D. SOLAR, GEOTHERMAL, AND ADVANCED SYSTEMS ISSUE PAPERS

1. Setting Criteria for Program Priorities

ISSUE

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

SUMMARY

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

QUESTIONS

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

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BACKGROUND

The lack of definitive program goals in the ERDA Plan can have two important consequences: It can distort projections of commercial acceptance of a technology, and it can increase the probability that an unsuccessful program will be drawn out longer than necessary. Criteria are needed to evaluate the relative rewards and costs of a research program in order to determine whether it should be continued, accelerated, or terminated,

Specific criteria, which may vary from project to project, are also needed in order to define the appropriate points at which paper studies move into component testing, component testing into pilot plant testing, pilot plant testing into demonstration projects; and demonstration projects into full commercialization.

An important criterion is the cost goal. For the different energy technologies treated in the ERDA planning documents these goals are represented by vague references to achieving economic viability (such as ocean thermal energy conversion), cost-cutting by given multiples where no present-day costs exist (solar thermal electric and wind), or specific cost goals in dollars per kilowatt (photovoltaics). Such goals have little meaning unless the assumptions and criteria that went into their formulation are available for comment by potential users. Furthermore, there is little indication that ERDA has conducted an analysis of the relative cost and performance risks, or of the costs associated with each of its programs in the light of future rewards of success.

2. Rationale for Funding of High-Risk Projects

ISSUE

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

SUMMARY

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

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

QUESTIONS

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

BACKGROUND

Evaluation and decisionmaking on large projects which involve major uncertainties are currently performed by one of several methods, The most common is that where an in-house decision is made to proceed, requests for proposals on a "zerophase" study program are issued, and one or more contracts are granted to the winning bidder or bidders, In projects where some degree or prior experience is available, even though the system applications are new (such as photovoltaic converters or solar heating systems), it is possible for ERDA to obtain competent reviews of early studies and analyses and make reasonably accurate system performance and cost estimates, However, when the prior technology is in its very early stages, even if technical feasibility has been demonstrated, there is no obvious mechanism by which ERDA can test the conclusions of its study contractor. No matter how objective he may be, if there is little or no prior body of knowledge, the contractor's estimates are necessarily uncertain, performance estimates tend to be optimistic, and cost estimates are almost always too low. Hence, some method for evaluation involving both technology and cost uncertainty forecasting is necessary. At the very least, study results must be subjected to careful and extensive (probably contracted) review by other sectors of the field.

If uncertainties cannot be narrowed by such reviews, proceeding to costly demonstrations could be questionable. Premature demonstrations can have a far more severe effect than the simple wasting of funds, Often a project having great potential can be "turned off" by an unsuccessful demonstration; whereas a more measured approach, which allows a somewhat greater development of the basic technology for the project, might have led to success and subsequent benefits to society. However, it may be necessary to proceed to a demonstration even where the uncertainties remain excessive, simply because there is no other way to reduce them. This decision clearly can constitute a major gamble and should be reached only after the broadest possible interdisciplinary review.

An example of such a project which is currently under ERDA's jurisdiction is the ocean temperature energy conversion program. It has been subjected to "phase zero" studies, and its cost/benefit projections appear quite promising. However, there still remain major cost uncertainties (both capital and operating/maintenance) because of the lack of experience with the large-scale specialized equipment needed, biofouling, and corrosion in long-life metallic marine structures, and powerplant operations associated with offshore locations. Whether these uncertainties should be resolved by further studies and limited testing, or by an early demonstration project, is a difficult and vital decision, which probably is best approached (although not necessarily successfully) by extensive multisector review of study results.

A second example is the satellite solar power station, a concept which could offer significant long-range potential but does not appear anywhere in the plan, despite its identification by other Federal agencies as a highly promising future option. The decision processes needed to initiate the low-cost but essential early studies and experimental research efforts for such concepts apparently have not yet been properly formulated or implemented.

The Congress does retain the ability to critically review the decisions with which ERDA will be confronted in the future since all demonstration projects requiring funding in excess of a specified amount must be brought to the Congress for approval. Consequently, the Congress can ask the appropriate ERDA personnel at that time if the required cost-benefit-risk analyses have been made. Furthermore, the Congress can ask that independent reviews/assessments be made prior to proceeding with an authorization.

3. Resource Availability

ISSUE

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

SUMMARY

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

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

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

QUESTIONS

1. What steps is ERDA taking to evaluate, on a per-unit output of energy basis, the demands of their proposed energy alternatives on water, land, materials, energy, capital, manpower, and air quality?
2. How are the potential environmental impacts for the various energy alternatives being assessed?
3. What input/output (1/0] balances, including time-to-repay, have been or will be prepared for the energy and capital 1/0 of the alternative energy systems?
4. Are potential multiple uses of land and water being considered for the alternative energy systems?
5. What manpower projections, by category, have been made in connection with the Nation's total energy program?

BACKGROUND

In our last environmental crisis, the United States took several steps to improve air quality without adequate concern for our limited domestic supplies of certain types of energy resources. For example, the air pollution standards that mandated a switch from coal-burning to gas or oil-burning in some electric powerplants were established without an adequate apprecia- t ion of the limited national supplies of oil and gas. The switch back to coal now in progress represents a waste of energy, capital, and manpower. It is important that we not make similar mistakes in t-he future.

We are well aware of the limitations on available energy and capital. The potentially large demands on our supplies of other critical resources should be of equal concern. There are many competing demands for water which may well be the next critical factor in limiting our choices of life style. Opportunities for multiple use of water must be explored actively, and careful planning is needed to avoid exceeding safe consumption rates in any one region. Land use, also, must be assigned only after careful evaluations of all multiuse opportunities and priorities have been determined,

The reduction of engineering graduates in the last few years has placed us in a position where we cannot mount simultaneously an effective, large development effort on all new energy alternatives. Fortunately, a turnaround in enrollments has occurred; however, there will be a shortage of engineers and scientists skilled in solar energy technology for some years to come if other energy technologies are also expanded more rapidly. Fortunately, many energy technologies are supportive and many of the required personnel will be drawn from existing manufacturing concerns. A more serious problem may occur in the skilled trades required for installation and maintenance of the solar systems. The environmental impact of various solar energy sources and conversion systems is an important factor which must be considered. For example, atmospheric disturbance caused by local heating near large solar collectors could be significant as solar energy use increases.

Although the subject of materials is touched upon in the ERDA Plan, it has received inadequate attention. A case in point is in the collector part of the solar heating and cooling program, where the amounts of materials required to meet the projected energy contribution do not appear to have been considered.

The energy required to produce these and other materials must also be accounted for in the calculation of the net energy consumed to produce *1* Quad of output. For example, the production and fabrication of each ton of aluminum requires from *20,000* to *90,000* kWh of energy. Therefore, the 4.3 million tons of aluminum needed to ha; e an installed annual collection capacity of 1 Quad by 1985, requires from *0.35* Quad to nearly 1.5 Quads, Thus, the aluminum alone could cost as much as 7,5 percent of the energy produced over a 20-year equipment life. These figures emphasize the importance of programs to reduce the amounts of critical materials in collectors when large-scale implementation is contemplated,

4. Organization of ERDA's Research Program

ISSUE

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

SUMMARY

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

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

QUESTIONS

1. What are some of the specific programs of basic materials research that ERDA is supporting? How do they relate to ERDA's mid-term or long-term goals?

2. Is engineering work toward these goals being done in the same laboratory? If so, are the engineering and scientific programs monitored by the same ERDA manager? Do they have a common laboratory leader? If not, what mechanisms have been established to insure dialogue between the two managers as well as between the engineering and scientific efforts?

3. How is ERDA addressing the social, legal, and institutional problems associated with solar and geothermal energy?

4. How many dollars have been allocated to the ERDA laboratories for basic research in nonnuclear energy? How large a fraction of the total budget for such research does this represent? How many engineers and how many scientists are involved? Is this a typical program? Is ERDA supporting similar research at other institutions? If so, how are these programs coordinated?

5. Do you think SERI should be established as a central managerial and assessment office having regional technical laboratories? As a central research laboratory having regional demonstration projects? What function would ERDA like to see it exercise? What relationship does ERDA think it should have to existing facilities.

BACKGROUND

The distinction between basic and supporting research is motivated by the need to preserve scientific freedom in the research aimed at developing the conceptual context within which innovative technology operates. Experience has shown that those charged with engineering responsibilities and constrained by timetables are not effective managers of this type of research. However, experience has also shown that scientists do not generally apply their insights to the solution of practical problems if they are isolated from engineers and a participation in the mission orientation that engineering provides. Therefore, the optimum solution to innovation in advanced technology is cooperative leadership between scientists and engineers and other individuals and groups responsible for commercialization. Effective implementation of mid- and long-term programs in energy-oriented research requires a continuing dialogue not only between scientists and engineers, but also between design, materials development, materials processing, and system engineers, and marketing people. This dialogue can be effectively carried on within interdisciplinary teams sharing a common sense of responsibility. The following elements appear essential to successful advanced-technology development:

- A large measure of local management autonomy
- A definite, though broadly defined, mission
- Full-time, interdisciplinary technical staff selected by management to implement an engineering objective having a multidisciplinary dimension
- Adequate support that allows for program continuity by committing a full-time staff engaged in high-risk, high-payoff technical development
- A high degree of interaction with individuals responsible for commercialization
- Intelligence and strong personal motivation for performance at all levels of the organization.

Neither management practices nor funding decisions by ERDA have yet taken adequate advantage of existing organizations that have interdisciplinary capabilities.

5. ERDA Program Management

ISSUE

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

SUMMARY

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

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

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

QUESTIONS

1. What is the cost in time and money of interposing an additional management level in the energy development program?
2. Is a highly structured management style consistent with the goals of ERDA? What alternative management systems has ERDA investigated?
3. What portion of the ERDA budget is used to support program management and program planning by outside organizations and Federal laboratories?
4. What new responsibilities have the National laboratories undertaken in the last year? What staffing levels have these required? To what extent have the new staffing requirements been met by new hires? By internal reassignment?
5. What are the existing guidelines for number of contracts monitored by each program manager?

BACKGROUND

The rapid expansion of the Federal agency budget has forced ERDA to contract with organizations which have immediately available management capability. Their function is to provide an intermediate level of program management which has responsibility for the success of a large research area within which it selects, contracts for, and monitors specific research and development projects. In such a program, all communication with ERDA by individual researchers is through these intermediate agencies.

To a large extent, the past experience of these organizations has been in fields in which cost has not been a major constraint and in which highly structured crash programs have been frequent. Such approaches may not be appropriate for R&D programs which are aimed ultimately at commercialization.

6. Support for Study of Decentralized Solar Electrical Generation

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ISSUE

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

SUMMARY

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

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

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

QUESTIONS

1. Is present ERDA solar organization (which separates electrical and thermal areas) appropriate for undertaking a project which combines several technologies in a system?

z. What coordination is now occuring with the ERDA Conservation Division which is responsible for fossil-fired total energy systems?

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3. Why is no further immediate solar thermal hardware deployment planned, in light of the successful Sandia work, and the rapid cost improvements already obtained?

4. Why has the photovoltaic program not been more active in placing experimental total energy systems into the field (the only one is the very early "Solar One" at the University of Delaware, which was in large part funded locally)?

BACKGROUND

This topic is the subject of an extensive assessment by the Office of Technology Assessment which will be released at approximately the same time as this ERDA Plan review. Consequently, little more detail will be provided here, The interested reader is urged to contact OTA for the report from this additional solar energy assessment.

7. Emphasis on Electric Energy Systems

ISSUE

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

SUMMARY

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

QUESTIONS

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

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

BACKGROUND

The ERDA Plan is apparently guided by the logic that: (a) because mid-term energy demands will be met increasingly by coal and nuclear energy (both best suited to electric power generation), (b) because maximum advantage is to be gained by having interchangeable energy sources, and (c) because electric power generation is the best "common denominator" for all sources (including geothermal, fusion, and solar), it is necessary to begin changing our infrastructure for energy conversion, delivery, and consumption to a massive dependence upon electrification. Thus, top priority in the ERDA Plan is given to systems that convert primary energy (coal, nuclear, solar, geothermal) to electricity. Lower priority is given to the direct utilization of thermal sources, whether from solar energy (a distributed source) or from geothermal and nuclear energy (centralized sources).

The use of biomass for fuel is regarded as a possible long-term energy supplement, but no explicit considerate ion is given to the production of alternative fuels, such as hydrogen, methane, and methanol. However, high-temperature electrolysis, photolysis, and pyrolysis for alternate-fuel product ion from solar or nuclear energy are attractive options awaiting technical development,

These priorities are not consistent with the present patterns of energy consumption. Approximately 25 percent of the present energy demand is for industrial process heating and direct heat. Moreover, about 25 percent of the energy demand will probably continue to be for transportation which is at present totally dependent on fossil fuels. There will be a continuing need for fuels for heating and cooling as a supplement to solar energy utilization systems.

8. Emphasis on Solar Heating and Cooling of Buildings

ISSUE

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

SUMMARY

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

QUESTIONS

1. How does ERDA reconcile the inconsistencies between the statements made concerning priorities and emphasis on solar heating and cooling in ERDA-48 and the projected fuel savings shown in ERDA-48?
2. How does ERDA justify lower 1985 goals than those put forward by FEA in Project Independence as being attainable with an "accelerated government program?"
3. How does ERDA define the interface between solar "demonstration" and solar "commercialization"?

BACKGROUND

Solar water heaters are used extensively abroad (Israel, Japan, and Australia) and to a lesser extent in the United States (Florida and California). In excess of 100 solar space heating systems have been installed in the United States, most of which were not Federally funded. There is no similar foundation of existing technology in use to serve as a point of departure for other solar technologies,

The existing base for solar heating and cooling provides an opportunity for rapidly accelerating its growth through governmental action, including: (a) government-funded demonstration program intended to accelerate consumer acceptance; (b) more government-funded R&D to accelerate development of more efficient and lower cost systems; and (c) an incentive program, needed temporarily to enhance production and to bring down costs. The ERDA priorities in funding do not appear to recognize adequately this opportunity,

ERDA-48 (volume II, p. 40) projects energy saving objectives for solar heating and cooling at 0.2 to 0.6 Quad in 1985, The maximum objectives projected in 1985 for other individual solar technologies are small compared to the 0.2 to 0.6 Quad range projected for solar heating and cooling. Further, the 1985 goals may be too low. The accelerated program of FEA's Project Independence projects 1.5 to 2.0 Quads per year in 1985. Although the 2-Quad level may seem large, it is only 2 percent of anticipated total energy use projected by FEA in 1985 compared to almost 25 percent of total energy use for heating and cooling of buildings.

In view of the above, it seems reasonable to anticipate that ERDA would assign high priority to solar heating and cooling programs needed to capture this potential. The statements quoted in the Summary to ERDA-48 suggest otherwise.

9. Purposes of the Solar Heating and Cooling Demonstration Program

ISSUE

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

SUMMARY

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

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

QUESTIONS

1. Does ERDA agree that acceptable solar water and space heating systems are now commercially available?

2. Does ERDA agree that there is a disparity between the emphasis placed on demonstration of solar heating and cooling in ERDA-48 and in (Public Law 93-409), the Solar Heating and Cooling Demonstration Act?

3. What should be the principal purpose of the demonstration program in the solar heating of buildings?

4. Is the suggested 400 solar-heated residential installations over a 4-year period sufficient for a vigorous demonstration program? If not, how many should there be?

5. Should solar-heating demonstrations be concentrated in the present year and next year, or should they be approximately evenly distributed over a 4- to 5-year period?

6. If solar heating is expected to grow in the private sector without government demonstration, is there justification for a demonstration program?

BACKGROUND

Commercially acceptable equipment for solar space and water heating is available in today's market and has already experienced limited sale in several sections of the country. The primary objective of the solar heating demonstration program is to stimulate a large increase in the rate of application of the technology and thereby a reduction in fuel consumption. By providing funds for a significant number of solar-heated buildings, ERDA's Plan could stimulate additional solar installations. The solar-heating demonstrate ion program is designed to show to the public at large (users; designers; builders; financiers; and tax, insurance, and regulatory authorities) the extent to which solar heating can be applied successfully and economically to a variety of buildings in wide areas of the country. Legal, institutional, environmental, and social deterrents to adoption should be assessed and dealt with as part of the demonstration.

Another purpose of the solar-heating demonstration program is the integration of various available components and subsystems into effective heating systems, and the determination of performance and cost of such systems, This program should demonstrate the benefits attainable by use of various subsystem and system improvements resulting from research and development.

The overall goal of the program should not be the development of technology or of hardware, but rather the development of consumer markets.

Research on and development of solar cooling and advanced solar-heating components and systems are important activities which should be conducted under a well-funded R&D effort, but this should be dissociated from the demonstration programs. Whenever such developments reach the stage at which available solar-heating systems have now reached, they should be included in the demonstration program as outlined above.

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

ISSUE

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

SUMMARY

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

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

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

QUESTIONS

1. Why, as stated in ERDA-23, does ERDA propose to delay study of incentive programs until 1979?
2. What agency, or agencies, should develop a structured incentive program, and what should be the nature of ERDA's interaction with it?

BACKGROUND

The development of large-scale application of solar energy for the heating and cooling of buildings requires that a very large number of individual favorable decisions be made. In the majority of cases these decisions will be made by individual consumers, and a major factor in these decisions is the economics of the choice as perceived by the potential user, Each has his own perception of the relationship between first cost and annual savings required-to elicit a favorable decision, and the rate at which conventional energy costs will escalate, Thus, a properly structured incentive program which reduces the users first cost and operating cost will increase the number of individual favorable decisions. By subs id i zing equipment cost to the user, the cost savings effected by increased production can be made available to the consumer. On the basis of present equipment costs, the current payout time on solar systems, resulting from savings in conventional energy costs, is satisfactory to a significant but moderate number of consumers, mainly if the user's current alternative is electric energy. Because heating oil and gas prices are lower than electricity prices, for home heating, present costs of solar equipment currently represent an attractive investment only to a minority of consumers.

In a very real sense, the user of solar energy becomes an energy producer. His costs, which are largely investment related, must be competitive with those of producers of competitive forms of energy. Many of these are also capital-intensive. The corporate producer of competing energy is assisted in recovering his investment by investment tax credits which provide for immediate recovery of a portion of the investment from pretax income. Also, he can recover the balance of his fixed investment over time with pre-tax income through depreciation allowances. In addition, in some cases he also receives tax-free depletion allowances. If the solar energy producer is an individual homeowner, he receives none of these tax benefits, and must pay for his productive facilities with after-tax income, As an owner of commercial or rental property, he receives only depreciation allowances, Therefore, under present tax laws, the individual (noncorporate) producer of solar energy is subjected to discrimination and faces a disincentive to use solar energy.

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

ISSUE

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

SUMMARY

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

QUESTIONS

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

BACKGROUND

It is generally true in the development of an industry that some of those who enter it seek to capitalize on the consumer's lack of knowledge by marketing products which are either unsuitable for their intended purpose or which do not perform as claimed. Significant commercial sale of solar heating equipment is now emerging and volume will grow, particularly if sales are stimulated by the government through demonstration programs and user incentives. There is evidence that unscrupulous suppliers have already entered the market.

For the consumer to intelligently compare the solar equipment of different manufacturers, realistic and consistent ratings are necessary. To select equipment for a particular application, valid performance data are also required. At present, the performance of much equipment is unspecified or is presented in a manner unique to the particular manufacturer, and it is difficult to make comparisons or to size installations, This is true even of manufacturers whose reputation is such that there is no serious question of fraudulent claims. There are others whose performance claims are at least suspect.

Standards intended to establish equipment durability and life are also required to protect the user's investment, Although manufacturers' warranties are important, they are not a substitute for standards at this stage in industry development. Many equipment producers do not have the financial strength required to back up meaningful warranties, and therefore valid equipment ratings are essential.

Standards intended to assure adequate installation practices are also needed in lieu of nonexistent local codes and regulations. It should be expected that in time, such standards will be replaced by local codes and regulations.

It appears that the industry is still in a formative stage of development and that Government assistance is required to accelerate development of standards, It is paramount to rapid consumer acceptance of solar energy that the credibility of this industry be guaranteed by industry self-regulation and government vigilance.

12. Impact of Solar Energy on Utility Peak Demand

ISSUE

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

SUMMARY

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

QUESTIONS

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

BACKGROUND

At present, solar energy represents a negligible contribution to any region's energy economy and therefore has little effect on a utility's load distribution. As onsite solar energy use makes a greater impact, it in itself will cause an increasing peak demand problem for utilities unless these systems are designed wisely. If the utility standby capacity is used, then the solar energy system should be designed to demand supplementary energy at off peak hours and store it until needed, thereby minimizing the peak demand problem and possibly even enhancing the relation between peak and baseload for the utility. Another option is onsite, self-contained auxiliary energy storage (such as fuel oil, replenished as needed). This makes the user independent of a utility, but provides a long-term demand for onsite fuel (fuel oil). The extent and seriousness of this problem should be studied by FEA in conjunction with the utility industry, FPC, and citizen energy groups.

13. Biomass Energy and Food

ISSUE

Biomass energy generation may conflict with food production.

SUMMARY

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

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

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

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

QUESTIONS

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

BACKGROUND

Biomass energy production has a number of attractive features. Aside from being environmentally benign, the organic products may be burned for energy or converted to liquid, gaseous, and solid fuel forms, They may be used for either peak- or baseload electric-generating capacity in central power systems, or may be used as transportable fuels.

This flexibility y of end-use extends to construct ion (lumber), food (cellulose), and the farms themselves (green belts and recreation), The specific way in which the organic farm product is used will depend on need and economics rather than on rhetorical choices between food and energy. Food and biomass energy are not mutually exclusive, and such implications may foreclose an attractive option, unless viable development strategies are pursued which do not seriously affect food production,

In addition the relatively low conversion efficiencies may mean that single-purpose energy plantations are not economically competitive. Energy biomass as a by-product from food production, however, may be economically a t tract iv e. Reorientation is needed in agricultural R&D to maximize food/energy production cost effectiveness,

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14. Legal and Institutional Constraints in Geothermal Energy

ISSUE

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

SUMMARY

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

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

QUESTIONS

1. What can ERDA do to expedite the leasing and exploration of potential geothermal resources?
2. Can the Environmental Impact Statement (EIS) requirements be modified to stimulate exploration without damage to the environment?
3. What steps can be taken to ensure the efficient development of the total geothermal resource ?

BACKGROUND

Current exploration for and development of geothermal reservoirs is being slowed by problems with the licensing, permitting, and leasing process. The present pace and requirements of the Bureau of Land Management's (BLM) procedures for leasing Federal lands, which con t a in much of the Nation's resources, hinder exploration. Experience shows that leasing without exploration will not encourage the resource industries to expand the data base required for valid resource evaluation.

Requirements for a complete Environmental Impact Statement prior to exploratory drilling may be an unnecessary burden. A complete EIS is not required for exploratory oil and gas drilling. Perhaps a better plan would be to allow exploratory activities to be initiated with limited initial environmental analysis, but subject to minimum standards. Upon discovery and con firmat ion of a resource, a master plan, including a complete EIS, would then be filed for approval before development of the field, The various states with geothermal resources define the material in different ways—that is, as water, as a mineral, as a fossil fuel, or not at all—and no ownership is defined for the dissolved minerals and gases, These ownership quest ions can only hinder development, since the problems of leasing large areas with multiple ownership of water and mineral rights are sufficient in themselves to prevent utilization of the resource, To encourage geothermal development, the resource will have to be uniformly defined as water, as a mineral, or as a unique resource. It may be in the interest of rapid utilization to cons icier innovative solutions, such as defining geothermal fluids and all associated minerals, gases (methane, carbon dioxide, etc.), and thermal energy, as a unique resource. Furthermore, to conserve the available resources, it may be necessary in some cases to consider legislation which would prevent exploit a t ion of the resource solely for the recovery of the mineral or methane content while wasting the thermal energy (heat) which is also available. A situation could develop similar to the one which existed when it was considered uneconomical to recover natural gas and it was wasted (flared),

Jurisdiction of regulatory agencies often overlaps and, in many cases, results in conflicts which can almost totally prevent utilization of the resource. An elimination of multiple permits for the same steps and unnecessary multitiered regulation may be one approach to the solution of this problem.

The use of water from geothermal reservoirs presents similar problems. In most cases, it will be necessary to reinject the spent fluids into either the reservoir or some adjacent geological formation to prevent subsidence and to dispose of any undesirable fluids. In some cases, water usable for irrigation must be wasted because current regulation may prevent its use simply because the composition of the geothermal fluid is different than that of the underlying fresh water aquifiers. Such restraints may be un-necessary in many areas,

15. Environmental Constraints on Geothermal Energy Development

ISSUE

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

SUMMARY

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

QUESTIONS

1. To what extent is land subsidence a potential problem with geothermal energy development, and how large a geographical area will be affected?

z. What types and degrees of exhaust gas treatment will be required to minimize potential air pollutant emissions from geothermal energy development, and what will be the resultant costs?

3. What chemicals can be economically recovered from geothermal brine streams prior to reinfection, and what additional effluent treatment may be required for above-ground disposal?

4. What magnitudes of earthquake intensities may occur from varying levels of geothermal energy development, and how might this constraint affect future utilization?

BACKGROUND

Geothermal energy results from the heating of ground water in the Earth's crust by proximity to its molten core, The four basic types of geothermal energy developments are the hydrothermal brine, geopressurized water, geothermal steam, and molten magma systems. Potential environmental impacts from major producing fields and potential major fields are as follows:

- The Geysers, California. Geothermal steam production for electric-power generation at the Geysers releases hydrogen sulfide to the atmosphere in small quantities with the noncondensable gases, whereas the major portions are precipitated as a sulfide sludge to constitute a potential solid waste problem. Mercury vapor is also released in trace quantities from the exhaust gases from the geothermal steam fields.
- Imperial Valley, California. Hydrothermal brine development in the Imperial Valley necessitates the disposal of highly saline brine streams through either deepwell reinjection or surface disposal. The potential for land subsidence and the activation of earthquakes are environmental constraints that can deter future development. The release of hydrogen sulfide in significant quantities constitutes a potential odor problem, while trace element releases of arsenic, boron, and

mercury also pose possibl e environmental problems.

- Gulf Coast, Texas, The geopressurized-geothermal water sources along the Gulf Coasts of Texas and Louisiana pose problems, relating to water quality, land subsidence, fault activation, and air pollution, but also provide for potential natural gas recovery, This energy source is still in the developmental stage where technical and economic feasibility has not yet been fully established. There is an additional need to provide for a detailed environmental assessment of this energy resource.

16. Nonelectric Uses of Geothermal Energy and Geothermal Goals

ISSUE

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

SUMMARY

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

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

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

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

QUESTIONS

1. What portion of the 10,000 to 15,000 MW of geothermal energy projected by ERDA for 1985 is expected to come from nonelectric uses?
2. Is a process heat survey being planned to determine what fraction of the total industrial heat could be supplied by geothermal sources?
3. Would a person or firm who was interested in using geothermal process heat be eligible for the Federal Geothermal Loan Guarantee Program?
4. Does ERDA feel that as part of its dissemination and implementation function it should encourage the location or relocation of industries using low-grade heat near geothermal resources? Would the loan program apply?
5. Does ERDA plan to use geothermal resources to develop central systems for the space heating and cooling of buildings in populated areas?

BACKGROUND

A problem in interpretation of the ERDA document arises since it does not specify what fraction of the total utilization is, to be electric.

By 1985, the Geyser's vapor-dominated geothermal field may be producing l,550 MWe. The moderate temperature, low salinity hydrothermal demonstration plants (100 MWe total capacity] will not be operational until 1979-82. Pilot plant programs to test other geothermal sources are not scheduled to be operational until 1978-80. When the time required to advance from operation of a pilot plant through completion of a significant number of commercial plants (greater than or equal to 50 MWe) is considered, it is difficult to conceive that over 4,000 MWe could be on line by 1985.

Where geothermal energy is available, however, it can readily be used to replace electric or fossil fuels as sources of heat, Much of the energy expended in this country is used to provide heat for industrial processes, space heating, and for processes which depend on a supply of moderate temperature fluids. These include control of chemical reactions in petrochemical and chemical plants, drying of agricultural products, processing of foods, paper production, and mineral extraction and purification. Geothermal water could be used for food production enhancement processes that use temperature control to generate maximum crop yield, such as field and greenhouse heating. Protein supplies could be expanded by algae growth in ponds heated year-round by geothermal sources.

Geothermal fluids may contain valuable minerals that are recoverable. In many cases, the thermal energy in the fluids is sufficient to effect this recovery.

These nonelectric uses of geothermal resources can expand the definition of a geothermal resource because a low-temperature reservoir, which is not usable for electric generation, can be used for some of these nonelectric applications. Note, however, that nonelectric uses will, in general, probably be site specific. The ERDA Plan includes a pilot plant to investigate "multiple nonelectric uses of thermal waters." It is difficult to determine whether or not multiple uses will be practical at a given geothermal reservoir. Support for "demonstrations" at different locations for different purposes may prove to be more desirable.

To achieve the goal of extensive nonelectric use, a greater emphasis is needed, especially in the area of dissemination of information and in the technology of conversion of existing industrial heat processes from fossil fuels to geothermal heat.

17. Variability of Geothermal Reservoirs

ISSUE

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

SUMMARY

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

QUESTIONS

1. What cycles has ERDA identified for its pilot/demonstration program in geothermal energy?
2. How will advanced power cycles be demonstrated?
3. To what extent will the pilot/demonstration program be concerned with problems associated with integrating a geothermal source with an existing power grid?

BACKGROUND

The Energy Research and Development Administration has identified two moderate-temperature (about 200°C), low-sal inity reservoirs for demonstration and may choose the binary cycle (or a version thereof) for both of these reservoirs, A variety of canal: date power cycles are possible, but they have not been included in the current demonstration program.

The ERDA program also includes pilot power plants for a high-temperature, high-salinity reservoir, a geopressured reservoir, and a dry hot-rock reservoir. The best choice of power cycle for these pilot plants may be other than binary. Since most of the known high-tempera ure reservoirs are located in the South and Southwest where water is scarce the most appropriate cycle for a given reservoir should be determined by both the reservoir characteristics and the availability of cooling water.

The demonstration of power cycles will not solve all the potential operational problems associated with widespread utilization of geothermal energy for electricity. Dynamic control of the production/power/injection system is important, particularly if the electric load is lost, Any interruption of electric load on the generator creates control problems for the well since the fluid must bypass the power conversion equipment until load is returned to the system. With a steam geothermal reservoir, it is safe and environmentally acceptable to vent the steam. However, with saline hot water systems, the fluid can not be dumped because of environmental considerate ions. Thus, an artificial load (storage system) might have to be applied or the hot fluids would have to bypass the power conversion equipment and be immediately reinjected. All of these control, grid interaction, and switching problems need to be considered when optimizing a geothermal electric installation,

E. COMMENTARY ON ERDA PLAN

This sect ion is devoted to several comments or short issue statements concerning the ERDA solar and geothermal programs. The nature of the issues addressed by these comments is such that a short exposition is all that is required to adequately express them. They should not be considered to be less important than the several issues developed in length in Section D.

1. Has proper attention been given to the necessary intraagency coordination mechanisms to ensure the cross-fertilization of information and technology between solar programs and necessary auxiliary efforts in other divisions?

   There are many aspects of the ERDA program which cut across divisional boundaries, and which, although assigned to one division, are of vital concern to the solar-geothermal programs. Examples of such areas are:

   - Energy storage
   - Hydrogen generation, distribution, storage, and utilization
   - Advanced power conversion cycles
   - Combined storage/conversion systems; e.g., fuel cells or thermal "batteries ."
   - Superconductivity y
   - Electric power conditioning (e.g., d.c, to a.c, conversion)
   - Resource availability, particularly fresh water.

2. Which research programs in the solar and geothermal areas are budget limited? If more funds were provided, what would be done with them, and how would they assist the research effort?

3. What are the differences between a test bed facility, a pilot plant, and a demonstration plant?

   In ERDA language, a test bed is a facility used to test components of and ideas for a total system. A pilot plant is a complete system assembled t() show technical feasibility and to gain construction and operating experience. A demonstrate ion plant is a near commercial scale facility used to show economic feasibility y although the plant itself may not be economically competitive at that time. Another but totally different concept of "demonstrations" is illustrated in connection with solar heating and cooling of buildings (see Issue Paper 9), where the objectives are to generate a user market.

4. Does ERDA's patent policy enhance or impede development and application of solar and/or geothermal energy?

5. Should ERDA research funding include requirements that access to background proprietary information and patent positions be granted to the Federal Government?

6. How does withholding of "proprietary information" by industry affect ERDA's state-of-the-art reviews and data-bank usefulness'?

7. What should be the nature of incentives to use windpower systems and geothermal heating systems?

   The issue of incentives related to solar heating and cooling has been discussed previously (see Issue Paper 10). Many of the same points also apply to wind power and geothermal heat utilization,

8. Would it be appropriate for ERDA to fund traineeships in solar and geothermal technology?

   The discipline requirements for the utilization of these resources is such that some incentive, similar to the former NASA traineeships, may be required to encourage pursuit of these specialized educational backgrounds. The need for these hybrid scientists/engineers is immediate,

9. What is the reason for the apparent emphasis on the central tower solar electric concept to the exclusion of solar electric approaches?

10. Should the Plan make a specific commitment of allocating a portion of the solar heating and cooling demonstration projects to the retrofitting of existing residential and commercial buildings?

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Although solar heating and cooling systems will be more cost effective in new buildings designed with the systems, the approximately 65 million existing buildings present an immense potential for solar heating and cooling, with a subsequent significant potential fuel savings. This is particularly true in the case of solar-heated domestic water.

11. What is the status of the Guaranteed Geothermal Loan Program?

The Geothermal Guaranteed Loan Program will be impossible to implement without appropriate ions available to back up the guarantee.

12. Why does a solar thermal total-energy system demonstration appear in the plan, but no photovoltaic total energy system?

Photovoltaics (at least onsite) would appear to be at least as well suited for total energy systems.

13. How does ERDA plan to verify and supplement the estimate of geothermal resources indicated in the USGS Assessment Program?

USGS cannot drill exploratory geothermal wells, but in order to determine the potential reserves, geothermal exploratory wells must be drilled. Such exploratory drilling will allow for better planning of resource utilization and determine the resource for which conservation technology should be developed.

14. Why is little emphasis placed on alternative solar-cell materials (other than silicon) considered in the ERDA Plan?

A number of other materials (such as gallium arsenide, cadmium sulfide, and iridium phosphide) are receiving considerable attention from the private sector, and some of them appear quite interesting.

15. Does the potential for the export of solar, wind, and geothermal technology and equipment have any impact on R&D strategies?

‘ 16. Will geothermal resources benefit only certain segments of the country?

Even though geothermal resources are regional in occurrence and nontransportable, this does not make it a regional resource which will benefit only a small segment of the population. Because of the nature of the resource (heat), it must be used near the well site. However, when geothermal energy is used in one portion of the country to replace fossil fuel heat sources, the fossil fuel saved is available to the country as a whole in the form of high value liquid fuel,

17. What is the role of ERDA in the development of geothermal exploration methods?

The development of advanced geophysical exploration techniques is needed to ensure full and rapid development of geothermal resources, If ERDA agrees that it is within the scope of their mandate to do this type of work, such a statement should be made with details provided.

18. Has ERDA given adequate attention to the use of international research efforts to solve common energy problems?

The solar energy field is a particularly attractive area for cooperation.

19. Why hasn’t the use of wind energy for nonelectric applications been considered; e.g., water-pumping, with pumped-storage capability?

It is possible that significant capital cost and energy savings might be realized by exploiting all possible avenues for these applications.

20. Has ERDA considered establishing test facilities, pilot plants, and demonstration plants on Federally controlled rather than privately controlled lands?

This approach, with the assistance of private industry, would allow the rapid testing of technology without many of the long delays associated with licensing and restraints on private land. This approach should be considered for cases where early testing of a resource or technology is mandatory.

21. What is the nature of ERDA’s interaction with the EPA program in urban waste disposal? How do you integrate the use of agricultural and forest wastes with your program of energy from biomass?

The use of’ organic wastes: urban, agricultural, and tree farming, can make a modest contribution to the fuel supply while reducing an adverse environmental problem.

22. What ocean areas have you identified that have suitable upwelling conditions for marine biomass cultivation? Is this area large enough to allow a significant impact? What is your estimate of the net energy-gain per acre of marine biomass and the cost to harvest?

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