

## SOLAR APPLICATIONS ANALYSIS FOR ENERGY STORAGE

T. Blanchard  
DOE/STOR Aerospace Corporation

The Department of Energy, Division of Energy Storage Systems (STOR) recently started an analysis of the role of energy storage as it relates to solar energy systems to 1) determine where storage technologies can best support solar energy applications, 2) assess the current status of storage technologies, 3) establish requirements and specifications for storage technologies and 4) evaluate the adequacy of the current storage R&D program to meet these requirements. The basic objective of the study is to determine where the greatest potential exists for energy storage in support of those solar energy systems which could have a significant impact on the U. S. energy mix. Such a determination could consequently provide program guidance as to how STOR can best expand their R&D resources to meet this potential.

The four parts of the study can be seen on the facing chart. The first will be the determination of the spectrum of roles for solar energy storage technologies. This will include an evaluation of the potential impact of solar/storage systems to displace fossil fuel systems. The second part will look at ongoing and completed solar/storage assessments to determine their adequacy and validity and will identify specific requirements and goals for storage technologies. Specific operational properties of storage technologies, as well as the system performance and cost goals required to meet the solar program needs, will be identified. The above information will then be utilized to determine the adequacy of the STOR R&D program, and recommendations will be made for supplementing or altering the STOR multiyear program plan, as needed.

## SOLAR APPLICATIONS ANALYSIS FOR ENERGY STORAGE

**WHAT DO WE HOPE TO ACHIEVE DURING THIS ANALYSIS OF SOLAR APPLICATIONS AND THEIR REQUIREMENTS FOR ENERGY STORAGE?**

- **AN ANALYSIS OF THE SPECTRUM OF SOLAR ACTIVITIES AND APPLICATIONS TO DETERMINE THEIR NEEDS FOR ENERGY STORAGE, SENSITIVITY TO THE AVAILABILITY AND PROPERTIES OF STORAGE, AND POTENTIAL IMPACT OF THE SOLAR/STORAGE SYSTEMS ON FOSSIL FUEL USE**
- **BRING TOGETHER BOTH SOLAR AND STORAGE PROGRAM RESEARCHERS TO ASSESS THE RESULTS OF ONGOING AND COMPLETED EFFORTS AND DEVELOP ADDITIONAL PARAMETRIC DATA TO IDENTIFY REQUIREMENTS AND GOALS FOR STORAGE TECHNOLOGIES IN SUPPORT OF SOLAR PROGRAMS**
- **IDENTIFICATION OF SPECIFIC ENERGY STORAGE PROPERTIES, DESIRED FEATURES AND PERFORMANCE/COST GOALS IN ORDER TO MEET THE NEEDS OF SOLAR PROGRAMS**
- **WITHIN THE CONTEXT OF TEA ACTIVITIES GENERATE DECISION CRITERIA WITH WHICH TO EVALUATE THE ADEQUACY OF STORAGE TECHNOLOGIES MULTI YEAR PROGRAMS PLANS WITH RESPECT TO THEIR SUPPORT OF PROPOSED SOLAR PROGRAMS**

The study is planned to be completed in about 24 months and consists of three specific tasks, applications analysis, storage technology and systems analysis, and solar and storage systems assessment. The relationship of energy storage to both the user and the energy source will be addressed and input/output requirements and energy source/user relationships will be used to establish characteristic storage data.

In order to determine the need for energy storage and desired system properties, i.e., size, storage, density, etc., interactions between the user and solar energy source must be examined and specific items of information determined. These required data inputs and analysis represent those that must be developed in order to generate rationale and tradeoffs necessary to determine goals and requirements of storage systems. Much of this information has been developed in prior solar program/project studies that have addressed the problem of storage from a limited perspective or economic viewpoint that possibly presupposed the need for storage. The multitude of separate solar projects that have addressed energy storage must be reviewed to determine the level to which storage had been considered and the availability of information to develop storage requirements. In those areas lacking sufficient information, special studies will be proposed to develop the needed data. Parametric analyses will also be required to examine the influence of energy storage characteristics on the economic and performance aspect of solar applications. The results of the parametric studies can be used to establish driving or highly leveraged storage/solar application categories in terms of performance or economy. The identification of this type of sensitivity information is essential in developing an overall set of goals and requirements for energy storage.

## STUDY APPROACH

### TASK I APPLICATIONS ANALYSIS

#### REVIEW & SCREEN ENERGY SOURCE/USER DATA FROM ONGOING AND COMPLETED SOLAR PROGRAM EFFORTS

- REVIEW TO ASSESS LEVEL OF STORAGE CONSIDERATION
- ANALYZE STORAGE SYSTEM SPECIFICATIONS/REQUIREMENTS
- CONSOLIDATE SPECIFICATIONS/REQUIREMENTS

### TASK II STORAGE TECHNOLOGY AND SYSTEMS ANALYSIS

#### ASSESS THE ABILITY OF CURRENT STORAGE TECHNOLOGY PROGRAMS TO MEET REQUIREMENTS/GOALS

- DEVELOP CANDIDATE STORAGE OPTIONS & CHARACTERISTICS
- EVALUATE AND ASSESS PREVIOUS ANALYSES OF OPTIONS
- SPECIAL STUDIES: ECONOMIC, TECHNICAL, INSTITUTIONAL, ENVIRONMENTAL
- SUMMARIZE ASSESSMENT OF EACH APPLICATION CATEGORY

### TASK III SOLAR AND STORAGE SYSTEMS ASSESSMENT

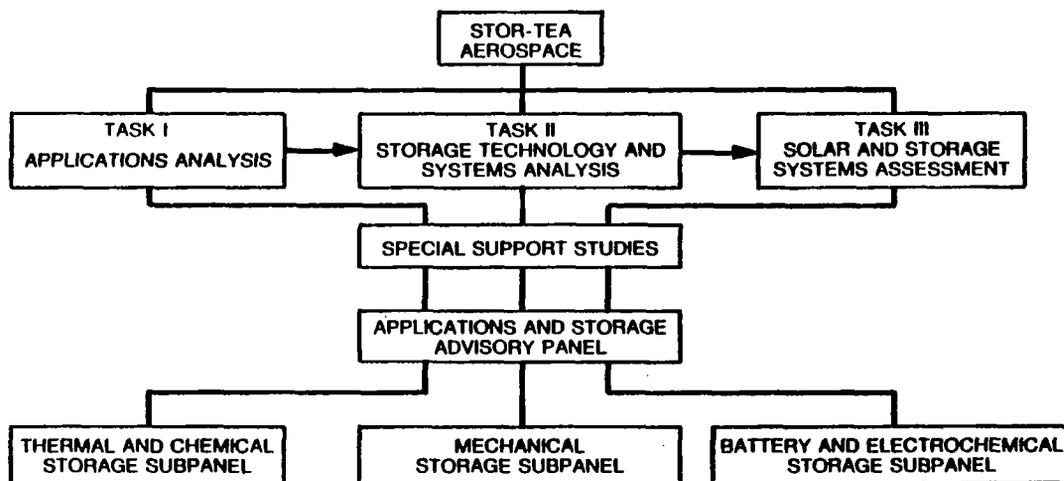
#### RECOMMEND STORAGE R&D EFFORTS

- ASSESS TASK I & II EFFORTS TO DETERMINE STATUS OF STORAGE TECHNOLOGIES TO MEET REQUIREMENTS OF SOLAR APPLICATIONS
- RECOMMEND R&D PROGRAMS

Overall guidance and management of the study is being provided by STOR's Technical and Economic Analysis Branch and by The Aerospace Corporation. Technical expertise and support required in reviewing solar program data and in performing required special studies will be provided through the use of an Application and Storage Advisory Panel which includes three subpanels for specific storage technology assessments. Due to the cross-section of solar programs and offices involved, membership in the Applications and Storage Advisory Panel is quite broad and includes representation from DOE, and the National and Solar Laboratories.

Technical support for the study is solicited mainly from these National and Solar Laboratories; however, representatives from the university and industrial sectors will be utilized as needed to provide specific expertise.

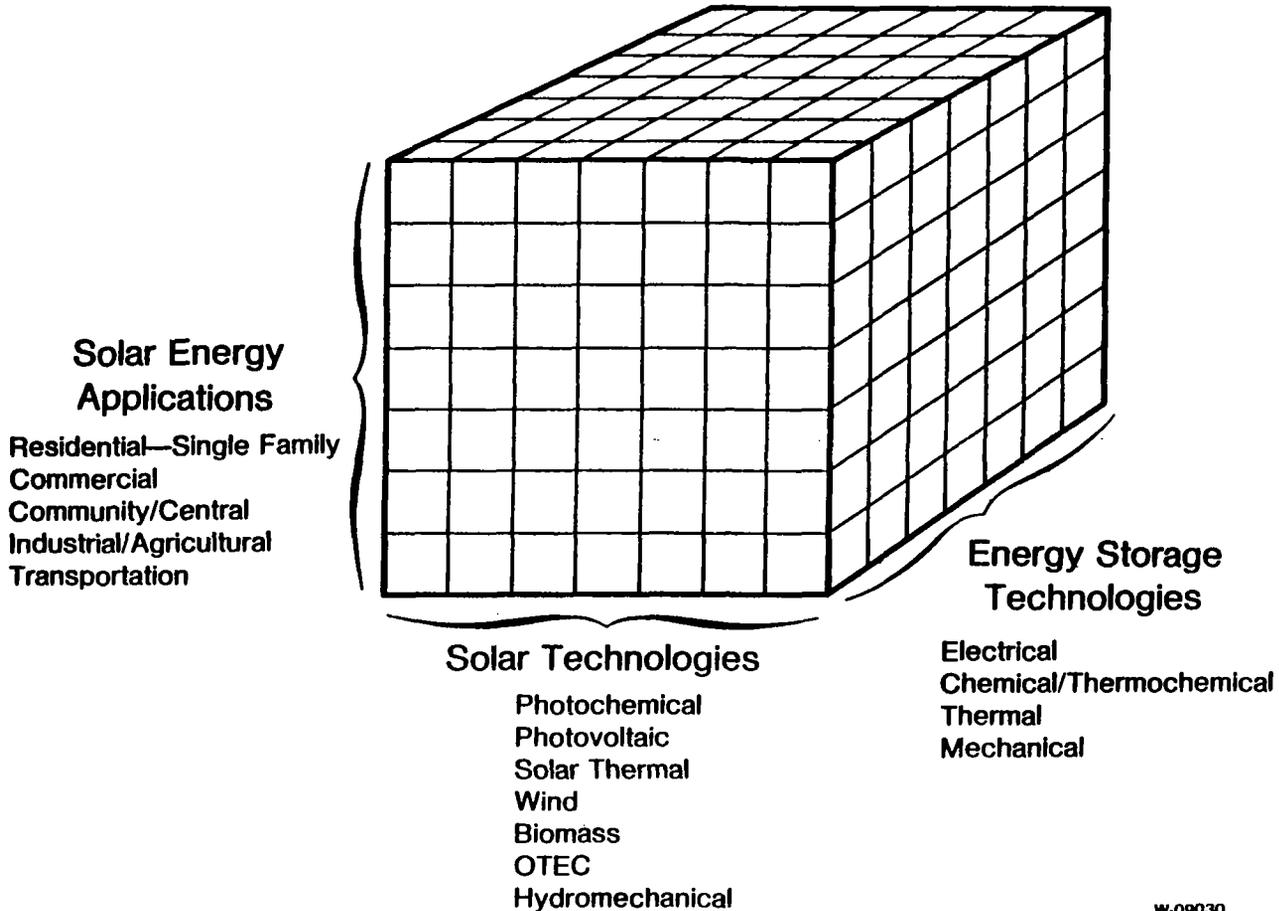
## Organizational Structure



As mentioned earlier, the study is currently planned to conclude in about two years during which time recommendations would be made for inclusion in the STOR program planning cycle. However, as a means for providing some near term guidance to STOR, a workshop was held in November, 1979. This workshop was attended by representatives from DOE and the National and Solar Laboratories as well as academic and industrial sector.

The workshop was conducted to identify the areas where the use of energy storage systems could have some impact upon the applications of solar energy sources and to select several which could have a near term impact for either displacing a portion of the fossil fuel energy sector or for providing a noticeable effect on the conservation of existing energy resources. First, the three dimensional matrix seen on the facing figure was to be completed to identify which solar sources are most appropriate to provide energy for the identified applications areas, and those storage technologies which best support the solar energy/application combinations. One sample matrix, for Residential-Single Family applications, was completed during the workshop. The development of a methodology for completing the matrixes was a meaningful product of the workshop and the matrixes for the other applications areas will be completed in the near future by the workshop participants.

## Solar Applications/Energy Storage Matrix



W-09030

## THERMAL ENERGY STORAGE SYSTEMS USING FLUIDIZED BED HEAT EXCHANGERS

V. Ramanathan, T. E. Weast, and K. P. Ananth  
Midwest Research Institute

### PROJECT OUTLINE

**Project Title:** TES Utilizing Fluidized Beds Assessment

**Principal Investigator:** Dr. K. P. Ananth

**Organization:** Midwest Research Institute  
425 Volker Boulevard  
Kansas City, MO 64110

**Project Goals:** The objective of this project is to identify and analyze the operation, characteristics and economics of potential thermal energy storage applications using fluidized bed heat exchangers.

**Project Status:** Identify potential fluidized bed concepts for thermal energy storage applications and perform a technoeconomic evaluation of selected heat exchanger/storage applications.

Potential fluidized bed/thermal storage applications have been identified.

A technoeconomic evaluation is being performed on two selected concepts

**Contract Number:** DEN3-96

**Contract Period:** January 1979 to September 1979

**Funding Level:** \$99,000

**Funding Source:** NASA Lewis Research Center