C. INTRODUCTION

The review of ERDA's Plan for solar and geothermal technology is an attempt to examine the plan with as balanced a view as possible, in order to identify and summarize for the Congress those areas of the plan in which Congressional interest might be both appropriate and useful in the national interest. These areas are discussed in a series of issues, some of which cut across all aspects of geothermal, solar, and others which pertain to a specific technology.

There is unanimous appreciation of the problems and difficulties faced by ERDA in preparing the first National Plan for Energy, R, D&D in so short a timespan. In view of these difficulties, most observers feel that the plan is generally well done. There are important shortcomings, however, and it is hoped that the issues raised in this report will help the Congress and ERDA to refine the plan more effectively.

1. General Issues

In establishing a program that involves choices among several technologies of varying degrees of cost uncertainty, careful attention must be paid to the decision process to ensure not only that the most promising technologies are rapidly developed and commercialized, but also that marginal or high-risk technologies are not prematurely pushed into engineering development and demonstration phases (Issue Papers 1 and 2). Without these decision criteria much time, effort, and money can be wasted on unproductive projects.

A lack of adequate emphasis on resource assessment can lead to development of technologies which are counterproductive in that their use of other valuable resources (such as water, land, and materials) is excessive compared to the energy produced. The question of available manpower must also be considered in any resource assessment because of its potential for limiting program development (Issue Paper 3).

A final set of general issues deal with ERDA organization and program emphasis. If ERDA staffing is adequate, program management and assessment can be carried out centrally. This eliminates problems brought about by the multilayered management which occurs when out side organizations and/ or Federal laboratories are extensively used (Issue Paper 5). The separation between science, engineering, and marketing research which appears in the ERDA structure can reduce efficient flow from basic research to commercial application, This is critical when the nontechnical aspects of energy R, D&D are considered, but even more so for the development of high-risk technologies (Issue Paper 4), With regard to program emphasis, there is concern that ERDA has given inadequate attention to decentralized solar electric generation systems, Their ability to take advantage of the distributed nature of solar energy and to utilize waste heat is reason for giving them high priority (Issue Paper 6). Finally, a heavy emphasis on development of electric energy systems fails to address important possibilities for synthetic-fuel production and could preclude widespread direct use of solar and geothermal heat which may be more efficient both technically and economically (Issue Paper 7),

2. Solar Electric

Solar-generated electric energy is considered as one principal option for an inexhaustible energy source in the long term, Although no technical barriers exist which could preclude development of solar-generated electricity, the uncertain costs of these plants necessitate a careful development program if they are to be economically competitive. It appears that accurate full scale estimates, necessary for intelligent national energy planning, may only follow full scale prototype testing, regardless of whether these plants are themselves cost effective.

The large cost uncertainties of different solar electric concepts (ocean thermal energy conversion, solar satellite, solar thermal) necessitate development of precise decision criteria for

alternative energy technologies (Issue Papers 1 and 2). Consideration of resource availability is critical due to the extensive use of land and, in some cases, water by solar electric systems (Issue Paper 3), Finally, the emphasis placed by ERDA on developing electric systems of all types, affects the priority placed on solar electric. If this emphasis is reconsidered, it could affect the rate at which solar electric is pursued (Issue Paper 7),

There should be a reassessment of the programs which call for pursuing four parallel efforts on a single concept—the central tower, Concern is also express that the ERDA approach to solar total energy systems may be too narrow in that photovoltaic systems were not included. Finally, there is the need to ensure that a full range of photovoltaic cell candidates is investigated (Commentary),

3. Solar Heating and Cooling of Buildings

Approximately 25 percent of the total energy used in the United States is for domestic water heating (4 percent) and for heating and cooling of buildings (2 I percent). In addition, approximately *29* percent of our total energy is used for industrial process steam and direct heat, Thus, in excess of 50 percent of total energy demand is the direct use of thermal energy. Solar energy is best suited to many of these direct thermal applications and it is in these areas that it can have its most immediate impact on our energy economy and can contribute substantially as a long-term, inexhaustible energy source,

The technology and economics for solar water and space heating are available now. Greater near-term emphasis should be placed in this area, relative to solar electric, along with acceleration of the Solar Heating and Cooling of Buildings (SHACOB) demonstration program. This is proposed as a more effective way to develop solar energy (Issue Papers 8 and 9). User and manufacturer incentives, as well as the educational and market development value of an effective demonstration program are necessary for effectively introducing solar heating and cooling into the economy (Issue Paper 10). Furthermore, to protect the consumer and maintain a high industry standard, it will be highly desirable to require manufacturers of solar equipment to provide valid performance information on their products (Issue Paper *11].* Although many of the legal and institutional issues will be resolved easily as the technolog, advances, some, such as guaranteeing access to sunlight, require attention now. Finally, as the solar energy industry develops, plans should be made to minimize the impact on-utility peak demand (Issue Paper 12).

4. Biomass

Synthetic fuel from biomass is considered by ERDA as a lower priority technology which could contribute in the long term, The uncertainty as to the economic and technological requirements for large-scale bioconversion systems makes premature any definite estimate as to the eventual contribution of biomass to the energy system, but support of genetic studies for the development of better energy crops is warranted. The potential conflict with food requirements for arable land is probably the most severe limitation on large-scale fuel production from biomass, Unless strategies can be developed to resolve both the perception and the fact of this competition, biomass energy will necessarily have limited impact (Issue Paper 13), Use of organic wastes, both urban and agricultural, offers another potential source of synthetic fuels from the bioconversion process, It is not clear to what extent ERDA has considered this, Finally, a careful assessment of the land availability and net energy gain per acre for marine biomass are needed for a sound decision on how to proceed with this technology (see Commentary, pages 165-167).

5. Geothermal

Geothermal energy is derived from the abundant thermal energy of the earth's core and usually is available for use as hot water or steam. "There is a substantial, but limited, number of individual geothermal reservoirs in which recovery of geothermal energy is deemed practical," Depending on the temperature and characteristics of the reservoir, geothermal fluids can be used for electric generation, industrial process heat, space heating, and air conditioning. Geothermal energy has a large mid- to long-term potential to contribute to the Nation's energy supply.

The main impediments to rapid utilization of geothermal resources are the legal and institutional constraints which could effectively

prevent utilization of this resource (Issue Paper 14). The resolution of these legal and institutional problems is critical to the success of any geothermal energy development programs. Other potentially severe impediments relate to environmental considerations. Disposal of geothermal pollutants and avoidance of geological disturbances need to be given greater emphasis to ensure acceptable development of geothermal energy (Issue Paper 15).

An estimate of the exact rate at which geothermal energy sources will be developed is difficult to make and perhaps the ERDA near-term predictions are optimistic. Even though geothermal resources have the potential to meet the ERDA goals, they will probably not be achieved as soon as predicted unless there is a substantial increase in emphasis on nonelectric use. Since a major portion of the geothermal resources is low temperature, the most important use of geothermal energy in the United States may be for nonelectric uses as is presently the case throughout the world. The ERDA Plan may not assign enough significance to the development of the nonelectric uses of geothermal energy (Issue Paper *16).* Each geothermal reservoir is unique in its characteristics, and, if the maximum amount of energy is to be extracted from any reservoir, the applications and the equipment technology must be optimum and must match the characteristics of the reservoir, Thus, the equipment and power conversion research strategy will have to be designed for a wide variety of possible utilization systems in order to minimize resource waste (Issue Paper 17).