REVIEW AND SUMMARY OF SOLAR THERMAL CONVERSION PROGRAM PLANNING ASSISTANCE

ltr dtd 7/16/75 1080/8-2 **MASTER**

THE AEROSPACE CORPORATION

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER
This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ATR-75(7523-01)-1

REVIEW AND SUMMARY
OF
SOLAR THERMAL CONVERSION
PROGRAM PLANNING ASSISTANCE

Prepared for:

Energy Research and Development Administration
Division of Solar Energy
Solar Thermal Branch
Washington, D.C.

June 1975

Prepared by:

Energy and Resources Division
The Aerospace Corporation
El Segundo, California
Telephone: (213) 648-5615

EY-76-C-03-1080

Letter Contract No. AT/04-3/-1080

REP

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
2.0 BASIC SOLAR THERMAL PROGRAM PLAN, ANNUAL THRU FY 1981	3
Major Results and Key Decision Dates	4
Budget Summary	6
Solar Thermal Program Summary	8
Central Receiver Power Plant	9
Solar Thermal Test Facilities	15
Solar Total Energy System	19
Distributed Collector Power Plant	27
Hybrid Solar Thermal Systems	31
Research and Development	35
Program Support	37
3.0 ALTERNATIVE FUNDING PLANS, ANNUAL THRU FY 1981	39
Plan #1, \$20.9M	40
Plan #1, \$13.2M	42
Plan #2, \$20.9M	44
Plan #2, \$13.2M	46
4.0 BASIC PROGRAM PLAN, ANNUAL THRU FY 1985	48
Funding Requirements	49
Element Funding Requirements	50
Expense Summaries	57
Major Results, Key Decision Dates, and Budget Summary	58
5.0 REVISED SCHEDULE / FORMAT PLAN SUMMARY OF 14 MAY 1975	62

TABLE OF CONTENTS (Continued)

	<u>Page</u>
APPENDIX A - Memoranda, Directives, and Notes of Instruction for "Phase II" Budget Submissions	A-1
Responsibilities for "Phase 3" Solar Reports - 3/6/75	A-2
Objectives, Strategy, and Issues	A-4
Helpful Hints for Preparing Objectives	A-6
Strategy Considerations for Energy R&D Programs	A-9
Program Implementation	A-11
Program Element Summary Sheet	A-13
ERDA Coordinators	A-14
Program Unit Titles	A-15
Program Outputs and Projections (Exhibits 1-6)	A-16
Fiscal Year 76 Equipment Budget - 3/11/75	A-22
Preparation for the First Meeting of the NAS Study Committee - 3/19/75	A-24
Call for Agency Planning and Budgeting Information - 3/21/75	A-25
Program Implementation Schedule - 3/19/75	A-29
General Instructions for Preparation of Material for Program Unit Descriptions - 3/20/75	A-31
Instructions for Preparation of Material for Program Outputs/Milestones	A-35
Outline of Meeting with Senior Planning Group - 5/13/75	A-39
"Oil and Gas Extraction" Example Program Sub-Unit	A-41
 APPENDIX B - Solar Electric Applications "Phase III" Budget Submissions	 B-1
March 21, 1975, Draft	B1-1
March 28, 1975, Draft	B2-1
April 5, 1975, Draft	B3-1

1.0 INTRODUCTION

The Solar Thermal Conversion Program comprises a major part of the national solar energy program which must be continuously reviewed and modified where necessary. Modifications are typically required to reflect technical achievements and uncertainties which arise from within the program or from other technical programs, changes in budgets available for supporting the program as well as internal program funding priorities, changing goals such as through acceleration or stretch-out of the program schedule, significant organizational changes involving responsible governmental agencies, the introduction of new project management support contractors, and required budget or schedule changes occurring within individual projects that make up the Solar Thermal Conversion Program. The Aerospace Corporation has provided data to assist in planning, review, coordination, and documentation of the overall Solar Thermal Conversion Program by performing the following activities:

A. The objectives, goals, top level schedules, and major program structure have been updated in the form of the accompanying Program Plan. This Program Plan includes the major organizational and technical advances since publication of the most recent "Five Year National Solar Energy Program" plan in early 1974. Specific projects and probable Project Management Contractors have been identified which include:

(1)	Central Receiver Proof-of-Concept Experiment Project (1st generation concept)	Sandia Corporation
Livermore, California
(2)	The Solar Thermal Test Facility (Central Receiver Concept)	Naval Weapons Center
China Lake, California
(3)	Solar Total Energy Test Bed	Sandia Corporation
Albuquerque, N. M.

B. As part of the preparation of the Program Plan, alternatives were identified and compared. Specific recommendations were developed. Factors that were considered in the identification of alternatives include:

- (1) The objectives, schedules, and funding requirements for individual projects (e.g., the Central Receiver Pilot Plant

Project) and the major elements of each project (e. g., the Subsystem Research Experiments of the Central Receiver Pilot Plant).

- (2) The technical, cost, and schedule risks associated with major project elements.
- (3) The dissemination and utilization in industry of the technology developed within the Solar Thermal Program.

C. The Program Plan was prepared in accordance with the memoranda, directives, schedules, and notes of instruction from Dr. LaGassie and Dr. Mock. These directives are included as Appendix A of this report.

Sections 2.0 through 5.0 cover the discussion and detail planning covering the objectives, justification, basic and alternative plans, budgets, and schedules for the Solar Thermal sub-unit portion of the Solar Electric Applications effort. Appendices B1, B2, and B3 include the March 21, March 28, and April 5, 1975, Program Plan submissions of the complete Solar Electric Applications effort. In Appendix B the Solar Thermal, Solar Photovoltaic, Wind Energy, and Ocean Thermal sub-unit texts have been condensed and formatted for integration in the overall ERDA budget package.

SECTION 2.0 BASIC SOLAR THERMAL PROGRAM PLAN,
ANNUAL THRU FY 1981

The basic program plan for the Solar Thermal subprogram contains:

- (1) a milestone chart, titled "Major Results and Key Decision Dates," summarizing the major events for each of the subprogram elements (e.g., central receiver power plant decision to build 10 MWe pilot plant, pilot plant checked out and operating, decision to build 100 MWe demonstration plant);
- (2) Table I, "Budget Summary Solar Thermal Subprogram" detailing the fiscal year dollar expenditures for each subprogram element through FY 1981 with a FY 1976 budget of \$29.5 million;
- (3) a Solar Thermal Subprogram "Project Summary Sheet" identifying the objectives, justification, strategies, task description, approach, major results, and total funding; and
- (4) two versions of the "Program Element Summary Sheets." The first version is a one-page summary as backup support for the congressional budget and second version, up to seven pages in length, provides project descriptions and detailed task funding and schedules required to develop the one-page summary. The Element Summaries are ordered as follows:

<u>Title</u>	<u>Project Index Number</u>
(a) Central Receiver Power Plant	V-5-1
(b) Solar Thermal Test Facilities	V-A-2
(c) Solar Total Energy Systems	V-A-3
(d) Distributed Collector Power Plant	V-A-4
(e) Hybrid Solar Thermal Systems	V-A-5
(f) Research and Development	V-A-6
(g) Program Support	V-A-7

In general, the material in Section 2.0 flows from the presentation of the overall basic Solar Thermal Subprogram Plan to successively more detailed descriptions of the individual projects, subprojects, and elements.

**SOLAR THERMAL SUBPROGRAM
MAJOR RESULTS AND KEY DECISION DATES**

PROGRAM ELEMENT	FY	75	76	Trans.	77	78	79	80	81	
1. Central Receiver Powerplant										
Component Testing	(1)				(3)			△4		
Pilot Plant (10 MWe)	(2)									
2nd Gen. Pilot Plant					(5)			(7)		
Demonstration Plant (50-100 MWe)								(6)		(8) FY 85
2nd Gen. Demonstration Plant (100 MWe)									(6)	(8) FY 87
Commercial Plant (100-300 MWe)										(9) FY 82 (10) FY 87
Adv. Comm. Plant (100-300 MWe)										(11) FY 84 (12) FY 89
Project Management & Eng. Sup.										Continues through project
2. Solar Thermal Test Facilities										
Central Receiver Facility	(1)		(3a)		(3)					
Distributed Collector Facility		(1)				(3)				
Project Management & Eng. Sup.										Continues through project
3. Solar Total Energy System										
#1 System (Military/Institutional)										
Component Testing	(1)									
Bench Model					(3)					
Pilot Plant #1 (200 KWe, 2 MWth)		(2)							△4	(7) FY 83
2nd Gen. Pilot Plant						(5)				
Demonstration Plant (5-10 MWe, 100-200 MWth)								(6)		(8) FY 85
#2 System (Industrial/Residential)										
Component Testing	(1)									
Bench Model					(3)					
Pilot Plant #2 (200 KWe, 2 MWth)		(2)							△4	(7) FY 84
2nd Gen. Pilot Plant								(5)		(8) FY 86
Demonstration Plant (5-10 MWe, 50 MWth)								(6)		
Project Management & Eng. Sup.										Continues through project

Milestones

- (1) Decision to Build Bench Model/Test Facility
- (2) Decision to Build Pilot Plant
- (3) Bench Model/Facility in Operation
- △4 (3a) Partial Capability
- △4 Pilot Plant Checked Out and Operating
- (5) Decision to Start Second Generation Pilot Plant
- (6) Decision to Build Demonstration Plants

- (7) Second Generation Plant in Operation
- (8) Demonstration Plant in Operation
- (9) Decision to Build Commercial Plant
- (10) Commercial Plant in Operation
- (11) Decision to Build Advance Comm. Plant
- (12) Advance Commercial Plant in Operation

SOLAR THERMAL SUBPROGRAM
MAJOR RESULTS AND KEY DECISION DATES (Cont'd)

PROGRAM ELEMENT	FY	75	76	Trans.	77	78	79	80	81	
4. <u>Distributed Collector Power Plant</u>										
Component Testing		(1)			(3)					
Pilot Plant (10 MWe)					(2)					4
2nd Gen. Pilot Plant							(5)			
Demonstration Plant										(6)
Project Management & Eng. Sup.										
5. <u>Hybrid Solar Thermal Systems</u>										
Component Testing					(3)					
#1 System Pilot Plant						(2)				
#2 System Pilot Plant							(2)			
#3 System Pilot Plant								(2)		
Project Management & Eng. Sup.										
6. <u>Research and Development</u>										
7. <u>Program Support</u>										
Management Support										
Mission Analysis										

(7) FY 82
(8) FY 87
Continued through project

(4) FY 82
(4) FY 83
(4) FY 84
Continued through project

Continued through project

Milestones

- (1) Decision to Build Bench Model/Test Facility
- (2) Decision to Build Pilot Plant
- (3) Bench Model/Facility in Operation
- △ Pilot Plant Checked out and Operating

- (5) Decision to Start Second Generation Pilot Plant
- (6) Decision to Build Demonstration Plants
- (7) Second Generation Plant in Operation
- (8) Demonstration Plant in Operation

BASIC PLAN
FY 1976 \$29.5M

TABLE 1
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

PROGRAM ELEMENT	FY	75	76	Trans.	77	78	79	80	81	
1. <u>Central Receiver Powerplant</u>										
Component Testing			7.0 [#]	1.5	3.5	3.9	2.5	2.5	2.0	
Pilot Plant (10 MWe)			1.8	0.4	8.9	18.3	14.6	3.4	1.7	1.7 through FY 82
2nd Gen. Pilot Plant					1.3	8.4	14.6	14.6	3.4	3.4 through FY 83
Demonstration Plant (50-100 MWe)							0.8	5.2	14.7	80 to 150 through FY 85
2nd Gen. Demonstration Plant (100 MWe)								1.7	4.2	90 to 160 through FY 86**
Commercial Plant (100-300 MWe)										130-390 through FY 88*
Adv. Comm. Plant (100-300 MWe)										130-340 through FY 89*
Project Management & Eng. Sup.			0.8	0.2	1.3	2.8	3.2	2.5	2.2	14.0 through FY 86
2. <u>Solar Thermal Test Facilities</u>										
Central Receiver Facility			4.5	1.2	19.6	5.4	3.5	2.7	2.7	8.4 through FY 85
Distributed Collector Facility			1.7	.4	11.5	3.6	2.5	2.7	2.7	8.4 through FY 85
Project Management & Eng. Sup.			0.6	0.2	2.8	0.8	0.5	0.5	0.5	1.7 through FY 85
3. <u>Solar Total Energy System</u>										
#1 System (Military/Institutional)										
Component Testing			1.7	0.4	2.4	2.0	2.3	1.7	1.7	
Bench Model			0.7	0.1	2.5	3.1	2.9	2.5	2.5	
Pilot Plant #1 (200 KWe, 2 MWth)			0.3	0.1	2.2	2.9	5.3	8.0	1.7	1.7 through FY 82
2nd Gen. Pilot Plant						1.5	4.4	6.5	6.1	3.4 through FY 83
Demonstration Plant (5-10 MWe, 100-200 Mwth)							0.8	2.4	14.2	40-80 through FY 86
#2 System (Industrial/Residential)										
Component Testing			1.7	0.4	2.4	3.1	2.9	2.5	2.5	
Bench Model			0.7	0.1	1.4	3.6	3.8	3.8		
Pilot Plant #2 (200 KWe, 2 MWth)			0.3	0.1	3.2	3.2	4.2	7.7	5.2	1.7 through FY 82
2nd Gen. Pilot Plant							2.2	4.6	4.6	12.5 through FY 85
Demonstration Plant (5-10 MWe, 50 MWth)								0.8	4.2	60-120 through FY 88*
Project Management & Eng. Sup.			0.5	0.1	1.2	1.8	2.5	3.3	3.3	5.6 through FY 86

* Not included in runout past 1989

Includes allocation of \$1M from Solar Storage 1976 budget item

TABLE 1
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM
Funding in Millions of Dollars

#Includes allocation of \$1M from Solar Storage 1976 budget item

PROJECT SUMMARY SHEET

Program Element Index Number and Title: V Solar Electric Applications

Project Index Number and Title: V-A Solar Thermal

Project Objective: To provide full system capability for: 1) economical and natural resource conserving production of supplemental electric power in the 1980's, and 2) total energy systems for urban/rural communities and industrial/institutional/military centers at competitive rates.

Project Justification: Few fundamental technical limitations. Analyses indicate that solar thermal power plants can be competitive with fossil fuels and total energy systems should be competitive with conventional energy sources in the 1980's.

Project Strategy: Develop and demonstrate the economically competitive capabilities for solar thermal systems compared to fossil fuel operations. Industry/Utilities to participate in research and development to expedite commercial development.

Description of Task and Approach: Development and demonstration of central receiver power plant, solar total energy systems, distributed collector power plant, hybrid solar thermal systems. Solar thermal test facilities, research, development and program support are included.

Major Results and Key Decision and Dates:

Central Receiver Power Plant 10MWe Pilot Plant checked out & operating	1979
Decision to build 100-300MWe Commercial Central Receiver Power Plant	1982
200KWe/2MMth Solar Total Energy System Pilot Plants checked out & operating	1981
10MWe Distributed Collector Power Plant Pilot Plant checked out & operating	1981
Hybrid Solar Thermal Systems pilot plants (3) checked out and operating	1983
40,000 MWe Solar Thermal power generation by 400 commercial plants saving 320 million barrels of oil	2000

Task Funding (1977 dollars):

	Est. FY75	FY 1976 Cong.	Rev.	Transition Period Cong.	Rev.	FY77	FY78	FY79	FY80	FY81	Through Completion
Operating Expenses	10.0		28.0 [#]		6.1	47.3	56.1	66.2	77.4	75.2	150.2
Capital Equipment			0.7		0.2	11.9	16.5	27.9	32.2	49.3	107.0
Computers											
Other Equipment											
Plant Construction			0.8		0.8	24.3	27.1	32.2	40.1	37.5	329.0
Pass-Through Funding											
Joint Funding											(330-790)*
TOTAL	10.0		29.5		7.1	83.5	99.7	126.3	149.7	162.0	586.2

* Utilities anticipated contribution to demonstration and commercial plant developments (not included in total)

Includes allocation of \$1M from Solar Storage 1976 budget item

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT

PROGRAM ELEMENT SUMMARY SHEET

Sub-Program Unit: Solar Thermal

Program Element Index Number and Title: V-A-1 Central Receiver Power Plant

Program Element Objective: To provide stimulation to utilities sufficient to result in several 100 to 300 MWe commercial plants in operation by 1990.

Program Element Justification: Electric utilities have expressed interest in this project and are expected to contribute to the construction of commercial plants following demonstration of the technical and economic feasibility. Electric Power Research Institute has recommended that priority be given to this development over all others SEA sub program elements. The high capital expenditure requirements dictate these demonstrations.

Program Element Justification: Electric utilities have informally expressed interest in this project and are expected to contribute to the construction of commercial plants following demonstration of the technical and economic feasibility. The high capital expenditure requirements dictate these demonstrations.

Program Element Strategy: Major hardware development will be funded by ERDA with electric utilities beginning to contribute significantly at the demonstration plant stage. Busbar generation of electricity at the price of 25 to 30 mills per KWh is desired.

Description of Task and Approach: Hardware development and testing is currently being conducted and planning for a 10MWe pilot plant is in work and expected to be constructed and tied into utility grids in 1979. A 100MWe demonstration plant and a second generation plant will follow. These plants will utilize a pressurized steam Rankine cycle initially and probably an air or gas Brayton cycle in the second generation. Several commercial plants in the 100 to 300 MW capacity range are expected to follow.

Major Results and Key Decision Dates:

Decision to build 10MWe pilot plant	In Work-Operational - 1979
Bench model test facility	In Work-Operational - 1977
Second generation pilot plant decision	1977 - Operational 1980
100MW demonstration plant decision	1979 - Operational 1985
Second generation pilot plant decision	1981 - Operational 1987
First commercial plant decision	1982 - Operational 1987
Advanced commercial plant decision	1984 - Operational 1989

Program Element Funding (1977 dollars):

	Est. FY75	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through completion
		Cong.	Rev.	Cong.	Rev.						
Operating Expenses	5.1		9.6		2.1	7.1	9.1	10.7	17.3	18.2	29.1M
Capital Equipment											
Computers							0.5	0.8	0.5		
Other Equipment						2.9	9.1	9.8	4.6	5.0	50.0
Plant Construction						5.0	14.7	14.4	7.5	5.0	250.0
Pass-Through Funding											
Joint Funding											
TOTAL	5.1		9.6		2.1	15.0	33.4	35.7	29.9	28.2	329.1

Guidance on Pass-Through and Joint Funding: Possible industry funding of 50% of demonstration plant should be encouraged.

Fire, Safety and Other Requirements: Evaluation of safety/building/environmental codes unique to solar thermal not included in these plans.

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT
PROGRAM ELEMENT SUMMARY SHEET

Subprogram. Solar Thermal - V-A.

Project Index Number. V-A-1.

Project Title. Central Receiver Power Plant.

Project Objective. To provide a full system capability for the widespread production of supplementary electric power in the 1980s to meet electric utility requirements for load - following or intermediate load electric generating systems which are capable of supplying power at economical prices while simultaneously conserving natural resources.

Project Justification. The higher initial capital expenditure required for solar thermal conversion plants when compared to conventional fossil fuel plants requires that the economic feasibility be demonstrated before private capital sources will make the necessary commitments.

Project Strategy. The major hardware developments will be funded by ERDA through industry with increasing support by the electric utilities as the project progresses. Overall program planning and mission system analysis support from the Aerospace Corporation, an FCRC project direction by the ERDA Laboratory with program management retained by ERDA.

Description of Task. The project was initiated in 1973/1974 with four parallel control network system design studies funded by NSF through industry. In 1975 three parallel contracts were awarded to industry for subsystem hardware development (component testing) and for a preliminary design of a 10 megawatt electric (MWe) pilot plant. This subsystem hardware will be tested at the Solar Thermal Test Facility (Project Index Number V-A-2). In 1977 a contract will be initiated with industry for the construction of a 10 MWe pilot plant which will be tied into a utility grid in 1979. Some electric utilities have informally indicated interest in participating in the critical receiver pilot plant, and the extent of this participation is being explored. The initial pilot plant which utilizes steam and a Rankine cycle will be followed by a second generation 10 MWe pilot plant probably utilizing air or a gas and the Brayton cycle. Design of a 100 MWe demonstration plant will be initiated in 1979. The plant will become operational in 1985. It is anticipated that the demonstration plant will be funded up to 50% private capital (the utilities). The demonstration plant will verify the technical and economic feasibility of the central receiver solar thermal conversion intermediate load electrical power plant.

Upon completion of the demonstration plan the plant will be handed over to the participating utility for use as a commercial plant. The 100 MWe demonstration plant is followed by the advanced demonstration plant and advanced commercial central receiver power plants. Several of these plants are to be operational by 1990. It is anticipated that these commercial plants will be funded entirely with private capital. However, the initial generation of commercial central receiver plants may require a portion of the funds to be made available in low interest government backed loans in order to obtain the necessary larger initial capital required to build solar plants rather than conventional front face power plants.

Task Funding (1977 dollars): V-A-1 CENTRAL RECEIVER POWER PLANT

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong. Rev.	Cong.	Rev.						
Subproject #1										
COMPONENT TESTS										
Operating expenses ⁽³⁾		7.0 #		1.5	3.5	2.9	2.5	2.5	2.0	
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL		7.0		1.5	3.5	2.9	2.5	2.5	2.0	
Subproject #2										
PILOT PLANT (10 MWe)										
Operating expenses		1.8		0.4	1.0	2.0	2.2	3.4	1.7	1.7 FY82
Capital equipment					2.9	6.6	5.5			
Computers						0.5	0.5			
Other equipment ⁽¹⁾						6.1	5.0			
Plant construction ⁽²⁾					5.0	9.7	6.9			
Pass-through funding										
Joint funding										
SUBTOTAL		1.8		0.4	8.9	18.3	14.6	3.4	1.7	1.7 FY82
Subproject #3										
2nd GEN. PILOT PLANT (10 MWe)										
Operating expenses					1.3	1.4	2.0	2.0	3.4	3.4 FY83
Capital equipment						3.0	5.1	5.1		
Computers						--	0.3	0.5		
Other equipment ⁽¹⁾						3.0	4.8	4.6		
Plant construction ⁽²⁾						5.0	7.5	7.5		
Pass-through funding										
Joint funding										
SUBTOTAL					1.3	8.4	14.6	14.6	3.4	3.4 FY83

Guidance on Pass-Through and Joint Funding:

(1) Utility grid interface furnished by a utility; funding not included.

Fire, Safety, and Other Requirements:

(2) New codes may be required.

Includes allocation of \$1M from Solar Storage 1976 budget item

Task Funding (1977 dollars): V-A-1 CENTRAL RECEIVER POWER PLANT (Continued)

	FY 1976	Transition							
	FY75	Cong. Rev.	Period	Cong. Rev.	FY77	FY78	FY79	FY80	FY81
									Through
									Completion
Subproject #4									
100 MWe DEMONSTRATION PLANT									
Operating expenses						0.8	5.2	4.7	10 FY86
Capital equipment								5.0	12 FY85
Computers									
Other equipment									
Plant construction								5.0	60-130 FY85
Pass-through funding									
Joint funding									
SUBTOTAL						0.8	5.2	14.7	80-150 FY85
Subproject #5									
ADVANCED 100 MWe DEMONSTRATION PLANT									
Operating expenses							1.7	4.2	10
Capital equipment									30
Computers									
Other equipment									
Plant construction									50-120 FY86
Pass-through funding									
Joint funding									
SUBTOTAL							1.7	4.2	90-160 FY86
Subproject #6									
COMMERCIAL PLANT 100-300 MWe									
Operating expenses									
Capital equipment									
Computers									
Other equipment									
Plant construction									
Pass-through funding									
Joint funding									
SUBTOTAL									(1) 130-390 FY87

Guidance on Pass-Through and Joint Funding:

(1) Not included in run-out totals.

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-1 CENTRAL RECEIVER POWER PLANT (Continued)

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong. Rev.	Cong.	Rev.						
Subproject #7										
ADVANCE COMMERCIAL PLANT (100-300 MWe)										
Operating expenses										
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL										(1) 130-390 FY89
Subproject #8										
PROJECT MANAGEMENT & ENGINEERING SUPPORT (Sandia Livermore)										
Operating expenses 0.8 0.2 1.3 2.8 3.2 2.5 2.2 14 FY86 (8 to 10% of CR project)										
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL										0.8 0.2 1.3 2.8 3.2 2.5 2.2 14 FY86
PROJECT TOTAL										
Operating expenses 9.6 2.1 7.1 9.1 10.7 17.3 18.2										
Capital equipment 2.9 9.6 10.6 5.1 5.0										
Computers .5 .8 .5										
Other equipment 9.1 9.8 4.6										
Plant construction 5.0 14.7 14.4 7.5 5.0										
Pass-through funding										
Joint funding										
TOTAL										9.6 2.1 15.0 33.4 35.7 29.9 28.2 189-259 FY86

Guidance on Pass-Through and Joint Funding:

(1) Not included in run-out totals.

Fire, Safety, and Other Requirements:

**DIRECT SOLAR CONVERSION PROGRAM UNIT
PROGRAM ELEMENT SUMMARY SHEET**

Sub-Program Unit: Solar Thermal

Program Element Index Number and Title: V-A-2 Solar Thermal Test Facilities

Program Element Objective: To provide test facilities for component and subsystem hardware (model or module level for pilot and demonstration plant hardware) of central receiver and distributed collector power plant systems.

Program Element Justification: To provide early verification of alternative solutions to component and subsystem hardware design requirements and thereby reduce program risk and accelerate schedule at minimum cost.

Program Element Strategy: Develop a 5MW thermal central receiver facility capable of doing scale model studies of hardware. In same site develop distributed collector facility utilizing facilities and services jointly with central receiver facility when feasible.

Description of Task and Approach: An initial 1MW thermal central receiver will be constructed for early testing followed by establishment of a full 5MW capability facility. This facility will be developed and built by industrial contractors. A distributed collector system will also be developed to facilitate component testing.

Major Results and Key Decision Dates:

Decision to build central receiver facility	In Work	Operational 1977
Decision to build distributed receiver facility	1976	Operational 1978
Test of first generation pilot hardware	1977	

Program Element Funding (1977 dollars):

	Est. FY75	FY 1976		Transition Period		FY77	FY78	FY79	FY80	Through Completion	
		Cong.	Rev.	Cong.	Rev.						
Operating Expenses			5.3		0.8	8.9	4.8	4.5	5.9	5.9	18.5
Capital Equipment			0.7		0.2	8.5	3.0	2.0			
Computers											
Other Equipment											
Plant Construction			0.8		0.8	16.5	2.0				
Pass-Through Funding											
Joint Funding											
TOTAL			6.8		1.8	33.9	9.8	6.5	5.9	5.9	18.5

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT

PROGRAM ELEMENT SUMMARY SHEET

Sub-Program Unit: Solar Thermal, V-A

Project Element Index Number and Title: V-A-2 Solar Thermal Test Facilities

Program Element Objective: To provide solar thermal test facilities to test the components and subsystem hardware that is either a model or module of both the pilot plant and the demonstration plant hardware. If a model or module is used, the test data must be scalable for use in both pilot plant and demonstration plants. Separate test facilities are required for both the Central Receiver Power Plant and the Distributed Collector Power Plant due to the inherent differences in the basic design and potential performance differences of the two types of plants. To obtain a precise comparison between the two types of plants it is an objective to have the two test facilities receive the same insolation.

Program Element Justification: To reduce the program risk and cost, and to accelerate the program schedule, it is required that a solar thermal test facility be available early in the program to test many varied but parallel technological approaches to the components and subsystem hardware required for solar thermal power plants. The most promising component and subsystem hardware will then be selected for the pilot plant design and construction.

Program Element Strategy: Recent mission analysis studies utilizing industry and university design parameters and performance have shown the Central Receiver Power Plant to be the preferred (highest efficiency and lowest cost) solar thermal conversion electric power plant. The approach is to provide a Solar Thermal Test Facility for models or modules central receiver hardware the results of which will be scalable and used for detail design of a 10MWe Central Receiver Pilot Plant. Scaling studies of the various hardware subsystems and components have shown that a 5MW thermal Solar Test Facility is required. This should be constructed in two stages, a 1MW thermal for early testing followed by the 5MW thermal full capability one year later. The Central Receiver Test Facility will be followed by a parallel development of the Distributed Collector Test Facility. The selection of the same site for the two test facilities could appreciably reduce the costs and development time required for supporting constructions of roads, utilities, cafeteria, etc.

Description of Task and Approach: The first task is the preparation by an architecture and engineering firm of the conceptual design, detail design and specifications required for the construction and fabrication of the 5MW thermal Central Receiver Test Facility. Funds for the construction, fabrication and operation of the test facility will be transferred to the Naval Weapons Center (NWC) China Lake, California. NWC will advertise for bid, award, supervise and operate the test facility as directed by ERDA. Monies required by industry to support testing of the component and subsystem hardware will be funded directly to industry by ERDA as part of the development hardware contracts. Following the Central Receiver Test Facility by about 9 months a similar approach will be taken for the Distributed Collector Test Facility. A location has not been identified for the second facility. However, costs, schedule, insolation and required supporting facilities would deem selection of the same facility location most desirable.

Major Results and Key Decision Dates: The performance evaluation of the central Receiver Pilot Plant in 1979 dictates the following schedule:

Award A&E facility design	in work
Transfer of supervision, construction & operation of facility to NWC	Jul 75
Award of (1MW thermal) heliostate subsystem contracts by NWC	Sep 75
Award of facility construction contract	Spring 76
Award of (5MW thermal) heliostat fabrication contract	Jul 76
IOC for 1MW thermal test facility	Dec 76
Test of 1st generation pilot plant hardware	Jan-Jul 77
IOC for 5MW thermal test facility	Jul 78

Task Funding (1977 dollars): V-A-2 SOLAR THERMAL TEST FACILITIES

	FY 1976	Transition								Through	
	FY75	Cong. Rev.	Period	Cong.	Rev.	FY77	FY78	FY79	FY80	FY81	Completion
Subproject #1											
CENTRAL RECEIVER FACILITY											
Operating expenses		3.0		0.2	3.6	2.4	2.5	2.7	2.7	8.4	FY85
Capital equipment		0.7		0.2	4.0	2.0	1.0				
Computers					(1.0)	(1.0)					
Other equipment					(3.0)	(1.0)					
Plant construction		0.8		0.8	12.0	1.0					
Pass-through funding											
Joint funding											
SUBTOTAL		4.5		1.2	19.6	5.4	3.5	2.7	2.7	8.4	FY85
Subproject #2											
DISTRIBUTED COLLECTOR FACILITY											
Operating expenses		1.7		0.4	2.5	1.6	1.5	2.7	2.7	8.4	FY85
Capital equipment					4.5	1.0	1.0				
Computers											
Other equipment											
Plant construction					4.5	1.0					
Pass-through funding											
Joint funding											
SUBTOTAL		1.7		0.4	11.5	3.6	2.5	2.7	2.7	8.4	FY85
Subproject #3											
PROJECT MANAGEMENT AND ENGINEERING SUPPORT											
Operating expenses		0.6		0.2	2.8	0.8	0.5	0.5	0.5	1.7	FY85
Capital equipment											
Computers											
Other equipment											
Plant construction											
Pass-through funding											
Joint funding											
SUBTOTAL		0.6		0.2	2.8	0.8	0.5	0.5	0.5	1.7	FY85

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-2 SOLAR THERMAL TEST FACILITIES (Continued)

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong. Rev.	Cong.	Rev.						
PROJECT TOTAL										
Operating expenses		5.3	0.8	8.9	4.8	4.5	5.9	5.9	18.5	FY85
Capital equipment		0.7	0.2	8.5	3.0	2.0				
Computers										
Other equipment										
Plant construction		0.8	0.8	16.5	2.0					
Pass-through funding										
Joint funding										
TOTAL		6.8	1.8	33.9	9.8	6.5	5.9	5.9	18.5	FY85

Operating expenses
Capital equipment
Computers
Other equipment
Plant construction
Pass-through funding
Joint funding
SUBTOTAL

Operating expenses
Capital equipment
Computers
Other equipment
Plant construction
Pass-through funding
Joint funding
SUBTOTAL

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT

PROGRAM ELEMENT SUMMARY SHEET

Sub-Program Unit: Solar Thermal

Program Element Index Number and Title: V-A-3 Solar Total Energy Systems

Program Element Objective: To demonstrate commercial viability of providing for electric power and heating/cooling requirements of urban and rural communities, institutional/industrial load centers and military bases.

Program Element Justification: Since there are few fundamental technical limitations, substantial commercial utilization requires economic feasibility and reliability demonstrations.

Program Element Strategy: Development of hardware through industrial contracts with program planning, mission and systems analysis contributed by ERDA. As project matures, power utilities are expected to increase their involvement and financial support.

Description of Task and Approach: This element is currently in process with completion of a test bed model and test operations to validate analyses planned for July 1975. Two (2) subsequent pilot plant development efforts are planned with 200 KWe and 2MWth capabilities. Two plants are required to provide different load splitting (electric versus thermal energy). Two demonstration plants of 5-10MWe and 50-200MWth capacities will follow to verify technical, operational and economic feasibility and to establish basis for commercial plants by 1990.

Major Results and Key Decision Dates:

Decision to build 200KWe, 2MWth Pilot Plant (system #1)	1975	Operational 1981
Bench model	In Work	Operational 1976
Decision to build 200KWe, 2MWth Pilot Plant (system #2)	1976	Operational 1981
Decision to build 5-10MWe, 100-200MWth demonstration plant (Sys. #1)	1979	Operational 1985
Decision to build 5-10MWe, 50MWth demonstration plant (Sys. #2)	1980	Operational 1986
Program Element Funding (1977 dollars):		

	Est. FY75	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
		Cong.	Rev.	Cong.	Rev.						
Operating Expenses	2.3		5.9		1.3	12.0	15.4	18.2	20.1	19.4	13.0
Capital Equipment						0.5	2.0	3.3	9.1	12.7	27.0
Computers											
Other Equipment											
Plant Construction						2.8	4.4	9.8	14.6	13.9	60.0
Pass-Through Funding											
Joint Funding											130*
TOTAL	2.3		5.9		1.3	15.3	21.8	31.3	43.8	46.0	100.0

*Expected Utility contribution to demonstration plants

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT
PROGRAM ELEMENT SUMMARY SHEET

Subprogram. Solar Thermal - V-A.

Project Index Number. V-A-3.

Project Title. Solar Total Energy Systems.

Project Objectives. To provide a full system capability for total energy systems for the production of electric, heating and cooling power for urban and rural communities, industrial load centers and military bases in support of the overall national energy program and to demonstrate commercial viability by the late 1980s.

Project Justification. Although there are no fundamental technical limitations that would prevent substantial applications of solar thermal energy systems, the relatively higher capital investments estimated for solar power systems as compared to the investments for utilizing fossil or nuclear fuels requires that the economic feasibility be demonstrated before private capital sources would undertake the large long-term capital commitments.

Project Strategy. The major hardware developments will be funded by ERDA through contracts to industry with increasing support from the power utilities as the project matures. The program management will rest in ERDA with program planning, mission and system analysis support from the Aerospace Corporation (an FCRC) and the day by day project direction by the ERDA Sandia Laboratories at Albuquerque.

Description of Task and Approach. The project was initiated by AEC in July 1972 by funding of Sandia Laboratories, Albuquerque. Phase I, background studies; Phase II, preliminary system design, analysis and economic evaluations; and Phase III, exploratory development including a collector test bed, computer simulation program, and distributed trough type collector tests have been completed. Phase IV, a 2-year effort started in July 1974, is to test and evaluate the components and to assemble a test bed model of the baseline system. Phase V, which starts in July 1975, is the operational phase of the test bed model and is intended to validate the computer simulation developed in Phase III.

Subsequent efforts are divided into two system development efforts: #1 system is directed at providing the total energy needs for military bases while #2 system is directed at providing the total energy needs for institutions, communities and industrial complexes. #1 system will generally lead #2 system development schedule by 1 year. Contracts to industry will be initiated in 1976 for the design and

subsequent construction of Pilot Plants of approximately 200 KWe and 2 MWth to be operational in 1979 for #1 system and 1980 for #2 system. Second generation pilot plants of similar capacities will be designed and fabricated with operation planned in 1981 and 1982. The performance and economic viability of these pilot plants will be evaluated and projected to larger demonstration and commercial size plants. The close participation of industry throughout these efforts will assure an orderly transition from development phases into commercial operations for these systems. The design of demonstration plants of 5-10 MWe and 50-200 MWth capacities are to be initiated in 1980-1981 with plant operations anticipated for 1985-1986. These demonstration plants will verify the technical, operational and economic feasibility of the Solar Total Energy Systems and evolve directly to the establishment of commercially operating plants by early 1980s. The successful demonstration plants are expected to continue to operate beyond the performance demonstration period in a commercial mode. It is anticipated that the demonstration plants will be funded by 50% or more by private capital and the commercial plants entirely with private capital. However, the initial generation of commercial solar total energy plants may require government funding assistance in the way of low interest rate loans.

Major Results and Key Decision Dates. The performance evaluation of the pilot plants in 1980 and 1981 will provide the necessary data for the key decision to proceed with the high expense of fabrication and construction of the demonstration plants.

Preliminary and detail designs for the demonstration plants will start in 1979 and 1980 but the long term, high cost commitment for fabrication and construction of the demonstration plants should be made to facilitate 1981 and 1982 contract awards.

Task Funding (1977 dollars): V-A-3a #1 SYSTEM, SOLAR TOTAL ENERGY SYSTEMS

	FY 1976	Transition							Through	
	FY75	Cong. Rev.	Period	Cong. Rev.	FY77	FY78	FY79	FY80	FY81	Completion
Subproject #a1										
COMPONENT TESTING										
Operating expenses		1.7		0.4	2.4	2.6	2.3	1.7	1.7	
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL		1.7		0.4	2.4	2.6	2.3	1.7	1.7	
Subproject #a2										
BENCH MODEL										
Operating expenses		0.7		0.1	2.5	3.1	2.9	2.5	2.5	
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL		0.7		0.1	2.5	3.1	2.9	2.5	2.5	
Subproject #a3										
PILOT PLANT #1 (200 KWe, 2 MWth)										
Operating expenses		0.3		0.1	0.3	0.3	0.7	0.7	0.7	1.7 FY85
Capital equipment					0.5	1.0	1.6	2.5	1.0	0
Computers										
Other equipment										
Plant construction					1.4	1.6	3.0	4.8		0
Pass-through funding										
Joint funding										
SUBTOTAL		0.3		0.1	2.2	2.9	5.3	8.0	1.7	1.7 FY85

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-3a #1 SYSTEM, SOLAR TOTAL ENERGY SYSTEMS

(Continued)

	FY 1976	Transition							
	FY75	Cong. Rev.	Period	Cong. Rev.	FY77	FY78	FY79	FY80	FY81

Through

Completion

Subproject #a4

2ND GENERATION PILOT PLANT

Operating expenses					0.5	0.6	1.0	0.5	1.4	FY85
Capital equipment						1.0	2.0	2.0	2.0	FY83
Computers										
Other equipment										
Plant construction					1.0	2.8	3.5	3.6		
Pass-through funding										
Joint funding										
SUBTOTAL					1.5	4.4	6.5	6.1	3.4	FY85

Subproject #a5

DEMONSTRATION PLANT (5-10 MWe, 100-200 MWth)

Operating expenses					0.8	2.4	2.6	6-10		
Capital equipment							5.6	13-20		
Computers										
Other equipment										
Plant construction							6.0	21-50		
Pass-through funding										
Joint funding										
SUBTOTAL					0.8	2.4	14.2	40-80	FY85	

Operating expenses

Capital equipment

Computers

Other equipment

Plant construction

Pass-through funding

Joint funding

SUBTOTAL

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-3b #2 TOTAL ENERGY SYSTEM

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	<u>FY75</u>	<u>Cong.</u>	<u>Rev.</u>	<u>Cong.</u>	<u>Rev.</u>					
Subproject #b1										
COMPONENT TESTING										
Operating expenses			1.7		0.4	2.4	3.1	2.9	2.5	2.5
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL			1.7		0.4	2.4	3.1	2.9	2.5	2.5
Subproject #b2										
BENCH MODEL										
Operating expenses			0.7		0.1	1.4	3.6	3.8	3.8	
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL			0.7		0.1	1.4	3.6	3.8	3.8	
Subproject #b3										
PILOT PLANT										
Operating expenses			0.3		0.1	1.8	0.4	0.5	1.0	1.0 0.7 FY
Capital equipment							1.0	0.7	3.7	3.2 1.0 FY82
Computers										
Other equipment										
Plant construction						1.4	1.8	3.0	3.0	1.0
Pass-through funding										
Joint funding										
SUBTOTAL			0.3		0.1	3.2	3.2	4.2	7.7	5.2 1.7 FY82

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-3b #2 SOLAR TOTAL ENERGY SYSTEM (Continued)

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong.	Rev.	Cong.	Rev.					
Subproject #b4										
2ND GEN. PILOT PLANT										
Operating expenses							1.2	0.4	0.4	3.0
Capital equipment								0.9	0.9	6.2
Computers										
Other equipment										
Plant construction							1.0	3.3	3.3	3.3
Pass-through funding										
Joint funding										
SUBTOTAL							2.2	4.6	4.6	12.5 FY84
Subproject #b5										
DEMONSTRATION PLANT										
Operating expenses								0.8	4.2	10
Capital equipment										20-60
Computers										
Other equipment										
Plant construction										30-60
Pass-through funding										
Joint funding										
SUBTOTAL								0.8	4.2	60-120 FY86 ⁽¹⁾
Subproject #6										
PROJECT MANAGEMENT & ENG. SUPPORT (Sandia Albuquerque)										
Operating expenses			0.5		0.1	1.2	1.8	2.5	3.3	3.3 5.6
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL			0.5		0.1	1.2	1.8	2.5	3.3	3.3 5.6 FY86

Guidance on Pass-Through and Joint Funding:

(1) Not included in run-out totals.

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-3 SOLAR TOTAL ENERGY SYSTEMS

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	<u>FY75</u>	<u>Cong. Rev.</u>	<u>Cong.</u>	<u>Rev.</u>						
PROJECT TOTAL										
Operating expenses		5.9		1.3	12.0	15.4	18.2	20.1	19.4	11-13
Capital equipment					0.5	2.0	3.3	9.1	12.7	24-27
Computers										
Other equipment										
Plant construction					2.8	4.4	9.8	14.6	13.9	25-60
Pass-through funding										
Joint funding										
TOTAL		5.9		1.3	15.3	21.8	31.3	43.8	46.0	60-100 FY86

Operating expenses										
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL										

Operating expenses										
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL										

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT

PROGRAM ELEMENT SUMMARY SHEET

Sub-Program Unit: Solar Thermal

Program Element Index Number and Title: V-A-4 Distributed Collector Power Plant

Program Element Objectives: To develop and demonstrate commercial viability of system to provide widespread production of supplemental electric power and stimulate electric utilities to build plants for load following or intermediate load electric power requirements.

Program Element Justification: In order to benefit from collector efficiency improvement studies planned and in progress, evaluation of power generation capability is required. This system may offer a viable alternative to central receiver system (V-A-1)

Program Element Strategy: The collector developments and other components will be tested at the solar thermal test facility (V-A-2). After evaluation of results, a 10MWe pilot plant will be constructed.

Description of Task and Approach: The collectors and other components will be thoroughly tested and economic evaluations made to verify viability of concept. After evaluation of results, a 10MWe pilot plant will be constructed. A second generation plant will be designed and constructed to employ new or alternate concepts. Success of these plants is expected to result in a 100MWe demonstration plant being completed by 1987 with utilities involved in this effort.

Major Results and Key Decision Dates:

Decision to build bench model	In Work	Operational 1977
Decision to build 10MWe pilot plant	1977	Operational 1982
Decision to build 100MWe demonstration plants	1982	Operational 1987

Program Element Funding (1977 dollars):

	Est. FY75	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
		Cong.	Rev.	Cong.	Rev.						
Operating Expenses	0.1					5.5	5.8	9.6	8.0	9.0	14.0
Capital Equipment							1.9	9.0	7.0	12.6	3.0
Computers											
Other Equipment											
Plant Construction							6.0	4.0	10.0	6.6	2.0
Pass-Through Funding											
Joint Funding											160.0*
TOTAL	0.1					5.5	13.7	22.6	25.0	28.2	19.0

*Anticipated Industrial Involvement in demonstration plants (Not included in total).

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT
PROGRAM ELEMENT SUMMARY SHEET

Subprogram: Solar Thermal- V- A

Project Number: V-A-4

Project Title: Distributed Collector Power Plant

Project Objectives: To provide a full system capability for the widespread production of supplementary electric power in the 1980's to meet electric utility requirements for load-following or intermediate load electric power generating systems economically in support of the overall national energy program.

Project Justification: Although initial analysis indicates that the central receiver concept (V-A-1) promises to provide the greatest efficiency for conversion of solar energy into electric power, it is essential to consider and analyze the alternate concept of distributed collector power plants. A great deal of technology has been generated for heating and cooling systems employing distributed collectors which should be evaluated further for potential adaptation to electric power generation systems. It is essential to demonstrate collector efficiency increases from about 60% to near 90% for continuing project justification.

Project Strategy: The major hardware evaluation and application development will be funded by ERDA through contracts to industry with increasing support anticipated from the power utilities as the project feasibility is developed and established. The program management will rest in ERDA with program planning mission and system analysis support from The Aerospace Corporation (an FCRC). The day by day project direction will be designated by ERDA after suitable collector efficiencies have been established.

Description of Task and Approach: Earlier mission and system analysis by The Aerospace Corporation indicated that the distributed collector efficiencies were too low compared to the central receiver collector concept to be economically or technically competitive. The first phase will include a re-evaluation and component testing of existing collector systems to determine the probability of increasing the collector efficiencies and improving the quality of thermal conversion to acceptable values. This effort will also include preliminary designs for a 10 MWe pilot plant which will include estimates for the cost of generating electric power. Further effort must be based on the positive results from the above efforts. Assuming positive results, detail designs and construction of the 10 MWe pilot plant will be initiated. It is anticipated that a second generation pilot plant will be designed and constructed to employ new or alternate concepts. These pilot plants are expected to be operational in 1980 and 1982, respectively. The performance and economic viability of these pilot plants will be projected to a larger demonstration plant. The close participation of the power utilities in the pilot plant development and operations will contribute to the design and construction of a 100 MWe demonstration plant.

Major Results and Key Decision Dates: The mission and system analysis, together with selected component testing and evaluation, is required in late 1977 or early 1978 to establish collector efficiency increases sufficient to justify project continuation. Pilot plant operational evaluation in 1981 is required to justify the design and construction of the demonstration plant.

Task Funding (1977 dollars): V-A-4 DISTRIBUTED COLLECTOR POWER PLANT

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong.	Rev.	Cong.	Rev.					
Subproject #1										
COMPONENT TESTS										
Operating expenses						2.4	3.6	4.2	2.8	1.7
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL						2.4	3.6	4.2	2.8	1.7
Subproject #2										
PILOT PLANT										
Operating expenses						2.6	1.0	1.3	2.0	2.4 7.6
Capital equipment							1.9	9.0	5.0	5.0 --
Computers										
Other equipment										
Plant construction							6.0	4.0	4.0	1.0 --
Pass-through funding										
Joint funding										
SUBTOTAL						2.6	8.9	14.3	11.0	8.4 7.6 FY85
Subproject #3										
2ND GEN. PILOT PLANT										
Operating expenses								2.1	1.0	1.0 4.3
Capital equipment									2.0	7.6 3.0
Computers										
Other equipment										
Plant construction									6.0	5.6 2.0
Pass-through funding										
Joint funding										
SUBTOTAL								2.1	8.4	14.2 9.3 FY85

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-4 DISTRIBUTED COLLECTOR POWER PLANT

(Continued)

	FY 1976		Transition		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong. Rev.	Cong.	Rev.						

Subproject #4

DEMONSTRATION PLANT

Operating expenses										1.7
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL										1.7 90-160 FY85 ⁽¹⁾

Subproject #5

PROJECT MANAGEMENT & ENGINEERING SUPPORT (ERDA Lab)

Operating expenses				0.5	1.2	2.0	2.2	2.2	1.7
Capital equipment									
Computers									
Other equipment									
Plant construction									
Pass-through funding									
Joint funding									
SUBTOTAL				0.5	1.2	2.0	2.2	2.2	1.7

PROJECT TOTAL

Operating expenses				5.5	5.8	9.6	8.0	9.0	14.0
Capital equipment					1.9	9.0	7.0	12.6	3.0
Computers									
Other equipment									
Plant construction					6.0	4.0	10.0	6.6	2.0
Pass-through funding									
Joint funding									
TOTAL				5.5	13.7	22.6	25.0	28.2	19.0 FY85

Guidance on Pass-Through and Joint Funding:

(1) Not included in Run-out Totals

Fire, Safety, and Other Requirements:

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT
PROGRAM ELEMENT SUMMARY SHEET

Sub-Program Unit: Solar Thermal

Program Element Index Number and Title: V-A-5 Hybrid Solar Thermal Systems

Program Element Objective: To maximize utilization of complementary solar thermal systems in conjunction with fossil fuel and other energy systems.

Program Element Justification: Utilization of solar thermal energy developments with other energy systems will result in fossil fuel usage reduction and capitalization of hardware development efforts of solar thermal projects.

Program Element Strategy: Determine possible hybrid systems and select viable economic/energy conserving systems for pilot plant testing.

Description of Task and Approach: Mission analysis to identify potentially efficient hybrid systems and to identify market potential and demand. Component testing and development of three promising systems. Encourage commercial application through pilot plant operation.

Major Results and Key Decision Dates:

Decision on component hardware	1976
Test Facility complete and component testing begin	1977
Decision to build initial pilot plant	1978
Initial pilot plant in operation	1981
Third pilot plant in operation	1983

Program Element Funding (1977 dollars):

	Est. FY75	FY 1976 Cong	Rev	Transition Period Cong	Rev	FY77	FY78	FY79	FY80	FY81	Through Completion
Operating Expenses						1.9	4.1	6.3	9.2	10.8	28.0
Capital Equipment								3.0	11.0	19.0	27.0
Computers											
Other Equipment											
Plant Construction								4.0	8.0	12.0	17.0
Pass-Through Funding											
Joint Funding											
TOTAL						1.9	4.1	13.3	28.2	41.8	72.0

PROJECT SUMMARY SHEET

Program Element Index Number and Title: Solar Thermal

Project Index Number and Title: V-A-5 Hybrid Solar Thermal System

Project Objective: To utilize some of the solar thermal systems to complement energy progress. Both solar and other new energy developments as well as conventional fossil fuel systems.

Project Justification: To capitalize on the solar thermal energy developments so as to maximize the rapid development and implementation of plants minimizing the use of fossil fuels.

Project Strategy: Review the possible solar thermal hybrid systems (i. e. fossil, fuel, geothermal, photovoltaic, etc.). Identify promising efficient combinations. Conduct component research and pilot plant tests.

Description of Task and Approach: Hybrid mission analysis to identify potentially efficient hybrid systems, identify potential margin and demand. Conduct component test and pilot plant development for the three most promising.

Major Results and Key Decision and Dates:

- Oct. 76 - component hardware contracts initiated.
- Oct. 77- Test facility complete, component tests start.
- Oct. 77- Starts design of first pilot plant.
- Oct. 78- Start construction of first pilot plant.
- Oct. 79- Start construction of second pilot plant.
- Oct. 80- Start construction of third pilot plant
- Oct. 81- first hybrid plant in operation. (pilot plant)
- Oct. 82- second hybrid plant in operation. (pilot plant)
- Oct. 83- Third hybrid pilot plant in operation

Task Funding (1977 dollars):

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong: Rev.	Cong.	Rev.						
Operating expenses					1.9	4.1	6.3	9.2	10.8	28.0
Capital equipment							3.0	11.0	19.0	27.0
Computers ⁽¹⁾										
Other equipment										
Plant construction ⁽²⁾							4.0	8.0	12.0	17.0
Pass-through funding ⁽³⁾										
Joint funding ⁽⁴⁾										
TOTAL					1.9	4.1	13.3	28.2	41.8	72.0 FY86

Fire, Safety, and Other Requirements:

Prerequisite Project Index Number(s) and Title(s):

- (1) Include a listing of major computers (\$500,000 or over) and associate costs by year
- (2) Include a listing of projects with total estimated costs of \$5 million or more and associated costs by year
- (3) Include listing of pass-through funding from other agencies by agency and year
- (4) Include listing of joint funding from industry by industry and year

Task Funding (1977 dollars): V-A-5 HYBRID SOLAR THERMAL SYSTEMS

		FY 1976	Transition							Through
	FY75	Cong. Rev.	Period	Cong. Rev.	FY77	FY78	FY79	FY80	FY81	Completion
Subproject #1										
COMPONENT TESTING										
Operating expenses					1.7	2.4	2.4	2.4	2.4	
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL					1.7	2.4	2.4	2.4	2.4	
Subproject #2										
#1 SYSTEM PILOT PLANT										
Operating expenses						1.3	1.4	1.6	1.7	7.2
Capital equipment							3.0	8.0	8.0	1.0
Computers										
Other equipment										
Plant construction							4.0	4.0	4.0	1.0
Pass-through funding										
Joint funding										
SUBTOTAL						1.3	8.4	13.6	13.7	9.2 FY85
Subproject #3										
#2 SYSTEM PILOT PLANT										
Operating expenses						1.3	1.4	1.7		6.8
Capital equipment							3.0	8.0		9.0
Computers										
Other equipment										
Plant construction								4.0	4.0	6.0
Pass-through funding										
Joint funding										
SUBTOTAL							1.3	8.4	13.7	21.8 FY86

Guidance on Pass-Through and Joint Funding:

Fire, Safety, and Other Requirements:

Task Funding (1977 dollars): V-A-5 HYBRID SOLAR THERMAL SYSTEMS (Continued)

		FY 1976	Transition						Through	
	FY75	Cong. Rev.	Period	Cong. Rev.	FY77	FY78	FY79	FY80	FY81	Completion
Subproject #4										
#3 SYSTEM PILOT PLANT										
Operating expenses								1.3	1.4	7.4
Capital equipment									3.0	17.0
Computers										
Other equipment										
Plant construction									4.0	10.0
Pass-through funding										
Joint funding										
SUBTOTAL								1.3	8.4	34.4 FY87
Subproject #5										
PROJECT MANAGEMENT & ENGINEERING SUPPORT										
Operating expenses					0.2	0.4	1.2	2.5	3.6	6.5
Capital equipment										
Computers										
Other equipment										
Plant construction										
Pass-through funding										
Joint funding										
SUBTOTAL					0.2	0.4	1.2	2.5	3.6	6.5 FY87
PROJECT TOTAL										
Operating expenses					1.9	4.1	6.3	9.2	10.8	28.0
Capital equipment							3.0	11.0	19.0	27.0
Computers										
Other equipment										
Plant construction							4.0	8.0	12.0	17.0
Pass-through funding										
Joint funding										
TOTAL					1.9	4.1	13.3	28.2	41.8	72.0 FY86

Guidance on Pass-Through and Joint Funding:

re, Safety, and Other Requirements:

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT

PROGRAM ELEMENT SUMMARY SHEET

Sub-Program Unit: Solar Thermal

Program Element Index Number and Title: V-A-6 Research and Development

Program Element Objective: To provide the R&D efforts required to improve the systems technical performance over the development years and R&D efforts required to reduce system cost and to develop and encourage adoption of required mass production techniques for system and components.

Program Element Justification: Electric utilities will not adopt the use of solar thermal power conversion plants until demonstration that electrical power can be provided at competitive rates. Continued performance improvements are required to meet that objective.

Program Element Strategy: The research and development effort will address areas identified by the mission/system analysis studies (V-A-7) that offer the greatest potential benefit to the program and to the various projects. As technical breakthroughs are made, new mission analysis studies will again establish R&D priorities.

Description of Task and Approach: R&D efforts will be assigned to increasing the performance and reducing costs of Central Receiver Power Plants. It will also include surface coatings, high temperature materials, testing of various types of distributed collectors, examination of Brayton Cycle Systems, etc.

Major Results and Key Decision and Dates: There are no major results or key decision dates. However, it appears that if the distributed collector electrical power plant is to be a contender with the central receiver power plants an increase in collection efficiency of about twenty percent will be required. Other areas will be identified as the analysis progresses

Program Element Funding (1977 dollars):

	Est. FY75	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
		Cong	Rev	Cong	Rev						
Operating Expenses	1.9		6.0		1.5	10.0	15.0	15.0	15.0	10.0	40.0
Capital Equipment											
Computers											
Other Equipment											
Plant Construction											
Pass-Through Funding											
Joint Funding											
TOTAL	1.9		6.0		1.5	10.0	15.0	15.0	15.0	10.0	40.0

PROJECT SUMMARY SHEET

Program Element Index Number and Title: Solar Thermal

Project Index Number and Title: V-A-6 Research and Technology

Project Objective: To provide the substantial R&T efforts to improve the systems technical performance over the development years and any additional R&D efforts required to reduce system cost and to develop and encourage adoption of the required mass production techniques.

Project Justification: Electric utilities will not adopt the use of solar thermal power conversion plants until demonstration that electrical power can be provided at competitive rates, continued performance improvements are required to meet that objective. Research and technology effort will be directed at those areas with greatest payoff.

Project Strategy: The research and technology effort will address those areas identified by the mission/system analysis studies (V-A-7) that offer the greatest potential benefit to the program and to the various projects. As tentative break-throughs are made new mission analysis studies will again establish R&D priorities.

Description of Task and Approach: R&D efforts will be assigned to increase the performance and reduce costs of central receiver power plants. It will also include surface coating, high temperature material, testing of various types of distributed collectors, examination of Brayton cycle systems, etc.

Major Results and Key Decision and Dates: There are no major results of key decision dates. However, it appears that if the distributed collector electrical power plant is to be a contender with the central receiver power plants, an increase in collection efficiency of about twenty percent will be required for the distributed collector. Other areas will be highlighted for R&D as the analysis progresses.

Task Funding (1977 dollars):

	FY 1976		Transition Period		FY77	FY78	FY79	FY80	FY81	Through Completion
	FY75	Cong. Rev.	Cong.	Rev.						
Operating Expenses		6.0		1.5	10	15	15	15	10	40 FY 85
Capital Equipment										
Computers ⁽¹⁾										
Other Equipment										
Plant Construction ⁽²⁾										
Pass-Through Funding ⁽³⁾										
Joint Funding ⁽⁴⁾										
TOTAL		6.0		1.5	10	15	15	15	10	40 FY 85

Fire, Safety, and Other Requirements:

Prerequisite Project Index Number(s) and Title(s):

- (1) Include a listing of major computers (\$500,000 or over) and associate costs by year
- (2) Include a listing of projects with total estimated costs of \$5 million or more and associated costs by year
- (3) Include listing of pass-through funding from other agencies by agency and year
- (4) Include listing of joint funding from industry by industry and year

SOLAR ELECTRIC APPLICATIONS PROGRAM UNIT
PROGRAM ELEMENT SUMMARY SHEET

Sub-Program Unit: Solar Thermal

Program Element Index Number and Title: V-A-7, Program Support

Program Element Objectives: To provide the mission system analysis and program management support to coordinate planning and to maintain perspectives of projects to the total program.

Program Element Justification: The thermal program comprises a major part of the national solar energy program and must be continuously reviewed and modified where necessary.

Program Element Strategy: Continuously maintain up to date technical data, schedule, cost and performance parameters from industrial contractors participating in the program. Utilize this information to update the system/mission analysis thus identifying changes to be made internal to each project. Reestablish priorities among various program projects to obtain the overall solar thermal program objectives.

Description of Task and Approach: Timely review of contractors and projects technical and schedule performance, preparation and maintaining a coordinated program plan, preparation of overall project program test plan, test facilities plan, site selection criteria, environmental impact criteria and plan, test facility and pilot plant climatic measurement plan and research.

Major Results and Key Decision and Dates: This element continues through completion of projects - FY 1985.

Program Element Funding (1977 dollars):

	Est. FY75	FY 1976 Cong	Rev	Transition Period Cong	Rev	FY77	FY78	FY79	FY80	FY81	Through Completion
Operating Expenses	0.6	1.95	1.2	0.5	0.4	1.9	1.9	1.9	1.9	1.9	7.6
Capital Equipment											
Computers											
Other Equipment											
Plant Construction											
Pass-Through Funding											
Joint Funding											
TOTAL	0.6		1.2		0.4	1.9	1.9	1.9	1.9	1.9	7.6

PROJECT SUMMARY SHEET

Program Element Index Number and Title: Solar Thermal

Project Index Number and Title: V-A-7 Program Support

Project Objective: To provide the mission system analysis and program management support for the Solar Thermal Program that is required to provide the coordinated planning and maintain the proper perspective of project to the total program so that each individual effect is consistent with and contributes to the technical and schedule requirements of the total solar thermal program.

Project Justification: The Solar Thermal Program comprises a major part of the National Solar Energy Program which must be continuously reviewed and modified where necessary. Modifications are typically required to reflect technical achievements and uncertainties which arise within each project from within the program or from other technical program changes in the budgets available, program funding priorities, changing goals, or schedule changes occurring within individual program projects.

Project Strategy: To continuously obtain the most up to date technical data schedule, cost and performance parameters from the many industry contractors participating in the program to utilize this information to update the system/mission analysis, thus identifying changes to be made internal to each project and also to reestablish priorities among the various program projects to best obtain the overall solar thermal program objectives.

Description of Task and Approach: Timely review of contractors and projects technical and schedule performance, preparation and maintenance of a coordinated program plan, selection criteria, environmental impact criteria and plan, test facility and pilot plant climatic measurement plan and research.

Major Results and Key Decision and Dates: The major result and key decision dates have been identified in projects V-A-1, V-A-2, V-A-3, V-A-4 and V-A-5.

Task Funding (1977 dollars):

	FY 1976		Transition Period								Through Completion
	FY75	Cong.	Rev.	Cong.	Rev.	FY77	FY78	FY79	FY80	FY81	
Operating Expenses	0.6	1.95	1.2	0.5	0.4	1.9	1.9	1.9	1.9	1.9	7.6 FY 85
Capital Equipment											
Computers ⁽¹⁾											
Other Equipment											
Plant Construction ⁽²⁾											
Pass-Through Funding ⁽³⁾											
Joint Funding ⁽⁴⁾											
TOTAL	0.6	1.95	1.2	0.5	0.4	1.9	1.9	1.9	1.9	1.9	7.6 FY 85

Fire, Safety, and Other Requirements:

Prerequisite Project Index Number(s) and Title(s):

- (1) Include a listing of major computers (\$500,000 or over) and associate costs by year
- (2) Include a listing of projects with total estimated costs of \$5 million or more and associated costs by year
- (3) Include listing of pass-through funding from other agencies by agency and year
- (4) Include listing of joint funding from industry by industry and year

SECTION 3.0 ALTERNATIVE FUNDING PLANS, ANNUAL THRU FY 1981

Section 3.0 consists of two alternative budgeting plans. Each budget plan is presented at two levels of funding below that of the basic plan for FY 1976 presented in Section 2.0. Each of these plans provides that the program will be "back on schedule" by 1978 to 1979 (as nearly as possible) by increased funding for 1977, 1978, and 1979 to attempt to maintain overall program schedules and objectives. Alternative Plan #1 assumes the priority objectives of the Central Receiver Project, including its Test Facility, and allocates the FY 1976 funding levels of \$20.9M in Table II and \$13.2M in Table III reflecting this priority status of the Central Receiver Project. Alternative Plan #2 assumes the same funding priority allocations as the Basic Plan, i. e., \$29.5M, so that each of the several projects shares in the funding levels of \$20.9M in Table IV and \$13.2M in Table V in the same proportions as for the Basic Plan funding of \$29.5M.

Alternative Plan #1 is recommended for use in the event of actual budget funding less than the \$29.5M (i. e., additional funding to the Central Receiver Project, if available). Alternative Plan #2 is included for comparison purposes only.

Alternative Plan #1
FY 1976 \$20.9M

Table II
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Millions of \$)							
		75	76	Trans.	77	78	79	80	81
1. Central Receiver Power Plant									
Component Testing			6.0	1.5	3.5	3.9	2.5	2.5	2.0
Pilot Plant (10 MWe)			1.8	0.4	8.9	18.3	14.6	3.4	1.7
2nd Gen. Pilot Plant					1.3	8.4	14.6	14.6	3.4
Demonstration Plant (50-100 MWe)							0.8	5.2	14.7
2nd Gen. Demonstration Plant (100 MWe)								1.7	4.2
Commercial Plant (100-300 MWe)									
Adv. Comm. Plant (100-300 MWe)									
Proj. Management & Eng. Support			0.8	0.2	1.3	2.8	3.2	2.5	2.2
2. Solar Thermal Test Facilities									
Central Receiver Facility			4.5	1.2	19.6	5.4	3.5	2.7	2.7
Distributed Collector Facility			0.1		12.5	4.6	3.5	2.7	2.7
Proj. Management & Eng. Support			0.5	0.1	3.0	1.0	0.7	0.5	0.5
3. Solar Total Energy Systems									
#1 System (Military/Institutional)									
Component Testing			1.7	0.4	2.4	2.6	2.3	1.7	1.7
Bench Model			0.7	0.1	2.5	3.1	2.9	2.5	2.5
Pilot Plant #1 (200 KWe, 2 MWth)			0.3	0.1	2.2	2.9	5.3	8.0	1.7
2nd Gen. Pilot Plant						1.5	4.4	6.5	6.1
Demonstration Plant (5-10 MWe, 100-200 MWth)							0.8	2.4	14.2
#2 System (Industrial/Residential)									
Component Testing					3.4	4.2	2.9	2.5	2.5
Bench Model					1.8	4.0	3.8	3.8	
Pilot Plant #2 (200 KWe, 2 MWth)					3.4	3.4	4.2	7.7	5.2
2nd Gen. Pilot Plant							2.2	4.6	4.6
Demonstration Plant (5-10 MWe, 50 MWth)								0.8	4.2
Proj. Management & Eng. Support			0.3	0.1	1.5	2.0	2.5	3.3	3.3

1.7 thru 1982
3.4 thru 1983
80-150 thru 1985
90-160 thru 1986
130-390 thru 1988**
130-390 thru 1989**
14.0 thru 1986
8.4 thru 1985
8.4 thru 1985
1.7 thru 1985
1.7 thru 1982
3.4 thru 1983
40-80 thru 1986**
1.7 thru 1982
12.5 thru 1985
60-120 thru 1988**
5.6 thru 1986

Table II
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Millions of \$)								
		75	76	Trans.	77	78	79	80	81	
4. Distributed Collector Power Plant										
Component Testing					2.4	3.6	4.2	3.4	1.7	
Pilot Plant (10 MWe)					2.6	8.9	14.3	11.0	8.4	7.6 thru 1985
2nd Gen. Pilot Plant							2.1	8.4	14.2	9.3 thru 1985
Demonstration Plant									1.7	90-160 thru 1986**
Proj. Management & Eng. Support					0.5	1.2	2.0	2.2	2.2	1.7 thru 1985
5. Hybrid Solar Thermal Systems										
Component Testing					1.7	2.4	2.4	2.4	2.4	
#1 System Pilot Plant						1.3	8.4	13.6	13.7	9.2 thru 1985**
#2 System Pilot Plant							1.3	8.4	13.7	21.8 thru 1986**
#3 System Pilot Plant								1.3	8.4	34.4 thru 1987**
Proj. Management & Eng. Support					0.2	0.4	1.2	2.5	3.6	6.5 thru 1987**
6. Research and Development			3.0	0.8	12.0	15.0	15.0	15.0	10.0	40 thru 1985
7. Program Support/Mission Analysis										
Management Support			0.7	0.2	1.2	1.2	1.2	1.2	1.2	4.8 thru 1985
Mission Analysis			0.5	0.1	0.7	0.7	0.7	0.7	0.7	2.8 thru 1985
TOTALS			20.9	5.2	88.6	102.8	127.5	149.7	162.0	

** UTILITIES PARTICIPATION

Assumes 50% funding by Utilities for demonstration plants and 100% funding by utilities for commercial plants with low interest government loans for first generation commercial plants.

Alternative Plan #1
FY 1976 \$13.2M

Table III
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Millions of \$)							
		75	76	Trans.	77	78	79	80	81
1. Central Receiver Power Plant									
Component Testing			3.6	0.9	5.0	5.4	2.5	2.5	2.0
Pilot Plant (10 MWe)			1.2	0.3	9.3	18.6	14.6	3.4	1.7
2nd Gen. Pilot Plant					1.3	8.4	14.6	14.6	3.4
Demonstration Plant (50-100 MWe)							0.8	5.2	14.7
2nd Gen. Demonstration Plant (100 MWe)								1.7	4.2
Commercial Plant (100-300 MWe)									
Adv. Comm. Plant (100-300 MWe)									
Proj. Management & Eng. Support			0.4	0.1	1.6	3.2	3.2	2.5	2.2
2. Solar Thermal Test Facilities									
Central Receiver Facility			3.1	0.8	20.5	6.3	3.5	2.7	2.7
Distributed Collector Facility					12.6	4.6	3.5	2.7	2.7
Proj. Management & Eng. Support			0.3	0.1	3.2	1.1	0.7	0.5	0.5
3. Solar Total Energy Systems									
#1 System (Military/Institutional)									
Component Testing			1.2	0.3	2.7	2.9	2.3	1.7	1.7
Bench Model			0.3	0.1	2.7	3.3	2.9	2.5	2.5
Pilot Plant #1 (200 KWe, 2 MWth)					2.4	3.1	5.3	8.0	1.7
2nd Gen. Pilot Plant						1.5	4.4	6.5	6.1
Demonstration Plant (5-10 MWe, 100-200 MWth)							0.8	2.4	14.2
#2 System (Industrial/Residential)									
Component Testing					3.4	4.2	2.9	2.5	2.5
Bench Model					1.8	4.0	3.8	3.8	
Pilot Plant #2 (200 KWe, 2 MWth)					3.4	3.4	4.2	7.7	5.2
2nd Gen. Pilot Plant							2.2	4.6	4.6
Demonstration Plant (5-10 MWe, 50 MWth)								0.8	4.2
Proj. Management & Eng. Support			0.2	0.1	1.6	2.1	2.5	3.3	3.3

1.7 thru 1982
3.4 thru 1983
80-150 thru 1985
90-160 thru 1986**
130-390 thru 1988**
130-390 thru 1989**
14.0 thru 1986
8.4 thru 1985
8.4 thru 1985
1.7 thru 1985
1.7 thru 1982
3.4 thru 1983
40-80 thru 1986**
1.7 thru 1982
12.5 thru 1985
60-120 thru 1988**
5.6 thru 1986

Alternative Plan #1
FY 1976 \$13.2M (Continued)

Table III
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Millions of \$)								
		75	76	Trans.	77	78	79	80	81	
4. Distributed Collector Power Plant										
Component Testing					2.4	3.6	4.2	3.4	1.7	
Pilot Plant (10 MWe)					2.6	8.9	14.3	11.0	8.4	7.6 thru 1985
2nd Gen. Pilot Plant							2.1	8.4	14.2	9.3 thru 1985
Demonstration Plant									1.7	90-160 thru 1986**
Proj. Management & Eng. Support					0.5	1.2	2.0	2.2	2.2	1.7 thru 1985
5. Hybrid Solar Thermal Systems										
Component Testing					1.7	2.4	2.4	2.4	2.4	
#1 System Pilot Plant						1.3	8.4	13.6	13.7	9.2 thru 1985**
#2 System Pilot Plant							1.3	8.4	13.7	21.8 thru 1986**
#3 System Pilot Plant								1.3	8.4	34.4 thru 1987**
Proj. Management & Eng. Support					0.2	0.4	1.2	2.5	3.6	6.5 thru 1987**
6. Research and Development			2.0	0.5	13.0	15.0	15.0	15.0	10.0	40 thru 1985
7. Program Support/Mission Analysis										
Management Support			0.5	0.1	1.2	1.2	1.2	1.2	1.2	4.8 thru 1985
Mission Analysis			0.4	0.1	0.7	0.7	0.7	0.7	0.7	2.8 thru 1985
TOTALS			13.2	3.3	93.8	106.8	127.5	149.7	162.0	

** UTILITIES PARTICIPATION

Assumes 50% funding by Utilities for demonstration plants and 100% funding by utilities for commercial plants with low interest government loans for first generation commercial plants.

Alternative Plan #2
FY 1976 \$20.9M

Table IV
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Millions of \$)							
		75	76	Trans.	77	78	79	80	81
1. Central Receiver Power Plant									
Component Testing			4.3	1.0	4.5	5.1	2.5	2.5	2.0
Pilot Plant (10 MWe)			1.3	0.3	9.2	18.6	14.6	3.4	1.7
2nd Gen. Pilot Plant					1.3	8.4	14.6	14.6	3.4
Demonstration Plant (50-100 MWe)							0.8	5.2	14.7
2nd Gen. Demonstration Plant (100 MWe)								1.7	4.2
Commercial Plant (100-300 MWe)									
Adv. Comm. Plant (100-300 MWe)									
Proj. Management & Eng. Support			0.6	0.2	1.5	3.2	3.2	2.5	2.2
2. Solar Thermal Test Facilities									
Central Receiver Facility			4.5	1.2	19.6	5.4	3.5	2.7	2.7
Distributed Collector Facility			0.1		12.5	4.6	3.5	2.7	2.7
Proj. Management & Eng. Support			0.5	0.1	3.0	1.0	0.7	0.5	0.5
3. Solar Total Energy Systems									
#1 System (Military/Institutional)									
Component Testing			1.7	0.4	2.4	2.6	2.3	1.7	1.7
Bench Model			0.7	0.1	2.5	3.1	2.9	2.5	2.5
Pilot Plant #1 (200 KWe, 2 MWth)			0.3	0.1	2.2	2.9	5.3	8.0	1.7
2nd Gen. Pilot Plant						1.5	4.4	6.5	6.1
Demonstration Plant (5-10 MWe, 100-200 MWth)							0.8	2.4	14.2
#2 System (Industrial/Residential)									
Component Testing			0.8	0.2	3.0	3.6	2.9	2.5	2.5
Bench Model			0.4	0.1	1.6	3.7	3.8	3.8	
Pilot Plant #2 (200 KWe, 2 MWth)			0.2	0.1	3.2	3.3	4.2	7.7	5.2
2nd Gen. Pilot Plant							2.2	4.6	4.6
Demonstration Plant (5-10 MWe, 50 MWth)								0.8	4.2
Proj. Management & Eng. Support			0.5	0.1	1.5	1.9	2.5	3.3	3.3

1.7 thru 1982
3.4 thru 1983
80-150 thru 1985**
90-160 thru 1986**

130-390 thru 1988**
130-390 thru 1989**
14 thru 1986

8.4 thru 1985
8.4 thru 1985
1.7 thru 1985

1.7 thru 1982
3.4 thru 1983
40-80 thru 1986**

1.7 thru 1982
12.5 thru 1985
60-120 thru 1988**

5.6 thru 1986

Alternative Plan #2
FY 1976 \$20.9M (Continued)

Table IV
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Missions of \$)							
		75	76	Trans.	77	78	79	80	81
4. Distributed Collector Power Plant									
Component Testing					2.4	3.6	4.2	3.4	1.7
Pilot Plant (10 MWe)					2.6	8.9	14.3	11.0	8.4
2nd Gen. Pilot Plant							2.1	8.4	14.2
Demonstration Plant									1.7
Proj. Management & Eng. Support					0.5	1.2	2.0	2.2	2.2
5. Hybrid Solar Thermal Systems									
Component Testing					1.7	2.4	2.4	2.4	2.4
#1 System Pilot Plant						1.3	8.4	13.6	13.7
#2 System Pilot Plant							1.3	8.4	13.7
#3 System Pilot Plant								1.3	8.4
Proj. Management & Eng. Support					0.2	0.4	1.2	2.5	3.6
6. Research and Development			4.0	1.0	12.5	15.0	15.0	15.0	10.0
7. Program Support/Mission Analysis									
Management Support			0.6	0.2	1.2	1.2	1.2	1.2	1.2
Mission Analysis			0.4	0.1	0.7	0.7	0.7	0.7	0.7
TOTALS			20.9	5.2	89.8	101.6	127.5	149.7	162.0

** UTILITIES PARTICIPATION

Assumes 50% funding by Utilities for demonstration plants and 100% funding by utilities for commercial plants with low interest government loans for first generation commercial plants.

Alternative Plan #2
FY 1976 \$13.2M

Table V
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Millions of \$)							
		75	76	Trans.	77	78	79	80	81
1. Central Receiver Power Plant									
Component Testing			2.7	0.7	5.6	5.9	2.5	2.5	2.0
Pilot Plant (10 MWe)			0.8	0.2	10.0	18.4	14.6	3.4	1.7
2nd Gen. Pilot Plant					1.3	8.4	14.6	14.6	3.4
Demonstration Plant (50-100 MWe)							0.8	5.2	14.7
2nd Gen. Demonstration Plant (100 MWe)								1.7	4.2
Commercial Plant (100-300 MWe)									
Adv. Comm. Plant (100-300 MWe)									
Proj. Management & Eng. Support			0.3	0.1	1.7	3.3	3.2	2.5	2.2
2. Solar Thermal Test Facilities									
Central Receiver Facility			3.0	0.7	20.6	6.4	3.5	2.7	2.7
Distributed Collector Facility					12.6	4.6	3.5	2.7	2.7
Proj. Management & Eng. Support			0.3	0.1	3.2	1.1	0.7	0.5	0.5
3. Solar Total Energy Systems									
#1 System (Military/Institutional)									
Component Testing			1.7	0.4	2.4	2.6	2.3	1.7	1.7
Bench Model			0.7	0.1	2.5	3.1	2.9	2.5	2.5
Pilot Plant #1 (200 KWe, 2 MWth)			0.3	0.1	2.2	2.9	5.3	8.0	1.7
2nd Gen. Pilot Plant						1.5	4.4	6.5	6.1
Demonstration Plant (5-10 MWe, 100-200 MWth)							0.8	2.4	14.2
#2 System (Industrial/Residential)									
Component Testing			0.2	0.1	3.3	4.0	2.9	2.5	2.5
Bench Model					1.8	4.0	3.8	3.8	
Pilot Plant #2 (200 KWe, 2 MWth)					3.4	3.4	4.2	7.7	5.2
2nd Gen. Pilot Plant							2.2	4.6	4.6
Demonstration Plant (5-10 MWe, 50 MWth)								0.8	4.2
Proj. Management & Eng. Support			0.3	0.1	1.5	2.0	2.5	3.3	3.3

Alternative Plan #2
FY 1976 \$13.2M (Continued)

Table V
BUDGET SUMMARY
SOLAR THERMAL SUBPROGRAM

Program	FY	Project Funding (Millions of \$)								
		75	76	Trans	77	78	79	80	81	
4. Distributed Collector Power Plant										
Component Testing					2.4	3.6	4.2	3.4	1.7	
Pilot Plant (10 MWe)					2.6	8.9	14.3	11.0	8.4	7.6 thru 1985
2nd Gen. Pilot Plant							2.1	8.4	14.2	9.3 thru 1985
Demonstration Plant									1.7	90-160 thru 1986**
Proj. Management & Eng. Support					0.5	1.2	2.0	2.2	2.2	1.7 thru 1985
5. Hybrid Solar Thermal Systems										
Component Testing					1.7	2.4	2.4	2.4	2.4	
#1 System Pilot Plant						1.3	8.4	13.6	13.7	9.2 thru 1985**
#2 System Pilot Plant							1.3	8.4	13.7	21.8 thru 1986**
#3 System Pilot Plant								1.3	8.4	34.4 thru 1987**
Proj. Management & Eng. Support					0.2	0.4	1.2	2.5	3.6	6.5 thru 1987**
6. Research and Development			2.0	0.5	13.0	15.0	15.0	15.0	10.0	40 thru 1985
7. Program Support/Mission Analysis										
Management Support			0.5	0.1	1.2	1.2	1.2	1.2	1.2	4.8 thru 1985
Mission Analysis			0.4	0.1	0.7	0.7	0.7	0.7	0.7	2.8 thru 1985
TOTALS			13.2	3.3	94.4	106.3	127.5	149.7	162.0	

** UTILITIES PARTICIPATION

Assumes 50% funding by Utilities for demonstration plants and 100% funding by utilities for commercial plants with low interest government loans for first generation commercial plants.

SECTION 4.0 BASIC PROGRAM PLAN,
ANNUAL THRU FY 1985

Section 4.0 consists of the extension of the Basic Plan to show funding detail beyond FY 1981 to include FY 1985. The revised formats used were as requested by Dr. Mock about 21 April 1975 and are included as funding Tables VI, VII, and VIII, and a combined Milestone and Budget Summary, Table IX. The contents of the tables are as follows:

Table VI	"Solar Thermal Subprogram Planning/Funding Requirements"
Table VII	"Solar Thermal Subprogram Element Funding Requirements"
Table VIII	"Solar Thermal Subprogram Operating, Capital Equipment, and Plant Construction Expense Summaries"
Table IX	"Solar Thermal Subprogram Major Results, Key Decision Dates, and Budget Summary"

TABLE VI. SOLAR THERMAL SUBPROGRAM PLANNING/FUNDING REQUIREMENTS

	75	76	Trans. Qtr.	77	78	79	80	81	82	83	84	85
1. Central Receiver Power-plant	5.1	9.6	2.1	15.0	33.4	35.7	29.9	28.2	49.2	67.5	95.8	85.8
2. Test Facilities		6.8	1.8	33.9	9.8	6.5	5.9	5.9	4.7	4.6	4.6	4.6
3. Total Energy System	2.3	5.9	1.3	15.3	21.8	31.3	43.8	46.0	51.4	53.5	57.5	47.5
4. Distributed Collector Power Plant	0.1			5.5	13.7	22.6	25.0	28.2	40.3	51.0	67.8	30.8
5. Hybrid Solar Thermal System				1.9	4.1	13.3	28.2	41.8	33.9	21.9	8.7	5.4
6. Research and Development	1.9	6.0	1.5	10.0	15.0	15.0	15.0	10.0	10.0	10.0	10.0	10.0
7. Program Support	0.6	1.2	0.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Total	10.0	29.5	7.1	83.5	99.7	126.3	149.7	162.0	191.4	210.4	246.3	186.0
Operating Expenses	10.0	28.0	6.1	47.3	56.1	66.2	77.4	75.2	53.4	50.9	48.3	46.0
Capital Equipment		0.7	0.2	11.9	16.5	27.9	32.2	49.3	55.0	48.2	34.0	26.0
Plant Construction		0.8	0.8	24.3	27.1	32.2	40.1	37.5	83.0	111.3	164.0	114.0
Total	10.0	29.5	7.1	83.5	99.7	126.3	149.7	162.0	191.4	210.4	246.3	186.0
Operating Expense Escalation Factor		1.00	1.00	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
Plant Escalation Factor		1.00	1.00	1.22	1.30	1.38	1.47	1.57	1.67	1.67	1.67	1.67

Note: Utilities are encouraged to contribute as much as 50% to demonstration plant development, participation amounting to 200-320 million dollars thru FY 1985. Utilities are expected to provide the commercial plant development which amounts to 260-780 million dollars thru FY 1987 and are not included in the run-out totals.

TABLE VII: Solar Thermal Subprogram
Element Funding Requirements

	75	76	Trans. Qtr.	77	78	79	80	81	82	83	84	85
1. Central Receiver Power Plant												
Component Tests:												
Operating Expenses		7.0	1.5	3.5	2.9	2.5	2.5	2.0				
Pilot Plant:												
Operating Expenses		1.8	0.4	1.0	2.0	2.2	3.4	1.7	1.7			
Capital Equipment				2.9	6.6	5.5						
Plant Construction				5.0	9.7	6.9						
2nd Generation Pilot Plant												
Operating Expenses				1.3	1.4	2.0	2.0	3.4	1.7	1.7		
Capital Equipment					3.0	5.1	5.1					
Plant Construction					5.0	7.5	7.5					
Demonstration Plant (1)												
Operating Expenses						0.8	5.2	4.7	2.0	2.0	2.0	2.0
Capital Equipment								5.0	3.0	3.0	3.0	3.0
Plant Construction								5.0	20.0	30.0	50.0	20.0
Adv. Demonstration Plant (1)												
Operating Expenses							1.7	4.2	2.0	2.0	2.0	2.0
Capital Equipment									6.0	6.0	6.0	6.0
Plant Construction									10.0	20.0	30.0	50.0
Commercial Plant (2)												
Operating Expenses												
Capital Equipment												
Plant Construction												
Adv. Commercial Plant (2)												
Project Management												
Operating Expenses		0.8	0.2	1.3	2.8	3.2	2.5	2.2	2.8	2.8	2.8	2.8
Totals												
Operating Expenses		9.6	2.1	7.1	9.1	10.7	17.3	18.2	10.2	8.5	6.8	6.8
Capital Equipment				2.9	9.6	10.6	5.1	5.0	9.0	9.0	9.0	9.0
Plant Construction				5.0	14.7	14.4	7.5	5.0	30.0	50.0	80.0	70.0
Totals		9.6	2.1	15.0	33.4	35.7	29.9	28.2	49.2	67.5	95.8	85.8

TABLE VI (Cont.)

2. Test Facility	75	76	Trans. Qtr.	77	78	79	80	81	82	83	84	85
Central Receiver												
Operating Expenses		3.0	0.2	3.6	2.4	2.5	2.7	2.7	2.1	2.1	2.1	2.1
Capital Equipment		0.7	0.2	4.0	2.0	1.0						
Plant Construction		0.8	0.8	12.0	1.0							
Distributed Collector												
Operating Expenses		1.7	0.4	2.5	1.6	1.5	2.7	2.7	2.1	2.1	2.1	2.1
Capital Equipment				4.5	1.0	1.0						
Plant Construction				4.5	1.0							
Project Management												
Operating Expenses		0.6	0.2	2.8	0.8	0.5	0.5	0.5	0.5	0.4	0.4	0.4
TOTALS												
Operating Expenses		5.3	0.8	8.9	4.8	4.5	5.9	5.9	4.7	4.6	4.6	4.6
Capital Equipment		0.7	0.2	8.5	3.0	2.0						
Plant Construction		0.8	0.8	16.5	2.0							
TOTALS		6.8	1.8	33.9	9.8	6.5	5.9	5.9	4.7	4.6	4.6	4.6

TABLE VII (Cont.)

		75	76	Trans Qtr.	77	78	79	80	81	82	83	84	85
3. Solar Total Energy Systems													
#1 System Component Testing													
Operating Expenses			1.7	0.4	2.4	2.6	2.3	1.7	1.7				
Bench Model	Operation		0.7	0.1	2.5	3.1	2.9	2.5	2.5				
Pilot Plant #1													
Operating Expenses			0.3	0.1	0.3	0.3	0.7	0.7	0.7	0.5	0.4	0.4	0.4
Capital Equipment					0.5	1.0	1.6	2.5	1.0				
Plant Construction					1.4	1.6	3.0	4.8					
2nd Gen. Pilot Plant													
Operating Expenses						0.5	0.6	1.0	0.5	0.4	0.4	0.3	0.3
Capital Equipment							1.0	2.0	2.0	1.0	1.0		
Plant Construction						1.0	2.8	3.5	3.6				
Demonstration (1)													
Operating Expenses							0.8	2.4	2.6	3.0	3.0	2.0	2.0
Capital Equipment									5.6	5.0	5.0	5.0	5.0
Plant Construction									6.0	8.0	12.0	18.0	12.0
#2 System													
Component Tests	Operation		1.7	0.4	2.4	3.1	2.9	2.5	2.5				
Bench Model	Operation		0.7	0.1	1.4	3.6	3.8	3.8					
Pilot Plant #2													
Operating Expenses			0.3	0.1	1.8	0.4	0.5	1.0	1.0	0.4	0.3		
Capital Equipment						1.0	0.7	3.7	3.2	1.0			
Plant Construction					1.4	1.8	3.0	3.0	1.0				

TABLE VII (Cont.)

3. Solar Total Energy Systems		75	76	Trans. Qtr.	77	78	79	80	81	82	83	84	85
<hr/>													
2nd Gen. Pilot Plant													
Operating Expenses							1.2	0.4	0.4	0.8	0.8	0.7	0.7
Captial Equipment								0.9	0.9	2.0	2.2	2.0	
Plant Construction							1.0	3.3	3.3	2.0	1.3		
Demonstration (1)													
Operating Expenses								0.8	4.2	2.0	2.0	2.0	2.0
Captial Equipment										12.0	12.0	12.0	12.0
Plant Construction										12.0	12.0	12.0	12.0
Project Management Operation			0.5	0.1	1.2	1.8	2.5	3.3	3.3	1.2	1.1	1.1	1.1
<hr/>													
TOTALS													
Operating Expenses			5.9	1.3	12.0	15.4	18.2	20.1	19.4	8.4	8.0	6.5	6.5
Captial Equipment					0.5	2.0	3.3	9.1	12.7	21.0	20.2	19.0	17.0
Plant Construction					2.8	4.4	9.8	14.6	13.9	22.0	25.3	32.0	24.0
<hr/>													
TOTALS			5.9	1.3	15.3	21.8	31.3	43.8	46.0	51.4	53.5	57.5	47.5

TABLE (Cont.)

		75	76	Trans. Qtr.	77	78	79	80	81	82	83	84	85
4. Distributed Collector													
Component Tests Operation					2.4	3.6	4.2	2.8	1.7				
Pilot Plant													
Operating Expenses					2.6	1.0	1.3	2.0	2.4	2.0	2.0	1.8	1.8
Capital Equipment						1.9	9.0	5.0	5.0				
Plant Construction						6.0	4.0	4.0	1.0				
2nd Gen. Pilot Plant													
Operating Expenses							2.1	1.0	1.0	1.3	1.0	1.0	1.0
Capital Equipment								2.0	7.6	3.0			
Plant Construction								6.0	5.6	2.0			
Demonstration (1)													
Operating Expenses									1.7	5.0	5.0	5.0	5.0
Capital Equipment										5.0	10.0	5.0	
Plant Construction										20.0	30.0	50.0	20.0
54	Project Management Operation				0.5	1.2	2.0	2.2	2.2	2.0	3.0	5.0	3.0
TOTALS													
Operating Expenses					5.5	5.8	9.6	8.0	9.0	10.3	11.0	12.8	10.8
Capital Equipment						1.9	9.0	7.0	12.6	8.0	10.0	5.0	
Plant Construction						6.0	4.0	10.0	6.6	22.0	30.0	50.0	20.0
TOTALS					5.5	13.7	22.6	25.0	28.2	40.3	51.0	67.8	30.8

TABLE VII (Cont.)

	<u>75</u>	<u>76</u>	Trans. <u>Qtr.</u>	<u>77</u>	<u>78</u>	<u>79</u>	<u>80</u>	<u>81</u>	<u>82</u>	<u>83</u>	<u>84</u>	<u>85</u>
5. <u>Hybrid Solar Thermal Systems</u>												
Component Testing												
Operating Expenses				1.7	2.4	2.4	2.4	2.4				
#1 System Pilot Plant												
Operating Expenses					1.3	1.4	1.6	1.7	1.8	1.8	1.8	1.8
Capital Equipment						3.0	8.0	8.0	1.0			
Plant Construction						4.0	4.0	4.0	1.0			
#2 System Pilot Plant												
Operating Expenses						1.3	1.4	1.7	1.7	1.7	1.7	1.7
Capital Equipment							3.0	8.0	8.0	1.0		
Plant Construction							4.0	4.0	4.0	2.0		
#3 System Pilot Plant												
Operating Expenses							1.3	1.4	1.4	1.4	1.4	1.4
Capital Equipment								3.0	8.0	8.0	1.0	
Plant Construction								4.0	4.0	4.0	2.0	
Project Management & Eng. Sup.												
Operating Expenses				0.2	0.4	1.2	2.5	3.6	3.0	2.0	0.8	0.5
Totals												
Operating Expenses				1.9	4.1	6.3	9.2	10.8	7.9	6.9	5.7	5.4
Capital Equipment						3.0	11.0	19.0	17.0	9.0	1.0	
Plant Construction						4.0	8.0	12.0	9.0	6.0	2.0	
TOTALS				1.9	4.1	13.3	28.2	41.8	33.9	21.9	8.7	5.4

TABLE VII. Solar Thermal Program Element (Cont.)
Funding Requirements

	<u>75</u>	<u>76</u>	<u>Trans. Qtr.</u>	<u>77</u>	<u>78</u>	<u>79</u>	<u>80</u>	<u>81</u>	<u>82</u>	<u>83</u>	<u>84</u>	<u>85</u>
6. Research and Development												
Component Development		3.0	0.8	5.0	8.0	8.0	8.0	5.0	5.0	5.0	5.0	5.0
Improved Coatings & Materials		0.9	0.2	1.5	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5
Advanced Subsystems, Systems & Concepts		1.2	0.3	2.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0
Institutional, Safety, Siting & Environmental		0.9	0.2	1.5	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5
Total Operating Expenses		6.0	1.5	10.0	15.0	15.0	15.0	10.0	10.0	10.0	10.0	10.0
Total Research and Development		6.0	1.5	10.0	15.0	15.0	15.0	10.0	10.0	10.0	10.0	10.0
7. Program Support												
Operating Expenses	0.6	1.2	0.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9

(1) Utility participation anticipated as much as 50% for demonstration plant development.

(2) Utility development of Commercial plants - funding not included in run-out totals.

TABLE VIII. Solar Thermal Subprogram
Operating, Capital Equipment and Plant Construction
Expense Summaries

	<u>75</u>	<u>76</u>	<u>Trans. Qtr.</u>	<u>77</u>	<u>78</u>	<u>79</u>	<u>80</u>	<u>81</u>	<u>82</u>	<u>83</u>	<u>84</u>	<u>85</u>
<u>Operating Expenses</u>												
1. Central Receiver Power Plant		9.6	2.1	7.1	9.1	10.7	17.3	18.2	10.2	8.5	6.8	6.8
2. Test Facilities		5.3	0.8	8.9	4.8	4.5	5.9	5.9	4.7	4.6	4.6	4.6
3. Total Energy Systems		5.9	1.3	12.0	15.4	18.2	20.1	19.4	8.4	8.0	6.5	6.5
4. Distributed Collector Power Plant				5.5	5.8	9.6	8.0	9.0	10.3	11.0	12.8	10.8
5. Hybrid Solar Thermal System				1.9	4.1	6.3	9.2	10.8	7.9	6.9	5.7	5.4
6. Research and Development		6.0	1.5	10.0	15.0	15.0	15.0	10.0	10.0	10.0	10.0	10.0
7. Program Support		1.2	0.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Totals		28.0	6.1	47.3	56.1	66.2	77.4	75.2	53.4	50.9	48.3	46.0
<u>Capital Equipment Expenses</u>												
1. Central Receiver Power Plant				2.9	9.6	10.6	5.1	5.0	9.0	9.0	9.0	9.0
2. Test Facilities		0.7	0.2	8.5	3.0	2.0						
3. Total Energy Systems				0.5	2.0	3.3	9.1	12.7	21.0	20.2	19.0	17.0
4. Distributed Collector Power Plant					1.9	9.0	7.0	12.6	8.0	10.0	5.0	-
5. Hybrid Solar Thermal Systems						3.0	11.0	19.0	17.0	9.0	1.0	-
Totals		0.7	0.2	11.9	16.5	27.9	32.2	49.3	55.0	48.2	34.0	26.0
<u>Plant Construction Expenses</u>												
1. Central Receiver Power Plant				5.0	14.7	14.4	7.5	5.0	30.0	50.0	80.0	70.0
2. Test Facilities		0.8	0.8	16.5	2.0							
3. Total Energy Systems				2.8	4.4	9.8	14.6	13.9	22.0	25.3	32.0	24.0
4. Distributed Collector					6.0	4.0	10.0	6.6	22.0	30.0	50.0	20.0
5. Hybrid Solar Thermal Systems						4.0	8.0	12.0	9.0	6.0	2.0	-
Totals		0.8	0.8	24.3	27.1	32.2	40.1	37.5	83.0	111.3	164.0	114.0
Subprogram Totals		29.5	7.1	83.5	99.7	126.3	149.7	162.0	191.4	210.4	246.3	186.0

TABLE IX
SOLAR THERMAL SUBPROGRAM
MAJOR RESULTS, KEY DECISION DATES
AND BUDGET SUMMARY

PROGRAM ELEMENT	FY	75	76	Trans.	77	78	79	80	81	82	83	84	85
1. Central Receiver Power Plant													
Component Testing	(1)		7.0	1.5	3.5 (3)	2.9	2.5	2.5	2.0				
Pilot Plant (10 MWe)	(2)		1.8	0.4	8.9	18.3	14.6	3.4	1.7	1.7			
2nd Gen. Pilot Plant					1.3 (5)	8.4	14.6	14.6 4	3.4	1.7	1.7		
Demonstration Plant (50-100 MWe)							0.8 (6)	5.2	14.7	25.0	35.0	55.0	25.0 (8)
2nd Gen. Demonstration Plant (100 MWe)								1.7	4.2 (6)	18.0	28.0	38.0	58.0
Commercial Plant (100 - 300 MWe)										(9)	130 -	390	(a)
Adv. Comm. Plant (100 - 300 MWe)												130-390 (11)	(a)
Project Management & Eng. Sup.			0.8	0.2	1.3	2.8	3.2	2.5	2.2	2.8	2.8	2.8	2.8
2. Solar Thermal Test Facilities													
Central Receiver Facility	(1)		4.5 (3a)	1.2	19.6 (3)	5.4	3.5	2.7	2.7	2.1	2.1	2.1	2.1
Distributed Collector Facility	(1)		1.7	0.4	11.5 (3)	3.6	2.5	2.7	2.7	2.1	2.1	2.1	2.1
Project Management & Eng. Sup.			0.6	0.2	2.8	0.8	0.5	0.5	0.5	0.5	0.4	0.4	0.4

(a) Not included in run-out totals

Funding in Million Dollars

Milestones

(1) Decision to Build Bench Model/Test Facility	(7) Second Generation Plant in Operation
(2) Decision to Build Pilot Plant	(8) Demonstration Plant in Operation
(3) Bench Model/Facility in Operation	(9) Decision to Build Commercial Plant
(3a) Partial Capability	(10) Commercial Plant in Operation FY 1987
▲ Pilot Plant Checked out and Operating	(11) Decision to Build Advance Comm. Plant
(5) Decision to Start Second Generation Pilot Plant	(12) Advance Commercial Plant in Operation FY 1989
(6) Decision to Build Demonstration Plants	

Note: Utilities are encouraged to contribute as much as 50% to demonstration plant development, participation amounting to 200-320 million dollars thru FY 1985. Utilities are expected to provide the commercial plant development which amounts to 260-780 million dollars thru FY 1987 and are not included in the run-out totals.

TABLE IX (Cont.)

PROGRAM ELEMENT	FY	75	76	Trans.	77	78	79	80	81	82	83	84	85
3. <u>Solar Total Energy System</u>													
#1 System (Military/Institutional)													
Component Testing	(1)		1.7	0.4	2.4	2.6	2.3	1.7	1.7				
Bench Model			0.7	0.1	2.5	3.1	2.9	2.5	2.5				
Pilot Plant #1 (200 KWe, 2MWth)	(2)		0.3	0.1	2.2	2.9	5.3	8.0	1.7	0.5	0.4	0.4	0.4
2nd Gen. Pilot Plant						1.5	4.4	6.5	6.1	1.0	1.0		
Demonstration Plant (5-10 MWe, 100-200 Mwth)							0.8	2.4	14.2	16.0	20.0	23.0	17.0
#2 System (Industrial/Residential)													
Component Testing	(1)		1.7	0.4	2.4	3.1	2.9	2.5	2.5				
Bench Model			0.7	0.1	1.4	3.6	3.8	3.8					
Pilot Plant #2 (200 KWe, 2 MWth)	(2)		0.3	0.1	1.8	3.2	4.2	7.7	5.2	1.4	0.3		
2nd Gen. Pilot Plant							2.2	4.6	4.6	4.8	4.3	2.7	0.7
Demonstration Plant (5-10 MWe, 50 MWth)								0.8	4.2	26.0	26.0	26.0	26.0
Project Management & Eng. Sup.			0.5	0.1	1.2	1.8	2.5	3.3	3.3	1.2	1.1	1.1	1.1

Milestones

- (1) Decision to Build Bench Model/Test Facility
 (2) Decision to Build Pilot Plant
 (3) Bench Model/Facility in Operation
 ▲ Pilot Plant Checked out and Operating

- (5) Decision to Start Second Generation Pilot Plant
 (6) Decision to Build Demonstration Plants
 (7) Second Generation Plant in Operation
 (8) Demonstration Plant in Operation

TABLE ... (Cont.)

PROGRAM ELEMENT	FY	75	76	Trans.	77	78	79	80	81	82	83	84	85
4. <u>Distributed Collector Power Plant</u>													
Component Testing		(1)			2.4	(3) 3.6	4.2	2.8	1.7				
Pilot Plant (10 MWe)					2.6	(2) 8.9	14.3	11.0	8.4	△ 2.0	2.0	1.8	1.8
2nd Gen. Pilot Plant							2.1	(5) 9.0	14.2	6.3	(7) 1.0	1.0	1.0
Demonstration Plant									1.7	(6) 30.0	45.0	60.0	25.0
Project Management & Eng. Sup.					0.5	1.2	2.0	2.2	2.2	2.0	3.0	5.0	3.0
5. <u>Hybrid Solar Thermal</u>					1.7	(3) 2.4	2.4	2.4	2.4				
Component Testing													
#1 System Pilot Plant						1.3	(2) 8.4	13.6	13.7	3.8	△ 1.8	1.8	1.8
#2 System Pilot Plant							1.3	(2) 8.4	13.7	13.7	4.7	△ 1.7	1.7
#3 System Pilot Plant								1.3	(2) 8.4	13.4	13.4	4.4	△ 1.4
Project Management & Eng. Sup.					0.2	0.4	1.2	2.5	3.6	3.0	2.0	0.8	0.5
6. <u>Research and Development</u>													
Component Development			3.0	0.8	5.0	8.0	8.0	8.0	5.0	5.0	5.0	5.0	5.0
Improved Coatings & Materials			0.9	0.2	1.5	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5
Advanced Subsystems, Systems & Concepts			1.2	0.3	2.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0
Institutional, Safety, siting & Environmental			0.9	0.2	1.5	2.0	2.0	2.0	1.5	1.5	1.5	1.5	1.5

Milestones

- (1) Decision to Build Bench Model/Test Facility
 (2) Decision to Build Pilot Plant
 (3) Bench Model/Facility in Operation
 △ Pilot Plant Checked out and Operating

- (5) Decision to Start Second Generation Pilot Plant
 (6) Decision to Build Demonstration Plants
 (7) Second Generation Plant in Operation
 (8) Demonstration Plant in Operation

TABLE IX (Cont.)

PROGRAM ELEMENT	FY	75	76	Trans.	77	78	79	80	81	82	83	84	85
7. <u>Program Support</u>													
Management Support			0.7	0.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Mission Analysis			0.5	0.2	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Milestones

- (1) Decision to Build Bench Model/Test Facility
- (2) Decision to Build Pilot Plant
- (3) Bench Model/Facility in Operation
- 4 Pilot Plant Checked out and Operating

- (5) Decision to Start Second Generation Pilot Plant
- (6) Decision to Build Demonstration Plants
- (7) Second Generation Plant in Operation
- (8) Demonstration Plant in Operation

SECTION 5.0 REVISED SCHEDULE / FORMAT PLAN SUMMARY
OF 14 MAY 1975

Section 5.0 consists of the reformatting and summarizing of the Solar Thermal Sub-Unit as requested by George Kaplan 13 May 1975. This implementation schedule reflects an extension from two to three years for the Pilot Plant Preliminary Design and one year for the completion of the Solar Thermal Test Facility due to a delay in selection of the site for the Solar Thermal Test Facility. It is felt that the Basic Plan schedules for these projects are still attainable, though optimistic, and reflect the priority objectives for the Central Receiver Project and should be retained as part of the Program Planning.

SOLAR THERMAL SUB-UNIT

Problems

Technological

- o No fundamental technological limitations identified to prevent substantial applications.
- o Engineering and economical limitations may pose notable early risks to initial utilization.
- o Smooth integration into existing systems will require testing and demonstrations.

Institutional

- o Ownership, maintenance, and operational control of total energy systems by individuals or utilities must be resolved.
- o Impact on utilities of large solar unit penetrations must be assessed in selecting preferred concepts.
- o Volume production and tooling in industry will be required to achieve full economic potential.
- o Site selection of early facilities must be consistent with long-term technical objectives and not parochial interests.
- o State and regional regulation of public utility power networks must permit the use of a new technology.

Clarification of Government Role

- o Government must support technology development and demonstration to reduce risk to acceptable commercial level and minimize schedule delay.
- o Great public interest in solar energy will demand near-term tangible progress.
- o Government must coordinate and direct supporting technology for developmental efforts, i. e., NOAA for environmental data and NWC for technical support and test facilities.

Implementation

- o Initially, ERDA will fund industrial teams to develop and demonstrate the technical feasibility and indicate the economic attractiveness of solar thermal power plants and solar total energy systems.
- o Utility participation is planned in all demonstration projects to accelerate widespread technology utilization
- o Ultimately, industries and utilities will utilize the developed experiences and provide funding and direction for the commercial applications of solar thermal power plants and total energy systems.
- o Continuing research and development studies covering collector/surface coatings, high temperature material development, and solar thermal mission/system analysis are planned to keep the development efforts current with advanced engineering and economic applications.
- o In-house government efforts will emphasize management of industrial R&D rather than initial internal systems/subsystem development with subsequent commercialization.

1976-1979

- o Parallel contracts awarded in 1975 for system concepts, preliminary design, subsystem hardware and testing, all leading to a 10 MWe central receiver solar thermal electric power pilot plant.
- o Site selection, design, and construction of a 5 MWth solar thermal test facility 1976-1977, interim capability late 1976, full capability mid 1978.
- o Construction of a distributed collector test facility 1977-1978.
- o Detail design completed 1978 for 10 MWe central receiver pilot plant construction to start 1978.
- o Preliminary designs for total energy pilot plants to be initiated:
 - 1977 - military and institutional applications
 - 1978 - industrial and residential applicationsto determine economic feasibility of systems.
- o Detail design of total energy pilot plants to be initiated in 1978 and 1979 with construction starting in 1979 and 1980 - to demonstrate operational, technical, and economic feasibility of the systems.
- o Concurrent system, subsystem, materials, environmental, socio-economic studies conducted to identify second generation concepts and address institutional issues.

1976-1979 (Continued)

- o Detail design of 10 MW_e distributed collector pilot plant to be initiated in 1978 with construction starting in 1979.
- o Preliminary designs for hybrid solar thermal systems - initiated in 1977-1979: several concepts to be developed to establish relative feasibility of concepts.

1980-1985

- o Construction of 10 MW_e central receiver pilot plant completed in 1981 and plant integration tests to utility grid started to establish operations techniques and economics.
- o Detail design of 100 MW_e central receiver demonstration plant completed in 1982, construction started in 1983, industry/utility funding anticipated as much as 50%.
- o Continued testing of advanced hardware and components at test facilities.
- o Detail design of solar total energy demonstration plants initiated upon feasibility demonstration from pilot plant operation, anticipated in 1983-4 with industry/utility funding as much as 50%.
- o Detail designs of distributed collector demonstration power plant will be considered pending pilot plant operations and as the logical alternative to the central receiver power plant systems.

1985 and beyond

- o Completion of demonstration plants - operational experience utilized in subsequent commercial plants.
- o Successful demonstration plants to be employed in commercial operation - industry/utility acceptance of plant operation and capital obligations is anticipated.

SOLAR THERMAL SUB-UNIT

KEY MILESTONES

Output/Milestones	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	After 1985
Central Receiver: Pilot Plant Demonstration Plant		- P - - - - -		- D - - - - -	- C - - - - -		- O - - - - - - - D - - - -	- T - - - - - - - - - C - - - -				- O - -
Test Facilities: Central Receiver Distributed Collector	- - - -	- D - - - -	- O - - - -	- T - - - -								
		- - D - - - -		- O - - - -	- T - - - -							
Solar Total Energy: Pilot Plants Demonstration Plants			- P - - - -	- D - - - -			- O - - - - - P - - - -	- T - - - - - - D - - - -	- C - - - -			- O - -
Distributed Collector: Pilot Plant Demonstration				- P - - - -	- D - - - -	- C - - - -		- O - - - - - P - - - -	- T - - - - - - D - - C - -			- O - -
Hybrid Solar Thermal: Pilot Plants					- P - - - -	- D - - - -	- C - - - -		- O - - - -	- T - - - -		

NOTES:

- P = Preliminary Design Started
- D = Detail Design Started
- C = Construction Started
- O = Operational, Construction Completed
- T = Testing/Operations

APPENDIX A

MEMORANDA, DIRECTIVES, AND NOTES OF INSTRUCTION

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

March 6, 1975

MEMORANDUM

TO : Jerry Johnson (TRW)
Marty Scholl (Mitre)
Howard Webb (Aerospace)
FROM : Ted Mock *Ted*

SUBJECT: Responsibilities for "Phase 3" Solar Reports

I would like the members of the support team from TRW, MITRE, and AEROSPACE to take on the responsibility of preparing the two "Phase 3" solar reports required for final submission by April 4, 1975. This effort will require close cooperation among all support team members and the members of ERDA's technical staff (who will have the authority for making final decisions on technical, financial, and programmatic matters).

Because of other pressing demands on ERDA program managers at this time, I will be looking primarily to you to satisfy the following requirements:

1. 9:00 a.m., March 13, 1975 - submission to me and to the cognizant ERDA program managers of a preliminary draft of the "Phase 3" reports. The primary purpose of this draft will be to assure that a meeting of the minds exists among support personnel, ERDA technical staff, and ERDA's Assistant Administrator for Planning and Analysis.

2. 2:00 p.m., March 21, 1975 - submission to me in 20 copies of a first draft of the "Phase 3" reports. This report should be as close to the final report as possible. It will be reviewed by Dr. Teem, myself, and the appropriate members of the ERDA staff and returned to the support team by 11:00 a.m., March 25, 1975.

3. 2:00 p.m., April 3, 1975 - submission to me in 25 copies of the final draft of the "Phase 3" report.

I realize that the time is short and the requirements tough -- but I have the highest confidence in your ability to meet the deadlines with a quality product.

I look forward with pleasure to working with you on this most challenging task.

Deadlines

1. First cut March 21
2. Second cut April 1
3. Final submission - April 3

Format

1. Summary description of program content (for each program unit)
2. Tabulation of five-year financial projections (FY 1977-1981)
 - a) Any revised estimates requested for FY 1976
 - b) Level of detail -- subprogram
3. Tabulation of program outputs/milestones and decision points
4. Projection of operating cost trends at multiprogram laboratories
 - a) Include Solar Energy Research Institute

Enclosure I -- Objectives, Strategy, and Issues

Objectives

The objectives desired for each program unit must be consistent with the overall ERDA objective(s) and the overall objective(s) of each program AA.

A draft overall statement of ERDA goals and guidance is enclosed as Exhibit 1. All addressees are requested to furnish comments to AA/PA on this statement by the close of the First Phase reporting period (February 21). Each Program Assistant Administrator is requested to prepare draft objective(s) for each of their program units and submit these also to AA/PA by February 21. Final versions of objectives are to be established by the end of the Second Phase report period (March 7).

To assist in the preparation of objectives, some suggestions are enclosed as Exhibit 2.

Plan (Strategy)

Each Program Assistant Administrator should prepare a statement of no more than 20 pages which sets forth his program unit justification, and describes an integrated plan (strategy) for the accomplishment of his identified program unit objectives. The statement should directly address each of the relevant considerations identified in Exhibit 3 and should be prepared generally following the outline indicated in that Exhibit. This strategy statement should not be merely a compilation of program director strategies for meeting specific objectives. Rather, it should attempt to aggregate and integrate them into a self-consistent package which identifies the important attributes of the identified program units, established priorities and interrelationships, and proposes realistic generic approaches to support the choice of objectives and their attainability.

Features of the programs which will specifically address how the objective is to be achieved should be included in the strategy statement but made independent of specific annual budgets.

These strategy statements will be aggregated and summarized by AA/PA pursuant to the needs of the Planning/Budget Review Council.

Draft plan write-ups should be submitted to the AA/PA in the Second Phase report (March 7). AA/PA will comment on these promptly to each Assistant Administrator. Final plan write-ups are due in the Third Phase report (April 4).

Issues

It is expected that the preparation of objectives and the plans will generate several policy issues which will require resolution at an early date and prior to the budget review. Such issues should be identified early in the planning process and should be submitted to the AA/PA in the First Phase report (February 21).

HELPFUL HINTS FOR PREPARING OBJECTIVES

It is helpful in preparing objectives to consider in order:

Role and Mission - Consider the responsibilities thrust upon you by your position in the organization. What have you been assigned to do in relation to the agency's mission?

Succinctly state your own mission.

Key Results Areas - Within your mission boundaries, what functions will your organization perform? What will you be expecting them to do with their time and the budget dollars allocated to them?

List these activity areas.

Indicators - What will tell you whether or not your organization is performing as it should? What do you expect out of them? Are there "events" that will signal to you the progress being made in your key results areas? Would delays in reaching such events require your management attention?

List those events.

After proceeding through the above thought process, writing objectives is an easier task. The objectives will become your directions for translating activity into the production of results that you want to satisfy your mission requirement.

EXHIBIT 2

An objective is a statement of results to be achieved. Any endeavor has a purpose and that purpose can be stated in terms of the expected result -- the objective.

All objectives have common features, such as:

1. They start with the word "to", followed by an accomplishment verb.
2. They specify a single key result.
3. They specify a target date for the accomplishment.
4. They specify maximum cost factors that the responsible individual is willing to invest in the venture.
5. They are as measurable and verifiable as possible.
6. They do not attempt to specify "why" or "how" the objective is to be reached. (That is left to the plan.)
7. They relate directly to the accountable manager's roles and missions and to higher level roles and missions.
8. They are realistic and attainable while still presenting a challenge.
9. They are readily understood by those who will be contributing to attainment.
10. They are consistent with resources available and anticipated.
11. They avoid or minimize dual accountability for achievement when joint effort is required.
12. They are consistent with organizational policies and practices.

Illustrative Program Unit Objectives

- I. To provide such technologic and other support as is necessary to ensure the development of workable and acceptable processes necessary to a viable fuel cycle industry for nonbreeder reactors by _____ at a cost not to exceed \$_____.
- II. To develop and demonstrate a safe, reliable, and economically viable breeder reactor by _____ at a cost not to exceed \$_____.
- III. To conduct the necessary research and development to demonstrate the technical feasibility of sustaining controlled fusion reactions by _____ at a cost not to exceed \$_____.
- IV. To develop and demonstrate by _____ at a cost not to exceed \$_____ an improved uranium isotope separation process that would reduce the cost of separative work by _____%.

EXHIBIT 2

Strategy Considerations for Energy R&D Programs

- I. Establishment of context.
 - A. Identification of the problem which the proposed R&D or demonstration will address.
 - B. Basis of the need for Federal involvement.*
 - C. Interrelationship with other energy R&D or demonstration efforts undertaken by ERDA, other Federal agencies, state and local Government, U.S. industry, and other nations.
- II. Specification of expected program results (consistent with objectives).
 - A. Nature and magnitude of contribution.
 - B. Timetable for achieving results.
 - C. Economic targets and/or other specific program success criteria.
 - D. Remaining obstacles to commercial adoption.
- III. Major technological alternatives.
 - A. Nature of present state of development.
 - B. Nature of the technological hurdles which must be surmounted.
 - C. Limiting factors on the rate at which progress can be made.
 - D. Justification for deciding for commercial demonstration in the near-term, intermediate or long-term.
 - E. Approach to be used in dealing with technical uncertainties.
- IV. Identification of relevant external factors.
 - A. New authorities, legislation, etc., which will be critical to the ultimate success of program.
 - B. Government policies whose adoption, continuation, or revision will be critical to the ultimate success of program.
 - C. Other parties who can affect program success.

* See Section 5.b.2., Federal Nonnuclear Energy R&D Act of 1974, enclosed as Appendix _____.

- V. The economic, environmental, and societal impacts and significance which the proposed strategy may have either during the conduct of the R&D or the commercial adoption of the technology.

VI. Management Approach

- A. Basis for establishment of priorities.
- B. Nature, quantity, and source of resources which are required.
- C. Definitions of roles and responsibilities for ERDA and U.S. industry (and other agencies or nations if appropriate).
- D. Key decision points in fulfilling the objectives.

Enclosure II - Program Implementation

Each Assistant Administrator should submit by April 4 for his area of responsibility the following materials covering each of his program units: a summary description of program content; a tabulation of five-year financial projections (FY 1977-1981) and any revised estimates requested for FY 1976; a tabulation of program outputs/milestones and decision points; and a projection of operating cost trends at multiprogram laboratories.

Guidance on content and format is provided below.

Program Description

Program narratives should be submitted for each program unit limited, on the average, to two pages, which summarize the objectives, the program justification, the program strategy and the approach taken in implementing program strategy to achieve objectives in the current planning year and the outyears. The major portion of the text should stress the implementation item since the other material will appear in the longer strategy write-ups requested under Part I.

Outputs/Milestones and Decision Points

This is a multi-page tabulation for each program unit which categorizes key outputs or milestones under three time periods: near-term, mid-term and long-term (Exhibit 1). These time periods are defined as the present through 1984 (near-term), 1985-2000 (mid-term), and beyond 2000 (long-term). Each program unit will normally have outputs or milestones which extend beyond the five-year financial projections. In addition, decision dates keyed to major policy or program choices should be identified in this tabulation. Total estimated costs for program units should also be included.

Financial Projections

Financial projections should be submitted for program unit operating costs, equipment and construction and for operating cost trends at multiprogram facilities. Format guidance is given in Exhibits 2-6. It should be noted that the level of detail for operating costs is the subprogram (Exhibit 3).

Funds from other government agencies or industry should be identified separately where applicable in the case of pass-through or jointly-funded programs (Exhibit 2).

Equipment projections should provide subtotals for "computers" and "other" equipment (Exhibit 4). The computer subtotal should include a listing of major computers (\$500,000 or over).

Construction projections should include total dollar levels proposed and an individual listing of projects with a TEC of \$5 million or more (Exhibit 5). Fire, Safety, and Adequacy of Operations, Environmental, and OSHA requirements should be indicated. Sequential priority numbers should be assigned to new project requests.

Projections of operating costs and equipment, FY 1977-1981, should be in FY 1977 dollars. Suggested rates for escalating from FY 1976 to FY 1977 are as follows: Operating 8%, Equipment 10%. Submissions may use rates other than those suggested but in such cases must specify the particular escalation rates used and indicate the basis for the rates selected.

Since most construction estimates are prepared with currently available prices for material and labor, an allowance must be made to cover anticipated escalation for new projects. This is often computed to the mid-point of the construction period (as the average time of expenditure). In a more sophisticated analysis, escalation may be calculated separately to the mid-point of each specific obligational or costing period (either fiscal year or calendar year). Also escalation for a specific project may be computed from different material and labor rates, rather than using a composite rate.

Each office should determine the appropriate rates to be included for their location and specific types of construction projects. However, for your general guidance the Division of Construction prepared the following tabulation which gives their best estimate for future rates:

<u>Year</u>	<u>Annual Construction Escalation Rate</u>
Escalating from FY 1975 to FY 1976	10 to 12%
Escalating from FY 1976 to FY 1977	8 to 12%
Escalating from FY 1977 to FY 1978 and Beyond	5 to 8%

DIRECT SOLAR CONVERSION PROGRAM UNIT
PROGRAM ELEMENT SUMMARY SHEET

Subprogram: Solar Thermal - 4A

Project Index Number: 4A1

Project Title: Central Receiver Project

Project Objective: Operation of a central receiver solar thermal commercial plant of 100-300 MWe (research, development, & demonstration) must include these words

Project Justification:

Commercialization needs to be proven

Project Strategy:

- funding through industry by contract
- management by ERDA labs

Description of Task and Approach:

Major Results and Key Decision Dates:

10 MWe plant in operation 5 May 79

Task Funding (1977 dollars):

	FY75	FY76 Cong. Rev.	Transition Period Cong. Rev.	77	78	79	80	81	Through Completion
Operating Expenses									
Capital Equipment									
Computers									
Other Equipment									
Plant Construction									
* Pass-Through Funding (NASA, EPA, Industry)									*rough it if industry funding
* Joint Funding									

TOTAL

Guidance on Pass-Through and Joint Funding:

* Statement explaining

Fire, Safety, and Other Requirements:

Prerequisite Program Subunit - Project Index:

ERDA Coordinators

Wind	Divone
Solar thermal	Kaplan
Bioconversion	Bogan
Heating/cooling R&D	Horowitz
Heating/cooling demonstration	Blieden
Agriculture	Cherry
Industrial process	Doering
Photovoltaic	Magid
Ocean thermal	Cohen
Meteorology/oceanology/insolation	Leech
Solar Energy Research Institute	Mock

Program Unit

Title

IV.

DIRECT SOLAR CONVERSION

- A. Heating and Cooling of Buildings
- B. Agricultural and Process Heat
- C. Bioconversion to Fuels
- D. Technology Utilization

V.

SOLAR ELECTRIC APPLICATIONS

- A. Solar Thermal
- B. Photovoltaic Research
- C. Wind Energy Conversion
- D. Ocean Thermal Energy Conversion

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

EXHIBIT 1

[FORMAT]

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

Program Unit TitleList Major Results^{a/}Decisions Points Anticipated^{b/}

Identify approximate dates when results (use o) are expected
or decisions (use x) required - e.g., ERDA demo plant start
1981, full scale joint industry/ERDA plant start 1987.

[EXAMPLE:]

Decision Points Anticipated

Decision to build a pilot plant; selection
made from competing approaches; (____ MW or
____ bbls of oil or equivalent)

x(1979)

Major Results Expected

Operation of a demonstration plant
(____ MW or ____ bbls of oil or
equivalent)

o(2000)

^{a/} Used broadly here to identify timed measurable outputs, accomplishments, targets, etc., which indicate expected results or
performance relative to program objectives and which have greatest impact on program success.

^{b/} Signals a management decision on critical planning choices.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTIONS SUMMARY
(Dollars in Millions)

EXHIBIT 2

[FORMAT]

PROGRAM UNIT TITLE

	FY 1976		Transition Period		PROGRAM PROJECTIONS					Thru Completion Where Applicable ^{a/}	
	<u>FY 75</u>	<u>Cong.</u>	<u>Rev.</u>	<u>Cong.</u>	<u>Rev.</u>	<u>FY 77</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>	<u>FY 81</u>	
Operating Expenses											
Capital Equipment											
Plant											
<u>Total [Program Unit Title]</u>											
 <u>FUNDS FROM OTHERS</u> (not added to ERDA total)											
Funds from other agencies and industry; pass thru and joint programs.											
Other Agency A											
Industry C											
<u>Total [Program Unit Title] Funds From Others</u>											

^{a/} Where available, provide in a footnote the basis for cost estimate.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTIONS
(Dollars in Millions)

EXHIBIT 3
[FORMAT]

PROGRAM UNIT TITLE

OPERATING EXPENSES	FY 75	FY 1976		Transition Period		FY 77	FY 78	FY 79	FY 80	FY 81	Thru Completion ^{a/}
		Cong.	Rev.	Cong.	Rev.						
Subprogram [ABBREVIATE WHERE NECESSARY] ..											
Subprogram											
Subprogram											
Total [Program Unit Title Operating]						b/					

[EXAMPLE:]

SOLAR ENERGY DEVELOPMENT

OPERATING EXPENSES

Solar Energy for Buildings & Facilities .. \$ 6.8	16.6	4.9								
Solar Thermal	2.9	10.9	3.2							
Photovoltaic Research	1.3	9.9	2.9							
Wind Energy Conversion	2.2	8.4	2.5							
Bioconversion to Fuels	0.5	1.5	0.4							
Ocean Thermal Energy Conversion	-	2.0	0.6							
Supporting R&D	-	-	-							
Total Solar Energy Development Operating \$13.0	49.3	14.5	b/							

a/ Where available, provide in a footnote the basis for cost estimate.

b/ Escalation factor __%, FY 1976 to 1977.

PROGRAM PROJECTIONS (Cont'd)
PROGRAM UNIT TITLE (Cont'd)

(Dollars in Millions)

EXHIBIT 4
[FORMAT]

CAPITAL EQUIPMENT (BUDGET AUTHORITY)	Est.	FY 1976		Transition		PROGRAM PROJECTIONS					Thru Completion ^{a/}
	FY 75	Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
<u>Computers</u>											
List major computers (\$500,000 and over).											
Other Computers											
Total Computers											
											[Round to nearest tenth of a million]
Other Equipment											
<u>Total [Program Unit Title Equipment]</u>											

b/

[EXAMPLE:]

PROGRAM PROJECTIONS (Cont'd)
PROGRAM UNIT TITLE (Cont'd)

CAPITAL EQUIPMENT (BUDGET AUTHORITY)

ABC Model, NAL											
XYZ Model, HNL											
Other Computers		1.0		0.3							
Total Computers	\$12.0	1.0		0.3							
Other Equipment	7.8	15.0		3.8							
<u>Total [Program Unit Title] Equipment</u>	\$19.8	16.0		4.0							

a/ Where available, provide in a footnote the basis for cost estimates.

b/ Escalation factor _ 1, FY 1976 to FY 1977.

PROGRAM UNIT TITLE (Cont'd)

(dollars in millions)

[FORMAT]

PLANT (BUDGET AUTHORITY)	TEC	FY 1976		Transition Period		PROGRAM PROJECTIONS					Thru Completion
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	

Authorized Projects74-1-3 title, location (App. thru FY 75 ;
FY 76)General Plant Projects (FY 75 ; FY 76)New Projects

[Round to nearest tenth of a million]

Title, location (Note if FSAOC, Environmental,
or GSHA requirement)

Total [Program Unit Title] Plant b/

[EXAMPLE]

PROGRAM PROJECTIONS (Cont'd)

FUSION POWER RESEARCH AND DEVELOPMENT (Cont'd)

PLANT (BUDGET AUTHORITY)Authorized Projects73-x-x Wire factory facility, BNL (App. thru
FY 75 \$10) \$16.0 6.0General Plant Projects (FY 75 \$0.5 million) ... 0.7 0.3 1.0 1.0 1.0 1.0 1.0New Projects [numbered by priority order]

1. Tckamak fusion test reactor (A-E and long-lead procurement), PPPL 10.5^{c/} 7.5 3.0
2. Cable facility upgrading, PNL 4.0
3. Bottle-fusion facility, MIT 10.7
4. Exercise ring, ANL 22.0

Total Fusion Power Res. & Devel. Plant \$14.2 3.3 15.7 23.0 1.0 1.0 1.0

a/ Where available, provide in a footnote the basis for cost estimate.

b/ Escalation factors over the period of the construction schedule used in estimating TEC are as follows:

c/ Excludes \$400,000 CP&D.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
 PROJECTED OPERATING COST TRENDS AT MULTIPROGRAM LABORATORIES
 (Dollars in Millions)

EXHIBIT 6

[FORMAT]

PROGRAM UNIT TITLE

	Est. FY 75	FY 1976		Transition Period		PROGRAM PROJECTIONS				
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81
Argonne National Laboratory										
Brookhaven National Laboratory										
Lawrence Berkeley Laboratory										
Lawrence Livermore Laboratory										
Los Alamos Scientific Laboratory										
Holifield National Laboratory										
Pacific Northwest Laboratory										
Sandia Laboratories										

[Round to nearest tenth of a million]

11 MAR 1975

Program Manager
Solar and Geothermal

FISCAL YEAR 76 EQUIPMENT BUDGET

Dr. Teem has requested that an equipment budget be developed for FY 76.

There is attached an informal definition of capital equipment as it pertains to the separate appropriation in ERDA. Your informal input as to probable FY 76 equipment requirements, using these guidelines, will be appreciated as soon as possible. Please identify insofar as possible, types of equipment items and contractor, facility, or project for which needed.

It is suggested that for this purpose a liberal interpretation be used in classifying items as chargeable to operating costs as "experiments", limiting equipment requirements essentially to major items for ERDA laboratories and off-site (non-university) contractor uses.

T. M. Prather

ATTACHMENT

CAPITAL EQUIPMENT

Capital equipment funds are used when the cost of the item is capitalized as an asset in the ERDA accounts. (Exception-Equipment purchased as part of a construction line item). The basic definition is that the item have: (a) an initial cost of \$500 or more; and, (b) an expected useful life of one year or more.

The first of these is self-explanatory. The second, however, is subject to interpretation as to the type of useful life, with a distinction to be made between items for experimental use as opposed to those for general use. Clearly, equipment items for general or multi-purpose use at a Government owned laboratory are always capitalized. Similarly, items of this type purchased for use in an off-site contract effort are capitalized unless a separate decision is made for title to vest in the contractor. (Legal basis is available to usually vest title in educational institutions but not in private contractors or other Government agencies). Conversely, equipment type items for one-time use as components of an experimental device clearly are not to be capitalized and are chargeable to operating funds. In between these obvious examples is a grey area in which a decision on the type of funds is made on the basis of the particular circumstances involved. Factors in this decision include: (a) probable ultimate location and disposition of the items; and, (b) extent of useful life apart from the experimental use. Incidentally, the question of Government ownership is not controlled by the type of funds used since title to all tangible property is retained by the Government unless specifically granted elsewhere, and whether capitalized or not. Also incidentally, the final decision on capitalization and therefore type of funds is an accounting decision but based extensively on program guidance.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

March 19, 1975

MEMORANDUM

TO : All Members of the Solar Energy Task Force

FROM: Ted Mock *fem*

It appears that we will be able to negotiate a contract with the National Academy of Sciences by April 1, 1975, to carry out a study to help define the role, mission, organizational structure, and site selection criteria for the Solar Energy Research Institute.

Members of the NAS staff have requested the following types of material in order to prepare for the first meeting of the NAS study committee:

- Summary of our current and past solar energy programs complete with descriptions of the research being carried out, funding levels, and project personnel.
- A list and/or description of existing and planned research (and development) facilities with their associated manpower and funding levels.
- A list of solar energy research organizations (universities, industry, etc.) experts, and reports.
- A list of solar energy newsletters, and other publications.

I am not expecting anyone to sit down and come up with new listings or program descriptions. What I am looking for is simply material which you may have in your files or on your shelves.

Please send me by Thursday afternoon, March 20, 1975, one copy of everything you may have available. If you have only one copy of any document, please send it to me with a note attached and I will duplicate it and send it back to you immediately.

Thank you for your help.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

March 21, 1975

Director, Division of:

Solar Energy
Geothermal Energy
Physical Research
Controlled Thermonuclear Research

CALL FOR AGENCY PLANNING AND BUDGETING INFORMATION

In a memorandum dated February 7, 1975, on the above subject, the Controller and the Assistant Administrator for Planning and Analysis provided a schedule for submission of certain material to be used in the following documents:

1. A National Comprehensive Energy R&D Plan.
2. A Federal Comprehensive Energy R&D Program Implementation.

The Phase 3 Response under this schedule is due on April 4, 1975, and consists of final draft strategies and Program Implementation detail.

In a meeting of the Senior Staff Planning Group held on March 20, 1975, chaired by Richard M. Pastore, further instructions were provided for the preparation of the Phase 3 Response. The following paragraphs and the attachments to this memorandum summarize these instructions.

STRATEGY - In the opinion of Plans and Analysis, the March 7, 1975, submissions on the first draft strategy were satisfactory as regards "what" is to be done under each program unit. However, they were not satisfactory as regards "why" the work is being done. Hence, we are required to provide answers to the set of eight questions posed on the attached sheet. Please prepare for your program unit(s) a brief response to each question. I need to have your written answers to these questions by noon on March 27, 1975, so that I can assemble the composite response for Dr. Teem's review prior to April 4, 1975.

PROGRAM IMPLEMENTATION - The detailed schedule for the Program Implementation is attached. The AA/Solar, Geothermal, and Advanced Energy Systems submission must be made on April 4, 1975. A set of "General Instructions for Preparation of Material for Program Unit Descriptions" was distributed in the March 20

meeting. Please compare these instructions (see attachment) with the Program Implementation drafts that you prepared for Dr. Teem for March 21, 1975, and make any necessary revisions to format or content.

George K. Hess Jr.

George K. Hess Jr.
AA/SGAES Representative
to the Senior Staff
Planning Group

Enclosures:
as stated above

cc: Dr. J. Teem

Questions

1. To which of the nine National Energy R&D Goals are the Program Units under your control responsive?
2. What key words or phrases characterize the dominant problems and/or constraints that are associated with your contribution to the attainment of those goals? Answer in relation to the Program Units for which you are responsible.
3. What can the Government do to help industry solve or alleviate these problems by:
 - . Time?
 - . Quantity output?
 - . Cost?
4. What Government/industry relationships would provide that help? Why?
5. What measurable indicators would prove to you that progress is being made toward the resolution of stated problems?
 - . Economic.
 - . Technical.
 - . Institutional (including political, social, and legal).
 - . Environmental.
6. How can these indicators be made meaningful in a public forum?
7. What near, mid, and long-term objectives are derived from these indicators?
8. How do the emphases which you will apply to pursue these objectives vary over time to satisfy the National goals? Why?

NATIONAL ENERGY R & D GOALS

- I. Expand the domestic supply of economically recoverable energy producing raw materials.
- II. Increase the utilization of essentially inexhaustible domestic energy resources.
- III. Efficiently transform fuel resources into more desirable forms.
- IV. Increase the efficiency and reliability of the processes used in the energy conversion and delivery systems.
- V. Transform consumption patterns and improve energy utilization.
- VI. Increase end use efficiency.
- VII. Protect and enhance the general health, safety, welfare and environment related to energy.
- VIII. Perform basic and supporting research and technical services related to energy.
- IX. Improve management effectiveness throughout the energy system.
- X. Administer the ERDA operations efficiently, reliably and safely.
- XI. Provide the nuclear related support for the maintenance of a viable defense establishment.

3/19/75

PROGRAM IMPLEMENTATION SCHEDULE

April 4	Phase III Submissions from AAs
April 7-11	Ø III Review and Critique
April 7-11	Revise Ø III Recycle and Consolidate
April 8-14	Type and Proof
April 15	Reproduction
April 16	First Draft to SSPG
April 17	Recommendation on priorities (SSPG)
April 18	Ø III Reviewed, Formulate SSPG Guidance
April 21	Guidance to SSPG (Implementation Detail)
April 22	First draft Comments - Implementation Detail
April 23	Incorporate SSPG Revision - Implementation Detail
April 24	Type and proof - Second Draft Implementation Detail
April 25	Reproduction - Second Draft Implementation Detail
April 28	Program Implementation Submittal
April 29-May 2	P/BRC Member Review
May 5-9	Formal P/BRC Meeting and Review (Final Plan and Report)
May 12-14	Incorporate P/BRC Revisions
May 13-15	Type and Proof
May 16	Reproduce Final Plan and Program Implementation Reports
May 19-20	Coordinate Final with P/BRC and D/A
May 21	Final Plan and Report Submittal to ERDA Administrator
May 22-26	Incorporate Administrator Revisions
May 23-27	Type and Proof
May 28-29	Reproduction
May 30	Submit to OMB
June 2-27	OMB Review
June 13	OMB Comments
June 16-17	Incorporate OMB Revisions
June 18	Type and Proof
June 19	Reproduction
June 20	Submit to Administrators
June 23	Incorporate Administrators' Changes

June 24	Reproduction
June 25	Submission to OMB
June 30	Submission to Congress

**General Instructions for Preparation of Material
For
Program Unit Descriptions**

1. The program unit description is a summary statement of the program unit objective and strategy, and the program implementation. The intent is to provide a concise, factual description of program content and the specifics of the approach taken to assure successful achievement of planned results in the near term, mid term and long term periods of the plan.
2. Program unit objectives and strategy are treated more fully in the strategy plan; they are summarized in the program unit description to provide a "stand alone" document. The narrative will deal mostly with the implementation: the characterization of the research, development, demonstration or other attributes of the program and the logic of program design, i.e., the actions, decisions, resource commitments and other arrangements to achieve the results contemplated by the program strategy.
3. The program unit descriptions will be included in a document along with the sub-program unit outputs and five-year planning projections.
4. The program unit description should provide adequate explanatory detail for understanding the program outputs and cost projections considered in the budget and planning review process.

Length and Format

5. Because some program units may have five or more subunits, or may be more complex than others, precise space allocations are not possible at this time. However, program unit descriptions should be limited to two pages, on the average.
6. The April 4 submission should be in "Prestige Elite" type, on legal-size sheets (8-1/2"x 14") in accordance with the format in Exhibit 1 and submitted as an original and two Xeroxed copies (the latter will be used for a preliminary markup of Planning and Analysis comments and will be returned to contributors for appropriate revisions prior to assembling the complete draft).
7. Some descriptive flexibility geared to the particular characteristics of operating programs and projects is desirable and expected. In general, however, the narrative will provide a lead statement for the program unit and descriptive detail for subunits following the generic outline below and format guidance provided in Exhibit 1.

a. Lead Statement for Program Unit

This is a concise statement of the program unit objective and the program unit goal orientation and strategy.

b. Subunit Implementation

This is a brief narrative for each program subunit, describing specific milestones and outputs, and assumptions -- including costs, timing, decision points -- and other salient features of implementation. (See format guidance in Exhibit 1 and 2).

General Criteria

8. The content of initial program descriptions, due on April 4, should satisfy the following general criteria:
 - a. Descriptions should be well organized to reveal the logic of program design and the key actions and decision points for managing the successful achievement of research, development and other objectives.
 - b. Economic, technological, environmental, social or other merits of the program should be described objectively as possible, and supported by quantitative data as appropriate.
 - c. The total estimated costs of major proposals should be identified.
 - d. Key assumptions and constraints which underly the scope and design of the sequence of the implementing actions -- including costs, timing, outputs, and institutional or other arrangements -- should be identified and the implications made clear.
 - e. Coordination with other federal agencies and the private sector and the degree of financial participation by federal agencies and industry should be emphasized where appropriate.
 - f. The relationship of the proposed program to any Federal national energy or fuel policies should be identified.
 - g. Near term activities and costs should be related to longer term objectives and costs. The rationale for the degree of emphasis given to activities in the various time periods should be explained.
9. In the preparation of copy, the following standards will apply:
 - a. Material should be written in a language understandable to an intelligent "lay" reader. Technical detail should be minimized. The focus should be on matters of broad significance to the public interest, including how the program implementation deals with problems, risks and uncertainties.
 - b. Care must be given the choice of certain words in order to convey their intended meaning. (e.g., "commercialization" of technology -- if this is meant to identify a timed result, it should be clear to

the reader whether this is an initial step in the process or whether it signifies the time of significant impact on the solution of an energy problem) Similarly, care should be exercised in using terms such as feasibility, demonstration, requirements, needs, etc.

- c. Statistical material should be briefly summarized in the narrative. One or two brief, simple table may be included, as appropriate.
- d. Names of ERDA laboratories, sites, key contractors, and other public or private contractors or organizations should be included in the text when they represent a capability committed to a significant aspect of the program, or represent entities with whom integrated planning relationships are established.
- e. ERDA internal organization names should be used only if necessary to put an item in perspective.
- f. Language should reflect a fresh ERDA point of view and not the reports and documents of previous agencies.

Schedule

- 10. The draft program unit descriptions must be submitted to the APA no later than April 4. This timing provides little flexibility for final preparation of the complete program package which is to be submitted to the P/BRC by April 28. Thus, submission of early drafts prior to the April 4 due date is encouraged.

[FORMAT]

Reduced for purpose of Call only.
Use 8½" x 14" paper for submission.
Allow a 15 space left margin.
Use Prestige elite type.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
Program Description

Program Unit Name

Provide a concise summary of the program unit objective and strategy. There may be a separate objective for each time period of the plan-near term (thru 1984), mid term (1985-2000), and long term (beyond 2000).

Program Subunit Name (repeat for each subunit)

Output

Specify the output for this subunit.

Assumptions

Identify any key assumptions which underlie or constrain the program implementation. Include those matters which may be uncertain but which are taken to be true for purposes of program design. Assumptions may include estimates of: availability of manpower or other resource constraints; supply and demand forecasts; probabilities of technical success and public acceptance; federal agency and private industry roles; cost sharing, etc. Program implementation should be sensitive to the accuracy of these assumptions. The logic of the implementing actions may include reducing the uncertainty of assumptions or minimizing the risks involved.

Implementation

Highlight the major elements of program subunit implementation. The narrative should reveal the logic of the planning and the specific actions to achieve planned outputs. Include adequate detail for understanding subunit outputs and cost projections. Stress the factual content -- what, when, who, how much -- the context is already provided by the preceding material. Cross-reference may be made to other parts of the program unit document (e.g., the program output tabulation or financial projections), as appropriate. Further guidance is provided in the General Instructions.

Major changes from last year's agency budget request (President's budget to Congress) proposed for FY 1976 or FY 1977 should identify any significant impacts on resource requirements and/or results over the succeeding four years.

Instructions for Preparation of Material for Program Outputs/Milestones

1. General

The program outputs for all ERDA programs are to be presented by subprograms according to Exhibit 2. The combination of milestones and decision points should lead logically to one output identified with completion of each subprogram. More than one output may be meaningful (see glossary). The description of the relation between subprograms, subprogram outputs and program objectives should be presented under Program Unit Description. The complete description of each milestone, decision and output for a subprogram should be contained in this section and should follow the guidance given in the glossary. The program managers are responsible for these descriptions with consultative guidance to be provided by the AA's planning staffs and APA.

Each subprogram should show a direct relation between its output (especially the program completion aspect) and the program unit objective for that time period. The program objectives in the near, mid or long term are supportable only by subprogram outputs. Milestones should thus be directed toward subprogram output as these are most meaningful in terms of completing the subprogram, which then provides the basis for judgment that program objectives have been met. This will avoid heavily qualified or partial objectives being targeted for programs and will rather emphasize the more productive, final results.

2. Glossary Of Terms

An Output is defined as the completed task of a subprogram unit. For research subprograms the output may be a level of investigative activity that is targeted and reached. At the other end of the output spectrum, a manufacturing oriented subprogram, the number of fuel cells, kilograms of material or other unit quantities would be output. These manufacturing tasks would be completed each year and measured against their targets or schedules. For more development oriented subprograms, the completion of one R&D approach as evidenced by successful or unsuccessful operation of equipment or prototype demonstration plants would be typical output.

Subprogram outputs and milestones should be defined so that they are either directly relatable to dollars and manpower projections^{1/} or supported with accompanying background information which indicates the relation between these results and the subprogram projections of funds and manpower.

Milestones may be defined as key accomplishments or plateaus of performance level. They are measurable interim steps to achieve subprogram output. Examples are: completed preparation for a choice of technology where more than one approach exists; laboratory scale pilot operation of key hardware; pilot plant or demonstration plant operation at targeted levels; and proof-of-principle or empirical evidence for research hypotheses.

^{1/} Manpower data will be requested for each subprogram during the next year. APA analysts will be contacting the planning staff of program Assistant Administrators to prepare these projections.

Decisions described under program outputs should be those involving critical choices for subprogram direction, such as choice of technology; decisions to proceed along several approaches rather than one; decisions to accelerate funding and shorten the time between interim subprogram steps; or any major change in plans for a subprogram.

3. Subprogram Unit Emphasis

The emphasis for program implementation to be used in the annual planning cycle will be on subprogram units. These units are large enough organizationally to be funded and managed separately and small enough to have clearly measurable results. The subprogram unit managers will have prior agreement through the Assistant Administrators on the planned results by which his progress can be measured. These results will be defined (and revised as necessary) by the subprogram and program manager in consultation with the AA's planning staffs and reviewing by APA as action plans each year during the planning cycle. APA interests will be principally overview with respect to program unit objectives and general planning strategy. The purpose of such specific planning is two-fold, to provide the Administrator with clear, measurable progress plans and the program and subprogram unit managers with specifically approved targets and direction. Many of the subprograms are not amenable to precisely defined direction, but do have planning indicators available through targetable performance levels. These subprograms may require efforts to develop unique planning rationale, but they should adhere as closely as possible to this guidance.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

[FORMAT]

Reduced for Purpose of Call only
Use 8 1/2" x 14" paper for submissions.
Allow a 15 space left margin
(elite type).

[1 page minimum for each subprogram]

	Total Est. Cost Through Completion (Millions of Dollars)	(elite type).					
		Near Term		Mid Term		Long Term	
<u>Program Unit Title</u>		1975	1980	1985	1990	1995	2000
<u>Subprogram Unit Title</u>							
Identify criteria for subprogram completion or target activity level	(TEC)	Energy supply contribution of _____					
Manpower ^{b/}							
List Major Results		Identify approximate dates when results (use o) are expected or decisions (use x) required - e.g., ERDA demo plant start 1981, full scale joint industry/ERDA plant start 1987.					
Decisions Points Anticipated							
Milestones/Output							

[EXAMPLE:]

Manpower

Peak: 1500 professionals
Average: 1100 professional

Peak: ~30% increase professionals
Average: ~30% similar increase

Peak: Fewer than mid-term approach zero by 20

Decisions Points Anticipated

Decision to build a pilot plant; selection made from competing approaches (refer to competing approaches); a/ MW or _____ bbls of oil or equivalent.

Major Results Expected

Operation of a demonstration plant.
a/ MW or _____ bbls of oil or equivalent.

Subprogram Output

Successful transfer and operation by private industry of all necessary technology.

a/ Potential total impact of decision or result in terms of possible energy supplied.

b/ Projection of either professional or gross manpower, at least by the three time periods. Numerical data should be presented for near term and relative changes for the next two periods.

OUTLINE OF MEETING WITH SENIOR PLANNING GROUP - MAY 13, 1975

1. Outcome of P/BRC Meetings, May 5-9

- o Consensus on General Methodologies for presenting:
 - The energy problem and its ramifications
 - The domestic resource base and its uncertainties
 - The possible responses to the problems that form goals
 - The probable contribution of key technologies (scenarios)
 - The messages that result from studying scenarios
 - The problems with the key technologies and the role of supporting technologies
 - The need for program design that addresses the identified problems
 - The role of the Federal Government as determined from program design
- o A Budget Mark

2. Outcome of APA/OC Work on AA submissions

- o Reduced versions of technology descriptions in Plan - Chapter 2
- o Strawman objectives and Program Strategies in Plan - Chapter 6
- o Reduced versions of Program Implementation - Vols. I and II for volume reduction and clarity

3. Projected APA/OC work:

- o Rewrite Plan generally along lines of APA presentations at P/BRC meeting
- o Prepare budget tables in accordance with marks on May 9
- o OC prepare supplemental request
- o Rewrite Program implementation to agree with Plan & budget mark. PI to address:
 - Program unit (technology) objectives

- Designation of sub-program priorities.
- Identification of major technologies problems, institutional problems
- Clarification of Government role
- Description of activities that attack problems to achieve objectives
- Key milestones

4. Projected AA work

- o Rework financial tables per mark up - primarily OC
- o Revise technology description for Plan - Chapter 2
- o Revise Objectives and Program Strategies for Plan - Chapter 6
- o Revise Program Implementation pages for Volume II

(Note: the last three tasks should be accomplished simultaneously since the material is duplicative in Plan and Program Implementation)

- Should be accomplished by May 16
- APA Team approach will be used

5. Schedule:

- o APA Staff work with AA staffs on rewrites May 14 - 16
- o Draft of Volume I and Volume II for Fri/Seamans May 28
- o Draft Report to OMB on June 1

NOTES

1. The Section "Other Federal Programs" has been inserted for only the Sub-unit "Oil & Gas Extraction" and is to be used as a guide for the Solar Thermal sub-unit of the Solar Electric unit.

It is not clear whether such other Federal inputs will be available for inserting in many of the Program Sub-units.

2. Federal Roles may not be appropriate for each sub-unit.
3. There is an overlap between the implementation and the Milestones/Output charts. We desire the Implementation to improve the comprehensibility of the charts.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
Program Description
Solar Electric Applications Technology Unit
1. ~~OIL AND GAS FROM UNDERGROUND SOURCES~~

Technological

Program Unit Summary

Objectives

- To provide
- Near Term (1985): Increase annual production from bitumens, tar sands and oil shale by 500 million barrels of oil, 5 trillion cubic feet of natural gas, 18 million barrels of shale oil.
- Mid Term (-2000): Transfer technology to industry for in-situ conversion of coal to intermediate or low BTU gas.
- Long Term (2000+): Develop in-situ technology for recovery of fuel values from resources not economically recoverable by conventional means.

Strategy

- o Produce more oil and gas from existing sources.
- o Increase rate of recovery/conversion from existing sources.
- o Develop new sources.

Subprogram Units (by rank order)

- o Oil and Gas Extraction
- o In Situ Oil Shale Processing
- o In Situ Coal Gasification
- o Advanced Research and Supporting Technology

Oil and Gas Extraction Subprogram

Assumptions

- o Tax and other legislative remedies will be enacted to permit field unitization.
- o Adequate supplies of necessary chemicals will be available.
- o Field personnel can be recruited and trained in advanced recovery techniques.
- o Energy policies and demonstrations will provide investment incentives for adoption of advanced recovery techniques.

Problems

Technological

- o Data limitations prevent making high success probability forecasts of incremental output.
- o Possible breakouts of stimulation fluids from unitized reservoirs may pose catastrophic risk to entrepreneur.
- o Massive hydraulic or chemical explosive fracturing is especially risky for individual wells.

Institutional

- o Unavailability of resources because of its stated proprietary nature.
- o The difficulty of unitization of reservoirs or fields, i.e. highly fragmented ownership.
- o The availability of presently known or proven technological data or technologies because of a stated proprietary nature.

Institutional (continued)

- o State-by-state control and regulations of oil production and conservation.
- o Anti-trust problems because of mutual benefit agreements among major oil producers.
- o Price controls and taxation make high risk investments by industry in enhanced recovery uncertain.

Federal Role

- o Public distrust of oil industry requires even handed Government treatment for leasing, developmental support, output price guarantees.
- o Cost sharing proffers for stimulation projects should be on a RFP bid basis.
- o Equitable tax and price treatment for recovery increments from stimulation compared with new drilling.

Implementation

Initially, ERDA will share the costs of projects involving new technology for demonstrating fluid injections and thermal methods to recover oil as well as hydraulic and/or chemical explosive fracturing of gas-containing formations. A few major demonstrations are already underway; more will be initiated in FY 76. As experience with these demonstrations grows, new innovative demonstration projects will promptly be activated. Substantiation by 1980 of the commercial viability of some or all of the tested methods is sought. Utilization of the newer technology could yield an increase by early 1983 in daily production of 1 million barrels of oil and 6 billion cubic feet of natural gas.

1976-

Demonstrations will be initiated or expanded for:

- o micellar and polymer flooding through fluid injection;
- o carbon dioxide injections systems;
- o water flood recovery systems in untested conditions;
- o thermal recovery;
- o Solfrac extraction and cyclic solvent stimulation;
- o massive hydraulic fracturing;
- o chemical explosive fracturing;
- o deviated wells and earth fracture systems.

1979-82

Demonstrations will be evaluated. Resulting technology will be transferred to industry.

Other Federal ProgramsAgencyOutputs

Dept. of Interior	Improved reservoir data for unitization
N. Science Foundation	Study relating water flooding yields to down hole temperatures
Texas Railroad Commission	CO ₂ proximity to viscous oil reservoirs
Dept. of Commerce	Study of distribution pipelines for multiple product distribution

In Situ Oil Shale Processing Subprogram

Assumptions

- o Resource lands will be made available from both publicly and privately held sources.
- o Venture capital can be attracted to demonstration projects.
- o World oil prices will remain above the break-even point for shale oil.
- o Necessary water can be made available.

Federal Role

- o Longer range product price guarantees may be required to obtain process scaleups.
- o Interacting conservation, wildlands, wildlife, Indian lands, and other constituencies must be weighed against domestic energy requirements.

Problems

Institutional

- o Price structure for syncrude is clouded and therefore private investment capital is limited.
- o Land acquisition procedures are not clear.
- o Acceptability of environmental and socio-economical impacts on the sparsely populated Western areas are unclear.

Technological

- o Ultimate resource recovery efficiency has not been demonstrated at an acceptable level.
- o Demonstration of control ability and acceptability of subsidence, structural water impacts and product burn is necessary.
- o No transport methods exist to move the product to market in the quantities produced.

Implementation

Design of several large scale tests (about 10 acres) of the oil shale processing concept in FY 76 will lead to the first test operation in FY 77. Additional tests, in-house and under contract, will be undertaken in the following years, with a demonstration scale (50-acre) test scheduled to be in the design stage by 1980. Meanwhile, beginning with the design phase in FY 76, an above-ground simulation facility for demonstration of in situ oil shale gasification will started. Actual field tests of the facility are projected for FY 80. If successful, the process will make possible commercial installations producing 250 billion BTU equivalent by 1985.

1976-77

- o Field test number 1 above-ground, engineering scale, modified vertical retorts will begin.
- o Field test number 1 and number 2 and evaluation of modified horizontal retorting will take place.
- o A 25 ton/day test facility for gas production will start operation.
- o Operation of field test number 1 of true in situ oil shale processing will be initiated.

1978-82

- o Evaluations of test undertaken in FY 76 and 77 will continue.
- o Field test number 5 of true in situ oil shale processing will begin in FY 78 and continue through FY 82.
- o Field tests 5 and 6 of modified horizontal retorting and their evaluations will also begin and run for the entire period.
- o The 25 ton/day test facility for gas production will continue operation through 1981.

1983

- o The 25 ton/day test facility for gas production from oil shale will be followed by a full field test, scheduled for extensive operation and evaluation in 1983.

In Situ Coal Gasification Subprogram

Assumptions

- o Environmental impact problems can be identified and solved.
- o Optimum borehole configurations can be determined.
- o Effective bed pre-ignition preparation means can be determined.
- o Economical systems of underground gasification and above-ground boilers/turbines can be designed and demonstrated.

Federal Role

- o International cooperation will continue on in situ coal gasification.
- o Identification and solution of problems involving privately owned data and technologies.
- o Federal resource surveys well attuned to in situ gasification needs so best methods of resource recovery may result.

Problems

Institutional

- o Longer term, Stabilized prices for product gas.
- o Inequity of depletion treatments between coal and gas.
- o Availability of coal lands for in situ gasification.

Technical

- o Control and determination of subsidence.
- o Control and capture of products.
- o Directional control of fire front.

Implementation

Field studies initiated previously and operating in Western coal beds will continue in FY 76. Similar studies with Eastern beds will be started up. Various methods to increase gas heat value (e.g., oxygen injection) will be tested, as will the feasibility of direct methanol and/or ammonia production. Efforts in subsequent years will be centered on scaling up to a 300 MW demonstration system of coal underground gasification that includes environmental controls, such as removal of SOX from the produced gas.

1976-77

- o Eastern Area field pilot test will be run and evaluated.
- o Evaluation of oxygen injection experiments, Western Area field pilot test will be completed.
- o Decision to proceed with prototype demonstration unit construction will be made; construction will begin if decision is affirmative.

1979-80

- o Gasification experiment at the prototype demonstration unit will be completed and evaluated by 1980.
- o Decision to proceed, followed by design and construction, of a commercial scale demonstration plant is scheduled for 1979. Results of extensive operation and evaluation will be in by 1989.

Advanced Research and Supporting Technology Subprogram

Assumptions

- o The utilization of fossil fuels from tar sands and oil shale deposits requires detailed product characterization and refining process developments will proceed including possible automotive fuel studies so utilization of tar, sand and shale oil outputs will be optimal.

Federal Role

- o Use of Energy Centers, National Laboratories, academia and technically centered organizations to collect characterizing data improve instrumentation and controllability and guarantee public acceptability of activities.

Problems

Technical

- o Product liquids poorly characterized relative to further refinability or end uses.
- o Prompt, better definition of equipment materials problems to minimize technology impediments.

Implementation

Concurrent with the work on other subprogram units, and in support of them, there will be carried out:

- o Physical and chemical characterization studies of tar sand and shale oil;
- o refining tests of crude tar sands and shale oils to define conditions needed for the commercial processing of these fuels to distillates;
- o automotive tests to determine the suitability of these distillate fuels for conventional motor transportation;
- o basic and applied colloid chemistry studies for improved additives and polymers for waterflooding and micellar/polymer flooding;
- o system studies to compare progress and cost of the program with estimated cost of product, market requirements and environmental conditions.

[illegible]

[illegible]

APPENDIX B

SOLAR ELECTRIC APPLICATIONS
"PHASE III" BUDGET SUBMISSIONS

APPENDIX B1

MARCH 21, 1975, DRAFT

V.

SOLAR ELECTRIC APPLICATIONS

The objective of the Solar Electric Applications (SEA) Program is to establish the technical and economic feasibility of using solar thermal, photovoltaic energy, wind energy and ocean thermal energy conversion to produce electricity. This will be accomplished through research, development and demonstration (RD&D) programs. These programs will result in the operation and test of demonstration plants in the near-term and the expanded use of commercial plants in the mid and long-terms.

Government sponsorship of the solar electric programs is required in the formative years to ensure that first-generation commercial plants can begin operating as early as possible. This sponsorship will also create the integrated government-institutional-industrial basis so necessary for the timely accomplishment of the overall program objectives. The specific objectives, strategy and approaches of the program subunits comprising the Solar Electric Applications are as follows:

A. Solar Thermal

The major objectives of solar thermal are: (1) to provide full system capability for production of supplementary electric power and thermal power in the 1980's to conserve natural resources and (2) to provide a full system capability for total energy systems (combined electric-thermal) for urban and rural communities, industrial/institutional load centers and military bases at rates competitive with conventional energy sources.

Few fundamental technical limitations exist to prevent substantial application of solar thermal systems. The subprogram objective is therefore to develop and demonstrate the economically competitive capabilities of intermediate load (load-following) solar thermal power plants and solar total energy systems.

Parallel contracts were awarded in 1975 for subsystem hardware for a load following/intermediate load central receiver solar thermal electric power plant. These contracts include the development and test of collector, receiver, and thermal storage concepts. A 5 MWth Solar Thermal Test Facility will be constructed in 1976 to test the subsystem hardware. Construction of a 10MWe Central Receiver Pilot Plant will be initiated in 1977 and the plant integrated with a utility grid in 1979 in cooperation with several utilities. This pilot plant will be followed by a second generation pilot plant. A 100MWe demonstration Central Receiver Plant will be operational by 1985 to demonstrate technical and economic viability. Similar developments are planned for Total Energy Systems (combined electrical-thermal), Distributed Collector Systems and Hybrid Solar Thermal Systems. Additional Research and Development studies covering collector/surface coatings, high

temperature material development and solar thermal mission/system analysis are also planned.

B. Solar Photovoltaic Conversion

A major near-term objective of the Solar Photovoltaic Conversion is to stimulate a U.S. production capacity of 500 MWe per year of silicon solar arrays at a price of less than \$500 per peak kilowatt by 1984. This will be accomplished by initiating an annual procurement schedule for these arrays, ranging from 75 KW in FY 76 to 4 MW in FY 83. These arrays will be used in a blend of applications to generate electrical energy. The initial 75 KWe (peak) of arrays will be used in cooperation with DOD on isolated military bases for demonstrations of energy self-sufficiency beginning in FY 76. If these demonstrations prove successful, DOD is planning to buy substantial quantities of solar arrays for further applications starting at an annual level of 100 KWe (peak) when array prices approach \$5,000 per peak kilowatt, and at an annual level of 5 MWe (peak) for an array price near \$2,500 per peak kilowatt. Studies on promising concentration systems, operating and maintenance procedures, electrical storage and power conditioning, electric utility grid interfaces, and materials and device testing and standardization procedures, as well as studies of environmental, legal, societal, institutional and other possible system constraints, will also be conducted.

A research and development program on alternative materials and low-cost devices will be pursued in parallel with these efforts to insure meeting about 1% of the Nation's electrical power requirements goals in the 1990 to 2000 year period.

C. Wind Energy Conversion

The objective of the Wind Energy Conversion is to accelerate the development and commercial use of economic reliable wind energy systems. Such systems have a minimal environmental impact, use a non-depletable energy source and are capable of producing significant energy outputs.

The strategy of the wind energy conversion programs will be to develop a series of experimental systems of increasing size and capability, supported by a research and technology base, leading to incrementally installed multi-unit demonstration systems, jointly funded with users, in the early 1980s. While the emphasis is on electrical generation for electrical utility use, direct heat, crop drying and fertilizer, manufacturing, and fuel generation will also be demonstrated. Since large-scale production of individual units that are small by utility standards (one MW per unit) is anticipated, the Federal involvement in the development of suitable production facilities by the mid-1980s is a possible portion of the strategy.

The planned R&D program would lead to verification of successful systems by 1979, several 100 MW demonstrations by the early 1980s and

mass-production capabilities in excess of 15,000 MWe per year, at a cost of \$250 - \$300 per rated kilowatt in the mid term.

D. Ocean Thermal Energy Conversion

The objective of Ocean Thermal Energy Conversion (OTEC) is to demonstrate the feasibility of producing electricity through the ocean temperature differences. The feasibility of producing energy-intensive fertilizers and fuels from seawater and refining metals will also be investigated.

The commercial acceptance of the sea-based ocean thermal conversion stations requires the full-scale demonstration of system performance and cost estimates. Studies now in process indicate the technical knowledge is available for building an experimental prototype. The additional engineering development required is of the adaptive and scale-up variety. The scientific efforts paralleling this effort will provide design optimization and reduce construction costs. The program development emphasis has been placed on advancing a baseline design incorporating low-risk design concepts and incorporating design improvement only as their feasibility is documented. This approach ensures that the overall progress of the program will not be impeded.

The initial prototype is planned around the use of a full scale platform as hydrodynamic, thermodynamic mooring and environmental effects do not lend themselves to subscale testing. System design, critical component testing, material, and implementation studies are in process. Land test facilities will be constructed in 1976 and sea test facilities in 1977. The prototype floating ocean thermal plant will be tested in 1981. The first commercial ocean thermal plants will be brought on line by 1985. Production of these and larger size plants can then be accelerated in the intermediate-term.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

V. Solar Electric Applications

A. Solar Thermal 1251.7

- 40,000 MWe generated saving 320 million
barrels of oil per year

●2000

1. Central Receiver Power Plant (487.1)

Decision to build 10 MWe Pilot Plant X(in work)

Decision to build 100 MWe
Demonstration Plant X(1979)

Decision to build First Commercial
Plant (100 to 300 MWe) X(1982)

10 MWe Pilot Plant checked out and
operating ●(1979)

100 MWe Demonstration plant in
operation ●(1985)

Initial Commercial 100 to 300 MWe
Plants in operation ●(1987)

B1-5

X Decisions ● Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

	Total Est. Cost Through Completion (Millions of Dollars)					
		Near Term		Mid Term		Long Term
		1975	1980	1985	1990	1995 2000
<u>A. Solar Thermal</u> (Continued)						
2. Solar Thermal Test Facilities	(89.1)					
Decision to build Central Receiver Facility			X(in work)			
Decision to build Distributed Collector Facility			X(1976)			
Central Receiver Facility Operating				•(1977)		
Distributed Collector Facility Operating					•(1978)	
3. Solar Total Energy Systems	(265.8)					
Decision to build Pilot 200KWe, 2 MWth (System #1)			X(1975)			
Decision to build Pilot 200KWe, 2MWth (System #2)				X(1976)		
Decision to build 10MWth (System #1) Demonstration Plant					X(1979)	
Decision to build 10MWe, 200MWth (System #2) Demonstration Plant						X(1980)

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term	
	1975	1980	1985	1990	1995	2000	

A. Solar Thermal
(Continued)

3. Solar Total Energy Systems
(Continued)

200 KWe, 2MWth Pilot Plants
(Systems 1 & 2) checked out
and operating

•(1981)

10MWe, 200MWth Demonstration Plant
(System #1) in operation

•(1985)

10 MWe, 50MWth Demonstration Plant
(System #2) in operation

•(1986)

4. Distributed Collector Power Plant (114.1)

Decision to build 10 MWe Pilot Plant

X(1977)

Decision to build 100MWe Demon-
stration Plant

X(1982)

10MWe Pilot Plant checked out
and operating

•(1981)

100MWe Demonstration Plant in
operation

•(1987)

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

A. Solar Thermal
(Continued)

5. Hybrid Solar Thermal Systems	(161.3)						
Decision to build initial pilot plant		X(1978)					
Pilot Plant #1 checked out and operating				●(1981)			
Pilot Plant #3 checked out and operating					●(1983)		
6. Research and Development	(114.4)						
7. Program Support	(19.3)						

B1-8

X Decisions ● Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications
(Continued)

B. Solar Photovoltaic Conversion 1,427.9
1. Systems and Applications (225.6)

Candidate SPC Applications selected X(1976)

SPC System Constraints Defined X(1977)

SPC Demonstration Plan selected X(1976)

SPC Systems and Sub-Systems Specified •(1978)

Operation of Demonstrations
Initiated: 75KW/1976; (76)(77)(78)(79)
300KW/1977; 500KW/1978;
1 -MW/1979; 2-MW/1980; 4-MW/
1981; 7-MW/1982; 11-MW/1983
(80) 81 82 (83)

2. Low-Cost Silicon Array Project (731.3)

Silicon Material Process Selected X(1977)

Silicon-Array Accelerated-Lifetime Test-Approach Selected X(1977)

Silicon-Sheet Growth-Process Selected X(1979)

Automated Array-Fabrication Process Selected X(1978)

Go-Ahead on Construction of 500-MW Fabrication Plant X(1979)

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications

B.2 Low-Cost Silicon Array Project
(Continued)

Go-Ahead on Continued-Production for
Demonstrations

X(1976) → yearly

Pilot-Plant for Silicon-Material in
Operation

•(1979)

Pilot-Plant for Large-Area Silicon-
Sheets in Operation

•(1982)

Pilot-Plant for Automated-Production of
Arrays in Operation

•(1982)

Large-Scale Plant for Silicon-Material
in Operation

•(1983)

Large-Scale Plant for Automated-
Production of SPC Arrays: \$500/KW

•(1984)

Delivery of SPC-Arrays for ERDA Demon-
strations 75KW/1976; 150KW/1977; 200KW/
1978; 500KW/1979; 1-MW/1980; 2-MW/1981;
3-MW/1982; 4MW/1983

(1976) → (1983)
• • • • • • • •

X Decisions • Results

B1-10

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est.
Cost Through
Completion
(Millions of
Dollars)

1975	1980	1985	1990	1995	2000	Long Term

V. Solar Electric Applications

B. Solar Photovoltaic Conversion
(Continued)

3. Concentrator Systems (84.9)

Concentrator System Design Selected:

X(1976)

X(1981)

\$5,000/KW in 1976; \$250/KW in 1981
Production and Operation of Con-
centrator Systems: \$5,000/KW in
1977; \$250/KW in 1984

•(1977)

•(1984)

4. Testing and Standards (57.0)

Solar Array Performance Measure-
ments Approach Selected

X(1976)

Go-Ahead on SPC Test and Standard-
ization Facility

X(1976)

Final Performance Specifications
defined

•(1978)

Test and Standardization Facility
in Operation

•(1976)

5. Research and Development (155.4)

Other SPC Candidate Materials and
Devices Selected for Further
Development

X(1976) → yearly

Go-Ahead on Large-Scale Production

X(1984)

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications

B. 5. Research and Development
(Continued)

Thin-Film SPC Demonstrated at 10%
Efficiency

•(1980)

Feasibility of \$100/KW Arrays
Demonstrated

•(1984)

50,000 MW/Year Produced at \$100/KW

•(1992)

6. Energy Storage and Power Conditioning (168.0)

Final Candidates Selected

X(1979)

Test Program Approach Selected

X(1977)

Evaluation of Energy-Storage and
Power-Conditioning Completed

•(1977)

Prototype Testing Completed

•(1978)

Testing of Control Systems Completed

•(1983)

7. Assessment of Goals (5.7)

Plant Ownership and Operation Plan
Selected

•(1979)

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications

109.0 (R&D)
331.2 (RD&D)*

C. Wind Energy Conversion

B1-13

1. Research, Technology and (36.6)

Program Development

Initial Application Regions
Selected

Recommendations on Possible
Incentives

Initial WECS Systems Analyses
Completed

Initial Env/Legal/Public
Acceptance Results

Site Selection Completed

TP
X(1976)

X(1978)

•(1976)

•(1977)

•(1979)

2. Individual Farm WEC System (6.9)

Decision to Implement Major
Farm Demonstration or
Incentives Program

Initial Heating and Cooling
Practicality of Fertilizer
and Crop Drying Determined

X(1978)

•(1977)

•(1979)

3. 100-KW Systems (15.2)

Sites Selected for Mod-1

Alternate Concepts Selected

Decision for Large Demonstration

X(1976)

X(1977)

X(1979)

X Decisions • Results

*Includes demonstration costs but not the costs of manufacturing plant or Federal incentives for accelerated commercial production

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications

C. Wind Energy Conversion (Cont'd):

Fabrication of Mod-0, Completed •(1976)
Initial Tests Completed, Mod-0 •(1977)
Initial Test Completed on Mod-1 •(1978)
Practicality of Mod-2, Alternate •(1979)
Concepts Determined

4. MW-Scale WECS (\$31.8M)
Sites Selected for Mod-1, X(1976)
MW-Scale
Sites Selected for Mod-2, X(1977)
MW-Scale
Alternate Concepts for MW-Scale X(1977)
Selected
Fabrication of Mod-1, MW-Scale •(1977)
Completed
Fabrication of Mod-2, MW-Scale •(1979)
Completed
Tests of Mod-1 and 2, MW-Scale •(1980)
Completed
Practicality of MW-Scale Alternate •(1981)
Concepts Determined

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications

C. Wind Energy Conversion (Cont'd)

5. <u>Large-Scale, Multi-Unit</u>	(240.7)					
Initial 10-MW Multi-Unit WECS Committed to Incremental Construction		X(1978)				
Initial 100-MW Multi-Unit WECS Committed to Incremental Construction		X(1979)				
Commitment to Large-Scale Pro- duction of MW-Scale WECS		X(1981)				
Fabrication of 10-MW Multi-Unit WECS Demonstration Completed		•(1979)				
Fabrication of 100-MW Multi-Unit WECS Demonstration Completed		•(1981)				
Initial Tests of 10-MW Multi- Unit WECS Demonstration Completed		•(1981)				
Initial Tests of Fourth 100-MW Multi-Unit WECS Demonstration Completed				•(1985)		
(170 MW _e Capacity Achieved)		•(1981)				
Large-Scale Production of WECS Started*			•(1983)			
(15,000 MW _e Capacity Achieved)*				•(1985)		

*Assumes major Federal commitment and incentives program.
Costs of WECS production and Federal incentives program are not included in funding shown.

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications
(Continued)

D. Ocean Thermal Energy Conversion

704.9¹

1. System Studies

(2.5)

X(in work)

Award contracts to study technical
and economic feasibility of ocean
thermal differences, conduct
engineering evaluations and
develop test program

2. Land-Based Test Facility

(24.5)

Award design contracts

X(1975)

Award construction contracts

X(1976)

Facility design completed

●(1976)

First phase of construction complete

●(1977)

Second phase of construction complete

●(1978)

3. Sea-Based Test Facility

(25.5)

Award design contracts

X(1975)

Award construction contracts

X(1976)

Facility design complete

●(1976)

Facility operating

●(1977)

¹ Estimates through 1985

X Decisions ● Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications

D. Ocean Thermal Energy Conversion
(Continued)

4. Critical System Components (65.9)
Research and Development

Award heat exchanger research
and development contracts X(in work)

Award mod 0 design and construction
contract X(1975)

Award research and development
contracts on turbines, pumps,
anchoring/mooring/dynamic positioning
deep water pipe, materials/corrosion
biofouling and screening X(1975)

Award mod 1 design and construction
contract X(1977)

Award systems engineering study of
anchoring/mooring/dynamic positioning X(1977)

Award contracts for prototype and
long-lead time pumps, turbines and
platform equipment X(1978)

Construction of Mod 0 designs initiated •(1976)

Construction of Mod 0 designs complete
and tests underway •(1978)

BI-17

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est.
Cost Through
Completion
(Millions of
Dollars)

	Near Term		Mid Term				Long Term	
	1975	1980	1985	1990	1995	2000		

V. Solar Electric Applications

D. 4. Ocean Thermal Energy Conversion
(Continued)

Construction of mod 1 designs initiated	•(1978)							
Complete systems engineering study of anchoring/mooring/dynamic positioning	•(1978)							
Construction complete and tests underway		•(1980)						

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

IV. Solar Electric Applications
(Continued)

5. Prototype Floating Power Plant (301.0)

Award Preliminary Design

X(1979)

Contracts (2) for 100 MWe
Floating Plant and 25 MWe Power
Module (hull to be full size,
surface and semi submersible
options to be investigated)

Select Contractor for Final
Design and Award Contract

X(1980)

Award Contract for Purchase of
Long-Lead Time Materials and
Equipment for Prototype 100 MWe
Floating Plant

X(1980)

Award Contract For Construction
of Hull and Initial Power Module

X(1981)

Preliminary Design of Prototype
100 MWe and 25 MWe Power Module
Complete

•(1979)

Detailed Design of Prototype 100
MWe and 25 MWe Power Module
Complete

•(1981)

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications

(Continued)

5. Prototype Floating Power Plant
(Continued)

Test and Evaluation of Prototype
100 MWe Plant and 25 MWe Power
Module Commences

●(1983)

6. Commercial Demonstration Power Station (250.0)

Award Contract For Power Modules
for Commercial Demonstration
Model (Prototype Hull Will Be
Retrofitted with new Modules)

●(1982)

Test of 100 MWe Commercial Demonstration
Model Containing Four Improved 25
MWe Power Modules

●(1985)

7. Advanced Research and Technology (35.4)

Award Study Contracts on Energy
Delivery, Product Mix Impact and
Siting, Thermal Resources and
Legal Considerations (Includes
provision for Maritime Administra-
tion assistance in establishing
platform design requirements)

X(In Work)

X Decisions ● Results

B1-20

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term				Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications

(Continued)

8. Other Renewable Energy Resource
Studies (0.1)

Award Contract to Review Potential
of Ocean Currents, Waves, Tides
and Salinity Gradients as Energy
Source

X(1975)

X Decisions • Results

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTION SUMMARY
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

	FY 75	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
Operating Expenses.....	27.0		95.9		37.9	169.5	215.4	214.4	221.2	208.7	516.1
Capital Equipment.....	0.5		14.9		7.0	43.7	52.5	77.4	107.2	132.4	243.5
Plant.....			5.6		2.0	36.3	46.2	87.2	119.1	208.5	742.5
<u>Total SEA Program.....</u>	<u>27.05</u>		<u>116.4</u>		<u>46.9</u>	<u>249.5</u>	<u>314.1</u>	<u>379.0</u>	<u>447.5</u>	<u>549.6</u>	<u>1502.1</u>

FUNDS FROM OTHERS (not added to ERDA total)

A. Solar Thermal (Anticipated Utility participation)											330.0 to 790.0
B. Solar Photovoltaic Conversion (Department of Defense)						2.0	3.5	6.4	15.0	33.0	50.0 (Thru 1984)
C. Wind Energy Conversion (Joint Funding from Utilities)									6.0	36.0	73.5 (Thru 1986)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTIONS
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

OPERATING EXPENSES	EST.	FY 1976		Transition Period		Program Projections					Thru Completion
	FY 75	Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
A. Solar Thermal											
1. Central Receiver Power Plant	5.1		8.6		2.1	7.1	9.1	10.7	17.3	18.2	29.1
2. Solar Thermal Test Facilities			5.3		0.8	8.9	4.8	4.5	5.9	5.9	18.5
3. Solar Total Energy Systems	2.3		5.9		1.3	12.0	15.4	18.2	20.1	19.4	13.0
4. Distributed Collector Power Plant	0.1					5.5	5.8	9.6	8.0	9.0	14.0
5. Hybrid Solar Thermal Systems						1.9	4.1	6.3	9.2	10.8	28.0
6. Research and Development	1.9		6.0		1.5	10.0	15.0	15.0	15.0	10.0	40.0
7. Program Support	0.6	1.95	1.2	0.5	0.4	1.9	1.9	1.9	1.9	1.9	7.6
Total	10.0		27.0		6.1	47.3	56.1	66.2	77.4	75.2	150.2
B. Solar Photovoltaic Conversion	7.5	10.8	49.8	25.8	40.6	94.3	133.0	116.5	114.5	109.0	307.5 (Thru 1984)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTIONS
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

OPERATING EXPENSES (Continued)	EST. FY 75	FY 1976		Transition Period		Program Projections					Thru Completion
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
C. Wind Energy Conversion	6.5		12.7		4.2	16.8	15.8	11.9	10.3	4.7	5.5 (Thru 1986)
D. Ocean Thermal Energy Conversion											
1. System Studies	1.1		0.5			0.3	0.3	0.2	0.1		
2. Land Based Test Facility			0.5			0.3	0.7	1.0	1.0	1.0	
3. Sea Based Test Facility			0.5			0.3	0.8	0.8	0.8	0.8	16.6 (Thru 1985)
4. Critical System Components Research & Development	0.5		3.3		1.2	9.0	7.2	5.9	7.7	5.5	8.5 (Thru 1985)
5. Prototype Floating Plant Design								5.0	5.0	7.0	14.0 (Thru 1985)
7. Advanced Research & Technology	1.4		1.5		0.6	2.5	3.5	3.9	4.4	3.7	13.9 (Thru 1985)
8. Other Renewable Energy Sources Studies			0.1								
Total	3.0		6.4		1.8	12.4	12.5	16.8	19.0	18.0	52.9 (Thru 1985)

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

CAPITAL EQUIPMENT (BUDGET AUTHORITY)	Est.	FY 1976		Transition Period		Program Projections					Thru Completion
	FY 75	Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
A. Solar Thermal											
1. Central Receiver Power Plant						2.9	9.6	10.6	5.1	5.0	50.0
2. Solar Thermal Test Facilities			0.7		0.2	8.5	3.0	2.0			
3. Solar Total Energy System						0.5	2.0	3.3	9.1	12.7	27.0
4. Distributed Collector Power Plant							1.9	9.0	7.0	12.6	3.0
5. Hybrid Solar Thermal Systems								3.0	11.0	19.0	27.0
Total			0.7		0.2	11.9	16.5	27.9	32.2	49.3	107.0
B. Solar Photovoltaic Conversion											
Computers (less than \$500,000)		0.2	0.2			0.2		0.2	0.4	0.4	1.5
Other Capital Equipment	0.5	1.8	8.8	4.0	—	24.8	30.0	44.8	74.6	84.6	135.0 (Thru
Total	0.5	2.0	9.0	4.0		25.0	30.0	45.00	75.0	85.0	136.5 1984)
C. Wind Energy Conversion			5.2		2.8	6.3	5.0	4.5			(Thru 1986)

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

PLANT (BUDGET AUTHORITY)	Est.	FY 1976		Transition Period		Program Projections					Thru Completion
	FY 75	Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
A. Solar Thermal											
1. Central Receiver Power Plant						5.0	14.7	14.4	7.5	5.0	250.0
2. Solar Thermal Test Facilities			0.8		0.8	16.5	2.0				
3. Solar Total Energy Systems						2.8	4.4	9.8	14.6	13.9	60.0
4. Distributed Collector Power Plant							6.0	4.0	10.0	6.6	2.0
5. Hybrid Solar Thermal Systems								4.0	8.0	12.0	17.0
Total			0.8		0.8	24.3	27.1	32.2	40.1	37.5	329.0
B. Solar Photovoltaic Conversion											
1. Large-Scale Silicon-Material Plant								10.0	10.0	10.0	5.0
2. Large-Scale Plant for Automated Production of Arrays								15.0	15.0	15.0	10.0
Total								25.0	25.0	25.0	15.0 (Thru 1984)

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

PLANT (BUDGET AUTHORITY) (Continued)	Est. FY 75	FY 1976		Transition Period		Program Projections					Thru Completion
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
C. Wind Energy Conversion							7.0	18.0	29.0	36.0	13.5 (Thru 1986)
D. Ocean Thermal Energy Conversion											
2. Land Based Test Facility			4.8		1.2	7.0	7.0				
3. Sea Based Test Facility						5.0					
4. Critical System Components Research & Development							5.1	12.0			
5. Prototype Floating Plant Design									25.0	110.0	135.0 (Thru 1982)
6. Commercial Demonstration Plant											25.00 (Thru 1985)
Total			4.8		1.2	12.0	12.1	12.0	110.0	110.0	385.0 (Thru 1985)

APPENDIX B2

MARCH 28, 1975, DRAFT

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

The objective of the Solar Electric Applications (SEA) Program is to establish the technical and economic feasibility of using solar thermal, photovoltaic energy, wind energy and ocean thermal energy conversion to produce electricity. This will be accomplished through research, development and demonstration (RD&D) programs. These programs will result in the operation and test of demonstration plants in the near-term and the expanded use of commercial plants in the mid and long-terms.

Government sponsorship of the solar electric programs is required in the formative years to ensure that first-generation commercial plants can begin operating as early as possible. This sponsorship will also create the integrated government-institutional-industrial basis so necessary for the timely accomplishment of the overall program objectives. The specific objectives, strategy and approaches of the program subunits comprising the Solar Electric Applications are as follows:

Solar Thermal

Output

The major objectives of solar thermal are: (1) to provide full system capability for production of supplementary electric power and thermal power in the 1980's to conserve natural resources and (2) to provide a full system capability for total energy systems (combined electric-thermal) for urban and rural communities, industrial/institutional load centers and military bases at rates competitive with conventional energy sources. It is anticipated that 40,000MW_e will be generated by the year 2,000 saving 320 million barrels of oil per year.

Assumptions

Few fundamental technical limitations exist to prevent substantial application of solar thermal systems. The subprogram strategy is therefore to develop and demonstrate the economically competitive capabilities of intermediate load (load-following) solar thermal power plants and solar total energy systems.

Implementation

Parallel contracts were awarded in 1975 for subsystem hardware for a load following/intermediate load central receiver solar thermal electric power plant. These contracts include the development and test of collector, receiver, and thermal storage concepts. A 5 MW_{th} Solar Thermal Test Facility will be constructed in 1976 to test the subsystem hardware. Construction of a 10MW_{th} Central Receiver Pilot Plant will be initiated in 1977 and the plant integrated with a utility grid in 1979 in cooperation with several utilities. This pilot plant will be followed by a second generation pilot plant. A 100MW_{th} Demonstration Central Receiver Plant will be operational by 1985 to demonstrate technical and economic viability. Similar developments are planned for Total Energy Systems (combined electrical-thermal), Distributed Collector Systems and Hybrid Solar Thermal Systems.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

Continued

Additional Research and Development studies covering collector/surface coatings, high temperature material development and solar thermal mission/system analysis are also planned.

Solar Photovoltaic Conversion

Output

A major near-term objective of the Solar Photovoltaic Conversion is to stimulate a U. S. production capacity of 500MW_e per year of silicon solar arrays at a price of less than \$500 per peak kilowatt by 1984. The production of about 1% of the Nation's electrical power requirements in the 1990 to 2000 year period is anticipated.

Assumptions

Studies on promising concentration systems, operating and maintenance procedures, electrical storage and power conditioning, electric utility grid interfaces, and materials and device testing and standardization procedures, as well as studies of environmental, legal, societal, institutional and other possible system constraints, will be conducted. A research and development program on alternative materials and low-cost devices will also be pursued.

Implementation

This will be accomplished by initiating an annual procurement schedule for these arrays, ranging from 75 KW in FY 76 to 4 MW in FY 83. These arrays will be used in a blend of applications to generate electrical energy. The initial 75 KW_e (peak) of arrays will be used in cooperation with DOD on isolated military bases for demonstrations of energy self-sufficiency beginning in FY 76. If these demonstrations prove successful, DOD is planning to buy substantial quantities of solar arrays for further applications starting at an annual level of 100 KW_e (peak) when array prices approach \$5,000 per peak kilowatt, and at an annual level of 5 MW_e (peak) for an array price near \$2,500 per peak kilowatt.

Wind Energy Conversion

Output

The objective of the Wind Energy Conversion is to accelerate the development and commercial use of economic reliable wind energy systems. Such systems have a minimal environmental impact, use a non-depletable energy source and are capable of producing significant energy outputs. The planned R&D program would lead to verification of successful systems by 1979, several 100 MW demonstrations by the early 1980s and mass-production capabilities in excess of 15,000 MW_e per year, at a cost of \$250 - \$300 per rated kilowatt in the mid term.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION
SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

Continued

Assumptions

Since large-scale production of individual units that are small by utility standards (one MW per unit) is anticipated, the Federal involvement in the development of suitable production facilities by the mid-1980s is a possible portion of the strategy.

Implementation

The strategy of the wind energy conversion programs will be to develop a series of experimental systems of increasing size and capability, supported by a research and technology base, leading to incrementally installed multi-unit demonstration systems, jointly funded with users, in the early 1980s. While the emphasis is on electrical generation for electrical utility use, direct heat, crop drying and fertilizer, manufacturing, and fuel generation will also be demonstrated.

Ocean Thermal Energy Conversion

Output

The objective of Ocean Thermal Energy Conversion (OTEC) is to demonstrate the feasibility of producing electricity through the ocean temperature differences. The feasibility of producing energy-intensive fertilizers and fuels from seawater and refining metals will also be investigated.

Assumptions

The commercial acceptance of the sea-based ocean thermal conversion stations requires the full-scale demonstration of system performance and cost estimates. Studies now in process indicate the technical knowledge is available for building an experimental prototype. The additional engineering development required is of the adaptive and scale-up variety. The scientific efforts paralleling this effort will provide design optimization and reduce construction costs. The program development emphasis has been placed on advancing a base-line design incorporating low-risk design concepts and incorporating design improvement only as their feasibility is documented. This approach ensures that the overall progress of the program will not be impeded.

Implementation

The initial prototype is planned around the use of a full scale platform as hydrodynamic, thermodynamic mooring and environmental effects do not lend themselves to subscale testing. System design, critical component testing, material, and implementation studies are in process. Land test facilities will be constructed in 1976 and sea test facilities in 1977. The prototype floating ocean thermal

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

Continued

plant will be brought on line by 1985. Production of these and larger size plants can then be accelerated in the intermediate-term.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications

A. Solar Thermal 1251.1a/

-40,000 MW_e generated saving 320 million
barrels of oil per year

•2000

Decision Points Anticipated

1. Central Receiver Power Plant

Decision to build 10 MW_e Pilot Plant X(in work)

Decision to build 100 MW_e
Demonstration Plant X(1979)

Decision to build First Commercial
Plant (100 to 300 MW_e) X(1982)

2. Solar Thermal Test Facilities

Decision to build Central Receiver
Facility X(in work)

Decision to build Distributed
Collector Facility X(1976)

a/Estimate through 1 year test of initial commercial plants in 1987.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Application (cont.)

A. Solar Thermal (cont.)

Decision Points Anticipated (cont.)

3. Solar Total Energy Systems

Decision to build Pilot 200 KW _e , 2MW _{th} (System #1)	X(1975)
Decision to build Pilot 200KW _e , 2MW _{th} (System #2)	X(1976)
Decision to build 10MW _{th} (System #1) Demonstration Plant	X(1979)
Decision to build 10MW _e , 200MW _{th} (System #2) Demonstration Plant	X(1980)

4. Distributed Collector Power Plant

Decision to build 10MW _e Pilot Plant	X(1977)
Decision to build 100MW _e Demonstration Plant	X(1982)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Application (cont.)

A. Solar Thermal (cont.)

Decision Points Anticipated (cont.)

5. Hybrid Solar Thermal Systems

Decision to build initial pilot plant

X(1976)

6. Research and Development

X(In-work and through completion of program)

7. Program Support

X(In- work and through completion of program)

Major Results Expected

1. Central Receiver Power Plant

10MW_e Pilot Plant checked out and
operating

•(1979)

100MW_e Demonstration plant in
operation

•(1985)

Initial Commercial 100 to 300MW_e
Plants in operation

•(1987)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Application (cont.)

A. Solar Thermal (cont.)

Major Results Expected (cont.)

2. Solar Thermal Test Facilities

Central Receiver Facility Operating •(1977)

Distributed Collector Facility
Operating •(1978)

3. Solar Total Energy Systems

200KW_e, 2MW_{th} Pilot Plants
(Systems 1 & 2) checked out
and operating •(1981)

10MW_e, 200MW_{th} Demonstration Plant
(System #1) in operation •(1985)

10MW_e, 50MW_{th} Demonstration Plant
(System #2) in operation •(1986)

4. Distributed Collector Power Plant

10MW_e Pilot Plant checked out
and operating •(1981)

100MW_e Demonstration Plant in
operation •(1987)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Application (cont.)

A. Solar Thermal (cont.)

Major Results Expected (cont.)

5. Hybrid Solar Thermal Systems

Pilot Plant #1 checked out and
operating

•(1981)

Pilot Plant #3 checked out and
operating

•(1983)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications

B. Solar Photovoltaic Conversion 1468.7^{a/}

-50,000 MW/year produced at \$100/KW

•(1992)

Decision Points Anticipated

1. Systems and Applications

Demonstration Plan selected X(1976)

Candidate Applications
selected X(1976)

System Constraints Defined X(1977)

2. Low-Cost Silicon Array Project

Accelerated-Lifetime Test-
Approach Selected X(1977)

Silicon Material Process Selected X(1977)

Automated Array Fabrication
Process Selected X(1978)

Silicon-Sheet Growth-Process
Selected X(1979)

Go-Ahead on Construction of 500-MW_e
Fabrication Plant X(1979)

^{a/}Include RD&D costs but not costs of manufacturing plants or Federal incentives for accelerated commercial production in mid and long terms.

(B2-1)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

B. Solar Photovoltaic Conversion (cont.)

Decision Points Anticipated (cont.)

2. Low-Cost Silicon Array Project (cont.)

Go-Ahead on continued Production for
Demonstrations

X(1976) → yearly

3. Concentrator Systems

\$5000/KW Design Selected

X(1976)

\$250/KW Design Selected

X(1981)

4. Testing and Standards

Solar Array Performance Measure-
ments Approach Selected

X(1976)

Go-Ahead on Test and Standard-
ization Facility

X(1976)

5. Research and Development

Other Candidate Materials and
Devices Selected for Further
Development

X(1976) → yearly

Go-Ahead on Large-Scale Production

X(1984)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

V. Solar Electric Applications (cont.)

B. Solar Photovoltaic Conversion (cont.)

Decision Points Anticipated (cont.)

6. Energy Storage and Power Conditioning

Test Program Approach Selected

X(1977)

Final Candidates Selected

X(1979)

Major Results Expected

1. Systems and Applications

Systems and Sub-systems Specified

•(1978)

Operation of Demonstrations

Initiated: 75KW/1976; 300KW/1977;

500KW/1980; 4-MW/1981; 7-MW/1982;

11-MW/1983

•(1976) → •(1983)

2. Low-Cost Silicon Array Project

Pilot-Plant for Silicon-Material in
Operation

•(1979)

Pilot-Plant for Large-Area Silicon-
Sheets in Operation

•(1982)

Pilot-Plant for Automated-Production
of Arrays in Operation

•(1982)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

B. Solar Photovoltaic Conversion (cont.)

Major Results Expected (cont.)

2. Low-Cost Silicon Array Project (cont.)

Large-Scale Plant for Silicon-Material
in Operation

•(1983)

Large-Scale Plant for Automated-
Production of SPC Arrays: \$500/KW

•(1984)

Delivery of SPC-Arrays for ERDA Demon-
strations 75KW/1976; 150KW/1977; 200KW/
1978; 500KW/1979; 1-MW/1980; 2-MW/1981;
3-MW/1982; 4MW/1983

•(1976) —————> •(1983)

3. Concentrator Systems

Production and Operation of \$5000/KW
Systems

•(1977)

Production and Operation of \$250/KW
Systems

•(1984)

4. Testing and Standards

Test and Standardization Facility
in Operation

•(1976)

Final Performance Specifications
Defined

•(1978)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

B. Solar Photovoltaic Conversion (cont.)

Major Results Expected (cont.)

5. Research And Development

Thin-Films Demonstrated at 10%
Efficiency

•(1980)

Feasibility of \$100/KW Arrays
Demonstrated

•(1984)

50,000MW/Year Produced at \$100/KW

•(1992)

6. Energy Storage and Power Conditioning

Evaluation of Energy-Storage and
Power-Conditioning Completed

•(1977)

Prototype Testing Completed

•(1978)

Testing of Control Systems Completed

•(1983)

7. Assessment of Goals

Plant Ownership and Operation Plan
Selected

•(1979)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion

274.7^B/

-15,000 MWe capacity achieved

• (1985)

Decision Points Anticipated

1. Research, Technology and
Program Development

Initial Application Regions
Selected

X(1976)

Recommendations on Possible
Incentives

X(1978)

2. Individual Farm WEC System

Decision to Implement Major
Farm Demonstration or
Incentives Program

X(1978)

3. 100-KW Systems

Sites Selected for Mod-1

X(1976)

Alternate Concepts Selected

X(1977)

Decision for Large Demonstration

X(1979)

Includes demonstration costs but not the costs of manufacturing plants or Federal incentives for accelerated commercial production

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.)

Decision Points Anticipated (cont.)

4. MW-Scale Systems

Sites Selected for Mcd-1	X(1976)
Sites Selected for Mcd-2	X(1977)
Alternate Concepts Selected	X(1977)

5. Large-Scale, Multi-Unit WECS

Commit to Incremental Construction - Initial 10 Mw	X(1978)
Commit to Incremental Construction - Initial 100 Mw	X(1979)
Commitment to Large-Scale Production	X(1981)

B2-17

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.)

Major Results Expected

1. Research, Technology and
Program Development

Initial Systems Analyses
Completed

•(1976)

Initial Env/Legal/Public
Acceptance Results

•(1977)

Site Selection Completed

•(1979)

2. Individual Farm System

Initial Heating and Cooling

•(1977)

Practicality of Fertilizer
and Crop Drying Determined

•(1979)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.)

Major Results Expected (Cont.)

3. 100 KW Systems

- Fabrication of Mod-0, Completed •(1976)
- Initial Tests Completed, Mod-0 •(1977)
- Initial Test Completed on Mod-1 •(1978)
- Practicality of Mod-2, Alternate Concepts Determined •(1979)

4. MW-Scale Systems

- Fabrication of Mod-1 Completed •(1977)
- Fabrication of Mod-2 Completed •(1979)
- Tests of Mod-1 and 2 Completed •(1980)
- Practicality Alternate Concepts Determined •(1981)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.)

Major Results Expected (Cont.)

5. Large-Scale, Multi-Unit
Systems

Fabrication of 10-MW
Demonstration Completed

•(1979)

Fabrication of 100-MW
Demonstration Completed

•(1981)

Initial Tests of 10-MW
Demonstration Completed

•(1981)

Initial Tests of Fourth
100-MW Demonstrated
Completed

•(1985)

(170 MW_e Capacity Achieved)

•(1981)

Large-Scale Production
Started^a

•(1983)

(15,000 MW_e Capacity Achieved)^{a/}

•(1985)

^{a/} Assumes major Federal Commitment and incentives program.

Costs of WECS production and Federal incentives program are not included in funding shown.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (con't)

D. Ocean Thermal Energy Conversion
-100 MW_e Commercial Demonstration
Model Operating

1058.6^{a/}

•(1985)

Decision Points Anticipated

1. System Studies

Contracts to study technical
and economic feasibility of
ocean thermal differences,
conduct engineering evalua-
tions and develop test program.

X(In work)

2. Land-Based Test Facility

Decision to Build

X(1975)

3. Sea-Based Test Facility

Decision to Build

X(1975)

4. Critical System Components
Research and Development

Heat exchanger research and
development contracts

X(in work)

Mod 0 design and construction
contracts

X(1975)

^{a/}Estimate through test of 100 MW_e Commercial Demonstration Model in 1985

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Decision Points Anticipated (cont.)

4. Critical System Components
Research and Development (cont.)

Research and development con-
tracts on turbines, pumps,
anchoring/mooring/dynamic posi-
tioning deep water pipe,
materials/corrosion biofouling
and screening

X(1975)

Mod 1 design and construction
contracts

X(1977)

Systems engineering study of
anchoring/mooring/dynamic
positioning

X(1977)

Contracts for prototype and
long-lead time pumps, turbines
and platform equipment

X(1978)

5. Prototype Floating Power Plant

Preliminary Design
Contracts (2) for 200 MW_e
Floating Plant and 25MW_e
Power Module (hull to be

B2-22

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Decision Points Anticipated (cont.)

5. Prototype Floating Power Plant (cont.)

full size, surface and semi
submersible options to be
investigated)

X(1979)

Contract for Purchase of Long-Lead
Time Materials and Equipment for
Prototype 100MW_e Floating Plant

X(1980)

Contract for Construction of Hull
and Initial Power Module

X(1981)

6. Commercial Demonstration Power Station

Contract for Power Modules for Commer-
cial Demonstration Model (Prototype
Hull will be Retrofitted with new
Modules)

X(1982)

7. Advanced Research and Technology

Study Contracts on Energy Delivery,
Product Mix Impact and Siting, Thermal
Resources and Legal Considerations
(Includes provision for Maritime
Administration assistance in establish-
ing platform design requirements)

X(In work)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Decision Points Anticipated (cont.)

8. Other Renewable Energy Resources
Studies

Contract to Review Potential of Ocean
Currents, Waves, Tides and Salinity
Gradients as Energy Source

X(1975)

Major Results Expected

1. System Studies (None identified)

2. Land-Based Test Facility

Facility design completed

•(1976)

First phase of construction complete

•(1977)

Second phase of construction complete

•(1978)

3. Sea-Based Test Facility

Facility Operating

•(1977)

4. Critical System Components
Research and Development

Construction of Mod 0 designs
initiated

•(1976)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Major Results Expected (cont.)

4. Critical System Components
Research and Development (cont.)

Construction of Mod 0 designs
and tests underway

•(1976)

Construction of Mod 1 designs
initiated

•(1978)

Systems engineering study of
anchoring/mooring/dynamic posi-
tioning complete

•(1978)

Construction complete and tests
underway

•(1980)

5. Prototype Floating Power Plant

Preliminary Design of Prototype
100MW_e and 25MW_e Power Module
complete.

•(1979)

Detailed Design of Prototype 100
MW_e and 25MW_e Power Module complete.

•(1981)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term	
	1975	1980	1985	1990	1995	2000		

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Major Results Expected (cont.)

5. Prototype Floating Power Plant (cont.)

Test and Evaluation of Prototype
100MW_e Plant and 25MW_e Power
Module Commences

•(1983)

6. Commercial Demonstration Power Station

Test of 100 MW_e Commercial Demonstration
Model Containing Four Improved 25MW_e
Power Modules Retrofitted into
Prototype Hull

•(1985)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTION SUMMARY
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

	Est. FY 75	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
Operating Expenses.....	27.0		71.7		17.5	202.8	246.2	213.7	223.5	210.5	520.7
Capital Equipment.....	0.5		10.0		3.5	45.3	56.5	77.9	107.2	132.4	243.5
Plant.....			5.6		2.0	38.9	51.9	98.6	144.5	221.7	1009.5
<u>Total SEA Program.....</u>	<u>27.5</u>	<u>40.7</u>	<u>87.3</u>	<u>11.8</u>	<u>23.0</u>	<u>287.0</u>	<u>354.6</u>	<u>390.2</u>	<u>475.2</u>	<u>634.6</u>	<u>1773.7</u>
<u>FUNDS FROM OTHERS</u> (not added to ERDA total)											
Funds from other agencies and industry, pass through and joint programs.											
U.S. Department of Defense ^{a/}			5.0		1.4	1.5	2.5	4.8	13.0	22.5	90.0
Joint Participation by Utilities ^{b/}									6.0	36.0	400.0 to 800
<u>Total Solar Electric Applications Funds From Others</u>			<u>5.0</u>		<u>1.4</u>	<u>1.5</u>	<u>2.5</u>	<u>4.8</u>	<u>19.0</u>	<u>58.5</u>	<u>490.0 to 890.0</u>

^{a/} Includes anticipated special opportunities for FY 76 Budget and Transition Period of \$3.8M for Solar Storage and Power Conditioning and \$2.6M for DOD Energy Self-Sufficiency Demonstration.

^{b/} Anticipate utility participation of up to 50% for demonstration facilities.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTIONS
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

OPERATING EXPENSES ^{a/}	Est.	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
	FY 75	Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
A. Solar Thermal	10.0		27.0		6.1	46.0	54.1	66.2	77.4	77.0	150.2 ^{b/}
B. Solar Photovoltaic Conversion	7.5		25.5		6.4	124.3	161.5	116.5	114.5	109.0	307.5 ^{c/}
C. Wind Energy Conversion	6.5		12.8		3.2	19.1	17.1	12.9	11.1	5.1	5.9 ^{d/}
D. Ocean Thermal Energy Conversion	3.0		6.4		1.8	13.4	13.5	18.1	20.5	19.4	57.1 ^{e/}
Total Solar Electric Applications Operating	27.0		71.7		17.5	202.8	246.2	213.7	223.5	210.5	520.7

- ^{a/} Escalation factor of 8% used for FY 1977 through completion
^{b/} Through 1 year of operation of 100MW_e Demonstration plant in 1987
^{c/} Through large scale production decisions in 1984
^{d/} Through 1 year of operation of large scale system in 1986
^{e/} Through 1 year of test of 100MW_e Commercial Demonstration Model in 1985

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

CAPITAL EQUIPMENT (BUDGET AUTHORITY) a/	Est. FY 75	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
Computers (less than \$500,000)			0.2			0.2	0.5	1.0	0.9	0.4	1.5
Other Equipment	0.5		9.8		3.5	45.1	56.0	76.9	106.3	132.0	242.0
Total Solar Electric Applications Equipment	0.5		10.0		3.5	45.3	56.5	77.9	107.2	132.4	243.5

a/ Escalation factor of 10% used for FY 1977 through completion

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

PLANT (BUDGET AUTHORITY)	TEC	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
New Projects ^{a/}											
Solar Thermal ^{b/}											
Central Receiver Power Plant	296.6					5.0	14.7	14.4	7.5	5.0	250.0
Solar Thermal Test Facilities	20.1		0.8		0.8	16.5	2.0				
Solar Total Energy Systems	105.5					2.8	4.4	9.8	14.6	13.9	60.0
Distributed Collector Power Plant	28.6						6.0	4.0	10.0	6.6	2.0
Hybrid Solar Thermal Systems	41.0							4.0	8.0	12.0	17.0
Solar Photovoltaic Conversion											
Large-Scale Silicon-Material Plant	35.0							10.0	10.0	10.0	5.0
Large-Scale Plant for Automated Production of Arrays	55.0							15.0	15.0	15.0	10.0
Wind Energy Conversion	155.5						9.1	24.8	42.6	56.5	22.5
Ocean Thermal Energy Conversion											
Land Based Test Facility	23.6		4.8		1.2	8.5	9.1				
Sea Based Test Facility	6.1					6.1					

B2-30

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

PLANT (BUDGET AUTHORITY) (cont.)	TEC	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
Ocean Thermal Energy Conversion (cont.)											
Critical System Components											
Research & Development	23.2						6.6	16.6			
Prototype Floating Plant											
Design	435.0								36.8	172.7	225.5
Commercial Demonstration Plant	417.5										417.5
Total Solar Electric Application Plant	1642.7	5.6		2.0		38.9	51.9	98.6	144.5	291.7	1009.5

a/ All project costs based on preliminary estimates, escalation factors over the period of construction schedule use FY 1975 as the base years: 1.11 for FY 76 and transition period, 1.22 for FY 77, 1.3 for FY 78, 1.38 for FY 79, 1.47 for FY 80, 1.57 for FY 81 and 1.67 for following years.

b/ Utilities are anticipated to contribute as much as 50% to demonstration and commercial plant developments.

APPENDIX B3

APRIL 5, 1975, DRAFT

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

The objective of the Solar Electric Applications Program is to establish the engineering and economic feasibility of using solar thermal, photovoltaic energy, wind energy and ocean thermal energy conversion to produce electricity. This will be accomplished through research, development and demonstration (RD&D) programs. These programs will result in the operation and test of pilot and demonstration plants by 1985 and in a technology and data base for implementation of commercial plants by the mid 1980's.

Government sponsorship of the solar electric programs is required in the formative years to accelerate the development and implementation of solar energy systems, shorten development times and overcome the lack of an industrial understanding of the potential of solar energy technology to meet U.S. energy needs. This sponsorship will create the integrated government-institutional-industrial basis so necessary for the timely accomplishment of the overall program objectives. The specific objectives, strategy and approaches of the program subunits comprising the Solar Electric Applications are as follows:

Solar Thermal

Output

The objectives of solar thermal subprogram are: (1) to provide full system capability for the production of supplementary electric and thermal power in the 1980's to conserve natural resources and (2) to provide a full system capability for total energy systems (combined electric-thermal) for urban and rural communities, industrial/institutional load centers and military bases at rates competitive with conventional energy sources. It is projected that 40,000MW_e of solar thermal power plants will be constructed by the year 2,000 saving about 320 million barrels of petroleum per year.

Assumptions

No fundamental technical limitations exist to prevent substantial application of solar thermal systems. Solutions to engineering and economic limitations must be developed, however. The subprogram strategy is therefore to develop and demonstrate the economic attractiveness of intermediate load and load-following solar thermal power plants and solar total energy systems.

Implementation

Parallel contracts are being awarded in 1975 for system concepts, subsystem hardware and for testing a load following/intermediate load central receiver solar thermal electric power plants. These include the design and test of collector, receiver, and thermal storage subsystems. A 5 MW_{th} Solar Thermal Test Facility will be constructed in 1976 to test subsystem hardware. Construction of a 10MW_e Central Receiver Pilot Plant will be initiated in FY 1977 and the plant integrated with a utility grid in FY 1979 in cooperation with several utilities. A 100MW_e Demonstration Central Receiver Plant will be operational by 1985 to demonstrate engineering and economic viability. Similar demonstrations are planned for total energy systems (combined electrical-thermal), distributed collector systems and hybrid solar thermal systems. Additional research and development studies covering

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

Continued

collector/surface coatings, high temperature material development and solar thermal mission/system analysis are also planned.

Solar Photovoltaic Conversion

Output

The major objective of the Solar Photovoltaic Conversion subprogram is to stimulate a U. S. production capacity of 500MW_e per year of silicon solar arrays at a price of less than \$500 per peak kilowatt by 1985. The production of 190,000 MW_e or about 1% of the Nation's electrical power requirements by the 2000 year period is anticipated resulting in an equivalent annual savings of 900 million barrels of petroleum.

Assumptions

Studies will be conducted on low cost silicon solar arrays, alternate materials, promising concentration systems, operating and maintenance procedures, electrical storage, power conditioning, electric utility grid interfaces, crystal growth, encapsulation and mass production processes, as well as studies of environmental, legal, societal, institutional and other possible system constraints.

Implementation

This will be accomplished by the annual procurement of silicon solar arrays for generating electrical energy, ranging from 75 KW_e in FY 76 to 4 MW_e in FY 83. The initial 75 KW_e (peak) of arrays will be used in cooperation with DOD on isolated military bases for demonstrations of energy self-sufficiency beginning in FY 76. If these demonstrations prove successful, DOD is planning to buy substantial quantities of solar arrays for further applications starting at an annual level of 100 KW_e (peak) when array prices approach \$5,000 per peak kilowatt, and increasing to an annual level of 5 MW_e (peak) for an array price near \$2,500 per peak kilowatt. DOD is expected ultimately to increase this annual rate of purchase to 60 MW_e as the prices of solar arrays continue to drop. A total Government procurement of approximately 250 KW_e of solar arrays will be shared between ERDA and DOD in 1977 and used in both military and civilian applications. All subsequent ERDA array procurements will be directed toward civilian solar photovoltaic demonstration projects, leading to an 11 MW_e Demonstration in 1983. The rationale for the combined ERDA-DOD purchases is to stimulate the solar cell market in the FY 1976-1983 time period.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

Continued

Wind Energy Conversion

Output

The objective of the Wind Energy Conversion subprogram is to accelerate the development and the commercial implementation of reliable wind energy systems. Such systems have a minimal environmental impact, use a non-depletable energy source and are capable of producing significant energy outputs. The planned R&D program would lead to demonstration of systems by 1979, several 100 MW demonstrations by the early 1980s, and mass-production capabilities in excess of 15,000 MW_e per year, at a cost of \$250 - \$300 per rated kilowatt in the mid 1980s.

Assumptions

The individual wind energy conversion units are small by utility standards (two MW per unit). It is anticipated that the implementation strategy will call for the involvement of the Government in the development of suitable production facilities by the mid-1980s.

Implementation

The strategy of the wind energy conversion programs will be to develop a series of experimental systems of increasing size and capability, supported by a research and technology effort, leading to incrementally installed multi-unit demonstration systems, jointly funded with users, in the early 1980s. While the emphasis is on the use by electrical utilities, direct heat, crop drying, fertilizer manufacturing, and fuel generation will also be demonstrated.

Ocean Thermal Energy Conversion

Output

The objective of the Ocean Thermal Energy Conversion (OTEC) subprogram is to demonstrate the technical and economic feasibility of producing electricity from the ocean temperature differences. The feasibility of producing energy-intensive fertilizers and fuels from seawater and the refining of metals will also be investigated.

Assumptions

The commercial acceptance of the sea-based ocean thermal conversion energy requires the full-scale demonstration of system performance and cost estimates. Studies now in process indicate the technical knowledge is available for building an experimental prototype. The

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM DESCRIPTION

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

Continued

additional engineering development required is of the adaptive and scale-up variety. The engineering efforts paralleling this effort will provide design optimization and reduce construction costs. The program development emphasis has been placed on advancing a baseline design incorporating low-risk design concepts and incorporating design improvement only as their feasibility is documented. This approach ensures that the overall progress of the program will not be impeded.

Implementation

The initial prototype is planned around the use of a full scale platform as hydrodynamic, thermodynamic mooring and environmental effects do not lend themselves to subscale testing. System design, critical component testing, material, and implementation studies are in process. Land test facilities will be constructed in 1976 and sea test facilities in 1977. The floating prototype ocean thermal plant will be brought on line by 1983 and converted into a demonstration plant by 1985. Production of commercial plants patterned after the demonstration plant can then be accelerated in the mid-term.

Solar Energy Research Institute,
Technology Utilization and Solar Resource Data

Programs established for conducting research and development in support of the National Solar Energy Program, disseminating technical, economic and regulatory data on solar energy applications and for developing an integrated data collection and assessment function are described in the Direct Solar Conversion Program.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications

A. Solar Thermal

1251.1^{a/}

40,000 MW capacity achieved
saving 328 million barrels of
petroleum annually.

•(2000)

Decision Points Anticipated

1. Central Receiver Power Plant

Decision to build 10 MW_e Pilot Plant X(in work)

Decision to build 100 MW_e
Demonstration Plant

X(1979)

Decision to build First Commercial
Plant (100 to 300 MW_e)

X(1982)

2. Solar Thermal Test Facilities

Decision to build Central Receiver
Facility

X(in work)

Decision to build Distributed
Collector Facility

X(1976)

Program Output

To produce 1.5×10^8 MW hours of electrical energy

* (1985)

•(2000)

^{a/}Estimate through 1 year test of initial commercial plants in 1987.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term	
	1975	1980	1985	1990	1995	2000		

V. Solar Electric Application (cont.)

A. Solar Thermal (cont.)

Decision Points Anticipated (cont.)

3. Solar Total Energy Systems

Decision to build Pilot 200 KW_e,
2MW_{th} (System #1)

X(1975)

Decision to build Pilot 200KW_e,
2MW_{th} (System #2)

X(1976)

Decision to build 10MW_{th} (System #1)
Demonstration Plant

X(1979)

Decision to build 10MW_e, 200MW_{th}
(System #2) Demonstration Plant

X(1980)

4. Distributed Collector Power Plant

Decision to build 10MW_e Pilot Plant

X(1977)

Decision to build 100MW_e Demonstration
Plant

X(1982)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Application (cont)

A. Solar Thermal (cont)

Decision Points Anticipated (cont)

5. Hybrid Solar Thermal Systems

Decision to build initial pilot plant X(1978)

6. Research and Development

X(In-work and through completion of program)

7. Program Support

X(In-work and through completion of program)

Major Results Expected

1. Central Receiver Power Plant

10MW_e Pilot Plant checked out and
operating

•(1979)

100MW_e Demonstration plant in
operation

•(1985)

Initial Commercial 100 to 300MW_e
Plants in operation

•(1987)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Application (cont.)

A. Solar Thermal (cont.)

Major Results Expected (cont)

2. Solar Thermal Test Facilities

Central Receiver Facility Operating •(1977)

Distributed Collector Facility
Operating •(1978)

3. Solar Total Energy Systems

200KW_e, 2MW_{th} Pilot Plants
(Systems 1 & 2) checked out
and operating •(1981)

10MW_e, 200MW_{th} Demonstration Plant
(System #1) in operation •(1985)

10MW_e, 50MW_{th} Demonstration Plant
(System #2) in operation •(1986)

4. Distributed Collector Power Plant

10MW_e Pilot Plant: checked out
and operating •(1981)

100MW_e Demonstration Plant in
operation •(1987)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Application (cont)

A. Solar Thermal (cont)

Major Results Expected (cont)

5. Hybrid Solar Thermal Systems

Pilot Plant #1 checked out and
operating

•(1981)

Pilot Plant #3 checked out and
operating

•(1983)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications (cont)

- B. Solar Photovoltaic Conversion 1252.1^{a/}
190,000 MW_e (peak) capacity achieved saving
900 million barrels of petroleum annually

•(1995)

Decision Points Anticipated

1. Systems and Applications (176.9)
 - Demonstration Plan selected X(1977)
 - Candidate Applications selected X(1977)
 - System Constraints Defined X(1978)
2. Low-Cost Silicon Array Project (700.4)
 - Accelerated-Lifetime Test-Approach Selected X(1978)
 - Silicon Material Process Selected X(1978)
 - Automated Array Fabrication Process Selected X(1979)
 - Silicon-Sheet Growth-Process Selected X(1980)
 - Go-Ahead on Construction of 500-MW_e Fabrication Plant X(1980)

^{a/}Include RD&D costs thru 1985 but not costs of manufacturing plants or Federal incentives for accelerated commercial production in mid and long terms.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont)

B. Solar Photovoltaic Conversion (cont)

Decision Points Anticipated (cont)

2. Low-Cost Silicon Array Project (cont)

Go-Ahead on continued Production for
Demonstrations

X(1976) → yearly

3. Concentrator Systems (49.7)

\$5000/KW Design Selected
\$2000/KW Design Selected
\$1000/KW Design Selected
\$250/KW Design Selected

X(1977)
X(1978)
X(1980)
X(1982)

4. Testing and Standards (35.9)

Solar Array Performance Measure-
ments Approach Selected

X(1976)

Go-Ahead on Test Standard-
ization Facility

X(1976)

5. Research and Development (114.3)

Other Candidate Materials and
Devices Selected for Further
Development

X(1976) → yearly

Go-Ahead on Large-Scale Production

X(1985)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont)

B. Solar Photovoltaic Conversion (cont)

Decision Points Anticipated (cont)

6. Energy Storage and Power Conditioning (168.3)

Test Program Approach Selected

X(1977)

Final Candidates Selected

X(1979)

Major Results Expected

1. Systems and Applications

Systems and Subsystems Specified (176.9)

•(1979)

Operation of Demonstrations

Initiated: 75KW/1976; 300KW/1977;

500KW/1978; 1MW/1979; 2MW/1980;

4MW/1981; 7MW/1982; 11MW/1983

•(1976) —————>•(1983)

2. Low-Cost Silicon Array Project (700.4)

Pilot-Plant for Silicon-Material in
Operation

•(1980)

Pilot-Plant for Large-Area Silicon-
Sheets in Operation

•(1983)

Pilot-Plant for Automated-Production
of Arrays in Operation

•(1983)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont)

B. Solar Photovoltaic Conversion (cont)

Major Results Expected (cont.)

2. Low-Cost Silicon Array Project (cont)

Large-Scale Plant for Silicon-Material
in Operation

•(1984)

Large-Scale Plant for Automated-
Production of SPC Arrays: \$500/KW

•(1985)

Delivery of SPC-Arrays for ERDA Demon-
strations 75KW/1976; 150KW/1977; 250KW/
1978; 500KW/1979; 1MW/1980; 2MW/1981;
3MW/1982; 4MW/1983

•(1976) —————> •(1983)

3. Concentrator Systems

Production and Operation of \$5000/KW
Systems

•(1978)

Production and Operation of \$2000/KW
Systems

•(1980)

Production and Operation of \$1000/KW
Systems

•(1982)

Production and Operation of \$250/KW
Systems

•(1985)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term		Long Term	
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont)

B. Solar Photovoltaic Conversion (cont)

Major Results Expected (cont)

4. Testing and Standards

Test and Standardization Facility
in Operation

•(1976)

Final Performance Specifications
Defined

•(1978)

5. Research and Development

Thin-Films Demonstrated at 10%
Efficiency

•(1980)

Feasibility of \$100 to \$300 per
KW Arrays Demonstrated

•(1985)

50,000MW/Year Produced at \$100 to
\$300 per KW

•(1995)

6. Energy Storage and Power Conditioning

Evaluation of Energy-Storage and
Power-Conditioning Completed

•(1977)

Prototype Testing Completed

•(1978)

Testing of Control Systems Completed
and Subsystem Hardware Developed

•(1984)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term
	1975	1980	1985	1990	1995	2000	

V. Solar Electric Applications (cont)

B. Solar Photovoltaic Conversion (cont)

Major Results Expected (cont)

7. Assessment of Goals (6.1)

Plant Ownership and Operation Plan
Selected

•(1980)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)					
	Near Term		Mid Term		Long Term
	1975	1980	1985	1990	1995
V. <u>Solar Electric Applications (Cont.)</u>					
C. Wind Energy Conversion (Cont.) 279.9 ^{a/}					
15,000 MW rated capacity achieved saving 106 million barrels of petroleum annually.					
<u>Decision Points Anticipated</u>					
1. Research, Technology and Program Development (39.3)					
Initial Application Regions Selected			X(1976)		
Recommendations on Possible Incentives			X(1978)		
2. Individual Farm WEC System (7.3)					
Decision to Implement Major Farm Demonstration or Incentives Program			X(1978)		
3. 100-KW Systems (13.2)					
Sites Selected for Mod-1			X(1976)		
Alternate Concepts Selected			X(1977)		
Decision for Large Demonstration			X(1979)		

• (1985)

^{a/} Includes demonstration costs but not the costs of manufacturing plants or Federal incentives for accelerated commercial production

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.)

Decision Points Anticipated (Cont.)

4. MW-Scale Systems (33.7)
 - Sites Selected for Mod-1 X(1976)
 - Sites Selected for Mod-2 X(1977)
 - Alternate Concepts Selected X(1977)
5. Large-Scale, Multi-Unit WECS (186.4)
 - Commit to Incremental
Construction - Initial 10 M_e X(1978)
 - Commit to Incremental
Construction - Initial 100 M_{W_e} X(1979)
 - Commitment to Large-Scale
Production X(1981)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.).

Major Results Expected

1. Research, Technology and
Program Development

Initial Systems Analyses
Completed

•(1976)

Initial Env/Legal/Public
Acceptance Results

•(1977)

Site Selection Completed

•(1979)

2. Individual Farm System

Initial Heating and Cooling

•(1977)

Practicality of Fertilizer
and Crop Drying Determined

•(1979)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.)

Major Results Expected (Cont.)

3. 100 KW Systems

Fabrication of Mod-0,
Completed

•(1976)

Initial Tests Completed,
Mod-0

•(1977)

Initial Test Completed
on Mod-1

•(1978)

Practicality of Mod-2,
Alternate Concepts
Determined

•(1979)

4. MW-Scale Systems

Fabrication of Mod-1
Completed

•(1977)

Fabrication of Mod-2
Completed

•(1979)

Tests of Mod-1 and 2
Completed

•(1980)

Practicality Alternate
Concepts Determined

•(1981)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (Cont.)

C. Wind Energy Conversion (Cont.)

Major Results Expected (Cont.)

5. Large-Scale, Multi-Unit
Systems

Fabrication of 10-MW
Demonstration Completed

•(1979)

Fabrication of 100-MW
Demonstration Completed

•(1981)

Initial Tests of 10-MW
Demonstration Completed

•(1981)

Initial Tests of Fourth
100-MW Demonstrated
Completed

•(1985)

(170 MW_e Capacity Achieved)

•(1981)

Large-Scale Production
Started^a

•(1983)

(15,000 MW_e Capacity Achieved)^{a/}

•(1985)

^{a/} Assumes major Federal Commitment and incentives program.

Costs of WECS production and Federal incentives program are not included in funding shown.

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (con't)

D. Ocean Thermal Energy Conversion 1058.6^{a/}
100MW_e Commercial Demonstration
Model Operating

•(1985)

Decision Points Anticipated

1. System Studies

Contracts to study technical and
economic feasibility of ocean
thermal differences, conduct
engineering evaluations and
develop test program.

X(In work)

2. Test Facilities

Decision to Build

X(1975)

3. Critical System Components
Research and Development

Heat exchanger research and
development contracts

X(In Work)

Mod 0 heat exchanger design and
fabrication contracts

X(1975)

^{a/} Estimate through test of 100MW_e Commercial Demonstration Model in 1985

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Decision Points Anticipated (cont.)

3. Critical System Components

Research and Development (cont.)

Research and development con-
tracts on turbines, pumps, anchor-
ing/mooring/dynamic positioning
deep water pipe, materials, corro-
sion biofouling and screening

X(1975)

Mod 1 heat exchanger design and
construction contracts

X(1977)

Systems engineering study of anchor-
ing/mooring dynamic positioning

X(1977)

Contracts for prototype and long-
lead time pumps, turbines and
platform equipment

X(1978)

4. Floating Prototype Module A

Preliminary Design Contracts (2)
for 100MW_e Floating Platform and 25MW_e
Power Module (hull to be full size,
surface and semi-submersible option
to be investigated)

X(1979)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Decision Points Anticipated (Cont.)

4. Floating Prototype Module A (cont.)

Contract for Purchase of Long-Lead
Time Materials and Equipment for
Prototype 100MW_e Floating Plant

X(1980)

Contract for Construction of Hull
and Initial Power Module

X(1981)

5. Demonstration Power Station

Contract for Power Modules for
Demonstration Model (Prototype)
Hull will be Retrofitted with B
Modules)

X(1982)

6. Advanced Research and Technology

Study Contracts on Energy Delivery,
Product Mix Impact and Siting, Thermal
Resources and Legal Considerations
(Includes provision for Maritime
Administration assistance in establish-
ing platform design requirements)

X(In work)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term			Mid Term			Long Term	
	1975	1980	1985	1990	1995	2000		

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Decision Points Anticipated (Cont.)

7. Other Renewable Energy Resources
Studies

Contract to Review Potential of Ocean
Currents, Waves, Tides and Salinity
Gradients as Oceanic Energy Sources

X(1975)

Major Results Expected

1. System Studies

2. Test Facilities

Facility design completed

•(1976)

First phase completed

•(1977)

Second phase completed

•(1978)

3. Critical System Components
Research and Development

Fabrication of Mod 0 heat
exchanger initiated

•(1976)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Major Results Expected (cont.)

3. Critical System Components

Research and Development (cont.)

Fabrication of Mod 0 heat exchanger
completed and tests underway

•(1976)

Fabrication of Mod 1 heat exchanger
initiated

•(1978)

Systems engineering study of
anchoring/mooring/dynamic posi-
tioning complete

•(1978)

Construction complete and tests
underway

•(1980)

4. Floating Prototype Module A

Preliminary Design of Prototype
100MW_e platform and 25MW_e Power
Module A complete

•(1979)

Detailed Design of Prototype 100MW_e
platform and 25MW_e Power Module A
complete

•(1981)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Major Results Expected (cont.)

4. Floating Prototype Module A (cont.)

Test and Evaluation of Prototype
100MW_e Platform and 25MW_e Power
Module Commences

•(1983)

5. Demonstration Power Station

Test of 100MW_e Demonstration Model
Containing Four Improved B Power
Modules Retrofitted into Prototype
Hull

•(1985)

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM OUTPUTS

Total Est. Cost Through Completion (Millions of Dollars)	Near Term		Mid Term			Long Term
	1975	1980	1985	1990	1995	2000

V. Solar Electric Applications (cont.)

D. Ocean Thermal Energy Conversion (cont.)

Major Results Expected (cont.)

4. Prototype Floating Eower Plant (cont.)

Test and Evaluation of Prototype
100MW_e hull and 25MW_e Power
Module Commences

•(1983)

5. Commercial Demonstration Power Station

Test of 100 MW_e Commercial Demonstration
Model Containing Four Improved 25MW_e
Power Modules Retrofitted into
Prototype Hull

•(1985)

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTION SUMMARY
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

	Est. FY 75	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
Operating Expenses.....	27.0		73.6		18.0	139.6	168.5	199.5	214.9	240.5	568.0
Capital Equipment.....	0.5		11.1		3.3	37.3	46.0	58.0	66.2	89.1	192.6
Plant (With Escalations).....	-		5.6		2.0	38.9	52.9	73.6	149.6	274.5	1092.2
<u>Total SEA Program (With Plant Escalations).....</u>	27.5	40.7	90.3	11.8	23.3	215.8	267.4	331.1	430.7	604.1	1852.8
<u>FUNDS FROM OTHERS</u> (not added to ERDA total)											
Funds from other agencies and industry, pass through and joint programs.											
National Science Foundation ^{a/}			0.8								
U.S. Department of Defense						0.8	2.0	3.9	8.0	16.5	82.0
Joint Participation by Utilities ^{b/}									6.0	36.0	400.0 to 800
Total Solar Electric Applications Funds From Others			0.8			0.8	2.0	3.9	14.0	52.5	482.0 to 882.0
<u>SPECIAL FUNDING REQUEST</u> (For FY 1976 and Transition Period)											
To Fund cooperative ERDA-Department of Defense (DoD) Energy Self-Sufficiency Demonstration			2.0		0.6						

^{a/} Funds provided for advanced ocean thermal conversion studies.

^{b/} Anticipate utility participation of up to 50% for demonstration facilities.

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTION SUMMARY
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

	Est. FY 75	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
Operating Expenses.....	27.0		73.6		18.0	139.6	168.5	199.5	214.9	240.5	568.0
Capital Equipment.....	0.5		11.1		3.3	37.3	46.0	58.0	66.2	89.1	192.6
Plant (1977 Dollars).....			<u>6.2</u>		<u>2.2</u>	<u>38.9</u>	<u>48.7</u>	<u>87.2</u>	<u>119.9</u>	<u>226.7</u>	<u>737.5</u>
<u>Total SEA Program (1977 Dollars).</u>	27.5	40.7	90.9	11.8	23.5	215.8	263.2	344.7	401.0	556.3	1498.1

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
PROGRAM PROJECTIONS
(Dollars in Millions)

SOLAR ELECTRIC APPLICATIONS (SEA) PROGRAM

	Est. FY 75	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
<u>OPERATING EXPENSES</u> ^{a/}											
A. Solar Thermal	10.0		28.0		6.1	46.0	54.1	66.2	77.4	77.0	150.2 ^{b/}
B. Solar Photovoltaic Conversion	7.5		25.4		6.6	62.6	83.7	102.4	105.9	139.0	354.6 ^{c/}
C. Wind Energy Conversion	6.5		13.3		3.5	17.6	17.2	12.8	11.1	5.1	5.9 ^{d/}
D. Ocean Thermal Energy Conversion	<u>3.0</u>		<u>6.9</u>		<u>1.8</u>	<u>13.4</u>	<u>13.5</u>	<u>18.1</u>	<u>20.5</u>	<u>19.4</u>	<u>57.1</u> ^{e/}
Total Solar Electric Applications Operating Expenses	27.0		73.6		18.0	139.6	168.5	199.5	214.9	240.5	568.0

^{a/}In FY 1977 dollars with 8% escalation rate from FY 1976

^{b/}Through 1 year of operation of 100 MW_e Demonstration plant in 1987

^{c/}Through large scale production decisions in 1985

^{d/}Through 1 year of operation of large scale system in 1986

^{e/}Through 1 year of test of 100 MW_e Commercial Demonstration Model in 1985

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

<u>CAPITAL EQUIPMENT (BUDGET AUTHORITY) a/</u>	<u>Est. FY 75</u>	<u>FY 1976</u>		<u>Transition Period</u>		<u>Program Projections</u>					<u>Thru Completion Where Applicable</u>
		<u>Cong.</u>	<u>Rev.</u>	<u>Cong.</u>	<u>Rev.</u>	<u>FY 77</u>	<u>FY 78</u>	<u>FY 79</u>	<u>FY 80</u>	<u>FY 81</u>	
<u>Computers</u> (less than \$500,000)	-		0.1	-		0.2	-	0.2	0.4	0.4	1.5
<u>Other Equipment</u>	0.5		11.0	3.3		37.3	46.0	57.8	65.8	88.7	191.1
Total Solar Electric Applications Equipment	0.5		11.1	3.3		37.5	46.0	58.0	66.2	89.1	192.6

a/In FY 1977 dollars with 10% escalation rate from FY 1976

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

PLANT (BUDGET AUTHORITY)	TEC	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
New Projects ^{a/}											
Solar Thermal ^{b/}											
Central Receiver Power Plant	296.6					5.0	14.7	14.4	7.5	5.0	250.0
Solar Thermal Test Facilities	20.1		0.8		0.8	16.5	2.0				
Solar Total Energy Systems	105.5					2.8	4.4	9.8	14.6	13.9	60.0
Distributed Collector Power Plant	28.6						6.0	4.0	10.0	6.6	2.0
Hybrid Solar Thermal Systems	41.0							4.0	8.0	12.0	17.0
Solar Photovoltaic Conversion											
Large-Scale Silicon-Material Plant	50.0								12.0	12.9	25.1
Large-Scale Plant for Automated Production of Arrays	79.2								18.1	19.3	41.8
Wind Energy Conversion	162.9						10.1	24.8	42.6	32.1	53.3
Ocean Thermal Energy Conversion Test Facilities	29.7		4.8		1.2	14.6	9.1				

(Continued on Following Page)

PROGRAM PROJECTIONS (Continued)
SOLAR ELECTRIC APPLICATIONS (Continued)

(Dollars in Millions)

PLANT (BUDGET AUTHORITY) (cont.)	TEC	FY 1976		Transition Period		Program Projections					Thru Completion Where Applicable
		Cong.	Rev.	Cong.	Rev.	FY 77	FY 78	FY 79	FY 80	FY 81	
Ocean Thermal Energy Conversion (cont.)											
Critical System Components											
Research & Development	23.2						6.6	16.6			
Floating Prototype Module A	435.0								36.8	172.7	225.5
Demonstration Plant	417.5										417.5
Total Solar Electric Application Plant	1689.3		5.6		2.0	38.9	52.9	73.6	149.6	274.5	1092.2

a/ All project costs based on preliminary estimates, escalation factors over the period of construction schedule use FY 1975 as the base years: 1.11 for FY 76 and transition period, 1.22 for FY 77, 1.3 for FY 78, 1.38 for FY 79, 1.47 for FY 80, 1.57 for FY 81 and 1.67 for following years.

b/ Utilities are anticipated to contribute as much as 50% to demonstration and commercial plant developments.