EXECUTIVE SUMMARY

The ERDA Plan (volume I) is a significant milestone in the evolution of a long-term national energy policy, However, the ERDA Program (volume II), to implement this plan does not appear adequate to achieve the stated goals,

In particular, there are two broad areas in which the differences between the policy goals mandated by Congress and the programs proposed by ERDA to meet those goals are especially significant. These deficiencies, unless remedied, could impede the solution of short-term and mid-term energy problems by the United States, which could lead to an increased dependence on foreign energy sources.

The first deficiency occurs because of ERDA's pursuit of technological options at the expense of a focus on a broader approach toward the solution of energy problems. Simply establishing technical feasibility is insufficient as non-technical constraints may prohibit implementation. Such constraints could include any or all of: transportation, resource, manpower, and capital availability y; public acceptability; or institutional, jurisdictional, economic, and environmental compatibility. If ERDA is to supply solutions to energy problems as mandated by Public Law 93-577, none of these can be neglected. If ERDA confines its activities predominantly to the proving of the feasibility of technological options, some other entity should address the more complex issues underlying energy solutions. In such a case clear coordination with ERDA would be essential.

The second departure from congressional mandate is to be 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, In Public Law 93-577 (Sec. 5(a)(l)), the Congress defined energy conservation as meaning "both improvement in efficiency of energy production and use and reduction in energy waste. " The law requires energy conservation be "a primary consideration in the design and implementation" of the ERDA program, Yet only 2 percent of ERDA's budget appears to be allocated to conservation programs.

It is well recognized that expansion and conversion of our large energy supply systems will be very costly and cumbersome, but that our dwindling oil and gas reserves dictate such modification. By contrast, successful widespread implementation of conservation programs with increased efficiency or waste reduction objectives can have both a rapid and a continuing effect. Such improvements need not be technologically complex; they may include merely removing jurisdictional or institutional constraints, such as building codes which require energy-inefficient designs.

If ERDA is to provide near-term and mid-term energy problem solutions, conservation through efficiency and waste-reduction programs should be an essential ingredient. The present ERDA program orientation toward developing complex technological supply options for the long-term overshadows the importance of less-complex *so* lutions with near-term potential,

OVERVIEW ISSUES*

I. The Nature of the Energy Goals

In preparing its Plan, ERDA proposes five goals which, taken together, may constitute the energy policy for the Nation.

The five energy goals are stated as follows:

1, To maintain the security and independence of the Nation;

2. To maintain a strong and healthy economy, providing adequate employment opportunities and allowing the fulfillment of economic aspirations (especially *in* the less affluent parts of the population);

3. To provide for future needs so that life styles remain a matter of choice and are not limited by the unavailability of energy;

* Attachment II, page 311, compares overview issues to Public Law 93-577 and Public Law 93-438.

4. To contribute to world stability through cooperative international efforts in the energy sphere;

5. To protect and improve the Nation's environmental quality by assuring that the preservation of land, water, and air resources is given high priority;

These goals and the emphasis among them warrant careful congressional review. Without agreement between the Administration and Congress on these overall objectives and priorities, ERDA's development of an R, D&D program is more difficult.

Review and consensus become all the more appropriate in view of the major influence these goals and their priorities will have on the Nation's economy, quality of life, environment, foreign affairs, and many other sectors.

2. The ERDA Response

ERDA acted ambitiously in proposing the set of national energy policy goals, Its interpretations of them are much too modest, however,

Basically in addressing the energy goals ERDA adopted a narrow, hardware-oriented approach. Its R, D&D effort is designed primarily to develop technologies . . . rather than to explore solutions to energy problems.

An almost exclusive emphasis on technology has gotten results in some other national research effort s—not ably, in the space program and military weaponry,

In these cases however, the "missions" have been very sharply defined, decisionmaking has been centralized, and ample resources have been available. The relative narrowness of these miss ions allowed a heavy application of hardware, and success has been achieved,

The energy crisis is a far more complex and wide-ranging challenge. It is a problem spanning the whole of man's activity. It involves decisions from individual householders to entire blocs of nations. Its "solution" depends on natural resources and human values, new sources of fuel, public perceptions, and government and industry responses,

As a consequence, ERDA's narrow approach to the national energy policy goals might well fulfill a mission—developing new technology—without providing an answer—a secure energy future, Unresolved "nontechnological" issues—from inadquate incentives for commercialization, through environmental demands, competitive use of resources, to community resistance—could block the most sophisticated engineering achievement,

The OTA Overview Task Group identified a number of very specific issues with respect to the approach of the ERDA Plan and Program to the national energy goals. These issues have an important common denominator—they arise from, and reflect, the narrow, hardware-oriented approach reflected in ERDA's Plan and Program.

3. The Issues

The issues with respect to the ERDA approach are summarized as follows. Each of the following is treated in more detail in chapter 1.

(a) Insufficient emphasis is placed on international *considerations:* International cooperation is essential to cope with the environmental effects of energy-generating technologies; to address security issues such as, specifically, the management of nuclear materials and wastes, and to manage resources, like the oceans, that are a common world heritage. ERDA identifies such considerations in its Plan but barely recognizes them in its Programs.

(b) Incomplete plans are provided for coordination with other Federal agencies: Split responsibilities among Federal agencies are a major potential obstacle to a comprehensive and balanced energy R, D&D program. ERDA has been mandated by Congress as the leading energy R, D&D agency and has been given responsibility to integrate and coordinate national efforts, But it is not evident in ERDA's plans whether a framework is being established to permit adequate performance of this role,

(c) Inadequate provision is made for cooperation between ERDA and State and local governments. The involvement and support of State and local governments is crucial to the success of ERDA's projects. These levels offer strong experience and capabilities in important "nonhardware" areas such as water allocation, land use, taxing policies, manpower training, environmental controls, and public education. While the ERDA plan recognized the importance of close and continuous coordination, it does not include procedures or mechanisms for accomplishing it.

[d) Little attention is devoted to near-term (next ten years) energy problems: 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 nuclear reactors, shifting demand away from petroleum, and increased conservation practices. However, a review of ERDA's FY 76 budget indicates that only about 5 percent is devoted to solving near-term problems.

(e) Only limited attention is given to socioeconomic research and analysis in addressing the Nation's energy problems: Broad-ranging research is needed to identify non-technological obstacles to energy solutions and to better understand the relationships of energy and the quality of life. ERDA's program and budget 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 technical R&D.

(f) ERDA's program overemphasizes energy supply technology relative to consumption: In the past era of constantly decreasing real energy prices, little emphasis was placed on efficiency in "end-use"-energy consumption in the business or home. This, however, is now an area in which significant and cumulative gains could be accomplished.

ERDA's plan makes provision for energy conservation. But the focus is primarily on the near-term, estimates of long-term importance of improved efficiency in energy end-use are undefined.

(g) The development of effective **commercialization** policies is not adequately addressed in the ERDA Plan: Bringing a new energy technology to the point of commercial feasibility is a risky process, especially when it involves diffuse markets, the uncertainty of global energy and economic circumstances, the competition for capital. ERDA's Plan outlines a philosophy for commercialization, but clearly needs a more detailed explanation and careful definition of plans for developing a mechanism for coordination with industry.

(h) Careful attention should be given to assessing energy resources: An incorrect assessment of the Nation's energy resource base could cause severe distortions in ERDA priorities and schedules.

Recent analyses clearly show there is still major uncertainty regarding the nature of our energy resources and point out the critical need for developing better estimation methodologies,

(i) Physical, institutional, and social constraints may limit the progress of the ERDA Energy Plan: As indicated earlier, there are many potential physical and social constraints to the introduction of new energy technologies. The potential for program disruption by possible obstacles demands careful study by ERDA.

(j) The ERDA Plan appears to overemphasize electrification: All three major "inexhaustible" sources (solar, breeder, and fusion) identified by the ERDA Plan are producers of electricity, Yet intensive electrification will have a noticeable social impact and may present problems of vulnerability and reliability.

In order to avoid dangerously narrow future options, the long-term electrification approach should be more thoroughly analyzed than presently proposed to make sure that viable alternatives are not lost by default.

(k) The ERDA Plan relies on assumptions which appear to bias its priorities toward high technology, capital intensive energy supply alternatives: Many of these not only are questionable, but, further, tend to distort the value of various R, D&D options, ERDA plans do not take into account the effect of higher prices on energy demand; they do not include consumer costs in calculating the costs of new energy systems, and they assume exponential energy growth will resume after 1985.

This concentration of focus tends to minimize the potential impact of R, D&D to improve end-use energy efficiency and bias the choice of research priorities toward the supply sector.

(1) Application and questions with respect to net energy analysis receive little attention: "Net energy" measures total energy output relative to total energy input, thereby indicating which technologies are likely to be most useful,

This technique can aid in the establishment of priorities for existing and developing technologies, but research is needed before it can be a consistent and widely accepted tool. The ERDA Plan and Program is not responsive to the Act in this area.

4. Other ERDA Issues

In addition to the above issues related to ERDA's narrow approach vis-a-vis energy policy goals, the OTA overview analysis identified the following three concerns:

(a) There is a need for a reexamination of the overall energy R, D&D budget: The Federal energy R, D&D budget (about $2.3 billion for FY 1976) was largely an outgrowth of decisions made prior to the Arab oil embargo, and should be reexamined.

(b) ERDA's present management policies could hinder achievement of its goals: present ERDA management practices have three recognizable drawbacks: (1) Internal project management tends to impose inhibitingly detailed restrictions on the R, D&D program; (2) project management delegated to external organizations has been awarded to organizations having excessively detailed management structures, resulting in a corresponding loss of program control by ERDA; (3) there is too little emphasis on systems analysis and too much on proof-of-concept experiments,

(c) The goals of ERDA's basic research program have not yet been established: ERDA's program for basic research has largely been inherited from the agencies which it incorporated, It is not surprising because of the short life of ERDA, but nonetheless a concern that the basic research program does not yet reflect ERDA's basic R, D&D goals.

5. Possible Remedies

Whether or not ERDA assumes responsibility for the broader, "nonhardware" R, D&D issues described above, there can be no question of their importance. As emphasized earlier, technology alone will not solve the Nation's energy problems.

Thus, answers to the Nation's energy problems require that the programs deemphasized by ERDA in its narrow interpretation of its role be vigorously pursued somewhere in the Government. Most are not, at present, receiving priority attention anywhere.

One possible answer lies close at hand—in the Acts of Congress. The Energy Reorganization Act establishing ERDA and the Energy Research and Development Act authorizing its programs provide ample latitude for a broad-gaged, well-coordinated R, D&D effort led by ERDA.

ERDA's Plan in many instances acknowledges the need for such a broad perspective and program, In fact, the problems are not so much within the Plan itself—which is a serious and praiseworthy initial effort—but in the lack of broad commitment and coordination when the Plan, Program and Budget are considered together.

Within the mandates of the Congressional Acts, a variety of actions could be considered. They are summarized as follows:

(a) The scope of ERDA's mission could be expanded and clarified, particularly in the areas of demonstration and commercialization. A major requirement is to clarify ERDA's jurisdiction and responsibilities with respect to those of the Federal Energy Administration, the Environmental Protection Agency, the Nuclear Regulatory Commission, and the Department of the Interior, in order to remove overlap, and ambiguity and to provide the grounds for efficient and effective mission management.

(b) As noted, widespread utilization of newly developed technologies depends on a complex process involving the removal of nontechnological constraints on commercialization, industrial incentives, and technology transfer. This process requires further delineation than exists in the present ERDA Plan,

(c) Programs associated with the identification and evaluation of environmental, institutional, and societal constraints associated with alternative energy technologies should receive immediate and substantial attention,

(d) Programs directed toward increasing the efficiency of energy use should be accorded the highest priority,

[e) New efforts to assess global issues associated with energy, such as climate modification, international energy supply and demand estimates, the role of multinational energy corporations, and the link with ocean resources, should be instituted,

(f) The ERDA management approach, including the management of national and Federal laboratories and the role of contract R, D&D should be reevaluated.

(g) Closer working relationships with State and local governments, including their participation in ERDA program planning, should be established.

(h) The potential national benefit which would result from higher ERDA budget levels should be examined.

Fossil Energy

- There is an urgent need to develop increased supplies of oil and natural gas.
- Programs to develop synthetic fuels from coa1 and shale should continue to be given very high priority.
- The ERDA fossil energy program should emphasize the demonstration of technologies on a scale sufficient to provide reliable information for evaluating their technical, economic, and environmental feasibility.
- Attention should be directed toward the broad range of non-technological impediments that can seriously delay, if not altoget her block, the introduction of otherwise economically viable technologies.

By focusing on new technologies, the fossil fuel program (contrary to the supply projections contained in it) limits itself to an insignificant impact on energy supplies in the short-term—before 1985, The first priority should be to get better information about presently available technologies and to facilitate their use when feasible: primary oil and gas extraction from new sources (especially the Outer Continental Shelf) and enhanced recovery of oil. Many of the problems impeding the increase in production of liquid hydrocarbons are nontechnical in nature.

Techniques for the production of synthetic oil and gas from coal and oil shale are available now and should be vigorously pursued, Although the economic feasibility of many of these technologies is highly uncertain at present, the promise of second generation technologies may not be much brighter. In the meantime there is a need for better information about the impacts, economics, and operating experience of commercial-scale operations. It must be recognized that the era of abundant cheap energy is over—especially in the cases of liquid and gas fuels.

Because of the urgency of the national energy situation, the ERDA fossil-fuel program should emphasize the demonstration of available technologies at a scale appropriate to their stage of development: near-commercial scale for cases where no serious technical obstacles exist (such as high-Btu gas and possible oil shale with surface retorting), and pilot scale for cases where technical problems still need to be solved (such as tertiary recovery of oil, stimulation of tight gas formations, coal liquefaction, and low-Btu gas, combined cycle power plants). Better and more universally credible information can only be obtained through demonstration,

While fuel technologies are discussed in some detail by ERDA, too little attention may have been directed towards the broad range of impediments that can seriously delay, if not block altogether, the introduction of otherwise economically viable technologies, Institutional constraints must be addressed early if the technologies upon which ERDA is concentrating its efforts are to be brought to commercialization. It is questionable planning, for example, for ERDA to pour large amounts of funds into the development of a commercially feasible technology for coal liquefaction if the technology cannot then be used—because coal mines cannot supply the coal, transportation facilities are inadequate, capital is unavailable, or water is insufficient. The efficient use of ERDA R, D&D funds requires a systematic look at entire energy development systems. The fact that ERDA does not have the primary responsibility within the Federal Government for dealing with some of these constraints is not a sufficient response; all the more reason exists in such cases for concern that the Government may not adequately consider some components vital for the successful introduction of new technologies.

Nuclear Energy Program

- Improvement in the light water reactor design and operational reliability is required to assure the near- and mid-term potential for nuclear energy,
- Uranium resources should be more precisely defined.
- A final decision on disposal of nuclear wastes should be made and implemented.
- The breeder reactor program continues to require analysis, especially as regards timing of need for the LMFBR cost and management,
- Alternative reactor systems need to be re-examined, and consideration given to ex-

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ploratory program plans to develop such systems,

- Reexamination, should be considered of the balance and rate of expansion of the fusion program.

The present generation of light water reactors is well developed, but problems still exist, as evidenced by rapidly increasing construction costs and disappointing reliability. In a major shift from AEC policy, ERDA recognized a responsibility to support light water reactor technology, but the program is not clearly spelled out; how does ERDA intend to encourage the standardization of power plants, improve their reliability, and build LWR's on floating platforms? Continuation of ERDA's LWR safety research is a part of this support, and should be encouraged,

The future of nuclear fission power is dependent on an adequate fuel supply. The present, highly speculative estimates indicate a uranium shortage early next century. More precise estimates are needed for better planning of LWR growth and scheduling of the breeder development program. The National Uranium Resource Evaluation (NURE) is now underway; when completed in 1980 it should tell us whether we have enough uranium to fuel the LWR's until the breeder can be deployed, It seems, therefore, that NURE ought to be pressed with more vigor than is evident in the ERDA program.

The rest of the fuel cycle—reprocessing, enrichment, and waste disposal—is probably not in as critical a state as is the supply of uranium, at least if the nuclear industry expands no faster than at the moderate rate now projected. Of the remaining components of the fuel cycle, waste disposal should be regarded as the one which needs most attention. In principle, safe disposal of reprocessed radioactive waste in salt appears to be technically feasible. Prompt resolutions of remaining questions and a firm decision by ERDA to proceed with a demonstration are urgently needed.

By far the largest component of the ERDA nuclear program is the development of an "inexhaustible" energy source based on fission breeders, in particular the liquid metal fast breeder. The high cost of the program, especially when compared to its French equivalent, has led to extensive criticism. In retrospect, it may be that the early emphasis on commercialization was premature and expensive. Recent management changes should streamline the project and help prevent further cost escalation, but their effectiveness remains unproven. Although the schedule for demonstration has slipped recently, delayed commercialization of the LMFBR is consistent with lower projections now being made for nuclear power growth. Safeguards against plutonium diversion is a problem intimately involved with the LMFBR, but adequate solutions appear to be possible.

With the creation of ERDA, AEC policies should be reexamined, Perhaps most importantly, it is now possible to reopen the issue of alternative breeder systems, Three such systems are being worked on: the light water breeder (LWBR), the gas cooled fast breeder, (GCFBR), and the molten salt breeder (MSBR), Of these only the LWBR is being pursued vigorously, It is appropriate to ask why the MSBR and the GCFBR should not receive emphasis at least comparable to the LWBR.

The plutonium-based economy entailed by LWR's and LMFBR's increases concern over plutonium toxicity safeguards against diversion and possible problems with long-term waste management. A nuclear system based on thorium (LWBR, MSBR, high-temperature gas-cooled reactor, HTGR, or thorium version of LMFBR), may be less vulnerable to some of these difficulties, Yet a fuel analysis has never been made of thorium-based systems as an alternative to the plutonium-based system; such an analysis is badly needed as a guide to comprehensive nuclear system development. Additionally, the role of high temperature process heat from nuclear reactors, most importantly the HTGR, should be examined. The use of nuclear energy for this purpose could save large amounts of fossil fuel.

Fusion is the other potential "inexhaustible" nuclear energy source, The prevailing opinion is that fusion will probably be successfully harnessed, and that it could be an attractive means of supplying much of the Nation's electrical energy next century. Thus fusion appropriately occupies a prominent position in the ERDA plan, yet there are reasons to remain cautious about the development of the program, Scientific demonstration of controlled fusion, i.e., achieving energy "breakeven" conditions, is still to be reached, This is the goal of the next generation of fusion devices, called "fusion test reactors", which in fact are large experimental devices to test the concept not generate power,

They will operate in new regimes of physics and technology. Because these machines are so costly, a central issue is whether ERDA can meet its very heavy commitment to the tokamak fusion concept while, at the same time, preserving its options on other promising fusion concepts in case the tokamak is not successful,

Solar, Geothermal, and Advanced Technology Programs

- The ERDA solar-energy program underemphasizes the potential of solar heating and cooling relative to solar electric technologies.
- In its solar heating and cooling program, ERDA should consider giving increased emphasis to: user incentives, standards for measurements of equipment performance, and impact on utility peak demand of solar systems,
- Improved decision criteria in the solar electric program are needed to avoid premature exclusion of promising concepts. All the technologies proposed for solar electric generation presently have large cost uncertain ties.
- The legal and institutional problems associated with geothermal resources should receive greater emphasis in ERDA planning.

The principal issue raised with respect to the ERDA Plan concerns the relative emphasis accorded solar-electric and solar heating and cooling technologies, Solar-electric technology is identified by ERDA as one of the three long-term inexhaustible sources; solar heating and cooling is listed merely as an underexploited technology appropriate for mid-term utilization. The relative importance of these two technologies thereby implied by the Plan is judged to be out of balance. The technology and economics for solar water and space heating are available now, A greater near-term emphasis placed in this area relative to solar electric along with acceleration of the solar heating and cooling demonstration program, may be the most effective way to develop solar energy.

Solar energy is suited to many direct thermal applications, and it is in these areas that solar energy can have its most immediate impact on our energy economy and can contribute substantially as a long-term inexhaustible energy source, It is, however, extremely important that necessary attention be given to user incentives, standards for measurement of equipment performance, and the impact on utility peak demand of solar power systems, including wind-energy users.

Although no technical barriers exist to solar generation of electric energy, the high costs estimated for these technologies necessitate a long-term research program if they are to be economically competitive. The large cost uncertainties of different solar electric concepts (ocean thermal energy conversion, wind energy, solar satellite, solar thermal) necessitates development of precise decision criteria for alternative energy technologies. Consideration of resource availabilities is critical due to the extensive use of land and, in some cases, water, by solar electric systems. One specific concern with the ERDA Plan involves the apparent lack of consideration of a number of promising candidates for photovoltaic cell materials.

Legal and institutional constraints are more severe impediments to the rapid utilization of geothermal resources than are technical problems. The ERDA near-term projections for geothermal energy development appear to be optimistic, although geothermal resources do have the potential to meet ERDA goals, if not limited solely to electricity product ion. The most important role for geothermal energy in the United States may be in nonelectric uses, a role which is given inadequate significance in the ERDA Plan. Because each geothermal reservoir has unique characteristics, research strategy on power conversion will have to consider a wide variety of possible utilization systems in order to minimize resource waste.

Conservation Program

- The ERDA Plan for conservation is timid and underfunded, despite strong congressional encouragement,
- The conservation program contains elements largely unrelated to end-use conservation, a situation which threatens to keep the program unfocused and further exacerbate the problems of funding and staffing for end use conservation R, D&D.
- ERDA has not adequately established priorities within its conservation program.

- The success of ERDA's conservation efforts will depend on close cooperation with Federal, State and local agencies, industry, and private citizens.
- Nontechnological constraints could impede the implementation of energy conservation technologies unless addressed and removed,
- ERDA's program does not sufficiently address nontechnological aspects of energy conservation. Social science research is needed to:
    1. Identify and overcome institutional obstacles to implementation.
    2. Evaluate the economic (e.g., labor, capital, growth) implications of alternative conservation programs,
    3, Analyze the appropriate roles of Federal and State regulatory agencies with respect to energy use,
    4. Assist in continuing cost/benefit analyses of conservation options and research programs.

The new high price of energy has made our present use of energy wasteful and uneconomic. There are wide variations in the possible savings among energy use sectors but a major efficiency of energy use over pre-1973 practices will be cost-effective. The optimum rate at which the transition to higher efficiency should be made depends upon market factors, such as the inventory of existing stock, and upon nonmarket factors, such as the national policy decision to cut oil imports. There are, therefore, two reasons for active Federal energy conservation efforts: 1) to assist governmental, corporate, and individual energy consumers to become more energy-efficient in order to ease the economic hardship caused by higher prices; and 2) to accelerate this transition in accordance with the national policy of reduced dependence on imported oil. Although ERDA was assigned broad responsibilities for energy conservation R, D&D, and has been given strong congressional encouragement, the program as presently conceived is very limited compared to the productive opportunities in the near-term and major savings in the mid- and long-term. Only about two percent of the revised fiscal year 1976 budget sent to the Congress can properly be termed applicable to "conservation" activity; moreover, only about one percent is actually designated for end-use conservation programs.

ERDA's Plan contains a very broad interpretation of conservation, It includes increased end-use efficiency through use of technology and elimination of waste; fuel shifts away from petroleum; energy storage; and even capital savings in various parts of the supply/demand system, However important all these actions may be, there is danger that such a broad operational definition can shift the emphasis on conservation from the consumer to the suppliers and distributors of energy. For example, inclusion of electric power transmission and distribution and energy storage as conservation programs could mask a low level of commitment to important programs directed at increasing efficiency of energy utilization.

Federal investments in various supply and conservation efforts should be weighted in terms of their cost-effectiveness, taking environmental consequences as well as other nonmarket considerations into account. The amount spent to save a barrel of oil, or its energy equivalent, is directly comparable to the money spent on new domestic supplies to produce an additional barrel of oil or its energy equivalent. The ERDA Plan does not appear to employ this type of assessment in determining priorities, although there are many conservation opportunities that appear more attractive than many new supply options on this cost basis, When environmental costs are included, the advantage to conservation efforts usually becomes even more impressive. ERDA should incorporate this kind of trade-off analysis into its program decision structure more explicitly.

The implementation of energy conservation measures can be significantly influenced, not only by technical problems but by nontechnical difficulties as well. Impediments to the adoption of sound energy conservation practices include government regulations, building codes, lack of consumer understanding of life cycle costs, industry and consumer resistance to change, and capital availability, Development of technologies without regard for the institutional constraints, social impacts, and the imperfect workings of the market is unlikely to achieve optimal energy conservation results,

ERDA's separation of programs by end-use sector appropriately mingles research, development, and implementation. This problem-solving approach to conservation should prove very

productive in coordinating the Federal program, assuring comprehensiveness and relevancy in research, promoting rapid information transfer, and facilitating effective implementation.

Environment and Health Programs

- Better integration of means to minimize environmental and health impacts should be integrated into the ERDA development programs.
- ERDA should analyze the environmental impact of the vastly enlarged use of fossil fuels in conventional technology envisioned in the Plan.
- ERDA should address the environmental and health problems that may be created by the emerging synthetic fuels technologies.
- Regulations concerning environmental quality should be analyzed as they often impose energy penalties.
- ERDA should examine the global environmental consequences of new energy technologies.
- ERDA should take a more active role in assessing its programs in the context of energy and non-energy demands for water.

The ERDA Program document contains an extensive description of proposed activity in environmental, health, social, and institutional topics. Almost all of this description occurs in the sections of the report devoted to Environment and Safety and Systems Analysis. Discussion of these topics in the sections of the report devoted to technology development generally consisted of one-line statements recognizing the existence of a potential constraint. There was no reference in the schedules appended to technology oriented sections to the environmental or health research programs. Interviews with ERDA personnel yield the strong impression that the stated objective of integrating the environmental control research into the technology development was at present illusory. Given that environmental, health, social, and institutional problems are likely to impose serious constraints on implementation of ERDA's programs, much better integration of these concerns into the pursuit of the technology programs themselves is indicated.

At this time, the adequacy of air quality regulations concerning sulfur dioxide is being questioned. The complex interaction between sulfur oxides and other constituents in the atmosphere, rational and noninduced, is the subject of extensive study by EPA, ERDA, and others. The outcome in terms of sulfate standards for protection of public health and environmental quality is unknown, but could have a serious constraining effect on achievement of ERDA's Plan, which relies heavily on coal in the near and intermediate term. The health programs relating to potential new chemical intrusions from coal conversion and oil-shale programs, some of which may be potent carcinogens should be considered. In the general area of health studies, there is little evidence of a serious effort to define the relative priority between programs. There are also indications that ERDA is involved in programs which do not relate to its energy mission and needs to reassess the usefulness of other programs in terms of the validity of the results these programs will yield.

Existing regulations concerning air and water quality and some which will become effective in the next few years may impose significant energy costs or environmental impacts in categories which are not encompassed by the regulating agency. There has been no systems evaluation of the interact ions between environment al regulations and their total effect. This is a valid and important area of inquiry for ERDA which has not been addressed.

There is a significant risk inherent in the totality of ERDA's mission. The impact on climatic balance of massive increases in heat rejection to the atmosphere by man is unknown but potentially catastrophic. There is an urgent need for careful analysis by ERDA of global meteorological consequences of the atmospheric impacts (heat, $C0_2$, particulate matter, etc.) from the processes it proceeds to develop.

The problems of water availability for coal conversion to liquid or gaseous fuels, shale oil retorting, electrical generation by any means and other energy oriented activities will have to compete with other uses for water in water-short areas, These same activities and associated mining and waste management operations may impact water quality in the same areas, thus potentially affecting agriculture and domestic and municipal water supplies. There are serious questions concerning the impact on air quality of the addition of new energy facilities to the

existing field of air pollution sources. These problems indicate an urgent need for a strong regional and site-specific component in ERDA's systems modeling and data acquisition program.