Chapter I

Overview Issues

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OVERVIEW ISSUES LIST

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?