REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

An Evaluation Of Proposed Federal Assistance For Financing Commercialization Of Emerging Energy Technologies

Multiagency

In March 1976 GAO said that the Congress needed better information before approving the administration's proposed multibillion dollar Federal loan guarantee program for synthetic fuel plants.

This report analyzes the pros and cons for commercializing synthetic fuels and other emerging energy technologies by responding to the following questions:

--What can Government do to accelerate development of synthetic fuels?

--Can more energy be produced at less cost by stimulating the development of other new energy technologies?

--Is conservation a more cost-effective alternative to Federal incentives?

--Which types of Federal financial incentives are best in specific situations?

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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

On March 19, 1976, in response to his request, we reported to the Chairman of the Subcommittee on Energy Research, Development, and Demonstration (Fossil Fuels), House Committee on Science and Technology, our comments on the Administration's proposed synthetic fuels commercialization program (RED-76-82).

Subsequently, we testified before the House Committee on Science and Technology; Subcommittees of the Senate Committee on Banking, Housing and Urban Affairs, House Committee on Banking, Currency and Housing; and House Committee on Interstate and Foreign Commerce, on developing and commercializing energy technologies. In that testimony, we indicated that we were doing further work on the status of feasible technologies which appear to have impediments to full commercialization.

In addition, we indicated that this work would include an assessment of the priorities attached to the various technological options, and our assessment of the most appropriate incentives or other actions for encouraging their development. As our study of the matter progressed, it became evident that pursuit of alternative technologies is extricably intertwined in overall national energy strategies, including strategies for implementing energy conservation actions.

This report is the result of our analysis. It is intended to aid the Congress by providing a framework and perspective for making decisions on the many energy options before it.

Copies of this report are being sent to the Director, Office of Management and Budget, and the Administrators of the Federal Energy Administration and the Energy Research and Development Administration.

Elmer B. Staats

Comptroller General
of the United States

C O N T E N T S

ABBREVIATIONS

EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
FEA	Federal Energy Administration
FPC	Federal Power Commission
GAO	General Accounting Office

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

AN EVALUATION OF PROPOSED FEDERAL ASSISTANCE FOR FINANCING COMMERCIALIZATION OF EMERGING ENERGY TECHNOLOGIES

D I G E S T

GAO seeks to provide a framework and perspective for considering actions by the Federal Government which could contribute to solving energy problems confronting the United States over the next 10 to 25 years.

Unless choices of technology and financing methods are considered in perspective, the risk of piecemeal decisionmaking increases substantially.

Making the right choices among energy technologies, in GAO's view, requires consideration of three factors.

--The contribution that each technology can make in meeting the Nation's energy needs within a specified time frame either through reducing demand or increasing energy supply.

--The total cost of making the technology commercial including costs of plant construction, costs of alleviating adverse socio-economic impacts caused by the energy development, and the costs of price supports or further subsidies which may be required.

--The price at which energy produced by the technology would have to be sold and the means by which the price would be assimilated by our economic system. (See p. 45.)

Making the right choice among financing mechanisms requires, in GAO's view, interrelated analysis of at least three factors.

--The technology's state of development. Is the technology developed to the extent that it can be deployed on a broad basis?

--The technology's economic feasibility. Will the energy produced as a result of deploying the technology be economically competitive with competing energy sources?

--The target group whose actions will be influenced. Are they large industrial firms or diverse and widely dispersed groups of homeowners? (See p. 46.)

The recent slowdown in the rate of growth in demand for energy is a sharp reminder of the importance of the demand side of the energy equation and of conservation in particular. This fact, and the wide differences of opinion on the sources of energy supplies to meet that demand, suggest that the Nation should carefully explore all supply sources as well as conservation alternatives before embarking on a program to commercialize synthetic fuels. (See p. 5.)

CONCLUSIONS

GAO concluded that certain conservation measures are by far the most cost effective way to "produce" energy and therefore should have the top priority for Government financial assistance.

Among the energy supply-increasing technologies considered, GAO found several that are cost effective throughout the country or in particular geographical areas. These technologies are hydrothermal energy, municipal waste combustion systems, solar hot water and space heating, and tertiary oil recovery. The ultimate supply of energy to be captured from these sources may be smaller than the ultimate potential of other supply technologies such as synthetic fuels, but they appear more cost effective.

The cost effective technologies should be given priority in Government assistance for commercial development in GAO's judgment. This assistance will ensure their maximum contribution between now and 2000 and give the Nation time to consider the potentially larger supply sources and develop them as appropriate. These latter sources include synthetic fuels as well as fusion, solar photovoltaic cells, thermal gradients, and breeder reactors. (See p. 47 and 48.)

Synthetic fuels production is not cost effective in that the total cost of output is not price competitive with foreign oil. Nor does it look attractive on the basis of present knowledge when compared to other technologies on an actual, or incremental, price basis.

Serious questions exist regarding any national commitment at the present time to uneconomic, high-cost supply technologies which substantially exceed the cost of imported oil. Certainly, larger commitments to building complex, highly capital-intensive energy sources will result in less incentive in future years to develop alternative lower cost energy sources. In addition, technologies producing energy that costs more than energy from imported oil would put exporting countries in a position to increase energy prices. (See p. 51.)

The pricing yardstick used in evaluating emerging technologies needs to be considered very carefully. An incremental cost standard is the only realistic one for making sound economic judgments which treat all emerging technologies equally. The alternative is average, or "rolled-in" pricing. This means that the real cost of new supply sources is averaged with a far larger volume of lower priced energy.

The rolled-in yardstick favors synthetic and other fuels susceptible to rolling in treatment. Incremental cost, on the other hand, would apply the same test to all energy options, including conservation. Decisions made on this basis would allow a consistent and rational process of choice on a cost effective basis. (See p. 49.)

Conservation

Areas offering the greatest opportunity for conservation include

--insulation and other measures that conserve energy in all buildings,

--less wasteful uses of energy by industry, and

--improved management of electrical demand.

A variety of financial mechanisms can be used to stimulate conservation. (See page 51.) Many of the actions GAO believes are desirable to encourage conservation and are authorized by the recently passed legislative extension of the Federal Energy Administration (FEA).

Synthetic fuels

The Energy Research and Development Administration's (ERDA's) most optimistic projections show synthetic fuels production reaching the equivalent of 2.4 quads and 22 quads in 1985 and 2000, respectively. (See p. 8.) However, ERDA is in the process of revising these estimates downward. Moreover, the projected prices are not competitive with existing or other emerging energy sources.

The large investments required to build synthetic fuel plants would direct Federal incentives primarily to the large industries which have access to capital. Two basic concerns underlie the stated need for Federal loan guarantees to finance synthetic fuels technology:

--concern that the product produced will not be economically competitive, particularly since the existing world market price for oil could always be manipulated to substantially undercut the price of synthetic fuels; and

--concern that technological advances in other energy areas or within synthetic fuels technology will make "first generation" synthetic fuels plants obsolete before they ever operate.

Research and development on "second generation" synthetic gas technologies is expected to reduce costs by about 15 percent.

In the present circumstances, GAO believes Government financial assistance for commercial development of synthetic fuels should not be provided at this time. Full priority should be directed to development of improved synthetic fuels technologies, however, it appears possible to gain adequate information of an environmental and regulatory nature from smaller plants under Government control. When commercialization of the technology becomes a prime objective, consideration also should be given to approaches other than loan guarantees for gaining private industry interest.

AGENCY ACTIONS AND UNRESOLVED ISSUES

In commenting on a draft of this report (see Appendices III and IV) the ERDA Administrator expressed deep concerns with GAO's analysis, presentation, conclusions, and recommendations, particularly as they related to actions on synthetic fuels. The Administrator pointed to what he regarded as five serious deficiencies.

In some of the items pointed out by the ERDA Administrator, GAO made revisions to its final report. Basic differences remain over what steps the Government should take today to maintain the option of developing a synthetic fuels industry in the 1990s. (See p. 60.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

GAO recommends that the Congress:

--Continue to place the highest priority on energy conservation actions, including obtaining better cost/benefit data on the whole range of conservation opportunities. This will provide the basis for further developing and funding specific programs.

--Maintain close oversight of the new conservation programs. As these programs prove effective or ineffective, shift emphasis accordingly.

--Continue to encourage the installation of units for solar hot water and space heating.

--Maintain close oversight of the Federal Energy Administration's actions to increase incentive for tertiary recovery of oil and authorize further incentives if the need and possibility to increase tertiary oil recovery becomes apparent in light of other energy developments.

--Consider whether it is advisable to enact legislation which would at this time authorize Federal loan guarantees to builders of synthetic fuel plants and consider instead directing ERDA to continue research and development to improve the technology and; in addition construct and operate smaller plants of a size sufficient to meet its stated goal of obtaining socio-economic, environmental, and regulatory information in a timely fashion.

--Consider further actions, including the provision of loan guarantee authority to encourage municipal waste combustion systems.

CHAPTER 1

INTRODUCTION

In recent months considerable legislation has been introduced in the Congress which would provide various forms of Federal assistance to encourage private sector use, or implementation of, a variety of energy technologies. One such bill, H.R. 12112, is currently the subject of intense congressional deliberations. It would provide Federal loan guarantees to accelerate the commercialization of synthetic fuels--gas from coal, oil from coal, and/or oil from shale.

The President, in his 1975 State-of-the-Union-Message, called for Government financial incentives to stimulate industry interest in developing and demonstrating the commercial viability of synthetic fuels. In February 1975, an Interagency Task Force on Synthetic Fuels Commercialization was established to study the various factors associated with commercializing synthetic fuels.

Because the price of synthetic fuels is almost certain to be higher than the price of energy produced from traditional energy sources, the Task Force recommended that loan guarantees, construction grants, and price supports would be needed to encourage industry participation. A GAO report entitled "Comments on the Administration's Proposed Synthetic Fuels Commercialization Program" (March 19, 1976) evaluated that proposal.

This report goes beyond the earlier effort, addressing the following questions bearing on whether Federal financial incentives should be used to accelerate commercialization of alternative energy sources and conservation actions.

--How could the Government accelerate the development of synthetic fuels to meet the Nation's future energy needs?

--Can more energy be produced at less cost if Federal incentives are used to stimulate the development of other new energy supply technologies such as solar energy, geothermal power, and enhanced oil recovery?

--Is conservation a more cost effective alternative for use of Federal incentives?

--Which types of Federal financial incentives--loans, loan guarantees, tax actions, purchase agreements, price regulation, Government ownership--are most appropriate in specific situations?

In considering these issues, the report attempts to avoid the risk of piecemeal decisionmaking by directing attention to some of the implications of certain choices for our national energy situation.

Our report examines a number of emerging energy supply technologies and conservation actions which are technically feasible and estimated to have a significant supply impact by 1985 and 2000, but are not being actively commercialized by the private sector. A major consideration in choosing among energy technologies obviously is the total time and cost to make the technology commercial. The report does not include a discussion of more uncertain technologies not ready for commercialization such as fusion, solar photovoltaic, thermal gradients, or breeder reactors.

No single mechanism for providing financial incentives appears appropriate to all circumstances. In determining the incentive which would best stimulate a particular energy or conservation technology, we believe the following three factors are important:

--The technology's state of development. Is it developed sufficiently so that it can be scaled up and deployed on a broad basis?

--The technology's economic feasibility. To determine this, we compared the incremental cost of the appropriate competing sources of supply. For example, synthetic oil was compared with imported oil, synthetic gas with imported liquified natural gas and with imported oil, solar heating with electricity, and retrofitting actions with imported oil.

--The target group who would be influenced by the incentives. Are we trying to influence the actions of a few large industrial firms or of many small businesses or of a large number of homeowners? What kind of resources does the target group normally have at its disposal?

Individual bills before the Congress cover a wide range of objectives and financing techniques. However, no one bill focuses on all emerging energy technologies, considers all costs associated with development, or more importantly, attempts to focus on targets of proposed actions on some consistent priority basis.

In the remaining chapters of this report, we

--Provide perspective on the role of new energy technologies and energy conservation. (Chapter 2, pages 4 to 11.)

--Analyze the potential energy savings associated with various energy conservation actions, the cost of such actions, and the impediments to their widespread implementation. (Chapter 3, pages 12 to 23.)

--Discuss the status of emerging energy supply technologies, the potential supply impact and cost of these technologies, and the obstacles to their commercial implementation. (Chapter 4, pages 24 to 37.)

--Review the actions available to the Government to accelerate development of emerging energy supply technologies or conservation actions, including the advantages and disadvantages of each. (Chapter 5, pages 38 to 43.)

--Present our conclusions as to the Government actions we believe are desirable to accelerate energy conservation and supply, focusing on the relative priority of various conservation and supply choices. (Chapter 6, pages 44 to 56.)

CHAPTER 2

PERSPECTIVE

Before the Arab oil embargo in the fall of 1973, the United States was importing about 6 million barrels of oil a day, principally from the Arab oil producing countries. This oil accounted for about 35 percent of domestic oil consumption. The embargo made the American public aware that energy consumption was exceeding domestic production and that the Nation was becoming increasingly dependent on imported oil. In response to the embargo, the President established the goal of "Energy Independence."

Progress toward achieving this goal is, as yet, not apparent as oil imports have risen to about 6.8 million barrels per day and now represent about 42 percent of the oil being consumed in this country. This growing dependence on imports has increased the United States' vulnerability to supply disruptions and oil price rises.

What can be done to lessen U.S. dependence on imported oil as well as to what extent that dependence should be lessened have been the subject of considerable debate on the part of the Administration, the Congress, and the Nation. One of the issues in this debate is how we will assure our energy supplies in case of future embargos. The major action which has been legislated so far to respond directly to the embargo problem is the authorization of a strategic petroleum reserve in the Energy Policy and Conservation Act (Public Law 94-163). In addition, debate on the issue also centers around uncertainties over (1) our future energy needs, (2) the probability of further domestic discoveries of oil and natural gas, and (3) the ability to properly balance social, environmental, economic, and technological concerns associated with the future development of existing and new energy sources and conservation technologies.

Numerous studies 1/ have been made using various scenarios to attempt to understand the nature, extent, and timing of

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

actions required to balance future energy supply and demand. The conclusions reached by these studies differ widely on the mix and relative emphasis that should be given to developing new and existing energy sources primarily because different sets of assumptions are made. The assumptions in turn reflect differing levels of optimism about the feasibility of obtaining slower growth through conservation. The energy growth rates and the level of imports are the two most crucial components of most of these studies because they have a direct bearing on how urgent the need is to develop domestic energy sources, i.e., the higher the growth rate, the greater the need to aggressively develop all possible energy supplies.

The highest energy growth studies are generally based on the 4.3 percent rate of growth in energy consumption experienced in this country from 1965 to 1973. However, most studies now question whether historical trends are the best indication of future energy growth. For example, the lowest of the scenarios (zero energy growth scenario) presented in the Ford Foundation study is predicated on redirecting economic growth away from energy intensive industries toward economic activities that require less energy. This assumption results in very limited increases in energy demand until the late 1980s and then zero growth after that.

In a recent speech, the Administrator of the Federal Energy Administration (FEA) stated that the United States must set up a goal of limiting the growth in energy demand to 2 percent per year if it is to escape the political and economic consequences of energy dependence. Different scenarios show energy growth rates ranging from 0 to 4.5 percent annually, however, recent studies appear to cluster around 2-1/2 to 3 percent annual growth in energy demand. This consensus on reduction in historical growth rates is based largely on increased conservation measures--both price induced and as a result of explicit Government actions. This rate of growth suggests that although the United States must step up its work on developing emerging energy technologies to meet long-term needs, conservation actions may buy time to fully consider trade-offs and make choices that will result in the most energy at the least cost to society. This is not to say that conservation and improved efficiency in energy use are not also long-term options and that energy conservation in particular could not be a cornerstone of any national energy policy.

The uncertainty over the mix of energy sources that will best meet future energy growth rates is caused by the lack of systematic methods of computing, comparing, and projecting the costs and benefits associated with implementing energy conservation measures, new energy supply technologies, and the future development of existing energy sources. However, to some extent the costs and to a larger extent the benefits are not always clear and, in many cases, may be subjective. Another important factor, but one which can only be roughly estimated, is the time frame required for perfecting new technologies still in the research and planning stages.

Even though uncertainties exist, based on the energy supply and demand scenarios, the following are available courses of action which can be taken individually or in some combination to help lessen U.S. reliance on imported oil.

1. Adoption of conservation measures to reduce the growth rate in energy demand.

2. Increase (or slow the decline of) domestic production of oil and natural gas through new exploration and greater use of enhanced recovery techniques.

3. Expanded use of coal.

4. Expanded use of nuclear power.

5. Encouraging the use of emerging energy technologies such as synthetic fuel, solar power, and geothermal power.

Both the appropriate mix and the possible contribution of these opportunities are still hotly debated. To illustrate the possible role of different energy sources, we use in this perspective two scenarios from the Energy Research and Development Administration report entitled "A National Plan for Energy Research, Development, and Demonstration: Creating Energy Choices for the Future,"--one emphasizing the energy savings potentially available through conservation measures and the other emphasizing the additional energy supplies available from emerging technologies.

ERDA's Scenario I--Improved Efficiencies in End-Use--shows that an intensive energy conservation program directed at improving end-use efficiencies has the potential of making a substantial impact on total energy consumption. Much of the energy savings are not dependent on technological development but on educational programs and other policies that will assist end-users in making decisions necessary to implement energy efficient technologies. Beyond the initial phases, however, substantial new technology is seen to be needed to continue the drive toward efficiency in energy production and use to achieve the full set of benefits which are indicated by the scenario.

ERDA's Scenario V shows simultaneous commercialization of all new technologies. The scenario assumes continuation of historical demand trends modified to reflect recent price increases. ERDA points out that this scenario is idealistic and that it is highly unlikely that all new technologies can be developed with complete success. However, according to ERDA, based on the assumption that domestic production of oil and gas has peaked, and is declining, only the successful development and implementation of a large number of new technologies in a combination of approaches can make importing fuel a matter of choice.

In this report we concentrate only on those new technologies that have been proven technically feasible and are estimated to be capable of making a significant supply contribution by 2000, not the broad range of new technologies covered by the ERDA study, such as solar photovoltaic. All of the technologies covered in this report could be simultaneously commercialized if the country is willing to pay the price.

The table on page 8 shows for both ERDA scenarios the mix of energy sources and conservation actions to meet demand for 1985 and 2000. The charts are calibrated in terms of quadrillion British thermal units (Btu) 1/ or quads. One quad equals a thousand trillion (10^{15}) or 180 million barrels of oil equivalent.

The table serves to illustrate the range of choices available for the United States energy future depending on the extent to which conservation actions or various new supply technologies are emphasized. There are of course many possible scenarios for the United States energy future presented in a variety of studies all of which illustrate the range of the choices facing our Nation.

In the case of the two ERDA scenarios, the largest differences by the year 2000 are in (1) the amount of energy saved by conservation actions (43 quads in Scenario I versus 28.4 quads in Scenario V); (2) the amount of oil imports required (20.6 quads in Scenario I versus 4.1 quads of exports in Scenario V); and (3) the amount of supply from emerging technologies (19.6 quads in Scenario I versus 48.6 quads in Scenario V). The differences in the two

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1/ The amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit.

COMPARISON OF ERDA'S SCENARIO I (EMPHASIS) ON CONSERVATION) AND SCENARIO V (EMPHASIS ON NEW ENERGY TECHNOLOGIES) FOR 1985 AND 2000

	1985		2000	
	Scenario I	Scenario V	Scenario I	Scenario V
	(In Quads)		(In Quads)	
Existing Sources:				
Domestic oil	21.1	21.1	12.5	12.5
Natural gas	26.5	26.5	22.8	22.8
Coal a/	18.5	16.7	22.9	25.1
Nuclear	10.9	13.2	20.4	24.4
Hydroelectric	3.4	3.4	3.6	3.6
Imported oil	10.5	7.8	20.6	b/ .0
Subtotal	90.9	88.7	102.8	88.4
Emerging Sources:				
Tertiary oil	3.0	3.0	7.2	7.2
Geothermal	.9	1.6	2.4	6.6
Solar	.2	.3	3.5	4.8
Biomass	2.0	2.0	6.5	8.0
Oil Shale	.0	1.0	.0	8.0
Liquids from coal	.0	.5	.0	10.5
Gas from coal	.0	.9	.0	3.5
Subtotal	6.1	9.3	19.6	48.6
TOTAL - Energy resources	97.0	98.0	122.4	137.0
Impact of energy conservation	10.3	9.2	43.0	28.4
	107.3	c/ 107.2	165.4	165.4

a/ Excludes synthetic fuels from coal.

b/ No imported oil, furthermore 4.1 quads of exports are assumed.

c/ Difference due to rounding.

scenarios indicates to us that while the roles of conservation and emerging supply technologies are uncertain, both have vast potential depending upon the priorities assigned to them.

Also obvious from the scenarios is that extra emphasis on either conservation or energy supply technologies can likewise reduce the need to emphasize the other. Moreover, because emerging energy supply and conservation technologies are potential sources to balance our energy needs, they will involve consideration not only of the aggregate role of each source but also of the individual technologies which make up the aggregate source. Hence, less emphasis on emerging supply technologies could provide more flexibility of choice between, for example, synthetic fuels and solar and biomass. On the other hand, less emphasis on conservation could provide more flexibility, for example, between efficiency measures and so-called "belt tightening" measures.

Energy conservation

Many conservation technologies can provide potentially cost effective alternatives to developing new energy supplies --i.e., in many instances it can cost less to save a barrel of oil through, for example, constructing more energy efficient buildings than it will to supply a new barrel.

ERDA's Scenario V which emphasizes simultaneous commercialization of all new technologies shows conservation contributing 9.2 and 28.4 quads by 1985 and 2000, respectively. In contrast, Scenario I, which emphasizes energy conservation actions, shows conservation contributing 10.3 quads and 43 quads in 1985 and 2000, respectively.

Other studies assume considerably higher estimates of the potential savings from energy conservation actions. For example, the Ford Foundation in its Technical Fix Scenario estimated that using energy saving technologies presently known and economically justified at existing prices, conservation actions could contribute about 24 quads and 64 quads in 1985 and 2000, respectively. That scenario is the "middle case" scenario for that project. Their more optimistic "Zero Energy Growth" Scenario is not used in this report for analytical purposes.

Oil and natural gas production

Domestic Oil production peaked in 1970 at 9.6 million barrels per day and has been declining ever since to the current level of 8.2 million barrels per day. Production of natural gas has fallen from a peak of 22.6 trillion cubic feel (TCF) in 1973 to 20.1 TCF in 1975. The only expected major increases in the near future are from the Prudhoe Bay field on the North Slope of Alaska and the Outer Continental Shelf.

Before the embargo, new oil exploration and development was curtailed because of availability of less expensive imported oil. The advent of higher crude oil prices has stimulated greater exploration activities, however, U.S. production continues to decline. The Trans-Alaskan pipeline, when it is completed, will initially deliver about 1.2 million barrels per day 1/, an increase which at most could lift domestic supplies to levels reached in the early 1970s.

Under both Scenarios I and V, ERDA-48 shows domestic oil production (including tertiary oil production) to be 24.1 quads in 1985 and 19.7 quads in 2000. For 1985 this represents an increase of 14 percent over 1974 production and for 2000 a decrease in production from 1974 of 6 percent. These figures include production from the Outer Continental Shelf and Alaska.

ERDA's Scenarios I and V show natural gas production to reach 26.5 quads in 1985 and to decline to 22.8 quads by 2000. However, a January 14, 1976, GAO report entitled "Implications of Deregulating the Price of Natural Gas" (OSP-76-11) pointed out that even with price deregulation, production of natural gas can be expected to deline to 16.8 quads in 1985 primarily because of the inability to sustain the new field discovery rate experienced in the past.

Expanding the use of coal

Coal is the country's most abundant energy resource. The U.S. coal resources are estimated to be about 4 trillion tons. However, over the last 75 years, the use of coal has declined from supplying over 90 percent of the Nation's energy needs to about 17 percent.

The regulated price of natural gas, cheap import prices before the embargo, and continued development of nuclear power have limited the growth of coal use. Additionally, growth in coal production and consumption has been affected by State and Federal laws governing mining health and safety, strip mining and land reclamation, and air quality.

The Arab embargo and the dramatic increase in the price of oil have stimulated interest in direct burn of coal as a primary energy source.

1/ FEA's latest estimate.

Most studies indicate that coal production must rise substantially. The question is by how much? Under its Scenario V which emphasizes commercialization of new technologies ERDA shows coal consumption (including coal for synthetics and exports) to be 18.1 quads or 18 percent of 1985 resource consumption and 39.1 quads or 28 percent of resource consumption in the year 2000.

Under its Scenario I, which emphasizes conservation actions, coal use in 1985 and 2000 is estimated to be 18.5 quads and 22.9 quads, respectively. No coal is used for synthetics under this scenario.

Expanding the use of nuclear power

The use of nuclear power has grown in recent years, but it still only supplies about 2 percent of total energy demand. Nuclear plays a signficant role in both the ERDA scenarios.

In Scenario I it provides 10.9 quads and 20.4 quads in 1985 and 2000, respectively. In Scenario V which emphasizes technological development it supplies 13.2 quads or 14 percent of 1985 resource consumption and 24.4 quads or 18 percent of resource consumption in the year 2000. Other studies have included lower predictions for nuclear power. These predictions reflect certain problems that have yet to be overcome including economic considerations, availability of uranium, efforts to develop new nuclear reactor technologies, and certain safety and safeguard problems.

Development of new energy supply technologies

Some energy technologies appear to be technically feasible and are at the point where they could be demonstrated: tertiary oil recovery, solar hot water heating, solar space heating, biomass conversion, synthetic gas from coal, synthetic liquid from coal and/or shale, and geothermal power. Many of these technologies are not being commercialized because the technology is simply too expensive, resulting in the price of energy produced from projects using these technologies being greater than competing prices from traditional energy sources, like foreign oil. Others, like certain solar technologies, appear to be cost effective on a life cycle basis but are not being widely commercialized because of higher initial costs and perhaps, because of lack of information on the part of the consumer.

ERDA in its most optimistic scenario for new technologies shows new energy sources providing 7 percent of resources consumed in 1985 and 34 percent of resource consumption in the year 2000.

CHAPTER 3

ENERGY CONSERVATION

Energy conservation means using less energy and using it more efficiently. There has been increasing recognition of the major role conservation can play in slowing or even reversing the growth of the gap between energy demand and our domestic energy supplies. The overall potential is prodigious. A recent report by two physicists estimated that available and feasible changes could have reduced 1973 energy consumption in the United States by a full 43 percent 1/. Another report, by the Office of the Chief Engineer of the Federal Power Commission, indicated that a number of common energy-consuming systems use only 2 to 8 percent of the total energy available from the fuels they consume 2/.

ERDA's plan recognizes energy conservation as its highest priority and cited the following characteristics:

--"A barrel of oil saved can result in reduced imports."

--"It typically costs less to save a barrel of oil than to produce one through the development of new technology."

--"Energy conservation generally has a more beneficial effect on the environment than does energy produced and used."

--"Capital requirements to increase energy use efficiency are generally lower than capital needs to produce an equivalent amount of energy from new sources since most new supply technologies are highly capital intensive."

--"Conservation technologies can generally be implemented at a faster rate and with less government involvement in the near term than can supply technologies."

--"Energy efficiency actions can reduce the pressure for accelerated introduction of new supply technologies."

1/ "Assessing the Potential for Fuel Conservation," Marc H. Ross and Robert H. Williams, The Institute for Public Policy Alternatives, State University of New York, July 1, 1975.

2/ "Staff Report - A Technical Basis for Energy Conservation," Office of the Chief Engineer, Federal Power Commission, April 1974.

-- "Since the actions persist over time, the benefits are continuing."

Beside the continuing effects of conservation, measures taken need not be repeated to continue saving energy. For example, as a rule of thumb, one barrel saved in consumption saves an additional barrel used for conversion and delivery of energy.

The physical potential for energy conservation has been estimated in a number of studies. However, the questions of how much of the potential can be realized, in what time frame, at what cost, and with what approaches, requires much more examination. One study planned by a Federal agency to perform such an in-depth assessment was not completed, while another study to assess the capital costs of energy conservation actions, was not funded.

The following section of this chapter presents a review of the conservation programs included in the Energy Policy and Conservation Act, along with FEA's estimates of their potential impact. 1/ The analysis in the latter portions of this chapter is based, in large measure, on the Ford Foundation's Energy Policy Project (hereafter referred to as the Ford Project) project entitled "A Time to Choose." Because the energy situation has been changing, some of the Project's work is dated. Even so, it provides useful estimates of the energy savings possible through conservation.

ENERGY SAVINGS FROM CURRENT POLICY

The Energy Policy and Conservation Act, Title III, requires mandatory fuel economy standards for new autos starting in 1978, provides for voluntary energy efficiency improvement goals for consumer products, includes a voluntary industrial conservation program, continues the Federal conservation program, and supports voluntary state energy conservation programs. By 1985, these efforts will reduce energy requirements about 7 quads per year which represents only a small portion of the potential for conservation. Conservation potentials cited for these activities are FEA estimates.

1/ On August 14, 1976, the President signed legislation extending FEA's life (Public Law 94-385) which included a number of new conservation programs. While many of the programs address conservation opportunities discussed in this chapter, we have not had time to fully analyze their potential impact. Page 51 in our summary chapter contains a brief discussion of these conservation programs.

FEA estimates that the auto fuel economy standards will lead to savings of 2.1 quads a year by 1985. Based on the historical automobile replacement rate, we estimate that the entire auto fleet will reach the maximum efficiency requirement of 27.5 miles per gallon by the mid-1990s. This would result in a further saving of 24.5 percent in automobile fuel use or an additional 1.5 quads a year.

Should consumer products meet the efficiency goals scheduled for 1980, 1.6 quads a year will be saved by 1985. Because this goal is scheduled for 1980, a large proportion of the savings will be realized by 1985, so this saving will not grow as much as the auto saving will in the years beyond 1985. FEA estimates that the State energy conservation programs under the Energy Policy and Conservation Act will result in savings of 1.8 quads a year by 1985. The Federal program is expected to slowly expand on savings previously achieved under the presidentially mandated Federal Energy Management Program. FEA estimated that the savings attributable to this program were 0.6 quads in 1975 and will remain in this range through 1985.

Smaller amounts of energy savings are anticipated from the voluntary industrial energy conservation program. The industrial program, aimed at the ten most energy-intensive industries, is expected to save 0.9 quads in 1980, but only 0.6 quads in 1985. This decline is anticipated because the program is only expected to accelerate actions which companies would have carried out on their own by 1980 because of price increases.

FURTHER POTENTIAL FOR ENERGY CONSERVATION

The major thrust of the programs adopted in the Energy Policy and Conservation Act have aimed at a limited number of fairly significant energy use activities, such as automobiles and home appliances. Additional measures focusing on other energy uses can yield substantial savings beyond those anticipated for the programs now in effect.

Changes in energy use which could result in energy savings can be classed roughly into three types. The first class involves changes in practices which can be implemented immediately (turning down thermostats) or within a few months or years. These changes, such as the mandatory 55 mile per hour speed limit, will usually not have large dollar costs, but the changes of convenience or habits can be important. The second class of changes can be called "retrofitting." Retrofitting involves changes or additions to existing energy using equipment, such as adding insulation to buildings, or adding an automatic control system for a factory process. Individual retrofitting actions can be carried out relatively quickly, but it will take a number of years, for example, for insulation retrofitting to be completed in the tens of millions of American houses in which it is cost-effective: such a program could begin to yield energy savings very quickly, with little lag period, but the full savings would not be achieved until the program was completed.

Retrofitting changes will involve dollar costs, which can range from being very cost effective to being prohibitively expensive, and thus their extent of accomplishment will be affected greatly by economic factors. For example, expensive storm windows may be cost effective in New England but probably not in most Southern states.

The third class of energy-use changes involves replacing existing equipment, facilities, and processes. These will be the slowest to reach their full potential for energy savings, because many of these changes may be delayed until existing equipment has served its useful lifetime. This lifetime ranges from over a decade for cars to half a century or more for homes and commercial buildings. Increasing energy costs may speed up the retirement of some extremely energy-intensive equipment or structures.

In light of those differences of timing, it will be important to focus on changes of practices and retrofitting to achieve early energy savings from conservation policies, and also to consider ways in which the retirement of inefficient energy-using equipment and structures can be accelerated.

For our estimates of the potential for additional energy savings, we have relied on the Ford Foundation's Energy Policy Project. The project considered several scenarios, one called "Historical Growth" which projects the trend of energy use if energy supplies are emphasized, one called "Technical Fix" which incorporates a number of supply and conservation actions, which the Foundation saw to be both energy and economically efficient, and another named "Zero Energy Growth" which emphasizes energy conservation and even greater efficiency. The conservation estimates we use are based on the "Technical Fix" results and the consumption estimates are based on the "Historical Growth" projection. Though energy consumption is not expected to grow as fast as the 3.4 percent growth rate of the Historical Growth scenario (most projections today are in the 2.5 to 3 percent growth range), the higher consumption estimates still can be used to illustrate the potential impact for conservation actions.

Finally, it should be noted that neither the Ford Project's study nor other studies mention every possible opportunity. In the following discussion, we consider only some of the more important actions which could be taken by the residential, commercial, transportation, and industrial sectors and the utility industry to conserve energy.

The residential sector

The residential sector consumed about 22 percent or 15.3 quads of energy during 1975. Without additional Federal actions, consumption would grow to about 22.9 quads by 1985 and 30.1 quads by 2000. About 21 percent of this energy can be saved each year by 1985 and, by 2000, almost 36 percent. The following table shows the major areas where the savings can be achieved.

Savings area	Potential savings in quads 1985	Potential savings in quads 2000
Space heating	2.7	7.0
Air conditioning	.8	1.3
Water heating	.6	1.5
Other	.6	1.0
Total	4.7	10.8

The largest opportunity for saving energy in the residential sector is in space heating and water heating. Weatherproofing both existing buildings and new housing with ceiling and wall insulation, storm windows, weatherstripping, and constructing thermally "tighter" homes are important conservation steps. Using heat pumps in homes with central air conditioning rather than electric resistence heating is another important measure. Other conservation actions in this area include use of more efficient fossil fuel furnaces, and electric igniters rather than pilot lights.

Besides these measures, consumers themselves can reduce consumption by lowering thermostat settings and not heating or cooling unoccupied rooms. A study done for the Environmental Protection Agency (EPA) estimated that a practical thermostat control program could achieve as large a saving in 1985 as an insulation program could. Public education would improve awareness of these opportunities.

The commercial sector

The commercial sector used about 14 percent or 9.8 quads of energy during 1975. By 1985, consumption is expected to grow to 15.1 quads and 21.3 quads by 2000 without additional Federal actions. About 9 percent of this energy can be saved each year by 1985 and, by 2000, about 21 percent. The following table shows the major conservation areas.

Savings area	Potential savings in quads 1985	2000
Space heating and total and energy systems	a/ 0.7	3.2
Air conditioning	0.3	0.5
Other	0.3	0.7
Total	1.3	4.4

a/ Figure based on space heating at 1.3 quads plus total energy systems at a decrease of 0.6 quads.

Many of the savings opportunities for the residential sector apply in this sector as well. For instance, better insulation could save 0.7 quads in 1985. Other opportunities include using heat pumps instead of electric resistence heating and using total energy systems, which would combine electricity generation with waste heat recovery for use in space heating and cooling, say for use in a large building or a shopping mall. Though total energy systems could only make a minor contribution during the next 10 years, they could over the long-run, be almost as important an energy saver as the improved insulation of commercial buildings.

Additional conservation opportunities pertaining more to user practices than installed technology are available in the commercial sector. Examples include reduced lighting levels and reduced ventilation rates. These changes could be implemented quickly, according to an EPA study, and could save as much as 1.6 quads by 1985, but would require changes in building codes.

The transportation sector

The transportation sector of the economy accounted for 26 percent--or 18.6 quads--of the Nation's energy use in 1975.

Without Federal actions, it is expected to grow to 26.0 quads in 1985 and 38.4 quads by 2000. Automobiles consume about 57 percent of the transportation energy and offer the largest potential for saving energy. This was recognized by the setting of fuel economy standards in the Energy Policy and Conservation Act discussed earlier. Additional transportation savings can be obtained from the following areas.

Savings area	Potential savings in quads 1985	2000
Air transportation	1.1	3.4
Trucks	0.3	2.1
Total	1.4	5.5

For air transportation, the conservation opportunities include increasing passenger and freight load factors, slightly reducing flight speeds and reducing the number of short distance flights. Fuel use by trucks can be reduced by shifting from gasoline to diesel engines and increasing the use of trains for intercity freight.

Additional opportunities, such as increased carpooling, vanpooling, and shifts from autos to buses in urban areas will reduce fuel use. Regarding carpooling, a study done for EPA estimated that an increase of average vehicle occupancy of 0.4 persons in commuting trips could be attained and result in energy savings of 1.0 quads a year by 1985.

The industrial sector

Industry is the largest of the Nation's energy consuming sectors accounting for about 38 percent of U.S. energy use, or 27.3 quads in 1975. Without Federal actions, this is expected to grow to 52.1 quads in 1985 and 96.9 quads by 2000. The voluntary industry efficiency program of the Energy Policy and Conservation Act will obtain only a small portion of the potential for industrial conservation.

Overall savings opportunities in the industrial sector constitute about 12.1 quads of the energy projected to be used by industry in 1985. This is more than double the savings potential of the residential sector and about 80 percent of total energy use by the commercial sector. By 2000, about 36 percent of projected industry energy consumption could be saved.

By 1985, roughly 30 percent of all industrial energy use will occur in five industries--paper, aluminum, steel, plastic, and cement. Major savings are possible through the use of more efficient production processes in these five industries. The steel industry has the largest potential but by 2000 the introduction of new processes could make the percentage savings in paper and plastic comparable. Today some Swedish and German industries are using 20 to 43 percent less energy per ton of output than U.S. industry requires. Major conservation opportunities for industry are identified below.

Savings area	Potential savings in quads 1985	Potential savings in quads 2000
Five energy intensive industries	4.0	11.6
Miscellaneous cogeneration of steam and electricity	0.4	2.9
Miscellaneous direct heat	2.9	5.4
Other	4.8	13.9
Total	12.1	33.8

Energy savings pertaining to industry across the board are available for direct heat applications by using heat recuperators and regenerators and if fossil fuels were used instead of electric resistence heating. Another possibility is cogeneration, which is the simutaneous production of steam and electricity. However, cogeneration has a long implementation time associated with it, and is not expected to make its major contribution until after 1985. Yet it is a proven technology--almost 30 percent of electricity generated in West Germany is produced in industrial plants.

Electric utilities

In addition to the four end-use categories, the electric utility industry plays an important role in the energy economy. In 1975, utilities consumed over 28 percent of all U.S. primary energy resources for generating the electricity consumed in other sectors. (Consumption statistics for the sectors previously discussed include the appropriate electricity they consume.)

Because electricity was an inexpensive and flexible source of energy, its use has been promoted for many years. Utility rate structures were designed this way--rewarding power users with lower priced electricity as their consumption grew. Changing utility rate structures to end these promotional features and substituting conservation oriented rate structures will discourage wasteful electricity use, encourage industrial and onsite power generation, and reduce peak load demands.

The major aspect of conservation oriented utility rate structures is called load management. Utilities generally meet base-load and intermediate demands with nuclear and coal-fired plants, and meet short-term (several hours per day) peak demands with oil or gas fired turbines which have substantially lower capital costs but which have much higher energy costs. Pricing structures which increase electricity costs when demands are greatest can reduce the range of daily fluctuations in electricity demand. This will allow utilities to generate a greater share of their output with the more energy-efficient nuclear and coal-fired plants and, thus, save some of the energy wasted due to the inefficiency of peaking turbines. Consideration is also being given to special measures to protect low income persons such as "life line pricing" which would provide a minimum amount of electricity at low rates.

Besides such rate structure revisions, improvements can be made by increasing generating and transmission efficiency, and sharing demands through system interconnections.

<u>Cost effectiveness of conservation</u>

Many of the conservation strategies discussed above are cost effective today. For example, FEA has found that in a climate like Indianapolis, Indiana, a typical homeowner could install ceiling insulation at a cost that would be equivalent to purchasing oil at $5.90 a barrel, or 14 cents per gallon of heating oil. Additional retrofitting might be wall insulation and storm windows, at 28.5 cents and 30.5 cents per gallon of oil equivalent. These savings can be compared to heating oil which is now priced at over 40 cents per gallon and rising with the cost of petroleum.

A study by the National Bureau of Standards found a number of industrial conservation actions to be cost effective. Some of these examples are shown below.

Action	Estimated cost	Estimated annual savings
Schedule use of 12 30KW furnaces to minimize peak demand	None	$3,600
Insulate 420 feet of steam line	Minimal	$1,720
Installing steam traps on phonograph record molding presses	Minimal	$105,000
Recover boiler flue gas heat for space heating and feed-water preheating	a/ $9,040	$5,360
Improved Combustion Control for Dual Feed Systems	$29,000	$40,090

a/ Incremental cost for recovery system.

There are other energy conserving actions which have been proposed that appear to be cost effective because they entail no capital expenditure. Changes in user practices such as turning down thermostats cost nothing and offer immediate savings.

Modifying transportation practices such as increasing airline load factors, reducing the number of short distance air trips, and increasing carpooling and railroad use are all cost effective changes. Changes such as these reduce the passenger or freight costs per mile traveled.

These examples show some conservation actions which are cost effective, however, many more not mentioned here may also be cost effective. Often, specific circumstances will dictate whether an action is economical, and a determination can only be made on a case-by-case basis.

IMPEDIMENTS TO IMPLEMENTATION OF ENERGY CONSERVATION

Although many potential energy conservation actions are now cost effective, there are a number of impediments to accomplishing these actions. These include (1) a need for more accurate and complete information on conservation costs and benefits, (2) a lack of incentive for many users to improve their energy efficiency, (3) preoccupation with initial costs rather than life-time costs, (4) several Government regulations, and (5) the slow rate at which existing technology is replaced.

Besides the lack of information, access to capital, especially for small borrowers, also may be lacking. Another problem is the lack of incentive, especially in the case of builders, owners, and renters in the residential and commercial sectors who may not pay utilities directly or who may not plan on occupying the building long enough to justify retrofitting it themselves.

An obstacle to more efficient new homes and manufactured goods is the concern of manufacturers and builders regarding the impact that the selling price of their products will have on sales. The problem is that initial cost can determine salability of a product, even though the total life cycle cost of buying and operating an energy efficient house, car, appliance, or other product would be lower.

Industry, as well as consumers overemphasize first cost, or avoid conservation investments for other reasons. Tentative indications in one of our reports now in preparation are that, in parts of the industrial sector, energy-conserving investments are only being made if they offer extremely fast paybacks (1 to 3 years).

Several Federal regulations promote inefficiency. For example, Interstate Commerce Commission regulation of the trucking industry results in inefficient routing and empty backhauls, and Civil Aeronautics Board rules may adversely affect airline load factors. These regulations were written with service and industry competition in mind, but may need to be overhauled to take into consideration the efficient use of energy. Electricity and steam cogeneration by industry is impeded by laws which discourage the sale of electricity by industry.

A final impediment is the slow rate at which equipment and facilities throughout the economy are replaced; for example, there are steel plants in operation today that were built in the first quarter of this century. Often the potential energy savings from a new process or efficient industrial equipment are insufficient to justify replacing the existing ones while retrofit may also be unjustified.

Despite the potential for conservation and recent recognition, Federal funding is only a small portion of total energy expenditures. Excluding the state energy conservation programs, about 8 percent of FEA's fiscal year 1977 budget is devoted to conservation. About 4 percent of ERDA's fiscal year 1977 budget is devoted to conservation research and development activities. In addition, ERDA's combustion, fuel cell, and magnetohydrodynamics research may begin to contribute to energy efficiency between 1985 and 2000.

Although better data on costs and potential impacts needs to be developed, energy conservation should play a major role in Federal energy activities. Enough is known to place priority on particular conservation actions in each sector. Federal activities can be pursued which would emphasize the major opportunities, provide public information services and, in some cases, financial incentives to stimulate activity.

CHAPTER 4

EMERGING ENERGY

SUPPLY TECHNOLOGIES

In addition to improving existing technologies and encouraging and developing energy conservation techniques, energy research and development also involves new energy technologies. This chapter focuses on these new technologies designed to increase the Nation's energy supply, their potential, and the factors constraining their widespread use. Included are those technologies that have been proven technically feasible and are estimated to be capable of making an important supply contribution by 2000.

Although there exists a wide range of projections of the potential of new energy supply technologies, ERDA's most optimistic scenario in their National Plan 1/ shows that no individual new technology which we examined in this report is expected to provide more than 10.5 quads or 8 percent of total domestic supply required by 2000. 2/ Within this perspective, synthetic liquid fuel from coal is expected to produce the largest impact in 2000 (10.5 quads), followed--in descending order--by oil from shale (8 quads), oil recovered using tertiary techniques (7.2 quads), energy from biomass (waste material only--mostly municipal waste) (6.5 quads), electric energy from geothermal (mostly hydrothermal) resources (5.6 quads), solar water and space heating energy (3.5 quads), and synthetic gas from coal (3.5 quads). The combined potential impact from synthetic fuels shown in ERDA's National Plan is higher than the other emerging energy supply technologies. However, synthetic fuels technologies appear to us to be the only ones which could need all three levels of financial assistance --front end money, construction assistance, and product price supports. Essentially, this is because synthetic fuels technologies appear at this time unable to compete economically with conventional energy sources.

1/ Throughout this chapter, we use Scenario V of ERDA's National Plan.

2/ ERDA is in the process of reevaluating and adjusting downward its projections for synthetic fuels.

TECHNOLOGIES WHICH APPEAR TO BE ECONOMICALLY COMPARABLE TO CONVENTIONAL ENERGY SOURCES

Along with their potential impact, any ranking of the relative attractiveness of new energy supply technologies should also consider their economic feasibility in comparison to traditional energy sources. The cost of solar space heating, solar hot water heating, energy from municipal waste, tertiary oil recovery, and geothermal energy (hydrothermal) appear favorable in certain applications and locations.

Energy from municipal waste systems

The combustion methods of recovering energy from municipal waste which now appear to be commercially viable are (1) waterwall incinerators which burn municipal waste directly and (2) powerplant boilers which burn municipal waste mixed with a fossil fuel in industrial or utility powerplants.

Estimates in ERDA's National Plan indicate that by 1985 2 quads per year of municipal waste materials could be converted to usable energy. The plan also shows that, by 2000, 6.5 quads per year could be converted.

An EPA official stated that some municipal waste conversion processes appear economically attractive in locations where the alternative cost of waste disposal is over $6 per ton. He further stated that the actual cost of waste disposal ranges between $2 and $25 a ton, however, most cost over $6 per ton.

EPA has a program which provides planning assistance to municipalities for demonstrating the use of municipal wastes as a fuel. ERDA also has a biomass program, however, its program is directed toward developing biomass technologies other than municipal waste combustion.

At least five municipal waste systems are currently operating. Twenty-eight additional plants are planned or under construction and approximately 37 other communities have expressed interest in building plants.

Obstacles to implementing municipal waste systems

Although the municipal waste combustion technologies appear commercially viable and should not be impeded by major technical problems, fuel resources and plant planning may affect the growth of this industry. A concern among municipalities is access to a reliable source of sufficient waste material to fuel a plant. ERDA has also cited inadequate information and planning as obstacles to implementation. Lack of information slows planning, system selection, procurement, and project financing. The failure of municipalities to recognize the importance of the planning process, hire appropriate experts to guide them, and carry out the planning properly has, in the past, slowed system implementation.

Tertiary oil recovery techniques

Primary recovery of oil is that produced by drilling and natural forces, such as gas in solution, subsurface pressures, and natural water drives.

The two terms secondary recovery and tertiary recovery are often used synonymously with enhanced recovery. Technically, secondary recovery means a "second crop" of oil after the "first crop" from primary production and tertiary means a "third crop".

For simplicity, we will define secondary recovery to include the already economically and technically proven techniques of pressure maintenance, traditional waterflooding, and cyclic steam injection. Tertiary oil recovery--the subject of this section--will be defined to include the newer, less widely used techniques.

Nearly 106 billion barrels of oil (about 590 quads) --about 24 percent of total identified domestic reserves --have been recovered using largely primary and secondary recovery techniques. Another 34 billion barrels (about 190 quads)--about 8 percent--remain recoverable using primary and secondary techniques. 1/

Tertiary oil recovery techniques may be used after primary and secondary methods no longer yield economic quantities of oil. According to an ERDA official, 20 to 60 billion barrels (about 110 to 330 quads) may be recoverable using tertiary recovery techniques. Others estimate range from less than 20 to over 100 billion barrels.

1/ "Analysis of the Potential and Economics of Enchanced Oil Recovery," Preliminary Report, October 31, 1975, Lewin and Associates, Inc.

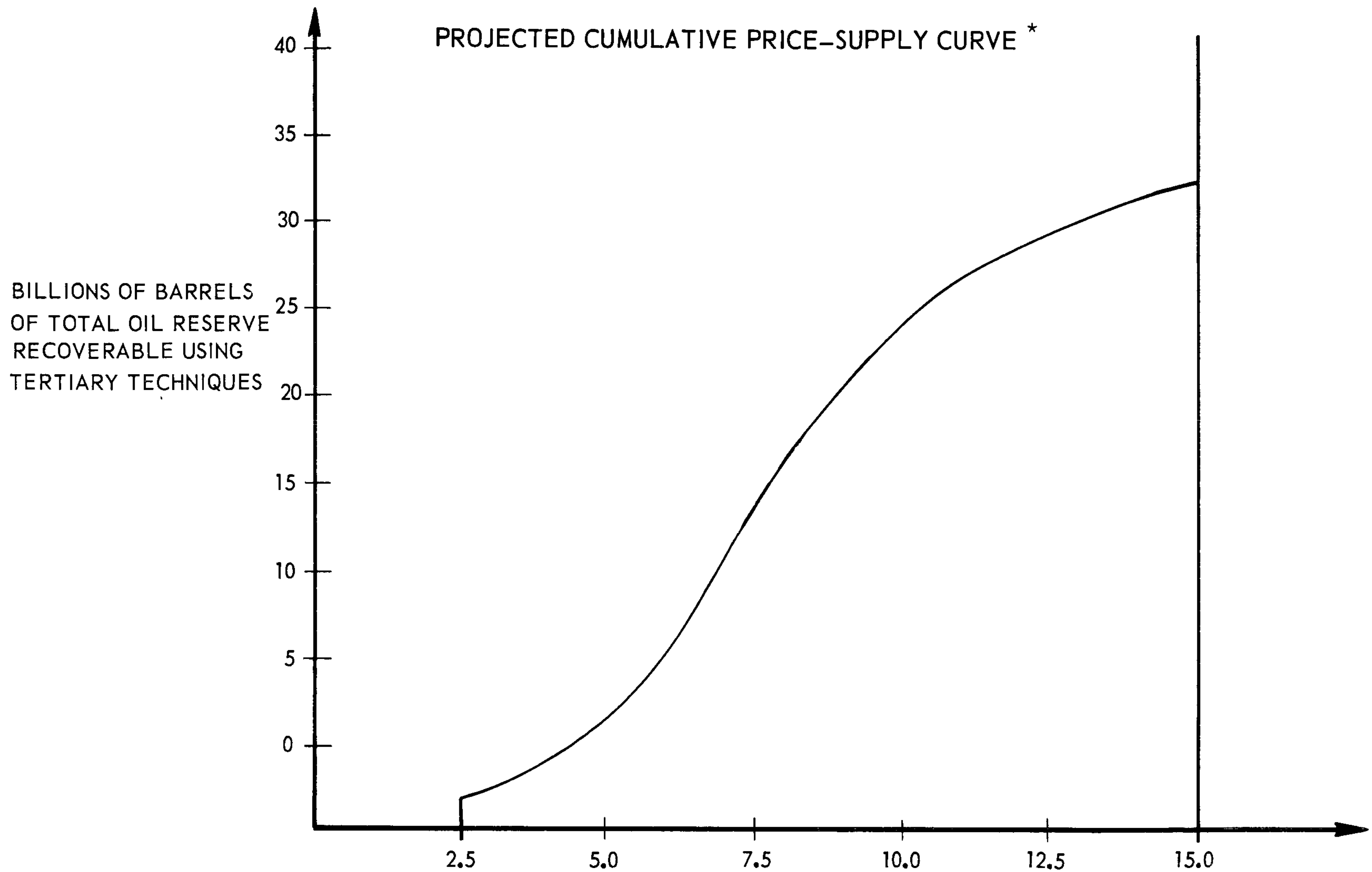
Among the three tertiary recovery techniques that have the widest application, ERDA considers chemical flooding to be the most promising. Chemicals are injected into the oil reservior to free or displace petroleum from the rock formations. Chemical flooding is expected to provide about 50 to 60 percent of total oil recovered using tertiary recovery techniques.

Another method, thermal enhanced recovery, involves injecting an oil reservoir with steam or hot water or using in-situ combustion to release petroleum which is trapped in rock formation. Carbon dioxide can be injected into oil reservoirs, reducing the oil viscosity and stripping it from the rock formations. Gas or water is then pumped into the reservoir to drive the combined carbon dioxide and oil through the formation to a recovery well. Gulf Universities Research Consortium estimates that thermal recovery techniques will account for about 30 percent and carbon dioxide injection less than 10 percent of all oil recovered by tertiary techniques.

ERDA's National Plan projections show that tertiary recovery technique may provide an additional 1,500,000 barrels of oil per day (3.0 quads per year) by 1985 and 3.6 million barrels of oil per day (7.2 quads per year) by 2000.

A Lewin and Associates, Incorporated, study conducted for FEA included an analysis of the potential for tertiary recovery in California, Texas, and Louisiana--which account for 64 percent of total domestic reserves (lower 48 States only)--indicated, as can be seen in the following chart, that recovery of some tertiary oil is now economically attractive, but that the majority of tertiary oil will not be recovered at current prices.

PROJECTED CUMULATIVE PRICE–SUPPLY CURVE *



* ADOPTED FROM "THE POTENTIAL AND ECONOMICS OF ENHANCED OIL RECOVERY -- PRELIMINARY REPORT #3," MARCH 19, 1976, BY LEWIN AND ASSOCIATES, INC. WASHINGTOND.C.

Other studies differ widely on the projected cost of oil recovered using tertiary techniques. A variety of estimates indicate that oil recovered using tertiary recovery techniques will cost about $8 to $18 per barrel. Lewin and Associates, Incorporated, attribute the wide variation to the variety of technologies. The Oil and Gas Journal 1/ projects the cost of tertiary oil at $20 to $25 per barrel.

Industry is currently sponsoring over 150 tertiary recovery projects. Tertiary recovery currently provides about 270,000 barrels of oil per day or .54 quads per year in the United States. ERDA is sharing in the cost of 8 projects at a cost of $16.2 million. Project cost sharing (ERDA will provide up to 50 percent of total project costs) and widespread dissemination of data are the methods ERDA intends to use to accelerate commercialization of tertiary recovery techniques. ERDA plans to participate in 111 enhanced oil projects by 1980. Once these projects have been completed, an ERDA official stated that additional incentives should not be required.

Obstacles to implementing tertiary oil recovery 2/

The initial investment and lengthy payback period are major obstacles to widespread commercial use of tertiary technologies. Tertiary projects require two to four times the investment which is required for secondary recovery projects during the first 2 years. The greater investment is required because of the cost of pumps, compressors, redrilling, distribution lines, treating facilities, and injection fluids. After the first 2 years, project costs would be similar for secondary and tertiary projects.

The major problem with carbon dioxide injection is obtaining the required quantities of carbon dioxide at the oil field. Chemical flooding may require chemicals which are in short supply. The industrial capacity to produce enough chemicals to support widespread use of this technology does not

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1/ Oil and Gas Journal, Annual Production Report, Enhanced Recovery Survey, April 5, 1976, Volume 74, Number 14.

2/ To make tertiary oil recovery more attractive, the law to extend FEA's life (P.L. 94-385) allows the petroleum price regulations to be modified to provide additional price incentives for tertiary recovery techniques.

now exist. In addition, the amount or combination of chemicals required may have to be altered to suit each oil field. Chemically saturated water retrieved from wells present a disposal problem. Except for this chemical disposal problem, environment problems are principally the same as those associated with primary recovery.

Solar energy

Numerous systems have been devised to convert sunshine into usable energy. However, only direct thermal systems--solar hot water heating and solar space heating appear to have economic application today and only in some geographic areas. Direct thermal applications involve collecting solar energy for heating water and heating and cooling homes. Industry and agriculture can also use direct thermal technology as a source of low temperature heat. Currently, solar equipped buildings are custom designed and require an energy storage system or a conventionally fueled backup system. A typical system for solar heating consists of a collector exposed to the sun's rays, a heat transfer fluid (usually air or liquid) which carries the collected energy to the points of storage or use, a storage device, and equipment for distributing heat within the building as well as conventional backup equipment.

According to an ERDA official, solar water heating appears to be competitive with electricity in about 90 percent of the country, where electricity costs exceed 5 cents a kilowatt hour in the Northeast or 3 cents a kilowatt hour in other parts of the country, and assuming a 10-year payback. However, solar space heating would only be competitive in about 20 to 30 percent of the country, under these conditions.

The U.S. Department of Labor's data on the cost of electricity for March 1976 shows the cost of electricity in the Northeastern United States to average 4.41, 5.86, and 7.23 cents per kilowatt hour for 500, 250, and 100 kilowatt hours per month respectively. The rest of the country's metropolitan areas average cost was between 3.7 and 6.2 cents per kilowatt hour, depending on quantity consumed.

The Federal Government intends to demonstrate the practical use of this technology by 1977. Systems analysis and overall design of the demonstration program for Federal buildings are underway and proposals have been solicited for installing heating systems in new and existing buildings at selected locations. A variety of Federal incentives--including low interest loans to homeowners and builders, tax credits, and accelerated amortization of solar energy equipment for commercial buildings--are being considered to remove barriers for widespread use and commercialization. 1/

Already, State Governments have begun to encourage the use of solar equipment. Ten states have passed legislation and two others have proposed legislation which reduces the taxes associated with solar energy systems. In these cases, all or a portion of the solar equipment was exempted from property taxes. Texas has exempted solar systems from sales tax. New Mexico and Arizona have reduced solar's first cost handicap by providing an income tax credit of 25 percent of the cost of the solar equipment (up to $1,000).

Because solar energy systems offer opportunities to reduce life-cycle costs, five states have passed legislation requiring life-cycle cost analyses to be considered for new and remodeled state buildings. Demonstration of solar systems on state buildings are also authorized in four states. Acceptance by the building industry is being encouraged directly in Florida and Minnesota by adding solar provisions to their state building codes. For example, Florida's building code was amended to require home hot water systems which will accept solar heating devices.

Obstacles to implementing solar hot water and space heating

The solar energy industry is small but expanding rapidly; about 118 manufacturers now produce solar equipment. Most applications require conventional (oil, gas, or electric heating systems) backup systems, however, few integrated solar-conventional heating systems are available. Evaluations of system efficiency and durability, storage subsystems, backup system requirements, aesthetics and mass production costs are not complete.

Life-cycle costs of solar hot water and space heating are less than conventional systems in many areas of the country but high initial costs may be a major problem. A typical hot water unit may cost about $1,000 to $2,000, but units are also available costing up to and above $16,000 for space heating. The homeowner who decides to equip his home with solar hot water or space heating must finance these costs

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1/ As discussed in the summary chapter of this report, the FEA extension legislation recently signed by the President includes a number of incentives of this type (see page 51).

at installation time and builders must include solar costs in their selling prices. However, banks do not uniformly allow inclusion of the solar system costs in their mortgages. The institutional problems associated with heating involve, among other things, sun rights, acceptance by the building industry, zoning laws, and building codes.

Geothermal energy

Geothermal energy is the natural heat of the earth. Where heat is concentrated in areas of the earth's crust similar to oil reservoirs, it is accessible and has potential commercial uses. Geothermal reservoirs have been found primarily in the Western United States; more than half are on Federal land.

Only the hydrothermal technology--which includes dry steam and steam from mineralized water (wet steam)--has progressed to the commercial stage. Dry steam is now being used at an area known as the Geysers to generate power for northern California. This hydrothermal dry steam field, located about 85 miles north of San Francisco, is operated by the Pacific Gas and Electric Company and has an electrical generating capacity of 502 megawatts to help meet the power requirements of San Francisco. The Geysers' ultimate capacity is expected to reach 2,500 megawatts of electric power by the year 1985. The United States Geological Survey has not identified any other major dry-steam fields suitable for commercial production in the United States.

Another hydrothermal field exists in the Imperial Valley in Southern California. Private concerns plan to produce electricity from wet steam in this area in the near future. Hot geothermal fluids are also providing heat to more than 400 buildings in Klamath Falls, Oregon, and to about 200 homes in Boise, Idaho. ERDA's National Plan projections show that this form of energy will provide 1.4 quads per year by 1985 and will increase to about 5.6 quads per year by 2000. It should be noted that this impact is highly regionalized.

ERDA currently estimates that electricity produced from hydrothermal (wet steam) energy resources, when built, will be competitive with any new coal or oil fueled generating plant. ERDA has estimated that electricity generated from the wet steam fields in the Imperial Valley may cost 1.5 cents to 2 cents a kilowatt hour which would be more than 1 cent per kilowatt hour cheaper than current electric costs in any major metropolitan area of the country except Seattle.

Effective June 25, 1976, ERDA implemented a 75 percent loan guarantee program ($30 million for fiscal year 1977 to cover possible defaults) designed to encourage, assist, and accelerate private development of geothermal energy by minimizing the lender's financial risks and to develop normal borrower-lender relationships which will eventually encourage the flow of credit without the need for Federal assistance. ERDA expects to be able to guarantee loans totaling approximately $200 million (assuming 1 in 7 default ratio) with the fiscal year 1977 funds. As of August 12, 1976, ERDA had not received any loan guarantee applications.

ERDA anticipates that additional incentives may eventually be required to further accelerate and enhance the economic attractiveness of geothermal energy. ERDA is considering the impact created by tax incentives, direct project subsidies, cost sharing projects and financial support to local communities for planning grants. Tax incentive possibilities include depletion allowances and deductions for intangible drilling costs.

Obstacles to implementing geothermal energy

Today's only major commercial areas are the hydrothermal steam fields at the Geysers in California. For this area and other geothermal sources, there are uncertainties or a lack of information on exact location, magnitude and longevity of exploitable resources. Technical problems include demonstration of the technology on a commercial scale, corrosion and scaling. Concern has also been expressed over the resource lifetime and ability to sustain a given level of power generation. Hydrothermal, like all geothermal energy, use is highly regionalized; steam cannot be transported without high heat loss. Plants and associated facilities must be constructed onsite.

Effluents from hot water or vapor systems can pollute streams or ground waters, although objectionable fluids and gases could be reinjected into a deep reservoir. Noise, land use, visual impact, potential subsidence of the land surface due to fluid withdrawal, and potential seismic disturbances are other problems faced in geothermal energy development.

TECHNOLOGIES WHICH APPEAR UNABLE TO COMPETE ECONOMICALLY WITH CONVENTIONAL ENERGY SOURCES

The ERDA plan shows that of the total energy demand projected for 2000, synthetic gas from coal could supply about

3 percent, synthetic liquid from coal over 8 percent, and shale oil could contribute about 6 percent. 1/ However, at this point, synthetic fuel technologies are the least economical of all the new energy supply technologies.

Coal liquefaction

Coal liquefaction is the process of converting coal into a liquid fuel. There are several different methods; some processes burn coal, condense the resulting gases, and add hydrogen to form a liquid while other processes chemically dissolve coal with hydrogen to form a liquid.

Technology for converting coal to liquid fuels was developed in Germany over 60 years ago. Commerical operation, which started in Germany in the 1930s, expanded and accelerated with the onset of World War II. However, there appears to be only one commercial coal liquefaction plant in the world. This plant is owned and operated by a South African government-controlled corporation and produces about 5,000 barrels of fuel per day as well as other chemicals, petro-chemicals, and fertilizers.

ERDA's National Plan projects that the coal liquefaction processes will be capable of providing .48 quads per year by 1985 and 10.5 quads per year by 2000.

Oil shale

Two methods are being studied to recover shale oil from rock--surface retorting and in-situ retorting which is not far enough developed to be considered a near-term alternative. In the surface retorting process, oil shale is mined, crushed, and hauled to a surface retort, where it is heated and the oil recovered. Spent shale is dumped on the surface or partially returned to the mine.

Oil shale deposits are found in several areas of the United States. However, the only U.S. deposit having adequate size and availability using present technology is the Green River formation, located in Colorado, Wyoming, and Utah. These deposits are estimated to contain about 600 billion barrels of shale oil (over 3,000 quads). Much larger quantities are believed to be contained in poorly defined and generally lower grade oil shale deposits. The ERDA plan shows that the potential

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1/ ERDA's now reevaluating these estimates and adjusting them downward.

impact of oil recovered from oil shale is 1 quad by 1985 and 8 quads by 2000. Currently, eight firms have announced plans for oil shale projects.

Coal gasification

In this process, coal is fed into a high-temperature vessel, called a gasifier, into which steam and either air or oxygen is injected. Chemical reactions occur and a mixture of gases is produced; usually carbon monoxide, hydrogen, and methane. Methane is the main constituent of natural gas. The gases are then cooled and undesirable components, such as carbon dioxide and sulfur, are removed.

The raw gas produced at this point is referred to as low British thermal unit (Btu) 1/ gas if produced with air, and medium Btu if produced with oxygen. This gas has a low or medium heat value (less than 450 Btu's a cubic foot) and cannot be economically transported over long distance by pipeline. It is valuable, however, as a fuel supply for electrical power generation plants or industrial processes using gas-fired furnaces which are located near the conversion plants. Low- and medium-Btu gas can be upgraded to a high-Btu gas --950 to 1,000 Btu's a cubic foot--through a reaction between hydrogen and carbon monoxide, referred to as methanation. High-Btu synthetic gas is a direct substitute for natural gas and can be transmitted in existing pipeline networks with natural gas.

Coal gasification processes were used in the United States in the late nineteenth century. During the 1920s and 1930s, approximately 12,000 coal gasification units were in operation in the United States. These units produced a low-Btu gaseous fuel generally known as producer, or town gas. With the advent of inexpensive natural gas during the next 2 decades, most of the units were either scrapped or mothballed. Today, low-Btu coal gasification processes are used rarely in the United States. In many foreign countries where domestic natural gas and oil are not as abundant as in the United States gasification processes have been able to survive. All of these (at least 50 plants) processes produce either low- and/or medium-Btu gas.

1/ The amount of energy necessary to raise the temperature of 1 pound of water by 1 degree Fahrenheit. A barrel of crude oil has an energy content of 5.6 million Btu's; a gallon of gasoline, 125,000 Btu's.

Projections in ERDA's National Plan show that by 1985, coal gasification will provide about .92 quads of energy. By 2000, the output is expected to increase to about 3.5 quads--only 2 percent of total projected demand.

At least 16 U.S. companies have announced plans to build high-Btu gasification plants in the United States. Three of these companies have applied to the Federal Power Commission (FPC) for approval of their projects.

ERDA feels that to develop a scale of synthetic fuel industry by the year 2000 which will hold oil imports at current levels, an informational 350,000 barrel-a-day program, must exist by 1985, which could be expanded later as results from the program indicated.

Obstacles to implementing synfuels

The major financial obstacles are the high cost of the output from synfuels plants--projected to be substantially higher than oil and natural gas, and the high capital costs--about $1 billion for a commercial size (about 50,000 barrels of oil a day equivalent) synfuel facility. The Synfuels Interagency Task Force estimated the prices of synfuels which would be required to yield various rates of return (on discounted cash flows after taxes on entire capitalization).

At 15 percent rate of return, the estimated regulated price of high-Btu synthetic gas--$2.61 to $3.02 per thousand cubic feet 1/--is about double the proposed FPC domestic price of new natural gas ($1.42 per thousand cubic feet). Converted to the equivalent price per barrel of oil, the $15 to $18 per barrel price of high-Btu synthetic gas does not favorably compare with the $12 current price of foreign oil. However, the estimated price of synthetic gas compares more favorably with the current price of imported liquified natural gas --approximately $3.00 per thousand cubic feet.

The Synfuel Interagency Task Force's report shows the price of oil from shale to be in the $10 to $18 per barrel range. However, some recent industry estimates of the expected cost of shale oil range up to $18.90 per barrel. The Task Force's report and recent industry estimates project the price for synthetic oil from coal to be about $20 to $30 per barrel.

1/ Projection contained in the report by the Synfuels Interagency Task Force. Most of the recent industry estimates are over $3.00 per thousand cubic feet.

Officials of the three companies which have applied to FPC to build high-Btu coal gasification plants said that lenders are reluctant to finance plants partly because the lenders are skeptical of technical success. However, ERDA officials, as well as other industry officials, told us that the technical risks of the proposed gasification plants using first-generation technology are minimal.

Shale oil technology does not appear as advanced as existing gasification technology. A commercial-size module (approximately 10,000 ton a day) has not been built. To date, in the United States, operation has occurred in experimental 1,000 ton-a-day plants and there are differences of opinion about the technical risk in scaling up to commercial size. Some companies believe a single, commercial-size module should be built, while other companies, believing the technology proven, consider the module approach a waste of time and money and that building a commercial plant with five or six modules is preferable.

Risks associated with coal liquefaction appear to be greater than gasification and oil shale. The only commercial plant in the world today uses coal provided at roughly one-third to one-half the projected costs of eastern U.S. coal. Based on the data resulting from operation of this South African plant, the economics of first-generation liquefaction technology and the product mix appear to constrain application of the process in the United States. We were unable to find anyone who is actively seeking to commercialize this technology in the United States.

Air and water pollution, solid waste disposal and water use problems are expected for the plants and associated coal mines. The extent of the environmental effects would depend on what type of process and equipment is used. Besides the environmental effects of mining, other environmental effects of shale oil production include solid waste disposal --which in some cases are expected to be of an amount larger than the shale used--and effects on wildlife, land, air, and water quality.

There are also social-economic considerations. Coal conversion plants or shale facilities are expected to be built in a rural setting close to the resource. This would increase population and therefore increase demand on schools, stores, roads, waste facilities, water, police and fire protection, and other important community services. These areas often are not well prepared or in a position to finance the front end cost of such rapid change.

CHAPTER 5

PROS AND CONS OF ALTERNATIVE FEDERAL FINANCING INCENTIVES

This chapter discusses the major Federal actions that can be used to stimulate new energy supply technologies and conservation actions. The array of potential Federal actions can be classified as indirect or direct. Indirect actions operate through the market mechanism to affect the price of products, thereby influencing, hopefully, consumer behavior. They are the best suited to new energy supply technologies and conservation actions that are currently economic or nearly so.

In contrast, direct actions bypass ordinary market mechanisms, involving the Government as a commercial agent, allocating resources directly.

The principal types of direct and indirect actions are shown below.

Major Government actions available for stimulating new energy technologies and conservation actions

Type of action	Examples of such action
Indirect:	
1. Tax action	Excise tax on gasoline/percentage depletion allowance
2. Price regulation	Price controls on oil
3. Credit assistance	Direct loan/loan guarantee
4. Subsidy	Price guarantee
Direct:	
1. Specific regulation	Tariffs/quotas
2. Contracts	Purchase agreement
3. Grants	Construction grants
4. Government ownership	Tennessee Valley Authority

This report does not take a position on whether market or nonmarket forces work best in the U.S. economy. Rather, it tries to address various actions from the perspective of what each can be expected to do to "get a particular job done."

INDIRECT ACTIONS

As stated earlier, these actions operate through the market mechanism to affect the price of products and, hopefully, appropriately modify energy supply and use patterns. The steps involved seek to modify the decisions of energy users and energy producers. Since such actions generally result in only moderate shifts in cost-benefit ratios, they are not normally best suited to assist technologies which require large advances to become economically competitive.

Tax actions

Tax actions are some of the most effective and frequently used methods of influencing economic behavior. Tax actions can be used to stimulate conservation actions and accelerate the commercialization of emerging energy supply technologies. Like other indirect actions, tax incentives (tax credits to promote insulation of residences and business structures) and disincentives (excise tax on gasoline to promote conservation) are most effective when applied to conservation actions and energy technologies that are currently economic or nearly so.

The major advantages of tax actions over other types of Federal incentives are that tax actions can be relatively easy to administer, provide for public visibility, and are capable of being precisely tailored to reach the targeted population. Most ordinary tax incentives may not be effective in modifying the behavior of low income individuals. Thus, low interest loans or other incentives may be needed in such cases.

Tax incentives, of course, have the disadvantages of reducing the tax revenue collected by the U.S. Treasury and of assuming permanent status.

Price regulation

Price controls are useful in emergency situations in that they can temporarily prevent hardship to low income consumers. On the other hand, price controls may induce waste, often require a large bureaucracy to administer them, and reduce--or render more costly--the effectiveness of other initiatives such as price supports for synthetic fuels.

As indicated above, price controls may be imposed in the context of regulation, such as setting a "fair rate of return" on utility profits. In that event, price controls on one fuel may be set so as to affect the use of another fuel.

For example, if FPC regulation extended to synthetic gas, the costs of such gas might be "rolled-in" with the costs of natural gas and the consumer charged a price based on average costs. In this case, price controls on natural gas would be used to promote development of a new fuel source, rather than merely to set a ceiling on the price of traditional fuel.

One of the major drawbacks to price controls, which hold prices below market levels 1/, is that they work at cross purposes with national efforts to conserve energy. For example, natural gas consumers have little incentive to upgrade the insulation of their buildings given the continuation of gas price controls.

Conversely, allowing gas prices to rise should tend to encourage installation of insulation in structures. It should be obvious here, that the issue is one of relative prices, not regulation *per se*.

Credit assistance

Loans and loan guarantees are most effective in making investment decisions in which fixed costs are a major component of total costs and investor choice is sensitive to relatively small variations in the cost of capital. In such a situation, a loan guarantee can eliminate or reduce any risk premium demanded by investors. Loan guarantees also appear attractive because their observable, direct, and immediate impact on the budget is low or even trivial. (See below for the GAO position on this issue. Appendix I also addresses this question in more detail.)

However, loan guarantees have several disadvantages. First, and most importantly, they are unlikely to increase the total supply of investment funds 2/ and hence would likely divert such funds to insured areas and away from others. This affects both the economy as a whole and the energy sector. If loan guarantees were issued for energy

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1/ Whether or not those levels are themselves "controlled" by other forces, such as the Organization of Petroleum Export Countries control of world oil prices.

2/ This issue is not clear cut. Some members of the financial community are now arguing that some money, otherwise not available for venture capital, might be siphoned from nonproductive savings activities (hoarding and gold holding) into these relatively secure areas.

projects, this might divert investment funds away from home mortgages or even State/local bond issues. In addition, any stimulus to investment in certain energy projects may come at the expense of investment in oil or gas or other areas.

Alternatively, loan guarantees may be ineffective. Despite the lower interest rates which loan guarantees would generate, firms may be unwilling to undertake the activity if a higher rate of return on capital is available elsewhere. If the loan guarantee is for a basically unprofitable activity such as the production of synthetic fuels, the reduction in interest rates would not reduce total costs by enough to make the venture look attractive and to warrant participation by firms with alternate investment possibilities.

Thus, to the extent that loan guarantees stimulate investment and result in lower (than otherwise) prices for certain fuels, users of those fuels benefit in proportion to their consumption. However, the stimulus to investment was effected by a transfer of risk from investors to taxpayers. This risk transfer is a form of indirect subsidy, which under currently proposed legislation for synthetic fuels would not completely appear in the budget. The true costs of such subsidies may also be hidden because they are difficult to estimate at the time decisions are made. To exemplify, prospective default rates often cannot be reasonably calculated at the time guarantees are made.

Loan guarantees also frustrate budgetary discipline because they do not compete for Federal tax monies in the same manner as other programs. Since few--if any--immediate outlays are made as the program begins, less attention is paid to the opportunity costs of any guarantee program.

Subsidies

Because the output from synthetic fuel plants is not expected to be competitive with the price of energy from traditional sources, subsidies in the form of price guarantees may be needed.

Price guarantees would involve a commitment by the Federal Government to pay the difference between market prices at the time of production and any costs of production above those prices. For a price guarantee to be of much use for development of synthetic fuels, for example, it would have to be considerably above the equivalent current world price for crude oil.

The cost of price guarantees would depend on expected volume of the fuel whose price was being guaranteed. For limited commitments to synthetic fuels, e.g., 350,000 barrels per day or equivalent, the budgetary cost would be over $600 million per year (assuming a $5 per barrel equivalent price differential between the cost of synthetic fuels and the world oil prices).

However, a price guarantee system may eventually lead to large expenditures if there is significant growth in the industry being so subsidized. These expenditures can also present a problem if economies of scale necessitate production of the subsidized product by one or a few firms. In such a situation lack of adequate competition and/or inefficiency could result in excess costs to the Government.

DIRECT ACTIONS

These actions are best suited to situations when (1) some action is required to deal with an emergency or very urgent problem, usually national in scope; (2) effective action of the type desired in a predetermined time frame by private enterprise seems unlikely; (3) the action is deterred principally by cost-ineffectiveness together with uncertainty regarding the future and the size of necessary capital requirements; or (4) the action requires attention to goals, such as developing environmental and socio-economic data, which industry may be unwilling or unable to pursue.

Direct actions would tend to provide more specific visibility and control than some indirect actions. This can be important in (1) assessing performance on projects, and (2) making appropriate comparisons with competing alternatives.

Specific regulation

A tariff on imported oil would stimulate production of and drilling for domestic crude oil and could also be used to provide partial support for development of new energy technology. However, tariffs on imported crude oil are not a precise means of stimulating any given activity, such as synthetic fuels or other new energy technologies. This is because the effect of higher prices caused by the tariffs may not be directed at the activities which the policy seeks to promote. Quotas, on the other hand, may create equity problems by producing large windfall gains to favored domestic producers.

Contracts

Related to price guarantees are actions such as procurement contracts and grants. For example, the Federal Government might choose to promote synthetic fuel development of new energy technologies by guaranteeing to purchase at a stated price a specific amount of output. This would provide producers a minimum demand for their products and hence set a floor for potential profits. Unless a firm price is agreed to beforehand, such contracts tend to be "cost-plus" in nature and share all the advantages and disadvantages of similar Government involvements in the past. Disadvantages common to such contracts include complexity, incentives for inefficiency, and the need for sustained monitoring. However, the Government need not retain the output purchased. It could resell it on the open market were that course of action the least costly one. As stated earlier, advantages of this option include more control of project efficiency and progress and greater visibility of financing as compared to indirect methods.

Grants/Government ownership

Grants could be provided for specific development work or for construction. In the latter case, the required volume and cost of capital to the enterprise would be reduced. In some circumstances, the Federal Government might finance all of the construction costs, in which case it would still have the option of contracting out to private industry operation of the plants as was done during World War II, and as we are doing with uranium enrichment.

If Federal ownership were retained, the operation would not be constrained by a need for profit and such an effort would less likely be deterred by large capital requirements. Again, these options would provide the Government with greater control of project efficiency and progress and greater visibility of funding as compared to indirect methods.

CHAPTER 6

SUMMARY

OVERALL CONCLUSIONS

Our basic purpose in this report has been to provide a framework and perspective for considering (1) energy actions which could contribute to solving energy problems in the next 10 to 25 years and (2) the role of the Federal Government in encouraging activity in each of the areas. Without such a framework and perspective, we run the risk of piecemeal decisionmaking on our energy options without ever focusing on the implications for overall energy policy of the choices we make.

Our report focuses on two things:

--Emerging energy supply and conservation technologies which are technically feasible but for a variety of reasons, are not being actively commercialized by the private sector. For each technology, we have attempted to define and assess its potential role in filling energy needs by both 1985 and 2000.

--The major financial and pricing mechanisms which are available to the Government for stimulating activity with regard to emerging energy supply and conservation technologies.

The recent slowdown in the rate of growth in demand for energy is a sharp reminder of the importance of the demand side of the energy equation and of conservation in particular. This fact and the wide differences of opinion on the sources of energy supplies to meet that demand suggest that the Nation should carefully explore all supply sources as well as conservation alternatives before embarking on a program to commercialize synthetic fuels. Even if an all out effort were undertaken to develop commercially all new supply technologies, such technologies offer little hope for reducing dependence on imported oil prior to 1985. Also their impact beyond 1985 is highly uncertain. The projected output in 2000 of each of the new supply technologies cited throughout much of this report are based on ERDA's most optomistic scenario which ERDA acknowledges is idealistic. Moreover, ERDA believes that it is highly unlikely that all new technologies can be developed with complete success.

Major considerations in choosing among technologies

The three key factors which we believe should be carefully considered in choosing among energy technologies are:

--The contribution that each technology can make in meeting the Nation's energy needs within a specified time frame either through reducing demand or increasing energy supply.

--The total cost of making the technology commercial including costs of plant construction, costs of alleviating adverse socio-economic impacts caused by the energy development, and the costs of price supports or further subsidies which may be required.

--The price at which energy produced by the technology would have to be sold and the means by which the price would be assimilated by our economic system.

Analysis of the potential contribution of energy technologies indicates that some are preferable to others. In particular, conservation technologies and actions seem to offer great potential. Once a conservation investment is made, the energy savings go on year after year. Conversely, failure to make conservation investments will require the production of more and more energy supplies year after year to meet essentially inefficient uses of energy.

With regard to the choices among new supply technologies the various forms of oil and gas production from coal and oil shale are complex and highly capital intensive. Development of the technology on a commercial scale requires creation of a substantial industry infrastructure to sustain it once it is in place even if the product produced cannot compete economically. There are obvious disadvantages in sinking costs in technologies where the economics are uncertain and where improved technology or competing energy sources in years ahead may make the plants obsolete. For example, the costs of constructing an oil shale plant producing 50,000 barrels a day is estimated at $1 billion. If the price of a barrel of oil from shale were to exceed the price of imported oil by $5 a barrel, then an additional price subsidy of $250,000 a day or about $90 million each year could be required for just one small plant.

It is important also to focus on the incremental price of the energy produced or saved by any action. The incremental price of numerous supply increasing actions is often overlooked because the additional supply will initially be only a small part of the total energy used and the price can be "rolled in" with the substantially lower price of existing energy supplies. Any immediate effect on the consumer is thereby mitigated. For example, the price for synthetic gas is expected to be twice the recently announced FPC price for new gas discovered, but because it might be rolled in with the price of existing gas supplies, the incremental price of the new supply can be easily overlooked. Conversely, the cost of implementing certain other technologies or actions including most conservation options and many solar options is usually presented only on an incremental basis. We discuss the importance of this distinction later in this chapter.

In short, in choosing any energy technologies, it is important to keep in mind the full implications of the technology to which we commit ourselves and the incremental costs of the actions we take.

Financing mechanisms

In determining the mechanism which would best stimulate a particular energy technology, we believe at least three factors should be carefully examined.

--The technology's state of development. Is the technology developed to the extent that it can be deployed on a broad basis?

--The technology's economic feasibility. Will the energy produced as a result of deploying the technology be economically competitive with competing energy sources?

--The target group whose actions will be influenced. Are they large industrial firms or diverse and widely dispersed groups such as homeowners?

Interrelated analysis of these three factors should precede the choosing of the most appropriate financing mechanism or other Government activity to stimulate a particular financing technology.

For example, loan guarantees have received much attention as a potential way of encouraging a variety of energy technologies. In general, loan guarantees would seem to best fit those circumstances where the technology has been known to work, is economical, and where the person wanting to make an investment in the economically attractive energy technology cannot do so primarily because of financial constraints. By transferring some of the risk, loan guarantees tend to marginally reduce the interest costs of a loan and to assure the availability of financing which otherwise may not have been available. This is the basic logic, for example, for making Federal loan guarantees available for housing. Conversely, loan guarantees should be carefully examined and other options considered where there are questions regarding the viability of the technology or the economic competitiveness of the product.

Loan guarantees also may not be appropriate for target groups consisting of large firms with reasonable access to capital markets even if the energy activity in question is technically and economically feasible. Investment capital is normally available to such firms and their basic decision not to invest in a particular energy activity may be influenced primarily by the availability of attractive investment opportunities elsewhere.

CONCLUSIONS REGARDING TECHNOLOGIES

On the basis of our review, in terms of dollars expended on a cost effective basis, we believe that certain conservation measures have by far the greatest potential benefits and should have the top priority for stimulative Government actions.

Among the supply-increasing technologies considered, we found several technologies to be cost effective either in total or in particular geographic areas. These technologies are hydrothermal energy, municipal waste combustion systems, solar hot water and space heating, and tertiary oil recovery. Because they are cost effective, these technologies would be the most efficient to implement in the near future in terms of dollars expended now and in the near future on supplies of energy.

The supply of energy to be captured from these sources may be smaller than the potential of other supply technologies considered in this report such as synthetic fuels, but the economics appear more certain. Thus, we believe these technologies should be given priority for Government assistance in commercialization to (a) insure their maximum contribution between now and 2000 and (b) to provide a source of additional supply to give the Nation additional time to consider and fully develop efficient means of producing energy from larger supply sources including synthetic fuels and other technologies not considered in this report such as fusion, solar photovoltaic cells, thermal gradients, and breeder reactors.

Synthetic fuels production--while technically feasible with first-generation technologies--is not cost effective in that the total cost of output is not price competitive with foreign oil. Nor does it look as attractive when compared to other technologies, which we examined, on an incremental price basis. We believe synthetic fuels technologies should receive a high priority for Government research, development, and demonstration efforts designed to develop more advanced and efficient production technologies, but we question whether assistance should be given to commercialization of synthetic fuels at the present time.

There are also serious questions regarding any deep national commitment to uneconomic, high-cost supply technologies which substantially exceed the cost of imported oil; certainly, the deeper the commitment to building a broad industry infrastructure of highly capital intensive energy sources, the less the incentive in future years to support development of lower cost energy supply options. Further, for such high cost technologies, imported oil is likely to form a defacto price floor as opposed to its current role as an energy price ceiling. In such circumstances, the exporting countries could be in a better position to exert continued upward pressure on energy prices.

The role of pricing policy as a tool to help stimulate commercialization of emerging technologies also needs to be considered very carefully.

Certainly, careful decisions are needed to provide a stable regulatory framework for oil and gas which clearly recognizes that the Nation is moving into an era of higher priced and relatively scarce energy and that world energy prices are established not in a free market, but by a cartel of producing Nations. The alternative, of course, is orderly deregulation of oil and gas--a process already started with oil.

In any event, we need to remove the current uncertainty as to the duration and intent of Government price regulation. Such uncertainty is at least as much a deterrent to commercializing of emerging energy technologies as the concern that the current average regulated price of oil and gas may not fully reflect the costs of developing or finding new energy supplies. Further, if future decisions to provide Government assistance to new technologies for commercialization purposes are to be made on an incremental cost basis, then the price of oil and gas, which in effect will be the standard for many years, must be both realistic and certain.

We believe that the incremental cost standard is the only realistic one for making sound economic judgments and treating all emerging technologies equally. The only other measure which can be used is rolled-in pricing which would serve to average the real cost of a new supply source across a far larger volume of lower priced energy.

Among the technologies we have considered, a rolled-in yardstick would clearly favor synthetic fuels; likewise, it would clearly discriminate against such options as conservation and solar hot water and space heating. Using incremental cost to evaluate alternatives on the other hand, would reduce all of these options to the same test --the actual cost of the output from the new technology--and allow a consistent and rational process of choice on a cost effective basis.

1. We favor the use of incremental cost as a yardstick to select cost-effective technologies or actions which receive priority for government financial assistance in the commercialization process.

2. We believe that certain conservation actions and other technologies are cost effective and should receive top priority for Government financial assistance.

3. We believe that emerging and promising technologies which are not cost effective, such as synthetic fuels, should receive high priority for research, development, and demonstration assistance but we question whether commercialization assistance should be given to technologies that are not cost effective.

4. We believe further recognition needs to be given to the role of pricing policy in developing new energy technologies and the related need for the price of domestic oil and gas to reflect clearly the cost of finding and developing new energy supplies. Higher prices can be provided either in a stable, responsive regulatory environment or through deregulation.

Our specific conclusions regarding the areas of technology we examined follow.

Conservation

Conservation should have top priority for Government financial assistance because it has the greatest potential payoff and is most attractive on an incremental cost basis. Areas offering the greatest opportunity include insulation and other measures to conserve energy in new and existing buildings, industrial energy conservation, and improved utility load management. Still, there is a need as discussed in our report for more detailed, reliable, and comprehensive information on a variety of energy conservation opportunities.

The preferable financial mechanism or Government action for stimulating different conservation opportunities varies because different target populations are involved. For example, tax credits would likely be most effective in stimulating middle and upper income homeowners to install energy conserving measures. However, for low income homeowners and others of limited financial capability, low interest loans or grants from the Treasury may be more effective mechanisms. In addition, Federal leadership and action in developing uniform building standards which incorporate desirable energy conservation features would be useful.

Tax credits also could be used to stimulate energy conservation investments by industry. However, because the payback period for such investment may not compare favorably with other investment opportunities--even with added incentives--consideration should be given to establishing Federal standards for energy efficiency, particularly for the more important industrial uses of energy.

Utility load management affects a broad range of consumers and can best be addressed by Federal leadership in establishing and encouraging implementation of utility rate structures which use the price mechanism to encourage reduced use of energy.

Overall, price is an important concept in achieving effective energy conservation. Energy price increases would serve to stimulate the implementation of some conservation technologies without direct Government financial assistance. However, we emphasize that both price induced conservation measures and those resulting from explicit Government actions are needed to insure the desirable and necessary goal of maximum energy conservation implementation.

Many of the incentives and actions which we believe are desirable to encourage conservation are addressed in whole or in part in the recently signed law to extend the Federal Energy Administration. This includes:

--A variety of proposals for improving electric utility rate design including Federal funding of demonstration projects and participation in the proceedings of utility regulatory commissions ($15 million is authorized to be appropriated for these activities during fiscal year 1977).

--Federal development of conservation-oriented performance standards for new residential and commercial buildings ($5 million is authorized to be appropriated for grants to State and local governments to finance the cost of adopting these standards).

--FEA's development of a program to assist low income persons in weatherizing their homes ($200 million is authorized to be appropriated through fiscal year 1979).

--Federal support and assistance to States which develop energy conservation programs ($105 million is authorized to be appropriated through fiscal year 1979).

--A 2-year energy conservation and renewable resource demonstration program to test various forms of Federal financial assistance including grants, low interest loans, and loan guarantees ($200 million is authorized to be appropriated for the demonstration program).

--Federal loan guarantees for installing conservation and renewable resource equipment (obligation authority for loan guarantees up to $2 billion is authorized).

Careful monitoring of the effectiveness of these new programs will be required and adjustments made in the incentives authorized and more stringent measures adopted as needed to achieve conservation savings. In this regard, we are specifically required to monitor the new program to test various forms of financial assistance.

Synthetic fuels

ERDA's most optomistic scenario shows synthetic fuels production reaching the equivalent of 2.4 and 22 quads in 1985 and 2000, respectively. However, ERDA is in the process of revising these estimates downward. Moreover, the projected prices are not competitive with traditional energy sources and research and development on second-generation technologies is expected to reduce costs by only about 15 percent.

Because of the size and investment required to build synthetic fuel plants, incentives must be targeted at large industry which normally has access to the capital markets. Two basic concerns underlie the stated need for Federal loan guarantees to induce the investment needed to commercialize first-generation synthetic fuels technology: (1) concern that the product produced will not be economically competitive and that the existing world market price for oil could always be manipulated to substantially undercut the price of synthetic fuels, thereby increasing its economic unattractiveness and (2) concern that technological advances in other energy areas or within synthetic fuels technology will make first-generation synthetic fuel plants obsolete before they ever become operational.

Against those concerns, the stated purpose of ERDA's synthetic fuels commercialization program is to identify and resolve potential future socio-economic, environmental, and regulatory impediments associated with constructing large commercial scale synthetic fuels plants before the synthetic fuels are needed to meet our Nation's energy needs.

Given ERDA's basic objective and the present economic unattractiveness of first-generation synthetic fuel technology, we believe that, in lieu of providing Federal loan guarantees for billion dollar size "commercial" plants, efforts should be directed to research and development of improved synthetic fuels technologies and to meeting ERDA's objective of identifing and resolving socio-economic, environmental, and regulatory problems. To meet this latter objective, it appears possible to gain adequate information from smaller plants under Government control. At the point in time that commercialization of the technology becomes the prime objective, we believe consideration also should be given to the "commercial pull" approach of gaining private industry interest in commercialization.

<u>Smaller plants</u>

Because synthetic fuels are not expected to be economic, even if built to commercial size, an alternative approach would be not to emphasize the cost of the output and concentrate on acquiring the socio-economic, environmental, and regulatory information. We believe this could be done by having the Government construct and operate--either itself or with a contractor--smaller synthetic fuels plants.

Assuming synfuels demonstration plants are successful and prove feasible and capable of regulated, environmentally safe operation, the demonstration plants could be sold to private firms. At that time--when synfuels have been proven viable--if it is considered desirable and inducements are required to stimulate private firms to enter commercial operations of synfuels, consideration could be given to offering some sort of financial assistance to private firms.

In the meantime, the Congress could maintain oversight of the plants through the yearly authorization and appropriation process. This yearly monitoring of plant progress offers enhanced potential for building smaller, less costly plants while still maintaining maximum information capability. Should the plant not prove to be feasible, yearly oversight would enable project termination at the earliest possible date and may allow minimizing the financial loss related to the project.

Commercial pull

The so-called "commercial pull" approach advocated by a number of people 1/ could also be considered as a way of moving the commercialization of technologies such as synthetic fuels where the economic competitiveness of the product produced is in question. Using this approach, the Government could announce that it would purchase a set amount of synthetic oil or gas at some future point in time and request bids from industry. The Government then could select the lowest bid that appeared technically feasible. This method may prove to be a less cumbersome and perhaps less costly way of stimulating the construction and operation of a desired number of synthetic fuel plants.

1/ Dr. R. H. Holloman, Director, Center for Policy Alternatives, Massachusetts Institute of Technology, discusses potential new approaches by Government of this type to encourage commercial implementation of energy technologies in the book Energy Research and Development, prepared for the Ford Foundation's Energy Policy Project, Ballinger Publishing Company, Cambridge, Massachusetts, 1975.

Municipal waste combustion

This is a cost-effective technology, and while it is being implemented to a limited extent, Federal financial assistance could hasten and maximize its use. Because this technology could best be employed by utilities, municipalities, or local government units which, in many instances, may have limited financial capability, loan guarantees would appear to be a preferred mechanism for accelerating this technology.

Solar heating

Solar hot water and solar space heating are currently economic in many parts of the country, but like many conservation measures, are not being widely implemented because of the long payback period and general lack of consumer awareness. We believe that Federal financial incentives should be used to accelerate the commercialization of these technologies. The incentives should be directed to consumers--homeowners and businesses. Again, like certain conservation actions, tax credits seem like the most appropriate mechanism to stimulate middle and upper income homeowners and business to install solar heating units, while low interest loans or grants would best stimulate low income homeowners and small businesses with limited financial capability. In addition, loan guarantees could be a useful mechanism to assist State, municipal, and non-profit institutions obtain the necessary capital to invest in such solar heating for their facilities.

As indicated earlier, the legislation to extend the FEA includes a program designed to test various forms of financial assistance. Under that program, persons installing renewable energy resource devices could receive a grant not to exceed $2,000 or 25 percent of the cost of installing such devices and could have obligations issued to finance installation of such devices guaranteed by the Government. Whether or not the magnitude of incentives offered will be sufficient to encourage wide implementation of solar heating is something we have not analyzed.

Hydrothermal

ERDA recently implemented a loan guarantee program to accelerate the development of geothermal energy, including hydrothermal technology--the only type of geothermal energy currently economic. We believe no further Federal financial assistance to accelerate commercialization of hydrothermal energy is warranted at this time. For other geothermal applications, Federally sponsored research, development, and demonstration of the economic and technical visibility of the concept seems to us to be the appropriate Government role.

Tertiary oil recovery

In general, secondary measures to recover oil are economic and widely used. Tertiary recovery techniques for the most part are not widely used since they are not economic. One quick action which would improve the economics would be to release domestic oil produced by tertiary techniques from price controls. This should increase the use of tertiary techniques on old producing wells. In this regard, the bill to extend FEA recently signed by the President requires that early consideration be given to amending petroleum price regulations to provide additional price incentives for bona fide tertiary recovery techniques.

In addition, ERDA should continue to carry out its program of research, development, and demonstration designed to acquire more information and promote the use of tertiary oil recovery techniques. We have in process a report on ERDA's progress under the program which will include specific recommendations for program improvement.

MATTERS FOR CONSIDERATION
BY THE CONGRESS

This report is intended to provide the Congress with a framework and perspective to aid it in making decisions on the plethora of energy options before it. We have analyzed the various options in the light of the key factors which must be carefully considered in choosing (1) among energy technologies and actions and (2) funding mechanisms for encouraging implementation of the technologies and actions. On the basis of our work, we recommend that the Congress:

1. Continue to place the highest priority on energy conservation actions, requiring improved information on major conservation opportunities which will provide the basis for the development and funding of specific programs which can be tailored to take maximum advantage of the opportunities.

2. Maintain close oversight of the several new programs to encourage energy conservation, evaluate the effectiveness of incentives offered, and consider such further actions as may be necessary, including the greater use of mandatory energy

efficiency standards. The GAO will continue its efforts to aid the Congress in this regard.

3. Continue to encourage the installation of solar heating technologies targeting the financial incentives to the users as described in the report.

4. Maintain close oversight of FEA's actions to increase incentives for tertiary recovery of oil and authorize further incentives if the need and possibility to increase tertiary oil recovery becomes apparent in light of other energy developments.

5. Consider whether it is advisable to enact legislation which would at this time authorize Federal loan guarantees to builders of synthetic fuel plants, and consider instead directing ERDA to continue and expand its research and development to improve the technology and; in addition, construct and operate smaller plants of a size sufficient to meet its stated goal of obtaining socio-economic, environmental, and regulatory information in a timely fashion.

6. Consider further actions, including the provision of loan guarantee authority, to encourage municipal waste combustion.

LOAN GUARANTEES SHOULD BE INCLUDED IN THE BUDGET

The Congressional Budget Act of 1974 (Titles I - IX of Public Law No. 93-344, July 12, 1974) is a comprehensive statute which sets forth many of the procedures by which the Federal budgetary process is to operate. Our interpretation of the Act's language and the intent of the Congress in enacting this legislation is that the total amount of loan guarantees including associated contingent liabilities are not required to be included in the Federal budget. Review of S. 2532 and H.R. 12112 indicate that such disclosure is not contemplated.

However, one must look beyond the language of the Act and consider that one of the fundamental objectives of the Congressional Budget Act of 1974 was to establish a process through which the Congress could systematically consider the total Federal budget and determine priorities for the allocation of budget resources. We believe this process achieves its maximum effectiveness when the budget represents as complete as possible a picture of the financial activities of Federal agencies. We further believe it is vital to maximizing the effectiveness of the process that Federal financial resources be measured as accurately as possible because priorities are actually established through decisions on the conferring of the authority to enter into obligations which will result in immediate or future outlays of Government funds. From this standpoint, therefore, the budget should (a) encompass all actions which confer authority to spend money, (b) reflect as accurately as possible the amount of such authority which is conferred, and (c) recognize the point at which control over the spending of the money passes from the Congress to the administering agency. The consequence of excluding loan guarantees and their associated contingent liabilities from the budget is to thwart Congress' achieving the maximum effectiveness of the process it established to review the Federal budget and determine priorities.

In the case of Federal loan guarantees for housing and other programs, historical experience permits the default rate to be estimated with reasonable accuracy and included in the budget. However, if the Congress enacts S. 2532, H.R. 12112, or similar legislation, authorizing a relatively small number of very large loan guarantees, we believe that it will be difficult to accurately predict the extent of default, and therefore, the total amount approved for loan guarantees should be shown in the budget.

COMMENTS ON THE PROPOSED FINANCIAL RESOURCES FOR THE ENERGY INDEPENDENCE AUTHORITY

The Energy Independence Authority (EIA), as proposed by President Ford on September 22, 1975, would be a quasi-public Federal corporation which would provide financial assistance to energy projects which would make a significant contribution to energy independence and would not otherwise be undertaken by the private sector. The Authority could create wholly owned subsidiaries to carry out its functions with financial resources of $100 billion. Of this amount, $25 billion would comprise capital stock to be purchased by the Treasury and the remainder would comprise debt obligations, requested initially as a once and for all congressional authorization. Any issuance of Authority securities or other assistance would be subject to Treasury Department approval.

EIA financing would be by direct loans, loan guarantees, price guarantees, purchase and leaseback of facilities, and even purchase of equity capital. Assistance to any one project would be limited to $10 billion. Loans would bear interest at a rate determined by the Authority Board and guarantees for loans would be backed by the full faith and credit of the government. EIA would concentrate its efforts in those energy subsectors least likely to attract private capital. Theoretically, EIA's efforts would stimulate investment in these areas from the private sector. The overall effect of EIA would presumably be an increase in the likelihood of energy independence in the foreseeable future.

EIA's success will depend largely on its ability to induce private investment. However, the likelihood of increasing private investment is dependent on other variables such as the price of foreign oil, the demand for energy, the economic attractiveness of investing in the energy sector as opposed to other possible investments, and the size of energy investments planned without inducement from EIA.

A priori arguments can be made that EIA's $100 billion would stimulate large amounts of investments by industry in energy projects, however, because of the many non-quantifiable variables, any assessment of the adequacy of EIA financial resources would be highly speculative and judgmental. If the Congress decides that legislation similar to S. 2532 is required, an attractive modification may be to provide a lesser amount initially, say for example, $10 or $20 billion.

Further funding could then be provided through annual appropriations as needed.

Funding EIA annually would provide the Congress with a mechanism to annually assess the impact Federal funds are having toward stimulating private investment in energy projects. Such assessments could be made through the annual authorization and appropriation hearings. These assessments could provide for not only an evaluation of the extent to which Federal funds have stimulated private investment, but also the impact additional Government funding could have on furthering energy independence. During this annual review, the Congress would assess the progress being made in developing new energy technologies and have greater flexibility in allocating Federal funds to technologies which industry is unlikely to develop independently.

ERDA COMMENTS AND GAO EVALUATION

In commenting on a draft of this report, 1/ the ERDA Administrator expressed his deep concern with our analysis, presentation, conclusions, and recommendations. For the most part, ERDA's concerns related to the position we take on Government loan guarantees for the construction of commercial-size synthetic fuel plants. The Administrator specifically pointed to five serious deficiencies that he felt were contained in the draft.

Subsequent revisions were made in the body of the report in light of items 1, 4, and 5 listed in the Administrator's letter. Specifically, we

--revised Chapter 2 to use instead two of ERDA's scenarios to set the perspective for our work and to illustrate the wide range of opinions regarding the energy choices our Nation faces.

--recognized that the current estimated price for liquified natural gas imports is similar to the estimates for synthetic gas from coal.

--cited disadvantages for tax incentives in Chapter 5.

Points 2 and 3 in the ERDA Administrator's letter go more to the heart of what we perceive as ERDA's basic concern. In essence, ERDA believes that a financial incentives program which includes loan guarantees is needed immediately if the Nation is to have the option of a major synthetic fuels industry in the 1990s. ERDA believes the plants constructed now must be of commercial size to obtain needed environmental, regulatory, and economic data and provide the commercial operating experience necessary to overcome investor uncertainty by the middle 1980s.

Nowhere in our report have we suggested that the synthetic fuels option be foreclosed. Rather, we concluded from our work (1) that synthetic fuels deserved high priority for

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1/ See Appendix IV for the full text of his comments.

Government research, development, and demonstration; and (2) that, given the state of the technology and current economic unattractiveness, Government loan guarantees or other financial incentives for commercial-size plants which could cost upwards of a billion dollars each did not seem appropriate at this time.

In a broader context, our more basic intent was to provide the Congress a framework and perspective for making choices among the many options before it, including not only synthetic fuels but other energy technologies and conservation actions.

UNITED STATES

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

WASHINGTON, D.C. 20545

AUG 19 1976

Honorable Elmer B. Staats
Comptroller General of
the United States
General Accounting Office

Dear Mr. Staats:

ERDA has reviewed the draft GAO report entitled "Are There Better Choices?" which is concerned with Federal proposals to finance the commercialization of advanced energy technologies.

We are deeply concerned about this report because it presents strong conclusions and recommendations to the Congress without a sound underlying basis of analysis supporting them. The draft report represents in our view, a presentation of a point of view rather than any new, independent analyses of alternatives.

This lack of underlying objective examination is particularly important since the opinions expressed in the report have implications not only with respect to important legislative proposals now pending before the Congress for synthetic fuels and other technologies, but also with respect to the broader matter of the overall balance among ERDA's energy R,D&D programs.

In particular, I wish to call your attention to the following major concerns which we regard as serious deficiencies in the draft report:

1. In arguing that it is not necessary to provide now a Federal guaranty program for synthetic fuels, GAO has used for its analysis a very optimistic estimate of the future effects of conservation (i.e., Ford Foundation technical fix case) and coupled this with an equally optimistic high estimate of domestic conventional oil and gas production in the year 2000 (20 million b/d greater than today's domestic production). We believe such unrealistic demand/supply

cases cannot prudently be used as a basis for national energy policy. Nevertheless, even using such optimistic projections, the GAO report still admits to a substantial synthetic fuel production requirement beginning in the 1990's if we are to avoid a further increasing dependence on foreign oil. With this requirement, lack of certainty as to the future price and availability of imported fuels, and with the long lead times associated with the growth of such a large new capital intensive industry, uncertainty facing investment must be resolved by the middle 1980's if we are to maintain a capability to have plants in operation in the early 1990's. This means that we cannot delay taking action now to obtain needed information regarding the environmental, regulatory and overall economic characteristics which can affect the commercial viability of this option.

2. The GAO draft report has numerous assertions about the favorable comparative economics of new and emerging conservation and renewable energy resource technologies vis-a-vis synthetic fuels. Such discussion is hardly germane to an evaluation of synthetic fuels technologies. Indeed, ERDA shares GAO's enthusiasm concerning the attractive features of conservation and renewable resource technologies. However, even if these technologies are very rapidly introduced, they, by themselves, cannot obviate the indicated need in the 1990's for substantial quantities of synthetic fuels, or alternatively, continued imports.

3. The GAO report fails to either present or analyze the underlying rationale for the financial incentive program for synthetic fuels and other technologies embodied in H.R. 12112. Repeatedly, the draft GAO report characterizes this program as one which is aimed at augmenting domestic fuel supplies through subsidized synthetic fuel production. While one effect of the program would be to supplement domestic fuel supplies by some modest amount, the primary purpose of the program is to maintain the option to develop a synthetic fuel industry that can meet a projected demand in the 1990's of several million barrels per day of synthetic liquids and gaseous fuels.

The guaranty program, therefore, is designed to acquire critical information and, to the extent possible, resolve at an early date regulatory, environmental, financial, political and other barriers which may preclude later private sector investment because of the lack of information concerning the commercial viability of these plants. The Nation's experience with commercializing nuclear power has demonstrated that early attention to these matters is essential to preclude later delays. The report continually refers to a production program which "chooses" or "commits" to synthetic fuels. Such choices, as we see it, are to be made by the Nation, not today, but at a later date. The Synthetic Fuels Commercialization Program is designed to provide a needed meaningful basis for that decision, not to preempt it.

4. The draft GAO report compares the costs of synthetic fuels with <u>today's</u> price of imported crude oil and today's regulated price of natural gas. We believe the price of synthetic fuel products should be compared with the price of <u>future</u> alternatives against which they will compete beginning in the late 1980's. They should also be compared with products that will realistically compete in the end use markets which they are likely to serve. For example, synthetically produced gas from coal should be compared with alternatives to natural gas such as Alaskan gas, LNG (now priced at about $3 per million Btu) and gas made from petroleum products, as well as higher priced depleting domestic conventional resources. When these comparisons are made, one finds that these other alternatives to natural gas are projected to be equally expensive and even more expensive in the case of gasification of petroleum products which is already occurring in the U.S. While over the next 20 years some substitution for natural gas will occur among electric utilities and large industrial users, we see no way in which these conversions can be assured to be large enough to offset a steady or rising demand for liquids and gaseous fuels and a steadily declining domestic supply.

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Mr. Elmer B. Staats 4

5. In Chapter 5, we found the comparisons of alternative Federal financial incentives to lack objectivity and to be without a systematic basis for comparison. For example, the incentive analysis did not contain criteria against which the incentives were compared. Furthermore, although advantages and disadvantages were cited for some incentives, in the case of loan guarantees the disadvantages were cited without noting some of the major advantages. Also in the case of tax incentives which were later recommended in the report for accelerating the introduction of conservation technologies, the report did not cite any major disadvantages, not the least of which is the permanent status tax subsidies generally assume and the general failure of tax incentives to be focused on individual projects. We continue to believe that in many situations where capital availability and project scale relative to the sponsor's net worth are the major financing problems, that loan guarantees are the most effective, efficient, and least costly financial tool available to the Government.

Finally, we believe that the draft GAO report is so substantially lacking in analysis and information supportive to its conclusions, that publication of the report would only serve to confuse and further obfuscate the issues discussed. Furthermore, the publication of the report in anything near its present form will be damaging to the early implementation of our needed energy supply programs.

My staff has transmitted more detailed concerns regarding the report in the nature of factual, editorial and judgmental material.

Sincerely,

Robert C. Seamans, Jr.
Administrator