Dear Mr. Canfield:

Thank you for the opportunity to comment on the draft report entitled "Federal Energy Resource and Reserve Estimates - Uses, Limitations, and Data Gaps."

The report discusses coal, oil and gas as well as uranium; however, comments concerning availability of reserve and resource information frequently contain the implication that they apply equally to all fuels, whereas in many cases the deficiency mentioned is not applicable, or only partly applicable, to uranium.

Energy reserves are defined as that portion of energy resources which are not "minable" due to high cost factors or lack of adequate technology. It is suggested that environmental restrictions should also be considered as a parameter which constrains total utilization of reserves.

The report also indicates that more accurate estimates of energy reserves are needed to deal with both near-term decisions for Federal land leasing and long-range decisions on energy alternatives. The accuracy of information required for each of these needs differs, as does the scope. For example, more accuracy may be required to deal with leasing Federally held lands than is required to deal with long-range decisions on alternative fuel development.

Regarding the statement [See GAO note 1, p. 51.] "GAO believes an estimate of those quantities of coal considered to be recoverable should be made", it is our understanding that this is published information. However, with respect to coal data that is being collected we agree with the necessity of developing better estimates of economically recoverable reserves. Data and methodologies should be developed to determine reserve levels as a function of available mining technologies and costs, market prices of coal, and regulatory policies. We would suggest that the report recognize the trade-offs involved in extensive coal exploration programs to map reserves on Federal lands. Additional information gained from large exploration programs may not be worth the cost compared to information obtained from more modest but well-targeted programs. Chemical composition of coals and information on washability of coal should be included in additional analyses

of coal seams. This would allow estimates of coal available for synthetic fuels and physical and chemical desulfurization of coal. An additional suggestion is for Federal agencies to examine the variety of coal data bases and develop plans to make data files as compatible as possible. For example, coal data bases from the Bureau of Mines and Geological Survey could provide good information on the potential for future coal use if information on resources and reserves were in similar formats. Reorganizing existing information is inexpensive compared to gathering new data, and desirable for increasing data analysis capabilities and identifying data gaps.

It is felt that an important aspect of energy resource data and its impact on ERDA has been overlooked. ERDA must plan research and development programs to encourage the utilization of a greater percentage of fossil energy resources in an economical and environmentally safe manner. Specifically with regard to oil and gas, ERDA's objectives include adding to reserves through the use of enhanced recovery techniques. These reserve additions would be from the category referred to in the report as "identified" resources. In order to properly plan our enhanced oil and gas recovery programs, ERDA must be able to assess the potential for adding reserves through enhanced recovery and the sensitivity of that potential to economic and institutional variables. This requires detailed knowledge of the identified resource -- its magnitude and characteristics. In recent planning efforts, ERDA has found that the necessary resource data is scattered, inconsistent and incomplete. FEA's engineering analyses of 59 oil and gas fields represents a good first step toward gathering and developing this resource data, but this GAO report might properly include an analysis of the desirability and feasibility of collecting data on identified resources (e.g., oil in place and reservoir and fluid characteristics). This data would contribute greatly towards the need "to better assess the availability of various energy fuels under different economic conditions..." as stated in the report.

Current views of in situ coal gasification suggest that seams thicker than four to five feet, at any angle of dip, to depths of 3,000 feet could be eventually classified as a reserve base for this processing technique. This option should be mentioned in the report to stimulate future work in developing a coal resource and reserve base for in situ processing.

The report does not consider estimates of oil shale resources and reserves. Oil shale is one of the major fossil energy resources in the U.S. but little is known of how the base of economically recoverable reserves will change as a function of prices of competing fuels, the state of technology used to recover shale oil and environmental regulations. Further exploration of resources may have a large payoff in providing energy from shale in future years.

An additional comment concerns the confidentiality of information collected by Federal agencies. We have found in our recent analyses on enhanced oil and gas recovery that some of the required data has been collected by other agencies from individual companies under agreements of confidentiality. This problem of sharing such confidential data among Federal agencies was not addressed in the report and it should be regarded as one of the limitations of the present system. While we have been able to arrange agreements with other agencies on a case-by-case basis, a comprehensive and consistent program of data-sharing would be much preferred to the current patchwork system.

[See GAO note 2, p. 51.]



We agree with the GAO recommendation that the NURE program be expedited to the extent practical. The NURE program is being rapidly expanded and should provide adequate information for more long-term planning. However, with respect to the recommendation on page 5 regarding extensive Federal Government sponsored exploratory drilling, we wish to reiterate our previous comments regarding this recommendation. In essence, we believe that the ERDA approach will result in a better appraisal than the USGS proposal in which extensive government drilling would be carried out in a relatively few selected areas. We believe the appropriate and most effective role of government to be that of providing the leading edge to an expanded private exploration program and that NURE in conjunction with the private effort will provide a better appraisal in a shorter period of time; equally or more important, it will result in a more expeditious development of the resources that do exist.



M. C. Greer  
Controller

Enclosure:

Press Release No. 76-94

[See GAO note 3.]

GAO notes:

1. Deleted page references refer to a draft on this report.
2. Deleted comments, which refer to the draft report, have been considered in this final report.
3. Press release has been deleted from this report.

FEDERAL POWER COMMISSION  
WASHINGTON, D.C. 20426

JUL 9 1976

Mr. Monte Canfield, Jr., Director  
Energy and Minerals Division  
U. S. General Accounting Office  
Washington, D. C. 20548

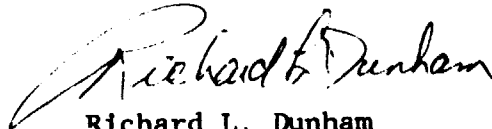
Dear Mr. Canfield:

Thank you for the opportunity to comment on your draft report "Federal Energy Resource and Reserve Estimates -- Uses, Limitations, and Data Gaps". FPC technical staff has reviewed the report and I have enclosed their comments and suggestions.

The Commission does indeed have an active interest and need for reliable, consistent energy resource and reserve estimates, particularly with respect to fossile fuels and uranium. If possible, I would like to receive a copy of the final report.

Please contact me if I may be of further help to you in this matter.

Sincerely,



Richard L. Dunham  
Chairman

Enclosure

**Federal Power Commission Staff  
Comments on the Draft  
Report to Congress by the  
Comptroller General of the United States  
"Federal Energy Resource and Reserve  
Estimates -- Uses, Limitations, and Data Gaps"**

[See GAO note 2, p. 56.]

[See GAO note 2, p. 56.]

#### GENERAL COMMENTS

In discussing the need for resource and reserves data on an ownership basis, the GAO report does not recognize that the FPC is in the advanced stages of implementing a data collection program, applicable to jurisdictional companies and their affiliates, which will provide an annual reporting, by owner, of a large portion of the Nation's proved reserves of natural gas on a reservoir by reservoir basis. <sup>1/</sup> The development of Form 40 required approximately two and one-half years.

1/ FPC Order Nos. 526 (2-25-75) and 526-A (8-18-75). Natural Gas Companies Annual Report of Proved Domestic Gas Reserves: FPC Form 40. These orders were vacated and remanded to the Commission in Union Oil Co. of Calif., et al. v. F.P.C., Nos. 75-2891, et al. (9th Cir. June 2, 1976) based on a finding that the record compiled by the Commission did not support the conclusion reached.

Comments rendered by some 77 private parties were incorporated wherever possible, and the GAO gave extensive study, prior to its approval of the Form, to the twin problems of minimizing reporting burden and elimination of duplicate data filing.

It would appear logical that any effort to obtain National oil and gas reserve data on an ownership basis would take advantage of the groundbreaking FPC natural gas reserves reporting program. With minor modifications the reserve accounting balance sheet format of FPC Form No. 40 can be converted to gather similar data on oil, natural gas liquids, and natural gas owned by non-jurisdictional companies. The combination of this data with that gathered by the FPC would then constitute a comprehensive and independently auditable survey of the status of the National proved domestic oil and gas reserves. This body of information would assist in the meaningful and important analyses necessary to support national energy policy formulation and implementation.

The FPC has, for a number of years, taken the position that for an inventory of proved reserves to be credible, it must have undergone audit by qualified personnel independent of those supplying the data. The Congress has taken a similar position. The Form 40 program calls for this type of auditing by the FPC staff.

While we do not debate the merits of the GAO recommendation that FEA take the necessary actions to obtain data on the effects of cost/price on recoverability, it should be emphasized, nevertheless, that estimating resource availability under various economic conditions is a much more complicated problem than the already complex problem of estimating reserves under existing economic conditions. The degree of uncertainty dramatically increases as alternate economic criteria are specified. Further, the application of price and cost ratios other than those which exist at the time the reserve estimate is made is not standard practice at the present time either within the industry or the Government. The commonly accepted definitions of proved reserves which, regardless of current minor problems in interpretation, have withstood the tests of time and experience, do not include variable economic and operating conditions. Consequently, entirely new estimation procedures and definitions would have to be developed by FEA, and their testing would require several years. They would undoubtedly remain highly controversial, limiting their usefulness as policy inputs for some time.

In order to maintain consistency, the GAO report indicates that it uses the U.S.G.S. definitions of resources and reserves. <sup>2/</sup>

<sup>2/</sup> Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey, Geological Survey Bulletin, 1450-A, 1976.

According to the U.S.G.S., reserves are a part of the total resource. However, the GAO report frequently refers to resources and reserves as being separate entities. It is likely that this confusion stems from an attempt to distinguish reserves from the undiscovered resource. The specific comments below point out the most obvious occurrence, but it is suggested that the use of these terms throughout the report be reviewed for consistency prior to publication.

GAO also found information on recoverable amounts of coal to be lacking and recommended that FEA obtain from coal producers estimates of domestic coal reserves using appropriate verification techniques, and update the estimates on regular basis. In seeking more information about the quantities of coal considered to be recoverable, it is suggested that an attempt be made to identify the reserves by Btu and sulfur content. Historically, reserve data was maintained on a tonnage basis, yet one ton of bituminous coal is equal to two tons of lignite on a Btu basis. Furthermore, because of environmental restrictions on sulfur emissions, we need to know much more about our supplies of low-sulfur coal.

Finally, it is noted that the GAO report does not treat hydroelectric power. Several suggested inserts concerning hydroelectric power are included in the specific comments below.

[See GAO note]

GAO note: Deleted comments, which refer to the draft report, have been considered in this report.