InterTechnology Corporation
Proposed
Systems Level Plan for Solar Heating and Cooling
Commercial Buildings
National Solar Demonstration Program

EXECUTIVE SUMMARY

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PREFACE

The InterTechnology Corporation (ITC) was one of two companies who received awards to conduct studies and analyses for the Energy Research and Development Administration (ERDA) in support of the National Solar Heating and Cooling Demonstration Program. The executive summary report "InterTechnology Corporation, Proposed Systems Level Plan for Solar Heating and Cooling, Commercial Buildings, National Solar Demonstration Program", was prepared as part of the requirements under contract E(11-1)2688. It is not intended to reflect an ERDA plan or position. It is expected to be used by ERDA in the development of their plans for implementing the Solar Heating and Cooling Demonstration Program.

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I. SUMMARY AND RECOMMENDATIONS

A. Systems Level Plan Definition

The goals of the National Solar Heating and Cooling Demonstration Program for non-residential buildings are embodied in the following:

1. Demonstrate the ultimate economic and technical feasibility of solar heating and combined heating and cooling.
2. Stimulate industry to produce and market solar equipment
3. Stimulate a commercial market for solar systems.

The systems level plan is designed to address the above stated goals as they relate to the building community associated with the commercial sector of the economy. We view it as a complete package which will provide ERDA with the following:

1. A flexible, time-phased, multi-purpose, integrated matrix of 200 demonstration sites designed to most cost effectively address the goals identified above,
2. A cost effective management plan (including structure and function) which will effectively implement the demonstration program and which will provide opportunity for small business participation,
3. The fundamental information required by various sectors of the building community and the most effective media for the dissemination of information gathered during the program,
4. An estimate of the total resources required to implement the program,
5. Opportunity to test and evaluate promising solar technologies and developments resulting from NASA R&D programs, and
6. Management and resource coordination of this plan with a systems test and evaluation plan currently being developed under a separate task.

B. Scope of the Systems Level Plan

1. Definition

For the purposes of determining program management manpower requirements, funding levels, and program coordination, a heating only demonstration has been defined to be complete upon collection of one full heating season of operational data, and for a combined heating and cooling demonstration, both a full heating and cooling season of operational data. Implicit in this definition is the assumption that any solar system down times and/or test and evaluation equipment outages lasting no more than several days during a given season will not preclude acceptable determination of system performance and operating costs. Neither will the program be disrupted should test and evaluation lasting for several years be desired for selected demonstrations.

2. Building Types

The sites recommended for the program employ 13 building types representing over 80 percent of the total commercial floor space inventory (apartments, dormitories, manufacturing, etc. excluded). The relative importance of each building type to the program is a function of the technical feasibility, estimated cost savings, and potential energy savings offered by all buildings of that type.

3. Climatic Regions

The technical feasibility, cost savings, and potential for energy savings discussed above are calculated for each building type for a city characteristic of each of 12 climatic regions. These 12 regions are those identified by General Electric in their Phase 0 contract with ERDA. Figure I-1 defines the boundaries of these regions. The characteristics of these regions then provide a basis for comparison of solar performance, energy costs, building energy loads, etc.

4. Program Size

A systems level base line of 200 demonstrations was established by ERDA as a guideline for the preparation of the system level plan.

5. New/Retrofit Market

This plan addresses both a new and a retrofit market with about equal emphasis in terms of numbers of demonstrations. The reasoning behind this emphasis is that the total building floor area which will be constructed during the next 15 years is approximately equal to the 1975 inventory less the inventory which is estimated to be removed. Thus the potential markets are about the same. Furthermore, the ultimate goal of reducing energy demand will be enhanced by retrofitting existing buildings since these buildings consume more energy than those to be built in the future.

6. Heating Only/Heating and Cooling

As required by law, this plan provides for the demonstration of heating only by the end of fiscal year 1977, and the demonstration of heating and cooling by the end of fiscal year 1979. The plan provides for more heating and cooling demonstrations than heating only demonstrations for two basic reasons: first, program funding and timing considerations constrain the number which can be accomplished by the end of fiscal year 1977, and second, the complexity of heating and cooling requires that more factors be addressed than is necessary for heating only.

7. SHAC Systems

The flat plate water collector coupled with an absorption chiller when cooling is required form the "backbone" of this program. The underlying criteria for selecting sites are based upon solar performance and costs associated with these systems.

The program is not, however, limited to the systems described above. We have incorporated flat plate air collectors and seven additional promising subsystems into about 22 percent of the 200 sites. Flexibility of the plan also allows for incorporation of additional promising concepts and subsystems should the technical and economic feasibility justify it.

8. Program Timing

As previously touched upon, program timing considerations are a serious problem. The law requires solar heating to be "demonstrated" by the end of fiscal year 1977. In most regions of the country, the heating season effectively begins about October 1976. If this date represents the beginning of one full heating season (consistent with our definition of a demonstration), then actual system installation on existing buildings must begin about May, 1976. Any installations on new buildings must begin even earlier. From these considerations, it is clear that in most cases, one full season of heating only data is not practically feasible. In order to provide a more tenable program, we scheduled many of the heating only demonstrations so that operational data will be available for at least one month of the fiscal year 1977 season.

C. Plan Summary

1. Recommended Demonstration Sites

A general overview of the distribution of sites recommended for each of the basic categories - new, retrofit; heating, heating and cooling; SHAC system type - is illustrated in Table I-1. Several general points should be noted. Severe program timing constraints hamper the opportunity to demonstrate solar heating only on new buildings; thus the reason for the lopsided emphasis on retrofit heating only demonstrations. The heating and cooling portion of the program allows for greater flexibility to conduct demonstrations on new buildings. Our overall design guideline specifying a program containing equal numbers of new and retrofit demonstrations results in the requirement of a heating and cooling program which emphasizes applications on new buildings.

Table I-1 also indicates the emphasis placed on flat plate water systems. Note also that we have identified a greater variety of (non-flat plate) subsystems available for heating and cooling applications than for heating only applications.

TABLE I-1
SITE DISTRIBUTIONS
(OVERVIEW)

New vs Retrofit

	Heating Only	Heat & Cool	Total Numbers
New	15	84	99
Retrofit	46	55	101
Total Numbers	61	139	200

Critical SHAC Systems

	Heating Only	Heat & Cool	Total Numbers
Flat Plate Air	16	--	16
Water	36	120	156
Other	9	19	28
Total Numbers	61	139	200

A summary of the recommended sites by climatic region and purpose is illustrated in Table I-2. As indicated, a number of demonstration sites are multi-purpose in nature. (Refer to Section II.A for their description.) These demonstrations, which are identified by their reference to the footnotes in the table, are particularly critical in that failure of these to perform as designed will jeopardize the success of their associated purposes. Thus, it is important that those proposals to conduct these demonstrations be scrutinized with extra care to ensure that these demonstrations will be successful.

The total recommended set of 200 sites are shown in Table I-3 by building type and climatic region. This table illustrates a plan guideline to distribute sites according to regional population. This distribution is reasonably approximated except in the Phoenix region. As discussed in Section II.A, this region has received special attention due to the very favorable economic position the solar heating and cooling alternative holds there. Table I-3 also illustrates the result of another design guideline - distribution of building types according to the fraction of each type's inventory in relationship to the total inventory of commercial buildings. It has not been possible to follow this guideline precisely for several reasons:

1. Relative economics (cost savings): Selection of buildings for the various strategies perturbed the distribution slightly.
2. Anticipated growth patterns in building types: While the inventory of shopping centers is small, this relatively new method of conducting retail business appears to be gaining increasing popularity. Thus, shopping centers are given some emphasis. Similarly, while the building inventory suggests a program containing 68 free-standing stores, these building types are losing favor to shopping centers. In addition, a program containing 68 stores was felt to place too much emphasis on one building type.

TABLE I-2

DISTRIBUTION OF DEMONSTRATIONS BY REGION AND PURPOSE

Region Number	Representative City	Heating Only							Heating and Cooling						TOTALS ^f
		Parametric Studies (PS)	Promising Technologies (PT)	Economy of Scale Studies(EOS)	Install. Learning Studies (ILS)	Local Industry Stimulation (LIS)	Instit./Societal/ Environ. (ISE)	Sub-Totals ^f	Parametric Studies (PS)	Promising Technologies(PT)	Economy of Scale Studies(EOS)	Install. Learning Studies (ILS)	Instit./Societal/ Environ. (ISE)	Sub-Totals ^f	
1.	Boston	3	1					4	3 ^c	2	3	6 ^d	22	36	40
2.	Washington, D.C	2					1	3	6	2	3		14	25	28
3.	Madison	5 ^a	1	3 ^d			1	10	1	1			8	10	20
4.	Los Angeles	2	1					3	8 ^c	3		6 ^d	2	19	22
5.	Charleston	3	1					4	1	1		6	5	13	17
6.	Bismarck	1	1					2	1	1			4	6	8
7.	Nashville	3						3		1			4	5	8
8.	Ft. Worth	6	1					7	7	3				10	17
9.	Omaha	3	1					4	2	1	3			6	10
10.	Seattle	1	1				1	3							3
11.	Phoenix	4 ^b	1		6 ^b	18 ^e		29	5	3				8	37
12.	Miami									1			2	3	3
TOTALS ^f		33	9	3	6	18	3	72	34	19	9	18	61	141	213

a. Double counted with Economy of Scale Study

b. Double counted with Local Industry Stimulation

c. Double counted with Installation Learning Study

d. One double count with associated Parametric Study

e. Including Parametric Study and Installation Learning Study

f. Including double counts

TABLE I-3.
DISTRIBUTION OF DEMONSTRATIONS

Region Number	Representative City	School	Office	Store	Shopping Center	Hospital	Church	Restaurant	Motel	Warehouse	Supermarket	Nursing Home	Social	Library	TOTALS
1.	Boston	7	11	4	3		1	1	3		3	3	1	2	39
2.	Washington, D.C.	3	8	6	2	1	1	1	1		2	2	1		28
3.	Madison	4	3	4	3	1			2			1		1	19
4.	Los Angeles	4	3	9	2	1	2								21
5.	Charleston	1	2	8			1	5							17
6.	Bismarck	2	3	1	1		1								8
7.	Nashville	1	2	2				1			1			1	8
8.	Ft. Worth	3	3	3			2	3	1			1		1	17
9.	Omaha	1	3	3					1	1	1				10
10.	Seattle				1					1				1	3
11.	Phoenix		5	9	1	2	4	4		1				1	27
12.	Miami	2												1	3
TOTALS		28	43	49	13	5	12	15	8	3	7	7	2	8	200

3. Exclusion of demonstrations on certain building types: We have not considered heating and cooling demonstrations on warehouses.
4. Provide coverage: According to the inventory of supermarkets, only two should be recommended in the program. However, supermarkets offer reasonable economics in more than two regions, thus, more than two were recommended.
5. Technical viability: While restaurants are historically large consumers of energy and may be considered as candidates for solar in this sense, they also require tremendous collector areas (far larger than the available floor space) in all but the most favorable regions. Thus, the number recommended is below that suggested by its inventory.

Table I-3 represents the composite of both the heating only and the heating and cooling demonstrations. Table I-4 illustrates the matrix of heating only sites and Table I-5 illustrates the matrix of heating and cooling sites. The emphasis on heating only in the Phoenix region is apparent, as well as the fact that no heating only demonstrations have been recommended in the Miami region due to the negligible heating loads there. Also, no heating and cooling demonstrations can be justified for the Seattle region because of the low electric utility rates and poor solar insolation characteristics in that area.

2. Time Phasing

We have assigned each site a "preferred" time frame for implementation which places that site into the context of the whole plan. The primary purpose for doing this has been to provide a mechanism to:

1. comply with the law,
2. estimate resources, management manpower, and T&E requirements, and
3. provide opportunity for R&D cycles.

TABLE I-4
HEATING ONLY DEMONSTRATIONS

Region Number	Representative City	School	Office	Store	Shopping Center	Hospital	Church	Restaurant	Motel	Warehouse	Supermarket	Nursing Home	Social	Library	TOTALS
1.	Boston	1		2								1			4
2.	Washington, D.C.		1		1			1							3
3.	Madison	3	1	2	1	1								1	9
4.	Los Angeles	1		1			1								3
5.	Charleston		1	1			1	1							4
6.	Bismarck		1	1											2
7.	Nashville		1	1				1							3
8.	Ft. Worth	1	1	1			1	1	1			1			7
9.	Omaha			2					1	1					4
10.	Seattle				1					1				1	3
11.	Phoenix		4	7		1	3	3		1					19
12.	Miami														0
TOTALS		6	10	18	3	2	6	7	2	3	0	2	0	2	61

TABLE I-5

HEATING AND COOLING DEMONSTRATIONS

Region Number	Representative City	School	Office	Store	Shopping Center	Hospital	Church	Restaurant	Motel	Warehouse	Supermarket	Nursing Home	Social	Library	TOTALS
1.	Boston	6	11	2	3		1	1	3		3	2	1	2	35
2.	Washington, D.C.	3	7	6	1	1	1		1		2	2	1		25
3.	Madison	1	2	2	2				2			1			10
4.	Los Angeles	3	3	8	2	1	1								18
5.	Charleston	1	1	7				4							13
6.	Bismarck	2	2		1		1								6
7.	Nashville	1	1	1							1			1	5
8.	Ft. Worth	2	2	2			1	2						1	10
9.	Omaha	1	3	1							1				6
10.	Seattle														0
11.	Phoenix		1	2	1	1	1	1						1	8
12.	Miami	2												1	3
TOTALS		22	33	31	10	3	6	8	6	0	7	5	2	6	139

We would obviously have preferred not to assign schedules to each site, as this additional constraint will no doubt mean that implementation will be more difficult. We could not, however, ignore the fact that smooth program implementation and compliance with the law would not be guaranteed through ad hoc selection of sites, disregarding the effect each site's implementation would have on the program as a whole.

We are quick to point out, however, that the recommended schedules are not "cast in concrete." No significant impact will be noticed if a number of demonstrations are rescheduled a quarter ahead or back, except that in certain cases, slipping a schedule by this amount may result in the loss of opportunity to collect data during the heating or cooling season. As mentioned, scheduling is basically a function of available resources and the size of the management staff. Thus, final scheduling decisions must lie with the Program Manager (See Section V).

A summary of the contract starts (assumed to correspond to the beginning of construction for new buildings and solar system installation for retrofit situations) are illustrated in Figure I-2. As may be seen, the peak occurs during the transition quarter, a consequence of the timing necessary to comply with the law. The reader is referred to Table I-2 for definitions of the symbolic notation.

II. DEMONSTRATION SITE MATRIX DEVELOPMENT

A. Design Strategies

The overall program goals identified in the Introduction to this report were analyzed to determine the specific issues which must be addressed in order to expeditiously and cost effectively achieve the stated goals. Having identified these issues, we observed that each could be assigned to one of three broad categories - technical, economic, or institutional/societal/environmental. These issues are related to the three categories and the program goals in Figure II-1. Each of these categories was then viewed as representing a strategic approach for the attainment of the program's goals. In order to

QUARTERLY TOTALS OF CONTRACT STARTS DIFFERENTIATED BY PURPOSE

FIGURE II-1
STRATEGY/GOAL MATRIX

<div>GOAL</div> <div>STRATEGY</div>	PREDICT LONG-TERM ECONOMIC VIABILITY	STIMULATE MARKET	CREATE INDUSTRY
TECHNICAL	MEASURE TECHNICAL PERFORMANCE	ESTABLISH SYSTEM DESIGN PROCEDURES	IDENTIFY MOST PROMISING DESIGNS
ECONOMIC	DETERMINE ECONOMIC PARAMETERS	EVALUATE FINANCIAL INCENTIVES	EXPLOIT PRESENT ECONOMIC VIABILITY
INSTITUTIONAL	DETERMINE COSTS OF BARRIERS, METHODS FOR MITIGATING THEM	DEVELOP PROCEDURES TO PROTECT CONSUMER	ACCEPTANCE BY BUILDING COMMUNITY

implement each strategy, a set of specific objectives were associated with each demonstration site or set of sites. The remainder of this section will clarify the concepts behind each strategy. The reader is referred to Table II-1 for a summary of the basic tasks assigned to carry out each strategy.

Two tasks are needed to conduct the technical strategy. The parametric studies are designed to provide a thorough investigation of all engineering aspects of the more widely available systems. The promising technology studies are intended to provide an opportunity to investigate engineering aspects of recently introduced but less well understood SHAC systems.

Three tasks are associated with the economic strategy. One study will explore those aspects associated with the installation of SHAC systems. Another study will explore cost factors associated with the size of the SHAC system. Another study is aimed directly at stimulating the creation of a local industry.

Three tasks are associated with the institutional/societal/environmental strategy. One study actually consists of many studies conducted on a site-by-site basis. In these studies, each site is selected because it will address one of the many issues associated with this strategy. Another study consists of surveying several locations participating in the program. Surveys before and after the program will identify any changes in the attitudes of the public and decision makers. The final task is the dissemination of information as it is obtained during the program. Through the process of education, many issues associated with this strategy will hopefully evaporate or be resolved.

B. Strategy Implementation Priorities

While we have allocated a number of demonstrations whose primary purpose is to explore institutional/societal/environmental (ISE) issues, we view every

TABLE II-1
SUMMARY OF STRATEGY TASKS

<u>STRATEGY</u>	<u>TASKS</u>	<u>PRIMARY PURPOSE</u>
Technical	1 Parametric Studies (PS) (Nucleus)	Document engineering performance over broad operating ranges
		Identify design procedures
		Identify ranges of applicability
		Assess reliability and identify technical problem areas
Economic	2 Promising Technology Studies (PT) (Nucleus)	Combine with cost data to forecast Life Cycle Costs
		Measure and compare performance for many concepts
		Provide for anticipated R&D cycles
		Identify regions of applicability
Economic	1 Installation Learning Studies (ILS)	Investigate potential for reduction of installation costs
		Forecast Life Cycle Costs based on results of study
	2 Economy of Scale Studies (EOS)	Investigate capital and maintenance costs as function of SHAC System size
		Forecast Life Cycle Costs based on results of study
Institutional/ Societal/ Environmental	3 Local Industry Stimulation (LIS)	Provide sufficient incentive to start industry on a local scale
	1 Site Specific Studies (ISE)	Establish labor jurisdictions, identify and develop appropriate building codes, identify and mitigate zoning problems, determine level of risk as expressed in financial arrangements, etc.
	2 Conduct Surveys	Assess effect of program on decision-maker attitudes
	3 Disseminate Information	Modify attitudes, overcome barriers through education.

demonstration as providing some opportunity to also address these issues. Thus, program funding levels should affect the number in the ISE group first. Being loosely defined, this group cannot be depended upon to provide all the necessary technical and economic data required by the program and has thus been assigned lowest priority.

Similarly, we view the documentation of costs associated with demonstrations as being primarily that - documentation. These costs will be combined with the measured engineering performance to assess one of the program's primary goals - ultimate economic viability. There are, however, a number of economic studies which will provide information and insight into probable future labor costs (ILS), the existence of economies of scale (EOS), and one which will provide incentive for the establishment of a local industry (LIS). These issues are important. However, they are not as critical to the attainment of the program's goals as the need to measure and document technical performance. Therefore, we have assigned second priority to the economic strategy.

Achievement of the program's goals hinges on the parametric studies (PS). We think of these studies as forming the nucleus of the entire program. The development of technical performance data over a wide range of operating conditions and system types is critical to the understanding of design rules, the development of handbooks, regional life cycle cost analyses, and the identification of those technical areas requiring further study. Similarly, the promising technologies (PT) study provide a preliminary assessment of the regions of applicability and relative performance and costs of many system types. The group of demonstrations associated with the parametric studies and promising technologies study represent the absolute minimum set in order to obtain any significant benefit from the program and are thus assigned highest priority.

III. SITE SELECTION METHODOLOGY

A. Objective

The two hundred demonstrations recommended in Section I.C represent hypothetical buildings and, as such, cannot be implemented of itself. What must be done is to locate real buildings which conform to the sites recommended in the Systems Level Plan. The general mechanism ERDA has chosen to locate real candidate sites is the PON (Program Opportunity Notice). However, not all of these candidates will be permitted to participate in the program.

B. Approach

Real sites are selected to maximize the effectiveness of the demonstration by employing the goals of the program as general selection guidelines, which are in essence, expressed through the recommended two hundred hypothetical sites. Thus, real sites must match those recommended in the plan. Many factors which determine whether a site will be a "good" demonstration must be evaluated on a case by case basis. These site specific factors can be divided into those which are amenable to numerical evaluation and those which are subjective and must be evaluated on their merits by a committee. Our overall approach is then to evaluate and rank a technical measure of effectiveness calculated by computer algorithm using the numerical values. The results of this evaluation will be submitted along with the qualitative factors for analysis by committee.

The process of evaluation can be briefly summarized as follows:

1. Each potential demonstration candidate is manually checked against a set of technical constraints to determine which can be eliminated on a technical basis. These constraints range from a building which is too old, to one which simply cannot be matched with one of the 200 recommended hypothetical sites.

2. That set of sites having met the technical and plan constraints is then subjected to a computer algorithm of the data amenable to numerical analysis and ranked by technical measure of effectiveness.
3. The technical measure of effectiveness and ranking generated for each site as described above is combined with the qualitative knowledge about the site. We visualize an interactive committee discussion to develop the value of each criteria (the rating) for each site. All sites are then ranked.
4. The ranking of the real sites then provides a guideline by which the better may be selected. Each site is checked with those demonstrations existing at the time of analysis to ensure that no duplication of that site will occur. After eliminating those sites already being conducted, the better sites of that total group of original candidates will be selected.

IV. TEST AND EVALUATION OF SITES

In order to carry out the goals of the program, a data collection procedure is required which is accurate, consistent, complete, timely, and cost-effective. A Test and Evaluation (T&E) Plan being prepared as a separate report is designed to satisfy these requirements. Below is a brief overview of this Plan.

Thorough instrumentation at each site will measure and record specific engineering data, and a national center will collect and process the site data. This will:

1. Centralize all data processing of technical and economic data,
2. Provide on-site intelligence to assure that accurate and complete data has been collected,
3. Provide the mechanism to compare and predict actual performance, and
4. Provide a mechanism to identify operational problems at the subsystem level.

The T&E equipment installed at a site must be adequate to record engineering data, and will be chosen so as to meet the following constraints in a cost-effective way:

1. The T&E equipment must be capable of recording the data presented to it in both digital and analogue form with sufficient resolution and sampling rates to permit the desired engineering analysis to be performed subsequently.
2. The T&E equipment at each site must be very reliable and capable of remote diagnostic interrogation from a central site.
3. Because of the variability in SHAC equipment from site to site the T&E equipment should be modular and readily configured for a site to assure ease of installation.
4. Vendor selection should give particular attention to vendor reliability, widespread service and support organizations as well as an integrated product line to make system responsibility a meaningful possibility.

V. PROGRAM MANAGEMENT PLAN

A. Introduction

The implementation of the National Solar Heating and Cooling Demonstration Program being a highly complex multi-purpose undertaking necessitates the establishment of effective program management direction and control. In view of this fact, numerous management approaches, such as decentralized management and direct functional line management were reviewed, each being weighted against its effectiveness in achieving the management objectives. The Focal Point Program Management concept, structured to allow for multi-tiered subcontractor responsibilities, was chosen as being the most versatile approach in providing flexibility yet affording positive control. The use of optional multiple contracts, in addition, assures small business participation in one or all of the contracts.

TABLE V-1
MANAGEMENT MANPOWER REQUIREMENTS
(Man-months)

<u>Contractor</u>	Fiscal Year				<u>Total</u>
	<u>1976-77Q</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	
Program Management Office	70	120	120	120	430
Site Management	39	111	108	64	322
Uniform Test & Evaluation	153	288	252	252	945
Information Dissemination	<u>11</u>	<u>30</u>	<u>30</u>	<u>30</u>	<u>101</u>
Total Man-months	273	549	510	466	1,798

B. Management Organization

The organizational structure allows for distinct management levels, pseudo-independent such that while separate subcontracts are feasible, direction and control will be maintained through layered management functionally reporting through a line organization to the ERDA Program Manager. The proposed functional management levels are to be staffed, predominantly by HVAC experienced consulting engineering and architect-engineering firms selected by the standards and guides developed by General Services Administration and the American Institute of Architects. The specific management functions are Program Management (PM), Construction and Operation (C&O), Information and Dissemination (ID), and Test and Evaluation (T&E). The functional organization is depicted in Figure VI-1 and general descriptions of the management levels follow.

1. Program Management Office (PMO): The PMO will provide the focal point management to ERDA. The PMO will be under the direction of a Program Manager supported by a technical staff and three functional element (tasks) managers. The tasks managers, as part of the PMO, will coordinate three functional elements within the PMO, namely, Construction and Operations (C&O), Information Dissemination (ID), and Test and Evaluation (T&E).

2. Construction and Operation (C&O): To be effective, the Construction and Operation phase must be carried out within an existing infrastructure, e.g., the building and trades industry. If the building and trades infrastructure is selected it is considered to be essential that the existing business structure, e.g., Architect-Engineer, Mechanical Contractor, builder, electrical, mechanical engineering design, and the various trades be utilized with a minimum disruption in the normal order of business. Elements of a construction management system that would be recognized by, and available to, the commercial construction industry were modified to meet the construction monitoring requirements of ERDA. The standard construction management system developed by the General Services Administration, and is known as the "Construction Management Control System (CMCS)", was

FIGURE VI-1: FOCAL POINT MANAGEMENT FUNCTIONAL ORGANIZATION

evaluated and used where appropriate. In developing the CMCS for this plan, particular emphasis was placed on streamlining the organizational structure and emphasizing the need for qualified technical personnel with a background of broad participation in the mechanical/HVAC industry and solar energy application.

The organization and procedures that make up the CMCS must be streamlined and flexible to allow coordination of a variety of activities between ERDA and the PON demonstration teams, as well as permit improvement in monitoring methods as experience is gained from the demonstration construction work.

3. Information Management: The Information Manager's primary responsibility is that of obtaining and distributing information which becomes available as a result of and during the course of the demonstration program. The major activity of the Information Manager will be to coordinate the planning and work of the information task force and to supply them with appropriate and timely information suitable for dissemination. In addition, the Information Manager will provide ERDA with responses to inquiries rising from the demonstration program and its information dissemination activity or will direct the inquiry to the proper responding activity. Last, but not least, the Information Manager will, by established protocol, deliver information concerning the demonstration to the ERDA data bank.

4. Test and Evaluation (T&E): The responsibility for T&E has been assigned as a totally independent function with a T&E manager reporting directly to the Program Manager. T&E Management will be supported by subcontractor(s) responsible for the implementation of the Uniform Test and Evaluation Plan. T&E Management will serve as the interface between the managers of the other functional elements, the Program Manager, and the subcontractor responsible for the five specific subtasks listed as follows:

1. Technical Data Collection,
2. Data Processing,
3. Analysis and Reporting,
4. T&E System Equipment
5. Societal Data Collection.

The Societal Data Collection subtask is one that may require the unique capabilities of firms experienced in the performance of opinion surveys. The "after" part of the Base Line Survey may be conducted by such a firm. The "before" part of the Base Line Survey is being performed in support of this work.

C. Program Management Costs, Manpower Requirements, and Schedule

Management costs by fiscal year to support the management plan are summarized in Table VI-3. Manpower requirements for each fiscal year are shown in Table V-1. A schedule of major milestones for PMO management is enclosed as Figure V-2.

VI. RESOURCES REQUIRED

A. System Installation

Installed solar system costs for the demonstrations were estimated by assuming the cost of the solar system will be \$30/ft² for new installations, \$40/ft² for retrofit installations. System sizing was based upon the assumption that the collector area would be one-half the average building size for each type of building considered. A tabulation of average building sizes employed is shown in Table VI-1. Regional cost variations were not considered. Cost sharing was not factored into the installation cost figures. Cost reductions as a result of learning and inflation cost additions were assumed to cancel each other thereby yielding the fixed costs/ft² of the system.

Present uncertainties associated with the variables which affect total installed solar system costs make this simplistic approach in determining the dollar

FIGURE V-2: PMO MANAGEMENT SCHEDULE

Milestone	Fiscal 1976				TQ	Fiscal 1977				Fiscal 1978				Fiscal 1979			
	1st	2nd	3rd	4th		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
1. Sign Management Contract			▽														
2. Write RFP For Site Manager			▽														
3. Write RFP for UTE Manager			▽														
4. Write RFP for ID Manager			▽														
5. Review RFP Responses and Select Site Management Con.				▽													
6. Review RFP Responses and Select UTE Management Con.				▽													
7. Review RFP Responses and Select ID Management Con.				▽													
8. Review PON Responses							▽				▽				▽		
9. Select Sites							▽				▽				▽		
10. Review Unsolicited Proposals														▽			
11. Technology Review and Feedback														▽			
12. UTE Operation and Data Analysis																	▽

TABLE VI-1

AVERAGE BUILDING SIZE FOR VARIOUS BUILDING CATEGORIES

<u>Building Type</u>	<u>Average Size (ft²)</u>	<u>Collector Area Assumed</u>
1. Restaurants	1,400	700
2. Stores, Service stations	4,200	2,100
3. Supermarkets	12,500	6,250
4. Churches	16,300	8,150
5. Offices	16,000	8,000
6. Schools	25,600	12,800
7. Hospitals	60,000	25,000
8. Shopping Centers	63,075	31,500
9. Motels	20,500	10,250
10. Warehouses	13,000	6,500
11. Libraries, Museums	25,000	8,333
12. Hotels	50,000	N.A.

TABLE VI-2
ESTIMATED INSTALLED SYSTEM COSTS BY REGION AND FISCAL YEAR

<u>Region</u>	<u>Fiscal Year</u>				<u>Total</u>
	<u>1976+77TQ</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	
	\$, Thousands				
Boston	1,069	6,896	2,996	3,158	14,119
Washington	1,848	5,237	491	1,703	9,279
Madison	1,480	5,478	2,275	-	9,233
Los Angeles	901	4,177	2,294	-	7,372
Charleston	730	783	481	-	1,994
Bismarck	649	896	240	1,580	3,365
Nashville	425	1,003	333	-	1,761
Fort Worth	1,589	2,255	425	-	4,269
Omaha	752	1,595	-	-	2,347
Seattle	1,785	-	-	-	1,785
Phoenix	3,860	1,744	1,413	-	7,017
Miami	-	512	634	-	1,146
Total	15,088	30,576	11,582	6,441	63,687

requirements to support the plan reasonable. The dollar amounts shown in Table VI-2 indicate the funding by regions. These figures represent the year funding is required, not necessarily the year the funds will be used.

As pointed out in previous sections, the legal constraints of overall program scheduling account for the large commitment in fiscal year 1977.

B. Management and Test and Evaluation Hardware

Management costs as well as test and evaluation hardware costs by fiscal year to support the management level as outlined in Section V are shown in Table VI-3.

TABLE VI-3
MANAGEMENT COST

<u>Management Task</u>	<u>FY1976-77TQ</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>Total</u>
Program Management	609	632	655	687	2,583
Construction & Operation	274	869	849	531	2,523
Uniform Test & Evaluation	392	854	533	818	2,897
Information Dissemination	52	366	215	469	1,102
UTE Site Hardware	<u>1,700</u>	<u>1,700</u>	<u>350</u>	<u>350</u>	<u>4,100</u>
Total Management	3,027	4,421	2,902	2,855	13,205
Total Management Less					
Hardware	1,327	2,721	2,552	2,505	9,105

C. Total Resources Required

Total resources to accomplish the tasks indicated in this plan are shown in Table VI-4.

TABLE VI-4
TOTAL PLAN COST
\$, Thousands

	<u>FY1976-77TQ</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>Total</u>
Management	3,027	4,421	2,902	2,855	13,205
Demonstration	<u>15,088</u>	<u>30,576</u>	<u>11,582</u>	<u>6,441</u>	<u>63,687</u>
Grand Total	18,115	34,997	24,484	9,296	76,892