D. ENVIRONMENTAL AND HEALTH ISSUE PAPERS

1. Environmental Impacts of High Voltage Transmission Lines

ISSUE

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

SUMMARY

While the ERDA Plan states program objectives on the biological, environmental, and health impacts of high voltage transmission technology, it does "not present explicit scheduling or resource information to relate such programs or findings to the schedules on decision processes of its high voltage transmission technology programs.

QUESTIONS

1. What potential effect could the ERDA biological, environmental and health investigations have on the contracting and implementation milestones shown in ERDA's technology program schedule for high voltage transmission?
z. At what level, in what facilities, with what manpower, and under which ERDA division will the environmental, biological, and health research on high voltage transmission be performed?

BACKGROUND

Along with the possibility of developing electrical power transmission lines operating at voltages as high as 1,500 KV comes the possibility of related adverse impacts on human health and on other biosystems. Sufficiently strong electromagnetic field gradients imposed by the transmission lines on plants and animal life in the nearby environment may induce internal currents which can affect the vital functions of the plant or animal organism. While knowledge is incomplete about the threshold and magnitude of such effects in humans, it is suspected these produce impacts on the nervous system, digestive system and heart. The environmental

effects of possible corona discharge and ozone gas production are not adequately known. Consideration of such effects is a vital element in the design, construction and installation of high voltage electrical power transmission systems. Integration of the necessary environmental research results into the technology program is essential for valid program evaluation and decisionmaking.

2. Ground and Surface Water Contamination From Surface Mining

ISSUE

Research is inadequate on the potential environmental problems arising from surface mining, particularly in terms of its impacts on ground and surface water quality.

SUMMARY

Large-scale surface mining of fuels to the extent necessary to meet ERDA's energy plans presents the potential for generating large amounts of a variety of pollutants that will be difficult to control by point-source control technology. Examples of this type of pollution are the leaching into ground and surface waters of sulfates, nitrates, ammonium, acids, and trace metals from strip mines and reclaimed areas.

The type of pollutants generated can vary from area to area depending upon geology, topography, and climate. The development of predictive models to evaluate the types and amounts of potential pollutants will ease the development of the technology needed to control and minimize these discharges.

QUESTIONS

1.. What is the effect of large-scale surface mining operations in the West on ground and surface water quality in the Missouri and Colorado River basins?

2. What impacts will changes in ground and surface water quality from large scale surface mining operations have on farming and ranching in the West, and on forestry, agriculture, and municipal water supplies in the East?

3. In what geographic areas is it necessary to replace topsoil to insure the productivity of the land, and in what areas will replacement of topsoil be unnecessary?

4. To what extent and in which areas will mining-induced water pollution limit energy development?

5. Which agency should take the leadership role in research relating to environmental impacts of surface mining operations, and what should be its relationship to other Federal and State agencies?

BACKGROUND

The ERDA plan to increase the production of coal, lignite, and shale oil fossil fuels will require extensive increases in surface mining operations in both the East and the West. These strip mining operations can significantly alter, through exposure to the atmosphere and rainfall, the geochemical environment of the overburden material that remains after the coal is extracted, Chemical changes which can occur include the oxidation of pyrites to sulfuric acid, ferrous iron, and sulfate ion; oxidation of ammonium ion to nitrite and nitrate ions; leaching of trace metals from the overburden; and the dissolving of cationic and anionic constituents from coal and soil, which increases salinity levels. The possible release of radioactive isotopes and trace metal constituents from uranium surface mining operations poses an additional problem in South Texas and the Rocky Mountains.

The problems to be faced vary with geographical regions, acid mine drainage bring a greater problem in the East and salt leaching a greater problem in the West. Environmental concerns so far have primarily centered on acid mine drainage in the East. There has been inadequate concern for the effect of large-scale surface mining on groundwater quality and the potential pollutants that can be leached from reclaimed areas. The large scale centamination of ground and surface waters from surface mining operations is a problem which is not easily amenable to existing control technology. The adverse effects on ground and surface water quality can impair subsequent use of the water for farming and ranching, forest productivity, and municipal and domestic drinking water supplies.

Predictive techniques need to be developed to assess, prior to their initiation, the potential for generating pollutants from specific surface mining locations. Extensive data are available on background levels of groundwater and surface water quality and geochemical make-up of overburden material, Some data are available on the impact of reclamation and surface mining, but these data sources are widely distributed through numerous State and Federal agencies and universities, The collection of these dispersed data, plus the collection of necessary additional information, will permit a nationwide determination of additional impact study needs.

3. Energy Consumption and Inadvertent Climate Modification

ISSUE

Not enough is known about the potential for detrimental or irreversible climate modification caused by increasing worldwide energy use over the long term.

SUMMARY

Changes in rainfall and temperature associated with increased energy consumption have been observed in specific localized areas. Evaluation of the potential for large scale changes in climate caused by escalating energy use requires a better understanding of the Earth's ultimate capacity to assimilate man-made heat, While the ERDA plan paid some attention to the relation between energy use and local meteorological changes, it does not address the larger question of the ultimately sustainable level of thermal loading.

QUESTION

1. Considering the difficulty of the problem and its potential importance, why has ERDA not initiated a program to study the problem of ultimately tolerable thermal loadings?

BACKGROUND

The current and anticipated thermal loadings associated with worldwide energy use represent potentially significant influences on local, regional, and worldwide meteorological conditions. Although every energy production method ERDA is considering could add to this loading, large scale climate change processes are not now sufficiently well understood to make quantitative predictions, The need for better understanding of these processes, however, is emphasized by the relatively short time periods (one to two centuries) which may be characteristic of the initiation or termination of ice ages.

During 1970, average worldwide, man-made power densities amounted to only 0.054 w/sq.m. By contrast, solar-energy input into the outer atmosphere is 340 w/sq. m of which about 158 w/sq.m is initially retained in the atmosphere or initially absorbed on the surface of the earth. Power release densities associated with human energy use have exceeded the average normal solar power input in some metropolitan areas for more than a decade, in some cases by substantial margins (Moscow by about a factor of 3 and in Manhattan by more than a factor of 6 during the 1965-68 period). By the year 2000, such heavily industrialized areas as the Ruhr Valley in Western Germany will produce thermal loads over a wide region which exceed the normal solar input by about a factor of 10, while new power generation from nuclear farms, currently being considered for implementation, will generate thermal loads that are 100 times larger than "normal. "

4. Variance on Environmental Standards During Development

ISSUE

Present environmental regulations on the functioning of environmental control equipment may tend to deter the development of new energy technologies at the pilot plant level.

SUMMARY

Development of necessary environmental control equipment can be as difficult and uncertain as the development of any other technology. The present regulatory climate in the United States does not provide for pilot plant development programs as special cases. Coupling the development of new energy technologies with that of their associated environmental protection technologies, as regulations now require, may seriously hamper ERDA efforts to bring new energy sources to commercial use. This presents a risk of abandoning potentially viable energy technologies because faulty performance of experimental environmental control equipment compromises (the proof-of-process) results obtained in pilot plant testing of the basic energy technology. ERDA should address the question of the environmental risks and ad hoc mitigating measures which may be appropriate in pilot level development. With the Congress and the regulatory agencies, ERDA should explore the advisability of special regulations for pilot and demonstration facilities.

QUESTIONS

1. What consideration has ERDA given to pilot plant development problems which could result from the parallel operation of experimental energy-associated and environmental control equipment?
2. Have the possibilities for flexible environmenta1 regu1ations and n ecessary precautions for experimental facilities been explored by ERDA with other agencies such as EPA?

BACKGROUND

The development history of flue gas desulfurization methods shows that development of ancillary environmental control equipment can be as difficult and traumatic as the development of the basic process itself. It is almost axiomatic that the scaling up of a process from the typical laboratory experimental level to a facility size which can begin to demonstrate the commercial economics of the process involves significant further development effort,

Shale oil retorting facilities, coal liquefaction and gasification processes and other major energy facilities of the sort contemplated in ERDA's programs commonly exhibit problems of process stability or equipment durability, Such problems do not emerge in laboratory-scale

experiments. These must be overcome before the process can be applied at the very large scales required t o make production facilities commercially feasible.

Beyond encountering development problems in experimental large-scale energy facilities, there is the equal probability of coming upon similar problems in associated environmental control equipment. By definition, this equipment will have to be tested on the same scale as those experimental energy facilities. The parallel operation of all the equipment together is likely to exhibit further problems. It makes sense to be sure that the primary processes in the technology are technically viable, whether or not the pollutant control equipment has been perfected or its integration into the overall operation has been achieved. The construction of demonstration plants with all environmental control equipment installed, but with the capability to decouple the control equipment, will provide the option to continue testing the technical process should problems be encountered with the control equipment. Pilot plant operation with and without the environmental control equipment will also demonstrate more clearly the true effect of such equipment on the total process. This information would be valuable in later research and development activities.

Any plan to operate a demonstration-level facility in the manner described above would require careful analysis of the level of environmental insult which uncontrolled operation would produce. Also required would be the provision of auxiliary equipment to protect against significant or irreversible environmental damage, risk to health or impact on activities surrounding the facility. Operation with substandard environmental controls would further require special provisions in environmental regulations to permit temporary non-compliance with emissions standards. Such provisions are not presently available to ERDA. The responsible formulation of flexible environmental standards for experimental facilities would assist ERDA in achieving its goals.

5. Energy Modeling and Data Bank Requirements

ISSUE

It is not clear from the ERDA Plan and Program that ERDA fully recognizes and accepts critical needs in energy modeling procedures and in the associated data requirements.

SUMMARY

Linear models, such as the Brookhaven Reference Energy System, used for projecting the ERDA scenarios can easily incorporate probabilistic measures of the accuracy of environmental information. Probabilistic calculations would give a more meaningful projection of future demand as well as pinpoint data which are important but highly uncertain,

A large increase in the number of categories of effluents measured and used in environmental impact modeling is also needed. Using the proposed Brook haven techniques, grouping of compounds results in, for example, the collection of all hydrocarbons in a single category. This procedure facilitates the collection and manipulation of data, but makes conclusions based on such data suspect, because of the substantial variation in environmental effects among the hydrocarbons.

The whole field of energy system modeling is in an early stage of development. ERDA's discussion of modeling recognizes a need for much more sophisticated techniques than those currently at hand. Several energy models are being developed around the country. It would be desirable for ERDA to interface on a continuing basis with these other activities so as to compare the sensitivity of modeling results to alternative techniques and data bases. Consistency of projections from alternative models does not guarantee accuracy. However, in the absence of an existing real basis for calibration, a consensus between independent efforts can increase confidence in the validity of the results obtained.

QUESTIONS

1. Are the energy demand projections in the ERDA Plan based on the best estimate of these values, or is there some conservatism factored in to reflect the Administration's aversion to the risk of energy shortfall?
2. What are ERDA's plans to incorporate in their modeling efforts information on the levels of uncertainty associated with environmental data?
3. The postulating of alternative scenarios is only one of several methods of treating the uncertainties associated with the development of new technologies. What methods will ERDA use to display the sensitivity of their results to changes in the assumptions used and to uncertainties in the environmental data?
4. In view of the number of independent energy system models that are being developed, what plans does ERDA have for making alternative projections?

BACKGROUND

The availability of assured supplies of energy in the future is important to environmental quality. If there is an energy shortfall, there will be pressure to relax environmental controls to alleviate the shortage. In order to avert such energy shortfalls, it is necessary to know in advance the level of energy demand.

One way to bracket future demand is to construct several scenarios for future events, such as those presented in ERDA-48. This is useful in that it shows common features of future activity even when the assumptions about future behavior are quite different. The difficulty with the alternative scenario approach is that it is difficult for decision-makers to assess the most likely conditions from the several scenarios. By estimating the probability of commercial success of various technologies, and using estimates of accuracy of various data, it should be possible not only to develop the environmental consequences of the several scenarios but also to predict the likelihood of occurrence of the situation the scenario projects.

The development of probabilistic scenarios of future energy demand will give decision-makers a view of alternative future effects and their probability y of occurrence. This will be useful for choosing among alternative courses of action. The construction of the scenarios will also point out shortcomings in the data required for forecasting and will serve as a guide for data acquisition.

As the ERDA health effects research programs advance to the point of yielding usable dose-effect information, it will be necessary to continually improve the quality and quantity of the residual materials data used in the Brookhaven environmental data base, The effluent categories will eventually have to be disaggregated to the point where data on different compounds are collected separately. In some cases the necessary information is available; in other cases this disaggregation exercise will point out important gaps in existing information,

Adverse environmental impacts stemming from future energy generation strategies can be minimized if demand levels as a function of time are accurately known. To predict most accurately, one should make energy system projections with a variety of types of available models. The ERDA Plan relies solely on the Brookhaven Reference Energy System, This energy model is a good, national, static model, but it cannot contend with situations that are dynamic. There are regional and dynamic models that can be applied to yield other ideas about the future of the energy system and its environmental consequences.

6. Site and Technology-Specific Nature of Cause-Effect Relationships in Environmental and Health Impacts

ISSUE

Simple extension of energy systems modeling capabilities to the regional discrimination level with expanded emissions categories will not yield a valid impact profile for energy technology decisionmaking.

SUMMARY

Considerable effort has been devoted to determining the rates of emission of various materials from energy conversion devices. These data are by no means complete, but in many cases they are adequate. Much less is known about the actual amounts of environmental degradation resulting from a given emission rate. The prediction of dose is complicated by site specific factors such as population density, climatology and ambient air quality. The further translation from pollutant dose to effect is known only for a very small number of pollutants (SO, ozone, PAN, lead, CO, etc.) and only in terms of their major effects on agricultural products and selected animal species. However, the effects of even these pollutants is not known for low dose levels. Chronic exposure conditions or possible synergistic relationships have seldom been explored. Expanded studies are needed to assess the impact, in quantifiable terms, of the many energy related pollutants at varying emission or release rates, Such studies will improve the effectiveness of modeling approaches and ultimately improve our capability to optimize energy choice/use patterns.

QUESTIONS

1. What new methodologies are being pursued that will lead to effective assessments of the environmental impacts of various scenarios?
2. What type of program is envisioned for determining the extent of the impact on the public of the "new" pollutants deriving from advanced fossil fuel technologies?
3. What efforts are planned to identify the potential environmental and health effects of typical mixes of pollutants associated with advanced technologies (including all the variants of types and control possibilities)?
4. How will data on the many diverse environmental effects of fossil fuels be displayed to allow meaningful comparisons in cost/benefit/risk analyses?

BACKGROUND

Many benefits could result from early, consistent, systematic analyses of the environmental effects of energy conversion. The analyses can provide early feedback for design and control options, provide a rational framework for the formulation of regu lations, and be used to initiate

well-aimed health effects studies. To be useful, however, the systematic analyses must model the real environmental degradation and not just national or even regional totals for tons of emissions.

It is, unfortunately, extremely difficult to make systematic environmental impact assessments. Reducing impacts to a common denominator, such as dollars, results in the loss of much necessary decision information. A possible format for the presentation of information is a matrix of options and effects.

The Matrix of Environmental Residuals for Energy Systems (MERES) system is a good first step toward the use of the matrix modeling concept. However, it deals only with the total emissions of the scenarios modeled. Simple modeling can grossly mislead any attempt to set emission standards for the protection of the environment or the public health. A serious inadequacy of the MERES effort is its failure to factor in the variations between regions and localities in terms of dispersive potentials, a tmospheric chemical transformations, background concentrations of pollutant species, or the nature and density of populations exposed to pollutants. While it is possible in principle to perform a scale-up of regional experience in pollutant loading to obtain better indications of total environmental degradation, such an extrapolation from existing regional conditions presents serious difficulties, The addition of new technologies and new facility sites will change both the configuration of pollutant sources and the mix of pollutants input to the environment. It will therefore be necessary to include site-specific characteristics in any model to be used for predictive analyses in the interest of energy decisionmaking processes.

Definition of alternative specific site types for energy facilities will make it possible to more realistically treat siting constraints such as climatological and demographic characteristics of powerplant environs. Attention to the characteristics of specific potential sites will facilitate the development of an inventory of potential sites for energy facilities. It would then be possible to develop sites in the inventory as the need arises with minimal adverse environmental effect.

7. Integration of Environmental, Health, Social, and Institutional Research Into Technology Programs

ISSUE

ERDA's presentation and discussion of environmental, health, social and institutional research indicates a lack of integration of this research into its R, D&D program.

SUMMARY

To maximize the effectiveness of research on environmental, health, social and institutional constraints, the results of that research should be available before the widespread implementation of the technology. The ERDA implementation schedules do not present environmental and health research timelines in parallel with the technical milestones. Further, the specific plans for environmental and health-related research, tailored to the individual technologies which will be promoted, are not detailed and discussed in the technology program statements provided in volume II.

The failure of volume II to define environmental, health, social and institutional problems which could constrain specific technology programs is a significant oversight. The oversight is emphasized by the established obligation of Federal agencies to consider potential environmental impacts at the earliest time in their planning processes. Explicit priority is given to analysis of environmental and social consequences of energy technology deployment in Section 5 (a) (z) of the Federal Nonnuclear Energy Research and Development Act of 1974. Because of the lack of specificity of the environmental activities defined in ERDA's technology program descriptions, there is no guarantee that the necessary environmental research and assessment will be conducted simultaneously with energy technology development.

QUESTIONS

1. How does ERDA plan to integrate environmental analyses into the development of a technology so that they are incorporated in decisionmaking as each discrete step is taken toward commercialization of the technology?
2. Although the National Environmental Policy Act and the Federal Nonnuclear Energy Research and Development Act both emphasize timely analysis of environmental and social consequences, why is there little detailed discussion of either in volume II's technology program statements?
3. What proportion of ERDA's proposed budgets for technology programs will be spent on environmental, social economic, and institutional analyses?
4. What rationale was used to schedule the environmental and health research required for assessing the suitability of emerging technologies?

BACKGROUND

Whenever a potential environmental problem related to a developing technology is identified, the maximum integration of environmental control technology into engineering design is required throughout the long process of bringing an energy technology to commercially proven levels. Otherwise, costly "add-on" modifications may be necessary as regulatory action or negative public reactions begin to constrain the development process. Adequate continual environmental research, beginning at the earliest time in ERDA's planning process (as detailed in volume II), is necessary through specifically tailored and detailed projects in order to achieve this goal,

'l'he NEPA environmental impact statement process already calls on Federal agencies to take environmental factors into account at the earliest possible time in decisionmaking. Federal court decisions, foremost among them being the Scientists' Institute case, have required that energy research and development programs be covered by impact statements. But the issue raised here goes beyond the impact statement preparation process (although not beyond the NEPA mandate to agencies) to recognition that the environmental research components of overall technology development should actually be written into planning and budgeting documents as integrated and systematically developed items.

The present structure of ERDA does not provide sufficient incentive for the technology divisions to incorporate at a meaningful level environmental control technology into their total development activities. The Environment and Safety Division (AES) is ERDA's reservoir of expertise in environment and health research, and is responsible for coordinating these activities with other agencies. However, the links between AES and the technology divisions within ERDA appear to be inadequate to ensure the necessary integration of its concerns into the activities of other ERDA divisions.

The discussion of program strategy in the Environmental Control Technology section of ERDA-48 makes the point that "most of the controls technology development funding as well as the manpower resources will be provided by program units under the Assistant Administrator for Conservation, Nuclear Energy, Fossil Energy, and Solar, Geothermal and Advanced Energy. " However, a careful reading of the various sections of the program volume shows very clearly that the only substantive discussion of needs for environmental, health, social and institutional research is housed in the Environment and Health, Safety and Systems sections of the report. In the discussions of technology programs, the references to these topics are generally restricted to single sentences which state the potential existence of an (uncharacterized) problem or the need to develop "environmentally acceptable" technology. Further, the schedules attached to the technology sections show only the technology development timelines and milestones. Finally, the interviews with ERDA personnel which took place in the course of the OTA review of the ERDA Plan and Program yielded the information that allocation of funds, staff assignments, and program definition by the technology-oriented divisions in the areas of environmental, health, safety, social, and institutional research were ill-defined at best and apparently nonexistent at worst.

A possible solution for this apparent dereliction by ERDA lies in reorganization of the relationship between the Environment and Health Division and the technology-oriented divisions. The technology divisions should be required to discuss in detail—and schedule—the necessary research on items which may constrain the technology development t for which they are responsible. Since it is apparent that the technology divisions do not now have the necessary staff capabilities to satisfactorily accomplish such an integral program definition, the y will e it her have to develop that capability or turn to the Environment and Health Division to provide it. The latter course may be preferable, as it could lead to a more integrated organizational structure in ERDA. The cross-linking of project organizations and specialty staffs has worked well in private industrial corporations and may, if undertaken in ERDA, enhance ERDA's capability to achieve its goals.

8. Energy Impacts of Air and Water Pollution Control Regulations

ISSUE

The interactions between energy, environmental and economic effects of Federal, State, and local air and water quality standards are not sufficiently understood.

SUMMARY

The enactment and enforcement of air and water pollution control regulations can have substantial impacts upon energy consumption requirements and solid waste generation. These potential impacts will become increasingly important in the future with the decreasing availability and increasing cost of fuel supplies and/or disposal sites. These complex interactions are not presently recognized by existing regulations, which tend to treat air pollution, water pollution, and solid wastes as separate problems unrelated to potential energy consumption requirements. Environmental protection and energy consumption optimization trade-offs are needed,

QUESTIONS

1. What changes need to be made in existing Federal, State, and local air and water pollution regulations regarding the trade-offs between environmental protection and energy con sump t ion?
2. What are the proper criteria for obtaining optimum balance between environmental protection and energy consumption at specific sites, and by whom should they be explored?
3. What improvements are needed in existing air pollution and water pollution control technologies to minimize potential energy consumption?

BACKGROUND

At present, policies which regulate discrete discharges of effluents are based on applications of ultimate control technology at or prior to point of discharge, Such stringent controls of both atmospheric and aquatic discharges are necessary in some cases, but no technical basis exists for their wholesale application as presently administered. These effluent controls may requires significant energy penalties, which result in not only additional fuel consumption but also added air pollutant and solid waste generation, Requirements for controls are better established on a technically-based optimization of environmental protect ion and energy consumption requirements,

Comp1iance with both the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500] and the Clean Air Act Amendments of 1970 can have significant impacts on energy consumption. Public Law 92-

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500 established the requirement that closed cycle cooling technology be applied in all thermal power installations prior to 1985, a goal based upon the best available technology. This law would eliminate thermal input to the aquatic environment where aquatic systems could not tolerate additional thermal increases over all or part of an annual cycle, In such cases, the only presently available alternative is the installation of cooling towers. In the majority of existing facilities extensive study has failed to demonstrate adverse changes as a result of thermal discharges. Most important environmental results, such as biocide effects and entrainment and impingement of aquatic organisms associated with the recommended and presently applied control technologies, can be minimized by proper modification of facility design.

Cooling towers function by transferring heat to the atmosphere through evaporative transport. Associated with this process is the potential for climatic changes and the concentration of solids which ultimately require disposal.

It is important to recognize that cooling towers possess associated environmental disbenefits and do not always have demonstrable benefits, and that they further impose a significant energy penalty (5 to 20 percent) on power generation facilities,

The proposed zero discharge requirements on wastewater treatment facilities can also cause substantial increases in the energy consumption necessary for water pollution control, resulting in increases in air pollutant emissions and solid waste generation. The dewatering and disposal of large quantities of solid waste sludges generated by air and water pollution control devices impose similar secondary environmental and energy penalties. Existing nonregenerative flue gas desulfurization systems at coal-fired power plants also impose energy penalties and generate large amounts of solid waste sludges. Energy penalties of 5 to 20 percent can result from lime or limestone sulfur dioxide scrubbing systems in terms of increased gas pressure drops and stack reheating, liquid pumping, sludge dewatering and transportation. Large quantities of sludge require major nearby land areas for disposal or transportation to distant landfill sties,

The need exists for analytical tools to provide for optimization of environmental control processes to minimize overall adverse environmental impacts,

9. Competing Demands for Water in Western River Basins

ISSUE

The limited availability of water in areas such as the Colorado and Missouri River basins will force systems evaluation of net benefit from energy and non-energy activities which depend on water.

SUMMARY

Large amounts of water wil 1 be required from available ground and surface water supplies in the arid Rocky Mountain states for energy production operations such as coal and oil shale mining, slurry pipeline coal transportation, minemouth electric power generation, coal and oil shale conversion to gaseous and liquid fuels, and environmental management of strip-mined areas and spent shale disposal areas. Extensive implementation of these projected energy production activities may adversely affect water quantity and quality for agricultural use in the same river basins. Development of geothermal energy resources, e.g., in the Imperial Valley, could result in either further water demand and water quality impact or in the production from saline water of a supplementary source of freshwater for agricultural use. Extensive analysis of the total system activity in these river basins will be required to ensure that the proposed energy development activities which are actually implemented will result in a net benefit to the country.

QUESTIONS

1. What is the maximum amount of water which can be made available for energy production in the Missouri and Colorado River basins without jeopardizing agricultural operations and other industrial or public demands for water?
2. What impacts upon water quantity and water quality will occur in the Rocky Mountain states from varying levels of energy production, and what impacts will these have on agricultural production and resultant food prices?
3. What are the relative environmental, energy and economic trade-offs of minemouth processing of coal to electrical energy or synthetic fuels in the arid Rocky Mountain states as compared to alternative transportation to water-abundant areas along the Mississippi River or Gulf of Mexico for subsequent processing?
4. What is your estimate for the potential production of desalinated water from geothermal resources in the Imperial Valley of California by the year 2000?
5. What plans does ERDA have for the construction of integrated regional development plans linking seemingly disparate energy technologies?

BACKGROUND

To meet the Nation's energy requirements, the Federal Government plans major use of the extensive coal, shale oil, and uranium resources in the arid regions of the Rocky Mountain States

between 1975 and 2000. Projections call for the possible construction of a significant number of coal-fired electric power plants, coal gasification and liquefaction plants, water slurry pipelines, and shale oil processing facilities. These facilities will have significant impacts upon available supplies of acceptable quality water for farming and ranching unless steps are taken to provide for proper development. Possible alternatives include the transportation of coal to water abundant areas for subsequent processing and extensive in-place water treatment and recycling.

Geothermal resource development in the Imperial Valley of California is currently receiving considerable attention from a number of industrial, governmental, and university groups. The importance of integrated regional development for the Imperial Valley is now recognized b y a number of people. But the close connection between the potential for water desalination, using geothermal energy, and proposed energy resource development in the Upper Colorado River Basin has not only not been emphasized, it has not even been mentioned in the ERDA plans, Similar arguments apply to other river basins in which major energy development programs are contemplated, Integrated regional planning by ERDA is necessary to ensure that its energy programs actually yield a net benefit.

10. Need for Social Research in Offshore Energy Programs

ISSUE

Social research is needed on institutional problems arising from the deployment of offshore energy technologies.

SUMMARY

Major problems in new offshore development are presented by the social and institutional constraints to developing offshore oil and gas production, nuclear, and fuels transportation facilities. One current major research need is to examine new institutional mechanisms in order to further understand the problems of government management and public acceptability. This research needs to be conducted on national, regional, and local levels.

QUESTIONS

1, What institutionally related research programs does ERDA have for evaluating offshore oil development?

2. What research is being conducted on new plans or arrangements for oil spill clean-up?

BACKGROUND

The present environmental research implementation program does identify research on offshore technologies in five areas: (1) collaborative efforts on hyperbaric medicine for diver safety, (2) new environmental programs to deal with oil well drilling, (3) criteria for offshore power plant siting, (4) aquatic chemistry of pollutants and (5) oil spill prevention and clean-up procedures and techniques. Although the above areas are important, a specific effort is needed which would focus on the social and institutional constraints to developing offshore oil, gas, nuclear, and fuels transportation facilities. Such a research effort requires an interdisciplinary group study of the full range of potential impacts and effects and alternative social and institutional arrangements.

Because this problem deals with both the means by which offshore areas are made available and the way in which technologies are deployed and standards are developed and enforced, the funding and oversight for this research would be an interagency effort. This research would be directly applicable to considerations of innovative siting, leasing, standards-setting, and enforcement procedures, some of which are subjects of current legislation.

11. Effect of Public Attitudes on Program Implementation

ISSUE

ERDA's plan for Energy Research, Development and Demonstration does not include research on how public attitudes and values affect implementation of Government energy plans and controls.

SUMMARY

Public attitudes about the proper role of Government, what constitutes quality of life, and what characterizes important threats to the human environment, greatly affect what Government actions people will support as well as the incentives and disincentives to which they will be willing to respond. ERDA's plan does not appear to include study of energy-related attitudes, their formation, intensity , a-n-d stability, and the impact of information upon attitude changes.

QUESTIONS

l. Since ERDA recognizes the need to maintain freedom of choice of lifestyles, how does ERDA propose to do research on the effect that different levels and kinds of energy consumption will have on lifestyles?

2. How will ERDA present the necessary results of research on public attitudes so that agencies and other policy makers can make judgments about what the public will accept in terms of energy development, conservation regulations, and environmental controls?

3. How well do the environmental impacts which ERDA proposes to predict for various technologies reflect the concerns that people actually have about their environment? What research is planned to discern public attitudes on environmental issues?

BACKGROUND

The desires and values of the public are as fundamental to energy development as is the availability y of fuel resources, capital, manpower, etc. Yet, ERDA's research plan and implementation program anticipate few studies of attitudes which will affect energy choice, For example:

1. The ERDA Plan recognizes as a national goal a need to maintain choice among life styles. To relate energy technology to life styles, it will be necessary to know what levels of energy consumption are essential for quality of life for people of different regions, with different backgrounds, incomes and family size. Much more must be known about those energy use activities which are simply a matter of habit and superficial convenience, Similarly, attitude research would help to identify the energy consuming activities which are important to certain ways of life.

z. The implementation of ERDA's Energy Plan and environmental controls implies an altered relationship of the Federal Government to private industry and to State and local governments. Attitudes held by different publics about the proper role of

Government may serve to impede the growth of Federal Government functions or channel Federal Government action into certain acceptable implementation techniques. Efficient implementation of the plan requires research in this area.

3. Environmental quality is a function of people's perceptions and values. It may be that the quantifiable and measurable environmental impacts of energy development are poorly related to the attributes of their setting to which people are sensitive. Research in this area is necessary,
4. ERDA's mission includes promoting public understanding of science. This function can be performed adequately only when public attitudes about energy technology are researched.

12. Program Focus in Fossil Fuel Health Effects Research

ISSUE

The ERDA program of research on the health effects of fossil fuels covers a broad range of biological responses and pollutant exposures. Some research areas do not appear to be relevant to ERDA's missions.

SUMMARY

ERDA's overall program of research into the effects of fossil fuel use on health places great emphasis on basic biological mechanisms of response, Certain important areas, such as biological screening, carcinogenesis and mutagenesis, and epidemiological studies, appear to be inadequately emphasized, while other areas, such as research on recovery, treatment, and development of radio-pharmaceuticals, may well be unnecessary under the primary mission of ERDA's health research program. The program description gives little detail as to which pollutants will be given highest priority, or on how the results of health effects research will be integrated into the decision process as to which alternative energy technologies to develop. To meet these research demands, there is a critical need for the training of additional cell- and tissue-culture experts, toxicologists and epidemiologists.

QUESTIONS

1. Which pollutants will be given highest priority for evaluation under the various categories of fossil fuel health effects research and by what criteria does ERDA assign these priorities?
2. What is the purpose in ERDA's mission of research on treatment of and recovery from health effects?
3. How will ERDA's health research program, which is largely directed toward animal models, evaluate known adverse effects on human health which cannot yet be modeled with animal experiments?
4. What plans does ERDA have for training programs to provide the additional man-power needed for their proposed health effects research programs?
5. If ERDA obtains positive results on screening for detrimental effects of a fossil fuel product, how will the results be validated with respect to human populations?
6. What plans does ERDA have to evaluate the safety of substances in humans, once they have successfully passed through the animal screening system?

BACKGROUND

ERDA's FY 1976 program plan for research on the health effects of fossil fuels provides for $32.5 million (including pass-through funds) to be nearly evenly divided between research directly

applied to the health effects of fossil fuel technologies ($16 million). These funds were programmed as follows:

I.	Technology-Oriented Objectives	Million $
(1)	Screening for hazardous agents	1.9
(2)	Fate metabolism of hazardous agents	0.9
(3)	Pathophysiological effects including respiratory taxicology	3.3
(4)	Carcinogenesis	1.3
(5)	Mutagenesis and developmental effects	1.5
(6)	Molecular and cellular mechanisms	4,0
[7]	Recovery from and treatment of pollutant-induced health effects	1,0
(8)	Epidemiological studies	2.0
	SUBTOTAL OF I	15.9

II.	Supporting Research	Million $
(1)	Research on critical organ systems of response	3.0
(2)	Improved bioassay screening system	2.4
(3)	Genetic research	1.3
(4)	Molecular and cellular studies	9.9
	SUBTOTAL OF 11	16.6

From the program description, the following issues have been identified:

(1) Selection of Pollutants: It is not clear which pollutants will be evaluated under the various research approaches listed above. High temperature combustion processes using most fess i 1 fuels result in widespread population exposure to sulfur and nitrogen oxides, while exposure to polycyclic hydrocarbons, generally associated with cancer induction will be more 1 i m i ted to relatively small occupational groups, Low temperature combustion reverses this pattern. In general, emissions of heavy and trace metals from energy sources tend to add relatively small increments to population exposures, whereas food chains and water present much larger avenues of exposure.

(2) Research on medical treatment: The ERDA health program includes research on medical treatment, that is, methods to remove metals from the body or to detoxify chemicals in the body. The rat ion ale forth is research program in an agency whose mission is the development of energy technology is unclear. Recovery and treatment may be inherently outside the scope of ERDA's health research responsibilities.

(3) Epidemiological studies: Animal models have been notoriously ineffective in predicting human response to long-term low levels of hazardous agents, particularly those associated with chronic degenerative noncancerous diseases such as coronary heart disease, emphysema, bronchi t is, and arthritis. Air pollution studies have shown that elderly persons which chronic degenerative diseases are among the most succeptible segments of the population with respect to community levels of air pollutants. These findings were derived through extensive epidemiological investigations; primary air quality standards are largely based on epidemiological information. Since animal models of chronic degenerative diseases will probably not be developed in the near-term, it appears that ERDA's health program would be enhanced by placing considerable y greater emphasis on systematic epidemiological research on population and occupational exposure to fossil fuel pollutants.

(4) Screening for hazardous agents: ERDA has programmed $1.9 million for systematic biological screening of hazardous agents in process streams and effluents from various fossil fuel energy technologies, and another $2.4 million to improve methods of detection and monitoring for damage to human populations. A large portion of the $1.9 million systematic screening effort is devoted to screening for mutagenic and carcinogenic agents. This program is smal1 relative to the number of pollutants associated with fossil fuel technologies. TO date, most of the recognized adverse human responses to fossil fuel pollutants have been noncancerous. Many more insidious potential

hazards are known to exist. Sulfur and nitrogen oxides have exerted their primary effects on respiratory airways and lung tissue in the form of causing or contributing to the development of acute and chronic respiratory diseases, including asthma, bronchitis, and emphysema. How ERDA proposes to incorporate these known and potential adverse health effects into its systematic screening program is unclear.

(5) Pathophysiological Effects Including Respiratory Toxicology: This program is largely designed to obtain dose-effect relationships from toxicological studies on animals. Inhalation studies will be emphasized. How the dose-effect data obtained from animal studies will be extrapolated to man, so that the information can be used to control or restrict emissions from a given fossil fuel technology, is unclear,

13. Inadequate Inventory of Skills and Techniques in Health Effects Research

ISSUE

Means are not available to estimate effects of coal combustion and conversion on human health. A broad-based research effort, in both university and Federal facilities, is critically required to develop improved techniques for evaluation of health impacts from coal combustion and conversion.

SUMMARY

The Health Studies Section of ERDA-48, volume II, emphasizes research in the area of longterm effects of coal-related pollutants. This emphasis on cancer and birth defects is most appropriate, since coal-related pollutants are known carcinogens and mutagens. The program, however, appears to stress traditional long-term animal experimentation. This approach cannot yield relevant data in time for decisions about national energy prerogatives. The program also suggests the use of recent research developments in the field of animal cell genetic assays. These show great promise as relevant bioassay systems and should receive greater emphasis. An intensive broad-based effort should be used in both data acquisition and innovative fundamental research. A significant increase in both the scope of the related ERDA research organization and the university production of trained researchers will be needed to meet the research program requirements.

QUESTION

What plans does ERDA have to stimulate the availability of trained researchers with skills other than those represented by former AEC activities; especially in the fields of mammalian genetics and cell biology?

BACKGROUND

The primary public health justification presented in ERDA-48 for research in the area of coal-related pollutants is damage to skin and respiratory systems. The probability of "secondary site for damage" for latent diseases, such as cancer and birth defects, is mentioned but not " emphasized. Emissions from all steps of coal processing release known lipid-soluble cancer-producing substances which are readily diffused across membrane barriers.

No data is available regarding the effects of coal-related pollution on human cancer and birth defects. There is in the public health research area a strong historical preoccupation with respiratory dysfunction. However, if the appropriate criteria for establishing priorities encompass severity and magnitude of effects and the urgency of information acquisition, the strong emphasis on respiratory disease over the more insidious (but later appearing) effects, such

as cancer and congenital disorders, is difficult to understand. The reorientation of preexisting AEC programs to the study of coal-related pollutants implies that this step will give ERDA the technical competency required. No misconception could be more damaging to ERDA's health research effort than to assume the presence of adequate scientific manpower in preexisting facilities. The most careful scientific review of the "reorientation" process should be carried out by non-ERDA oncologists (cancer researchers) and geneticists to identify areas of competence and suggest which areas must be implemented by university or other Federal laboratories. This point is doubly important because the "retraining" process may delay the necessary health assessments and will certainly prevent the rapid entry of young researchers because of the priority accorded to existing laboratories. In addition to the redirection of current research personnel, a significant increase in the training of new researchers through the university systems would appear to be necessary. The training process using current university facilities will require the better part of a decade to implement and will take a realistic specification by ERDA of the manpower needs and the desired university response through the 1980's.

As an example, the study of enzymatic reactions involved in metabolizing aromatic polycyclic hydrocarbons to powerful cancer-causing species is not represented in present ERDA facilities. However, strong programs in this area exist at McArdle Laboratory, Rockefeller University, MIT, and La Roche Laboratories, which could contribute to the necessary studies. The pattern of this example is repeated in other specific research areas.

The Health Studies Section of volume II shows a strong emphasis on animal studies in t ox - ecological research on the effects of exposure to pollutants. The statement that "no mammal is a sufficient model for man" is a well-documented toxicological fact won by decades of comparative studies in drug metabolism and DNA repair. The stated intent in the ERDA program to add several admittedly inappropriate studies of nonhuman species in order to gain data relevant to man is clearly illogical as well as expensive.

This traditional toxicological emphasis is inappropriate in a program demanding relevant data for a large number of coal-linked pollutants acting singly and in concert. The data from whole animal studies simply would not be available in time to guide decisionmaking in choosing among the various energy scenarios. Several years are required for evaluation of single substances using present FDA procedures. This part of the proposal seems to be planning research to fit existing facilities rather than fitting the public health needs,

To circumvent this difficulty, the encouragement of research in human genetics using the techniques of cell biology may offer a realistic solution. This approach is proposed by ERDA, and reflects well on the breadth of their proposed research, but its relative importance could be strengthened in the proposed program.

14. Atmospheric Sulfates as a Potential Constraint on ERDA's Fossil Fuel Program

ISSUE

Suspected health hazards of atmospheric sulfates may result in air quality standards which would constrain ERDA's programs based on coal.

SUMMARY

Questions have been raised concerning whether sulfate concentrations (as an index of SO_2 transformation products) throughout the mid-west and northeast may presently exceed threshold concentrations for adverse health effects. If substantiated, this finding would raise serious questions as to the advisability of introducing any new sources of sulfur oxide emissions into the atmosphere. There are considerable uncertainties about the concentration and chemical nature of atmospheric sulfates which are hazardous to health. Improved information on the relation of toxicity to sulfate concentrations is required to set ambient air quality standards. If the present fears are supported by scientific findings, standards could be set which would severely limit further energy development programs based on coal as a primary fuel, on direct utilization of geothermal resources, and on approaches to reduce automotive emissions. Immediate and concentrated attention to this area would help to resolve the existing uncertainties. Some of the energy goals set by ERDA, if pursued in the absence of the necessary health effects information on atmospheric transport and transformation of sulfates, may not represent an achievable objective.

QUESTIONS

1. What priority has ERDA set on resolution of the unanswered questions concerning sulfate reactions and transport in the atmosphere and consequent levels of health hazards?
2. What is the status of cooperative efforts between ERDA, EPA, and other agencies involved in sulfates research?
3. What is the perceived need for funds to achieve the earliest possible resolution of unanswered questions concerning sulfates, relative to the present funding level in ERDA and elsewhere?
4. How would a moratorium on additional input of sulfur-bearing compounds to the atmosphere from new facilities affect the ERDA Plan?

BACKGROUND

Sulfur dioxide has long been recognized as a pollutant of major concern, and has been singled out as one of the air pollutants most necessary to be controlled nationwide. Sulfur dioxide was one of the first pollutants for which national ambient air quality standards were established, A con-

certed effort was carried on from 1970 to the present to substitute low sulfur fuels for high sulfur coal and fuel oil. Significant reductions in sulfur dioxide emissions were achieved.

When the air quality standard for sulfur dioxide was established, it was generally recognized that SO_2 was an index for the class of pollutants emitted largely by fossil fueled power plants. Particularly in the animal toxicological effects area, SO_2 gas alone did not appear to have great toxic potential at ambient or near-ambient levels. Yet epidemiological studies revealed significant correlations between ambient SO_2 levels and adverse health effects.

The resolution of this contradictory evidence was first suggested in the toxicological studies of Dr. Mary Amdur, who showed that sulfuric acid, ferric sulfate, zinc ammonium sulfate, and other oxidation products of $S0_2$ caused an irritant response in guinea pig lungs at much lower concentrations (20 to 100-fold" lower) than SO_2 gas alone. Further, the irritant potency of SO_2 gas was increased 3- to 4-fold in the presence of high humidity, suggesting that the conversion of SO_2 to sulfuric acid aerosol greatly enhanced the biological reactivity of the sulfur oxides. These experimental findings have been confirmed by others.

These animal studies are supported by preliminary epidemiological results obtained from EPA's CHESS program. Among the various air pollutants measured, including SO_2, total particulate, NO_2 and suspended sulfates, concentrate ions of the latter group of atmospheric pollutants were associated with daily aggravat ion of asthma and of cardiopulmonary disease in the various study areas. Daily concentration of $S O_2$ and total particulate did not reveal a pattern of increased symptoms with higher atmospheric concentrations of these substances. The association of adverse health effects with suspended sulfates was tentatively shown even in communities where existing primary air quality standards for SO_2 and total particulate were met,

There is growing recognition that the existing air quality standard for sulfur dioxide is inadequate, What is needed is formulation of air quality standards for the atmospheric transformation products of SO_2. As a scientific basis for this standard, a better understanding of the atmospheric chemistry of $S0_2$ transformation products is necessary, as is the ability to measure these specific products in the ambient air. Further, the relative toxicities of these transformation products will have to be assessed in order to determine which are more hazardous to health. These findings should be substantiated in systematic human epidemiological studies. These investigations require the ability to generate specific sulfur oxide compounds for study and the ability to measure their concentrations in the ambient air. Finally, it is necessary to elucidate the atmospheric factors that affect the rate of transformation of SO_2 into more biologically reactive compounds.

A concerted research program of health and environmental studies of atmospheric sulfur oxides could produce the basic, though minimum, amount o f health information within three years. The National Academy of Sciences pointed out that "improving the available information about these aspects of sulfur emissions has an expected value on the order of hundreds of millions of dollars a year" (Air Quality and Stationary Source Emission Control, a report by the Commission on Natural Resources, National Academy of Sciences, prepared for the Committee on Public Works, U.S. Senate, Serial No. 94-4, March, 1975, p. xxxvii).