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SERI/PR-631-632

May 1980

Solar Energy Storage Program
FY79 Annual Report

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SERI

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Operated for the
U.S. Department of Energy
under Contract No. EG-77-C-01-4042

SERI/PR-631-632
UC CATEGORIES: UC-59,62

SOLAR ENERGY STORAGE PROGRAM: FY79 ANNUAL REPORT

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PREPARED UNDER TASK NO. 3441

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PREFACE

This report summarizes the activities of the SERI Solar Energy Storage Program during its first year, FY79. The authors particularly appreciate the strong support of Ken Touryan, who was largely responsible for ensuring the successful initial growth of the program. The guidance of Frank Kreith was also vital during this first year. The contributions of Mike Cease, Mike Karpuk, and Dean Stansbury were essential in starting the program.

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SUMMARY

This report summarizes the SERI Solar Energy Storage Program, which made a strong start in FY79. In support of the joint DOE Thermal Energy Storage for Solar Thermal plan, a ranking methodology was developed in the Thermal Storage Requirements Task for selection of thermal energy storage technologies for solar thermal applications. The ranking is based on cost and performance data, and a request for proposals was written in FY79 to be used in competitive selection of a subcontractor to generate this data. Also, thermal storage value data based on costs of alternate energy systems were generated for electric power plants and will be used for cost goals as a preliminary thermal storage screening tool. In the future, this task will provide support to key decision points in the joint multiyear program plan.

In the Thermal Storage Development Task, a survey was completed of thermal energy storage technologies, projects, and economics. An analysis was then made of latent heat storage for solar heating based on previous system simulations. The only major advantage shown for latent heat storage is a reduced storage volume and not the improved solar system performance frequently postulated. Therefore, latent heat storage must be competitively priced with sensible heat options. Direct contact latent heat storage offers satisfactory low-cost potential and has additional merit in that the concept could be used for a wide range of temperatures. Since the current knowledge of direct contact latent heat storage is insufficient to allow assessment of technical performance, analyses and experiments were begun in FY79 to understand its potential and limitations. The analysis and experimentation will continue in FY80 and will be extended to high-temperature applications in FY81. An activity will also be added in FY80 to assess thermochemical reactions for thermal energy storage and transport and to resolve significant technical uncertainties hindering their development if sufficient promise can be shown to warrant further study.

A low-temperature thermal energy storage review was written during FY79 as part of the Thermal Storage Coordination Task. In addition, more detailed draft reports were written on sensible and latent heat storage technologies, and a report was begun on issues in thermal energy storage for solar building heating and cooling applications. These documents are all valuable for determining thermal energy storage programs and needs and initiating coordination in FY80 among the various DOE divisions involved in such programs.

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SECTION 1.0

INTRODUCTION

1.1 THE DOE THERMAL ENERGY STORAGE PROGRAM

The national Thermal Energy Storage (TES) Program is conducted by the Chemical and Thermal Storage Branch of the U.S. Department of Energy (DOE), Division of Energy Storage Systems (STOR). The objective of this program is to develop and disseminate thermal energy storage and transport technology that offers the potential for energy conservation or petroleum and natural gas fuel substitution. In FY79, the national program consisted of three subprograms:

- Low-Temperature Thermal Energy Storage, managed by Oak Ridge National Laboratories. The objective was to develop sensible and latent heat technologies for low-temperature (<250° C) applications.
- High-Temperature Thermal Energy Storage, managed by NASA Lewis Research Center. The objective was to develop sensible and latent heat technologies for high-temperature (>250° C) applications.
- Thermochemical Energy Storage and Transport, managed by Sandia Laboratories, Livermore. The objective was to develop reversible chemical reaction technologies for thermal energy storage and transport.

During FY79, the structure of the TES Program was changed to reflect the focused development of thermal energy storage for end-use applications. Accordingly, the TES Program was modified to the following subprograms in FY80:

- Building Heat Storage, managed by Oak Ridge National Laboratory. The objective of this subprogram is to develop thermal storage technologies for applications in heating and cooling of buildings by off-peak electricity or solar energy.
- Industrial Heat Storage and Heat Transport, managed by NASA Lewis Research Center. The objective of this subprogram is to develop thermal energy storage for waste heat recovery from industrial sectors and to develop thermal energy transport primarily for industrial applications.
- Thermal Energy Storage for Solar Thermal Power, managed by Sandia Laboratories, Livermore. The objective of this subprogram is to develop advanced thermal energy storage technologies for solar thermal applications.
- Supporting Research and Technology (SR&T) and Systems Analyses and Assessments, managed by the Solar Energy Research Institute (SERI) and NASA Lewis Research Center. The SR&T activity provides research and analyses of advanced thermal storage options to establish a basis for adaption of thermal storage technologies to the various application areas. The systems analyses and assessments provide guidance for selection of appropriate storage technologies.

1.2 SERI SOLAR ENERGY STORAGE PROGRAM

The SERI storage activities began in the Thermal Conversion Branch during 1978. All the thermal energy storage technologies under development were reviewed at that time [1]. Particular emphasis was directed toward thermal storage systems having significant potential but technical barriers to their implementation. Based on the reviews and analysis, heat transfer in latent heat storage materials was identified as an area meriting research. A more detailed analysis was made of reversible chemical reactions to determine whether these systems could provide economical thermal energy storage. Solid-gas reactions were found to be the most promising known reversible chemical reactions for thermal energy storage; however, substantial R&D is needed on the heat and mass transfer and kinetics of these reactions to prove the viability of this option.

Latent heat storage research was incorporated into the first SERI Storage Program for FY79. In addition, a task was added to evaluate thermal energy storage systems for solar thermal applications in support of the joint DOE plan in this area [2]; this effort evolved from extensive SERI participation in development of the plan. A task was also instituted in thermal energy storage technology review. The early funding of the program was limited, and after discussions with the DOE Division of Energy Storage Systems, research on the reversible chemical reactions was not included in the FY79 SERI Storage Program.

The three tasks were only partially funded at the beginning of FY79, and considerable time was spent in submitting a number of requests for additional funds. Personnel assignments were not completed until final funding was committed, and each of the SERI Solar Energy Storage Program tasks had a limited scope. Despite these difficulties, substantial progress was made; and the FY79 tasks form a strong nucleus for the SERI Solar Energy Storage Program.

During FY79, the role of SERI in the DOE Thermal Energy Storage Program was resolved in meetings with the DOE Division of Energy Storage Systems, NASA Lewis Research Center, and Sandia Livermore Laboratory. SERI was identified as the lead laboratory for Advanced Thermal Energy Storage R&D and Systems Analyses and Assessments.

1.3 REPORT OUTLINE

In Section 2.0 of this report, the three FY79 SERI Solar Energy Storage Program tasks are described and appropriate task leaders indicated. The tasks are: Thermal Storage Requirements, Thermal Storage Development, and Thermal Storage Coordination. The first task is concerned with systems analyses of thermal energy storage for identified solar thermal applications in support of the joint DOE Program [2]. Research and analyses of advanced thermal energy storage are performed in the Thermal Storage Development Task. Finally, reviews and assessments of thermal energy storage are developed in the third task for coordination of the numerous thermal energy storage R&D activities conducted by various DOE divisions. In Section 3.0, the future plans of the SERI Solar Energy Storage Program are summarized.

SECTION 2.0

TASKS OF THE SERI SOLAR ENERGY STORAGE PROGRAM

2.1 THERMAL STORAGE REQUIREMENTS (R. Copeland, Task Leader)

2.1.1 Objectives

The objectives of the SERI Thermal Storage Requirements Task are to provide value data and compare thermal storage concepts. The value data are the basis for thermal storage program cost goals. Concepts that could potentially meet the cost goals are compared on a delivered-energy unit cost basis for the solar system (busbar energy cost for electric power). In this manner, promising thermal storage concepts will be identified for development.

2.1.2 Scope

The systems analysis of thermal storage is being conducted to support specific decision points in the joint Thermal Energy Storage for Solar Thermal Applications Program between the DOE Division of Energy Storage Systems (STOR) and the DOE Division of Central Solar Technology (CST) [2]. In this program, second- and third-generation thermal storage technologies will be developed to provide lower cost and/or improved performance over the first-generation technologies currently being deployed in solar thermal Large Scale Experiments (LSE). Thermal storage technologies will be developed that are appropriate for the following types of solar thermal systems:

- Water/steam collector/receiver;
- Molten salt collector/receiver;
- Liquid metal collector/receiver;
- Gas collector/receiver;
- Organic fluid collector/receiver;
- Liquid metal/salt collector/receiver; and
- Advanced technologies (third generation).

This task supports the first six elements, in which the second-generation technologies developed will be verified through a retrofit of a solar thermal LSE (e.g., Barstow, repowering, Shenandoah). Research on advanced technologies is performed in the last element for all types of solar thermal systems. The value analyses and cost and performance comparisons of this task are used to identify the most promising thermal storage technologies for the six development elements.

2.1.3 Approach

Value expresses quantitatively the price that a user is willing to pay for a system in a given application and is always based on the cost of alternative energy systems including capital, fuel, and operations and maintenance (O&M). The value thus depends on the energy supply alternatives (oil, gas, coal, nuclear, etc.), assumed future prices and escalation rates, and the performance of the storage-coupled solar thermal system.

For a given collector area with all other parameters constant except storage capacity (H), the contribution to the total system value by thermal storage is calculated from the storage-coupled solar thermal system value as follows:

Thermal Storage Value For Capacity H	=	Solar Thermal System Value With Storage Capacity H	-	Solar Thermal System Value Without Storage,

where the last term refers to the solar thermal system with no storage or only buffer storage. Data generated by solar thermal studies are used in the equation.

Comparisons of thermal storage are conducted for concepts that meet one or more of the cost goals derived from the equation. These evaluations are conducted on an element-by-element basis (i.e., the collector/receiver system is fixed and thermal storage concepts are integrated into that system). A ranking index is employed which is defined as the ratio of the unit energy cost of the solar thermal system with an alternative storage concept to that of the same solar thermal system with first-generation thermal storage. The ranking index is expressed in closed form, which yields accurate results without the use of a sophisticated computer routine. First-generation (reference) systems are defined for each second-generation program element. Cost and performance data for all of the storage systems are generated in a form readily usable in the ranking index equation. The results of the ranking methodology are also compared to absolute calculations of unit energy cost in which hour-by-hour insolation models and field size optimization are employed.

SERI conducts the comparisons based on both cost and performance data. To eliminate any differences in material cost data bases, SERI performs independent cost analyses on all concepts. Preliminary cost analyses and data screening are conducted in-house by SERI. In-depth thermal storage cost and performance analyses are performed by a SERI contractor who is experienced in design and costing of commercially sold hardware.

2.1.4 Technical Progress

During FY79, this task assisted the joint program planning, generated value data, and derived a methodology for ranking thermal storage concepts. The program plan, "Thermal Energy Storage for Solar Thermal Applications" [2], was prepared as a joint effort by DOE and several national laboratories, including SERI. The plan was prepared in draft form and circulated to interested nongovernment individuals. Comments were received and the plan was revised.

A method for determining the value of thermal storage in solar thermal systems was derived. Table 2-1 presents the results for stand-alone solar thermal electric plants. The values shown are for a plant start-up in the late 1980s and a small solar thermal penetration in the utility grid (less than 10% of the peak generation capacity). The data were generated employing conservative to average fuel price assumptions and Barstow solar thermal collector technology.

Table 2-1. RECOMMENDED COST GOALS FOR THERMAL STORAGE IN SOLAR THERMAL ELECTRIC PLANTS[a] (1976$)

Storage Capacity (hours)	High Insolation (Barstow, Calif.)		Medium Insolation (Midland, Tex.)		Low Insolation (Seattle, Wash.)	
	($/kW$_e$)	($/kWh$_e$)[b]	($/kW$_e$)	($/kWh$_e$)[b]	($/kW$_e$)	($/kWh$_e$)[b]
3	225	85	120	40	60	20
6	300	50	180	30	90	15
9	—[c]	—[c]	225	25	110	12

[a]Total cost of a thermal storage concept (including power-related, energy-related, nondirect, and O&M costs) must be lower than the value-derived cost goal.

[b]$/kW$_e$ = total thermal storage value.
$/kWh$_e$ = average thermal storage value; equal to total thermal storage value divided by H, the storage capacity.

[c]Data not available.

A ranking methodology for comparing thermal storage concepts was developed. The methodology compares concepts performing the same mission. A closed-form equation is obtained as the ratio of the delivered energy system cost with an alternative storage concept to that with a reference concept. Computation of this cost ratio does not require a computer routine, and the results are equivalent to those from other methods requiring sophisticated models. The necessary support data have also been prepared. A request for proposals has been written for competitive selection of a subcontractor to estimate the cost of performance of thermal storage options.

2.1.5 FY80 Plans

During FY80, SERI will complete the initial screening of thermal storage concepts for water/steam collector/receiver and organic fluid collector/receiver systems using SERI-generated cost and performance estimates. A competitive procurement will be conducted and a subcontract will be awarded for estimation of cost and performance of thermal storage concepts in solar thermal systems. Ground-mounted thermal storage for dish/Stirling solar thermal systems will be analyzed to identify concepts that could reduce energy system costs.

2.1.6 Multiyear Milestones

Figure 2-1 presents milestones for the thermal storage requirements task. This task supported the preparation of the draft program plan [2] and subsequent revisions. The milestones in Fig. 2-1 are in accordance with the latest program plan as of this writing. The initial value analyses will be documented in a preliminary requirements report. The preliminary data are for bulk electric power generation; subsequent analyses will address process heat and cogeneration applications.

Figure 2-1. MULTIYEAR MILESTONE SCHEDULE FOR THE THERMAL STORAGE REQUIREMENTS TASK

Activities	Fiscal Year 79	80	81	82	83	84	85
Value Analyses		▽1		▽2			
Technology Assessments							
Water/Steam Receivers		▽3	▽4			▽5	
Liquid Metal Receivers				▽4			▽5
Gas Receivers			▽4			▽5	
Organic Fluid Receivers		▽3	▽4		▽5		

1 Preliminary thermal storage value for solar thermal power.

2 Updated thermal storage value.

3 Preliminary screening of thermal storage based on SERI data.

4 Recommendation of thermal storage concepts for continued development.

5 Recommendation of thermal storage concepts for retrofit of solar thermal large-scale experiments.

The technology assessments are being conducted to keep pace with decision points in the program plan. The initial screenings are based on SERI in-house analyses. For the remaining milestones the cost and performance data will be generated by a subcontractor experienced in the design and costing of commercially sold hardware.

2.1.7 Publications

- Copeland, R. J. "Storage Systems Analysis FY78 Progress Report." SERI/PR-35-101. October 1978.
- Copeland, R. J. "Preliminary Requirements for Thermal Storage Subsystems in Solar Thermal Applications." SERI/RR-35-364. To be released in FY80.

2.2 THERMAL STORAGE DEVELOPMENT (C. Wyman and J. Wright, Task Leaders)

2.2.1 Objectives

The objective of the Thermal Storage Development Task is to provide an understanding of advanced thermal storage technologies for solar applications based on fundamental principles. Performance knowledge of storage units will allow solar system developers to select and design storage systems that are best suited to their applications. Economic analyses are also performed to identify research areas warranting experimentation and technical evaluation.

2.2.2 Scope

The scope of the Thermal Storage Development Task includes mathematical analyses based on fundamental principles to evaluate advanced sensible and latent heat thermal energy storage concepts. Laboratory and bench-scale experiments are also conducted to obtain information on storage capabilities and to calibrate and validate storage analyses. Limited economic studies are performed to identify areas warranting R&D.

2.2.3 Approach

Initial emphasis of the task is on latent heat storage because of its significant storage densities but important technical problems. First, an advanced latent heat storage concept is selected for study based on surveys of previous work and on analysis of economic potential. To minimize time, results of other researchers are used to predict performance of latent heat storage in home heating applications [3,4]. Advantages and limitations of the latent heat storage concept are identified and the economic merit of thermal storage is calculated. Alternate latent heat storage concepts are then evaluated in light of these analyses to determine which, if any, have sufficient promise to merit research. Furthermore, concepts are preferred that have a wide range of applications without known temperature or other constraints.

Once promising concepts are identified, preliminary analyses are initiated to predict operating characteristics. These analyses are based on the most fundamental information available for related systems to provide the most reliable basis for judging large-scale capabilities and limitations. Comparisons are made between the analyses and previous experimental and analytical results.

The preliminary analysis determines whether the advanced latent heat storage system still looks promising. For the most promising storage option, the validity of using the existing experimental data to check the model is evaluated. If further data is needed, operational characteristics are tested. In addition, experiments are designed to calibrate and validate the model. Experimentation and analysis are carried out iteratively until storage system performance can be accurately judged.

Once sufficient knowledge is obtained to predict system capabilities and limitations reliably, the latent heat storage concept is compared to the other available systems. If the system is promising, the technology is transferred to those responsible for developing and demonstrating commercial storage systems.

2.2.4 Technical Progress

First, a survey was completed of thermal storage technologies, economics, and projects [1]. Then an economic analysis was performed of latent heat storage for home heating applications. A significant volume decrease was found for latent heat storage compared to sensible heat options; the volume required was approximately half the required volume for water and one quarter of the volume required for rocks. However, none of the performance advantages frequently cited were evident for latent heat storage. Therefore, the cost of latent heat storage must be competitive with the cost of sensible heat options unless space is at a premium. For other applications with tighter restrictions on storage temperature swings, such as steam generation, air conditioning, or passive storage, latent heat systems are expected to have a more significant advantage.

Examination of latent heat storage system costs revealed that approximately one half or more of the cost is for heat transfer (power-related costs) while the remaining cost is for storage capability (capacity-related cost). If the power-related costs can be reduced, latent heat storage will become economically competitive with other options. Since direct contact latent heat storage offers the possibility of low-cost heat transfer, research and analyses were initiated in this area in FY79. This option has the added advantage that it has potential for high-temperature uses, thereby maximizing the impact of the study.

An analysis of direct contact latent heat storage was based on existing knowledge of drop formation, drop rise time, and heat transfer. The predictions agreed well with the limited experimental data available over restricted operating ranges. However, many of the physical parameters for the study were based on crude estimates for widely differing systems; the agreement achieved could have been fortuitous. The mathematical predictions need to be verified experimentally.

Based on the analysis, a single-drop direct contact column was designed to determine drop size as a function of dispersed phase fluid properties and flow rates. This device will also indicate which of three possible heat transfer mechanisms apply to the direct contact system. A multidrop apparatus was also designed to provide information on drop holdup, drop rise velocity, drop size, and heat transfer. Initially, water will be used as the continuous phase and a hydrocarbon as the dispersed phase in both experiments to check out system operation and verify the analysis. Then, salt hydrates will be employed as the continuous phase. Construction of the units was started in late FY79.

2.2.5 FY80 Plans

During FY80, construction will be completed for both the single- and multidrop experiments. Instrumentation will be installed and initial data obtained for the heat transfer analysis. The single-drop column will be used for water/oil and salt hydrate/oil fluid combinations to determine which of several models best describe drop formation as a function of fluid properties and flow rate. The experiment will also provide data to identify the mechanism limiting heat transfer from the continuous phase to the droplets of the immiscible, dispersed phase fluid. Since the droplets may be approximated as well-mixed, circulating, or rigid spheres, the heat transfer rate can vary by a factor of five between that expected in the first and last cases.

Initial experiments will be performed on the multidrop column to determine dispersed phase holdup and flow characteristics as a function of fluid velocity. The system model will be upgraded to simultaneously predict drop size, holdup, and heat transfer rate as a function of the operating parameters. Near the end of the year, work will begin on the conceptual design of high-temperature storage for solar thermal systems using liquid-liquid direct contact heat transfer to identify research issues at high temperatures.

2.2.6 Multiyear Milestones

Figure 2-2 presents the multiyear milestones for the Thermal Storage Development Task. After the performance analysis of liquid-liquid direct contact heat exchange is developed and validated with the low-temperature single and multidrop experiments, the analysis will be extended to high-temperature solar thermal operating conditions. Sensible heat storage will be examined first at high temperatures to minimize experimental difficulties. In addition, significant short-term potential is evident for sensible heat storage. An effort will be included to identify compatible materials and measure their properties at high temperature.

In later years, work will increase on direct contact vaporization systems. First, alternate storage materials and vaporizing heat transfer fluids will be evaluated to find compatible pairs for heat storage and transfer. In addition, the compatibility of heat storage media and water will be evaluated at high temperatures and pressures. If economical combinations are found, analyses and experiments will follow to develop quantitative predictions of system performance.

2.2.7 Publications

- Wyman, C. E. "Thermal Energy Storage for Solar Applications: An Overview." SERI/TR-34-089. March 1979.

2.3 THERMAL STORAGE COORDINATION (F. Baylin, Task Leader)

2.3.1 Objectives

The objective of the Thermal Storage Coordination Task is to provide coordination between the Thermal Energy Storage Program of the DOE Division of Energy Storage Systems (STOR) and DOE solar energy programs, particularly in the Division of Solar Applications. As part of this function, a data base is maintained to facilitate both DOE and SERI program planning, and assessments of energy storage technologies are conducted to identify important unresolved issues.

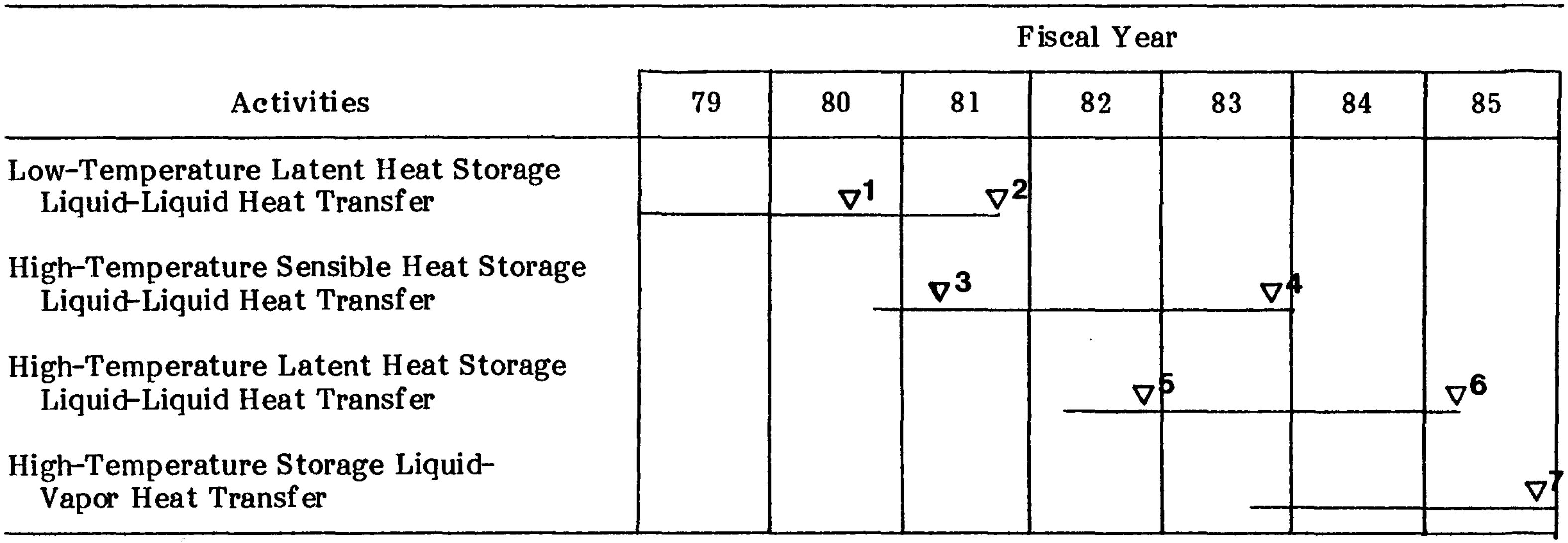
2.3.2 Scope

All thermal energy storage technologies, both U.S. and foreign, are included in the survey activities. Coordination efforts will concentrate on two application areas: solar heating and cooling of buildings (SHACOB) and agricultural and industrial process heat systems (AIPH).

2.3.3 Approach

The task objectives are met by three subtasks. First, a data base describing programs and activities in thermal energy storage (TES) is developed and maintained. Information on thermal energy storage is obtained from a variety of sources including DOE program managers, national laboratories, contractors, independent researchers, and foreign researchers. Second, specific assessments are prepared to allow selection of promising

Figure 2-2. MULTIYEAR MILESTONE SCHEDULE FOR THE THERMAL STORAGE DEVELOPMENT TASK



1 Measure direct contact heat transfer for single drops.

2 Evaluate experimentally performance potential of low-temperature direct contact heat transfer storage.

3 Evaluate liquid-liquid direct contact heat transfer storage system based on preliminary analysis.

4 Evaluate liquid-liquid direct contact heat transfer potential.

5 Evaluate liquid-liquid direct contact heat transfer storage system based on preliminary analysis.

6 Evaluate liquid-liquid direct contact heat transfer potential.

7 Evaluate material compatibility for direct contact vaporization heat transfer.

systems for development. Consultants perform such tasks as identifying storage issues and developing assessments related to their expertise. This second subtask is closely coordinated with other efforts, such as the Aerospace Corporation project in Solar Applications Analysis for Energy Storage. Major unresolved issues in mating TES to solar applications are studied. Third, meetings and dialogue between STOR and the DOE solar programs facilitate communication and cooperative interaction. Joint program plans are the outcome of this subtask.

2.3.4 Technical Progress

A thorough data base was developed during FY79. A survey on low-temperature thermal energy storage was published [5]. A draft survey of ongoing and recently completed activities in sensible and latent heat storage technologies was assembled. An in-house report on projects involving chemical heat pumps was prepared.

An assessment of community-scale solar systems based on annual cycle thermal energy storage was undertaken to investigate the potential role of annual storage. Close communication was developed and maintained with project field managers in the national laboratories responsible for thermal energy storage within the DOE Division of Energy Storage Systems and the DOE Division of Solar Applications.

2.3.5 FY80 Plans

During FY80, the survey of sensible and latent storage technologies will be completed. A report on major unresolved issues in mating TES with SHACOB applications will be issued. The economic and value analysis of annual cycle thermal energy storage for community solar systems will be completed and published. Systems will be studied for the distribution of low-temperature thermal energy.

All these efforts will be used as background for the most important activity: the coordination between STOR and the solar program. During FY80, one area will be emphasized: TES for SHACOB applications. The outcome of these activities will be a joint five-year program plan as well as a mechanism for ongoing program coordination and interaction.

2.3.6 Multiyear Milestones

Figure 2-3 outlines the multiyear milestones for this task. They are organized according to the three major subtasks: data base, issues and assessments, and coordination activities. A survey of sensible and latent heat technologies will be published at the end of FY80. This is an ongoing activity, and an updated edition will be published in FY82. The report on unresolved issues in TES for SHACOB applications will be published in mid-FY80. The counterpart on issues for AIPH and other applications will be published in FY81. An update of these will be issued in early FY83.

A draft joint five-year program plan between STOR and the Office of Solar Applications for Buildings will be written in late FY80. This draft will be a basis for discussion among the participants and will facilitate coordination between programs. A similar activity will result in a draft coordinated plan between STOR and a second DOE solar applications

Figure 2-3. MULTIYEAR MILESTONE SCHEDULE FOR THE THERMAL STORAGE COORDINATION TASK

Activities	Fiscal Year 79	80	81	82	83
Thermal Storage Data Base Development	▽1	▽2		▽3	
Thermal Storage Issue Identification and Assessments		▽4	▽5		▽6
Thermal Storage Coodination with Solar Application Programs		▽7		▽8	

1 Publish report on low-temperature thermal energy storage.

2 Publish survey of sensible and latent heat storage.

3 Update survey of sensible and latent heat storage.

4 Publish report on issues in thermal storage for solar heating and cooling of buildings (SHACOB).

5 Publish report on issues in thermal storage for agricultural and industrial process heat (AIPH).

6 Update reports on issues in thermal storage for SHACOB and AIPH.

7 Prepare a draft joint five-year program plan between DOE Division of Energy Storage Systems (STOR) and DOE Office of Solar Applications for SHACOB.

8 Prepare a draft joint five-year program plan between STOR and a second DOE solar application program.

program in late FY82. If these efforts are successful, an additional joint plan will be prepared near the end of the five-year planning period.

2.3.7 Publications

- Baylin, F. "Low Temperature Thermal Energy Storage: A State-of-the-Art Survey." SERI/PR-54-164. July 1979.

SECTION 3.0

FUTURE PLANS

During FY79, SERI was designated as the laboratory responsible for supporting research and technology (SR&T) and systems analyses and assessments in the Thermal Energy Storage Program of the DOE Division of Energy Storage Systems. Thus, SERI develops the data and information needed by solar energy developers to select the most promising advanced thermal energy storage technologies. Systems analyses are performed to develop cost goals based on the value of thermal storage in the appplication as well as to compare thermal storage performance in selected solar thermal systems. Research and analyses are a significant portion of the program to resolve technical and economic uncertainties that hinder development of advanced thermal energy storage systems. Finally, asessments are maintained and used to coordinate thermal energy storage R&D.

The tasks from FY79 all support the defined SERI thermal energy storage mission and will continue in FY80. In addition, reversible thermochemical reactions will be assessed for high-temperature thermal energy storage and transport to resolve the serious questions raised about their potential. The major emphasis of all of these efforts will be to support the joint DOE Thermal Energy Storage for Solar Thermal Applications Program [2] between the Division of Energy Storage Systems and the Division of Central Solar Technology.

Beyond FY80, efforts in new concepts definition and high-temperature thermal storage are important to support the joint program [2]. Research and analyses of thermal energy transport by sensible and latent heat media will be added. Finally, research to develop innovative thermal energy storage concepts for the full range of solar applications will round out the program.

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SECTION 4.0

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