

THE JPL ISOLATED APPLICATION EXPERIMENT SERIES

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ABSTRACT

The goal of the Applications Element of the Thermal Power Systems Project is to establish the technical, operational, and economic readiness of parabolic dish power systems for a variety of applications in the power range below 10 MWe. Power systems are being developed and tested to the point where commercialization efforts can lead to successful market penetration. A key element in this strategy is the use of experiments to test hardware and assess operational readiness. The JPL Isolated Application Experiments are described and their objectives discussed.

BACKGROUND

The three successive milestones required in the development of a new technology to the point of commercial readiness are: 1) demonstration of technical feasibility, 2) verification of readiness of the technology, and 3) achievement of cost goals required for commercial readiness. The three phases in the evolution of a new technology can be described as creation, development, and commercialization. Participation by both government and the private sector may be necessary, with increasing activity by the latter as the commercial readiness phase is approached. Potential users are involved early in the design phase to the maximum extent possible.

A key element of the program strategy is first the identification, and later the penetration, of near-term markets that will provide a stimulus for establishing a manufacturing industry. This, in turn, will lead to cost reductions as a result of improved manufacturing methods, coupled with an increasing volume of production as lower cost markets are penetrated. The importance of this program element lies in the belief that design improvement alone will not result in a sufficiently low price to penetrate the utility market. A combination of mature technologies and mass production, however, offers the potential for economically competitive power systems with a significant environmental advantage.

Potential users will be sought that fall into two broad market categories: 1) the near-to-mid-term market, which is smaller, and for which costs are higher; and 2) the far-term market which largely corresponds to the utility sector for which a mature solar thermal technology is needed before penetration can be expected. Application studies and system analyses are being conducted to develop candidate system configurations best matched to the users in each category. Selected system design concepts will be developed through contracts let to private industry.

THE ISOLATED APPLICATION EXPERIMENTS

The Isolated Applications Experiment Series is the second major activity within the Applications Element of the Project. The Series will be a set of small (approximately 60-150 kWe) solar thermal power experiments, each of which is meant to address a separate isolated load application.

These experiments will employ point focusing distributed receiver technology with emphasis on electric power applications. The program is closely integrated with the Technology Element of the Project with the objective of utilizing the technologies being developed under that program.

The first experiment in the Series is co-sponsored by the Dept. of Energy and the U.S. Navy under the auspices of the Civil Engineering Laboratory (CEL). CEL and JPL have worked together to develop system requirements. The experiment, designated as the Military Module Power Experiment, will be a modular system using a hybrid fired Brayton cycle energy conversion. Subsequent experiments will test different versions of similar hardware in different applications which are now being selected.

Primary considerations in implementing the series are to:

- o Test the readiness of suitable solar power technologies at the system level in a number of different applications.
- o Economically provide testing of both technologies and markets, thus meeting principal program objectives without large expenditures.
- o Involve a large constituency of industrial suppliers and users.
- o Address the potential for near-to-mid-term market for small power systems that is needed to provide the initial incentive to manufacture these systems.
- o Increase programmatic flexibility by employing a number of small and varied experiments.

Emphasis will be on:

- o High reliability and safety.
- o Early plant deployment.
- o Low program cost.
- o Complete test and evaluation.

The engineering experiments will be designed, installed, and operated to permit JPL to better understand solar thermal plant applications and technical feasibility.

The objective of the engineering experiments is not to maximize the kWh of energy generated by the solar plant or to lower the electric power costs of the site participants. Rather the objectives are to:

1. Verify that the solar thermal plant can produce power from solar radiation supplemented by fossil fuel to meet energy requirements for this application during designated test periods.
2. Verify that the solar hybrid plant concept can be considered as a firm power resource for this application during designated test periods.
3. Characterize the total performance of the plant (site preparation, components, subsystems, modules, and plant) as a function of load characteristics, insolation, weather, operations and maintenance activities, safety regulations, environmental regulations, seismic factors, and legal and socio-technical factors.
4. Identify and understand plant failure modes.
5. Identify and quantify the impact of solar hybrid plant operations on the daily operations activities of user personnel and on user manning requirements.
6. Identify and quantify the impact of solar hybrid plant installation and operations on the local environment.
7. Identify and quantify the impact of solar hybrid plant installation and operation on the acceptance of solar power plants by local public officials, local power system officials, and the local public.

SCHEDULE

The MMPE will enter design phase in FY81. The schedule for the first experiment now calls for a test and evaluation of two different modules to begin in CY83. Tests will be conducted at the PDTS at Edwards AFB. Two contracts will be awarded for system design, and this effort will culminate in a test program lasting for approximately 12 months (summer '82-summer '83). Severe cutbacks by DOE in the funds requested by the Thermal Power Systems Project have impacted the MMPE. The extent of the impact has been a slip of approximately 18 mos. in the module test completion date.

TECHNICAL FEATURES

The degree of MMPE module self-containment will be driven by both economics and reliability. Each module will contain (at a minimum) concentrator, receiver, hybrid combustor, turbine, recuperator, compressor, alternator, module controls, starter, concentrator drives, tracking devices and sensors, some fuel storage and necessary exhaust hardware. A completely self-contained module is desired with only the true plant functions located centrally. These will be power combination and conditioning equipment, module and plant performance indicators, grid interconnection equipment, computing and data recording facilities, instrumentation, plant safety and control equipment.

The normal mode of module operation will be unattended, however each module will be equipped for safety or emergency shutdown, both manual and automatic. Although a fixed installation is expected, individual modules must be transportable, field erectable and field serviceable.

Long term thermal storage will not be included in the plant. No thermal buffering will be provided except by the heat capacities of the installed components and working fluid. The hybrid combustor control system and/or engine controls will provide the desired transient response characteristics.

MMPE CONTRACT STRATEGY

Past performance of DOE solar thermal system integration contractors plus ordinary good business practice argue strongly for the creation and maintenance of a competitive environment for both subsystem development contracts and system integration contracts for the JPL Engineering Experiments. Competition can be introduced in several ways, although the best and most effective method is to finance it directly. This means the parallel development of alternative subsystems and/or interchangeable technologies, any one of which could meet the stated requirements for the system being developed. Competitive developments can then be pursued and final selections deferred until cost, performance, or schedule considerations dictate termination of all but the leading candidate or until the happy moment when one candidate demonstrates the assured achievement of acceptable cost, schedule, and performance.

The most obvious results of competitive, parallel, development is reduced program risk. A less obvious result is that competitive development does not necessarily increase total program costs. Competing contractors constantly strive to minimize cost and optimize performance particularly when a very large potential market is the ultimate prize. An optimum strategy is one which introduces and maintains competition as inexpensively as possible for as long as possible, ensuring maximum program benefits.

JPL's strategy is therefore to establish and maintain a competitive environment for the MMPE.

MMPE SITE SELECTION

Site selection for MMPE has been a U.S. Navy responsibility. It will be conducted in parallel with the system integration control activities and basically independent of the technical tasks. The Marine Corps Air Station at Yuma, Arizona, has been tentatively selected as the site for the experiment.

FUTURE EXPERIMENTS

Additional small scale experiments are being planned for inclusion in the Series. They will be designed to test developing solar thermal hardware with emphasis on economy and modularity. Future Program Review will afford the opportunity to present the details of these experiments.