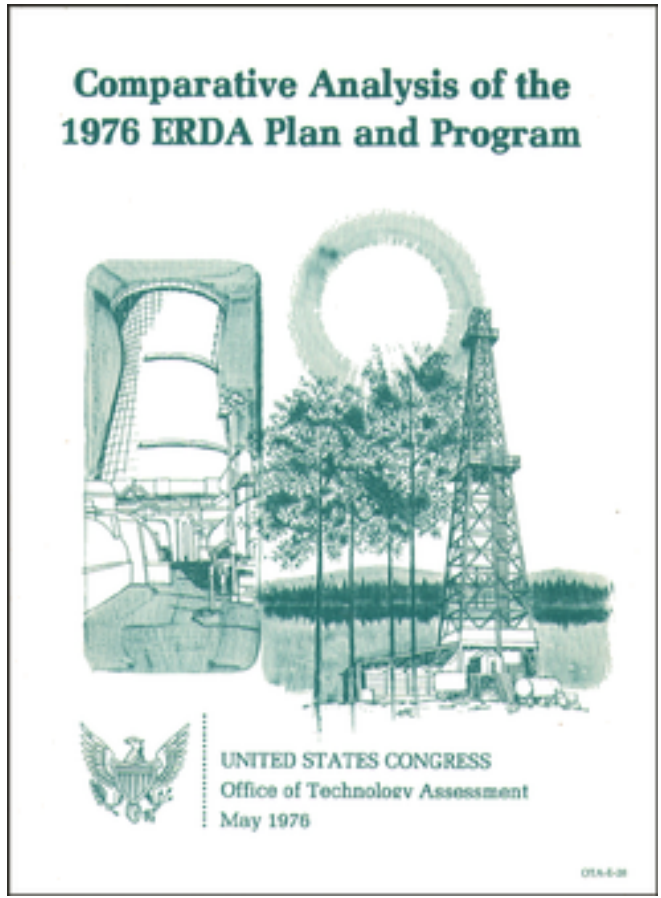
Comparative Analysis of the 1976 ERDA Plan and Program

May 1976

NTIS order #PB-254794



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WASHINGTON, D.C. 20510

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DANIEL V. DE SIMONE
DEPUTY DIRECTOR

May 27, 1976

Honorable Henry F1. Jackson
Chairman, Committee on Interior
and Insular Affairs
United States Senate
Washington, D. C. 20510

Honorable Olin E. Teague
Chairman, Committee on
Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Gentlemen:

On behalf of the Office of Technology Assessment, we are pleased to forward a report: Comparative Analysis of the 1976 ERDA Plan and Program.

The report represents the culmination of OTA's study of ERDA, begun in 1975, and was prepared with the assistance of representatives of the six panels of experts which contributed to the first OTA report, An Analysis of the ERDA Plan and Program. The present study is an analysis of the program and plan which is annually submitted by ERDA to the Congress, entitled: A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future. This analysis compares the 1976 plan and program to the issues identified by OTA in the first report. This report is being made available to your committees in accordance with Public Law 92-484.

Sincerely,

Olin Teague

OLIN E. TEAGUE
Chairman
of the Board

Sincerely,

Clifford P. Case

CLIFFORD P. CASE
Vice Chairman
of the Board

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May 27, 1976

Honorable Olin E. Teague
Chairman of the Board
Office of Technology Assessment
Congress of the United States
Washington, D. C. 20515

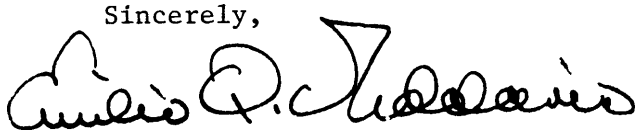
Dear Mr. Chairman:

This report, entitled Comparative Analysis of the 1976 ERDA Plan and Program, can be considered as the second in a series. It builds upon an earlier report, An Analysis of the ERDA Plan and Program, which examined the first ERDA Plan and Program, and affords the opportunity to examine changes that have taken place since the first version was submitted. The report was prepared at the request of the Senate Committee on Interior and Insular Affairs and the House Committee on Science and Technology.

Special thanks are due to ERDA Administrator, Dr. Robert Seamans, Jr., and Assistant Administrator, Mr. Roger LeGassie, for the cooperation provided by ERDA on this project. It should also be noted that Dr. Seamans has again shown a high degree of leadership, and we have confidence as a result that the significant progress ERDA has shown during its first year of operation will continue in the time ahead.

Early draft copies of this report were used to brief some of the Committees of the Congress during their consideration of authorization and appropriation legislation. This final version will be provided to the Congress and made available to the public. Although the final ERDA 1976 Plan (Volume I) was provided to OTA for the purposes of this analysis, only the draft version of the ERDA 1976 Program (Volume II) was available.

Sincerely,



EMILIO Q. DADDARIO
Director

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EXECUTIVE SUMMARY

In the year since ERDA's formation, domestic production of natural gas declined 6.9 percent and crude oil 4.5 percent. At the same time, petroleum imports accounted for 37 percent of the Nation's total petroleum consumption in 1975 and are now approaching 40 percent. Achieving energy independence by 1985 has become all but impossible. Even to hold import dependence to the present levels through 1985 would be a formidable achievement. The energy situation is serious and continues to deteriorate. In addition to Federal action, a sense of urgency, public awareness, and participation is required. These factors affirm the need for a national energy policy and a crucial role for ERDA in the years ahead.

The Office of Technology Assessment, in its 1975 analysis of ERDA's initial plan and program, cited two major areas of weakness. The first was ERDA's pursuit of technological options, while neglecting consideration of the broader aspects of energy production, delivery, and use, In particular, OTA indicated that the realization of technologically established energy options may be prevented by nontechnical constraints such as transportation, resource, manpower and capital availability; public acceptability; and institutional, jurisdictional, economic, and environmental compatibility. ERDA has made significant progress in this area as reflected in the updated Plan and Program (ERDA 76-l). ERDA has more aggressively interpreted its role in meeting the Nation's energy goals by expanding its efforts to deal with nontechnological constraints. It is apparent that ERDA has begun to orient its Research, Development, and Demonstration (R, D&D) program more toward solving energy problems rather than just creating technical options.

The second deficiency was found in the emphasis of both the ERDA Plan and Program on options directed toward increased energy supply, relative to the programs in end-use demand reduction. Supply programs were over conservation programs by a ratio of 49 to 1. ERDA has now increased the role and priority of conservation to the same level as the highest priority supply options in meeting the Nation's near-term energy needs.

Though the updated ERDA Plan and Program represents substantial progress in their approach to achieving the Nation's energy goals, other serious concerns deserve attention.

Of particular importance is the observation that important, potential near- and mid-term sources of domestic energy supply from first-generation technologies are not adequately pursued. The principal focus of ERDA's R, D&D programs in synthetic fuels is on second-generation technologies with mid- and long-term payoffs. A key strategy for commercialization of first-generation technologies in high-Btu gasification, liquefaction, surface retort of oil shale, and other alternative energy source programs is the synthetic fuel-loan guarantee legislation presently before Congress. Whether commercialization strategies involve loan guarantees, price supports, cost sharing, import tariffs or combinations thereof, early resolution is imperative. Presumably, alternate strategies for near- and mid-term commercialization will not be available until congressional action is completed either accepting or rejecting the proposed legislation.

ERDA does not sufficiently convey the urgency required to address the near-term energy problems. The framework for a procedure to accomplish this objective exists within ERDA through its new 5-year forward planning system which focuses on technology available in that period. A set of annual milestones to meet near-term energy objectives and annual reporting of progress in meeting those milestones would be very useful. They would give the Congress and the public the opportunity to evaluate progress in the achievement of the milestones. That evaluation, debate, and resultant action could assist in informing the American public of the serious energy problems and choices facing this Nation in the decade ahead. Executive and legislative support, to achieve these program milestones, would help to establish a sense of urgency and action.

ERDA has made substantial progress in its first year of existence toward the establishment of an effective energy research and development program, which represents a critical component of national energy policy.

ISSUE HIGHLIGHTS

Overview

The Energy Research and Development Administration has taken a number of significant steps in resolving the 16 overview issues set forth in the OTA analysis. The principal changes are summarized as follows. Each point is dealt with in more detail in the Overview chapter.

- ERDA has expanded the interpretation of their role in achieving the national energy goals. These goals are the same as set forth in ERDA-48. ERDA has broadened its approach by increasing emphasis on conservation and on the nonhardware aspects of the energy problem.
- The supply-demand balance in the revised ERDA Plan and Program has improved. ERDA has placed conservation at a priority equal to the highest priority supply options. Conservation is now considered the principal strategy for attacking the near-term (to 1985) energy problem.
- Emphasis on socioeconomic and environmental research has increased. The revised Plan and Program indicates the importance of including socioeconomic and environmental considerations with technology development. Efforts to incorporate socioeconomic analysis are described in each program area, and environmental review is to be a major part of the ERDA planning process.
- ERDA has taken steps to develop a commercialization strategy. A key element in this process is the establishment of the Office of Commercialization which has the responsibility of formulating these policies. Details need to be worked out and no judgment as to the effectiveness of the program can be made at this time.
- Greater emphasis is placed on international considerations in the revised Plan and Program. A planning activity is underway in ERDA to establish "courses of action" for international cooperation. Each program area describes international activities related to its various projects.
- ERDA is taking steps to increase the effectiveness of their planning and management structure. ERDA is developing the Planning, Programing, Budgeting, and Review (PPBR) system to establish R, D&D priorities and strategies.

While these represent substantial accomplishments, there remain unresolved points in each of the overview issues. The principal areas of concern can be summarized as follows:

- A sense of urgency is needed in addressing the near-term energy problem. Although enhancing the role of conservation, ERDA has still not adequately addressed the immediate problem of the Nation's increasing dependence on foreign oil. The 5-year planning system being instituted by ERDA, if properly supported by legislative and executive action, can do much to rectify this shortcoming.
- There remain limitations with the conservation program which could seriously reduce its potential contribution, The budget for conservation represents just 3.8 percent of the total ERDA energy overall

R, D&D budget compared to 3.0 percent in FY 76. Further, ERDA has virtually ignored the long-term, lasting potential of energy conservation by excessive concentration on its near-term impact.

- A gap remains between the scope of the basic research program and the needs of the energy technology programs. The basic research program remains weak in a number of important energy-related fields such as heat transfer, thermodynamics, and combustion processes. In addition, very little basic research can be identified in the solar, end-use conservation, fossil, and geothermal programs.
- Alternative energy R, D&D budget strategies have not been defined. ERDA has apparently not investigated the effects of various R, D&D budget levels on achieving the Nation's energy goals.
- Nonelectric energy technology development is still underemphasized. Although OTA does not imply reemphasis of programs directed toward electrification, it does appear desirable for ERDA to place greater emphasis on direct thermal use of solar and nuclear energy sources. This appears to a limited extent with solar and geothermal and is partially responsive to the prior critique.
- Interaction between ERDA and Federal energy related regulatory agencies needs definition. The profound effect that regulatory agencies have on energy resource development, delivery, and use will influence the implementation of ERDA's R, D&D program. An effective coordination effort depends to a large extent on the establishment of a clear national energy policy.

Fossil Fuel

In the fossil-fuel area, the original OTA analysis identified 16 areas of concern. The OTA examination of the FY 1977 ERDA budget and revised program, as reflected in ERDA 76-1, Volume z, indicates that ERDA is striving to be generally responsive to the concerns through the proper application of funds and intensified efforts. Contingencies have caused certain deficiencies to remain. These are, in large part, due to the lack of an expected clear national directive to accommodate the commercial development of currently available and future fossil-fuel technologies. The deficiencies are compounded by cuts in the Division and ERDA budget requests before they were submitted to Congress.

The OTA comparative analysis found that ERDA's approach to a number of issues under the fossil-fuel program was substantially improved over last year. These include: (1.) synthetic liquid fuels from coal; (2.) low-Btu and low-Btu, combined cycle systems; and (3.) direct coal utilization. Early transition of these technologies to commercial reality are of major importance for some measure of energy independence and stabilized fuel supply. ERDA has initiated a demonstration plant for coal liquefaction, and it has consolidated the various components of the low-Btu, combined cycle powerplant into an integrated and well-coordinated program, It has reduced its expectations of short-term payoff from fluidized bed combustion and added a program on coal-oil slurry.

Four concerns identified in the previous OTA analysis still remain and are particularly worth citing:

- In the area of primary oil and gas recovery, ERDA's program identified an intention to initiate advanced exploration and extractive techniques both onshore and offshore. However, there is no indication of work designed to improve oil spill clean-up for Outer Continental Shelf operations, or to provide satisfactory answers to other environmental and institutional issues that have the tendency of holding up adequate development.
- Enhanced oil and gas recovery could contribute significant quantities of oil and gas in the short run. ERDA in its original request for increased funds recognized the need identified by OTA for a program of 80 to 150 field tests and demonstrations. The reduction of ERDA's request before submission to Congress will limit the number of tests to the 33 now planned by ERDA.
- In the area of oil shale processing, the ERDA program has been partly responsive to needs. OTA identified in ERDA's earlier

program an excessive concentration on the Bureau of Mines, in-situ, horizontal process and also indicated that there was no program at all for mining plus above--ground retorting. The FY 1977 budget appears to have broadened the scope of the in-situ work to include other processes. The budget was not responsive to the mining plus the above-ground retorting issue probably due to the failure to pass commercialization legislation in 1975.

- In the field of high-Btu coal gasification, OTA initially identified a need for a first-generation, commercial-size plant. The ERDA program and budget remain focused solely on the development of second-generation technologies that can provide mid-term gas supply. The budget reduction in ERDA's budget request before submission to Congress does nothing to meet the concerns for first-generation plant development and lessens the support for even second-generation technologies needed for mid-term gas supply.

Nuclear

The nuclear program delineated in ERDA 76-1 is a constructive attempt to deal with many of the problems of the nuclear enterprise. In particular, the critical issues of waste disposal, safeguards, and uranium resource assessments have been accorded a new sense of urgency and substantially increased funding. In other areas such as closing the fuel cycle and developing the Liquid Metal Fast Breeder Reactor, ERDA seems determined to do whatever it has to in order to assure a workable system. In some areas, however, ERDA's efforts seem inadequate to ensure the development of potentially desirable technologies. The High-Temperature Gas Reactor and the Floating Nuclear Powerplant are examples. The following items seem particularly crucial and deserve particular consideration by ERDA:

- Improving Light-Water Reactor (LWR) Technology. Since our entire short-term nuclear option depends on the success of the LWR, a strong effort is warranted to keep this technology healthy, Problems with the LWR energy system have been identified often and in detail. ERDA's interest, as expressed in ERDA 76-1, in improving LWR technology is promising but program definition is only beginning to emerge.

. Siting of Liquid-Metal Fast Breeder Reactor (LMFBR). ERDA has no serious plans to study nuclear energy centers for LMFBR's, yet the decision as to collocation of LMFBR's is possibly the most important single long-range decision in nuclear energy. ERDA must launch a serious examination of LMFBR collocation.

. Cancellation of Molten Salt Breeder. ERDA has dropped the molten salt breeder without giving any clear justification. This action reduces the number of long-range nuclear options available to the United States. In particular, the only thorium cycle breeder still under development is the Light-Water Breeder Reactor, an option which may have very limited application even though near demonstration.

Solar, Geothermal, and Advanced

ERDA has made improvements in their solar program in addressing some of the issues raised in the OTA analysis. There has been increased attention paid to setting program priorities and making decisions on high-risk projects. Further, the revised ERDA Program places greater emphasis on the nontechnological aspects of solar energy development. These improvements are limited in scope. However, it must be noted that, to some extent, ERDA cannot be faulted for this because budget and personnel constraints preclude a more adequate response. Indeed, there are cases (discussed below) where the budget requests submitted to Congress tend to run counter to a more positive response to an issue as described in the ERDA Program.

The principal findings of this comparative analysis are as follows:

- Solar heating and cooling are still underemphasized relative to solar electric. This appears to be due in part to reductions of ERDA's budget requests in the budget submitted to Congress. The Solar Heating and Cooling and Agriculture and Industrial Process Heat Subprograms' budget as prepared by the Solar Division were increased a greater percentage than for the solar electric subprograms.
- Steps have been taken to develop systematic mechanisms for setting program priorities.
- The ERDA solar program management process has not noticeably changed

since the original OTA analysis. A major reason for the present management structure is the limited number of personnel in the Solar Energy Division. In this connection, the ERDA request for additional staff was reduced from 31 to 5.

- Decisions on high-risk projects appear to be under better scrutiny, Decision methodology has yet to be put into operation.

. The standards and incentives components of the solar heating and cooling programs have received increased emphasis, but there is still no systematic means to integrate them into the program and to assist in their implementation.

- Little change is evident in the structure of ERDA's research program with regard to enhancing the interaction between the basic science functions and the engineering, nontechnological, and commercialization functions of ERDA.

Geothermal Program. Substantial strides have been made in treating the issues raised by the OTA analysis. Major subprogram elements are presented in the ERDA Program document which considers nearly all the points raised in the issues relevant to geothermal energy development. This program appears to be very well organized and to treat the entire problem rather than deal solely with the technology.

The only major concern with the Geothermal Program is that the budget request, made by ERDA to OMB, was reduced when submitted to Congress by a higher percentage than the other major programs within ERDA. This is not consistent with the high degree to which the Geothermal Program has responded to the OTA issues.

Conservation

In general, the subprogram elements of the Conservation Program have been responsive to the issues identified in the OTA analysis insofar as the ERDA Plan and Program is concerned. Activities are described which account for most of the points raised in the issues when relevant. The ERDA Plan and Program presents a more vigorous approach to energy conservation and places it with their highest R, D&D priorities. ERDA has also expressed an increase in their efforts to deal with the social, political, economic, and environmental issues associated with the implementation of energy conservation technologies. Finally there is a greater emphasis placed on interaction with the private sector. This has become a principal component of the strategy outlined in the Program document.

There remain, however, some major concerns with the ERDA Conservation Program as determined by the comparative analysis. Chief among these are as follows:

- In many instances, efforts are described in the various subprograms which resolve points raised in the issues, yet, budget requests delivered to the Congress appear inadequate to effectively carry out these efforts.

- ERDA's use of the term 'conservation' remains too broad. It should be limited to subprograms which are principally oriented toward saving energy in a cost-effective way (Buildings, Industry, Transportation). By also including subprograms that deal principally with the storage and delivery of energy (Electric Energy Systems, Energy Storage), a distortion occurs that is both unnecessary and unfortunate in that it makes the evaluation of each category more difficult and gives the appearance of greater effort in conservation than there actually is.

- The problems of integration of new electric energy sources into the existing grid deserve a higher priority in the Electric Energy Systems and Conservation Research and Technology (Energy Storage) subprograms. There is a need to develop flexible systems which allow the use of small, total energy systems.

- Basic research on innovative energy conservation technologies, which have a high potential for energy savings in the long term, do not appear to be given sufficient emphasis in the ERDA Conservation Program.

- The Conservation Program has no apparent overriding sense of direction. A conservation strategy needs to be articulated so the program elements are viewed as parts of a whole.

Environment and Health

The revised ERDA program for Environmental Research and Safety represents a significant improvement over the planning and implementation programs in ERDA-48. ERDA has made significant progress toward augmenting its environmental efforts and, even more important, toward integrating an awareness of environmental, health, and socioeconomic considerations into its technology groups. In some cases the improvement may simply be a matter of more thorough description of existing programs. The program structure in the area of health effects of atmospheric sulfates is a significant example of this. Most of the many individual studies described either in the program document or in the budget are continuing efforts which existed at the time ERDA-48 was written. These, and other programs relating to health effects and to water contamination, are much more thoroughly defined in ERDA 76-1 than in ERDA-48. New, or at least significantly increased, efforts are evident in the areas of nontechnological research and technological evaluation in modeling, date compilation and characteristics of potential energy-impact regions.

With respect to the remaining issues, ERDA's response has not been adequate. The principal concerns can be described as follows:

. There is the need for a better definition of the competition between energy and non-energy sectors imposed by finite water availability in the arid but resource-rich Western States. ERDA has taken only small steps into this area; most of their concern relates to the siting of nuclear facilities, especially nuclear parks.

- The Biomedical and Environmental Research (BER) budget request has increased 4.70/o from 1976 compared to a 320/o increase for ERDA as a whole. The BER budget does not appear to be adequate to meet the problem of U.S. energy self-sufficiency with adequate protection of environmental goals.

- The program of social research in offshore energy development is structured too coarsely to cover this topic in the detail suggested by the issue. Further, in some cases, background work is not developed enough to provide an adequate attack on problems such as variances on environmental standards for demonstration plants.

. ERDA's budget for promotion of education and training in critical energy skills sustained an actual reduction. And there is little or no attention to the study of potential climate modification at the national or global scale.

Chapter I

Overview Issues

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OVERVIEW ISSUES LIST

1. The Nature of the National Energy Policy Goals 11

The national energy policy goals stated by ERDA deserve review and clarification.

2. Overall Level of the Federal Budget for Energy R, D&D 13

The overall level of the Federal budget for energy R, D&D (about $2.3 billion for FY 76) appears to bean outgrowth of decisions made prior to the Arab oil embargo and should be re-examined.

3. The International Aspects of ERDA's Plans and Programs 15

The ERDA Plan does not place sufficient emphasis on international considerations.

4. **Coordination of Programs Between ERDA and Other Federal Agencies .*********.*.*******.* 17**

ERDA's plans for coordination with other Federal energy agencies need to be more fully developed.

5. **Cooperation Between ERDA and State and Local Governments . . 19**

Success of the ERDA program will depend largely on close and continuous coordination with State and local governments. The ERDA Plan includes neither procedures nor mechanisms for accomplishing this coordination.

6. **Near-Term Energy Problems . . . 21**

The ERDA Plan gives very little attention to near-term (to 1985) energy problems.

7. Socioeconomic Research 23

ERDA's program of R, D&D does not give enough attention to socioeconomic analysis and research in addressing the Nation's energy problems.

8. Balance Between Supply Versus Demand R, D&D ..*******...* 25**

ERDA's program overemphasizes energy supply technologies relative to energy consumption.

8. ERDA's Basic Research Program 27

The goals of ERDA's basic research program have not yet been established. Considerable effort is required to organize a pertinent program of basic research.

10. Commercialization 30

The development of effective commercialization policies and procedures is not adequately addressed in the ERDA Plan.

11. Resource Constraints 32

Careful attention should be given to assessing energy resources, since they represent assumptions basic to the ERDA Plan.

12 Physical and Societal Constraints 33

Numerous physical, institutional, and social constraints may limit the orderly development and implementation of the ERDA energy plan.

13. Overemphasis on Electrification 35

The ERDA Plan appears to lean toward an overemphasis on electrification. This lack of diversity, especially in the long-term "inexhaustible" sources, may not be the most effective approach. .

14. **Methodology and Assumptions Used in Developing the R, D&D Plan . 37**

The ERDA Plan relies on a methodology and assumptions for developing R, D&D priorities that appear to bias the priorities toward high technology and capital-intensive energy supply alternatives and away from end-use technologies.

15. **ERDA Management Policy ..*** 39**

ERDA's present management policies could hinder achievement of its goals.

16. **Net Energy Analysis .****..**** 41**

Net energy analysis can aid indecisions as to which existing and developing technologies deserve emphasis, but this methodology must be employed with caution.

1. The Nature of the National Energy Policy Goals

ISSUE

The national energy policy goals stated by ERDA deserve review and clarification.

SUMMARY

ERDA's R, D&D plan, as outlined in ERDA-48, volume I, states five national energy goals to which energy R, D&D should contribute. Heavy emphasis on self-sufficiency as opposed to environmental concerns will have major consequences in the quality of life and economic well-being of the American people. Similarly, emphasizing self-sufficiency rather than international cooperation will have major impacts on our foreign policy. Emphasis among these goals warrants congressional review. Unless there is agreement between the Administration and the Congress on the priorities given different national energy goals, ERDA's development of an R, D&D program is made more difficult.

A congressional review of the priorities assigned to the five goals takes on particular importance because energy is so central to other policy areas. Other Government agencies will be planning programs ranging from foreign trade to welfare based on their perceptions of these priorities. For these reasons maximum clarification of priorities will be beneficial.

COMPARATIVE SUMMARY

The draft of ERDA 76-1 assumes precisely the same set of five national energy policy goals (and also the same set of eight energy technology goals) as did the first ERDA Plan, ERDA-48. The original issue declared that ERDA had interpreted these goals too narrowly. Several paths were suggested that ERDA could follow which would expand their role. These were presented more to call ERDA's attention to the issue rather than expecting them to have developed responses along these lines in the short time since its creation. ERDA 76-1 indicates that ERDA has expanded their interpretation of the national goals. Although they have not gone as far as suggested in the OTA analysis, ERDA is focusing their efforts more in the direction of solving energy problems rather than just developing technology options. The principal evidence for this is ERDA's increased emphasis on conservation. In the revised Plan, they state that "reduction of unnecessary waste in energy consumption" is required for successful achievement of the national goals.

ERDA is also devoting attention to nontechnological issues and physical and societal constraints. The "close coordination of technology development with socioeconomic and environmental factors" is to be emphasized in ERDA planning, As indicated in the OTA Overview issues 7 and 12, this attention falls somewhat short of resolution of these issues. However, ERDA's plans as expressed in the revised Plan and Program represent a significant step in its efforts to meet the mandate of P.L. 93-577.

The issue on National Energy Policy Goals also expressed concern with the relative emphasis among the goals, At this time there is still no national policy which assigns priorities to the five national goals, Therefore, the potential problems raised in the issue, such as the impacts caused by emphasizing self-sufficiency rather than international cooperation, remain valid. An assessment of these impacts would assist in determining whether the goal of self-sufficiency, a fundamental assumption in ERDA's energy projections, is reasonable. Similar analysis should be performed for the other goals. The lack of a national energy policy which would place priorities among these goals and clarify these impacts makes it difficult for ERDA to develop an R, D&D program,

A final consideration worth noting is the absence in the revised Plan of any discussion of the influence of the Energy Policy and Conservation Act of 1975 on the national goals. Although the Federal Energy Administration is the principal implementing agency in the Act, it has provisions, primarily in conservation, which will affect ERDA's activities.

QUESTIONS

1. How were the goals determined?

2. Did representatives of agencies responsible for economics, international affairs, the environment, and natural resources have an opportunity to participate in the formulation of the goals?

3. What are the implications for other important problems relating, for example, to high levels of production and employment, security, international trade and finance, abatement of environmental pollution, the oceans?

4, What are the implications of an energy independence goal on our major allies in Europe and Asia, who presumably will remain dependent upon imported oil into the foreseeable future? What are the implications for the oil-exporting nations?

5. How can Federal research, development, and demonstration programs in support of national energy goals be evaluated? What criteria and standards of measurement can be introduced early in the planning process to assist in determining later the relative success or failure of such programs?

z. Overall Level of the Federal Budget for Energy R, D&D

ISSUE

The overall level of the Federal budget for energy R, D&D (about $2.3 billion for FY 76) appears to be an outgrowth of decisions made prior to the Arab oil embargo, and should be reexamined.

SUMMARY

In theory, the overall Federal budget for energy R, D&D is established by developing a budget need for each component and then summing the components. In practice, however, the development of budgets for each component and the choices among components are greatly influenced by what is perceived to be the limit on the overall scale of the budget. The FY 76 Federal budget for energy R, D&D of $2,3 billion is largely influenced by decisions taken in 1973 before the Arab oil embargo had committed the United States to a policy of energy independence. ERDA should prepare R, D&D programs for higher overall budget levels (e.g., $20 or $3o billion for the 5 years beginning in FY 76).

BUDGET SUMMARY*

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	ERDA Request	Request to Congress	FY 76-77 Change
ERDA Energy R, D&D Budget	1,600.0	2,975.0	2,180.0	580.6

The request to Congress represents a 30.3-percent increase over FY 76, However, ERDA itself asked for an 86-percent increase. If one assumes ERDA, as the lead agency in determining the R, D&D necessary to achieve the Nation's energy goals, is best able to judge the requirements for reaching these goals, then the budget finally submitted to Congress falls short of these needs.

COMPARATIVE SUMMARY

ERDA presents an extensive justification of the FY 77 budget in their revised plan, Their justifications are presented in terms of objectives set forth in the President's energy message, national priorities in the revised Plan, and the perceived roles of the public and private sectors. To this extent, ERDA has addressed the points raised in the issue. The suggestion of preparing alternate budgets has not been acted upon, however, and the Plan lacks a discussion of whether the budget decided upon is the most effective in achieving the national energy goals.

*Unless otherwise noted, all figures are Budget Authority Operating Expenses.

There is, of course, no intrinsically correct answer to this important question. The answer arrived at depends upon the assumptions made relative to a number of important determinants which influence the preferred budgetary levels. These include in addition to those cited above in ERDA's justification:

1) The importance of the energy problem compared to other important national problems.

2) The role assumed for energy R, D&D, compared to other energy programs.

3) Future levels of demand for, and prices of, energy.

Depending upon the assumptions made about such determinants, widely varying estimates of the optimal size of the Federal energy R, D&D budget can be logically supported. The proponents of a larger budget can cite such evidence as the enormous and increasing costs of oil imports, the projected inadequacy of private investment for energy purposes, the continuing strength of OPEC, and the fact that current budgetary levels were originally envisioned prior to the energy crisis of late 1973.

Conversely, the proponents of a smaller energy R, D&D budget can support their views by assuming:

1) Goals considerably less ambitious than energy "independence," often referring to these as "insurance" goals.

2) Greater emphasis on alternative policies, such as:

   a) Regulatory actions; and

   b) More reliance on incentives to private enterprises and less reliance on governmental action.

3) Lower future projections of demand based on assumptions of greater demand elasticities associated with assumed price increases.

As indicated in the issue, such choices can best be analyzed considering alternate budgets and predicting their impacts on meeting national energy needs.

3. The International Aspects of ERDA's Plans and Programs

ISSUE

The ERDA Plan does not place sufficient emphasis on international considerations.

SUMMARY

ERDA's mission extends well beyond America's national borders. In the interdependent world of the 1970's and 1980's, energy independence, economic well-being and environmental quality (the essence of the five national energy goals) cannot be achieved without considering international factors. "project Independence" with its go-it-alone implications for R, D&D (let alone for national energy policy in general) may well be inconsistent with requirements for developing new energy sources in cooperation or coordination with other countries, particularly in undertaking joint exploration and exploitation of nonnational resources (e. g., the oceans). Moreover, the current proliferation of nuclear facilities in the face of the Nonproliferation Treaty poses difficult technical as well as institutional problems of monitoring, inventories, and control, ERDA identifies these considerations in its plan (volume I,) but barely recognizes them in its Programs (volume II).

COMPARATIVE SUMMARY

The revised ERDA Plan and Program places significantly more emphasis on international considerations. In each of the programs a section is devoted to international activities indicating an increased interest in solving energy problems on an international scale. Special note should be given to their program for an organized, systematic study of conservation in other industrial countries. Approaches will include identifying worldwide problem areas and evaluating alternatives for coping with them.

Moreover, the ERDA draft Plan, repeating ERDA 48, includes among its five assumed "National Policy Goals Related to Energy" the following:

1. Maintain the security and policy independence of the Nation. . .
2. Contribute to world stability through cooperative international efforts in the energy sphere.

In Chapter IV, "Implementing the Plan: Interrelationships Among Energy R, D&D Participants," a number of ongoing and proposed actions involving other nations and international agencies are discussed. ERDA groups this activity under the four "courses of action being proposed, " as follows:

1. Entering into bilateral R, D&D and nuclear supply agreements.
2. Participating in the International Energy Agency (IEA).

3. Providing assistance to developing countries.
4. Participating in the Safeguards Program.

Problems remain, however, in ERDA's international program which may not permit optimum benefits from the program. The principal deficiencies in the discussion of international considerations are the following:

1. It combines proposed and existing actions.
2. It does not address the purposes of the actions noted.
3. It does not differentiate between ERDA's actions and the actions of other Federal agencies.
4. It gives far too sanguine a view of the capabilities of the International Atomic Energy Agency (IAEA).
5. There is no discussion of the apparent inconsistency and therefore balance required between the two goals cited above — independence and interdependence.
6. Small technology which would be of immense importance in underdeveloped countries is not mentioned.

QUESTIONS

1. How does ERDA's Assistant Administrator for International Affairs plan to approach such issues as energy independence; the need for international coordination of energy, economic, and environmental policy; the exploitation of nonnational energy sources; and the challenges of nuclear proliferation?
2. What has been the role of ERDA's oversea staff ? Why should such a staff be concentrated in Brussels? Should not ERDA be in close liaison with the International Atomic Energy Agency, the International Institute for Applied Systems Analysis in Vienna, and the International Energy Agency in Paris?
3. What is the division of responsibility in the international energy area between ERDA, the Department of State, and other Federal agencies?
4. What plans or programs does ERDA contemplate for international research and development in the control and disposal of radioactive waste?
5. What role will ERDA play in aiding underdeveloped countries?

4. Coordination of Programs Between ERDA and Other Federal Agencies

ISSUE

ERDA's plans for coordination with other Federal energy agencies need to be more fully developed.

SUMMARY

ERDA has been mandated (Public Law 93-577) as the primary agency in energy R, D&D with responsibility to integrate and coordinate national efforts. It is not evident in ERDA's plans whether a comprehensive framework is being established to permit ERDA to perform this role adequately. Two types of multiagency research efforts exist where coordination is required. In the first, several agencies undertake different R&D programs aimed at one energy technology. An example are the three different approaches to coal cleanup by ERDA, Environmental Protection Agency, and Department of the Interior. Without a formal structure to bring together these diverse efforts, much waste can ensue with no assurance that the technology will be effectively developed. In the second case, different agencies are concerned with separate elements, such as regulatory, economic, and technological, of a given energy technology. The lack of effective coordination could lead to development of policy which could hinder introduction of technologies developed, for example, by ERDA.

COMPARATIVE SUMMARY

The coordination between ERDA and other Federal agencies assumes two major directions. The first, as encompassed in the Summary above, relates to the coordination between ERDA and other agencies exercising responsibility for energy R, D&D. The other major direction relates to the coordination between ERDA, as the primary agency for energy R, D&D, and agencies which exercise responsibility for other facets of the energy problem.

Considering first, energy R, D&D, the record to date, as reflected by the draft of the revised ERDA Plan and program, indicates considerable progress has been achieved. In some instances, effective coordination has already been realized. For example, in the conservation area, the draft of the revised ERDA Program cites the formation of the Federal Interagency Task Force on Buildings Energy Conservation R, D&D. Within the solar area, a well-defined interface has been developed between ERDA and HUD in the residential heating and cooling demonstration program. Another interface being developed is that with NASA in component and system development, although this is not yet firm. The National Bureau of Standards (NBS) has been given a role in standards. In addition, interfaces between ERDA and Federal Energy Administration (FEA) are indicated in terms of incentives, but this has not yet been structured.

In other instances, it appears that the requirement for coordination is not yet sufficiently recognized, or if recognized, few results have yet been achieved.

With regard to the coordination between ERDA and the Federal agencies responsible for non-research-related energy functions, room for improvement exists. In the absence of a clear, coordinated national energy policy, ERDA has been placed in the difficult position of having to make a number of assumptions relative to these critically important matters, such as the uncertain status of the Federal Energy Administration. The Energy Policy and Conservation Act of December 22, 1975, places many important responsibilities in FEA, which will significantly affect the actions of ERDA. The link with the Department of the Interior in terms of federally owned energy resources also needs to be clearly defined. A great portion of ERDA's supply-oriented R, D&D deals with energy resources on Federal lands. It is important that the development and demonstration of these technologies account for the Federal regulations regarding the leasing and use of these resources. Similar comments can be made with regard to the Federal Power Commission and other regulatory agencies. The role of each Federal agency and their interrelationships will be difficult to ascertain until each is striving for common goals.

A clear, coordinated national energy policy and an efficient organizational mechanism for implementing such a policy remain as important issues on the national agenda, clearly transcending ERDA's more limited responsibility as the lead agency for energy R, D&D,

QUESTIONS

1. With regard to energy research and development coordination, how broadly does ERDA view its role in energy R, D&D? Does ERDA have the responsibility for ensuring that all research needed to help solve the Nation's energy problems (including those that are nontechnical) is receiving proper attention?
2. What specific management mechanisms, techniques, or coordination controls will ERDA use to integrate and coordinate its activities with other affected Federal agencies?
3. Is the ERDA R, D&D Plan a plan within a national energy plan? Where is that plan?
4. To what extent is ERDA responsible for recognizing such other important national problems as high levels of production and employment, security, international trade and finance, abatement of environmental pollution, the oceans?
5. How should the Federal Government be organized to cope with the overall energy problem? With the energy R, D&D aspects of the problem?

15. Cooperation Between ERDA and State and Local Governments

ISSUE

Success of the ERDA program will depend largely on close and continuous coordination with State and local governments. The ERDA Plan includes neither procedures nor mechanisms for accomplishing this coordination.

SUMMARY

State and local governments are well aware of the Nation's energy problems and are committed to support the programs necessary to meet these problems. Their perception of the Nation's energy problems, however, differ from ERDA's. They are more concerned with local impacts of energy projects, accord more importance to conservation and, most important, feel strongly that they should be included not only in the planning phases of R, D&D programs but also in the implementation phases.

Failure of ERDA to consider properly these viewpoints may well result in unnecessary conflict and delays in program implementation. Thus, it is important for ERDA to expand the Office of Industry and State and Local Government Relations and to provide the local governments regularly with information, such as a 1isting of all energy R, D&D projects, clear definitions of State and local roles in energy R, D&D, and well defined planning procedures.

COMPARATIVE SUMMARY

ERDA, it seems clear, now realizes that State and local governments must play an important role with regard to energy R, D&D. In both the Plan and Program, ERDA makes numerous assertions about the role of State and local governments. For example, a somewhat typical statement from the Plan says:

> The Federal Government must therefore be sensitive to local and regional needs, It must also reach public and private groups at these levels to provide information to them; to develop effective, productive communication links with regional, State, local, university, financial, and industrial representatives; and to receive feedback from them on the problems, progress, public acceptability, and overall effectiveness of ERDA's programs and the National Plan for Energy R. D&D (p. 78).

ERDA has also taken a number of positive steps to establish working relationships with many individual States and regional organizations. These range from cooperation on specific energy projects with specific States to contact with State officials to determine future cooperative efforts.

At present, however, a systematic plan for interacting with State and local governments appear to be missing within ERDA as a whole. Such a plan should determine:

1. Whether to centralize or decentralize coordination between ERDA and State and local governments.

z. Just what role ERDA's Office of State and Local Governments should play.

3. How to differentiate between State and local governments; for one example, whether State governments should be used as a vehicle for communicating with local governments.

4. Whether State and local governments should, in fact, have an active role in the planning process; for example, to what extent should they participate in the preparation of the plan and Program in areas affecting specific regions?

While these deficiencies may be symptomatic of the continual problem of all coordination between the Federal and State and local governments, they should be resolved as soon as possible in order to effectively implement successful ERDA technology developments. The highly regionalized nature of the energy problem makes it imperative that cooperation between ERDA and State and local governments is fully developed.

QUESTIONS

1. What specific procedures does ERDA project for effecting coordination of its program with State and local governments through the R, D&D process? What is the schedule for their implementation?

2. Does ERDA plan to produce and circulate to State and local governments a listing of program plans to assist States in their own planning processes? When can distribution be expected?

3. Does ERDA plan to conduct or sponsor research projects concerning the potential impacts of its R, D&D program? What will be the scope of such research; by whom will it be conducted; and how will State and local governments be included in research efforts?

4. What plans does ERDA have for supporting and maintaining liaison with multistate organizations interested in regional energy planning? What are the mechanisms involved; who is responsible for coordinating ERDA's efforts; and what will be the scope of the effort in terms of manpower and funds?

6. Near-Term Energy Problems

ISSUE

ERDA's Plan gives very little attention to near-term to 1985 energy problems.

SUMMARY

The "first strategic element" in ERDA's Plan is "to ensure adequate energy to meet near-term needs until new energy sources can be brought on line. " ERDA plans to accomplish this through enhanced gas and oil recovery, direct use of coal, more use of nuclear reactors, shifting demand away from petroleum, and increased conservation practices, A review of ERDA's FY 76 budget indicates, however, that only about 5 percent is devoted to solving near-term problems, which does not seem consistent with the stated goals. This deficiency results primarily from the lack of emphasis given to end-use conservation, the lack of attention to nontechnical research needs, and a tendency to focus on large-scale electric supply technologies.

COMPARATIVE SUMMARY

In his 1975 State of the Union message, President Ford presented three national energy policy goals, The first two of these three goals dealt specifically with near-term energy problems (present to 1985). The revised Plan does indeed assign the highest priority to conservation, and notes its near-term impact with the statement, "conservation technologies can generally be implemented at a faster rate with less government involvement in the near-term than can new supply technologies". The key words are "implemented at a faster rate. " When one considers that conservation can be rapidly adopted on a broad scale and that it usually costs much less to save a barrel equivalent of oil than to produce one, the rationale for the highest priority ranking is clear. In addition the Highest Priority Supply category of R, D&D rankings recognizes the importance of direct coal utilization and enhanced recovery of oil and gas and reinforces the importance of reduced dependency on imported oil in the near-term.

There are, however, some serious questions with regard to the effectiveness of this increased emphasis on the near-term. Although projects for increasing the direct utilization of coal and improving nuclear converter reactors which appear to have a high probability of success with major near-term impact are funded at a high level, the conservation budget of $120 million is only 3.8 percent of total energy R, D&D budget outlays for FY 77. This allocation to the Plan's top priority area, conservation, appears to be inappropriate in light of the national near-term energy goals enunciated by the President. Overall, the ERDA Plan (including budget) does not establish how this Nation will reverse the near-term trend toward more dependence on foreign oil, a dependence which reached 37 percent of total U.S. petroleum consumption in 1975 and which is continuing to rise,

The principal areas where aggressive ERDA demonstration and commercialization programs could significantly enhance our ability to meet a future "energy crisis", regardless of whether it is triggered by an embargo, cartel price-fixing or other events beyond our control, are:

1. Energy end-use conservation.
2. Solar heating and cooling of buildings.
3. Waste energy recovery systems.
4. Time-of-day electrical load management.
5. High-efficiency electrical devices.
60 More efficient and environmentally acceptable utilization of coal for electrical generation.

Near-term objectives lend themselves to more frequent measurement of achievement than do long-term objectives. The 5-year planning system being instituted by ERDA with milestones to measure success annually could be a useful audit and planning tool to lend focus and urgency to near-term projects.

7. Socioeconomic Research

ISSUE

ERDA's program of R, D&D does not give enough attention to socioeconomic analysis and research in addressing the Nation's energy problems.

SUMMARY

ERDA's program plans, budgetary commitments, and professional staffing do not give adequate attention to social, economic, environmental and behavioral research needs, even though the legislative record makes clear that ERDA is given responsibility beyond technological R, D&D (Public Law 93-577, section 5A), Such research is needed for two reasons: (I) to better understand the relationships of energy and the quality of life, and (2) to identify nontechnological constraints to increased energy supply or reduced energy demand. The nonhardware research programs must be integrally tied to the hardware programs and the results used when evaluating and comparing alternative approaches to "solving the energy pro blem, "

BUDGET SUMMARY

Funds for socioeconomic and related research occur throughout the various subprograms in ERDA. Although the specific amount in each of these subprograms dedicated to socioeconomic research is not given, the total for the categories in which they fall is $28.2 million. In addition, funds for socioeconomic research exist in the Environmental Research and Safety Program.

S WARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 ERDA Request	FY 77 Request to Congress
Analysis and Assessment	11.6	27,8	19.0

The increase in funding from FY 76 indicates a stronger commitment by ERDA to socioeconomic R, D&D, although there is no strategy for funding across the whole of ERDA. This does not imply, however, that all socioeconomic research should be funded from one office. Indeed this is probably not conducive to integration of socioeconomic and technical research, but it does suggest the need for a comprehensive plan for this research. Incorporation of socioeconomic concerns in the Planning, Programming, Budgeting, and Review (PPBR) system (just as with environmental activities) would be an effective way to do this.

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COMPARATIVE SUMMARY

Research into nontechnical areas associated with the various energy technologies has been given considerable attention in the revised ERDA Plan and Program. The Program implementation states that "social and cultural impacts of the new institutions in energy production and use have emerged as the highest priority of new work". In each subprogram, efforts to incorporate socioeconomic analysis and research are described. In the revised Plan, an extensive procedure for integrating environmental concerns in all energy technology research is presented. ERDA will consider environmental trade-offs in the planning process in two stages: in an environmental development plan which will serve as a companion document to the Program Plan, and in the environmental impact statement which will be used to make major program decisions. The Plan also expresses the importance of considering social and political impacts of energy technologies when establishing research priorities. This will be incorporated in regional review of the plan and criteria for setting priorities.

Although the commitment to socioeconomic research is there, at this time it is largely intent. The plan and approach for carrying out research in these areas, except for environmental activities, are not nearly as developed as those for R, D&D in technical areas. In addition the purpose of socioeconomic research is not clear. In the Plan the apparent objective is to inform the public "of the true nature of trade-offs and the implications of various choices" allowing the consumer to make the ultimate decision under existing conditions. In the revised Program, the emphasis is placed on identifying the impediments to proposed programs and technologies and ways to overcome these impediments. The Program thus implies a more activist role on ERDA's part than the Plan does in utilizing socioeconomic research results. This role would be more in keeping with rectifying the principal deficiency identified by OTA, the need for ERDA to provide solutions to energy problems rather than just developing technological options. Clarification of this apparent contradiction between the Plan and Program is necessary if an effective socioeconomic research effort is to be developed.

QUESTIONS

1. What is the basic purpose of socioeconomic research in the ERDA Plan and Program?
2. Has adequate input been sought from the social science community in defining the nature and abilities in the area?
3. Within the budget areas in which social science research is listed, what portions will actually be committed to such research?
4. What is ERDA's specific plan for determining social science research requirements; how and by whom will the research be conducted; how will the results be evaluated; and how will the research be incorporated into other energy problems?

8. Balance Between Supply Versus Demand R, D&D

ISSUE

ERDA's program overemphasizes energy supply technologies relative to energy consumption.

SUMMARY

The present pattern of energy consumption was developed during an era of constantly decreasing real energy prices, so little emphasis was placed on end-use efficiency. Although there is some recognition of the need for improvement, ERDA's conservation program focuses primarily on the near-term and underestimates its long-term importance. Factors inadequately considered in the relative emphasis on consumption and supply technologies are cost-effectiveness, time to payoff, environmental benefits versus costs, and demand on resources.

COMPARATIVE SUMMARY

The present pattern of energy consumption was developed during an era of low and relatively stable energy prices. Little emphasis was placed on end-use efficiency. We now find ourselves as a nation living in houses, neighborhoods, cities, and metropolitan areas which are increasingly beyond our limited energy means. Our places of work are equally wasteful in energy consumption. Many architects, engineers, scientists agree that an effective, broad scope, national energy conservation program would be equivalent to a 20- to 30-percent increase in annual U.S. energy supplies in the near-term.

The revised ERDA Plan recognizes the importance of "conservation", emphasizing that "energy efficiency (conservation) is now of the highest national priority". Moreover, some of the great advantages of consuming less rather than producing more are clearly enunciated. To this extent ERDA has been clearly responsive to this issue.

ERDA's increased emphasis on conservation is not without problems however. The OTA issue expressed concern about the time focus of the conservation program. It was felt that ERDA underestimated the long-term importance of conservation by concentrating on near-term, existing technology while relying on increased supply technologies for mid- and long-term energy options. In the revised Plan and Program this difficulty appears to be even more pronounced. There appears very little in the way of research efforts directed at innovative energy conservation technologies with a high potential for payoff in the mid- and long-term (beyond 1985). Many such R, D&D opportunities exist in the energy-intensive industrial processes of aluminum, paper, and steel production. The impacts would be mid- to long-term and in many cases no R, D&D industry capability exists to address the problems.

Conservation appears to be a program which intends to implement existing or near-term technologies in the economy, with the assumption that increased supply will suffice in the mid- and long-term. Although the revised Plan places conservation with the highest priority supply options, the Plan appears to be supply oriented. This is reconciled by noting that conservation programs are new, while many of the supply programs are well established, and by assuming there are sufficient free market forces to motivate conservation with a minimum of government involvement. This assumption, however, should be carefully examined and reconsidered especially in light of the desirability to accelerate the adoption of conservation technologies to achieve national goals.

9. ERDA's Basic Research Program

ISSUE

The goals of ERDA's basic research program have not yet been established. Considerable effort is required to organize a pertinent program of basic research.

SUMMARY

ERDA's program for basic research has largely been inherited from the agencies that i t incorporated. It is not surprising, because of the short life of ERDA, but nonetheless worrisome, that the basic research program in large measure does not reflect ERDA's R, D&D goals. In particular, a need exists to reexamine (a) the relationship between ongoing research and ERDA's program disciplines, (b) the integration of basic and supporting research, (c) the distribution of emphasis on in-house and contracted research and (d) the role of the national laboratories vis-a-vis universities and industry. In addition, the program indicates no basic research in the social sciences, which could have a significant impact on the institutional, legal, and social aspects of ERDA's program.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress	Percent Increase
BASIC ENERGY SCIENCES					
Nuclear Science	82,4	95.1	93.1	81.2	– 1.4
Material Science	46.3	74,4	71.2	51.1	10,5
Molecular, Mathematical, and Geoscience	45,3	78.6	71.1	50.5	11,4
TOTAL BES	174.0	248.2	235.5	128,8	5.1
HIGH ENERGY PHYSICS	152.8	185.9	**178.6**	**167.5**	**9.6**
BIOMEDICAL (1) RESEARCH	174.6	245.5	234.8	182.9	4.7
(Education (2) & Training)	(3.5)	(7.6)	**(7.0)**	**(2.2)**	**(–37.0)**

(1) Biomedical Research is a subprogram in the Environmental Research and Safety Program.

(2) Education & Training is an element of the Biomedical Research subprogram; the budget numbers in the Biomedical Research subprogram in the line above include the Education & Training budget numbers.

Comments on the Budget:

1. Little basic research is funded in the end-use Conservation, Fossil, Solar, and Geothermal Programs of ERDA. Some important basic or near basic research programs are funded in the Conservation Research and Technology subprogram (storage and conversion), but it is difficult to arrive at a dollar figure for these efforts.

2. The Basic Energy Sciences Program has received a steadily decreasing fraction of ERDA's R&D budget (5.7 percent in FY 75 and, following OMB'S recommendations, 4.0 percent in FY 77). Support for the Basic Energy Sciences Program will decline in real terms from FY 76 to FY 77, if the budget requests to Congress are followed. This request has a large cut from the ERDA recommendation for Material Sciences and Molecular, Mathematical, and Geosciences. Part of the much needed growth in these fields has been made at the expense of Nuclear Sciences, which has declined in dollar terms since FY 76, and, because of inflation, in real terms since FY 75. It should be recognized that nuclear science contributes to many disciplines, including materials science, and biomedical research, and it should not be confused with or become a victim of the debate related to nuclear power usage in the United States. Moreover, a number of other countries currently spend a larger fraction of their GNP on basic nuclear research than does the United States, notably Great Britain and Canada (1.5 times as much on basic nuclear research, relative to GNP), and France and Germany (4.5 times as much, relative to GNP).

3. High Energy Physics has about kept pace with inflation from 1975 to 1977.

4. The Biomedical Research subprogram of the Environmental Research and Safety Program is receiving a declining fraction of the ERDA budget (5.3 percent in FY 75 to 4.o percent in FY 77). Funding for this program has declined in real terms since FY 76.

COMPARATIVE SUMMARY

Most of the questions and uncertainties raised by OTA last year about ERDA's basic research program remain, A need still exists to examine the integration of basic and supporting research and the distribution of resources between national laboratories, universities, nonprofit research centers, and private industry. In particular, there remains the need to examine the role and purpose of ERDA's basic research program (a) within ERDA and (b) within the total national R&D effort. The items in the ERDA FY 77 Budget which can be identified with basic research have declined in support from FY 76 to FY 77 relative to the total ERDA budget; the dollar increases in Basic Energy Sciences Program and the Biomedical Research subprogram have not matched inflation. As a result, although ERDA has increased its emphasis on nonnuclear research, particularly in the fields of materials and molecular science, basic research remains weak in a number of important energy-related fields. In the physical sciences, basic combustion research is notably underfunded. Climate modifications associated with energy use is another field receiving little or no attention. Heat transfer, fluid mechanics, and thermodynamics also receive little attention. The social sciences have apparently received increased support within a number of ERDA programs, but remain, as in FY 76, dispersed throughout the agency. Research in the life sciences is focused in the Biomedical subprogram of the Environmental Research

and Safety Program. This program concentrates on effects of energy production, and their appears to be a lack of recognition on the part of ERDA that certain types of fundamental life-sciences research, such as work on the production of enzymes in the biosphere, for example, might ultimately prove valuable in a variety of energy-related areas,

In conclusion, it is OTA's feeling that much-needed new programs should not be funded at the expense of reduced support for existing important, long-range studies (e.g., current studies in nuclear, high energy, and plasma physics).

QUESTIONS

1. A review of the budgetary development for funding by ERDA during FY 75 to FY 77 indicates that long-range and innovative research are receiving relatively reduced emphasis. It should be recognized that this reduced emphasis will lead to further erosion of the Nation's scientific resources. Is it ERDA's intention to reverse this trend?

2. What are the current ERDA budgets that are dedicated for the long-range support of energy-research programs in each of the following important areas:
   a. combustion kinetics relating to cost reduction of coal gasification?
   b. coal recovery and utilization?
   c. chemical research associated with the synthetic fuels program?
   d. shale-oil recovery and utilization?
   e. solar-energy implementation technologies?
   f. geothermal energy implementation technologies?
   g. combustion research relating to energy conservation?
   h. plasma physics relating to all types of fusion reactors?
   i. nuclear-reactor development?

3. What is ERDA's view and intent with respect to social science research, which bears on the institutional, social, and legal aspects of its energy program?

4. What are the pros and cons of a research policy that separates basic and supporting research?

5. How does ERDA envision the research role of the national laboratories, the universities, and industries? How does ERDA plan to rationalize and balance these various research capabilities?

6. With particular regard to the university role in energy research, how does ERDA view the establishment of "Centers of Excellence" for energy-related research in the pure and applied sciences, engineering, and interdisciplinary programs dealing with environmental, health, and policy issues?

7. What is ERDA's view of its responsibilities for the support and training of needed personnel in the energy field?

10. Commercialization

ISSUE

The development of effective commercialization policies and procedures is not adequately addressed in the ERDA Plan.

SUMMARY

ERDA-48 identified the commercialization program and the plans for its implementation; however, ERDA has not considered the commercialization process in sufficient detail. For example, specific mechanisms for assuring ERDA/industry coordination are not clearly outlined, and the administration's relationships with international companies is not defined. Moreover, the Plan does not address a number of very important issues; e.g., long-term support of energy industries that can be undercut by reduction in foreign energy prices. Because of the complexity of ERDA program markets, an effective commercialization program is very difficult to formulate. The key questions are which commercialization processes could be suitable for implementation and how will implementation be achieved.

COMPARATIVE SUMMARY

Throughout ERDA 76-1 there is a great deal of discussion of various aspects of commercialization. ERDA's planners recognize that private industry is to be ultimately responsible for the development and implementation of new energy systems and that the Federal Government will have to provide a set of stimulants to motivate private industry to invest in energy-related R, D&D. As an example, under "Domestic Energy Resource Development, Conservation and Storage, " of "The FY 1977 Budget" section of ERDA 76-1, ERDA discusses the use of financial assistance by changes in tax laws to provide for faster tax writeoffs, cost sharing plans, loans guarantees, and federally funded commercial demonstration plants for synthetic fuel production.

In addition, the establishment of the Office of Commercialization demonstrates ERDA's desire to formulate a set of strategies to ensure ERDA-industry coordination and commercialization of ERDA-developed technologies. It is important that such strategies propose more specific criteria for determining project suitability and the nature of Federal participation. To undertake such a task the new Office of Commercialization must be funded at a level that will permit it to investigate the market for new energy systems and the most appropriate incentive systems. The potential magnitude of such Federal support is very substantial and that the support should be allocated only on the basis of solid rationale and careful analysis of the complexities involved.

It is noted that the revised ERDA Plan describes efforts to deal with many of the concerns expressed in the OTA issue. These include measures to enhance the effectiveness of patent and licensing policy, to "aggressively seek out small business participation", and to analyze incentives for overcoming major constraints to commercialization. A number of programs to interact with the private sector are described,

Two points raised in the issue are not discussed in the revised ERDA Plan or Program, First, there is a need for a policy on long-term support of energy industries that can be undercut by reduction in foreign energy prices. This is a serious consideration for the proposed loan guarantee program for synthetic fuels, ERDA should establish a strategy for that eventuality. Second, the existence and growing importance of multinational companies further exacerbate ERDA's difficulties in program commercialization. The principal problem occurs when subsidizing a company whose best interest may be served by the failure of the subsidized project. Such a conflict of interest may exist between a synthetic fuel project undertaken by a company in a loan guarantee program and that company's interest in more profitable foreign sources of equivalent fuel. This problem has both real and perceived components and will be of concern to ERDA in any commercialization program.

QUESTIONS

1. What research has ERDA done on the relative cost effectiveness of various incentive systems?
2. Does the cost effectiveness of the various incentive systems vary for the type of organization that will be doing the R, D&D or the type of project? That is, will systems vary for universities, small businesses, large businesses, and so forth?
3. What formal procedures and agencies have been established by ERDA to participate in the development of new energy technologies?
4. How does ERDA plan to address the problem of long-term support for industries that may never become commercially viable but which are necessary for the Nation? (An example would include industries which are commercially viable at present prices of OPEC oil but which would become unprofitable if the price of world oil prices were to fall.)

11. Resource Constraints

ISSUE

Careful attention should be given to assessing energy resources, since they represent assumptions basic to the ERDA Plan.

SUMMARY

The direction and timing of the ERDA Plan is predicated, to a large extent, on the Nation's energy resource base. An incorrect assessment of the extent of all or part of the resource base could cause severe distortions in ERDA priorities and schedules, If the estimated recoverable reserves of a given resource are greatly overestimated, and several different technologies are developed and commercialized which would utilize that resource, the Nation could be in the position of developing a new energy infrastructure that would quickly find itself running out of fuel. On the other hand, underestimating these resources could cause a dependency on uneconomic energy systems.

To reduce the probability of such occurrences, accurate determinations of the upper and lower bounds of recoverable resource estimates are required, necessitating high priority efforts to improve the methods for making these estimates.

COMPARATIVE SUMMARY

The new ERDA Plan pays considerably more attention to resource issues than did ERDA-48. Discussions of the importance of utilizing our most abundant domestic energy resources in any plan that leads toward energy independence indicate an increased awareness of the fundamental significance of the resource base.

Contradictory opinions regarding the status of the understanding of the uranium resource base points out the need for increased accuracy of resource estimates. The National Uranium Resource Evaluation (NURE) Program should accomplish this; however, major commitments to utilization technology will have been made by the time the NURE Program has been completed. Because fission accounts for the largest part of the ERDA budget, documenting the validity of domestic uranium resource estimates, upon which this budget is based, should have high priority during the next year.

The chief issue in energy resources is the degree to which the efforts focus on technologies that will allow the United States to depend on resources that are plentiful in this country. This should be addressed more fully for uranium and in more detail for geothermal energy.

QUESTIONS

1. How reliable are energy resource estimates for petroleum, natural gas, coal, uranium ore, and thorium ore?
2. How are these uncertainties incorporated into the R, D&D strategies?

12. Physical and Societal Constraints

ISSUE

Numerous physical, institutional, and social constraints may limit the orderly development and implementation of the ERDA energy plan.

SUMMARY

potential physical constraints to the implementation of the ERDA Plan include water requirements, materials limitations, air pollution, land use, and net energy considerations. Among the social and institutional constraints are manpower; capital; lags in technology transfer; information accession, retrieval, and dissemination; regional and community impacts of mining and plant construction; metropolitan dislocations caused by fuel shortages and price increases; and social acceptability of new technology.

COMPARATIVE SUMMARY

ERDA has recognized that the constraints listed in the issue can inhibit or prevent commercialization of technologies developed in its programs. It is initiating or expanding programs in information dissemination and technology transfer in subprograms. Plans are underway to interact with the financial community with regard to capital constraints. The impacts of new energy facilities on regions and communities is to be assessed. The Plan recognizes water quality and quantity issues.

There remains an absence of an assessment program in ERDA planning to address physical and societal constraints. The nearest approximation in the new ERDA planning process is in environmental planning.

By instituting technology assessment as part of the planning system, a more effective technology development program can result and identify the impact of policies to overcome constraints. Of particular importance in this context is the need to be concerned with energy facility siting. Conflicts over siting regularly include the whole range of physical and social constraints. Longer term and better

informed planning is necessary about where to site facilities and how siting decisions can most effectively be made. This issue is intimately connected with the highly charged question of land-use planning.

The siting question is of special concern in connection with the development of the Liquid-Metal Fast Breeder Reactor (LMFBR), It is, however, equally central to solar and fossil energy development. Whether one proposes central station solar thermal plants, large-scale biomass production, western coal or oil-shale development, or Outer Continental Shelf (OCS) development of oil and gas, the same complex of physical-social problems arises.

The siting question is an attractive candidate for technology assessment in the planning process. This can be done by detailed case studies of specific sites and, more broadly, around regional siting or land-use strategies.

The effort ERDA is devoting to the siting question is being principally carried out within its national laboratories. There is a question concerning whether that is an appropriate location. Critics argue that the laboratories simply provide briefs to underpin their siting decisions. It appears necessary for ERDA to support additional siting research by groups with less of an apparent vested interest. It is encouraging to note that siting questions will be incorporated in the planning process through the environmental development plan and environmental impact statement.

QUESTIONS

1. What is ERDA's strategy for identifying and assessing the physical and societal constraints upon the implementation of a national energy plan?
2. What levels of effort are planned with respect to systems studies, cost-benefit analysis, technology assessment, and other energy policy planning research?

13. Overemphasis on Electrification

ISSUE

The ERDA Plan appears to lean toward an overemphasis on electrification. This lack of diversity, especially in the long-term "inexhaustible" sources, may not be the most effective approach.

SUMMARY

All three major "inexhaustible" sources identified by the ERDA Plan are producers of electricity having high capital cost and low operating or fuel cost. Examination of the functional energy needs indicates, however, that other concepts, although having less ultimate potential, should be given equal priority. Intensive electrification itself will have a noticeable social impact and may present problems of vulnerability and reliability. Alternatives include expanded direct use of solar, geothermal, and other direct heat sources for industrial processes, production of synthetic liquid or gas fuels by solar or nuclear energy, and increased emphasis on hydrogen, biomass, and conservation.

BUDGET SUMMARY

The programs in ERDA can be classified as either supporting electric energy production and delivery or directed toward nonelectric energy forms, or may be placed in an indeterminate category. The following table shows this division:

SUMMARY TABLE

(Dollars in millions)

	Budget Authority, Total Costs					
	Electric		Nonelectric		Indeterminate	
Program	FY 76	FY 77	FY 76	FY 77	FY 76	FY 77
Fossil	**47.5**	71.9	120.0	125.1	243.0	280.1
Conservation	**19.6**	24,4	38.8	73,2	16.3	22.3
Solar	**64.9**	102.5	39.8	49.2	9,9	8.3
Geothermal					31.4	100.1
Fusion	341.0	385.1	9.4	7.0		
Nuclear Fuel Cycle	68.9	178,8				
Fission Reactors	588.3	774.3				15,4
Environment	81.3	123.1				137.0
Safeguards	16.6	28.1				
Uranium Enrichment	59.5	82,3				
TOTAL	1,287.8	1,770.7	208.0	254.5	446.4	563,3
Percent of Total	66	68	11	**10**	23	22

More than two-thirds of ERDA's energy budget goes toward technologies supporting electrification and there has been a slight increase in emphasis since FY 76. This is consistent with ERDA's ranking of R, D&D technologies which places three electric production technologies in the highest supply priority as "inexhaustible sources for the long-term". Such a budget may not adequately reflect the potential of nonelectric contributions from solar and geothermal sources.

An example is that approximately 20 percent of our energy is used for residential/commercial hot water and space heat which is a low-temperature application for which solar energy is ideally suited. Yet in the solar program approximately one-third of the budget is allocated to direct solar thermal application. That is less than 1 percent of the total ERDA FY 77 budget. Another example is in the Conservation area where approximately 12 percent of the budget is allocated to electrical transmission losses which consume 3 percent of our energy. Only 10 percent of that budget is allocated to conservation of industrial energy which consumes 42 percent. Assuming an equal potential (percentage) for conservation in each case, its allocation of conservation funds would appear to be in imbalance by a factor of 15.

COMPARATIVE SUMMARY

The original issue intended to convey the point that development of non-electric energy technologies should be given greater emphasis. It was not meant that the technologies supporting electric energy should be deemphasized.

ERDA has changed this relative emphasis to a slight degree in terms of the way it characterizes the various technologies it is developing. The principal example is conservation which is placed with the highest ranking R, D&D technologies. There has been an increase in emphasis on non-electric uses of geothermal sources. Beyond these, however, few changes from ERDA-48 can be identified.

There are other potential areas of non-electric technologies which could be more actively pursued. The choices are more nearly alined with current energy demand, more than half of which is for thermal energy and half of the remainder for transportation. Synthetic fluid fuels produced by solar or nuclear energy could be emphasized. The production of hydrogen directly from water by photolysis or moderate-temperature catalytic reactions shows promise, but needs a substantial research program. The direct use of solar and geothermal energy for many moderate-temperature industrial processes is feasible. Biomass fuels from energy "plantations" or from wastes, mentioned in the Plan, could contribute to heating and transportation needs.

Further discussion of this issue is contained in the group of issue papers on Solar, Geothermal, and Advanced Systems.

QUESTIONS

1. Does allocation of a large portion of the ERDA budget to technologies related to electric power generation represent an a priori commitment to electrification versus direct use of thermal energy?
2. Does ERDA plan to establish the rationale for electrification based on cost-benefit, energy analysis, and other assessments?
3. Will the relative social, environmental, and institutional impacts of electrification's approaches be assessed vis-a-vis alternate technologies in various applications?
4. Will assessments of relative reliability and security of electrical systems versus alternative approaches be made to establish the degree of vulnerability to malfunction or sabotage?
5. Will major electrical energy conservation programs be established and promoted?

14. Methodology and Assumptions Used in Developing the R, D&D Plan

ISSUE

The ERDA Plan relies on methodology and assumptions for developing R, D&D priorities that appear to bias the priorities toward high technology and capital-intensive energy supply alternatives and away from end-use technologies.

SUMMARY

The ERDA R, D&D plan makes use of six energy scenarios as essential elements in arriving at R, D&D priorities. An analysis of this approach discloses a number of questionable assumptions which tend to distort the value of various R, D&D options. Included among these assumptions are:

- the scenarios all assume the same set of final demands,
- calculated energy system capital costs include only supply side costs and ignore consumer costs, and
- the scenario emphasizing improved efficiency in end-use assumes increased efficiency will have an effect only up to about 1985, after which exponential growth resumes.

These and other deficiencies tend to minimize the impact of end-use technology R, D&D and bias the choice of research priorities toward the supply sector. Although ERDA appears to recognize this problem, improvements in the application of the methodology are needed to develop the most effective set of energy R, D&D priorities.

COMPARATIVE SUMMARY

ERDA has made substantial changes in the background analysis that supports R, D&D priorities. These changes answer the main point raised in the original issues but also raise new ones.

The main point raised was that, since final demand was held constant across all scenarios, the analysis had an inherent bias toward supply rather than conservation technology. In the new energy analysis, the Brookhaven energy model (used in ERDA-48) is integrated with the Hudson-Jorgenson model, which incorporates price-sensitive demands. Since these two models are the most advanced energy modeling technology, their use cannot be criticized.

Two questions arise, however, when examining their use. First, under what set of assumptions were these models run to generate the results reported in the Plan? Second, how do these results influence the selection of technology priorities? A proposed formal ERDA approach, the Planning, Programing, Budgeting, and Review (PPBR) system is being developed and is described in Chapter V. However, there is little description of how the models will interact with this system,

On pages 96 and 97 of the Plan, the results of these runs with the new integrated model are described. However, we have neither a formal description of how the two models are interfaced nor a list of the assumptions behind the scenarios, The Plan promises later publication of this material but, at present, it is impossible to say anything about either the new modeling work involved in this study (i. e., the bridge between the two models), or about the relevance of the scenarios to the general issue of energy technology priority identification.

It is also not clear how the results influence the eventual selection of priority technologies. Only three scenarios are compared, and only one of them assumes a change in technology such as would be induced by R, D&D activities. It appears that the link between model results and program objectives is largely judgmental. ERDA does propose, earlier in the report, a more formal analytical mechanism for identifying priority technologies, the PPBR. This seems promising, but it is in a very early stage of development. No hard details about the structure of the Strategic Planning model are given. This model will presumably (I) model private-sector innovation activity under many kinds of uncertainty, and (2) perform social benefit cost analysis of new technologies under uncertainty. Both of these tasks constitute unsolved problems in economics, and considerable theoretical and empirical work is needed to produce a usable model. ERDA should supply more information about how this research will be conducted, since the results will surely be controversial.

In summary, the current Plan informally integrates the economic analysis with the technology priority selection. This approach is at present unavoidable since the economics profession has no accepted formal way of performing this task. The proposed integration of these two areas is ambitious and intellectually exciting, but the task is quite large and the results likely to be in dispute. ERDA should publicize its proposed approaches to the problem as soon as possible.

QUESTIONS

1. How were the Hudson-Jorgenson and Brookhaven models linked, and what assumptions led to the results shown on page 97 of the Plan ?
2. How were the results of these simulations used to inform the selection of priority energy technologies for R, D&D support?
3. What are the current plans for and status of the proposed PPBR system, especially with regard to Strategic Planning?

15. ERDA Management Policy

ISSUE

ERDA's present management policies could hinder achievement of its goals.

SUMMARY

Present ERDA management practices have three recognizable drawbacks:

- Internal project management tends to impose excessively detailed restrictions on R, D&D program.
- project management delegated to outside agencies or firms has been awarded to organizations having excessively detailed management structures, with a corresponding loss of ERDA program control.
- Improper balance between systems analysis and proof-of-concept experiments.

COMPARATIVE SUMMARY

Chapter V of the Plan describes the **planning, programming,** Budgeting, and Review (PPBR) system ERDA is developing to discharge its statutory mandates. It consists of normative, strategic, and program planning sequences which yields what ought to be done, how it can be done most effectively, and what will be done. This planning sequence is coupled with environmental planning to yield a set of program priorities which represent preferred solutions to national energy problems and environmentally acceptable energy technology options. This is a difficult and imperfect process with considerable subjective content. Nevertheless, it provides a logical framework for planning and decisionmaking which may be improved with use.

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The PPBR system, when fully developed, could provide management tools to all levels of ERDA, regional offices, regional coordination groups, institutions, contractors, and other agencies, and as well provide better understanding by nonresearch participants and the public. Adequate communication of the management philosophy and procedure may be the vehicle to promote wide understanding, cooperation, and support of ERDA's mission and activities.

The planned analysis of private sector R, D&D is a formidable but potentially valuable undertaking. It is critical, however, that the reciprocal benefits of program planning integration between the public and private sectors be adequately communicated and understood. Since the goals and utilization of R, D&D may be significantly different between the sectors, decisions concerning whether programs should be funded by private versus public funds cannot be based only on considerations of private returns versus public returns. It may not be most effective to restrict Government involvement in R, D&D to the two conditions stated in the Plan: (1) private returns are too low or market barriers too high to induce private sector activity, and (2) public returns are sufficiently high to justify a government role. For example, basic research might not be funded if the stated conditions were applied.

QUESTIONS

1. Does ERDA plan to publish more information on the PPBR, its basis, methodology, experiences in use, and continued evolution?
2. Does ERDA consider the PPBR only for internal use, or will its potential benefits be made more widely available?
3. Will ERDA employ a formalized project selection procedure, and will this procedure be made available as a planning and management tool for others?
4. How will ERDA employ the PPBR system to continually update the Plan?
5. What provision is made for project or program termination decisions?
6. What will be the motivations for voluntary submission of private sector R, D&D information and plans?

16. Net Energy Analysis

ISSUE

Net energy analysis can aid in decisions as to which existing and developing technologies deserve emphasis, but this methodology must be employed with caution.

SUMMARY

Net energy measures energy output relative to energy input, thereby indicating which technologies are likely to be most useful. However, the concept has been very loosely interpreted; as a result, comparisons of numerical estimates can be misleading, due to the use of differing definitions of net energy. The terms and assumptions used in calculations of net energy ratios must, therefore, be carefully defined. In addition, the numerical values of net energy ratios have different implications for different energy technologies, and even for different plant locations. Moreover, net energy may not comprise the most significant criterion in setting energy policies and pursuing national objectives; for example, reduction of oil imports may be more important than the net energy ratio of a coal liquefaction facility. The ERDA Plan does not address any of these considerations, nor does it establish quantitative net energy criteria for the evaluation of energy technologies.

COMPARATIVE SUMMARY

ERDA-76-1, Vol. 1, includes a discussion of net energy analysis—its value, limitations, and current status. A net energy analysis of nuclear power production is included. That the methodology is in an early stage of development and lacks a well-established set of rules and conventions is recognized.

Despite the methodological limitations, ERDA has made use of limited net energy studies to conclude that each of the technologies currently supported is favorable as regards net energy, with the exception of very low grade energy resources. The ERDA Plan concludes that most technologies return four to ten times the external energy expended for energy production, that nuclear electric power returns about four times the external energy required, and that net energy analysis is a supplement to, not a replacement for, other more **widely** used types of analysis. It is also indicated that additional analysis will be performed and reported. No clear indication is given that attempts will be made to improve the methodologies employed in these analyses. The limitations posed could be decreased by adequate study and specification of measurement boundaries, the measurement system, methods of aggregation, and methods for expressing results. The development of improved, applicable methodology should be considered if these analysis aid the program planning and decision process.

The value of the approach is not so much in the elegance or precision of the methodology but rather whether the net energy analysis does in fact aid the program planning and decision process. If it does, then improved methodology development would be indicated.

Although net energy analysis is defined to include "energy expenditures to . . . reduce consumption in a particular demand process, " only the supply aspect of the analysis is discussed. Efforts should be made to include end-use technologies in the analysis so that better comparisons between supply and demand options can be made.

The Plan recognizes the potential importance of net energy analysis; but where, and how, and to what extent it will be employed is unclear.

QUESTIONS

1. What are ERDA's intentions regarding development and use of net energy analysis or possible alternative methods?
2. What is considered to be a satisfactory net energy ratio?
3. Will net energy analysis and related analysis be routinely applied in R, D&D planning and decision processes?

Chapter II

Fossil Energy Issues

FOSSIL ENERGY ISSUES LIST

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1. Fossil Energy Objectives

ISSUE

Almost all of ERDA's programs in fossil energy contain unrealistically optimistic projections of the energy supplies that can be realized from new technologies in the near term.

SUMMARY

ERDA's objectives for 1985 call for 13 to 15 Quads* of fossil energy derived from new technologies. Institutional, environmental, and other nontechnical constraints aside, these objectives cannot possibly be met for the single reason that the time necessary to develop and demonstrate new technologies and to construct a commercial industry based on those technologies exceeds the 10 years between now and 1985. The lack of consistency between ERDA's overall plan in volume I and the specific program projections in volume II raises questions concerning the process by which the objectives were defined and the use served by the objectives in establishing priorities.

COMPARATIVE SUMMARY

Although ERDA has reduced its objectives, the OTA task force believes that even these goals for energy from fossil fuels cannot be realized without some clearly established bridge between R, D&D and commercialization. The ERDA Program does not address this deficiency.

If ERDA is to be effective in meeting short-term needs it will be in one or both of two circumstances. One involves efforts to push technologies which are presently available for testing on a commercial scale (e.g., high-Btu gasification). The other involves introducing existing technologies into new regions (e.g., OCS oil and gas development off the Atlantic coast).

The ERDA program does not address these two commercialization problems in any concrete way. In the cases of both, the issues are not primarily technological. They revolve around questions of social and environmental impacts, Federal-State coordination, capital needs, and regulation. Federal stimulation is required.

*A Quad is defined as 1 Quadrillion Btu's,

How should the Federal Government provide incentives for commercial demonstration? Incentive options may range from tax breaks, to guaranteed loans, to guaranteed prices for fuel output, to Federal funding of capital costs. These various incentive approaches have major implications for the ways in which other issues are resolved.

Local interests want an approach to commercialization which allows them to escape paying the front-end costs for such things as schools, sewers, roads, etc. They also want assurance that serious unexpected costs will be rapidly mitigated or that those who suffer the costs will be assured of adequate compensation. In extreme cases, they want assurance that a decision to test a commercial process will not be an irreversible commitment to development regardless of impacts.

The set of questions tied to commercialization and central to achieving fossil fuel supply objectives are not addressed in the ERDA Program and Budget. Until this is done, the ERDA effort will be seriously flawed.

z. Primary Oil and Gas Recovery

ISSUE

No Federal agency is engaged in a comprehensive research program for primary oil and gas recovery from new sources; the absence of such a program could lead to delays in the development of these resources.

SUMMARY

Exploration and development of oil and gas from new sources, particularly the Outer Continental Shelf, continues to be severely delayed by the lack of planning on the part of the Federal Government. An aggressive ERDA research program would complement industrial efforts. In particular, research is needed on the effects of offshore drilling and on ways of mitigating those which are harmful t o the environment. Congress mandated in Public Law 93-577 Sec. 6(b)(3)(Q) that ERDA engage in a program to explore methods for the prevention and cleanup of marine oil spills, but the scope of ERDA's proposed activities is not clear,

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Gas and Oil Extraction	41.4	70.3	70.3	35.1

COMPARATIVE SUMMARY

The budget is not responsive to the needs of primary oil and gas recovery. There is no indication of any work aimed specifically at improved oil spill clean-up techniques for Outer Continental Shelf operations. OTA specifically identified the need for comprehensive studies aimed at resolving institutional and environmental issues. Neither the ERDA budget nor the Program reflects a sensitivity to this need.

The Program recognizes a strategy that requires advance exploration and extractive techniques both onshore and offshore. It intends to implement the strategy through a program which in part includes research into drilling, exploration, and offshore operations. The budget does not provide for these

activities. A focus on the OCS is new to the FY 77 budget and is responsive to the issue raised in the OTA analysis of last year's plan and program. The response, however, is so limited both in funding and focus that it appears unlikely to make a near-term contribution to overcoming the delays forecast by OTA.

3. Enhanced Oil and Gas Recovery

ISSUE

The proper role for ERDA in enhanced oil and gas recovery is not well defined.

SUMMARY

Enhanced recovery of oil and gas from known reserves holds promise of significantly increasing the supply of these fuels. The need for research and development in the area of enhanced recovery clearly exists, but opinions differ as to the proper role of Government in this endeavor, The present pace of industry R&D could be accelerated by formulation of a detailed workable incentive plan, The present ERDA tertiary recovery program for oil, which involves special joint Government/industry field-pilot testing and demonstration, and the similar research on the recovery of gas from tight formations, will not yield a significant increase in production by 1985. ERDA's projection of an additional annual increase of approximately 6 Quads resulting from enhanced recovery is therefore unrealistic.

BUDGET SUMMARY

The budget information for this issue is contained in Issue 2.

COMPARATIVE SUMMARY

The budget is not responsive to the needs expressed in the issue. It is inadequate to meet the revised goal of 2 Quads of oil and gas by 1985 and 8 Quads by 2000 from enhanced recovery. OTA had earlier identified a need for 80-150 field tests and demonstrations. ERDA's existing and planned tests through this year may total 33. Its initial budget request was more consistent with the effort suggested in the OTA Analysis. The reduction of ERDA's request before submission to Congress places the budget 6 percent below the inadequate funding level of 1976. The ERDA budget justification substantiates that the present budget level will stretch out the demonstration program. This appears difficult to justify for one of the few program areas with a potential for major payoff in the short term. To the level that the oil and gas program is funded, it is devoted to a well-thought-out set of activities in enhanced recovery.

4. Oil Shale Processing

ISSUE

ERDA's priorities for oil shale R, D&D lack a sense of urgency in meeting the Nation's energy supply needs in the near- and mid-terms.

SUMMARY

ERDA's programs for oil shale development are concerned exclusively with in-situ processes, but these processes will make no contribution to liquid fuel supplies in the near-term and have uncertain prospects for the mid-term. The ERDA conclusion that the above ground processing of oil and shale is not economically feasible (or has no need for Federal R, D&D support) has no basis in operating experience. An oil shale demonstration program based on available technologies is needed.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Oil shale	13.7	25.7	25.7	21.1

COMPARATIVE SUMMARY

The ERDA program has been responsive in part to the issue. Two failings were originally identified in the ERDA oil shale development program. First, excessive concentration was placed on the Bureau of Mines horizontal in-situ process. Second, the mining and above ground' retorting processes were excluded from the ERDA program on the basis that the technology was ready for" commercialization by private industry.

The new Program and budget documents were responsive to the in-situ R&D issue. The program appears to have been expanded in scope to include in-situ processes other than the Bureau of Mines approach, although the various processes are not clearly defined nor is the emphasis on each identified.

The budget has not been responsive to the "mining and above ground retorting" issue, perhaps due to the failure of the commercialization program. The

Program discussion did identify the problems of mining and management of spent shale, but the budget indicates that the obstacles to commercial development are not visualized as requiring ERDA assistance.

Local political and public interest groups as well as national environmental interest groups have indicated that until substantive information is available on the problems associated with mining and aboveground retorting of oil shale, they will oppose any proposed commercial facility, wherever located. The OTA Analysis of ERDA-48 identified an ERDA-initiated demonstration facility under Federal control as an appropriate (and indeed perhaps the only) means of obtaining the necessary information without making an irreversible commitment to large-scale development before the consequences are known. That conclusion has not changed, nor has the ERDA response to the problem. There is some discussion of studies on spent shale in the Environment and Safety section of the ERDA program, but this is apparently to be done by other agencies (DOI, EPA) as no budget is indicated within ERDA (E&S) for such efforts.

QUESTIONS

1, Why does ERDA's oil shale program fail to include support for demonstrations of surface retorting technologies?

2. How serious are the problems of water consumption, waste disposal, revegetation, and water contamination for surface retorting processes?

3. How adequate are waste management procedures for the disposal of spent shale?

5. Synthetic Liquid Fuels From Coal

ISSUE

New and existing projects in coal liquefaction must be carried through the pilot and demonstration stages in order to determine what technical problems remain and to establish the oil price levels at which commercial production will occur.

SUMMARY

Justification of the coal liquefaction program rests primarily on the decline in U.S. oil production and on the need for supplies for those uses of liquid fuels for which there is no ready substitute. A successful commercialization program in the 1980's depends on the results of pilot projects. The existing and proposed development programs of ERDA are judged to be of the proper magnitude and in the correct direction. However, the constraints to commercialization, such as the capital investment, construction time, and development of associated mine facilities, imply that the projection by ERDA of 5 Quads per year cannot be overcome by 1985. Thus, ERDA's projection that coal liquefaction will significantly affect fuel supplies by 1985 is unrealistic.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Liquefaction	89.9	99.8	94,8	73,9
Clean Boiler Fuel Demonstration Plant (Construction Project)	20.0	(Not Available]		30.0

COMPARATIVE SUMMARY

The program and the budget is not fully responsive to the projected needs for synthetic fuels by 1985 even though ERDA has revised its projection of 5 Quads per year by then to 3.8 Quads. The Nation's utility and industrial coal-fired boilers remain under sulfur-emission limitations. The supply of flue gas desulfurization equipment and naturally occurring low sulfur coal is inadequate to bring all boilers into compliance. Demonstration and commercial support for a broader scope of processes that produce complying coal-based fuels will be required.

The liquefaction budget reflects a decrease due to lower requirements for the H-coal pilot plant, projects at the Cresaps test center, and support projects.

QUESTIONS

1. How did ERDA arrive at the projection of 3.8 Quads by the year 2000 in light of the budget reduction?
2. What improvement in process efficiency is indicated by second-generation technology and what is the magnitude of improvement needed over first-generation liquefaction processes to make them commercially viable?

6. High-Btu Gasification of Coal

ISSUE

The construction and operation of a first-generation, commercial-sized, high-Btu coal gasification plant is a prerequisite to any decision on a coal-based synthetic natural gas industry.

SUMMARY

A pioneer commercial plant, producing 250 million cubic feet per day of high-Btu gas from coal, can be constructed immediately using current technology. Through its construction and operation, the economic, technical, and operating data necessary to assess the desirability of a coal-based synthetic natural gas industry can be determined. The objective of this construction is to determine whether or not high-Btu synthetic natural gas from coal is economically justifiable as a means of using the Nation's coal reserves to replace the declining supplies of natural gas and oil.

While several companies have shown a strong desire to build a commercial plant, they have not done so because of difficulties in financing such a plant, which will cost at least $1 billion, Incentives of some form, such as loan guarantees or regulatory changes, may have to be provided by the Government if the natural gas industry is to build one of these plants.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
High-Btu Gasification	53.4	55.8	53.3	45.0

COMPARATIVE SUMMARY

ERDA 76-1 and the ERDA Budget request for FY 77 fail to make progress with the crucial issue of high-Btu gasification. ERDA chose to address the problem through the Commercialization Program which failed to receive authorization. No contingency plan is apparent to allow the immediate construction of a first-generation, commercial-sized plant and thus create an impact on the near-term gas supplies. Consequently, ERDA's available strategy is, "The investigation and advancement of technology in the development of improved second-generation processes", This sole strategy cannot achieve the stated objective of promoting "an energy production of 0.5 to 1.0 Quads per year" by 1985 by high-Btu gasification. Such an objective requires the construction of from 6 to 12 plants each with a capacity of 250 million cubic feet per day and each requiring a capitalization of at least $1 billion and taking many years to complete.

The second- and third-generation gasification processes upon which ERDA is concentrating its efforts can improve gasification efficiency. This is important in long-term conservation of resources and in reducing the cost of gas, but it has little to do with contributing to the solution of the Nation's immediate gas supply problem.

proven technology exists that permits the construction of commercial-sized plants, Since less than 25 percent of the cost of gas from such a plant is dependent on the gasification process, technical improvements in this phase of the high-Btu gas process will not fundamentally affect decisions. Anticipating the possibility that its Commercialization program may not materialize, ERDA needs contingency plans to assure that a large commercial gasification plant is built immediately to obtain data on the economic, technical, and operating characteristics. Information from the operation of first-generation plants remain essential for arriving at a judgment as to whether or not this country should proceed with a high-Btu synthetic gas industry to replace our declining reserves of natural gas.

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7. Low-Btu Coal Gasification for Industrial Use

ISSUE

The ERDA program on low-Btu coal gasification does not give attention to the fuel needs of industrial furnaces, kilns, and ovens.

SUMMARY

Many users of natural gas and oil in the industrial sector (ferrous and nonferrous metallurgy, glass, lime, cement, refractories, stills, etc.) could shift to low-Btu gas from coal if suitable gas producers were available, This shift would make an important contribution to the conversion from the use of oil and gas to the use of coal, and it would help to ensure against production cutbacks due to curtailments. There is much room for R, D&D supported by ERDA with a focus on assessment of the potential demand for low-Btu gas by the industrial sector, means for increasing this potential through modification of equipment or operations, and the development of gas producers having performance characteristics suitable for modern industrial use,

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Low-Btu Gasification	24.5	64.0	64.0	33.1

COMPARATIVE SUMMARY

The new program and budget is responsive to this issue and it appears that ERDA has developed an effective program.

8. Mining Technology

ISSUE

Research on underground mining technology is required if coal production is to double in the next 10 years as projected.

SUMMARY

Government and industry are expecting coal production to double to 1.2 billion tons annually by 1985. To help assure that these projections can be met, coal mining R, D&D will require priority support. The productivity per miner in underground mines has decreased in recent years, principally because of improvements in health and safety standards; technological progress has been unable to offset the decline. Improvements in mining technology have the potential for making significant contributions sooner than most R, D&D projects in fossil energy. Although Federal responsibility for coal mining rests with the Bureau of Mines in the Department of the Interior, ERDA has a responsibility to ensure that the research necessary to improve the technology of underground mining of fossil fuel resources is carried out.

BUDGET SUMMARY

No budget indicated.

COMPARATIVE SUMMARY

The ERDA program document recognized extractive technologies and stated that work is underway. No intensive or introspective analysis is indicated or budgeted to assure that the mining, coal preparation, and associated environmental R, D&D activities, regardless of performing agency, are in concert with national or ERDA energy goals. ERDA should schedule and budget for an examination of the Bureau of Mines and Environmental Protection Agency programs and ensure that a balanced program exists.

QUESTIONS

1. What contact has ERDA made with the Bureau of Mines and EPA regarding their coal mining, preparation, and associated environmental programs?
2. What has ERDA's analysis revealed regarding the adequacy, priority, and timeliness of the other agencies programs in meeting the needs of the goals of ERDA's R, D&D programs?

9. Direct Coal Utilization

ISSUE

ERDA's near-term program for direct coal utilization by utilities and industry is narrowly oriented toward fluidized-bed combustion.

SUMMARY

The use of fluidized-bed combustors with sulfur-absorbing beds to provide gas cleanup is unlikely to make a significant contribution in the near-term (to 1985), as predicted by ERDA, due to technological barriers to implementation. Two major coal combustion problems whose resolution would have major near-term impacts are:

1) the technical difficulties of substituting coal for gas and oil in presently existing utility and industry applications (retrofit), and

2) the direct use of coal in a way which will meet environmental requirements.

Other technologies which hold promise of providing solutions to these problems are pulverized fuel firing, and precombustion cleanup; both of these need research and development support in order to enhance their contribution to direct coal utilization by utilities and industry. There is also a need for more basic research in coal chemistry. The present division among three Federal agencies of responsibili-t y for coal cleanup causes variations in the criteria adopted by the agencies as well as in the size and effectiveness of their programs, By assigning the funds and responsibility for managing these programs to one agency, the development of a balanced coal cleanup program could be facilitated, In all areas, the energy program could be set back by a failure on the part of ERDA to recognize the needs of the industrial sector such as the ferrous and nonferrous metal fabrication industries, the glass and ceramics industries, and manufacturers of cement and lime.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division request	FY 77 ERDA Request	FY 77 Request to Congress
Direct Combustion	38.1	85.3	77.3	52.4

COMPARATIVE SUMMARY

Although the budget related to this issue has increased, ERDA's program remains unresponsive. Most of the increase is in the area of fluidized-bed combustion. Expanded research in the fluid bed technology is appropriate because of its midterm potential for economical and environmentally acceptable utilization of coal in industrial and utility systems. However, no near-term direct combustion development work is indicated. Moreover, within the direct combustion program, funds for supporting studies and engineering evaluations have been cut. This area contains the coal-based combustion research, coal-oil slurries work, and other activities which would have broadened the direct coal utilization effort and been more responsive to the issue. ERDA's program appears to be less than responsive to the issue and to near-term energy needs.

QUESTIONS

1. Why aren't the problems of pulverized fuel firing, precombustion cleanup, and basic research in coal combustion chemistry being examined with increased emphasis?
2. Why isn't R, D&D directed to improving the energy generation and environmental problems of existing direct coal utilization equipment ?

10. Low-Btu Gasification, Combined Cycle Powerplants

ISSUE

The present ERDA program to develop integrated low-Btu gasifier, combined cycle powerplants has underestimated their potential.

SUMMARY

In terms of both efficiency and economics, the integrated low-Btu gasifier, gas-turbine/steam-turbine, combined cycle electrical-generating system promises to become one of the best methods of using coal in an environmentally acceptable manner that is likely to be developed. Commercialization of such a system, which would have an overall efficiency of 37 to 38 percent (coal pile to bus bar), should be achievable in the mid to late 1980's if a balanced research and development program is conducted. The ERDA documents give no indication that planning for such a program is taking place.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Low Btu Gasification	24,5	64,0	64.0	33.1
Advanced Power Systems	10.0	35.2	28.2	22,5
Low Btu Demonstration Plant (Construction Project)	8.0	(not available)		12.0

COMPARATIVE SUMMARY

ERDA has responded to the issue by developing a coordinated and integrated program of activities. The original Division and ERDA budget requests as well as the reduced final request to Congress appear consistent with the early potential of this efficient process which provides energy by burning coal in an environmentally acceptable manner. The original budget requests, however, seem to more suitably represent a recognition of priority.

11. Advanced Fossil Fuel Combustion Programs

ISSUE

Frequent evaluation of progress in magnetohydrodynamic (MHD) and other high-efficiency energy R, D&D programs will be necessay to ensure maximum energy yield over the long term.

SUMMARY

The ERDA Direct Coal Utilization program contains both the Direct Combustion (i.e., fluidized bed) and Advanced Power Systems (i.e., gas turbine) programs. MHD research is a separate program, even though MHD is a direct combustion process. Fuel cell R&D is not included in the Fossil Fuel Division of ERDA, though it has more in common with the fossil programs than with the non-

combustion Advanced Division in which it is housed. Relative funding of these programs indicates heavy ERDA emphasis on fluidized bed and MHD, much less emphasis on advanced gas turbine research and an almost total disregard of fuel-cell technology.

A portion of the present ERDA emphasis is well placed, given that fluidized-bed combustors and MHD systems can burn coal directly, while the advanced gas turbine and fuel-cell technologies require liquid or gaseous fuels which over the long term will have to come from coal conversion. Thus, while the advanced gas turbine and fuel-cell technologies can probably be brought to commercial application much sooner than MHD or pressurized fluidized beds, their fuel deployment will depend on progress in the commercialization of synthetic fuels.

In many applications, these technologies are mutually exclusive. Funding and program decisions about each will be affected by progress in the other programs. The MHD program in particular has several major technology hurdles to overcome prior to commercial application using coal. While the MHD program appears to be adequately funded and structured, continuous assessment of progress in MHD development relative to the other technologies will be necessary to ensure that research expenditures yield the maximum benefit. By comparison, fuel-cell technology development deserves more support than it is currently receiving in ERDA. Both recent industrial progress in developing commercially feasible fuel-cell technology and the congressional mandate in Public Law 93-577, Section 6(b)(3)(N), "to commercially demonstrate the use of fuel cells for central station electric power generation" indicate a need for more ERDA attention to fuel-cell technology.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Advanced Power Systems	10.0	35.2	28.2	22.5
Direct Combustion	38,1	85.3	77.3	52.4
Fuel Cells	(Included in Conservation Division)			

COMPARATIVE SUMMARY

The budget was not responsive to needs for fuel-cell work. The original issue indicated that a change in relative emphasis between the MHD, advanced gas turbine, fluidized-bed combustion and fuel cells could yield a significant reduction in the time required to reduce dependence on petroleum and natural gas. Increased emphasis on fuel-cell research and on advanced gas turbines for electric generation from coal was identified as important.

The discussion in ERDA 76 and the budget requests for FY 77 indicate that ERDA has significantly upgraded the gas turbine program. The fuel-cell program, on the other hand, is recognized only rhetorically. That program is improperly housed in the Conservation Division and maybe suffering for that reason. The fuel cell research has more in common within the Fossil Energy Division and, if moved, might receive more attention as a technology for electric generation. As matters now stand, it is not possible even to identify a separate budget allocation for fuel-cell research.

QUESTIONS

1. What will be achieved in fuel cell R, D&D within the FY 76 budget?
2. Why has not more emphasis been placed on fuel-cell work?

12. Interagency Coordination: Coal Cleanup

ISSUE

Coordination between ERDA and other agencies appears to be inadequate in activities relating to research and development of fossil energy. This is particularly evident in coal **cleanup.**

SUMMARY

The responsibility for many programs important to the successful development of increased fossil fuel supplies lies outside ERDA, While this division of responsibility acknowledges the scope and expertise of other agencies, ERDA, in its capacity as lead agency in formulating Federal R, D&D strategy, has a responsibility y to participate in the design, development, and coordination of these outside activities and to evaluate their progress. This is necessary to ensure that no serious omissions or delays occur because of problems in non-ERDA programs on which ERDA programs are dependent either in their development or their implemental ion. Further, when policy decisions are made concerning alternative technologies, it is important that the criteria used in assessing the options do not vary among the decisionmaking agencies, In some cases, a redefinition of responsibilities may be desirable. A case in point is the problem of coal cleaning, Precombustion cleanup research is performed by the Bureau of Mines, during combustion cleanup by ERDA, and postcombustion cleanup by EPA.

BUDGET SUMMARY

Not applicable.

COMPARATIVE SUMMARY

The ERDA program document identifies R, D&D being conducted on coal mining, coal preparation, and associated environmental consequences. However, it is impossible to determine if they have addressed the issue and are achieving an appropriate coordinated interagency program. There is no way to determine the degree of ERDA participation in the design, development, and coordination of outside activities or of ERDA evaluation of other agencies' progress consistent with ERDA's interdependent program requirements.

QUESTIONS

1. What coordinating activities has ERDA undertaken with other agencies' programs with interdependent ramifications?
2. What analysis of the total system from mine face, preparation, transportation, combustion and conversion, to end use has ERDA undertaken?
3. What prescription of work has ERDA developed to guide outside agencies in performing work consistent with the needs of ERDA's interdependent R, D&D?

13. Environmental, Social, and Political Impacts of Mining

ISSUE

Even if mining technology is adequate to support an expanded use of coal and oil shale in the United States, there are potential obstacles associated with environmental, social, and political impacts of a massive increase in mining.

SUMMARY

A major increase in electricity generation from the direct combustion of coal or the conversion of coal to synthetic gas and liquid fuels at a commercial scale will require a significant expansion of coal extraction. For example, a 250 million cubic feet per day plant for producing pipeline gas from coal will require a coal mine as large as any presently operating in the United States. The plant will consume more coal than is now mined in Utah. An activity of this scope will almost certainly encounter resistance from groups in society that are especially concerned about environmental quality; these groups may have considerable influence at State and local levels. If these concerns are not to become a serious constraint to the use of improved fossil fuel technologies, ERDA must be sure that necessary programs are established to reduce uncertainties about environmental and social impacts and to mitigate serious negative impacts.

COMPARATIVE ANALYSIS

ERDA and private industry are conducting or contemplating a significant range of demonstration or commercial level programs in coal conversion, oil shale, and other fossil fuel activities. Significant concern regarding environmental, social, or institutional matters associated with each activity can be expected among local and national interest groups. These concerns should be anticipated and addressed early by the appropriate agency. To be most effective, the magnitude of the environmental, social, and institutional costs and benefits must be clearly and convincingly expressed at a high level of authority and preferably on site or near the place of the anticipated activity. Theoretical regional and national studies conducted by the laboratories, while necessary, are not fully responsive to the immediate promotional mandate of ERDA. Trained social and environmental scientists working in teams coordinated and supervised at a high level of authority are required. There is no evidence in the new ERDA Program that this approach is being taken, or indeed that the Fossil Division of ERDA has access to the necessary personnel. While the appropriate words appear briefly from place to place in ERDA-76, references to the required funds, staff, and programs do not appear.

QUESTIONS

1. Are the research activities of Federal agencies, other than ERDA, sufficient to avoid future environmental and social constraints on the application of improved fossil fuel technologies?
2. What are the options—and the pros and cons—for accommodating the concerns of States about potential negative environmental and social impacts of an expansion of coal and oil-shale mining?
3. How large a community must be established to build and operate a commercial-sized synthetic fuel plant and its associated mining activities?
4. How many trained personnel in the social and environmental sciences will be required to accomplish the work defined in the ERDA Program? What is ERDA's present staff size in these disciplines?

14. Manpower

ISSUE

ERDA's program for massive expansion of the use of coal will require far more trained personnel at various levels than can naturally be expected to enter those sectors of the labor market.

SUMMARY

ERDA estimates of increased coal production will require a significant increase in the number of underground coal miners, including first-line supervisory personnel and coal mining engineers. The fluctuating production levels of the coal mining industry over the last 25 years has resulted in a current work force composed principally of miners over 50 or under 30 years of age. Simultaneously, advanced mining techniques and machinery impose a requirement for more education and special training. Coal research and mining engineering programs at the university level are few and thinly staffed. Significantly more faculty are needed to expand and multiply these programs. The development of gasification and liquefaction plants will also increase demand for both university-trained professionals and for subprofessionals with special skills. Failure to support the development of the necessary manpower pool in these and other areas requiring critical skills could result in failure to achieve the goals which ERDA has set, even if the technology and other required inputs are available.

BUDGET SUMMARY

The budget request treating this issue is contained within the Advanced Research and Support Technology subprogram. No explicit amount can be identified.

COMPARATIVE SUMMARY

ERDA has acknowledged the need for professional manpower training and declares satisfaction of this need as a principal objective of its university-based research activities. There are no efforts described, however, to deal with the need for personnel in mining and equipment operation areas or those skills needed in construction and operation of synthetic fuel plants. Although treating part of the problem, ERDA has not effectively responded to this issue.

In related efforts, the Mine Enforcement and Safety Administration (MESA) has training programs focusing on strengthening health and safety factors in mining. The training is designed primarily for mine foremen. The Government program in total does not appear responsive enough to the requirements of the national energy objectives,

QUESTIONS

1. What role should ERDA play in developing the manpower required for coal mining and related equipment operation to meet ERDA's goals for expansion of coal use?
2. What special skills are critical to the SUC- cess of the proposed fossil fuel programs, and how many trained personnel will be needed?
3. What information is available concerning the ability of existing professional and trade educational facilities to provide the necessary trained personnel?
4. What impact will other energy programs have on manpower available for the fossil fuel industries?

15. Transportation Systems

ISSUE

The application of fossil fuel technology research will require improved transportation systems in the United States.

SUMMARY

A shift from the use of crude oil and natural gas, imported or domestic, to the use of coal and synthetic fuel products from coal will make heavy demands on existing transportation systems. The rail network, which moves most of the Nation's coal, will be especially affected. In order to avoid major constraints on the application of improved fossil fuel technologies, ERDA needs to anticipate the commodity movements that may be required and to assure that necessary additions to or changes in present transportation systems are brought about.

BUDGET SUMMARY

No budget can be identified.

COMPARATIVE SUMMARY

There is no indication in the revised Plan that ERDA has addressed the issue nor analyzed the questions that were posed and restated below. Many users of coal have found that they are inaccessible to rapid-unit train shipment due to the poor track maintenance that seems to prevail in many important energy regions of the Nation. ERDA should assume responsibility for fuel transportation studies, recommend actions required of other agencies, and provide for budget support of its own responsibilities.

QUESTIONS

1. What are the interregional transportation requirements of ERDA's scenarios in volume 1, and how do they compare with the present capacities of transportation networks?
2. In ERDA's opinion, what are the prospects for an increased use of coal slurry pipelines?
3. To what extent are the needed changes in transportation capabilities a problem of Federal regulatory policy rather than a problem of technology development?
4. What portion of the current railroad system can handle unit trains at high speed? How do they relate to source and users of coal?

16. Water Availability

ISSUE

ERDA has not established a systems-oriented study of water availability related to its energy program.

SUMMARY

ERDA has defined programs for extensive development of U.S. coal resources, for oil shale, and for increased electrification as part of its overall strategy for supply of energy in the United States. These programs all imply a greatly increased demand for water, in terms of both withdrawal and consumption. When these programs are viewed in the context of the total ERDA program, including nuclear and geothermal energy programs, it is apparent that the availability of water to supply commercial level energy production activities is uncertain, especially in the fossil fuel area. A large percentage of the fossil fuel development programs relate to the use of low-grade coal, generation of low-Btu gas, processing of oil shale and other activities which involve fuel sources or product streams which are not economically transportable, These activities may be located primarily in the resource-rich but water-short Northern Great Plains and Colorado River Basins, There is no evidence in the ERDA Plan of any coordinated water-resource planning activity to facilitate the implementation of the technologies for fossil energy production which ERDA has defined as critical to future energy supply.

BUDGET SUMMARY

No budget can be identified.

COMPARATIVE SUMMARY

ERDA 76-1 recognizes the importance of assessing the water resources of this country particularly as they impact on the development of fossil energy reserves. Water assessment programs are outlined in discussions both of Fossil Energy and of Environmental Research. However, since most of the Government research on water resources is conducted through the U.S. Geological Survey and the Water Resources Council, this issue is not indicated in ERDA's budget. It appears that consideration is now being given to this issue in the development of coal and oil shale in the Western States. No detail as to the role ERDA plays with respect to water resources is apparent. Neither is it obvious that ERDA considers the availability and use of water in its assessments of alternative strategies for meeting energy objectives.

Chapter III

Nuclear Issues

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15. **Fuel Recycle .********** 95**

Fission fuel recycling capability is needed for the orderly development of nuclear power.

16. **Public Understanding 97**

Public understanding of the energy problem, and especially of the nuclear option, receives minor emphasis in the ERDA Program.

17. **Controlled Fusion 98**

Great care must be exercised to ensure that the ERDA-controlled fusion program does not expand at a rate so fast that proper attention is not given to the different physics problems of controlled fusion and that development of new concepts is not prematurely abandoned.

18. **Technologies for Fusion 100**

New technologies, which will be critical to fusion's successful development through the **1980's,** require a long time to develop and will require rapidly increasing effort with time.

1. Standardization

ISSUE

The present procedure for the design, construction, and licensing of a nuclear powerplant is time-consuming, inefficient, and costly. An ERDA-supported standardization program could alleviate these difficulties.

SUMMARY

At present, virtually every nuclear powerplant is custom designed and built by a combination of suppliers. This procedure leads to very complex interfaces between the various suppliers, the utility, and the NRC. The incomplete status of the design at the time the construction permit is issued (conditioned upon the resolution of incomplete design features) and the changing regulatory requirements result in many design changes, imposition of retrofitted systems, delays, and cost increases. Standardization is a potential solution that is not feasible in the present environment of fragmented responsibility and rapidly changing regulatory requirements.

ERDA could support the development of a standardized design of a complete nuclear powerplant for which the NRC would issue a "license to manufacture. " Participation by all concerned parties would ensure a high-quality design. The licensing review of the utility's application would be limited to site-related issues and would require only a small fraction of the present licensing time and cost.

BUDGET SUMMARY

The budget for standardization activities is provided in the "Plant Design and Construction Technology" subsection of Light-Water Reactor Technology. Budget history tables do not provide a sufficiently fine breakdown to trace the relevant suggested budget from ERDA division through OMB. The LWR technology program budget is shown below.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
LWR Technology	4.0	51.9	51.9	12.5
Plant design & Construction Technology (Budget Outlay)	1 .15	[Not Available)		5.5

Although it cannot be determined what fraction of these funds will be used for standardization activities, the proposed budget indicates the possibility for substantially increased effort.

COMPARATIVE SUMMARY

The issue of standardization of nuclear powerplants has not been addressed in ERDA-76-1, However, the lesser (but significant) issue of standardization of selected plant systems and procedures is included under Plant Design and Construction Technology, A significant fraction of this program should be concerned with standardization of components, systems and design because of the potentially favorable impact upon reliability and safety. This action would be consistent with NRC's encouragement of NSSS vendors and architect-engineers to submit standardized safety analyses for their most commonly purchased NSSS's and designs.

QUESTIONS

1. Is ERDA willing to consider participation in a program to promote standardized nuclear powerplant design and construction and what form would this participation take?

2. Are there significant antitrust issues or other difficulties involved in specifying brands of pumps, valves, control systems, instruments, etc., or designs which clearly favor one supplier over another?

3. What are the advantages of standardization over present procedures if the latter were implemented more expeditiously? What is the evidence that standardization will actually reduce costs?

2. Performance and Reliability

ISSUE

Problems relating to the performance and reliability of light-water reactors have received insufficient attention since the AEC ceased nonsafety light-water reactor R&D.

SUMMARY

Until the late 1960's, substantial governmental research work was carried out on light-water-cooled nuclear power reactors. At that time, the AEC decided that LWR'S had reached commercial status area. Following that decision, a number of problems developed. First, the nuclear industry has been slow to see the need for and to initiate extensive IWD efforts of its own. Second, increases in reactor power levels greater than those warranted by existing technology resulted in component performance and reliability problems. Third, continuous AEC tightening of safety-related design criteria and operating restrictions over the past 6 to 8 years has resulted in economic penalties and reduction of plant operating flexibility, With respect to the first two problems, it is noted with approval that ERDA is planning to renew governmental support of R&D aimed **at** improving LWR performance and reliability. The third problem would seem to be NRC's responsibility. However, it is questionable whether NRC has adequate incentive for doing research to optimize the balance between costs and safety. Furthermore, it has little incentive to develop improved safety concepts or systems so long as it considers its primary responsibilities to the review of proposed systems for adequacy. The ERDA LWR safety program **can serve** both **to control** the costs of safety systems and reduce the unknown factors in safety-related areas, thereby possibly-increasing safety margins and reducing public fear.

BUDGET SUMMARY

Each of the five subsections of the LWR Technology section of the budget pertain to Performance and Reliability. The history of requests for this section is presented below.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	Division Request	ERDA Request	Request to Congress
LWR Technology	**4.0**	**51.9**	**51.9**	**12.5**

COMPARATIVE SUMMARY

This should be one of the high, short-term priority efforts within the Fission Reactors Program, although we would not expect the appropriation for it to exceed a few percent (perhaps 10 percent) of the Fission Reactors budget. This is because other program elements, notably the LMFBR Program, are at the stage of maximum funding requirements. Nevertheless, the LWR's must carry the nuclear power load for the next two decades. While the existing safety features of these reactors reduce the risk to the health and safety of the public to low levels, it appears that potential improvements in design and manufacture could improve reliability and safety. Such improvements would enhance both the usefulness and the acceptability of LWR's in our electric power system. ERDA has undertaken to provide assistance in this effort.

It is of concern, however, that the LWR Technology Program is still in the early stages of definition. The program description is couched in general terms, and there does not appear to have been much progress since July 1975, despite the fact that the last half of 1975 was to have been used to develop a detailed program plan. Several important program elements are now being identified. If this initial effort is expanded, the program may yet attain its goals.

There may be difficult problems of equity in this undertaking. Some suppliers may benefit more than others. Such questions should be resolved and a balanced LWR Technology Program developed if these reactors are to provide their full benefits to the American public at a level of risk that is generally acknowledged to be acceptable.

QUESTIONS

1. How can ERDA provide assistance without altering the competitive balance among suppliers?
2. How will the components and systems to be improved be selected?

3. Floating Nuclear Powerplants

ISSUE

Floating nuclear powerplants (FNP's) offer potential improvements in LWR licensing and construction, but implementation is in doubt.

SUMMARY

FNP's are commercially available, although none have yet been built. After several years of design and sales effort, only four units have been sold to one utility, and all four of these units were recently delayed from the 1979-86 period to the 1984-90 time period. As a result, the supplier is in financial difficulty. If this company fails, the FNP, which represents a major step forward in standardization, will be eliminated for the foreseeable future as an option in meeting the Nation's energy generation needs.

The FNP is to be built in a factory setting favorable to rapid, high-quality construction and controlled costs. The plant design is to be approved by NRC prior to the issuance of a "license to manufacture"; hence, a utility has only to license the site. Indeed, the concurrent construction of the plant and the licensing and preparation of the site significantly reduces the time to install FNP's.

The present reservations about FNP's among utilities concern the licensability y of the plant and site, and the performance of the plant upon completion. ERDA should consider aiding utilities in the 1icensing process and guaranteeing operating performance if the reactor vessel melt-through problem can be satisfactorily resolved.

BUDGET SUMMARY

No budget has been identified for this activity.

COMPARATIVE SUMMARY

The subject of ERDA support for floating nuclear powerplants is not addressed in ERDA 76-1. This would indicate that ERDA has no present plans to encourage the FNP concept as one of the methods of supporting standardization and its potential benefits.

Major assistance probably is not required since the manufacturer is proceeding with construction plans, but many serious problems remain. The benefits of the concept are sufficiently great that FNP's could constitute a large proportion of future nuclear construction if the initial difficulties can be surmounted. Recent utility analyses indicate that the cost for a 2-unit plant sited at a lagoon could be $500 million to $1 billion less than that for a land-based, 2-unit

plant of comparable size due to the assembly line construction of the FNP and the parallel construction of the plant and site, Such savings, however, are contingent upon the licensability and the reliable operation of the plants. The consequences of "being wrong" in deciding on FNP's are so large that utilities so far have chosen the more expensive, but less speculative, conventional nuclear route. ERDA activity to encourage early resolution of the technical, environmental, licensing, and financial risks could serve to assure the early availability of the advantages of FNP's.

QUESTIONS

1. Are the licensing questions of FNP's so different from those of land-based plants that a utility committed to nuclear power would not accept the risk of delays and additional costs to resolve the issues involved?
2. Are there any reasons that an FNP would not be expected to reach rated power or be restricted to less than rated power by NRC, i.e., the question of the ice condenser experience as well as the upper head injection?

4. Helium-Cooled Reactors—Converters and Breeders

ISSUE

Helium-cooled reactors have some potential advantages not offered by water- or sodium-cooled plants, yet have a relatively low priority in ERDA's program.

SUMMARY

The HTGR has never been accorded the degree of AEC support enjoyed by LWR's, but private and foreign development have brought it to the point where it could become a significant factor. The HTGR and its potential successor, the very high temperature reactor (VHTR), can be used to generate electricity at much higher efficiencies (up to 50 percent) than LWR's, but they may have even greater potential for producing industrial process heat. In addition, they would extend uranium resources and possibly present more easily managed safety and safeguards problems, although the spent fuel safeguards advantage is somewhat counterbalanced by the need to protect the clean fuel. The HTGR, however, is less developed than LWR's, thus presenting cost, performance, and licensing uncertainties.

The GCFR has been viewed as a backup to the LMFBR. It may, however, have sufficient advantages to warrant concurrent development. The breeding ratio is about 1.4, somewhat better than the LMFBR. The thermal efficiency is higher than the LMFBR, and the capital cost could turn out to be lower since the system is inherently simpler. There exist, however, serious uncertainties regarding the loss

of coolant accident, since the power density is higher than the HTGR and the core heat capacity is lower, resulting in a faster temperature rise,

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Thermal Reactors	14.8	25,8	15.6	15.6
Fast Breeder Reactors	6.2	15.3	7.8	7.8
Reactor Safety	4.3	6.6	6.6	5.3

COMPARATIVE SUMMARY

The High-Temperature Gas Reactor (HTGR) appears to have sufficient advantages over LWR's to justify keeping it available as an option. Private industry, however, has found immediate deployment impractical and rapid development beyond its means. In view of uncertainties in the industrial commitment to these reactors, it may, therefore, be appropriate for ERDA to carry the program at about its present level until the industrial position becomes clearer. This level is probably not sufficient to assure development on a reasonable time frame, even with full industrial participation. A significantly higher level of Federal support will be needed to ensure success of the program even on the time scale envisioned by ERDA, i.e., operation of an essentially commercial reactor by the later 1980's. Since this is close to the expected commercialization period for the LMFBR, the resource conservation rationale for the HTGR loses much of its force.

The budget for HTGR fuel-cycle R, D&D (Issue Paper 15) is slightly greater than that for the HTGR itself. This appears to be out of proportion.

Continued ERDA development of direct cycle HTGR's and VHTR's for high-temperature process heat may not be justifiable if industry should abandon development of the **steam cycle HTGR. This** aspect of the ERDA program **(at** present only a contingency) may not be realistic. Major review of the Federal role in supporting HTGR technology will soon become necessary. The ERDA program provides for such major decision points within the next 12 to 18 months.

The Gas-Cooled Fast Reactor (GCFR) program is continued as a backup to the LMFBR. The program is presently in a program definition and technology development phase. A decision whether or not to proceed with a demonstration reactor project is expected in about 3 years. The present program and budget appear to be consistent with that goal. Since this program is also heavily dependent on HTGR technology, continuation may become unrealistic if the HTGR is dropped.

QUESTIONS

1. Will ERDA consider developing the HTGR now that funding is drastically lowered by the private sector?
2. Will development of the GCFR be continued if the HTGR is dropped?

15. Liquid Metal Fast Breeder Reactor

ISSUE

The liquid metal fast breeder reactor (LMFBR) has great potential as an "inexhaustible" long-term energy source, but it poses serious technological and societal problems.

SUMMARY

A successful LMFBR could provide the bulk of the electricity for the United States for millennia at a competitive price. The U-238 which would be used in the LMFBR is readily available and is otherwise useless. Much of the technology has already been demonstrated here and abroad during the past 25 years. Advocates believe that the LMFBR will be an attractive energy source, both economically and environmentally, and that a delay in the present schedule would cause the dissipation of expertise in the development program and probably would lead to a stronger ultimate demand for fossil fuel. In addition, some form of a breeder will be vital if fusion is to be a major source of energy in the twenty-first century, and the LMFBR is the most advanced and promising of the various alternatives.

Opponents of the present plan argue that a year or two delay would make possible a better design, that electric forecasts and uranium reserves do not require the LMFBR on an expedited schedule, that proper safeguards for plutonium will be impossible to design and implement, that plutonium toxicity is not well enough understood, that large technological and economic uncertainties remain, that there will be preferable alternatives, and that proceeding with the Clinch River demonstration will commit the United States so strongly to the LMFBR that it would be commercialized even if it turned out to be a bad choice.

BUDGET SUMMARY

SUMMARY TABLE
(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Base Program	191.0	267.0	240.2	227.2
Clinch River	107.0	237.6	237.6	237.6
Reactor Safety	46.0	70,5	70.5	54.4
Advanced Funds	14.5	17.5	17.5	15.5
Total	358.5	592.6	565.8	534.8

COMPARATIVE SUMMARY

The program and budget seem appropriate to the task of producing an LMFBR. The base program R, D&D is developing the information necessary to support the design of LMFBR's. The design of the Clinch River demonstration plant is well underway. Reactor safety studies should eventually resolve principal safety issues.

Questions as to the overall cost and schedule of the program have been less satisfactorily addressed. The CRBR cost estimate has recently risen to $1.9 billion (about $3000/kWe for construction costs) and this can be expected to rise further if additional licensing delays are encountered. If the slowdown in construction of light water reactors continues, need for the LMFBR will be postponed because of the lowered demand for uranium. If rapid LWR growth does not resume soon, and uranium resources live up to ERDA's expectations, a delay of several years could be tolerated, If high-grade ore is depleted faster than presently projected, the LMFBR might be useful on an expedited schedule. Activities that could reduce the costs of the CRBR include redesign of the plant with cost control a primary parameter, and a reduction in the program emphasis on building an entire breeder support industry. This latter point seems particularly appropriate now that ERDA has redefined the CRBR as an R, D&D project only. Increased use of foreign technology could also prove helpful in cost reductions. International cooperation is mentioned in ERDA 76-1, but it is not obvious that it will be used constructively. Recent reports of lower than expected breeding ratios in the European breeders emphasize the importance of cooperation in order to avoid potential problems.

QUESTIONS

1. What steps will ERDA take to resolve the principal safety issues relating to the LMFBR? On what time scale are these issues expected to be resolved, if proposed

facilities and programs are completed satisfactorily and on schedule? Does this schedule mesh with ERDA's proposed schedule for developing designs for commercial LMFBR's and for initiating construction of near-commercial breeder be made?

2. To what extent is ERDA investigating the possibility of a thorium cycle LMFBR?

3. When will a decision on proceeding with the near-commercial breeder be made?

6. Light-Water Breeder Reactor

ISSUE

The light-water breeder reactor (LWBR) concept has several advantages, but the need for it is questionable.

SUMMARY

The LWBR is the only breeder reactor now being seriously pursued by the United States that uses thorium rather than uranium as its primary fuel. The technology of the LWBR is based on that of the main line light-water reactor; the original idea of the LWBR is that it would afford an all but inexhaustible source of energy yet would require relatively little development, About **$25** million per year has been spent on this concept for the past 9 years, and a demonstration LWBR is expected to operate in the pressurized water reactor vessel at Shippingport, Pa., by 1976. If a 1,000 MWe LWBR over 30 years requires as little as 1,500 tons of uranium, rather than the 3,000 to 5,000 required of other reactors, it could become a serious contributor to the nuclear energy programs, yet in the ERDA nuclear program there seems to be no mention of LWBR actually carrying some of the nuclear load at any time, and utilities have shown little interest in the concept.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Light-Water Breeder Reactor	39,5	47$0	41.0	37.0

COMPARATIVE SUMMARY

The ERDA-76 program for the LWBR represents a continuation of previous activities with one major exception. There is now added an Advanced Water Breeder Applications (AWBA) project "which is directed toward assisting U.S. industry in the evaluation and application of the technology developed and confirmed in the Light-Water Breeder (LWBR) Program to existing and future water reactor plants". This addition appears to respond to the question raised in the original OTA analysis: "What measures does ERDA intend to take to make LWBR technology more accessible to possible users of this reactor type?" No detail of AWBA is given. It is impossible, therefore, to judge how seriously AWBA is viewed by ERDA. There is still no evidence that LWBR is being factored into future planning of the U.S. energy system. This might imply that, despite AWBA, planners at ERDA are not counting on LWBR in the near term.

QUESTIONS

1. Why is LWBR not mentioned in ERDA projections of future nuclear mixes?
2. At what uranium price and rate of deployment does the LWBR look attractive?
3. What plans are there for incorporating developments in this program into existing type LWR cores (e.g., improved conversion ratios).

7. Molten Salt Breeder Reactor

ISSUE

Support for the molten salt breeder reactor (MSBR) development program is small compared to other reactors and maybe insufficient to permit evacuation within a reasonable time period.

SUMMARY

The MSBR program is presented by ERDA as a potential backup for solid fuel breeder reactors. It uses an inherently different nuclear technology, and hence provides technological insurance. Even if fast breeder reactors prove to be commercially successful and environmentally acceptable, the MSBR, based on thorium rather than uranium, would enlarge the options available for future energy systems and offer substantial advantages such as more easily managed safety and safeguards problems. There are unique problems associated with the development of the MSBR, however, which must be solved.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Molten Salt Breeder Reactor	3.3	9.5	4,3	0

COMPARATIVE SUMMARY

Termination of this program appears to have been decided without the benefit of the technical information that was to have been obtained from the program outlined in ERDA-48. That program was judged in the previous OTA review to be marginal for obtaining the needed information, The division request of $9.5 million for FY 77 is probably the minimum to realistically keep the option open.

The demise of this program is unfortunate as it deprives the country of an alternate approach to breeding (and hence to a major long-term energy source) which presents quite different technical solutions to many of the problems of nuclear energy. For example, with the MSBR, fuel-recycle facilities are automatically decentralized and collocated with the reactors. In addition, more options are available for the safeguarding of fuel, and reactor safety appears to be a less significant issue than with the LMFBR.

QUESTIONS

1. On what basis has ERDA abandoned the Molten Salt Breeder Reactor?
2. Will the MSBR be revived if the gas-cooled reactors are dropped or the LWBR proves unsatisfactory?
3. What studies have been made of the advantages of the unique system characteristics of the MSBR, particularly those relating to safeguards and reactor safety?
4. Given that ultimate success of the breeder program is of major importance to the Nation's energy future, to what degree has the assurance of success been reduced by loss of this option?
5. What level of funding would be required to maintain the MSBR Program as a realistic alternative to the Fast Breeder Reactor Program, so that commercial deployment of MSBR's could be undertaken by the end of the century, if needed?

8. Nuclear Environmental Effects

ISSUE

There is a continuing need for the evaluation of the environmental effects associated with nuclear energy sources.

SUMMARY

In the establishment of biomedical and environmental research priorities, ERDA has not identified clearly the continuing efforts needed in the assessment of environmental issues associated with nuclear-based technology. These efforts must be maintained on long-term studies of radionuclide accumulations and recycling in the aquatic and terrestrial environments. Other programs that should receive increased attention are concerned with reprocessing facility releases and impact/recovery studies of accidental releases from reprocessing facilities and reactors to local or regional areas.

BUDGET SUMMARY

SUMMARY TABLE
(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Nuclear Portion of Biomedical & Environmental Research (BER) (Budget Outlays)	60.3	(Not Available)		58.4
Operational Safety R&D (most of the OMB request to Congress is for nuclear-related R&D)	6.9	15.7	12.1	7,7
Nuclear R&D Portion of Environmental Control Technology (Budget Outlays)	Approx. 9.2	(Not Available)		Approx. 10.2
Reactor* Safety	0	39.6	34.6	33.3

*Note, The Reactor Safety Program is not new; it was funded by NRC in FY 76.

COMPARATIVE SUMMARY

ERDA 76-1 Volume 2 and the budget figures show a continuing increase in the emphasis on the non-nuclear sector of the Environmental Research Program. This is reasonable because nuclear environmental and health hazards are probably better understood than those from other sources. Although it is entirely appropriate to strengthen the fossil power environmental program, the question could be asked if it is appropriate to reduce the Nuclear Environmental Program after accounting for inflation. From FY 76 to FY 77, inflation will have decreased the nuclear portion of the Biomedical and Environmental Research Program by at least 15 percent,

QUESTIONS

1. In order of priority, what are the remaining questions connected with the environmental impact of nuclear energy?
2. How does ERDA evaluate the economic consequence of accidental releases that would restrict agricultural operations?

9. Plutonium Toxicity

ISSUE

The toxicity of plutonium may pose a serious threat to a plutonium-based nuclear option, such as the LMFBR or plutonium recycle in light-water reactors.

SUMMARY

Suggestions have been made recently that plutonium may be much more hazardous than had been previously believed to be the case. Though these claims have been specifically denied by the British Medical Council, ERDA scientists, and many other scientists and scientific groups, the issue remains a lively one requiring a more definitive resolution than exists at present.

BUDGET SUMMARY

The budget level, though not explicitly stated, appears to be adequate for the eventual resolution of this issue.

COMPARATIVE SUMMARY

The issue of whether the current radiation protection standards for plutonium and other transuranium elements are adequate is still unresolved. The positions of the ERDA scientists and their critics are unchanged. The EPA, NRC, and the Federal agencies responsible for setting radiation protection standards have yet to rule on the formal petition of the critics to amend the plutonium standard. The EPA, NRC, and the critics appear to be awaiting the final report on the plutonium toxicity issue by an ad hoc committee of the National Academy of Sciences (NAS). The NAS report is in the final review stage and should be available shortly. Final resolution of this issue, contingent on long-term animal studies, is anticipated by **1985.**

It should be noted that our understanding of the physical details of how radiation interacts with living cells is primitive. Little such work is being funded by ERDA.

QUESTION

1. What is the evidence that land contaminated by plutonium can be restored to a usable condition at a reasonable cost?

10. Waste Disposal

ISSUE

Satisfactory handling of nuclear fission wastes appears to be technologically feasible, although it has yet to be demonstrated. Other problems exist, mainly societal and institutional, which greatly influence the nature of the demonstration required.

SUMMARY

Spent fuel discharged from a reactor contains radioactive fission products which must be isolated from the biosphere for approximately 700 years as well as actinide elements (uranium, plutonium, americium, curium, and other heavier elements) which are radioactive for hundreds of thousands of years. Because there are no chemical reprocessing plants currently operating in the United States, spent fuel elements from nuclear powerplants are stored temporarily in water basins at the powerplants. Commercial facilities are being designed and constructed, however, to receive the spent elements and remove almost all of the uranium and plutonium, which can be recycled into new fuel, while the residue must be disposed of in solidified form. Several options for this exist, each with different short- and long-term economic and societal costs and benefits. If the wastes are sequestered

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without further separation, the long-term radioactivity between 700 and about 1,000,000 years of the approximately 1 meter^3 per reactor-year is several times that of natural pitchblende ore; but if diluted to the original volume of mined uranium ore, the radioactivity is less than that of the ore. If the actinide elements are also removed during reprocessing and recycled and "burned out" in the reactor itself, the toxicity after 700 years is essentially negligible thereafter.

Projected costs for almost all the water disposal options are small compared to the total value of associated power produced.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Waste Management Commercial	13.0	104.3	104,3	75.0

COMPARATIVE SUMMARY

The substantial increase in funding for this activity indicates that ERDA is taking the issue seriously. Resolution of the issue (which now appears feasible) will eliminate a major obstacle in the path of nuclear expansion. The FY 77 program appears well balanced and accelerated at about the maximum rate consistent with maintaining high quality. There is no mention, however, of research involving virtually complete actinide separation. The subsequent actinide burnup in reactors is covered with an unspecified budget under the Basic Energy Sciences Program. Since this would essentially eliminate the long-term radioactivity (after 700 years), it would appear to be a potentially valuable area to study. The program confirms ERDA's awareness of the societal and institutional problems involved in waste disposal. It is to be hoped that ERDA addresses these issues as actively as it is the technological issues.

QUESTIONS

1. What reservations does ERDA have concerning the disposal of solid waste in salt formations (as at Carlsbad, New Mexico)?
2. What priority and level of funding does ERDA assign to the actinide burnup plan?
3. What is to be done about the so-called alpha wastes (e.g., plutonium-contaminated tools, gloves, etc.) where the activity-per-unit volume is low, but the volume is so large that total activity is comparable to the high-level wastes?
4. What waste management scheme will ERDA implement if plutonium recycling does not materialize?

11. Safeguards for Nuclear Materials

ISSUE

Safeguards must be adequate to prevent the theft or loss of fission materials, with subsequent clandestine construction of nuclear weapons.

SUMMARY

Only about 20 pounds of reactor grade plutonium oxide, or comparably small quantities of other fissionable materials, are required to make a crude nuclear bomb, Furthermore, the information needed to design and construct nuclear weapons is readily available. Preventing diversion of small amounts is difficult because fissionable material must be processed and handled in multiton quantities annually. Plutonium, which is already produced in large quantities in light-water reactors, is an even larger component of the LMFBR fuel cycle. While it is widely agreed that past safeguards practices have been inadequate, a number of measures are under consideration to improve the safeguarding of nuclear materials in the United States. There are important international aspects to the problem, however, since, once diverted, the materials are rather easily concealed and transported.

BUDGET SUMMARY

SUMMARY TABLES

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Safeguards for Nuclear Materials	13.6	29.8	29,8	25.7

COMPARATIVE SUMMARY

Support for the Nuclear Materials Security and Safeguards subprogram in ERDA is slated to substantially increase between FY 76 and FY 77. ERDA 76-1, Volume 2, and the budget indicate that ERDA is aware of the importance of developing physical safeguard systems and more precise materials inventory systems, ERDA appears to be cooperating with the IAEA, but it is not possible to establish from ERDA 76-1 how extensive this effort is. A good deal of ERDA's R, D&D in physical systems could eventually have application to IAEA systems, even though the R, D&D is at present directed toward domestic application.

On the other hand, ERDA 76-1 does not address several of the broader questions related to nuclear safeguards. The only work to assess the social, industrial, and economic impact of various safeguards options is apparently a projected NRC study, for which no budget level was given. In addition, it is not clear from ERDA 76-1 how NRC and ERDA split up the safeguards work between them, nor how well the results of the one are integrated into the plans of the other. There are apparently no plans to make a comparative assessment of the risks and safeguards costs of different fuel cycles, particularly thorium cycles. Finally, it is not clear how the safeguards assessments will be placed in the broader context of the comparative total environmental, social, and technological impacts of the various large-scale energy generating options, both nuclear and non-nuclear.

QUESTIONS

1. To what extent would the safeguard problems be eased if the entire nuclear power program were shifted from uranium-plutonium to thorium-uranium?
2. What are the implications for safeguards if plutonium recycle in LWR's is further delayed?

12. Siting

ISSUE

Nuclear Regulatory Commission policy changes for siting could influence reactor and supporting system design.

SUMMARY

The Energy Reorganization Act (ERA) of 1974 calls for the Nuclear Regulatory Commission (NRC] to report to the Congress on the clustering of nuclear reactors and supporting facilities in "nuclear parks. " Nuclear parks offer several advantages: easier safeguarding of fissionable material, lower unit construction cost, probably increased safety, and less disruptive construction (since the work force is stable), Disadvantages include higher vulnerability in the event of war, creation of heat islands, and increased expense of transmitting power from the remote site. If nuclear park siting becomes a general practice, certain technical problems would require more serious study and resolution: electrical transmission of extremely large blocks of power; the simplification of transport systems between reactor and chemical plant; the incorporation of interim waste disposal facilities on the nuclear park site; and the design of different reactor systems that are better suited to park siting, Though siting policy and the possibility of nuclear parks is largely the responsibility of NRC, the matter is so vital to the entire future

of the nuclear energy enterprises that ERDA should be strongly involved in the development of the concept from the beginning,

COMPARATIVE SUMMARY

The ERDA-76 program does not respond adequately to the questions related to siting posed by OTA. The NRC study on nuclear energy centers has just been completed but this study was confined to the siting of LWR's. A primary long-term question that could dominate the entire course of nuclear energy development is the siting policy for breeder reactors. Simply stated, should breeder reactors be collocated with their supporting facilities, or should they be dispersed? Hardly any question is more central to the future of the nuclear enterprise than this one; hardly any is more difficult to settle. ERDA should carry out a definitive study of the siting of breeders in self-contained energy centers. The results of these studies ought to be available by FY 78, so that at that time the debate on a national policy for siting breeders can be based on solid information rather than on conjecture.

QUESTIONS

1. If nuclear park siting is required, how would this affect (a) the ERDA safeguards program; (b) the types of reactors ERDA develops; (c) the transport systems ERDA develops; and (d) the climatological effects program of ERDA?
2. Is ERDA planning to examine the social and institutional implications of nuclear parks?
3. What are the implications of confining breeder reactors and their subsystems to nuclear parks?

13. Uranium Resources

ISSUE

The lack of precision in present uranium resource estimates and questions as to the rate of expansion of uranium production capability make resource-related issues difficult to address.

SUMMARY

Since the adequacy of the domestic uranium resource base has an important bearing on ERDA's and utilities' nuclear strategy, and especially on the timetable for breeder reactor development, a much more precise evaluation is needed than in presently available or anticipated, To keep pace with the Nation's energy needs

as projected by ERDA, substantial expansion of domestic uranium production over the next 25 years will be required. This entails long leadtimes, major capital expenditures, and in the relatively near term, large exploration effort and ore-body development. The long time, perhaps 10 years, required for the development of a new mine-mill complex, together with the existence of competing investment opportunities, may require the creation of a relatively low-risk investment climate through loan guarantees, accelerated depreciation regulations, and assured uranium markets. Market prices have increased dramatically during the 1973-75 period from $7 per pound of U_3O_8 to about $30, and there is no reason to expect an early end to the seller's market.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Uranium Resources	16.8	41.3	41,3	31,3

COMPARATIVE SUMMARY

This program is projected to expand rapidly as is appropriate for such a critical subject. The bulk of the increase is in actual field surveys. The present phase consists of an aerial survey. The second phase, a hydrogeochemical and stream-sediment survey, is just getting underway. The next phase starting late FY 76 will be the first actual drilling. The program for identification of reserves appears to be adequately funded to meet a reasonable schedule. Recognition is given to the need for liaison with the private sector. No studies are mentioned of the impacts of dependence on foreign uranium.

QUESTIONS

1. What is ERDA's program for obtaining 2, uranium resource information from the private sector for its data base?

How does ERDA evaluate the impacts of dependence on foreign sources of uranium, exportation of domestic uranium, and participation of foreign interests in domestic resource development.

14. Uranium Enrichment

ISSUE

Expansion of uranium enrichment capacity is required to meet domestic requirements and foreign commitments for LWR and HTGR fuel.

SUMMARY

Enriched uranium fuel is needed in light-water reactors (LWR) and high-temperature gas-cooled reactors (HTGR). The existing ERDA diffusion plants are being upgraded and expanded, but their capacity will be exceeded within a decade if presently contemplated nuclear powerplant construction occurs. ERDA policy calls for development of new production facilities by the private sector, but the financial risks may be too great without some form of Federal economic assurance. Among the risks involved in the financing of new plants is the possibility that new technology, such as the gas centrifuge or laser separation, might render a new diffusion plant obsolete. A related management question concerns the proposal to allow the U-235 content of the enrichment plant by-products material ("tails") to increase, thereby producing increased enriched uranium output at the expense of greater natural uranium input.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
		OPERATING COSTS		
Uranium Production	636.7	822.3	818.3	803.3
Process Development	48.4	75.5	72.5	62,7
Other U-235	8.7	16.3	16.3	16.4
TOTAL	693,8	914.1	907.1	882.4
Advanced (laser)	29.5	50$1	46.1	36.8
Enrichment Revenues	—591 .5	—539. 1	—539.1	—539. 1
TOTAL OPERATING COSTS	131.8	425,1	414.1	380.1

SUMMARY TABLE – Continued

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
		Construction		
Uranium Production	—	521.8	521.8	521.8
Process Development	—	100.0	100.0	100.0
Advanced		15.0	0	0
TOTAL CONSTRUCTION		636.8	621.8	621,8
		Capital		
Uranium Production		17.2	17.2	17.2
Advanced	—	7.0	7.0	7,0
TOTAL CAPITAL		24.2	24.2	24.2
GRAND TOTAL	131.8	1,086.1	1,060.1	1,026.1

COMPARATIVE SUMMARY

ERDA recognizes the need for expansion of the Nation's enrichment capacity. Legislation has been introduced in Congress that would allow transfer of the technology to the private sector. Alternative plans for expansion are being prepared by ERDA. The centrifuge technology is nearing the commercialization stage, and ERDA is negotiating with the private sector. The laser enrichment process is still in the laboratory phase, but an orderly process of development has been proposed. There is no mention of the implications for nuclear weapons proliferation.

QUESTION

1. What are the implications for nuclear weapons proliferation in the advanced enrichment technologies?

15. Fuel Recycle

ISSUE

Fission fuel recycling capability is needed for the orderly development of nuclear power.

SUMMARY

Spent nuclear fuel assemblies still contain much valuable fuel material. The discharged fuel can be reprocessed to recover the usable fuel material, which can then be recycled through a reactor. There are four basic reasons for recycling the fuel: (a) the recycled fuel reduces the demand for new uranium that would have to be mined and refined; (b) recycling, desirable for LWR'S, is an economic necessity for HTGR's, LMFBR's, and other advanced reactor designs; (c) lower power-generating costs should result; (d) the chemical processing which is part of recycling is also an integral part of some of the more promising waste disposal schemes.

Recycling is, however, beset by several problems. First, a reprocessing, a refabrication, and a radioactive waste disposal industry must be constructed and operated. Second, safeguards and transportation must be developed to protect the material adequately. Third, the economic advantage of recycling in LWR's is small at best although the spent fuel still contains material that can produce a large amount of energy.

The central point is whether ERDA's budget is adequate to develop the necessary recycling capability or whether adequate incentives can be provided to industry to provide this capacity.

BUDGET SUMMARY

SUMMARY TABLE
(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 OMB Request
Support of Nuclear Fuel Cycle	35.5	160.5	160.5	56.7
Commercial LWR Reprocessing R&D (Budget Outlay)	7.5	(Not Available)		23.5
LMFBR Reprocessing R&D (Budget Outlay)	**4.0**	(Not Available)		6.8
HTGR Reprocessing R&D	14.6	(Not Available)		15,5
Supporting Services	5.0	(Not Available)		6.0

COMPARATIVE SUMMARY

The large budget increase proposed for LWR reprocessing R, D&D indicates that ERDA is actively pursuing its goal of closing the LWR fuel cycle. The ERDA program states that investigations of certain aspects of the technology, advanced design concepts, operability and maintainability of facilities, and environmental effects will be undertaken so as to minimize the time required for commercial deployment of reprocessing complexes. It is also indicated that if barriers to commercial deployment arise, ERDA will formulate programs to deal with the impediments. In summary it appears that ERDA is responding to the technological deficiencies in LWR reprocessing capabilities while continuing R, D&D on advanced cycle reprocessing in an orderly fashion.

Public acceptance of reprocessing, however, particularly plutonium recycle, may require the resolution of social problems such as the effect on those exposed to an accidental release of plutonium or the impact of an adequate safeguards system. The resources devoted to HTGR reprocessing are harder to justify. ERDA does not anticipate commercial plants starting out until 1990 if at all. Hence, this part of the program seems excessive compared to the HTGR development program.

QUESTIONS

1. How does the retrievable storage of spent fuel elements in geological formations compare with closing the fuel cycle?
2. What must be the price of uranium and plutonium to justify reprocessing including the cost of all expected health, safety, and environmental controls (e.g., krypton-85 capture) required for eventual licensing?
3. What studies are planned on questions of social acceptability in relation to fuel recycle?

16. Public Understanding

ISSUE

Public understanding of the energy problem, and especially of the nuclear option, receives minor emphasis in the ERDA Program.

SUMMARY

The energy problem is complex, and increased efforts must be directed toward better public information programs. Within the past several years, public anxiety, confusion, and doubts have increased, and the energy problem is widely perceived as a "contrived situation, " More effort must be directed toward better understanding of energy options so that well-informed energy decisions can be made by the public. One of ERDA's tasks is to create and encourage ", . , the development of general information to the public on all energy conservation technologies and energy sources. . ." In addition, the ERDA Administrator, in conjunction with the FEA Administrator, is directed to disseminate such information through the use of mass communications, (Section 103.7 of Public Law 93-577.]

BUDGET SUMMARY

Budget provision for Public Understanding is made in the Public Awareness portion of the Program Support Section. The requests are given below.

SUMMARY TABLE
(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 OMB Request
Program Support Public Awareness	2.6	7.1	6.0	3$0

COMPARATIVE SUMMARY

The ERDA budget request for FY 77 indicates that increased efforts were planned to communicate with larger segments of the population through organizations representing cross sections of the public. The increased effort planned in communicating through educational institutions could have provided information to many more people than have been reached by the more specialized past activities. The proposed ERDA activities appear to be responsive to the need for

widespread energy information dissemination. The substantial reduction by OMB (50 percent) will negate ERDA's planned FY 77 improvement.

QUESTION

1. How will the effectiveness of the public awareness programs be judged?

17. Controlled Fusion

ISSUE

Great care must be exercised to ensure that the ERDA-controlled fusion program does not expand at a rate so fast that proper attention is not given to the different physics problems of controlled fusion and that development of new concepts is not prematurely abandoned.

SUMMARY

The advantages of successful fusion power are great; fusion research needs should receive high priority, but success is not yet assured by any future date. For example, it appears necessary to scale present experiments up to larger machines in order to maintain an effective program. While these next generation devices are being conservatively designed, they are still experimental. In addition, even though the science may scale to larger sizes, technological, engineering and economic considerations may or may not permit exploitation of a given concept for practical fusion power,

This uncertainty has two practical consequences. First, since no clear or complete path to fusion power now exists for any fusion concept, and since fusion is one of the few major long-term energy options, no fusion scheme should presently be abandoned unless it can be shown fairly convincingly to be unproductive. Second, in order to establish proper priorities in the face of this uncertainty, a more or less continual assessment of fusion concepts and prospects must be maintained; otherwise the program may evolve into either uncritical support of unfeasible concepts or unwarranted and premature concentration on a single concept.

BUDGET SUMMARY

The budget requests for the controlled fusion program are summarized as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Confinement Systems Development & Technology	68.2	95.5 (see Issue 18)	85.4	80.3
Research	26.2	49,6	43.5	30.7
Reactor Projects	2.2	9.3	9.3	10.8
Total (Magnetic Fusion)	131,6	242.7	218.4	168.0

The budget request to the Congress is 25 percent greater than FY 76. The request appears to commit ERDA even more closely to the tokamak concept and may not allow adequate funding of other devices such as the mirror machine and theta pinch. Indeed, the budget may put pressure on the entire program (including the tokamak) and stretch out the timetable for ERDA to achieve a successful fusion reactor.

COMPARATIVE SUMMARY

The ERDA program document contains a fusion program description which acknowledges the points raised in the issue. The emphasis that will be placed on efforts to implement ERDA's concern on these matters is not clear, however. The financial requirements associated with the start of the large tokamak fusion test reactor project, combined with an increase in the operating budget 31 percent less than the division requested, are already putting pressure on other possibly viable concepts and supporting research. The statement made in the program document to the effect that eventual, practical fusion power can be confidently predicted because of sufficient understanding of the basic physics of magnetic fusion may not be valid, Practical fusion power also depends on technology and engineering advances which are much less well understood.

In this context, there are crucial questions that concern the direction and pace of the fusion program. The principal one is the urgency that the fusion effort is to be given among the various approaches to solving the energy problem. With a given funding level there are a certain set of priorities in the program which evolve over time depending on successes. If the level is increased more attention can be given

to difficult engineering problems, which are presently given a lower priority. This could reduce the time needed to successfully implement controlled fusion as a power source. The level at which fusion is funded will depend on the priority it is given among all supply options. It is important to carefully assess the potential of fusion, in terms of economics, environmental impact, material consumption, and the degree to which the program can be accelerated, so that the most effective funding level can be established.

QUESTIONS

1. Are there budget constraints which limit efforts to assess new and on-going fusion efforts to minimize the possibility of pursuing unproductive fusion concepts (i. e., unlikely to develop into a commercial reactor)?

2. Are the mirror and/or theta pinch confinement systems likely to be pursued at a rate slower than desirable as a result of the need to support the TFTR project coupled with the reduction of the division's budget requests before being sent to Congress?

3. Are there programs underway to determine the maximum rate at which fusion can be implemented as a function of various funding levels?

18. Technologies for Fusion

ISSUE

New technologies, which will be critical to fusion's successful development through the 1980's, requires a long time to develop and will require rapidly increasing effort with time.

SUMMARY

Many critical technological problems relate to more than one fusion concept. Some typical critical areas where much work needs to be done are:

(a) Materials and material combinations resistant to high energy neutron bombardment from the fusion reaction.

(b) Economical storage of large amounts of electrical energy to operate pulsed fusion devices.

(c) Very large superconducting magnetic systems needed for all but laser fusion schemes.

(d) Diffusion of tritium fuel into and out of reactor materials.

BUDGET SUMMARY

The budget requests relevant to this issue are principally as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Development & Technology	31.7	88.3	80.2	46.2

That this portion of the fusion program has grown at a greater rate than the rest of the fusion subprograms reflects the growing importance attached to this aspect of the fusion effort. It should be noted, however, that this subprogram received the largest percentage cut in the Division and ERDA requests of any of the subprograms within the fusion program.

COMPARATIVE SUMMARY

ERDA has responded favorably to this issue through the substantial increase in the budget request. Most of the points raised in the issue have been addressed in the ERDA Program document. There remain specific areas of concern:

1. There appears to be insufficient emphasis on the development of plasma engineering (plasma shaping, pumping, refueling, etc.).
2. The problem of diffusion and recovery of tritium from massive fusion reactor systems may not be receiving adequate attention. It is essential that this problem be resolved early in any reactor development program.
3. There seem to be inadequate systems studies and technology assessment, leading both to (a) early recognition of any promising new fusion confinement geometries, and (b) timely recognition of which fusion concepts have higher or lower probability of being extrapolated to eventual fusion reactors.

The fact that efforts in these areas appear to be lacking seems to be primarily due to budget limitations. It is precisely these kinds of problems that would receive more attention with higher budget levels for the fusion program as indicated in the Issue 17 comparative analysis. There is no doubt that these problems need to be solved before successful implementation of controlled fusion. They have been given a lower priority than problems of confinement and heating and therefore are receiving less emphasis at present, The principal issue that needs to be resolved is whether the potential contribution of fusion can be realized at a significantly earlier date than now envisaged, if the fusion program were to be given a greater sense of urgency, The resolution of this issue will determine the pace at which these important technology programs should be pursued.

QUESTIONS

1. How does ERDA set priorities among the various technology items given the size of the budget requests?
2. What would limit the rate at which these technological problems could be solved if budget requests were not a constraining factor (assuming that it presently is)?

Chapter IV

Solar, Geothermal, and Advanced Systems Issues

72-169 0-76 -8

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1. Setting Criteria for Program Priorities

ISSUE

Decision-point criteria defining measures for evaluating success within a given solar energy program, choices among programs, and readiness for commercialization need to be established, quantified, and justified.

SUMMARY

The ERDA Plan does not treat the important question of how decisions will be made between solar energy technologies, and between solar and other energy options. Criteria are necessary to evaluate, for each program: (1) the projected rewards upon success, (2) the total costs to the public and private sectors, (3) the relative risks of economic or technical failure, and (4) the potential and projected readiness for commercialization. The decision-point criteria, to be applied at regular intervals in this process, must be predetermined by making a number of specific assumptions concerning the potential of all forms of energy generation, whether conventional or advanced. These assumptions need to be continuously evaluated and revised in the light of changing conditions during the course of the program.

BUDGET SUMMARY

No specific budget allocation for this activity is identifiable in the budget documents. Although this function is being performed (see below), it is impossible to tell whether it is being done in Plans and Analysis, in Technology Support and Utilizations, or the subprograms themselves.

COMPARATIVE SUMMARY

In the revised Plan and Program there is little description of any methods or processes for establishing program priorities and decision-point criteria. There are subprograms where mention is made of evaluation criteria, but with little or no detail as to how they were established.

The Solar Energy Program approval document outlines a basic strategy for establishing the research, development, demonstration, and commercialization plan in the Solar Division. This is an iterative process which is designed to establish priorities through comparative analysis, define programs for technology development, carry out development, and phase over to private industry. The present schedule of projects in the solar program will be put through this process for evaluation. The process has not been in operation long enough to determine its effectiveness but it appears to be a positive step in developing a systematic means of setting criteria for program priorities. In this context, the Solar Division states that the planning process, itself, will be continually updated.

QUESTIONS

1. What specific goals will be set (and when) against which to measure your solar and geothermal programs; that is, how will ERDA define success?
2. In the ERDA estimates of the penetration of solar and geothermal technologies into use by the private sector, what costs and cost relationships were assumed for capital, interest rate, discount rate, fuel, and operations and maintenance for the solar and geothermal systems and the conventional systems that they are to replace?
3. How does ERDA make evaluations of various energy technologies which may have to compete for limited developmental funds, such as solar electric and fusion?
4. Has ERDA conducted cost-benefit and risk analyses which might help implement the decisions to accelerate, abandon, or delay available or near-term options, in the expectation that we can make it to the point where the more advanced technologies can adequately supply our needs?

2. Rationale for Funding of High-Risk Projects

ISSUE

It is important that effective mechanisms be developed by which ERDA can make rational decisions on solar energy projects having great potential as future energy sources, but involving large cost outlays, and being subject to major uncertainties in projected costs and/or technologies.

SUMMARY

The Energy Research and Development Administration is undertaking research and development of long-range solar energy projects which offer much promise in the future, but which, because they involve new and relatively unknown technology, suffer high levels of uncertainty.

Examples of such projects are the ocean thermal energy conversion and satellite solar power station programs in solar energy utilization. Although early-phase funding levels are not necessarily very large for these projects prior to reaching the demonstration phase, it is nevertheless very important that a rational method be established to decide: (a) whether or not to initiate the program, (b) at which level to maintain or accelerate it, and (c) when to implement major and costly undertakings such as demonstration **projects.** There appears to be no effective mechanism now being used to make these decisions.

BUDGET SUMMARY

No specific budget allocation for this activity has been identified nor has consideration by appropriate offices in ERDA been established.

In the two high-risk projects specifically identified by OTA in the issue, there are specific figures available for all analytical studies, as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
OTEC, Systems Development and Mission Analysis (Budget Outlays)	0	(Not Available)		$0.58
Space Solar Power Systems (SSPS) (Budget Outlays)	0	(Not Available)		0

In FY 76 there was no mention of any ERDA SSPS program. In FY 77 the program is identified, but with zero budget allocation. Also, there was some informal NASA budget in FY 76. NASA is precluded from having any terrestrial energy budget in FY 77.

COMPARATIVE SUMMARY

There is no indication that ERDA is developing mechanisms for making decisions on high-risk solar energy projects. It is also not clear from the budget and program documents that appropriate risk or cost/benefit analysis methodology is being developed or applied.

Within the subprograms, however, there is some evidence that there has been a response to the OTA issue. The OTEC program considers the need to demonstrate cost-effectiveness of critical components before proceeding, although there is no identifiable basis for ERDA's having doubled the OTEC budget authorizations for FY 77. There is also a mention of the need for "minimal risk" in the design of OTEC plants.

With respect to the space-based solar power system, ERDA did respond to the 0TA issue by establishing a formal program for FY 77, but no basis was given for making this decision. The establishment of a program with no budget allocation (and no possibility for NASA funding of terrestrial solar power research) represents a management inconsistency.

There are no identifiable projects underway (or planned) to develop the necessary decision-making guidelines. The basic issue is still unanswered.

QUESTIONS

1. How does ERDA determine the relative 2. founding levels for long-term, high-risk projects?
2. Does ERDA have a definite "plan" for continual review of these technologies and appropriate mechanisms to factor these analyses into its Program Plan?

3. Resource Availability

ISSUE

The ERDA Plan lacks adequate emphasis on the role that critical resources play in selecting energy alternatives.

SUMMARY

The following major resources are likely to be affected by the various solar energy technologies:

. Water • Land • Materials • Energy
• Capital • Manpower • Air quality.

The ERDA Plan does not appear to have addressed adequately the problem of resource requirements of the various solar energy alternatives. It is essential that in our preoccupation with our current energy shortage we do not divert excessive amounts o f our critical resources into energy production. Therefore, it is clear that integration of these impacts across disciplinary lines within ERDA will minimize the chance for oversight.

BUDGET SUMMARY

No specific budget request for this area has been identified.

COMPARATIVE SUMMARY

No specific program area addresses itself to this vital issue. Some mention is made of capital limitations (the high capital cost of solar components has thus far limited that market demand so that large industrial organizations have not entered the field in a major way) but the issues of land, water, materials, and energy are not addressed as such.

The program element of Technology Support and Utilization includes activities concerned with resource assessment. However, this largely deals with solar and meteorological data, and not the items listed in this issue. The latter are only implied within the Environmental and Resource Assessment category.

Under Solar Photovoltaic Conversion, materials and land requirements are mentioned but studies to examine them are not described.

A study is presently underway in the ERDA Solar Division which will address many of the points raised in the issue although it is not described in the Program and Plan,

4. Organization of ERDA's Research Program

ISSUE

A major concern with ERDA's research effort is that the management distinction between basic and supporting research formerly used in the AEC continues to polarize the sciences from engineering.

SUMMARY

It appears **(ERDA-48,** volume I, p, VIII-11) that the polarized research management policy is being carried over from the AEC into ERDA. The problem with this management policy is that its tendency to isolate scientific and engineering research has not produced innovative advances in technology comparable to those, for example, produced by the pacesetting electronics laboratories where a continuous spectrum of applied and fundamental research has been carried out under the cooperative leadership of scientists and engineers, Energy-oriented research is even more complex since it involves social and institutional problems in addition to the scientific and engineering aspects of advanced-hardware development. Thus, a nonpolarized institutional mechanism is needed if rapid solutions are to be found for these complex energy problems.

Creation of a Solar Energy Research Institute (SERI) represents one of several institutional mechanisms that can be utilized for this purpose, but there is as yet no indication that it will take the necessary interdisciplinary science/engineering form.

BUDGET SUMMARY

See Issue 9 in the Overview Chapter.

COMPARATIVE SUMMARY

Issue 9, in the Overview Chapter extensively discusses ERDA's response to the general issue of ERDA's basic research effort. Here, comments will be confined to the points raised in the issue reproduced above.

The principal concerns were the undesirable separation of science and engineering functions and the lack of interaction with individuals responsible for commercialization and marketing. The new plan has not responded to any of these points and it still appears that the ERDA basic research program does not adequately support the ERDA energy subprograms in many key areas,

An additional concern, is that the current ERDA program statement defines no goals, no strategy, and no plan for coordinating its basic research activities

with other government agencies, other countries, or the private sector, For example, the ERDA program document shows awareness of only one other Federal agency program (that of the Department of Commerce in materials research), implying that no basic research interaction is planned with the several other agencies performing such work.

QUESTIONS

1. What are some of the specific programs of basic materials research that ERDA is support ing? How do they relate to ERDA's mid-term or long-term goals?
2. Is engineering work toward these goals being done in the same laboratory? If so, are the engineering and scientific programs monitored by the same ERDA manager? Do they have a common laboratory leader? If not, what mechanisms have been established to ensure dialogue between the two managers as well as between the engineering and scientific efforts?

5. ERDA Program Management

ISSUE

The use of outside organizations and Federal laboratories by ERDA for some of its program management functions, particularly in the solar area, could produce an ineffective organization.

SUMMARY

Interposing an additional management level in the development of solar energy technology is not likely to be efficient because some of the organizations used by ERDA for this function have not been constrained by cost considerations. Their management and contractual procedures are highly structural and extremely detailed, an approach which may not be appropriate—or cost effective—for the development of new solar energy forms.

Since the new energy technologies are very sensitive to costs, require innovation, and must interface with commercial energy producers (the utilities), ERDA's current reliance on outside management organizations may cause serious problems with program costs and the cost effectiveness of end products.

Furthermore, when ERDA delegates complete control of an entire program or a large part of a program to one of these organizations, it may be too far removed from the actual research planning to maintain its mandated responsibility for the Nation's energy research and development,

BUDGET SUMMARY

The SERI subprogram is the only budget request applicable to this issue,

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
SERI (Budget Outlays)	1.5	(Not Available)		1.0

COMPARATIVE SUMMARY

This issue has not been addressed in the ERDA program. Specific examples of ERDA's lack of response are as follows:

1. Major program responsibility is still being given to national laboratories, risking a loss of program focus.

2. Increasingly, the program is relying upon highly specific project solicitations which tend to preclude the development of unplanned innovative concepts.

3. The program is substantially understaffed – the present ratio being $3.35 million per professional. This makes it extremely difficult to develop an efficient program in this rapidly expanding technology. It is also largely responsible for the above two items. The ERDA personnel requests for FY 76 and FY 77 were 99 and 130 while ceilings submitted to Congress were 75 and 80.

4. Actions to establish SERI as mandated by Congress have slipped considerably from the schedule submitted last year. This is reflected in the budget request which is 33 percent below the FY 76 figure.

The above points indicate that the dangers raised in the issue are still very real and appear to be increasing.

6. Support for Study of Decentralized Solar Electrical Generation

ISSUE

The study of the decentralized production of electricity has received limited attention, especially because it involves the potential utilization of waste heat.

SUMMARY

One chief advantage of solar energy is its relatively uniform distribution. Extensive electrical distribution systems are thereby rendered unnecessary, or at least can be appreciably smaller. The small distances between generator and user, which are possible with decentralized production, make utilization of the waste heat more feasible than with central station plants. Since future principal energy shortages are predicted mainly in the oil and gas supply areas, which have recently supplied the bulk of the country's thermal energy needs, there is added reason for extensive study of onsite production. The technology for solar onsite systems is at least as well in hand as central station technologies. Fossil-fired total energy systems are in use in many European countries. With photovoltaics especially there are no major economies of scale as larger electrical generating stations are contemplated.

The present ERDA organization establishes the study of decentralized electrical production as a small part of the central station solar thermal branch, A recent (and first) total energy symposium had almost no discussion of photovoltaic total energy systems, and very little on the problems of distributing the waste heat. The major issue of electric utility acceptance has received little attention.

The first major U.S. solar electrical system has recently been installed at Sandia, following an extensive survey under AEC sponsorship. No other electrical-generating facility will be ready for several years according to present ERDA plans, despite the relative simplicity of the technology and the availability y of all components. The reason for this delay in construction is not clear,

BUDGET SUMMARY

There are no explicit budget requests for decentralized solar electric systems. The projects that can be identified are in the following budget categories:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Solar Thermal Conversion (Budget Outlays)	3.0	(Not Available)		7,2
Farm & Rural Systems (Budget Outlays)	**0.9**	(Not Available)		1.2

The entire budget for these programs is directed toward hardware development. Total energy projects appear in the Conservation Research and Technology (CONRT) subprogram but no budget requests can be identified. Coordination between them and the Solar Program is discussed in the CONRT program approval document.

COMPARATIVE SUMMARY

This issue is partly addressed in the context of total energy systems discussed in the Solar Thermal Conversion subprogram, and of rural home and agriculture applications in the Wind Energy Conversion subprogram. Moderate scale photovoltaic, but not small scale, demonstrations are also proposed. Throughout the solar electric programs there is no discussion of studies to investigate the problems and benefits of decentralized systems, or of comparative assessments of central versus decentralized solar electric generation. The one statement dealing with the nontechnical problems of decentralized generation does not indicate any type of comparative analysis. Further, no studies are listed to deal with these suggested institutional problems. This issue is receiving some technical consideration but nontechnological concerns are not being addressed by ERDA.

No program is specifically defined for the “total energy” concept, i.e., use of thermal output as can be achieved in a decentralized system. It must still be concluded that there is not much emphasis placed on decentralized solar electric plants with the potential for both electrical and thermal outputs. The reason for this lack of emphasis may be the absence of a simple program office, and the diversified approach now employed may inhibit completion of a coordinated attack on this approach to solar utilization. It should also be noted that total energy research is now ongoing in the Projects Branch (of the Solar Electric Division) as well as in the Conservation Division of ERDA and at the Department of Housing and Urban Development (HUD).

QUESTIONS

1. Is the present ERDA solar organization (which separates electrical and thermal areas) appropriate for undertaking a project which combines several technologies in a system?
2. What coordination is now occurring with the ERDA Conservation Division which is responsible for fossil-fired total energy systems?
3. Why is no further immediate solar thermal hardware deployment planned, in light of the successful Sandia work, and the rapid cost improvements already obtained?
4. Why has the photovoltaic program not been more active in placing experimental total energy systems into the field (the only one is the very early "Solar One" at the University of Delaware, which was in large part funded locally)?

7. Emphasis on Electric Energy Systems

ISSUE

The program goals of the ERDA Plan appear to emphasize development of electric power systems to the point where the full potential of solar heating is not recognized, and the possibility of obtaining synthetic fuels from solar energy is largely ignored.

SUMMARY

Preoccupation with coal, solar, and nuclear energy for electric power generation has produced too narrow a view of the alternatives for utilizat ion of our energy sources and, in selected areas, would commit the Nation—perhaps prematurely-to a massive change in the infrastructure for energy delivery and utilization. Much of the Nation's thermal end-use energy requirements over the long term may be met by those energy sources, particularly solar and geothermal, that are well suited to supplying thermal energy directly.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress "
Direct Thermal	28.5	87.3	72.3	37.0
Biomass	3.8	6.6	6.6	**3,0**
Total (Nonelectric)	32,3	93,9	78.9	**40,0**
Solar Electric	43,6	112,5	99.3	67.5
Ratio: Electric Nonelectric		1.35	**1,20**	**1,69**

As the figures indicate, in terms of operating expenses ERDA attempted to bring two components of the Solar Program into better balance. However, the request to Congress has reversed this and enhanced the imbalance with respect to FY 76.

COMPARATIVE SUMMARY

The original issue had as its original objective the upgrading of direct solar thermal energy to a status equivalent to that of solar electric as an inexhaustible energy source for the long term. There was no intention to imply a reemphasis of solar electric.

In the revised Program, no programs are described for obtaining synthetic fuels from solar, other than through biomass or electrolysis by way of OTEC to produce hydrogen. Nonelectric uses of wind energy are mentioned and a sizable effort for nonelectric uses of geothermal energy is described (see Issue 16). However, no shift in emphasis is implied. In fact, the original ERDA 48 position that thermal applications were only valid as a mid-term stopgap is still reflected in the FY 77 budget document (page SE/D-1).

QUESTIONS

1. Since the production of heat from electricity is expensive and about half of the end-use energy consumption in the United States is in the form of heat, why hasn't more emphasis been placed on utilizing solar energy sources for direct thermal end-use requirements?

z. What are ERDA's plans for the development of technologies which produce synthetic fuels from solar and nuclear energies? How does ERDA's basic research program reflect these plans?

8. Emphasis on Solar Heating and Cooling of Buildings

ISSUE

The importance of solar heating and cooling relative to other programs is not recognized in the ERDA Plan.

SUMMARY

There is abundant evidence that solar heating and cooling applications offer a larger potential for energy savings in the immediate and near term (to 1985], and beyond this to 2000, than any other solar applications. Indeed, ERDA's figures (ERDA-48, volume I, table 6-1) verify this statement; yet, solar heating and cooling is categorized at the third level of priorities as an "under-used mid-term technology" and one which may "provide an energy 'margin' in the event of R, D&D failure in other areas. " These statements in the ERDA document project a significant potential for solar heating and cooling, yet underemphasize the development and actual impact of solar heating and cooling on our energy economy.

BUDGET SUMMARY

The budget information for this issue is given with Issue 7. It is apparent that ERDA attempted to place greater relative emphasis on solar heating and cooling (both in the buildings and the agriculture and industrial process areas) but was reversed when the budget was submitted to Congress. In particular, ERDA requested an increase of 41 percent in the agriculture and industrial process heat category whereas the budget request to Congress showed a 32-percent decrease from FY 76.

COMPARATIVE SUMMARY

The new program has partially recognized the long-term potential of solar heating and cooling; however in the Budget Estimate for FY 77,, on Page SE/D-1, only electric application of solar is recognized for long-term inexhaustible potential by the statement ". . . the 'Highest Priority Supply' category includes Solar Electric Applications under 'Inexhaustible' sources for the long term". It is further felt that the projections for energy displacement by solar in the solar heating and cooling sector are underestimated in the executive summary for the years 1985 and 2000. Presently approximately 25 percent of our energy is expended in water heating, space heating, and space cooling. By the year 2000 with total energy consumption estimated to be 140 Quads with 25 percent residential/commercial consumption, the projected 2 Quads means that less than 6 percent of the residential/commercial requirements in these areas will be met

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by solar thermal methods. Since it is now economically practical to provide solar water and space heating in many areas, solar heating and cooling projections should be more optimistic. It is felt that the predictions for solar contribution for heating and cooling requirements are pessimistic, while some of the other projections (i.e., ocean thermal, which has doubled since ERDA-48, Volume 2) are overly optimistic,

QUESTIONS

1. How does ERDA reconcile the low projections for solar heating and cooling compared to solar electric in the light of the present relative state of development of direct solar thermal and solar electric applications?
2. How does ERDA justify lower 1985 goals than those put forward by FEA in Project Independence as being attainable with an "accelerated government program"?

9. Purposes of the Solar Heating and Cooling Demonstration Program

ISSUE

The size, scope, and purposes of the solar heating and cooling demonstration program need specific definition.

SUMMARY

The prime objective of the demonstration program should be **to** accelerate consumer acceptance of solar energy as a heat source so that substantial fuel savings can be achieved at a considerable earlier date than would otherwise result. The plans set forth in ERDA-48 do not appear to be oriented to achieve these purposes. In particular they do not appear to place as much emphasis on demonstration programs as The Solar Heating and Cooling Demonstration Act (Public Law 93-409) does.

The manufacture and sale of solar energy systems for heating buildings and hot water has commenced on a small scale, while solar cooling is still in the development stage. Principal immediate emphasis in solar cooling should be research, development, and testing, whereas the thrust in the solar space and water heating effort should be demonstration.

BUDGET SUMMARY

The trend in funding of the solar heating and cooling demonstration programs can be seen as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Commercial Demonstration (Budget Outlays)	12,6	(Not Available)		12.2
Residential Demonstration (Budget Outlays)	**4.0**	(Not Available)		6.3
Development in Support (Budget Outlays)	4.5	(Not Available)		7.8
Total	21.1			26.3

The 25 percent increase in requests for demonstration is less than that for the solar heating and cooling subprogram as a whole. It is likely that this will not permit the increase in emphasis on demonstration suggested in the issue summary. In particular it is still unclear whether the objectives of the Solar Heating and Cooling Demonstration Act (Public Law 93-409) can be met.

COMPARATIVE SUMMARY

The purposes of the Solar Heating and Cooling Demonstration Program have been better formulated in the new program. However, it should be emphasized in the document that the demonstration of solar water and space heating is directed toward the public sector stressing the economic viability and availability of systems and components, rather than the need to prove the practicality of these applications. It is stated that, "The nationwide Federal demonstration program will illustrate the technical feasibility of solar heating and cooling equipment and investigate the economic viability of near-term applications of such equipment. " The differences between heating and cooling should be better delineated. Solar water heating is economical nationwide while solar heating is economical in many regions of the United States. It is stated in the document that additional development of cooling systems is definitely warranted and needs support.

A significant portion of the Solar Heating and Cooling Program deals with the demonstration program. The ERDA Program now recognizes the mandate of PL 93-409 and has increased the number of residential demonstration units from

110 to zoo (see budget, page SE/D4&5). However, this is still considered to be below an adequate number of units. A better awareness of the purpose of the act is given in the implementation section which discusses market development projects (see also budget, page SE/D-Z), including examination of non-technical questions. While ERDA's primary goal in the demonstration program still appears to be hardware demonstration, a noticeable shift toward one of encouraging consumer markets is evident.

10. Role of User Incentives in Solar Heating and Cooling of Buildings

ISSUE

A well-structured user incentive program would accelerate the solar heating and cooling of buildings (SHACOB) and accelerate development of the infrastructure to support large-scale applications.

SUMMARY

Properly structured user incentives are perceived as having the potential to substantially accelerate the growth of solar energy utilization. Although incentive programs should probably not be developed nor administered by ERDA, they have potential impact on ERDA's program. The important interfaces and distinctions between the various Federal agencies with regard to solar incentive responsibilities have not been delineated in ERDA-48.

Incentives may be looked upon as temporary. Economics are less favorable for solar heating and cooling systems now than they will be in the long term because: (a) mass production savings in producing solar equipment have not yet been attained, (b) cost reduction engineering accompanying volume production remains to be done, and (c) it is probable that costs of competing fossil-based energy forms will be higher relative to solar in the near future.

However, there is a clear need for equitable treatment of the solar energy user. The individual user, turned energy producer. does not now receive the benefits of investment tax credits, depreciation allowances, depletion allowances, and other incentives to corporate producers of fossil energy forms. No incentive recognizes his contribution to society in reducing pollution, preserving fossil resources or reducing the Nation's dependence upon imported oil.

BUDGET SUMMARY

No projects dealing with incentives are described in the Solar Heating and Cooling Program. The Technology Utilization and Information Dissemination subprogram calls for a request of $700,000 (Budget Outlay). The budget document

does not indicate that any of these funds will be used for projects concerned with incentives. Reductions of the ERDA budget requests before being submitted to Congress appear to affect these efforts.

According to the Solar Division, the cutbacks could include the elimination of programs which would initiate a regional solar information capability, incentive and barriers programs, a solar code for state implementation and development of comprehensive regional strategies, including cost-shared training and demonstration programs. In addition, publications, conferences, exhibits, films, and newsletters will be cut back.

COMPARATIVE SUMMARY

The issue of incentives is addressed throughout the Solar Heating and Cooling program with several studies on this and related subjects suggested.

The range of these studies is not precisely defined and it is not clear whether ERDA will consider the role of the solar energy user as an energy producer. Although mention of incentives is made in the strategy section in the Solar Heating and Cooling Program, nothing is mentioned in the implementation section about specific projects. It appears that ERDA has only slightly increased its activities dealing with the incentive issue.

In the Federal role section of the Program a "Need for governmental action (including State and local) to encourage use of solar energy" has been indicated. However, no structure is proposed to carry this out. The plan does not indicate ERDA's role nor the extent other agencies (especially FEA) should be involved in providing proper user incentives.

When ERDA mentions "incentives" no specification is made as to whether industrial or consumer incentives or both types are intended. ERDA's emphasis on industrial commercialization makes one think the former is the case. Little mention is made of the possibility of small businesses playing a major role in solar heating and cooling.

QUESTIONS

1. Why, as stated in ERDA-23, does ERDA propose to delay study of incentive programs until 1979?
2. What agency, or agencies, should develop a structured incentive program, and what should be the nature of ERDA's interaction with it?
3. What safeguards can be developed to protect the small business and consumer in his investments — credits or deductions for energy-conserving commercial and residential solar expenditures?

11. Standards for the Measurement of Solar Heating and Cooling Equipment Performance

ISSUE

For consumer protection, standards are needed to provide comparative performance ratings, to allow comparison of durability, and assure proper installation of solar equipment.

SUMMARY

In order for the consumer or builder to intelligently compare solar equipment produced by competing manufacturers, it is necessary that all equipment be rated according to realistic and consistent standards, In order for the owner, builder, or architect to properly size equipment to the load, the equipment performance as determined from a standard measurement procedure must be specified. At present, many equipment manufacturers omit rating data or rate their own equipment in different terms so that it is very difficult to make comparisons or to size installations. Thus, it appears that standards are required not to protect the consumer. It is particularly appropriate that proposed incentive programs be tied to standards so as to discourage fraudulent or mistaken practices.

BUDGET SUMMARY

No specific budget request for this area has been identified,

COMPARATIVE SUMMARY

In the area of heating and cooling, the issue of standards has been considered by ERDA within the residential and commercial demonstration programs (see budget, pg. SE/D-4&5). This deals with the questions of warranty development, system performance standards, system certification processes, performance criteria, manuals of practice, etc. However, no systematic consideration of standards to guide owners, builders, and architects, and to protect consumers is described in the program. Therefore, it is not clear how ERDA will treat this question in promoting commercialization of solar heating and cooling. Further, there is no discussion of the connection between standards and incentives.

ERDA is working closely with the National Bureau of Standards to develop standards in several aspects of solar heating and cooling. These will lead to the development of minimum property standards for solar heating and cooling equipment. In this context NBS is developing collector and storage test codes. Also, NASA/Lewis is providing valuable service in testing collectors.

QUESTIONS

1. What are ERDA and/or other agencies doing to accelerate development of adequate standards?
2. Is it intended that standards be written so that they consciously avoid stifling innovation?
3. Will future standards be so written as to enable the consumer to make his own comparisons on life-cycle cost effectiveness and energy conservation potential?

12. Impact of Solar Energy on Utility Peak Demand

ISSUE

Onsite solar energy sources (most immediately solar heating and cooling), unless developed properly, will cause a significant utility peak demand problem.

SUMMARY

The economics of solar heating and cooling show that much of a building's energy requirements can be met by solar energy. The remainder must be supplied from an auxiliary source—for example, electricity or natural gas from a public utility or a stored onsite source, such as fuel oil. As the use of solar energy becomes more extensive, it may contribute to an increased peak demand problem for the utilities (particularly the electric utilities), because such energy supply systems could need auxiliary power simultaneously. Expensive standby electricity rates for solar energy uses could result. If auxiliary energy is supplied by a public utility, the solar energy systems should be carefully designed to minimize regional standby capacity. An alternative is onsite, selfcontained auxiliary energy storage (such as fuel oil), which makes the consumer independent of the utility or which will ensure his utilization of auxiliary sources at offpeak times.

BUDGET SUMMARY

There is only one explicit request directed to this issue. Under Hybrid Systems (Solar Thermal Conversion) $425,000 (Budget Outlay) has been requested to determine the overall impact on a utility grid.

COMPARATIVE SUMMARY

The potential impact of solar energy on utility peak demand may seriously affect the development and growth of the various solar technologies. The ERDA

program has better reflected the importance of this aspect of solar technology development and implementation under "Status" and "Problems" of the various program areas:

1. Agricultural and Industrial Process Heat — problem recognized;
2. Wind Energy Systems — problem recognized;
3. Solar Photovoltaic — problem recognized;
4. Solar Thermal Conversion — initiated program and problems recognized;
5. Hybrid Power Plants — problem recognized.

In addition, it is stated that ''innovative techniques will be needed to solve the problem of load management and peak demand."

Thus it appears that ERDA is addressing this important problem but in a segmented way. It would be better approached through a structured program which is interfaced with the Electric Energy Systems and Conservation Research and Technology subprograms of the Conservation Division, with an identifiable budget for this area.

QUESTIONS

1. At what levels of implementation (percentage of solar homes) will a peak demand problem for utilities become serious?
2. What standby energy and\or capacity (peak and offpeak) rate structuring can be anticipated or recommended in the future for buildings using onsite solar energy?
3. What methods appear attractive for self-contained onsite supplementary energy storage?
4. How best can an onsite solar energy system be designed to minimize the impact on the utility system while simultaneously maximizing the benefit to the solar consumer?
5. What coordination is planned with the Conservation Division of ERDA for storage schemes uniquely applicable to solar systems?

13. Biomass Energy and Food

ISSUE

Biomass energy generation may conflict with food production.

SUMMARY

In a world in which hunger is an ever-present concern, the use of arable land in the U.S. explicitly for energy production may be seen as irresponsible and may conflict with our own capacity to produce food. For this reason, it is important that the biomass program should not have an adverse effect on the production of food, either in fact or perception.

A variety of development strategies are available to satisfy this requirement, including:

- Improved plant genetics to emphasize biomass production with low water and fertilizer demands
- Changes in cattle-feeding methods and a reduction in the United States demand for beef
- Development of lands unsuitable for food crops
- Integrated food and energy production systems.

Unless such approaches are successful [and are also perceived as being successful), a large-scale biomass energy program will probably be unacceptable.

BUDGET SUMMARY

The biomass subprogram budget is as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Biomass	4.5	8.1	8.1	4,3

Under the FY 77 Biomass subprogram, work is contemplated in 3 major areas: 1) terrestrial and marine biomass; z) agricultural and forest residue programs; and 3) research and development work directed toward optimizing plant growth for energy yield.

The reduction of ERDA and Division requests delays most of the alternative crop studies as well as the construction of the wood plantation pilot plant. Equipment ordering for the crop residue and feedlot pilot plants will be deferred and R, D&D in optimizing plant growth will be postponed.

COMPARATIVE SUMMARY

The ERDA Program states "These studies will address trade-offs resulting from using land for food or fiber production, recreation purposes, or for energy production in addition to surveying pertinent economic, technical, and environmental issues, " While the general thrust of biomass energy generation conflicting with food production was included in the above statement, the problems of changing cattle-feeding methods, reduced U.S. demand for beef, integration of food and energy production systems, and improved plant genetics to emphasize biomass production with low water and fertilizer demands were not mentioned. One is not certain of the importance of these components in ERDA's Biomass program planning.

QUESTIONS

1. Have studies been made of the comparable economic value of organic materials when used for food, lumber, and energy?
2. What support is ERDA giving to genetic studies for the improvement or development of plants with high energy yield — and with low water and nutrient demands?
3. Is ERDA undertaking studies or research to ensure the long-term productivity of land used for intensive agriculture or tree-farming?

14. Legal and Institutional Constraints in Geothermal Energy

ISSUE

Geothermal energy implementation is not so much constrained by technology as by legal and institutional restraints.

SUMMARY

Federal, State, and local agencies are inexperienced and inconsistent in dealing with leasing, exploration permits, and licensing of geothermal resources. For example, geothermal resources are variously classified as water, minerals, or fossil fuels by regulatory agencies. Furthermore, unlike oil and gas exploration, extensive 1icensing and environmental analyses are required prior to exploratory drilling.

ERDA sponsorship of innovative legal and institutional studies may determine the best methods of resolving these and similar problems to ensure the orderly development of the resource.

BUDGET SUMMARY

These refer to the Environmental Control and Institutional Studies subprogram, The budget requests pertaining to this issue (Economic Policy and Planning Analysis) are within this subprogram.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Environmental Control and Institutional Studies	3.9	8.9	7.4	4.8
Economic Policy and Planning Analysis (Budget Outlay)	**1.42**	(Not Available)		1.50

Additional funds are included within the technology subprograms (geopressured resources, advanced technology applications) but cannot be separated.

The $80,000 increase alone appears to be too low to implement the substantially increased effort described by ERDA in its programs.

COMPARATIVE SUMMARY

It is clear that ERDA has taken a major step in addressing this issue in their program document, The points raised by this issue form an important part of the strategy and implementation of the Geothermal Program. It is a part of the overall program strategy, it is considered as a key institutional problem and it is a major portion of the overall program implementation effort. An entire subprogram is devoted to studies in this area along with key environmental problems. The principal problem appears to be whether there are sufficient funds requested within each of the technology programs where this issue is applicable.

QUESTIONS

1. What are the principal institutional and legal impediments ERDA has identified to expedite the leasing and exploration of potential geothermal resources?

2. What policies can ERDA recommend to deal with these constraints?

3. Are there sufficient increases in the budget to continue an effective program in the area of legal and institutional constraints?

15. Environmental Constraints on Geothermal Energy Development

ISSUE

Environmental problems, which have been inadequately stressed by ERDA, can place constraints on the potential development of geothermal energy resources.

SUMMARY

Geothermal energy development will have environmental constraints because of the disposal of gaseous and liquid pollutants, the potential for large-scale subsidence, and the potential for fault movement and earthquake generation, The implemental ion document of ERDA's Energy Plan does not adequately define the necessary environmental evaluation problem for geothermal development.

BUDGET SUMMARY

The requests for funds in environmental matters occur in three subprograms: Environmental Control and Institutional Studies, Hydrothermal Technology Applications, and Advanced Technology Applications. For the latter, specific environmental figures are not available.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 OMB Request
Environmental Studies (Budget Outlay)	**0.9**	(Not Available)		2.8

The above figures represent a substantial increase from FY 76 figures and indicate that ERDA has addressed this issue well, at least within the context of this subprogram. The lack of specific budget information on environmental efforts within the other two subprograms does not permit **any** analysis of their effectiveness,

COMPARATIVE SUMMARY

ERDA has devoted considerable attention to this issue within the program. In both the overall strategy and implementation within the subprograms (Hydrothermal Technology Applications and Advanced Technology Applications), environmental problems and control technologies are considered. The Demonstration Projects subprogram will consider environmental problems as a part of this effort. In addition, the Environmental Control and Institutional Studies subprogram provides for a major effort concerning this issue.

All of the points raised in the issue (subsidence fault movement, disposal of gaseous and liquid pollutants) are specifically considered within the program areas. The principal remaining question is the extent to which each of these points are receiving funding and whether this funding is adequate to deal with the problems.

QUESTIONS

1. What environmental problems has ERDA 2, identified which could seriously hinder geothermal development?
2. Does ERDA have sufficient funding within the final requests to Congress to effectively deal with these problems?

16. Nonelectric Uses of Geothermal Energy and Geothermal Goals

ISSUE

The ability to approach ERDA's presently unrealistic 1985 goal for geothermal utilization will require a substantial increase in emphasis on nonelectric use.

SUMMARY

A realistic maximum prediction for electric generation by 1985 is 4,000 Megawatts of Electric Power (MWe). To reach the objective of 10,000 to 15,000 Megawatts (MW) stated by ERDA, however, will require a large amount of nonelectrical uses, Since a significant portion of the resource base is low temperature, the most important use of geothermal resources in the United States may be for nonelectric applications, Indeed, the principal impact of geothermal resources on worldwide energy needs, to date, has been through nonelectric u t ilizat ion.

The thermal energy from a geothermal reservoir can be used to replace electricity or fossil fuels in low-grade industrial heat applications and space heating. Geothermal water, because of its temperature, can also be used for solution mining, agricultural enhancement, and mariculture.

Of additional consideration in reaching the ERDA goal is the development of the number of wells needed for production and reinfection of 10,000 MW of geothermal fluids. This will require a significant fraction of the drilling rigs, material, and manpower presently being used for oil and gas exploration.

The ERDA Plan may not have assigned enough significance to the potentially important nonelectric uses of geothermal energy. By doing so, ERDA could much more realistically expect to reach their 1985 goals of geothermal utilization.

BUDGET SUMMARY

The requests for funds on development of nonelectric use of geothermal energy occur in two subprograms: Engineering Research and Development (Utilization Technology) and Advanced Technology Applications (Moderate Temperature Resources). In both cases requests which specifically relate to nonelectric use activities are not available. For reference, however, the funding for the total subprograms is given along with that for the areas within the subprogram that concern nonelectric utilization.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Engineering Research & Development	10.6	20.8	20.8	11.5
Utilization Technology (Budget Outlay)	6.2	(Not Available)		**7.0**
Advanced Technology	6.9	14.6	10.6	10.1
Moderate Temperature Resources (Budget Outlay)	5.6	(Not Available)		**4.0**

The effectiveness of the nonelectric utilization depends heavily on the funds allocated to this area within each of the subprograms. Again, this determination is not directly possible. In this connection, the Geothermal Program personnel indicate that the reduction of their requests before they were submitted to Congress will have the effect of slowing development of one of the projects which has nonelectric utilization aspects.

COMPARATIVE SUMMARY

In general ERDA has taken significant steps in addressing this issue, although some of the points raised have still not been considered, They have revised their estimates of geothermal's contribution downward to 6000 MW of electricity by 1985 and 0.1 quad per year of nonelectric use. The former is still greater than the limit suggested in the issue but is much closer to that estimate of 4000 MW. ERDA is considering to a greater extent the nonelectric contribution of geothermal resources. Projects are identified within the Hydrothermal Technology subprogram to develop such uses. Studies are to be initiated to identify and assess other nonelectric applications leading to field experiments for industrial use. Further, one of the hydrothermal demonstration projects is being considered for nonelectric use. There are also studies described to investigate the nonelectric use potential of hot dry rock. It is clear ERDA has increased its activities in this area. However, its goal of 0.1 Quad/year is short of that suggested in the issue of 0.3 Quad/year by 1985.

ERDA makes no mention, however, of the large requirement for drilling rigs needed to reach their goals and the potential conflict with oil and gas exploration needs. Some consideration of this problem may fall within the drilling technology activities but this is not discussed explicitly.

QUESTIONS

1. How did ERDA arrive at its estimate of geothermal's contribution for nonelectric uses of oil-Quad per year by 1985?

2. Does ERDA consider the availability of drilling rigs to be a serious problem in reaching its 1985 utilization goals?

3. Would a person or firm who was interested in using geothermal process heat be eligible for the Federal Geothermal Loan Guarantee Program?

4. Does ERDA feel that as part of its dissemination and implementation function it should encourage the location or relocation of industries using low-grade heat near geothermal resources? Would the loan program apply?

17. Variability of Geothermal Reservoirs

ISSUE

Each geothermal reservoir has its own unique characteristics, which affect the research strategy and demonstration portion of the ERDA program.

SUMMARY

Each geothermal reservoir has unique parameters, such as size, fluid characteristics, and location. Furthermore, the nature of its energy source (heat) requires that it be used at or near where it is found. Thus, the design of equipment and energy conversion technology must be tailored to the characteristics of the fluid in each reservoir; consequently, different power cycles may be used. If the ERDA pilot/demonstration program were to concentrate on a single type of power cycle, multiple demonstrations of the same cycle would not aid the **expansion and** use of this resource. Furthermore, the most useful cycle for a given reservoir may be determined by the availability of cooling water near the well site. Thus, the equip men t and power conversion research strategy will have to consider a wide variety o f possible utilization systems to ensure high efficiency.

BUDGET SUMMARY

Requests for R, D&D funds to account for the variability of Geothermal Reservoirs fall into three subprograms. These include Engineering Research and Development (utilization technology), Resource Exploration and Assessment (reservoir assessment technology), and Hydrothermal Technology Applications (demonstration projects). The amounts in these areas for activities specifically addressing this issue are not given. The budget requests for the entire first and third subprograms have been given previously (Issue 16). Presented here are the requests for the second subprogram.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Resource Exploration and Assessment	3,6	16.0	12,0	10.0
Reservoir Assessment Technology (Budget Outlay)	2.4	(Not Available)		3.5

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The determination of ERDA's effectiveness in treating this issue cannot be precisely made without knowing the specific funds. However, the increase in the ERDA budget in this subprogram should indicate a more intensive approach.

COMPARATIVE SUMMARY

ERDA does not discuss alternative power cycles for different geothermal reservoirs to much extent. Further they do not suggest methods for dealing with possible energy storage requirements in effectively integrating with the existing power grid. However, ERDA appears to have a fair awareness of this issue in their program. It is addressed in the Engineering Research and Development subprogram and is implicitly addressed with regard to hot dry-rock utilization activities. The Demonstration Projects subprogram also has a clear statement of the site-variable problem and intends to deal with it in the second demonstration project. Finally part of the reservoir assessment technology activities concerns utilization options within reservoir model development.

QUESTIONS

1. What cycles has ERDA identified for its pilot/demonstration program in geothermal energy?
2. To what extent will the pilot/demonstration program be concerned with problems associated with integrating a geothermal source with an existing power grid?
3. What portion of the budget requests deal directly with projects concerning the variability of geothermal resources?
4. What priority does ERDA attach to these projects?
5. What plans does the Geothermal Program have to coordinate activities with the Electric Energy Systems subprogram with regard to planning for integrating geothermal electric energy sources into the power grid?

COMMENTARY

In the initial OTA analysis, a number of short issue statements were made, following the 17 more lengthy issues. Repeated here are the original questions with a comparative summary. Many of the concerns have been addressed by **ERDA** (identified by "Adequately addressed"). Other concerns remain as discussed below:

ISSUE	COMPARATIVE SUMMARY
1. Has proper attention been given to the necessary intraagency coordination mechanisms to ensure the cross-fertilization of information and technology between solar programs and necessary auxiliary efforts in other divisions? There are many aspects of the ERDA program which cut across divisional boundaries, and which, although assigned to one division, are of vital concern to the solar-geothermal programs. Examples of such areas are: • Energy storage • Hydrogen generation, distribution, storage, and utilization • Advanced power conversion cycles • Combined storage/conversion systems; e.g., fuel cells or thermal "batteries. " • Super conductivity • Electric power conditioning (e.g., d.c. to a.c. conversion) • Resource availability, particularly fresh water.	1. Intraagency Coordination: ERDA was partially responsive. Although some subprograms describe their cooperative efforts (e.g., wind, agriculture) others which are known to exist are not discussed at all. An example is the total energy activities within the Conservation Branch of ERDA and at HUD, which have many features in common with the solar total energy program. Concern remains that storage may be the most critical solar technology, and that it may not receive the attention deserved. Ten million dollars was requested by the solar division for storage research; none was approved in the request to Congress.
2. Which research programs in the solar and geothermal ares are budget limited? If more funds were provided, what would be done with them, and how would they assist the research effort ?	2. Budget Limitations: Concern was raised initially about the limitations to the budget. No information is provided in the budget on the effects of cutting programs. A statement of assumptions behind the budget is essential for adequate analysis.
3. What are the differences between a test bed facility, a pilot plant, and a demonstration plant? In ERDA language, a test bed is a facility used to test components of and ideas for a total system. A pilot plant is a complete system assembled to show technical feasibility and to gain construction and operating experience. A demonstration plant is a near commercial scale facility used to show economic feasibility y although the plant itself may not be economically competitive at that time. Another but totally different concept of "demonstrations'" is illustrated in connect ion with solar heating and cooling of buildings (see Issue Paper 9), where the objectives are to generate a user market.	3. Definition of Terms: Adequately addressed.

ISSUE	COMPARATIVE SUMMARY
4. Does ERDA's patent policy enhance or impede development and application of solar and/or geothermal energy?	**4-6.** Patent Issues: Not discussed at all.
5. Should ERDA research funding include requirements that access to background proprietary information and patent posit ions be granted to the Federal Government?	
6. How does withholding of "proprietary informat ion" by industry affect ERDA's state-of-the-art reviews and data-bank usefulness?	
7. What should be the nature of incentives to use windpower systems and geothermal heating systems? The issue of incentives related to solar heating and cooling has been discussed previously (see Issue Paper 10]. Many of the same points also apply to wind power and geothermal heat utilization.	**7.** Incentives for Wind Power and Geothermal: It is indicated in the program that wind power incentives are as important as for solar heating and cooling, and it is indicated that wind power incentives are being coordinated through FEA. For geothermal, $4.4 million has been budgeted for FY 77 for loan guarantees.
8. Would it be appropriate for ERDA to fund traineeships in solar and geothermal technology? The discipline requirements for the utiliza - t ion of these resources is such that some incentive, similar to the former NASA traineeships, may be required to encourage pursuit of these specialized educational backgrounds. The need for these hybrid scientists/engineers is immediate.	**8.** Traineeships: There is no discussion of this topic in the solar portions of the plan or budget. ERDA's University Relations Division is reported to have funds for several traineeships, but studies of need are just beginning.
9. What is the reason for the apparent emphasis on the central tower solar electric concept to the exclusion of solar electric approaches?	**9.** Central Tower Emphasis: Adequately addressed, see Issue #6.
10. Should the Plan make a specific commitment of allocating a portion of the solar heating and cooling demonstration projects to the retrofitting o f existing residential and commercial buildings? Although solar heating and cooling systems will be more cost effective in new buildings designed with the systems, the approximately 65 million existing buildings present an immense potential for solar heating and cooling, with a subsequent significant potential fuel savings. This is particularly true in the case of solar-heated domestic water,	**10.** Specific Commitment to Retrofit Projects; The ERDA program and budget do not indicate specifically if and to what extent retrofit projects will be addressed. However, in the first series of "integrated residential project" solicitations, retrofit projects were considered, and a portion (33 of the 143 units, hot water and/or space heating) of the awards were for retrofit projects, However, neither the program nor the budget justification provides specifics or guidelines on the extent to which retrofit projects will be considered.
11. What is the status of the Guaranteed Geothermal Loan Program? The Guaranteed Geothermal Loan Program will be impossible to implement without appropriate ions available to back up the guarantee,	11. Geothermal Loan Guarantee: $4.4 million has been budgeted for FY 77.

ISSUE	COMPARATIVE SUMMARY
12. Why does a solar thermal total-energy system demonstration appear in the plan, but no photovoltaic total energy system? Photovo1taics (at least onsite) would appear to b e at 1east as wel1 suited for total energy systems.	**12.** Photovoltaic Total Energy: , Adequately addressed, see Issue #6.
13. How does ERDA plan to verify and supplement the estimate of geothermal resources indicated in the USGS Assessment Program? USGS cannot drill exploratory geothermal wells, but in order to determine the potential reserves, geothermal exploratory wells must be drilled, Such exploratory drilling will allow for better planning of resource utiliza - tion and determine the resource for which conservation technology should be developed,	**13.** Estimate of Geothermal Resources: See #17, below.
14. Why is little emphasis placed on alternative solar-cell materials (other than silicon) considered in the ERDA Plan? A number of other materials (such as gallium arsenide, cadmium sulfide, and iridium phosphide) are receiving considerable attention from the private sector, and some of them appear quite interesting,	14. Alternative Photovoltaic Materials: The transfer of NSF's solar program to ERDA, without transfer of funding, greatly increases the severity of this problem, although major studies are under way on some new photovoltaic materials. The need for basic research in photovoltaic materials has not been addressed.
15. Does the potential for the export of solar, wind, and geothermal technology and equipment have any impact on R&D strategies?	**15.** Export Potential: See comment 18 below,
16. Will geothermal resources benefit only certain segments of the country? Even though geothermal resources are region al in occurrence and nontransportable, this does not make it a regional resource which will benefit only a small segment of the population. Because of the nature of the resource (heat), it must be used near the well site. However, when geothermal energy is used in one portion of the country to replace fossil fuel heat sources, the fossil fuel saved is available to the country as a whole in the form of high value liquid fuel.	16. National Benefit of Geothermal; The fund allocated to geothermal energy development is indicative that it is recognized to benefit the Nation as a whole.
17. What is the role of ERDA in the development of geothermal exploration methods? The development of advanced geophysical exploration techniques is needed to ensure full and rapid development of geothermal resources. If ERDA agrees that it is within the scope of their mandate to do this type of work, such a statement should be made with details provided.	**17. Estimate of Geothermal** Resources: $9.6 million has been budgeted in FY 77 for Geothermal Exploration Reservoir Assessment and Reservoir Confirmation.

ISSUE	COMPARATIVE SUMMARY
18. Has ERDA given adequate attention to the use of international research efforts to solve common energy problems? The solar energy field is a particularly attractive area for cooperation,	**18.** International Research Efforts: ERDA has identified this as a topic for discussion under each program plan. The differences from the first plan's discussion is impressive.
19. Why hasn't the use of wind energy for nonelectric applications been considered; e.g., water-pumping, with pumped-storage capability? It is possible that significant capital cost and energy savings might be realized by exploiting all possible avenues for these applications.	**19.** Recognition of Other than Electric Uses for Wind: Some but little recognition of other than electric uses for wind are recognized. One area, irrigation: SE/D-19, is referred to under "farm and rural systems" but is placed under the Solar Electric Program.
20, Has ERDA considered establishing test facilities, pilot plants, and demonstration plants on Federally controlled rather than privately controlled lands? This approach, with the assistance of private industry, would allow the rapid testing of technology without many of the long delays associated with licensing and restraints on private land, This approach should be considered for cases where early testing of a resource or technology is mandatory.	**20.** Demonstration on Federal Lands: Adequately addressed. The Department of Defense appears to be taking an increasingly active interest in several phases of solar energy testing. NASA and several ERDA National Laboratories (especially Sandia) have active testing programs.
21. What is the nature of ERDA's interaction with the EPA program in urban waste disposal? How do you integrate the use of agricultural and forest wastes with your program of energy from biomass? The use of organic wastes: urban, agricultural, and tree farming, can make a modest contribution to the fuel supply while reducing an adverse environmental problem.	**21.** Urban Waste Disposal/Utilization: No coordination with the EPA Urban Waste Disposal program is indicated.
22. What ocean areas have you identified that have suitable upwelling conditions for marine biomass cultivation? Is this area large enough to allow a significant impact? What is your estimate of the net energy gain per acre of marine biomass and the cost to harvest?	**22.** Marine Biomass Cultivation: An assessment of prospective marine biomass cultivation sites available as a result of upwelling has not been discussed. However, an assessment of the energy potential from marine biomass has been made.

Chapter V

Conservation Issues

CONSERVATION ISSUES LIST

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1. Importance of Conservation

ISSUE

The ERDA Plan should better reflect the urgency and importance of conservation in responding to the national energy problem.

SUMMARY

ERDA-48 states that energy conservation is of "crucial" importance, particularly in the next decade. However, its program priorities and funding requests are inconsistent with the stated importance of conservation. There is little evidence that cost-effectiveness or environmental/economic impacts have been considered in establishing program priorities; moreover, programs to address nontechnological but none the less vital issues in developing and implementing conservation activities seem to be missing. A sense of urgency to achieve results (saved energy) seems wanting.

BUDGET SUMMARY

The budget requests for conservation are as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Conservation	71.7	209.0	193.9	113.0

The ERDA request is nearly three times the FY 76 budget while the final request to Congress represents a 64-percent increase, one of the largest of any of the offices in ERDA, However, the dollar increase is 80.9 million less than ERDA requested from OMB and represents 3.8 percent of the total ERDA FY 77 budget as against 3.o percent for FY 76. When just those programs which are concerned with the end-use sector are counted (see Issue 4), this becomes 2 percent. This in spite of the fact that conservation is now ranked with the highest R, D&D priorities

in ERDA. While reliable cost-benefit analyses of various conservation options have not been performed (as indeed they are also lacking for supply strategies as well) it is still difficult to justify giving conservation with its low-risk and high short-term potential for payoff such a small fraction of the total ERDA budget. The argument to which some subscribe, that the private sector can be expected to respond more easily in providing us with a cost-effective use of energy than it can in terms of developing additional supplies, neglects the tremendous advantages that accrue to the Nation if we can accelerate the transition to a more efficient energy system.

COMPARATIVE SUMMARY

ERDA has given considerably more emphasis to conservation as a means of achieving the Nation's energy objectives. The increased importance can be seen in the program document for FY 77 which places greater stress on the urgency of conservation and addresses the vital, nontechnological issues in developing and implementing conservation activities.

There are, however, two aspects of ERDA's program on end-use conservation which are still quite troublesome and which appear to seriously handicap the program. First: the conservation program has no apparent overriding sense of direction. A conservation strategy needs to be formulated so the program elements are viewed as parts of a whole. In spite of the value of the research being funded, this lack of a coherent, well articulated, conceptual framework may be responsible for the less than enthusiastic, although unjustified, budget treatment given the ERDA conservation program. Second: ERDA's program does not emphasize that conservation has a major role in solving our long-term energy problem. Activities on new technologies with payoff in the long term have not been identified and commenced. In summary, ERDA should create an imaginative, aggressive, and comprehensive strategy and program for conservation both for the short and long term.

QUESTIONS

1. What plans does ERDA have for establishing an overall strategy for energy conservation so that the various subprograms can be viewed as part of a comprehensive conservation R, D&D program?
2. Does ERDA intend to place more emphasis on the mid- and long-term contribution of energy conservation [1985 and beyond)?
3. Does ERDA feel that the adoption of conservation technologies by the private sector can be measurably accelerated by an aggressive conservation R, D&D program?

z. Program Management and Coordination

ISSUE

ERDA's plans for conservation program management and coordination within the agency, with other involved Federal agencies, with State and local governments, and with other nations need additional attention.

SUMMARY

ERDA has been mandated (Public Law 93-577) as the primary agency in energy R, D&D with responsibility to integrate and coordinate national efforts. Its mission is to assure that existing ancillary resources (e.g., capital, manpower, materials, and expertise) are utilized to the maximum extent, thereby making available the most promising energy alternatives.

It is not evident in ERDA's plans whether a comprehensive framework is being established to permit ERDA to perform adequately its required coordination / integration role. Insufficient attention is given in the Plan to the implementation of formal mechanisms or operating relationships to assure:

. location of programs within ERDA to maximize chances for an integrated systems approach to solving problems;

- coordination of programs with the various Federal agencies, and State and local governments involved in energy conservation work; and
- integration of foreign energy conservation R, D&D into domestic planning.

Lack of programmatic elements to deal with the above responsibilities could seriously impede the effort to achieve the stated objectives within the conservation program,

BUDGET SUMMARY

program management is not identified as a line item and is therefore assumed to be spread across the various subprograms. The portion of each Conservation subprogram which deals with State and local governments is principally contained within the information-dissemination/transfer categories summarized below:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Industrial Information Technology Transfer	**0.10**	(Not Available)		2.78
Buildings Dissemination and Transfer	1.05	(Not Available)		0.62

It must be noted that these requests include more than items pertaining to this issue (e.g., see Issue 3). The four remaining Conservation subprograms do not provide separate budget categories related to this issue.

COMPARATIVE SUMMARY

ERDA's plans for coordination with other Federal agencies and other nations have been thoroughly outlined by subprogram under the headings "Federal Role" and "International Cooperation". However, no overall management philosophy for the Federal Conservation Program is apparent and this is inappropriate for the "lead agency" role established for ERDA by Public Law 93-577. In this connection the relationship between ERDA and FEA continues to be of concern.

In the area of coordination within ERDA there are still several unresolved questions. For example there are several projects in the Energy Conversion subprogram which are relevant to subprograms in the Solar, Fossil, and Conservation programs (a. c. to d.c. conversion, fuel cells, etc.). The Energy Storage subprogram has obvious links to solar, transportation, and other conservation activities. While there is discussion within these subprograms of cooperation with other ERDA efforts, there is no apparent systematic approach to coordination. Without such a mechanism from the very start it is likely that some projects will be unnecessarily duplicated and others will not be effectively carried out. This lack of strong, effective intra-program coordination is especially dangerous in the Conservation Program because of the broad range of subprograms and effects they have on other ERDA programs.

QUESTIONS

1. In the near term where direct Government influence and incentives can create energy savings, how is the responsibility for energy conservation divided between ERDA and FEA?
2. What specific management mechanism, technique(s) or coordination controls will ERDA use to integrate and coordinate its conservation activities with other Federal agencies?
3. What is the Management Plan for coordination of conservation technologies within ERDA among the various programmatic groups?

3. Interaction With the Private Sector

ISSUE

A comprehensive plan is needed for interaction between ERDA and the private sector in energy conservation.

SUMMARY

Without close coordination with industry and other private organizations, widespread implementation of research results cannot be attained. The problem is complex since various areas of the private sector are organized quite differently and each (e. g., energy consuming industry, energy producing industry, the Electric Power Research Institute (EPRI), individuals, public institutions), will require a unique approach to constructive interaction, The ERDA Plan provides few details as to how this interaction is to be accomplished,

BUDGET SUMMARY

Interaction with the private sector is encompassed in every subprogram in two forms: 1) As a separate implementation subprogram (technology transfer, information dissemination), and 2) within each of the technology subprograms. The budget requests for the former are given here while those for the latter are not available.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Industrial Information Technology Transfer	0.10	(Not Available)		2,78
Buildings Dissemination and Transfer	1.05	(Not Available)		0.62
Transportation Implementation	0.60	(Not Available)		**1.30**

All of these categories include projects in addition to those dealing with the private sector but they are largely oriented toward the latter. The budget increases in all but the buildings subprogram indicate a significant recognition of the need for interaction with the private sector at least in terms of technology transfer and information dissemination.

It should be noted that the ERDA requests for the subprograms in which the above categories fall were higher than the final request to Congress. How this translates to those projects and efforts concerning interaction with the private sector cannot be determined from available data.

COMPARATIVE SUMMARY

ERDA has addressed this issue rather extensively in their program document, All of the subprograms contain projects and efforts to provide information and technology transfer to the private sector. To varying degrees they all have projects underway which coordinate with the private sector including cost-sharing activities.

The principal deficiency in ERDA's attempt to address this issue is the very limited discussion of how they will utilize the private sector to initiate programs and to set priorities. The efforts with the private sector are principally dissemination of information and technology transfer. The buildings and electric energy systems subprograms appear to be more responsive to this concern than the others. This deficiency could lead to R, D&D results that cannot be transferred regardless of how effective the implementation program is.

QUESTIONS

1. What mechanisms has ERDA established to bring in the private sector at the onset of programs and to assist in setting priorities?
2. Has ERDA involved the private sector in developing an overall R, D&D plan for the conservation program?

4. Use of the Term "Conservation"

ISSUE

ERDA's operational definition of energy conservation is too broad.

SUMMARY

ERDA uses the term "conservation" so broadly that almost any effort to improve efficiency or cost in either energy supply or energy demand can be subsumed within it. This has the possible consequence of shifting the emphasis on responsibility for conservation actions away from the consumer toward the suppliers and distributors of energy.

As an example, the Electric Conversion, Energy Storage, and Power Transmission programs can produce large cost savings but, in most instances, their energy savings potential is small in comparison with efforts in the energy demand sector. As important as they are, these cost savings could distort the contribution of these programs in terms of the objective of reducing energy use. This could cause a shift away from end-use conservation priorities to those on the supply side within the overall Conservation Program. Also to increase their chance of success these programs should be coordinated with research on other components of the electric power system with which they are related synergistically.

BUDGET SUMMARY

The budget implications for this issue can best be seen by looking at the requests of the subprograms grouped as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
		End-Use Subprograms		
Buildings	12.6	46.9	46.9	21,6
Industry	4.2	35.2	29.2	11,4
Transportation	12.5	36.5	34.0	23.2
TOTAL	29.3	118.6	110.1	56.2
		Non-End-Use Subprograms		
Electric Systems	18.0	35.6	29,0	21.0
Energy Storage	15.6	42.0	42.0	20.8
Energy Conversion	8.9	12.7	12.7	15.0
TOTAL	42.5	90.3	83.7	56.8
TOTAL CONSERVATION	71.8	208.9	193.8	113,0
End-Use Subprograms as percent of total	FY 76	41 percent (Appropriations)		
	(FY 77	57 percent	57 percent	50 percent

ERDA requests are weighted toward the end-use sector which places the emphasis where the greatest energy savings can be achieved. This represents a noticeable shift from FY 76 which appears to respond to some of the concerns raised by this issue. The request to Congress, however, partially reversed this trend by bringing about a 50-50 split between the two groups.

COMPARATIVE SUMMARY

This issue remains unresolved in the present ERDA program document and budget. ERDA 76-1 (Volume II) states “Conservation can be viewed, succinctly, as the use of energy in a cost-effective manner.*’ (emphasis added). Yet the ERDA Conservation budget is equally weighted toward technologies relating to electric energy systems (incorrectly called Power Transmission in the original issue

summary) and energy storage and conversion. These programs, while important, are not consistent with ERDA's own definition.

This is not to say that these other programs are overfunded. There is the danger that they may have insufficient funds since they may not be able to compete with end-use subprograms in terms of reduced energy use. Indeed these subprograms are extremely important in themselves and will directly effect the utilization and integration of solar, geothermal, fusion, and other new energy technologies into the U.S. energy infrastructure. Specifically these subprograms will have a great influence on the structure of the electric power grid as these new supply technologies are introduced. Whether the grid will be oriented virtually exclusively toward large central power generation systems or whether it will be flexible enough to permit both large, bulk systems and small, decentralized systems depends to a large part on the direction the Electric Energy Systems and Conservation Research and Technology subprograms take in their R, D&D programs. The combined influence of these subprograms will serve to establish the flexibility and rate of integration of all new energy sources into the Nation's energy economy. This role is as important to the supply sector as the end-use conservation program is to the demand sector in achieving national goals.

ERDA's broad definition of conservation could distort the situation to the detriment of both sets of programs and of developing solutions to the energy problem. This could be mitigated by either moving the Electric Energy Systems and Conservation Research and Technology (storage and conversion) subprograms out of the Conservation Program and integrating them within their related programs or establishing an effective management structure to ensure that non-end-use subprograms are evaluated on their own terms.

There is also a time-scale issue. Virtually all long-range programs are in the Electric Energy Systems and Conservation Research and Technology subprograms while the end-use subprograms have payoff beginning in the short-term. ERDA has yet to develop a long-term plan for end-use conservation. Despite the very large projected long-term impact of energy conservation, there are virtually no program elements which might contribute to this objective.

QUESTIONS

1. Why has the Conservation Program not made its program consistent with its definition of conservation?
2. What mechanisms has ERDA established to ensure that the funding levels of each set of subprograms, as defined above, are not distorted because they are all lumped within the Conservation Program?
3. What procedures is the Conservation Program using to identify ideas for energy conservation R, D&D for the long term (2000 and beyond)?

5. Need for Nontechnological Research

ISSUE

ERDA's role needs clearer definition with respect to research on non-technological issues associated with energy conservation.

SUMMARY

Present inefficient patterns of energy use, characterized by inefficiencies in buildings and consumer products, in transportation, in industrial processes, and in the generation and transmission of electricity, are to a large degree caused by a combination of historical, institutional, governmental, economic, and social forces. Implementation of known methods and technologies to improve energy use efficiency requires an understanding of how these forces operate and how changes in these forces will influence energy consumption patterns and fuel use. The regulatory policies and programs of various agencies need to be critically reexamined to see how they can be modified to promote greater energy efficiency. To accomplish this, identification of a lead agency which will decide on the trade-offs among separate agency interests and establish an overall government posture is a key requirement. Guidelines in Public Law 93-577, Sec. 5(a), imply a strong ERDA role.

BUDGET SUMMARY

No budget information concerning this issue could be determined.

COMPARATIVE SUMMARY

Throughout ERDA 76-1 extensive reference is made to research in non-technical problems which deal with the points raised in this issue. However, notwithstanding this recognition, no budget request appears explicitly within the conservation program for such research. Possibly these problems have become integral parts of other subprograms and, therefore, no specific allocations are requested. But research projects on nontechnological impediments to implementation of conservation measures are difficult to find within the discussion of the FY 77 Budget Estimate.

There are some areas of study not discussed in the ERDA Program and Plan which should be included in this issue discussion. Specifically, studies of the economic, labor, and other impacts of energy conservation technology should be performed. In this context it is quite important to examine the various supply and demand options with the objective of optimum use of R, D&D funds within ERDA.

QUESTIONS

1. Why does the Energy Conservation Program appear to place low emphasis on planning and analytical activities?
2. What role does economic analysis play in the ERDA process for establishing priorities?

6. Demand Modeling and Conservation Planning

ISSUE

The basic assumptions underlying ERDA's projections of future demands are unrealistic; as a result, the ERDA Plan has not accorded sufficient attention to conservation as a means of reducing energy demand, environmental impact, and financial stress.

SUMMARY

Investment in energy conservation can yield a high rate of return. In addition to lower total cost for a given standard of living, major benefits which result from conservation efforts include:

- Lower energy and natural resource consumption
- Lower capital investment requirements
- Reduced environmental impact.

The Reference Energy System model used in the ERDA Plan as a "baseline" reference for future energy demand growth is unrealistic in that it does not recognize the impact of even current price increases on future demand. As a result, an artificially high demand is projected for 1985 and 2000, and this inflated figure is the basis from which plans for new supply are developed.

Program emphasis and funding may thus be seriously biased toward the supply options. Such an overstatement of need is damaging to future efforts toward energy development in both the supply and demand areas. Since the ERDA Plan is closely tied to numbers generated in the model, we must be careful to keep in mind the assumptions that went into the ERDA calculations.

BUDGET SUMMARY

No budget information concerning this issue could be determined.

COMPARATIVE SUMMARY

ERDA has recognized the impact of price on demand projections. Various models were utilized including one which looked at a demand policy based on rising energy prices. These were compared to a reference case which assumed decontrol of oil and gas prices. It is encouraging to note, in this context, the collaboration between ERDA and FEA through formal agreement for ERDA to use the Project Independence Evaluation System (PIES) model for projections to 1985. It is not clear, yet, how consideration of the impact of rising prices on energy projections will affect ERDA's planning. It should be pointed out here that these analyses should be carefully evaluated. For just as too little emphasis on price could overstate the need for enhanced supply options, too much emphasis could understate the need for both supply and conservation technologies.

QUESTIONS

1. To what extent has ERDA's plans for demand modeling and subsequent conservation planning been curtailed by budget limitations?
2. How does ERDA intend to use the results of demand modeling and energy projections in setting priorities for conservation R, D&D?

7. Design Methods and Standards

ISSUE

Energy conservation efforts in the building and consumer products sector require the development and dissemination of analytic design methods and the adoption of reasonable energy standards.

SUMMARY

In order to realize the full potential of energy conservation in the building and consumer product sector, two major tasks must be accomplished. First, the design profession must be provided with improved design methodologies, as traditional design procedures do not place adequate emphasis upon energy considerations. A fundamental reorganization of the design process and the development of new energy-sensitive analytic tools is required. Second, realistic energy standards and/or energy budgets must be established as design guidelines. Data on existing energy use patterns in the buildings and consumer products sector must be analyzed in order to develop a rational basis for new standards. Finally, fundamental questions as to the form energy standards should take must be resolved. The ERDA Plan does not give sufficient emphasis to this need.

BUDGET SUMMARY

The budget requests which concern the points in this issue fall in most of the categories of the Buildings subprogram, and, except for the performance standards category, cannot be broken out.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Performance Standards	2.6	(Not Available)		1.3

A decrease in funds clearly indicates an underestimate of the money and effort needed to implement satisfactory performance standards in code jurisdictions. The projected energy savings due to activities in this category are much greater relative to the entire program than the budget requests indicate (see Budget Document, CR/U-25). Activities concerned with design methods and new, energy-sensitive analytic tools are not explicitly identified in the budget requests. Finally, information dissemination of standards and design techniques will also

likely be relatively ineffective as a result of the budget request for this category remaining at last year's level (see Issue 3).

COMPARATIVE SUMMARY

The question of energy standards for buildings and consumer products is discussed extensively in the program document. The development of energy standards is an implied goal of the Buildings subprogram and forms an integral part of its strategy and implementation activities. The major difficulty here appears to be budget restrictions which limit the effectiveness of these efforts. With regard to the other major task described in the issue, that of providing new design methods and energy-sensitive analytical tools, there is less said. Design criteria are mentioned in many places in the Buildings subprogram but no comprehensive program is laid out to develop these methods. In this sense the Buildings program appears to emphasize demonstrations of specific technologies (e.g., the annual cycle energy system and the thermally activated heat pumps) and puts less effort on generic design methods to improve energy use efficiency. It is no doubt true that such methods will be developed from the specific technologies, but it is still not clear that a systematic approach toward this goal exists,

QUESTIONS

1. Do budget constraints in the performance standards and dissemination and transfer categories severely limit the effectiveness of the performance standard and design method activities?

2. How is ERDA involving the construction industry in the standard setting and implementation process?

3. What plans does ERDA have to develop a program in design methods and energy-conservation analytic tools which can be used across the buildings and consumer products sector?

8. Development and Demonstration

ISSUE

ERDA's plans for R, D&D of energy conservation technologies in buildings and consumer products should be accelerated and expanded.

SUMMARY

In order to introduce the current technology into society as fast as justifiable by market economics and national need, demonstration projects must be developed for use in all sections of the Nation. ERDA's plans for the implementation of existing technology for energy conservation in buildings and consumer products appear inadequate; in add it ion, it is evident that ERDA is not spending a sufficient port ion of its resources on the research of new energy conservation technology which holds great promise for the future.

BUDGET SUMMARY

The budget requests for the various categories of the Buildings subprogram which relate to development and demonstration are given here along with a request for construction of a commercial building demonstration project.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Commercial Buildings	1.3	(Not Available)		3.9
Residential Buildings	0.9	(Not Available)		3.1
Community Systems	2.6	(Not Available)		6.9
Appliances	0.7	(Not Available)		1.2
Technology	1.8	(Not Available)		3.1
Commercial Building Conservation Demonstration	0	15.3	15.3	0

All of these requests show an increase from FY 76 reflecting an acceleration of demonstration and development of energy conservation technologies in the buildings and consumer products sectors. The elimination of ERDA's request for construction of the demonstration project coupled with the reduction of the division and ERDA's request for the entire Buildings subprograms (see Issue 4) implies that this acceleration is slower than ERDA itself feels is justified. This will slow the rate at which successful energy conservation technologies can be introduced into society.

COMPARATIVE SUMMARY

In the Buildings Conservation subprogram area four specific objectives are stated in the program document: a) to improve the energy utilization efficiency in new and existing buildings, b) to develop energy-saving technologies, c) to improve the energy efficiency of consumer products, and d) to develop "communit$_y$ systems" to improve overall energy efficiency. These objectives indicate that ERDA has responded well to most of the points raised in this issue. There are areas of concern, however, which may reduce the effectiveness of the energy conservation effort.

The expansion of the Commercial and Residential Buildings Programs (particularly demonstration efforts) is somewhat limited. This appears to be due to budget restrictions.

2. **ERDA** is still emphasizing the near-term in their R, D&D program (basic and applied) on new energy conservation technology. Very little discussion (both budget and program) is presented of efforts to investigate new, innovative technologies which may have a large long-term payoff (beyond 1985).

Examples of the latter include:

1. New approaches to high efficiency appliances including lighting.

2. Chemically stable fluids for heating and air-conditioning applications having useful thermal properties.

3. Research on human factors, such as people's adaptability to their thermal environment.

It should be noted that this concern about R, D&D on new technology extends across the entire Conservation Program (see Issue 1). That portion of the program which deals with research appears to lack a strong commitment to basic research on new long-term energy conservation technology such as those quoted above and efforts such as combustion chemistry and innovative industrial processes.

An important new consideration with this issue is the influence of the Energy Policy and Conservation Act of 1975 on ERDA's implementation plans. The provisions of this Act dealing with consumer products and State energy conservation efforts need to be considered by ERDA in formulating its programs.

QUESTIONS

1. Is it feasible to expand the demonstration program in buildings and, if so, to what extent can this accelerate implementation of these technologies?
2. What methods does ERDA have to define broad categories and initiate research into new, innovative conservation technologies for long-term payoff?
3. Has ERDA formulated plans for a basic research program in the conservation area?
4. How will the provisions of the Energy Policy and Conservation Act of 1975 influence ERDA's programs in the consumer products area?

9. Constraints in Building Construction

ISSUE

ERDA does not appear to be devoting sufficient effort to overcoming the nontechnological barriers to energy conservation in building construction.

SUMMARY

The technology to permit substantial reductions in energy expenditures on commercial and residential buildings is currently available. New technologies and designs promise cost-effective reductions of energy to operate buildings of 60 percent or more. However, five primary nontechnological barriers impede this objective and require R, D&D to provide ways to overcome them:

- The minimum first-cost syndrome.
- Antiquated local building codes.
- poor system design.
- Industry and consumer resistance,
- ERDA's budget control procedures,

BUDGET SUMMARY

The budget requests which relate to this issue fall within several of the categories of the Buildings subprogram, The dissemination and transfer category (see Issue 3) is the only one for which a significant fraction of funds appears to be related to this issue.

COMPARATIVE SUMMARY

In the Buildings subprogram the issue of constraints in building construction is given high priority in the revised ERDA Program. Also, in the descriptive material associated with the budget emphasis is given to the resistance to conservation measures by the construction industry, problems of adverse building codes, **etc.** Although the issue is discussed in some detail, there is no indication of the budget resources going **to** this effort, and it is not clear that the budget adequately addresses its magnitude.

10. Need for Thermodynamic Analysis

ISSUE

The ERDA Plan does not describe how the agency plans to identify areas with the highest theoretical potential for industrial energy conservation and to assess the practical feasibility of implementing programs in these areas.

SUMMARY

Prior to establishing research priorities in industrial energy conservation, a detailed assessment must be made of the amount and form of energy used in industry and the efficiency of industrial energy use, Thermodynamic analysis, which determines the theoretical minimum energy required for a given process, may be used to identify areas having a high theoretical potential for energy savings. Once promising areas have been identified, however, the feasibility of these improvements must be evaluated to determine whether economic, political, or social restraints might render a proposed solution useless, even if it is technologically possible. Such considerations must enter ERDA's program planning activities early in the cycle to assure ultimate utilization of research results.

BUDGET SUMMARY

Funding to implement thermodynamic analyses would be contained within the process analysis and modifications, and unit operations and equipment efficiency categories of the Industry Conservation subprograms. The amounts requested for such analyses are not detailed. However, these categories are presented here.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Process Analysis and Modifications	1.4	(Not Available)		1.7
Unit Operations and Equipment Modifications	1.1	(Not Available)		2.2

It cannot be determined, explicitly, whether there is adequate funding to identify targets for industrial energy conservation through thermodynamic analysis, or to assess the feasibility of implementation of these targets. It can be inferred, however, that the program will not accelerate as rapidly as ERDA feels it can, due to the reduction of their requests when submitted to Congress. This is particularly true of the implementation phase which will be addressed primarily by demonstration projects.

COMPARATIVE SUMMARY

The ERDA program document responds to this issue in its discussions concerning identification of 'targets of opportunity' for energy conservation. Although the program document does not specify that this will consist of thermodynamic analysis as described in this issue, the Program Approval Document of the Industry Conservation subprogram does make this point. Further, it charts how such analyses will be integrated into the overall assessment of a particular candidate for energy conservation. The Federal Energy Administration has carried out extensive thermodynamic studies of those industries using the largest amounts of energy. ERDA has noted this. From these discussions, it is clear that ERDA recognizes this issue. With regard to the projects underway or planned in the Industry subprogram, however, there has been little discussion of how thermodynamic analysis has been utilized so far.

The assessment of feasibility will be answered primarily by the comprehensive demonstration projects of energy-intensive processes scheduled from 1976 to 1985 (ERDA program document). The scope of these demonstration programs seems appropriate in light of the budget limitations and the lack of funding for conservation projects.

QUESTIONS

1. What procedures will ERDA establish to evaluate the nontechnical (economic, environmental, etc.) aspects of energy conservation technologies identified by a theoretical minimum energy consumption analysis?
2. How does ERDA propose to communicate thermodynamic and economic analysis results to industry so as to aid the technology transfer process?
3. Why was the ERDA budget in the industrial sector cut by OMB so much more severely than other sectors? (30 percent of ERDA's request allowed versus 58 percent for all conservation) ?
4. Has ERDA asked industry to provide documentation of the rationale and potential impact of industrial sector conservation R, D&D?

11. Oil and Gas Substitution

ISSUE

ERDA's plans for the substitution of other energy sources for oil and gas as part of the industrial conservation program are not well defined.

SUMMARY

Conservation strategies as defined by ERDA can take two forms:

- Conservation of energy by increasing efficiency of end use.
- Conservation of scarce resources, such as oil and gas, by substituting other energy sources, such as coal, nuclear, or organic wastes. Although ERDA is obviously aware of both of these options, the plans spelled out in the industrial sector do not clearly distinguish between them. ERDA should examine the potential and the impacts of fuel substitution in various key industries, and formulate the specific R, D&D strategies required. Possibilities exist for the production of process heat for industrial users by nuclear- and coal-fired plants. Also the use of synthetic fuels derived from coal, such as low-Btu gas, may prove to be an economical substitute for oil and natural gas in many applications, In the mid-to-long term, as advanced electric generating technologies reach commercialization, industries may shift to electricity for process heat and steam generation, With research and development, high-capacity high-temperature heat pumps may be able to provide process heat with an efficiency comparable to that of direct fuel firing.

BUDGET SUMMARY

The budget requests related to this issue fall in the technology categories within the Industry subprogram. The principal category is alternative energy fuels, materials, and process.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Alternative Energy Fuels, Materials and Process	0.6	(Not Available) .		2.2

Other efforts, such as an industrial heat pump, are also being funded. In addition, the fossil program contains efforts directed at efforts suggested in this issue. The fragmentation of these projects and the lack of specific budget information makes it difficult to determine how effectively ERDA is responding to this issue through the budget. It is still clear that an overall ERDA program to deal with oil and gas substitution has not been well defined in the sense of the budget.

COMPARATIVE SUMMARY

The ERDA program describes numerous efforts to deal with oil and gas substitution. This occurs in both the Conservation and Fossil programs. In the Industry subprogram by itself, a specific R, D&D strategy for fuel substitution has been developed which responds to the issue. It appears not to have a sufficient budget to implement the effort. The scope of the projects described for FY 77, which is set by budget restrictions, is considerably narrower than the overall program strategy.

ERDA has described efforts to look at high-temperature heat pumps and have budgeted this item for FY 77. There is no description of coordination with efforts in the fossil program on the points discussed in the issue.

There are two other aspects of this issue which deserve ERDA's attention. The first is the need to assist certain hard-hit industries to switch from natural gas to more abundant fuels before 1985. The second is the need to assess the social, economic, and political factors related to oil and gas substitution. Such impacts will be highly regionally dependent and would include changes in employment, inflation, environmental conditions, etc.

The rapid decline in natural gas availability is having a profound effect on industries in the Northeast Central and Atlantic coast regions and requires action on the part of all Federal energy agencies, including ERDA.

QUESTIONS

1. Has **ERDA** developed detailed scenarios as to how each industrial element might switch from its present reliance upon oil and gas to other fuels (on a time scale of 20-30 years)?
2. What plans does ERDA have to assist industries to convert from natural gas in the next 5 years?

12. Use of Foreign Technology

ISSUE

The ERDA program should consider the utilization of foreign technology as an alternative to new conservation research.

SUMMARY

The ERDA Program proposes new research in a number of areas in which technological innovations are already either under development or in operation in foreign countries, The adoption of such innovations should normally take priority over new research initiatives, since the former are cheaper and can impact faster on industry. Successful utilization of certain technologies may eliminate the necessity for research in peripheral areas which bear on the same basic problems.

While adoption of technology developed abroad may simplify the technological research problem, a number of institutional barriers may have to be overcome before successful implementation can be accomplished.

BUDGET SUMMARY

No budget information concerning this issue could be determined,

COMPARATIVE SUMMARY

ERDA has given significant recognition in its programs to the establishment of communication with energy use activities in other nations.

Comparative studies of U.S. energy use and energy use in other nations are being undertaken, but have not yet been built into ERDA programs.

QUESTIONS

1. What progress and problems has ERDA encountered in transferring foreign technologies to the United States?
2. What special licensing and patent provisions appear necessary?

13. Transmission and Distribution Priorities

ISSUE

The economic, environmental, and reliability criteria underlying ERDA's choice of projects and their relative priorities in the electrical transmission and distribution program need clarification.

SUMMARY

As the demand for electricity increases, and the shift from oil and gas to coal and nuc1ear fuels proceeds, addition a 1 electric transmission and distribution capacities will be needed, This increased capacity must be economically justifiable and environmentally acceptable, The ERDA transmission program does not address direct 1 y the relative benefits and difficulties of the successful development of various candidate technologies.

BUDGET SUMMARY

The budget summary related to this issue is as follows:

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 OMB Request
Electric Power Transmission	8.1	(Not Available)		12.9
Distribution	2.5	(Not Available)		3.9

The division of this budget request among the various technologies is not available. Therefore, it is not possible to determine how the budget addresses the issue of setting priorities among the various transmission and distribution technologies. However, no efforts which explicitly evaluate the economic, environmental, and reliability criteria needed to set these priorities are described in the budget document.

COMPARATIVE SUMMARY

The program document places the principal emphasis on a.c. and d.c. overhead transmission followed by compressed-gas-insulated underground systems and finally cryogenic and superconducting systems. ERDA's discussion of priorities is responsive to the issue. ERDA intends to assess the relative technical, environmental and economic merits and disadvantages of these systems but no justification of their choice of priorities appears as yet. Further, support efforts to look at the problems created by each of the systems, environmental (except those caused by high electric fields), material, and land requirements, etc., still appear to be insufficient to allow successful implementation of these technologies.

It must be recognized here that the Electric Energy Systems subprogram will play a major role in coordinating compatible access to the electric power grid for solar, geothermal, fusion and other new supply technologies. This requires total system planning including transmission capacity, controls, system interties, and regional development. The objective of this planning is to develop economical reliable, environmentally acceptable, and flexible electric energy systems. The last point is crucial if the future electric systems are not to exclude small, distributed total energy systems from connection. It is not clear that ERDA recognizes this. Although their revised program indicates the need for systems planning, the importance of maintaining flexibility to accommodate a diversity of generation sources, both in size and type, is not spelled out. The budget requests also appear to be inadequate for the task of systems planning. This may be due to the inherited nature of the program which emphasized transmission and distribution R, D&D. Nevertheless an accelerated effort in systems planning, emphasizing flexibility, should be initiated as soon as possible. This requires a strong effort on ERDA's part which must be well coordinated with the energy supply and conservation programs in ERDA.

QUESTIONS

1. Do the priorities in the ERDA program take into account the relative probabilities of success of the various transmission alternatives?

2. What is the justification for Federal expenditures in electrical transmission and distribution research? Is this area not adequately covered by research in the private domain?

3. How is ERDA intending to coordinate the various electric energy supply technology (nuclear, fusion, solar, geothermal, total energy) programs with the Electric Energy Systems subprogram to ensure adequate systems planning to integrate these supply options into the existing grid?

4. What areas of research does the Electric Energy Systems subprogram intend to emphasize in coming years?

14. Active Load Management

ISSUE

Active load management in electric power systems is not addressed as a cost-effective way to save energy.

SUMMARY

The problem of meeting large peak demands in electric power systems affects both the fuel consumption and the total capital investment required for generating plants, Energy consumption is affected because peak demands are met with a utility's least efficient generating units (i.e., those units kept off-line until needed for peaking), or by units such as gas turbines which have a low capital cost and low efficiency. Furthermore, large coal and nuclear units are not well suited for peaking service; hence, peaking service is most commonly accomplished with gas and oil consuming equipment. Equally important, capital, materials, and manpower of the very kind needed for energy resource development are conserved when the addition of new generating equipment can be slowed down by means of improved load management.

Several options exist for reducing peak load growth. Electrical demand at the end-use point may be controlled through the use of utility-operated remote controls on large consumption devices, by thermal storage at the use point, and by electrical storage in substations. Peak demand, which is more costly than average demand, may also be controlled through the use of rate incentives to encourage more uniform energy consumption. While some relevant experience exists in the United States and abroad, further technological, economic, and social evaluation is needed to achieve widespread implementation.

BUDGET SUMMARY

The budget requests for load management systems are principally located in the Electric Energy Systems subprogram. The Conservation Research and Technology (CONRT) subprogram contains requests for storage technology applicable to load management and the Buildings subprogram discusses load management but no budget data are given.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Systems Management Structuring	**4.0**	(Not Available)		6.8

Approximately $300,000 of this amount for FY 77 is designated for technologies and systems studies concerned with load management. No identifiable requests have been made concerning rate incentive questions and other economic and social impacts. This figure allows no more than a modest effort to look at the complex technologies and system development useful for load management.

COMPARATIVE SUMMARY

ERDA has described a broad effort to deal with issues in the program document. They have responded positively to most of the points raised and described coordination with FEA on rate matters. In addition to control over specific loads or customers' use patterns, ERDA is also examining other methods of load management such as storage at the load or generation site and expanded system interconnections. It is not clear, however, how extensive a role ERDA will play in the nontechnological aspects of this issue which are critical to the implementation of effective load management. In addition, there is little discussion concerning coordination of efforts between the end-use subprograms (Buildings, Industry) and Electric Energy Systems subprogram regarding load management.

QUESTIONS

1. Have alternatives to central station energy storage been considered in the ERDA Plan to reduce power generation requirements in electric power systems?

2. How soon might active load control systems be made available in the United States and when implemented, what impact might such systems have on system load factors, gas and oil demand, and capital requirements for new electric peak-power generation?

3. What technological, economic, social, and legal barriers exist which would impede the institution of rate structures designed to encourage better load management by consumers? What incentives do utilities have to improve efficiency through load management ?

4. Does ERDA have a well-defined role in studying the feasibility of time-of-day pricing?

5. What are the implications of time-of-day and seasonal pricing on various sectors of the economy?

6. What is the estimated capital tradeoff between investment in new electric utility plant construction and in load management of equivalent capacity?

7. What technical opportunities exist to increase this country's electric utility load factor to those of France and Germany?

15. Orientation of Automotive Programs

ISSUE

ERDA's program on highway vehicles is directed more toward prototype development than toward the technological breakthroughs necessary for successful commercialization.

SUMMARY

ERDA's program in automobile, truck, and bus research emphasizes the development and demonstration of major hardware systems (e.g., gas turbine and Stirling engine-powered automobiles, flywheel prototype car, hybrid bus powerplant, 60-mile range electric car, etc.] using state-of-the-art technology. The ERDA Plan gives no indication that payoff is likely to result from such R, D&D through the commercial introduction of more energy efficient vehicles. Obstacles which blocked the commercialization of the proposed systems in the past are not addressed, and there fore, it seems doubtful that these technical, economic, or environ mental impediments will be removed by the proposed R, D&D programs. ERDA should focus its attention less on production prototypes and more on long-term, basic supporting technologies.

BUDGET SUMMARY

The automotive activities are contained within two budget categories: Heat Engine Highway Systems and Electric and Hybrid Highway Systems. These two categories comprise 83 percent of the entire Transportation subprogram.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Heat Engine Higl~way Systems	8.5	(Not Available)		14.8
Electric and Hybrid Highway Systems	1.6	(Not Available)		4.6

Each of these categories has received substantial increases. The principal focus on the Heat Engine category is on the development of prototype gas turbine and Stirling engines which will take the major share of the budget. The Electric

Systems category also is oriented toward prototype development. There is very little R, D&Don basic, long-term support technology indicated in the budget. ERDA is presently engaged in some of these types of projects, such as those on ceramic materials for gas turbines and the sodium-sulfur battery, but overall, the budget still lacks the appropriate emphasis and balance.

COMPARATIVE SUMMARY

ERDA has chosen to continue focusing its automotive research activities on prototype development. There has been no significant change in emphasis toward research and development on basic support technology. Although aware of the points raised in the issue it is apparently ERDA's contention that prototype development will result in the highest payoff. However, there is no discussion justifying this choice. In particular, the likelihood of these activities leading to successful commercialization of alternatives to the internal combustion engine is not addressed. It is OTA's contention that this issue remains as valid as when first raised,

QUESTIONS

1. How does ERDA establish its priorities in advanced automobile technology?
2. What is the percentage of funds in the Heat Engine Systems category going to component and support technology development?
3. Does this represent in ERDA's view a reasonable division considering the likelihood of commercialization of prototype engines developed by ERDA?

16. Cooperation With the Transportation Industry

ISSUE

Successful commercialization of ERDA-sponsored technology in the transportation sector will be achieved more readily with close cooperation between ERDA and industry.

SUMMARY

Industry involvement in the commercialization of ERDA-sponsored technology, such as new and improved automotive powerplants, is critical. While technology transfer within a given organization is difficult, transfer between two different organizations, such as ERDA and the automotive industry, is vastly more difficult. To alleviate this problem, ERDA should solicit industry advice and input during the program planning stage; this input might consist of ERDA contracts with industry in the areas of feasibility, assessment, and systems planning, or of joint ERDA/industry advisory groups. Various constraints upon joint interaction exist, such as antitrust considerations in the automotive industry. Nevertheless, early industry commitment to commercialization is essential to the successful transfer of ERDA-sponsored technology to industry.

BUDGET SUMMARY

The budget item which is principally concerned with this issue is the Implementation category. This request is given in Issue 3. In addition there are elements of the other categories which deal with interaction with the transportation industry although specific budget amounts, if relevant, are undetermined. The available budget requests, however, indicate that ERDA has taken a significant step in addressing this issue.

COMPARATIVE SUMMARY

ERDA has addressed this issue quite extensively in the program document. They intend to make cooperation with the transportation industry a principal component of their strategy and implementation. In the case of high-risk, long-term projects ERDA states that the transportation industry will be involved from the beginning.

The mechanism for this cooperation is not clearly spelled out and it appears unsystematic. Finally, while ERDA considers various constraints, such as antitrust considerations, to joint industry involvement in projects, a strategy for resolving these problems is not spelled out.

QUESTIONS

1. Has ERDA established a formal systematic mechanism for industry involvement in ERDA's Transportation Program?
2. Is ERDA prepared to deal with possible legal constraints to industry involvement in the Transportation Program?

17. Nonhighway Vehicle Transportation Program

ISSUE

ERDA presently has no program for energy conservation in the nonhighway vehicle transportation sector.

SUMMARY

Although railroads, pipelines, waterways, and airplanes carry many of the passengers and much of the freight in this country and use a substantial quantity of petroleum fuel, the ERDA conservation program virtually ignores this sector. There is immediate need for the assembly of an adequate data base and for systems studies to identify the areas of greatest potential fuel savings, In addition to performing this analysis, ERDA must possess the capability to cooperate with and, in some instances, coordinate the efforts of other Federal agencies toward energy conservation in this sector.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Nonhighway Transportation Systems	0.5	(Not Available)		0.5

The amount for FY 77 does not appear to be commensurate with the large quantity of energy used by nonhighway transportation systems (6 percent of the Nation's total). This sum of $500,000 can do no more than initiate studies on technologies to reduce fuel consumption for nonhighway systems. It is inadequate

to deal with problems raised by regulations and legislation on both the State and local level and to examine the impacts of substitution of nonhighway transportation systems for a less efficient highway system.

COMPARATIVE SUMMARY

ERDA 76-1 makes repeated references to the necessity for research in problems associated with nonhighway transportation, Discussion is made of improved technology, regulatory problems, and modal shifts. However, a budget of $500,000 can hardly be an adequate response to the needs for a program in this area. Clearly, only preliminary studies can be initiated with such limited funding. This program level does not evoke confidence that systematic planning of possible energy conservation strategies has been carried out.

18. Energy Recovery From Waste

ISSUE

ERDA has formulated no plans or programs in the productive use of waste although specifically directed to do so by Congress.

SUMMARY

ERDA is mandated by law (PL 93-577, Sec. 6(b)(3)) "to assign program elements. . . to advance energy conservation technologies including but not limited to productive use of waste, including garbage, sewage, agricultural wastes, and industrial waste heat; reuse and recycling of materials and consumer product s," The ERDA programs in ERDA-48 vol. 11 make no mention of any such activities,

BUDGET SUMMARY

Use of waste, as defined in the issue, falls in the Energy Conservation Program and the Biomass subprogram in Solar Energy. The only budget request that can be determined is in the Buildings subprogram of Energy Conservation.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriation	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Waste Systems Utilization	1.5	8.0	8.0	1.7

In the ERDA-48 program document, no mention of energy recovery from waste was made, although it is clear funds were appropriated. It is also clear, however, that the FY 77 budget request to Congress does not permit ERDA to expand its efforts to fulfill the mandate of PL 93-577 as outlined in the issue summary. The ERDA and division requests would permit an approach more in keeping with the legislative objectives.

COMPARATIVE SUMMARY

The ERDA document presents a subprogram which deals extensively with this issue. The subprogram contains a description of activities to deal with urban, industrial, agricultural and forestry wastes. It discusses a variety of technological options to utilize these wastes and stresses their substitution potential for oil and gas. These activities would do much to meet the requirements of PL 93-577 in the waste utilization area.

The fact remains, however, that no distinct budget request for this subprogram can be found other than the urban waste category in the Buildings subprogram. Therefore, it is difficult to see how this effort can be conducted at the level that is suggested in the program document.

QUESTIONS

1. Why has ERDA no plans in the productive use of wastes?
2. In relation to other Federal agencies, what is the appropriate ERDA role in the area of R, D&D in energy and resource recovery from municipal solid wastes?
3. What is the real magnitude of ERDA's subprograms in energy recovery from waste?
4. Why was the budget cut so drastically for the subprogram on urban waste?

Chapter VI

Environmental and Health Issues

ENVIRONMENTAL AND HEALTH ISSUES LIST

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1. Environmental Impacts of High Voltage Transmission Lines

ISSUE

More explicit program planning is needed to relate High Voltage Transmission Line Program objectives and decisions to related research and decisions on biological and environmental impacts.

SUMMARY

While the ERDA Plan states program objectives on the biological, environmental, and health impacts of high-voltage transmission technology, it does not present explicit scheduling or resource information to relate such programs or findings to the schedules on decision processes of its high voltage transmission technology programs.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Environmental Control Technology—Conservation [Budget Outlays)	0.075	(Not Available)		0.300

The above figure is the Environment and Safety Division's budget for electrical transmission work. The budget of the Division of Electrical Energy Systems (EES) in the Office of Conservation is claimed by ERDA to include five health and environmental studies totaling over $1.8 million. It is not possible to extract this information from the more aggregated figures contained in the budget requests for EES. There is some question as to whether two of the programs are in fact primarily environment or health oriented.

COMPARATIVE SUMMARY

A general fault found with the first ERDA Plan and Program (ERDA-48) was that there was no integration of environmental or health-related work into the Technology Development programs. The electrical transmission area in ERDA is an example of at least partial integration of the Environmental and Health programs into the Technology Development Program. Description and budget presentation in the Program and Budget documents are still inadequate, especially when compared with the description of the technology programs. Further evaluation of ERDA internal documents and discussion with ERDA personnel yielded five programs which were claimed to be environment or health oriented. Of these, the available descriptions raise questions of applicability, though not appropriateness, concerning two of these programs. ERDA personnel have admitted that the results of health and environmental research will not be available in time to affect the design or equipment testing programs planned in electric transmission technology R, D&D but claim that the results would certainly affect deployment of the technologies if deleterious effects are identified.

QUESTIONS

1. EPRI is performing environmental assessments of high-voltage transmission lines. Are they also involved in health or biologic studies related to high-voltage problems?

2. What potential effect could the ERDA biological, environmental, and health investigations have on the contracting and implementation milestones shown in ERDA's technology program schedule for high-voltage transmission?

z. Ground and Surface Water Contamination From Surface Mining

ISSUE

Research is inadequate on the potential environmental problems arising from surface mining, particularly in terms of its impacts on ground and surface water quality.

SUMMARY

Large-scale surface mining of fuels to the extent necessary to meet ERDA's energy plans presents the potential for generating large amounts of a variety of pollutants that will be difficult to control by point-source control technology.

Examples of this type of pollution are the leaching into ground and surface waters of sulfates, nitrates, ammonium, acids, and trace metals from strip mines and reclaimed areas.

The type of pollutants generated can vary from area to area depending upon geology, topography, and climate. The development of predictive models to evaluate the types and amounts of potential pollutants will ease the development of the technology needed to control and minimize these discharges.

BUDGET SUMMARY

Funding referring to strip mining operations is contained in the Environmental Studies, Analysis and Assessment, and Environmental Control Technology sections of the ERDA Program.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Environmental Studies				
Coal Extraction (Budget Outlays)	0.6	[Not Available)		1.4
Oil Shale Technology (Budget Outlays)	0.4	(Not Available)		0.6
Analysis & Assessment				
Assessment of Environmental Impacts of Energy Systems (Budget Outlays)	1.6	(Not Available)		1.6
Assessment of Impacts of Energy Production on Local, Regional & National Scales (Budget Outlays)	7,7	(Not Available)		7.8
Environmental Control Technology — Coal (Budget Outlays)	1.2	(Not Available)		1.8

The only area of significant budget increase is in Environmental Studies, Coal Extraction. The increase in the budget of Environmental Control Technology, Coal, appears to be oriented toward coal combustion research, rather than extraction research. The budgets related to surface mining in the Analysis and Assessment Program have decreased in real dollar terms.

COMPARATIVE SUMMARY

ERDA's awareness of the environmental problems related to strip mining is evident in the program descriptions provided in the budget documents, and to a lesser extent in the Program document. There appears to be activity related to water resources and strip mining in several agencies other than ERDA.

There is little indication of how good the level of coordination is between ERDA and other agencies. The potential environmental effects of strip mining or in situ leaching of uranium are barely mentioned. This may be a significant oversight. The schedule on page 587 of the Program for the Coal/Uranium Extraction study indicates that completion of data on the most critical area, the Southwest, will not be completed until the end of 1981, which seems a long lead time. In general, however, ERDA is either doing much more in this area than it was a year ago or is reporting its programs better.

QUESTIONS

1. What is the effect of large-scale surface mining operations in the West on ground and surface water quality in the Missouri and Colorado River Basins?

2, What impacts will changes in ground and surface water from large-scale surface mining operations have on farming and ranching in the West, and on forestry, agriculture, and municipal water supplies in the East?

3. In what geographic areas is it necessary to replace topsoil to insure the productivity of the land, and in what areas will replacement of topsoil be unnecessary?

4. To what extent and in which areas will mining-induced water pollution limit energy development?

5. Which agency should take the leadership role in research relating to environmental impacts of surface mining operations, and what should be its relationship to other Federal and State agencies?

6. Why is there little mention of environmental effects from uranium extraction included in the Biomedical and Environmental Research (BER) or the Fuel Cycle Research and Development Programs?

7. What percent of the research is to be allocated to national laboratories and what percent to the private and university sector?

3. Energy Consumption and Inadvertent Climate Modification

ISSUE

Not enough is known about the potential for detrimental or irreversible climate modification caused by increasing worldwide energy use over the long term.

SUMMARY

Changes in rainfall and temperature associated with increased energy consumption have been observed in specific localized areas. Evaluation of the potential for large scale changes in climate caused by escalating energy use requires a better understanding of the Earth's ultimate capacity to assimilate man-made heat. While the ERDA plan paid some attention to the relation between energy use and local meteorological changes, it does not address the larger question of the ultimately sustainable level of thermal loading.

COMPARATIVE SUMMARY

The issue deals with the multiple aspects of inadvertent climate modifications associated with escalating energy uses of all types. Budget authorizations could not be identified for any of the following areas: 1) climate modifications produced by large nuclear farms; 2) long-term limits on supportable man-made thermal heat loads; 3) long-term impacts of pollutant generation (e.g., $C0_2$, SO_x, NO_x) associated with the use of fossil fuels; 4) identifiable constraints on energy-development scenarios that relate to thermal or pollutant environmental loadings; 5) international cooperation on problem areas of this type; 6) cooperative programs with NOAA, NASA, EPA, The potential long-term temperature change caused by increased atmospheric $C0_2$ concentrations is considered to be an especially critical unresolved problem.

QUESTIONS

1. What is the total requested budget authorization for work on the relation between energy consumption and inadvertent climate modification?
2. How much of this total will be allocated to studies on nuclear farms?
3. What is ERDA's financial contribution to cooperative programs with NOAA, NASA, and EPA?
4. Will the responsibility for early identification of environmental constraints (e. g., unacceptable $C0_2$-loading) in energy development schedules reside with the Assistant Administrator for Environmental Research and Safety, the Assistant Administrator for Systems Analysis and planning, or the manager of the new Overview and Assessment Program?

4. Variance on Environmental Standards During Development

ISSUE

Present environmental regulations on the functioning of environmental control equipment may tend to deter the development of new energy technologies at the pilot plant level.

SUMMARY

Development of necessary environmental control equipment can be as difficult and uncertain as the development of any other technology. The present regulatory climate in the United States does not provide for pilot plant development programs as special cases. Coupling the development of new energy technologies with that of their associated environmental protection technologies, as regulations now require, may seriously hamper ERDA efforts to bring new energy sources to commercial use. This presents a risk of abandoning potentially viable energy technologies because faulty performance of experimental environmental control equipment compromises (the proof-of-process) results obtained in pilot-plant testing of the basic energy technology. ERDA should address the question of the environmental risks and ad hoc mitigating measures which may be appropriate in pilot level development. With the Congress and the regulatory agencies, ERDA should explore the advisability of special regulations for pilot and demonstration facilities.

BUDGET SUMMARY

No section is directly applicable,

COMPARATIVE SUMMARY

ERDA is to be commended for the addition of $5 million in establishing the Analysis of Energy and Environmental Policy Considerations Program. The ERDA Program does not, however, discuss the complex issue of obtaining variances from existing environmental standards for pilot demonstration facilities for new energy-development technologies. It has not been established when environmental assessments or environmental impact statements will be needed.

The overview and analysis role of the Environment and Safety Division relative to the technology branches of ERDA needs to be more carefully defined. The role of EPA in enforcing existing environmental standards for new energy testing facilities needs to be carefully delineated. The problem of possible variances from existing or proposed regulations by State and local government agencies has not been discussed.

QUESTIONS

1. What consideration has ERDA given to prototype development problems which could result from the parallel operation of experimental energy-associated and environmental control equipment?
2. Have the possibilities for flexible environmental regulations and necessary pre - cautions for experimental facilities been explored by ERDA with other agencies such as EPA? Will the treatment of this problem open the door for general standard relaxation?

5. Energy Modeling and Data Bank Requirements

ISSUE

It is not clear from the ERDA Plan and Program that ERDA fully recognizes and accepts critical needs in energy modeling procedures and in the associated data requirements.

SUMMARY

Linear models, such as the Brookhaven Reference Energy System, used for projecting the ERDA scenarios can easily incorporate probabilistic measures of the accuracy of environmental information. Probabilistic calculations would give a more meaningful projection of future demand as well as pinpoint data which are important but highly uncertain.

A large increase in the number of categories of effluents measured and used in environmental impact modeling is also needed. Using the proposed Brookhaven techniques, grouping of compounds results in, for example, the collection of all hydrocarbons in a single category. This procedure facilitates the collection and manipulation of data, but makes conclusions based on such data suspect, because of the substantial variation in environmental effects among the hydrocarbons.

The whole field of energy system modeling is in an early stage of development. ERDA's discussion of modeling recognizes a need for much more sophisticated techniques than those currently at hand. Several energy models are being developed around the country. It would be desirable for ERDA to interface on a continuing basis with these other activities so as to compare the sensitivity of modeling results to alternative techniques and data bases. Consistency of projections from alternative models does not guarantee accuracy. However, in the absence of an existing real basis for calibration, a consensus between independent efforts can increase confidence in the validity of the results obtained.

BUDGET SUMMARY

ERDA's efforts to develop environmentally related data bases and modeling procedures appear to be primarily embodied in the Assessment of Impacts of Energy Production on Local, Regional, and National Scales (AIEP) section of the BER Analysis and Assessment Budget. Other sections of the budget allude to related activities. Although the original division and ERDA requests for AIEP funding are not known, it is assumed that reductions follow the overall Analysis and Assessment funding in a roughly proportional manner.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Analysis and Assessment	11.6	27.8	27.5	19.0
Assessment of Impacts of Energy Production on Local, Regional, and National Scales (Budget Outlays)	7.7	(Not Available)		7.8

COMPARATIVE SUMMARY

The FY 77 ERDA Budget indicates that during the year **ERDA** will develop models to evaluate the impacts of the development and use of prospective energy sources and to analyze and utilize appropriate models developed by other agencies. Moreover, the budgets also indicate that the relevant data bases in standardized form are being expanded and improved. Despite these indications that ERDA has given consideration to the key concerns involved in this issue, the FY 77 budget in this area represents an actual decline in funding in real dollar terms. If it is assumed that the decrease in the funding for this section is roughly proportional to the decrease in analysis and assessment funding overall, it would appear that OMB has failed to support ERDA's interest in this area.

QUESTIONS

1. What are ERDA's plans to incorporate in their modeling efforts information on the levels of uncertainty associated with environmental data?

2. The postulating of alternative scenarios is only one of several methods of treating the uncertainties associated with the development of new technologies. What methods will ERDA use to display the sensitivity of their results to changes in assumptions used and to uncertainties in the environmental data?

3. In view of the number of independent energy system models that are being developed, what plans does ERDA have for making alternative projections?

6. Site and Technology-Specific Nature of Cause-Effect Relationships in Environmental and Health Impacts

ISSUE

Simple extension of energy systems modeling capabilities to the regional discrimination level with expanded emissions categories will not yield a valid impact profile for energy technology decisionmaking.

SUMMARY

Considerable effort has been devoted to determining the rates of emission of various materials from energy conversion devices. These data are by no means complete, but in many cases they are adequate. Much less is known about the actual amounts of environmental degradation resulting from a given emission rate. The prediction of dose is complicated by site specific factors such as population density, climatology and ambient air quality. The further translation from pollutant dose to effect is known only for a very small number of pollutants (SO, ozone, PAN, lead, CO, etc.) and only in terms of their major effects on agricultural products and selected animal species. However, the effects of even these pollutants is not known for low dose levels. Chronic exposure conditions or possible synergistic relationships have seldom been explored. Expanded studies are needed to assess the impact, in quantifiable terms, of the many energy related pollutants at varying emission or release rates. Such studies will improve the effectiveness of modeling approaches and ultimately improve our capability to optimize energy choice/use patterns.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Health Effects of Energy Systems (Budget Outlays)	1,5	(Not Available)		**1.5**
Environmental Impacts of Energy Systems (Budget Outlays)	**1.6**	(Not Available)		**1,6**
Local, Regional and National Impacts (Budget Outlays)	7.7	(Not Available)		7.8
Environmental Data Integration (Budget Outlays)	0.6	(Not Available)		
Total Analysis & Assessment	**11.3**	**17.5**	**17.2**	**11.7**

There was a significant increase in budgetary allocation between FY 75 and FY 76 and an attempt by ERDA to further increase the budget for this work in FY 77. That attempt did not survive the budget review process outside ERDA.

COMPARATIVE SUMMARY

In addition to the work identified in the budget summary in the Analysis and Assessment area, there are significant programs identified elsewhere in the budget document that relate to pollutant emissions from specific technologies, the transport, transformation, and fate of those pollutants and the health and ecological impacts of pollutant concentrations identified in specific study areas. Studies are underway or planned for a number of critical areas. In sum, the various elements add up to a very-well-defined and well-structured program. The urgent need for the information sought in these programs places in question the action of OMB in reducing the budget request.

7. Integration of Environmental, Health, Social, and Institutional Research Into Technology Programs

ISSUE

ERDA's presentation and discussion of environmental, health, social, and institutional research indicates a lack of integration of this research into its R, D&D program.

SUMMARY

To maximize the effectiveness of research on environmental, health, social and institutional constraints, the results of that research should be available before the widespread implementation of the technology, The ERDA implementation schedules do not present environmental and health research timelines in parallel with the technical milestones. Further, the specific plans for environmental and health-related research, tailored to the individual technologies which will be promoted, are not detailed and discussed in the technology program statements provided in volume II.

The failure of volume II to define environmental, health, social and institutional problems which could constrain specific technology programs is a significant oversight. The oversight is emphasized by the established obligation of Federal agencies to consider potential environmental impacts at the earliest time in their planning processes. Explicit priority is given to analysis of environmental and social consequences of energy technology deployment in Section 5 (a] (2) of the Federal Nonnuclear Energy Research and Development Act of 1974. Because of the lack of specificity of the environmental activities defined in ERDA's technology program descriptions, there is no guarantee that the necessary environmental research and assessment will be conducted simultaneously with energy technology development.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Analysis and Assessment	11.6	27,8	27.5	**19.0**

Relatively large increases were requested by the Division and ERDA and approved by OMB for Analysis and Assessment. The percentage increase recommended by OMB is 63.5 percent and is much larger than the specified increase of 4.73 percent for all aspects of Biomedical and Environmental Research. The small increase for all of BER is inadequate, especially in view of a 31.9-percent increase in funding for all of the ERDA activities recommended by OMB.

COMPARATIVE SUMMARY

Initiation of the Overview and Assessment Program within ERDA is a major response to the primary OTA concern in the Environment and Safety area. According to ERDA 76-1 (p. 549), the activities of the Overview and Assessment Program will be defined during FY 77, thus leaving unanswered each of the following critical questions:

QUESTIONS

1. Who is in charge of the Overview and Assessment Program?
2. If its functions are not restricted to advisory and coordinating activities, by what mechanism will program implementation be accomplished?
3. Where and what are the direct budgetary authorizations for operation of the Overview and Assessment Programs?
4. How will this program be coordinated with EPA functions?

8. Energy Impacts of Air and Water Pollution Control Regulations

ISSUE

The interactions between energy, environmental and economic effects of Federal, State, and local air and water quality standards are not sufficiently understood.

SUMMARY

The enactment and enforcement of air and water pollution control regulations can have substantial impacts upon energy consumption requirements and solid waste generation. These potential impacts will become increasingly important in the future with the decreasing availability and increasing cost of fuel supplies and/or disposal sites. These complex interactions are not presently recognized by existing regulations, which tend to treat air pollution, water pollution, and solid wastes as separate problems unrelated to potential energy consumption requirements. Environmental protection and energy consumption optimization trade-offs are needed.

BUDGET SUMMARY

The considerations relevant to this issue appear to be most directly addressed by the Analysis of Energy and Environmental Policy Consideration (AEEPC) section of the Environmental Research and Safety's Analysis and Assessment Budget. However, funds expended in other sections of the Analysis and Assessment Budget also bear on these considerations. Therefore, the table below lists information on both the overall Analysis and Assessment Budget and the subordinate AEEPC section. Although the original division and ERDA requests for AEEPC funding are not known, it is assumed that the reductions follow in a roughly proportional manner the overall Analysis and Assessment funds.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Analysis & Assessment	11.6	27.8	27.5	19.0
Analysis of Energy — & Environmental Policy Considerations (Budget Outlays)	—	(Not Available)		5.0

COMPARATIVE SUMMARY

The addition of a new activity with a rather substantial budget to specifically analyze the relationship among interrelated environmental, health, economic and societal factors would indicate an appreciation of the need for a clearer understanding of the benefits and costs of air and water pollution control regulations. To the extent of the 24-percent reduction in the Analysis and Assessment request, the program desired by the Biomedical and Environmental Research Division would appear to have been reduced in scope. Without more detailed information of how the $5 million will be allocated it is difficult to analyze the effects of the program. Nevertheless, it does appear that ERDA has meaningfully addressed the issue.

QUESTIONS

1. What changes need to be made in existing Federal, State, and local air and water pollution regulations regarding the trade-offs between environmental protection and energy consumption?

z. What are the proper criteria for obtaining optimum balance between environmental protection and energy consumption at specific sites, and by whom should they be explored?

3. What improvements are needed in existing air pollution and water pollution control technologies to minimize potential energy consumption?

9. Competing Demands for Water in Western River Basins

ISSUE

The limited availability of water in areas such as the Colorado and Missouri River basins will force systems evaluation of net benefit from energy and non-energy activities which depend on water.

SUMMARY

Large amounts of water will be required from available ground and surface water supplies in the arid Rocky Mountain States for energy production operations such as coal and oil shale mining, slurry pipeline coal transportation, minemouth electric power generation, coal and oil shale conversion to gaseous and liquid fuels, and environmental management of strip-mined areas and spent shale disposal areas. Extensive implementation of these projected energy production activities may adversely affect water quantity and quality for agricultural use in the same river basins. Development of geothermal energy resources, e.g., in the Imperial Valley, could result in either further water demand and water quality impact or in the production from saline water of a supplementary source of freshwater for agricultural use. Extensive analysis of the total system activity in these river basins will be required to ensure that the proposed energy development activities which are actually implemented will result in a net benefit to the country.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Assessment of Impacts of Energy Production on Local, Regional & National Scales (Budget Outlays)	7.7	(Not Available]		7,8

Issue 9 is just one study of this subprogram; no figures are available for budget allocations for this specific program.

COMPARATIVE SUMMARY

It appears that ERDA's program only partially addresses the problem of water demands in western river basins. It further appears that ERDA's primary concern is for nuclear power complexes and ERDA's own demonstration facilities. The competing water demands between different energy production operations and the competing water demands between energy production and nonenergy production uses (agricultural, recreational, industrial, and municipal) are an all-encompassing problem that has not yet been addressed.

QUESTIONS

1. What is the maximum amount of water which can be made available for energy production in the Missouri and Colorado River basins without jeopardizing agricultural operations and other industrial or public demands for water?
2. What impacts upon water quantity and water quality will occur in the Rocky Mountain States from varying levels of energy production, and what impacts will these have on agricultural production and resultant food prices?
3. What are the relative environmental, energy and economic trade-offs of minemouth processing of coal to electrical energy or synthetic fuels in the arid Rocky Mountain States as compared to alternative transportation to water-abundant areas along the Mississippi River or Gulf of Mexico for subsequent processing?
4. What is your estimate for the potential production of desalinated water from geothermal resources in the Imperial Valley of California by the year 2000?
5. What plans does ERDA have for the construction of integrated regional development plans linking seemingly disparate energy technologies?
6. Which energy production and transportation operations become less attractive (environmentally and economically) with a limited availability of water?
7. What is the budgetary contribution for studies of water demand for nonnuclear operations versus studies oriented toward nuclear power complexes?

10. Need for Social Research in Offshore Energy Programs

ISSUE

Social research is needed on institutional problems arising from the deployment of offshore energy technologies.

SUMMARY

Major problems in new offshore development are presented by the social and institutional constraints to developing offshore oil and gas production, nuclear, and fuels transportation facilities. One current major research need is to examine new institutional mechanisms in order to further understand the problems of government management and public acceptability, This research needs to be conducted on national, regional, and local levels.

BUDGET SUMMARY

No direct budget information is available relative to the specific issue. A new division, Overview and Assessment, has been suggested within AES which will examine: 1) policy analysis, 2) overview management, 3) EIS monitoring and review, and 4) integrated assessment. This new division will inherit the functions of Analysis and Assessment (A&A). The A&A budget shows five categories, three of which mention socioeconomic studies. It is not clear, however, how the five A&A budget categories will relate to the four functions of Overview and Assessment.

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request *to Congress*
Analysis & Assessment (socioeconomic) Environmental Impacts of Energy Systems (Budget Outlays)	**1.6**	(Not Available)		**1.6**
Impacts of Energy Production on Local Regional & National Scales (Budget Outlays)	7.7	(Not Available)		7.8

SUMMARY TABLE — Cont.

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Energy and Environmental Policy Considerations (Budget Outlays)	0	(Not Available)		5.0
Analysis & Assessment, Office of Planning and Analysis	11,6	27.8	27.5	**19.0**

The ERDA budget in Analysis and Assessment grew by 65 percent between 1975 and 1976, and the requested figure sent to OMB of $27.5 million would have represented a 136-percent increase over the 1976 appropriation. By comparison the total ERS budget grew by 26 percent between 1975-76 and by 65 percent from 1976 to the 1977 ERDA request. A larger share of funds is going, then, to socioeconomic research.

COMPARATIVE SUMMARY

The social impacts of energy production have been mentioned under Policy Analysis, Environmental Effects, and Analysis and Assessment Programs in BER. However, these need to be more fully addressed for both onshore and offshore energy development, particularly in terms of new communities, quality of life, and employment mobility.

ERDA states that it desires to work with EPA on impacts from oil spills (p. 585). It also says that its Overview Management "assures proper integration and coordination of various programs. "

ERDA thus both recognizes social impacts and understands that it should cooperate in environmental problems related to offshore energy programs with other agencies, However, it does not specifically relate social research and offshore oil development problems.

11. Effect of Public Attitudes on Program Implementation

ISSUE

ERDA's plan for Energy Research, Development and Demonstration does not include research on how public attitudes and values affect implementation of Government energy plans and controls.

SUMMARY

Public attitudes about the proper role of Government, what constitutes qua lit y of life, and what characterizes important threats to the human environment, greatly affect what Government actions people will support as well as the incentives and disincentives to which they will be willing to respond. ERDA's plan does not appear to include study of energy-related attitudes, their formation, intensity, and stability, and the impact of information upon attitude changes.

BUDGET SUMMARY .

No specific budget allocation for this activity has been identified.

COMPARATIVE SUMMARY

The issue of how public attitudes affect program implementation of new energy technologies has not been fully addressed in the ERDA Program and budget. However, a section is devoted to Public Awareness in the ERDA Program (pp. 683-685). The goals are stated as:

"To increase public awareness and understanding of the nation's energy problems and of the resource and technology options which may be applied to their solution so that the public can make an informed choice. " (p. 683). Enhancement of public awareness and understanding is a necessary goal, but it is not the whole issue; the question includes the ways in which the public can or will affect the program, not just how the program affects the public.

The ERDA Program states that "Cooperative programs are being developed with organized groups — civic, labor, and management organizations and environmental, public interest, consumer, and youth groups — to provide and obtain information via the active communication channels such groups have with community cross sections throughout the U. S." (p. 685). Workshops, seminars, exhibits, films, etc., and other educational materials are also being produced or planned. These statements indicate that ERDA has at least committed itself to a good start in establishing a genuine dialogue with the public.

QUESTIONS

1. How will ERDA present the necessary results of research on public attitudes so that agencies and other policy makers can make judgments about what the public will accept in terms of energy development, conservation regulations, and environmental controls?
2. How well do the environmental impacts which ERDA proposes to predict for various technologies reflect the concerns that people actually have about their environment?

12. Program Focus in Fossil Fuel Health Effects Research

ISSUE

The ERDA program of research on the health effects of fossil fuels covers a broad range of biological responses and pollutant exposures. Some research areas do not appear to be relevant to ERDA's missions.

SUMMARY

ERDA's overall program of research into the effects of fossil fuel use on health places great emphasis on basic biological mechanisms of response, Certain important areas, such as biological screening, carcinogenesis and mutagenesis, and epidemiological studies, appear to be inadequately emphasized, while other areas, such as research on recovery, treatment, and development of radio-pharmaceuticals, may well be unnecessary under the primary mission of ERDA's health research program. The program description gives little detail as to which pollutants will be given highest priority, or on how the results of health effects research will be integrated into the decision process as to which alternative energy technologies to develop. To meet these research demands, there is a critical need for the training of additional cell- and tissue-culture experts, toxicologists and epidemiologists.

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Health Studies	65.1	83.1	79.7	63.3
Biological Studies	34.0	41.3	40.1	34.0
Education and Training	3.5	7.6	7.0	2.2

The budget history shows an attempt by ERDA to significantly increase both health effects and biological studies. The OMB screening process changed the ERDA budget requests to an effective reduction if inflationary effects are included. The Education and Training budget suffered an absolute decrease of almost 40 percent.

COMPARATIVE SUMMARY

The original issue identified a need for more emphasis on epidemiological studies and the training of cell and tissue culture specialists, toxicologists and epidemiologists. There appears to be no change in this situation. Some epidemiological and toxicological work is defined in the Health Effects budget, but the majority of the effort appears to be expended on delayed carcinogenic effects. The Biological Studies Program of ERDA 76-1 is much more oriented toward cellular and molecular biological studies than was the program description in ERDA 48. The education and training proposal of ERDA\AES, which would have doubled the budget in this area, did not survive OMB review.

QUESTIONS

1. How will ERDA's health research program, which is largely directed toward animal models, evaluate known adverse effects on human health which cannot yet be modeled with animal experiments?
2. What plans does ERDA have for training programs to provide the additional manpower needed for their proposed health effects research programs?
3. If ERDA obtains positive results on screening for detrimental effects of a fossil fuel product, how will the results be validated with respect to human populations?
4. What plans does ERDA have to evaluate the safety of substances in humans, once they have successfully passed through the animal screening system?

13. Inadequate Inventory of Skills and Techniques in Health Effects Research

ISSUE

Means are not available to estimate effects of coal combustion and conversion on human health. A broad-based research effort, in both university and Federal facilities, is critically required to develop improved techniques for evaluation of health impacts from coal combustion and conversion.

SUMMARY

The Health Studies Section of ERDA-48, volume II, emphasizes research in the area of longterm effects of coal-related pollutants. This emphasis on cancer and birth defects is most appropriate, since coal-related pollutants are known carcinogens and mutagens, The program, however, appears to stress traditional long-term animal experimentation. This approach cannot yield relevant data in time for decisions about national energy prerogatives. The program also suggests the use of recent research developments in the field of animal cell genetic assays, These show great promise as relevant bioassay systems and should receive greater emphasis. An intensive broad-based effort should be used in both data acquisition and innovative fundamental research, A significant increase in both the scope of the related ERDA research organization and the university production of trained researchers will be needed to meet the research program requirements,

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Education and Training	3.5	7.6	7.0	2.2

COMPARATIVE SUMMARY

Both ERDA and OMB have drastically cut the Education and Training Program. The problem of contributing to an adequate inventory of skilled professionals in the Environment and Safety area, however, has a larger focus than that of providing training grants. At issue here is the long-term evolution of

ERDA funding strategy with respect to the support of a broad-based research effort in the non-Federal sector, and the support of basic research relating to ERDA's long-term goals and objectives.

QUESTIONS

1. What was the FY 76 funding distribution in the Environment and Safety Program retween:
   (a) the in-house laboratories;
   (b) not-for-profit, non-ERDA organizations;
   (c) the private sector;
   (d) educational institutions?

2. What fraction of the total budget will ultimately be allocated to: (a) the in-house laboratories, and (b) other organizations?

3. How does ERDA management view its responsible and proper implementation strategy for assuring that an adequate number of trained professionals are available in the Environment and Safety Program area?

14. Atmospheric Sulfates as a Potential Constraint on ERDA's Fossil Fuel Program

ISSUE

Suspected health hazards of atmospheric sulfates may result in air quality standards which would constrain ERDA's programs based on coal.

SUMMARY

Questions have been raised concerning whether sulfate concentrations (as an index of SO_2 transformation products) throughout the Midwest and Northeast may presently exceed threshold concentrations for adverse health effects. If substantiated, this finding would raise serious questions as to the advisability of introducing any new sources of sulfur oxide emissions into the atmosphere. There are considerable uncertainties about the concentration and chemical nature of atmospheric sulfates which are hazardous to health. Improved information on the relation of toxicity to sulfate concentrations is required to set ambient air quality standards. If the present fears are supported by scientific findings, standards could be set which would severely limit further energy development programs based on coal as a primary fuel, on direct utilization of geothermal resources, and on approaches to reduce automotive emissions. Immediate and concentrated attention to this area would help to resolve the existing uncertainties. Some of the energy

goals set **by ERDA, if pursued in the absence of the necessary health effects information on atmospheric transport and transformation of sulfates, may not represent an achievable objective.**

BUDGET SUMMARY

SUMMARY TABLE

(Dollars in millions)

Budget Category	FY 76 Appropriations	FY 77 Division Request	FY 77 ERDA Request	FY 77 Request to Congress
Characteristics, Transport & Conversion (Budget Outlays)	17,6	(Not Available)		19.5
Fundamental Environmental Processes Related to Energy (Budget Outlays)	9.2	(Not Available)		8.3
Physics & Chemistry of Pollutant Interactions in the Environment (Budget Outlays)	1.0	(Not Available)		**1.6**
Characterization, Measurement & Monitoring (Budget Outlays)	10.5	(Not Available)		11.4

COMPARATIVE ANALYSIS

The question of sulfate air pollution is well addressed by BER in the Health Effects, Environmental Effects and Physical and Technological Studies Programs in the larger context of fossil fuel pollutants. The program is well characterized and will effectively define the magnitude and nature of sulfate problems from stationary sources.

Sulfates are also produced in automotive-engine exhausts as the result of catalytic oxidation of SO_x in emission-control devices. When allowable levels are defined by the EPA for this pollutant (hopefully, at concentration levels that can be monitored reliably), it will be necessary to consider the combined effects of sulfate emissions contributed by the transportation sector and by coal-based technologies.

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