MASTER

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Insolation Resource Assessment Program Plan

*Fiscal Year 1979 through
Fiscal Year 1981*

January 1979

**U.S. Department of Energy
Assistant Secretary for Energy Technology
Office of Solar, Geothermal, Electric
and Storage Systems**

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and Storage Systems
Washington, D.C.

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PURPOSE

The Office of Solar, Geothermal, Electric and Storage Systems (ETS) Insolation Resource Assessment Program Plan schedules research projects needed to identify the national insolation resource availability. The Insolation Resource Assessment Program (IRAP) is conducted in support of the Department of Energy (DOE) Solar Heating and Cooling of Buildings Program and the Agricultural and Industrial Process Heat Program, which are managed by the Office of the Assistant Secretary for Conservation and Solar Applications, and in support of the Solar Thermal Power Systems Program, Photovoltaics Program, and Fuels from Biomass Program, which are managed by the Office of the Assistant Secretary for Energy Technology. (Descriptions of the technologies involved in these programs can be found in the individual technology summary reports which are identified in the bibliography of this document.) The projects scheduled for Fiscal years 1979, 1980, and 1981 have been coordinated with the major milestones of the relevant solar technology programs.

The purpose of the Insolation Resource Assessment Program is to collect, standardize, certify, process, and archive geophysical data for solar energy applications. The principal solar parameters to be measured in support of solar RD&D are global, direct, diffuse and total radiation on an inclined surface. The measurement of the spectral distribution of solar radiation is also important to the development of several technologies such as photovoltaics and fuels from biomass. The aim of many of the completed, current, and planned projects presented in the IRAP Plan is to improve solar data collection methods and procedures and to refine solar radiation forecasting capabilities. The data, results, and information generated in the Insolation Resource Assessment Program are made available to all interested parties in order to foster solar RD&D and commercialization efforts.

The IRAP Plan will be updated periodically as new resource questions and new technology program goals are identified.

Michael R. Riches
Program Manager

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I. INTRODUCTION

The Insolation Resource Assessment Program (IRAP) had its beginning in a grant from the National Science Foundation (NSF) to the National Oceanic and Atmospheric Administration (NOAA). On the basis of this initial effort, the Energy Research and Development Administration further defined and expanded the program, which became the responsibility of the Environmental and Resource Assessments Branch (ERAB) of the Division of Solar Technology, Department of Energy. The program was transferred temporarily to the Environmental Planning and Analysis Branch (EPAB) of the Division of Planning and Technology Transfer and has now been assigned to the Division of Distributed Solar Technology (DDST) within the Department of Energy.

The goal of the IRAP, as outlined in the Purpose, is to provide a quality geophysical data base to further the development of solar energy applications. This quality geophysical data base is needed because, until recently, reliable baseline data were not collected consistently and continuously for long time periods, nor were these data sufficient for the design, evaluation, and siting of solar energy systems. The ongoing and planned projects presented in the IRAP Plan would ensure that future data users 5 to 20 years from now will have access to quality solar resource information. Access to such information will be necessary if solar applications are to achieve widespread use during this time period.

The determination of what constitutes a quality data base depends on the resolution of the following questions:

- Who are the end-users and what meteorological parameters must be measured for them?
- What data accuracy, geographic distribution, precision, frequency and format will fulfill user requirements?
- What alternatives to measurement exist?

- What data are now available and can these data be developed into a quality data set?

• The preceding questions overlap and must be considered in parallel. However, the key to assessing the nation's solar energy potential is in the identification of the user community and its current and future needs.

A classification has been selected that stratifies the solar energy user community according to the types of data, analyses, and output information required (Hamilton and Thomas, 1976). This mode of classification links the user requirements to the resource data base. The classification divides the user community into two groups - the researcher and the forecaster. The users classed as researchers are primarily interested in advanced solar energy applications and work at obtaining a better understanding of the physical and biological laws associated with solar climatology and solar energy systems. The forecasters use solar radiation data primarily as an input to problems of design, reliability, economics, and performance of solar systems.

Within the forecaster classification, three subgroups exist:

- Groups designing and operating decentralized systems, such as home solar heating and cooling systems.
- Groups designing and operating large and medium-scale photovoltaic or solar thermal power plants.
- General interest groups, such as homeowners, bankers, insurance agents, etc.

Although one must recognize that it is impossible to be all things to all people, it is possible to design a national insolation resource assessment program that collects, records and archives data useful to both researchers and forecasters.

II. USER DATA REQUIREMENTS

I. Formal Assessments

Two formal assessments of user data requirements were sponsored by the DOE Environmental and Resource Assessments Branch. These are the Battelle Report (Hamilton and Thomas, 1976) and the California Solar Resource Analysis (Berdahl et al, 1978).

The primary recommendations of the Battelle report were:

1. To establish a small research network.
2. To make no changes in the basic DOE/NOAA 38 station network until the questions posed in the introduction of this plan can be analyzed further.

The California analysis established the aggregated state user data needs through a survey. The survey results were also used to prepare a California solar data summary book, which included frequency diagrams, other statistical summaries, and estimated values of solar radiation on an inclined surface. The authors of the California study recommended that:

1. Global, direct beam, and inclined solar radiation data be taken at ± 5 percent accuracy with hourly integrals.
2. Stations be sited such that estimates at ± 10 percent accuracy can be made for any location between stations.
3. The data requirements of the flat plate and concentrator technologies be met.

2. Informal Assessment

In addition to the formal studies discussed above, a number of professional meetings, program reviews, etc. have been sponsored by the solar technology program offices and IRAP. Information obtained at these meetings suggests that the answers to the questions posed can be derived from the solar radiation requirements outlined in table 1a and table 1b.

Table 1a. Solar Radiation Data Requirements for Research

Research Activity	Data Required
A. Solar Heating and Cooling of Buildings; and Agricultural and Industrial Process Heat Systems	
1. Active and Passive Systems (e.g., Flat Plate and Evacuated Tube Collectors and Trombe Walls)	Several sample, short-term, detailed data sets of high quality nonhorizontal (including vertical surfaces) and direct beam solar radiation data, infrared, ultraviolet, and other spectral data for heat loss, materials reliability, and selective surface studies; sample micrometeorological studies to assess special design problems and unique solar applications; and sample data at short time intervals (1 minute) for special systems studies.
2. Concentrating Systems	As in part A-1 above; sample circumsolar data for concentrating parabolic collectors, Fresnel lenses, etc., systems studies.
B. Photovoltaic Applications	
1. Nonconcentrating Systems	As in part A-1 above, with more stress on spectral information.
2. Concentrating	As in part B-1 above, with more stress on direct beam data including spectral circumsolar information.
C. Solar Thermal Electric Systems	
1. Distributed Systems (e.g., water pumping)	As in part A-1 above, with stress on direct beam and circumsolar data.
2. Large-Scale Power Systems	As in part C-1 above.
D. Biomass Production (e.g., plantations)	Spectral quality of total radiation in sample climate regions for systems modeling.

Table 1b. Solar Radiation Data Requirements for Design Applications

Forecast Activity	Data Required
A. Solar Heating and Cooling of Buildings; and Agricultural and Industrial Process Heat Systems	
1. Active and Passive Systems	As for research; models to extend global, direct, and nonhorizontal data; macro-scale global, direct, and nonhorizontal measured data; meteorological data such as temperature, dew point, wind speed and direction, hail frequency, lightning frequency, etc.; standard year data sets; data atlas including monthly means, frequency statistics, etc., including solar and other meteorological variables; data at hourly intervals.
2. Concentrating Systems	As above; circumsolar data included in model data sets, atlas, and standard year data summaries.
3. Site-Specific Application	For large or unique systems, special site specific preoperational baseline and operational phase data and specially tailored data sets, such as cloud frequency data, seasonal measured data to test applicability of models (highly project specific).
B. Photovoltaic Applications	As in A-1 and A-2 above, greater emphasis on spectral data for data summaries; site specific data (preoperational baseline and operational phase data) at large and medium-scale power plant sites for design refinement.
C. Solar Thermal Electric Systems	As in A-1, A-2, and A-3 above.
D. Biomass Production	As in A-1 above, greater emphasis on spectral data for data summaries; regional solar radiation and climatology data to assist in siting and design.

III. CURRENT RESOURCE DATA AVAILABILITY AND PLANS FOR FURTHER RESOURCE DATA GENERATION

The Insolation Resource Assessment Program has been designed specifically to supply data that meet the requirements set forth in the previous section.

Table 2 indicates the breadth of the research, design, and site-specific data that have already been made available to the user community through the IRAP.

Table 2 also identifies categories of resource data which will be available in the near term as a result of both current and planned research.

The formal and informal data users' analyses have also contributed to the development of a network systems concept. It has been determined that an effective national network system could be comprised of the following elements:

- A small network of stations with limited geographical coverage but highly sophisticated measuring capabilities.
- A basic 38-station network providing global and direct insolation data.
- A larger cooperative network providing at least global insolation data.

The use of many highly sophisticated stations taking high quality data is not cost-effective, and a few such stations could meet the data needs of researchers and complement the data sets obtained from the basic network. Similarly, an increase in the numbers and geographical density of basic network stations would not necessarily improve the resolution of geographical variations in insolation resources. In many geographical areas, if the number of such monitoring sites is increased and the sites are consequently closer together, the accuracy of measurement must be increased to preclude the confusion of sensor errors with microclimatic variations between stations. These factors have influenced the design of the IRAP network system in use. This system employs a balance of stations with highly sophisticated measurement capabilities and basic network and cooperative stations, and this balance is designed to satisfy user needs.

Table 2. Insolation Resource Assessment Data

Activity	Data Available
Research	<ul style="list-style-type: none"> • Insolation and meteorological data in SOLDAY and SOLMET formats for stations throughout the U.S.; • LBL circumsolar data; • NOAA Calibration Center data and research projects on nonhorizontal measurements; • NOAA GMCC data; • One minute DOE/NOAA network data (global and direct).
Design	<ul style="list-style-type: none"> • As above; • NCC meteorological data; • NSF hail frequency data (through the Illinois State Water Survey); • Old climatic atlas; • SOLMET (model generated data set); • Publications on non-NOAA data sets, tilt effects, model generated direct and diffuse at some 175 sites (see references 3, 4, 8, 19, 29, 36, and 37).
Site Specific	<ul style="list-style-type: none"> • As for the "Research" and "Design" categories above; • Battelle mobile spectral monitoring device; • Meteorological consultants to tailor data sets.

Table 2 (Continued)

Activity	Data From Planned Efforts
Research	<ul style="list-style-type: none"> • Meteorological Research Site data; • LBL infrared data; • Micrometeorological data sets for urban-rural, mountain-valley, and coastal-inland difference studies; • NOAA albedo studies; • Model generated nonhorizontal insolation data; DOE/NOAA data in SOLMET format.
Design	<ul style="list-style-type: none"> • Instrumented DOE demonstration sites data; • New climatic atlas for energy applications including data applicable to quick design methods; • Special computer tape of summary data for quick design methods; • Frequency of wind and solar for hybrid applications.
Site Specific	<ul style="list-style-type: none"> • Portable meteorological monitoring device to measure standard meteorological and solar parameters.

The IRAP network system concept is portrayed schematically in figure 1. If there is a requirement for data for a large number of sites and with good geographical coverage, the number of measured parameters common to all the data sites selected will be low. On the other hand, if one needs high accuracy, high quality data, the variety of available measured parameters will be high while the number of available sites and their geographical coverage will be low.

The chief elements of this system are the basic DOE/NOAA network and the DOE research network as shown in figure 2. The data from the basic network, as well as the historical data set, are available in the SOLMET computer tape format which is illustrated in figure 3.

SOLAR RADIATION MONITORING SYSTEM CONCEPT

FIGURE 1

FIGURE 2. DOE/NOAA 38 Solar Radiation Monitoring Network and DOE 8 Solar Energy Meteorological Research and Training Sites.

I D E N T I F I C A T I O N										S O L A R R A D I A T I O N O B S E R V A T I O N											S U N S H I N E M I N
TAPE DECK #	WBAN STN #	S O L A R T I M E				LST TIME	ETR KJ/m ²	R A D I A T I O N V A L U E S KJ/m ²										A	B		
		YR	MO	DY	HRMN			D I R E C T	D I F F U S E	N E T	T I L T E D	G L O B A L									
												OBS	ENG COR	STD YR COR							
9724	XXXXX	XX	XX	XX	XXXX	XXXX	XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	1XXXX	XX	
FIELD	001	002	003			004	101	102	103	104	105	106	107	108	109	110	111				

SURFACE METEOROLOGICAL OBSERVATION																											
O B S E R V I N G L S T	C E I L I N G dam	SKY COND	VSBY hm	WEATHER	PRESSURE kPa		TEMP °C		WIND		CLOUDS														S N O W C O V E R		
					SEA LEVEL	STA- TION	DRY BULB	DEW- PT.	D I R deg	S P E E D m/s	T O T A L	LOWEST			SECOND			THIRD			FOURTH			O P A Q U E			
												A M P H	T Y P E	H E I G H T	A M P H	T Y P E	H E I G H T	A M P H	T Y P E	H E I G H T	A M P H	T Y P E	H E I G H T				
XX	XXXX	1XXXX	XXXX	XXXXXXXX	XXXXX	XXXXX	XXXX	XXXX	XXX	XXXX	XX	XX	XX	XXXX	XX	XX	XXXX	XX	XX	XX	XXXX	XX	XX	XX	XXXX	XX	X
201	202	203	204	205	206		207		208		209																210

TAPE FIELD NUMBER	TAPE POSITIONS	ELEMENT
001	001 - 004	TAPE DECK NUMBER
002	005 - 009	WBAN STATION NUMBER
003	010 - 019	SOLAR TIME (YR, MO, DAY, HOUR, MINUTE)
004	020 - 023	LOCAL STANDARD TIME (HR AND MINUTE)
101	024 - 027	EXTRATERRESTRIAL RADIATION
102	028 - 032	DIRECT RADIATION
103	033 - 037	DIFFUSE RADIATION
104	038 - 042	NET RADIATION
105	043 - 047	GLOBAL RADIATION ON A TILTED SURFACE
106	048 - 052	GLOBAL RADIATION ON A HORIZONTAL SURFACE - OBSERVED DATA
107	053 - 057	GLOBAL RADIATION ON A HORIZONTAL SURFACE - ENGINEERING CORRECTED DATA
108	058 - 062	GLOBAL RADIATION ON A HORIZONTAL SURFACE - STANDARD YEAR CORRECTED DATA
109, 110	063 - 072	ADDITIONAL RADIATION MEASUREMENTS
111	073 - 074	MINUTES OF SUNSHINE
201	075 - 076	TIME OF COLLATERAL SURFACE OBSERVATION (LST)
202	077 - 080	CEILING HEIGHT (DEKAMETERS)
203	081 - 085	SKY CONDITION
204	086 - 089	VISIBILITY (HECTOMETERS)
205	090 - 097	WEATHER
206	098 - 107	PRESSURE (KILOPASCALS)
207	108 - 115	TEMPERATURE (DEGREES CELSIUS TO TENTHS)
208	116 - 122	WIND (SPEED IN METERS PER SECOND)
209	123 - 162	CLOUDS
210	163	SNOW COVER INDICATOR

FIGURE 3. Computer Format for Hourly Solar Radiation Data and Other Meteorological Data.

IV. PROJECT MANAGEMENT

To facilitate management of the Insolation Resource Assessment Program, four project areas have been delineated. These are:

- Network and Data Collection
- Data Management
- Research and Analysis
- Program Management

The NOAA Air Resources Laboratories in Silver Spring, Maryland, currently manage Network and Data Collection projects which include the NOAA insolation network, calibration center, and data quality control. NOAA's National Climatic Center in Asheville, North Carolina, archives, formats and disseminates both NOAA and non-NOAA data as part of the Data Management effort. Sandia Laboratory in Albuquerque, New Mexico, manages the site-specific data collection projects, micrometeorological studies, and statistical analyses. Other Research and Analysis projects, including the Meteorological Research Sites, are managed directly by DOE with technical and program support from the three management groups and the Office of University Programs.

V. PROJECTS

Five key issues can be identified in the data requirements and research activities outlined in tables 1a, 1b, and 2. These issues are:

- Data Base Documentation
- Data Base Analysis and Presentation
- Site-Specific Data Collection for Large and Medium-Scale Solar Applications
- Research Data Set for Advanced Technology Studies
- General Network Review

It has been necessary to consider these issues in the program planning to develop an effective IRAP. The completed, current, and planned projects and concomitant research requirements that address these issues are summarized in table 3. Summaries of these projects can be found in Appendix I.

Figures 4 through 9 depict the Insolation Resource Assessment Program milestones and the milestones of those solar technology program elements that depend on IRAP research and data. A comparison of the milestones from these programs indicates that IRAP schedules have been coordinated with the technology program plans.

TABLE 3
ISSUES, REQUIRED RESEARCH, AND PROJECTS*

ISSUES	REQUIRED RESEARCH	PROJECTS		
		COMPLETED	CURRENT	PLANNED
Data Base Documentation	<ul style="list-style-type: none"> Insolation sensor calibration and maintenance/data quality control 	3,16	18,19,22,25	
	<ul style="list-style-type: none"> Processing and dissemination of data in SOLMET and SOLDAY formats 	12	19,22,23,24,26,27	
	<ul style="list-style-type: none"> Identification/inventory of potential and existing cooperative data stations 	14	22,27,42	
	<ul style="list-style-type: none"> Evaluation of validity and comparability of available solar data 	8,10,12,14	19,22,23,27,34,42,45	
Data Base Analysis and Presentation	<ul style="list-style-type: none"> Development and application of methodologies for measurement of meteorological/geophysical variables 	4,7,10,11,13	17,20,21,29,30,31,34,37,38,39	
	<ul style="list-style-type: none"> Publication of meteorological/geophysical data 	2,6,7,9,14,15,16	19,22,23,24,26,27,30,31,41,42,45	
	<ul style="list-style-type: none"> Assessment of regional insolation resource availability 	11,12,14,15,16	22,29,30,31,32,33,34,39,41,42,45	

*MANY PROJECTS ADDRESS MORE THAN ONE ISSUE.

TABLE 3 (continued)
ISSUES, REQUIRED RESEARCH, AND PROJECTS*

ISSUES	REQUIRED RESEARCH	PROJECTS		
		COMPLETED	CURRENT	PLANNED
Site-Specific Data Collection for Large-Scale Solar Applications	<ul style="list-style-type: none"> Construction and installation of portable insolation monitoring systems 	3	21	46
	<ul style="list-style-type: none"> Comparison of potential locations for large-scale solar applications 		31,41	46
Research Data Set for Advanced Technology Systems	<ul style="list-style-type: none"> Collection and analysis of data for use in development of advanced solar systems 	2,5,6,9,11,12,13,15,16	20,21,22,30,31,32,33,34,35,36,37,38,39,40,41,42,45	
	<ul style="list-style-type: none"> Improvement of basic solar radiation models 	5,6,7,8,9,12,13	29,31,32,33,35,36,37,38,39	
	<ul style="list-style-type: none"> Definition of microclimatic solar radiation differences 	12	32,33,34	
General Network Review	<ul style="list-style-type: none"> Evaluation of user needs and current network products 	1,4,14,15	25,29,41,42,43,44,45	47
	<ul style="list-style-type: none"> Identification of network improvements 	1,3,4,7,12,14,15	29,32,33,34,41,43,44,45	47

*MANY PROJECTS ADDRESS MORE THAN ONE ISSUE.

TABLE 3 (continued)
ISSUES, REQUIRED RESEARCH, AND PROJECTS*

ISSUES	REQUIRED RESEARCH	PROJECTS		
		COMPLETED	CURRENT	PLANNED
General Network Review (continued)	• Implementation of network improvements	1	17,18	47
	• Program support	3	28,43,44	

*MANY PROJECTS ADDRESS MORE THAN ONE ISSUE.

FIGURE 4
ERAB INSOLATION RESOURCE ASSESSMENT MILESTONES

ACTIVITY	FISCAL YEAR				
	1979	1980	1981	1982	1983
DATA BASE DOCUMENTATION	INITIAL COLLECTION OF NON-NOAA DATA	COOPERATIVE NETWORK ESTABLISHED			
	SECOND SURVEY OF NON-NOAA STATIONS	PRODUCTS OUTPUT AS THEY ARE GENERATED			
DATA BASE, ANALYSIS & PRESENTATION	INITIAL APPLIC. OF TMY	PRODUCTS OUTPUT AS THEY ARE GENERATED			
	MODELED DIRECT, AVAILABLE ON SOLMET	• COMPLETE APPLICATION OF TMY MODEL • MODELED INCLINED SURFACE DATA AVAILABLE • ATLAS COMPLETE			
SITE SPECIFIC DATA COLLECTION FOR LARGE-SCALE SOLAR APPLICATIONS	FULL-SCALE DATA COLLECTION OPERATIONS				
	INITIAL DATA COLLECTION OPERATIONS	TECHNOLOGY PROGRAMS TAKE OVER SITE-SPECIFIC MONITORING			
RESEARCH DATA SETS FOR ADVANCED TECHNOLOGY STUDIES	DECISION TO CONTINUE RESEARCH SITES & SPECTRAL MONITORING				
• MONITORING FOR HIGH QUALITY DATA/SPECIAL INSOLATION CHARACTERISTICS RESEARCH EFFORTS	MONITORING AT RESEARCH SITES	• CIRCUMSOLAR RADIATION STUDIES • CLOUDS & AEROSOL EFFECTS STUDIES • INITIAL RESULTS OF SPECTRAL MONITORING • SERI RESEARCH INITIAL RESULTS			
• MICROMETEOROLOGY & REGIONAL CLIMATOLOGY STUDIES	URBAN STUDIES	• COASTAL-INLAND STUDY • JOINT PROBABILITY OF WIND & SOLAR • MOUNTAIN-VALLEY STUDY			
GENERAL NETWORK REVIEW			NOAA TAKES OVER NETWORK REVIEW ACTIVITIES		
PROGRAM MANAGEMENT					

FIGURE 5
SOLAR THERMAL POWER SYSTEMS MILESTONES – APRIL, 1978

ACTIVITY	FISCAL YEAR				
	1979	1980	1981	1982	1983
CENTRAL POWER SYSTEMS					
● STORAGE COUPLED					
10 MW SOLAR THERMAL PILOT PLANT	▲ CONSTRUCTION			▲ OPERATION	
50 to 300 MW*		▼ SELECT UTILITY PARTNER			▲ CONSTRUCTION
● REPOWERING					
25 MW		▼ SELECT CONCEPT	▲ CONSTRUCTION		▲ OPERATION
50 MW		▼ SELECT UTILITY PARTNER		▲ CONSTRUCTION	
● HELIOSTAT DEVELOPMENT & MANUFACTURING PROCESS	▼ SELECT CONCEPT		▲ OPERATION		
● SOLAR/FOSSIL HYBRID	▼ SELECT CONCEPT		▲ CONSTRUCTION		▲ OPERATION
2.5 MW EPRI					
50 to 300 MW*		▼ SELECT UTILITY PARTNER			▲ CONSTRUCTION
DISPERSED POWER SYSTEMS					
● REMOTE APPLICATIONS	OPERATION		TO BE DETERMINED		
● SMALL COMMUNITY APPLICATIONS	SELECT TECH.	SELECT SITE	DECISION ON CONSTRUCT.		
1ST EXPERIMENT	▼	▼	▼		
2ND EXPERIMENT		▼ CONTINUATION DECISION		▲	DECISION ON CONSTRUCT.
 ● ALTERNATIVE PROJECTS					

▲ BEGIN MILESTONE
▼ COMPLETED MILESTONE

FIGURE 5 (CONT'D)
SOLAR THERMAL POWER SYSTEMS MILESTONES – APRIL, 1978

FIGURE 6
PHOTOVOLTAIC PROGRAM MILESTONES – APRIL, 1978

ACTIVITY	FISCAL YEAR				
	1979	1980	1981	1982	1983
RESEARCH PLANNING & SUPPORT					
• ADVANCED MATERIALS					
• THIN FILM TECHNOLOGY DEMO.		▲ 10% THIN-FILM ARRAY EFFICIENCY			
• STANDARDS PLAN					
ENGINEERING DEV. & SYSTEMS EXPERIMENTS					
• SYSTEMS TESTS & APPLICATIONS					
LEWIS RESEARCH CENTER— SYSTEM TEST FACILITY (30kW)	▲ OPERATION				
SANDIA ADVANCED SYSTEM TEST FACILITY	▲ OPERATION	TO BE DETERMINED			
FLAT PANEL APPLICATIONS PRDA	▲ RELEASE PRDA				
CONCENTRATOR APPLICATIONS PRDA	▲ RELEASE PRDA	▼ MERGER DECISION	▲ RELEASE PRDA	▲ RELEASE PRDA	▲ RELEASE PRDA
FEDERAL AND REMOTE EXPERIMENTS	▲ SELECT EXPERIMENTS & BEGIN OPERATION	TO BE DETERMINED			

▲ BEGIN MILESTONE

▼ COMPLETED MILESTONE

FIGURE 7
FUELS FROM BIOMASS PROGRAM MILESTONES – APRIL, 1978

ACTIVITY	FISCAL YEAR				
	1979	1980	1981	1982	1983
PRODUCTION & HARVESTING					
● FIELD EXPERIMENTS					
SILVICULTURAL					▼
HERBACEOUS			▼		
AQUATIC					
● PILOT ENERGY FARMS					
CONSTRUCTION	▼				
TERRESTRIAL					
● REGIONAL TEST FARMS	▲	AWARD CONTRACT			
● INTEGRATED SYSTEMS (PRODUCTION/CONVERSION)					
SILVICULTURAL ENERGY FARM/GASIFICATION		AWARD CONTRACT ▲		DESIGN ▼	INSTALLATION OF FARM ▼
HERBACEOUS ENERGY FARM/FERMENTATION		AWARD CONTRACT ▲		DESIGN ▼	INSTALLATION OF FARM ▼

FIGURE 8
SOLAR HEATING AND COOLING OF BUILDINGS MILESTONES – FEBRUARY, 1978

ACTIVITY	FISCAL YEAR				
	1979	1980	1981	1982	1983
COMMERCIAL DEMONSTRATION PROGRAM	▼ CYCLE 4		(DATA COLLECTION CONTINUES)		
HUD RESIDENTIAL DEMONSTRATION PROGRAM	▼ CYCLE 5		(DATA COLLECTION CONTINUES)		
RESEARCH & DEVELOPMENT					
• SERVICE HOT WATER	VALIDATE MODELS FOR VARIOUS CLIMATIC REGIONS	PERFORMANCE FOR VARIOUS CLIMATIC ZONES HANDBOOK			
	▼	▼			
• SPACE HEATING SYSTEMS ¹	VALIDATE SYSTEMS & MODELS	COSTS & PERFORMANCE IN VARIOUS CLIMATIC ZONES/ HANDBOOKS			
	▼ ▼	▼			
• SPACE COOLING SYSTEMS ²	MATERIALS, CONTROLS, HYBRID SYSTEM STUDIES				FINAL SYSTEM STUDIES
PERFORMANCE CRITERIA & STANDARDS DEVELOPMENT	SYSTEMS & MATERIALS STUDIES		EVALUATION & MODEL VALIDATION		HANDBOOKS & PERFORMANCE IN VARIOUS CLIMATIC ZONES
	DEFINITIVE CRITERIA				

¹KEY MILESTONES FOR 4 TECHNOLOGIES

²KEY MILESTONES FOR 5 TECHNOLOGIES

▲ BEGIN MILESTONE

▼ COMPLETED MILESTONE

FIGURE 9
AGRICULTURAL AND INDUSTRIAL PROCESS HEAT MILESTONES – MARCH, 1978

ACTIVITY	FISCAL YEAR				
	1979	1980	1981	1982	1983
AGRICULTURAL APPLICATIONS EXPERIMENTAL PROJECTS					
INDUSTRIAL APPLICATIONS					
● HOT WATER EXPERIMENTS & PROTOTYPE SYSTEMS (<212°F)	▲			▼	
● LOW TEMPERATURE AIR (<350°F) EXPERIMENTS & PROTOTYPE SYSTEMS	▲			▼	
● HIGH TEMPERATURE AIR (>350°F) EXPERIMENTS & PROTOTYPE SYSTEMS		EXPERIMENTS ▲			PROTOTYPE SYSTEMS ▲
● LOW TEMPERATURE STEAM (<350°F) EXPERIMENTS & PROTOTYPE SYSTEMS		EXPERIMENTS ▼	PROTOTYPE SYSTEMS ▲		▼
● INTERMEDIATE TEMPERATURE STEAM (350°F-600°F) EXPERIMENTS & PROTOTYPE SYSTEMS			EXPERIMENTS ▼	PROTOTYPE SYSTEMS ▲	
● HIGH TEMPERATURE STEAM (>600°F) EXPERIMENTS & PROTOTYPE SYSTEMS	EXPERIMENTS ▲			▼	PROTOTYPE SYSTEMS ▲
● OTHER EXPERIMENTS AND PROTOTYPE SYSTEMS (COOLING & REFRIGERATION)		EXPERIMENTS ▲			PROTOTYPE SYSTEMS ▲

▲ BEGIN MILESTONE

▼ COMPLETED MILESTONE

FIGURE 9 (CONT'D)
AGRICULTURAL AND INDUSTRIAL PROCESS HEAT MILESTONES – MARCH, 1978

ACTIVITY	FISCAL YEAR				
	1979	1980	1981	1982	1983
RESEARCH & DEVELOPMENT <ul style="list-style-type: none"> • SPACE HEATING FOR SHELTERS & GREENHOUSES AND DRYING OF AGRICULTURAL & INDUSTRIAL PRODUCTS* • PROCESS HOT WATER* • PROCESS STEAM/LIQUID HEATING COLLECTORS • COOLING FOR AGRICULTURAL & INDUSTRIAL PROCESS APPLICATIONS* 					
			VALIDATION OF SYSTEMS & MODELS	COSTS & PERFORMANCE IN VARIOUS CLIMATIC ZONES HANDBOOKS	
			VALIDATE MODELS FOR VARIOUS CLIMATIC REGIONS		
				COSTS & PERFORMANCE IN VARIOUS CLIMATIC ZONES HANDBOOKS	
			VALIDATE MODELS FOR VARIOUS CLIMATIC REGIONS		
				SYSTEM STUDIES FOR VARIOUS CLIMATIC ZONES HANDBOOK	
			SYSTEM STUDIES FOR VARIOUS CLIMATIC ZONES		
				FINAL SYSTEMS STUDIES, FINAL HANDBOOK	

*KEY MILESTONES FOR VARIOUS TECHNOLOGIES

▲ BEGIN MILESTONE

▼ COMPLETED MILESTONE

VI. GLOSSARY

<u>albedo</u>	The fraction or percentage of incident solar radiation which is reflected by a surface.
<u>circumsolar radiation</u>	Radiation scattered by the atmosphere into the area of the sky immediately adjacent to the sun. It causes the solar aureole, and its areal extent is directly related to atmospheric turbidity, being greater with higher turbidity (Johnson Environmental and Energy Center, 1977).
<u>diffuse solar radiation</u>	Downward scattered and reflected solar radiation, coming from the whole hemisphere with the exception of the solid angle subtended by the sun's disc (World Meteorological Organization, 1966; cited by Johnson Environmental and Energy Center, 1977).
<u>direct solar radiation (direct beam, direct normal)</u>	Solar radiation coming from the solid angle of the sun's disc on a surface perpendicular to the axis of this cone, comprising mainly unscattered and unreflected solar radiation (World Meteorological Organization, 1966; cited by Johnson Environmental and Energy Center, 1977).
<u>global radiation (total horizontal)</u>	Global solar radiation received on a horizontal surface direct from the solid angle of the sun's disc and also radiation that has been scattered or reflected in traversing the atmosphere (World Meteorological Organization, 1971; cited by Johnson Environmental and Energy Center, 1977).
<u>GMCC</u>	Geophysical Monitoring for Climate Change - program of the National Oceanic and Atmospheric Administration (NOAA).
<u>IEA</u>	International Energy Agency
<u>LBL</u>	Lawrence Berkeley Laboratory
<u>NCC</u>	National Climatic Center of the National Oceanic and Atmospheric Administration, Asheville, N.C.
<u>pyranometer-solarimeter</u>	A pyranometer is an instrument for the measurement of the solar radiation received from the whole hemisphere. It is suitable for the measurement of the global or sky radiation (World Meteorological Organization, 1971; cited by Johnson Environmental and Energy Center).

pyrheliometer-
actinometer

A pyrheliometer is an instrument for measuring the intensity of direct solar radiation at normal incidence. (World Meteorological Organization, 1971; cited by Johnson Environmental and Energy Center, 1977).

radiometer

Instrument for measuring radiation (World Meteorological Organization, 1966; cited by Johnson Environmental and Energy Center, 1977).

SOLDAY

NOAA/DOE computer tape archival format for daily totals for solar radiation variables and daily weather data.

SOLMET

NOAA/DOE computer tape archival format for hourly solar radiation and meteorological data.

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VIII. APPENDIX I

COMPLETED, CURRENT, AND PLANNED RESEARCH PROJECTS

The following is a summary of research which is directly applicable to the assessment of the national availability of insolation resources.

COMPLETED RESEARCH

Title	Objective
<p>1. USER MEETING TO COORDINATE RESEARCH PROGRAMS COMPLETION DATE: January, 1978 FUNDING AGENCY: DOE/ERAB</p>	<p>To conduct a conference coordinating Federal, regional, and local meteorological network planning. A coordinated meteorological data management plan is being developed for solar energy related meteorological monitoring. This plan will ensure quality meteorological resource and support data for this national solar energy effort directed toward eliminating duplication of effort. (Bibliography reference no. 10, 11.)</p>
<p>2. PROPOSAL FOR INDEX OF WIND RECORDS COMPLETION DATE: March, 1978 FUNDING AGENCY: DOE/ERAB</p>	<p>To index the existing wind records for the United States. The National Climatic Center (NCC) has prepared a publication indexing wind observations available for the United States. The index is in an agreed-to standard format. The project provides the user community with a readily available index of U.S. wind data. The index presents a brief history on each site including anemometer height. (Bibliography reference no. 9)</p>
<p>3. SOLAR RADIATION INSTRUMENT CATALOG UAH-1 COMPLETION DATE: 1977 FUNDING AGENCY: ERDA/ERAB</p>	<p>The catalog identifies approximately 130 different models or types of equipment produced by about 33 manufacturers. The catalog was published by the University of Alabama at Huntsville (UAH) in April, 1977. (Bibliography reference no. 7.)</p>
<p>4. SOLAR RADIATION NETWORK DESIGN HANDBOOK UAH-3 COMPLETION DATE: April, 1978 FUNDING AGENCY: DOE/ERAB</p>	<p>To prepare a solar radiation network design handbook that provides guidelines by first determining the need for a network, and then establishing the operating procedures. The handbook includes procedures established by the World Meteorological Organization (WMO) so that it may be proposed for international use. The widespread dissemination of significant data is a primary objective of this research program. The handbook includes information from many sources, organized so that solar radiation data may be made compatible with all other data. It will facilitate the design of systems that can meet the data requirements of private organizations such as power companies, universities, and industries, as well as Federal, state, and local government agencies. It is envisioned that it will provide guidelines that will enable all DOE-sponsored</p>

5. ESTIMATION OF INSOLATION AT
SELECTED LOCATIONS

COMPLETION DATE: April, 1978

FUNDING AGENCY: DOE/ERAB

projects to produce compatible baseline
baseline solar radiation data. (Bibliography
reference no. 22.)

To develop a tool/model to estimate insolation
data at many locations throughout the United
States. This project expands the insolation
data base required for design of solar energy
systems. The estimated data will also allow
for better interpolation between existing
insolation data points, thus fixing the present
network size and eliminating the need for
additional sites in a cost-effective manner.
(Bibliography reference no. 29.)

6. A STUDY OF THE DISTRIBUTION AND
CHARACTERISTICS OF SOLAR RADIA-
TION IN THE U.S. - A PROGRAM TO
DEVELOP MATERIAL FOR A SOLAR
RADIATION USERS MANUAL

COMPLETION DATE: March, 1978

FUNDING AGENCY: DOE/ERAB

To develop material for a Solar Radiation
Users Manual. This effort provides an accurate,
but not excessively complex insolation model
for direct and diffuse solar radiation and
will provide the material for a much needed
general users manual on insolation. (Bibli-
ography reference no. 46.)

7. ALTERNATIVE SOLAR RADIATION
NETWORKS SATELLITE DATA

COMPLETION DATE: 1977

FUNDING AGENCY: NOAA

To gather coincident satellite, meteorological,
and pyranometer data to investigate methods
of determining surface insolation from remote
sensing data. Data was collected for 60
days for the area of Great Plains extending
from 29°N to 49°N and 95°W to 105°W.
The coincident satellite, meteorological,
and pyranometer data set is available on
magnetic tape. (Bibliography reference
no. 39.)

8. SOLAR RADIATION ENERGY SOURCES
COMPARISON USING SOLMET DATA

COMPLETION DATE: 1977

FUNDING AGENCY: DOE CONSERVA-
TION AND SOLAR
APPLICATIONS

To make a comprehensive comparison of
SOLMET data and other data bases and long-
term mathematical predictor methods.
The comparison was made to determine what
technique was most suitable for generating
insolation values for non-SOLMET sites.
The study found that there are significant
differences between SOLMET and analytical
predictor techniques. (Bibliography reference
no. 40.)

9. INSOLATION DATA BASE

COMPLETION DATE: 1978

FUNDING AGENCY: DOE/SANDIA
LABORATORIES

To provide an hourly combined insolation
and meteorological data base including both
direct and global insolation covering a
statistically significant time period and
a variety of climatic regions in the United
States. This is an historical data base that
has been derived from the old NOAA hourly
network. Direct normal radiation values
have been modeled; measured total horizontal
radiation values were massaged and incorporated
into the data base. (Bibliography reference
no. 37.)

10. ALTERNATIVES TO A GROUND-BASED SOLAR RADIATION MONITORING NETWORK
COMPLETION DATE: 1978
FUNDING AGENCY: DOE/ERAB
To use hourly SOLMET cloudiness data to predict solar radiation. Regression equations will be applied to data from weather stations adjacent to the 26 rehabilitated NWS stations. (Bibliography reference no. 28.)
11. VARIABILITY OF SOLAR RADIATION WITH GEOGRAPHICAL LOCATION
COMPLETION DATE: 1977
FUNDING AGENCY: DOE
To investigate solar radiation at the earth's surface at five geographical locations. This study found that the amount of solar radiation received at a particular location and its degree of variability seem to depend to a large extent on synoptic weather patterns. This conclusion indicates that site evaluation for solar energy may have to be done on a location-to-location basis or at least on a small regional scale. (Bibliography reference no. 31.)
12. URBAN-RURAL RADIATION DIFFERENCES IN THE ST. LOUIS AREA
COMPLETION DATE: 1978
FUNDING AGENCY: DOE/ERAB
To analyze the urban-rural solar radiation variation in the St. Louis area. Data for mid-1975 through March, 1977 have been obtained from solar radiation instruments installed at six sites in the metropolitan area. The data provide a tool for estimating solar collector performance in the urban-rural environment. (Bibliography reference no. 33, 34.)
13. EFFECTS OF AEROSOLS AND CLOUDS ON SOLAR RADIATION
COMPLETION DATE: 1978
FUNDING AGENCY: DOE/ERAB
The effects of aerosols and clouds on solar radiation will be determined for three sites in the United States to aid in the improvement of basic solar radiation models. The data will also be used to provide appropriate research measurements for future modeling efforts. (Bibliography reference no. 25, 26, 27.)
14. THE STATE OF NEW MEXICO SOLAR RADIATION RESOURCE ASSESSMENT PROJECT
COMPLETION DATE: 1977
FUNDING AGENCY: STATE OF NEW MEXICO ENERGY RESOURCES BOARD
To evaluate solar energy available within New Mexico. Involves assessment of data required by various solar programs and other users of solar data; survey of past, present, and planned solar radiation monitoring programs to be carried out within New Mexico; and an attempt to formulate a program to coordinate local, state, and regional solar radiation data collection into a network. Rehabilitated data base available December, 1977. (Bibliography reference no. 6.)

15. ANALYSIS OF THE CALIFORNIA
SOLAR RESOURCE
COMPLETION DATE: 1978
FUNDING AGENCY: DOE/ERAB AND
STATE OF
CALIFORNIA
ENERGY
RESOURCES
CONSERVATION
AND DEVELOP-
MENT COM-
MISSION

To prepare a manual of California solar resource data intended for use by designers, architects, engineers, homeowners, and builders. To collect, assemble, edit, and correct insolation resource data and to present recommendations to the state as to what kinds of data collection are needed. This manual provides the basic solar data and sizing methods needed to design residential or commercial heating systems, solar heated swimming pools, and solar air conditioning systems. The data are provided in a variety of forms to make them accessible and useful to the broadest possible audience. (Bibliography reference no. 3, 4.)

16. SOLAR RADIATION MEASUREMENTS
IN HAWAII
COMPLETION DATE: 1977
FUNDING AGENCY: NSF, STATE OF
HAWAII, COUN-
TY OF MAUI

Diffuse and global radiation were measured at a number of sites. Data were quality controlled, processed, and summarized in usable form in a solar radiation data manual. (Bibliography reference no. 51, 52.)

CURRENT RESEARCH

Title	Objectives
17. DOE/NOAA PYRHELIOMETRIC NETWORK
COMPLETION DATE: June, 1978
FUNDING AGENCY: DOE/ERAB	To update the insolation measurement capability for the 38-station NOAA network by providing a pyr heliometer for each station. The pyr heliometer supplements the pyranometer now available at each of 38 stations. The pyr heliometers used with pyranometers provide the capability for measuring direct solar radiation and calculating diffuse radiation. The resulting data can be used in the design of collectors, for predicting the insolation falling on inclined surfaces, and in other solar RD&D activities. (Bibliography reference no. 32.)
18. ADDING STRIP-CHART RECORDERS TO DOE/NOAA NETWORK
COMPLETION DATE: January, 1979
FUNDING AGENCY: DOE/ERAB	To add strip-chart recorders to the DOE/NOAA solar radiation network as a backup to digital recorders. The addition of strip-chart recorders ensures the most complete data collection possible from the DOE/NOAA solar radiation network and aids in the quality control of the solar radiation data. (Bibliography reference no. 32.)
19. FINAL PREPARATION OF SOLMET TAPES
COMPLETION DATE: January, 1979
FUNDING AGENCY: DOE/ERAB	To update SOLMET tapes after 1 year of public use. To define the phase shift problem in the SOLMET tapes, develop a strategy to solve the problem, and correct the second addition of SOLMET as appropriate. This project provides the public with the most accurate historical, hourly insolation and related weather data possible at 26 locations in the U.S. (Bibliography reference no. 35, 36.)
20. GROUND-BASED INSOLATION MEASUREMENT AT SELECTED FIELD SITES
COMPLETION DATE: 1981
FUNDING AGENCY: ETS	To collect data, at two sites, with spectral insolation monitoring devices capable of measuring the direct and diffuse solar irradiance in seven spectral bands. Two new sites will also be selected and simultaneous monitoring will be initiated at these locations. The data obtained will be used in the development of photovoltaic and bioconversion techniques. (Bibliography reference no. 23, 24.)

21. IEA PORTABLE INSOLATION MONITOR

COMPLETION DATE: January, 1979
FUNDING AGENCY: DOE/ERAB AND SOLAR THERMAL POWER SYSTEMS BRANCH

To design and build a portable insolation and meteorological monitoring package to international specifications. Three systems have been installed and a fourth is scheduled for completion. The system output will be in digital form, formatted for interface to the user's computer.

22. SOLAR ENERGY RESEARCH SITES

COMPLETION DATE: 1982
FUNDING AGENCY: DOE/ERAB

To establish and operate an eight station meteorological research network at eight universities to: (1) collect detailed insolation and meteorological data needed for advanced solar energy studies; and (2) act as regional training centers for meteorologists and engineers. (Bibliography reference no. 2, 12, 51, 52.)

23. REHABILITATION OF DAILY SOLAR RADIATION DATA

COMPLETION DATE: October, 1978
FUNDING AGENCY: DOE/ERAB

To rehabilitate data from 25 sites with daily totals of solar radiation, to develop a new format for the daily solar radiation totals including other meteorological data, and to develop computer programs to publish the data and compute statistical summaries. (Bibliography reference no. 35, 36.)

24. KEYING INTERMEDIATE WEATHER DATA ONTO SOLMET TAPE

COMPLETION DATE: Ongoing
FUNDING AGENCY: DOE/ERAB

To key intermediate hourly weather data onto SOLMET data tapes for approximately 38 solar radiation stations. Hourly weather data will be on all the new network SOLMET data tapes. (Bibliography reference no. 32.)

25. NOAA CALIBRATION CENTER SUPPORT

COMPLETION DATE: Ongoing
FUNDING AGENCY: DOE/ERAB AND NOAA

To provide insolation data quality control and instrument calibration for the 38 station NOAA network. Insolation sensor calibration and maintenance will be undertaken by the Air Resources Laboratory to aid in the production of high quality solar radiation data. The center maintains the standard solar radiation instruments for the U.S. (Bibliography reference no. 14, 32.)

26. PROCESSING OF NOAA DATA

COMPLETION DATE: Ongoing
FUNDING AGENCY: DOE/ERAB AND NOAA

The DOE/NOAA network and modeled data will be processed and refined into the SOLMET and SOLDAY computer tape formats. Monthly printed summaries and hourly data tapes will be disseminated. (Bibliography reference no. 4, 19, 32.)

27. PROCESSING OF NON-NOAA INSOLATION AND METEOROLOGY DATA
COMPLETION DATE: Ongoing
FUNDING AGENCY: DOE/ERAB AND NOAA
Potential cooperative data stations and high quality data stations will be identified and inventoried. A methodology will be established for selecting new cooperative data stations/sites as future data sources. The resulting historical and new insolation and meteorological data will be processed and disseminated in monthly summaries and SOLMET and SOLDAY computer tapes. (Bibliography reference no. 4, 8, 19, 32.)
28. EDUCATIONAL AND SEMINAR SUPPORT ACTIVITIES
COMPLETION DATE: August, 1979
FUNDING AGENCY: DOE/ERAB
To provide educational materials and seminars related to environmental and insolation resource assessment. UAH will host seminars in Washington, D.C. These seminars will be aimed at increasing the level of professional expertise available to DOE. Further, UAH will draft educational materials for DOE use.
29. FORECASTING AND INTERPOLATION ANALYSIS
COMPLETION DATE: November, 1978
FUNDING AGENCY: DOE/ERAB
To define the representative area served by each past solar radiation site (51) and the ability of the NOAA model and satellite techniques to interpolate insolation between sites; to define the representative area served by each new insolation site (35) and the ability of the NOAA model and satellite techniques to interpolate insolation between sites; and to compile an inventory of techniques to calculate tilted solar radiation and evaluate these at selected locations. The definition of the representative areas for the past and new solar radiation network will define future network requirements. The evaluation of the modeling techniques will help establish the number of required solar radiation sites - the better these models aid interpolation, the fewer sites that will be needed (thus lowering costs). The inventory of tilted modeling techniques and their evaluation will establish which model to use or if new work is needed. This will also establish if tilted measurements are required. (Bibliography reference no. 48.)
30. TYPICAL METEOROLOGICAL YEAR
COMPLETION DATE: 1980
FUNDING AGENCY: DOE/ERAB
A typical meteorological year (TMY) selection methodology will be developed and applied to the 26 rehabilitated SOLMET data sites, rehabilitated SOLDAY data, model generated data, and various historical data sets. The resulting TMY's will be used for solar system design and for performance and economic analyses. (Bibliography reference no. 18.)

31. JOINT PROBABILITY OF WIND
AND SOLAR
COMPLETION DATE: 1979
FUNDING AGENCY: DOE/ERAB

The seasonal probability of consecutive days with both usable insolation and wind, insolation only, wind only, and neither will be determined for 25 to 50 locations. Northrop Services will apply this data to 26 sites and provide a preliminary interpretation of results for promising locations of hybrid solar and wind energy systems. The analysis techniques will be applied from approximately 200 additional sites. (Bibliography reference no. 38.)

32. MOUNTAIN-VALLEY SOLAR
RADIATION DIFFERENCE STUDY
COMPLETION DATE: 1978
FUNDING AGENCY: DOE/ERAB

Mountain-valley insolation gradients will be defined for a Rocky Mountain valley system by feeding 1 year's data into an inter valley solar energy variation model to be developed by the Utah State University. The results of the study will be used in network improvement efforts, help define microclimate solar radiation differences, and provide sample data sets for solar system simulation studies.

33. COASTAL-INLAND SOLAR RADIATION
DIFFERENCE STUDY
COMPLETION DATE: 1979
FUNDING AGENCY: DOE/ERAB

This study will develop the data and model(s) necessary to estimate direct and global coastal-inland solar radiation variations. The results will be incorporated into the network improvement effort, help define microclimate solar radiation differences, and provide sample data sets for solar system simulation studies.

34. A STUDY OF THE TEMPORAL AND
SPATIAL VARIATION OF CLIMATE
AND SOLAR RADIATION IN THE
METROPOLITAN PHOENIX AREA
COMPLETION DATE: August, 1978
FUNDING AGENCY: DOE/ERAB

To analyze the climatic and solar data available in the metropolitan Phoenix area to determine the validity and comparability of the data for use by the solar energy industry. All pertinent climatic and solar data available for the period 1950-1976 are included in this analysis. The nature and extent of the variations that occur in the climate of the metropolitan region and in the amounts of solar radiation available in various parts of the region will be determined. (Bibliography reference no. 13.)

35. MEASUREMENT OF CIRCUMSOLAR RADIATION
COMPLETION DATE: 1979
FUNDING AGENCY: DOE/ETS
AND DOE/
CONSERVATION
AND SOLAR
APPLICATIONS

Models will be developed to determine the relationships between the levels of circumsolar radiation and various meteorological and insolation conditions. Special attention will be given to the relationship between circumsolar radiation and the readings of normal incidence pyrheliometers. Data will aid in the accurate prediction of the performance of concentrating solar energy collectors. (Bibliography reference no. 15, 16, 17.)

36. ANALYSIS OF INSOLATION INPUT FOR SOLAR ENERGY TECHNOLOGIES
COMPLETION DATE: 1981
FUNDING AGENCY: ETS

SERI will estimate insolation input for various solar energy technologies from the basic global and/or direct insolation available from NOAA and assess microclimatic insolation effects on solar designs. The study will provide a high quality assessment of the sensitivity of solar design simulation models and the appropriateness of insolation and microclimatic variation models as sources of input data. The results of this effort will enable higher accuracy in solar system design and siting.

37. MEASUREMENT OF INSOLATION ON NONHORIZONTAL SURFACES AND VARIOUS APERTURES
COMPLETION DATE: 1981
FUNDING AGENCY: ETS

SERI will monitor the insolation on non-horizontal surfaces and into varying apertures. This effort will provide data for a monitoring and modeling effort aimed at obtaining a research data set for evaluation of the actual solar energy inputs for various solar collectors. Previous work carried out by Northrop Services under contract to ERAB will be used as a starting point.

38. RADIATIVE AND PASSIVE COOLING
COMPLETION DATE: Ongoing
FUNDING AGENCY: DOE/
CONSERVATION
AND SOLAR
APPLICATIONS

To assess the infrared radiative cooling resource to determine the extent to which radiative cooling can supplement or replace refrigerative-type systems for the space cooling of buildings, to accomplish this objective, the University of California (Berkeley) is developing a computer model to predict atmospheric infrared radiation as a function of wavelength. The University will also design a spectral sky radiometer as a part of this effort. (Bibliography reference no. 5, 30.)

39. A REGIONAL ASSESSMENT OF
PASSIVE COOLING PROCESSES
IN THE UNITED STATES

COMPLETION DATE: October, 1978

FUNDING AGENCY: DOE/
CONSERVATION
AND SOLAR
APPLICATIONS

To identify and categorize the thermal energy exchange rates, for various types of surfaces, for night air exchange and/or evaporative cooling processes, acting separately or in concert, for different climate zones and different times of the year. The Trinity University Solar Data Center is also assessing: (1) the regional typical year cooling rates from a horizontal surface due to convection, radiation, and evaporation; (2) the regional potential for convective and radiative cooling from tilted glass and plastic glazed and unglazed flatplate collectors, and (3) the regional feasibility of passive cooling of standard residences. Regional monthly cooling loads for two standard residences using hourly data will be simulated. (Bibliography reference no. 12.)

40. CLIMATE STATISTICS AND
ALTERNATIVE ENERGY FUTURES

COMPLETION DATE: 1979

FUNDING AGENCY: DOE/OFFICE
OF THE
ASSISTANT
SECRETARY
FOR POLICY
AND
EVALUATION

To describe a future U.S. society based entirely on solar energy in all its manifestations and to compare this scenario with other scenarios incorporating various fractions of nuclear energy. The Institute for Energy Analysis of the Oak Ridge Associated Universities has chosen eight SOLMET sites to serve as a data base for the assessment of solar energy resource availability. The analysis will determine the influence of the stochastic nature of climate on the reliability of solar energy supply and the effect of solar energy supply and reliability on solar technology itself.

41. SOLAR RESOURCE EVALUATION
PROJECT

COMPLETION DATE: 1982

FUNDING AGENCY: WESTERN
ENERGY
SUPPLY
AND TRANS-
MISSION
ASSOCIATES

To establish a regional data base for portions of the Southwestern U.S. for use by utilities in evaluations of solar technology. Thirty-eight stations are currently monitoring total insolation and air temperature, and 13 of these stations are also measuring direct radiation. Data collected on the WEST Monitoring Network are available in three formats: summaries for use in building applications; detailed statistical summaries for analysis; and unreduced data on magnetic tape.

42. SOLAR ENERGY ATLAS FOR
NEW YORK STATE
COMPLETION DATE: Ongoing
FUNDING AGENCY: NEW YORK
STATE ENERGY
RESEARCH AND
DEVELOPMENT
AUTHORITY,
DOE/ERAB

To compile an atlas and annual updated
atlases of the solar energy resource in New
York State. Tables, maps, and charts de-
scribing irradiation at a number of New
York State locations compose the bulk
of the atlas. This effort is jointly sponsored
by New York State and DOE and is an element
of the Solar Energy Research Sites project.
(Bibliography reference no. 1, 2, 20.)
43. MONITORING THE EIGHT METEORO-
LOGICAL RESEARCH AND TRAINING
SITES
COMPLETION DATE: 1981
FUNDING AGENCY: ETS

The Solar Energy Research Institute will
provide a scientist who will remain informed
of the educational and research programs
of the eight meteorological research and
training sites and participate in the Insolation
Resource Assessment Program. This individual's
duties will include participation in the review
of papers, and attendance at program reviews,
etc.
44. INSOLATION RESOURCE ASSESSMENT
PROGRAM MANAGEMENT
COMPLETION DATE: 1981
FUNDING AGENCY: ETS

The Insolation Resource Assessment Program
Manager will obtain support in the adminis-
tration and technical management of Insolation
Resource Assessment network data collection,
data management, and research and analysis
activities. Management support will (1)
ensure adequate, timely, and economic
completion of Insolation Resource Assessment
activities, and (2) provide the Program
Manager with a better view of the scope
and direction of such projects.
45. SOLAR ENERGY RESOURCE ATLAS
COMPLETION DATE: 1980
FUNDING AGENCY: DOE/EPAB

A solar energy availability atlas, including
graphs, maps, and tables of direct, global,
and tilted solar flux availabilities for fixed
and tracking collectors will be developed
from SOLMET, SOLDAY, and all other
appropriate insolation and meteorological
data bases. Prior to the publication of
the atlas the needs of the solar community
will be defined, trial products will be designed
and disseminated, and feedback from the
community will be used to refine the published
material.

PLANNED RESEARCH

46. **INSOLATION MONITORING AT
PROPOSED SITES OF LARGE AND
MEDIUM-SCALE PHOTOVOLTAIC
AND THERMAL POWER SYSTEMS
FACILITIES**

COMPLETION DATE: Ongoing

FUNDING AGENCY: DOE/ERAB AND
DOE SOLAR
TECHNOLOGIES

To build and install portable insolation and meteorological monitoring systems at possible sites of large and medium-scale photovoltaic and thermal power systems facilities. The insolation data will provide the basis for solar system designing and a comparison of candidate sites in terms of the quality and availability of the resource.

47. **IMPROVEMENT OF INSOLATION AND
METEOROLOGICAL DATA NETWORKS**

COMPLETION DATE: Ongoing

FUNDING AGENCY: NOAA

User needs and network products will be evaluated periodically by NOAA and the various network users, including DOE. With the assistance of user feedback, NOAA will identify and implement desirable improvements.