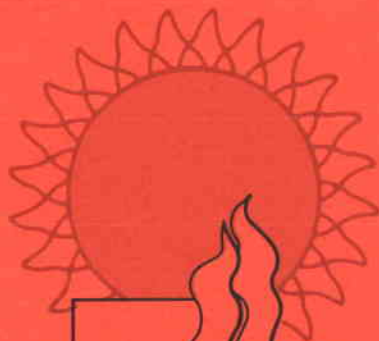
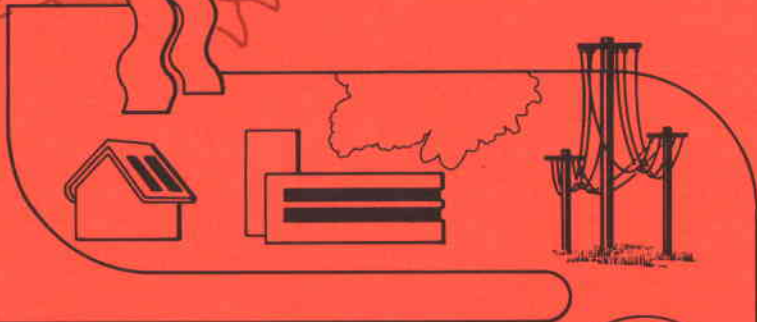




National Solar Data Network



Department of Energy

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by

Automation Industries, Incorporated
Vitro Laboratories Division

**NATIONAL SOLAR
DATA NETWORK**

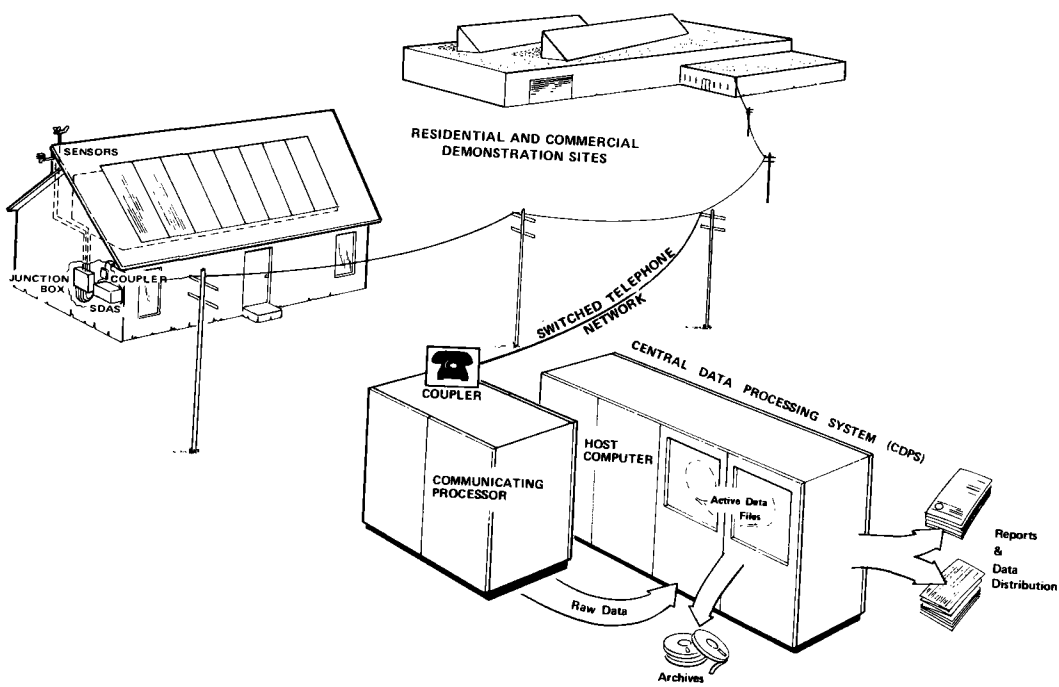
JANUARY 1980

OVERVIEW

A major goal of the National Solar Data Program is to collect and analyze data from solar sites throughout the United States to enable determination of solar energy system performance. Specifically, the data which is generated and collected in support of this program is used to:

1. Improve the general knowledge and understanding of the performance and operating characteristics of solar energy systems.
2. Develop definitive solar energy system performance criteria.
3. Provide a basis for component and system improvements.
4. Estimate the economic importance of solar energy systems in reducing the consumption of conventional fuels.

The National Solar Data Network is providing data to meet this major goal. Accurate, consistent, and orderly data is obtained from a variety of solar energy systems, located in many buildings and exposed to differing climatic conditions. The data is collected, organized, maintained and analyzed at a central point assuring consistent system analysis and performance evaluation.



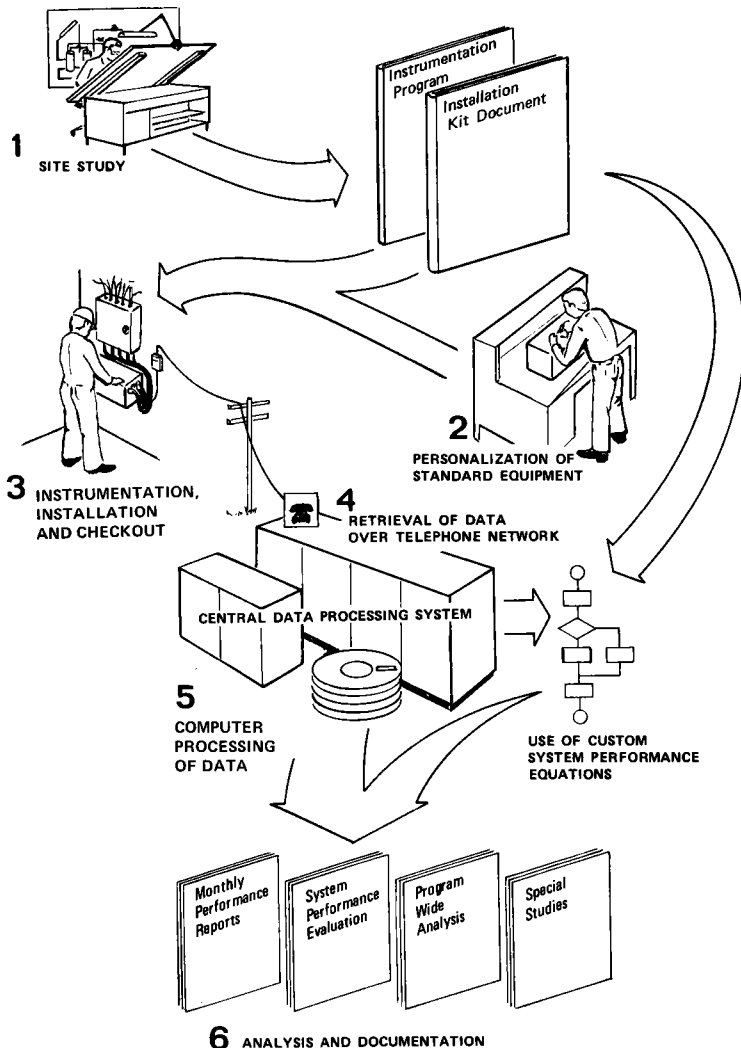
PROGRAM ACTIVITIES

To meet the goals and objectives of the National Solar Data Program, the National Solar Data Network is operated for the Department of Energy by Automation Industries, Incorporated, Vitro Laboratories Division. The network concept is based on automatic collection of data from remote solar sites and transmission of this data to a central computer facility. Thus, the National Solar Data Network was developed to gather, convert, transfer, and analyze demonstration site data using six basic steps:

1. Evaluate each site and its instrumentation requirements.
2. Select sensors and personalize standardized data acquisition equipment in order to meet specific site requirements.
3. Install and check out instrumentation on site.
4. Retrieve automatically collected site data over the telephone network on command from a central computer facility.
5. Process data in centrally located computers; this includes error checking, performance evaluation factor computation, and data base maintenance.
6. Analyze data received and document this analysis in a standard report format for distribution.

The following discussion will define each step in detail.

Program Activities



SITE EVALUATION

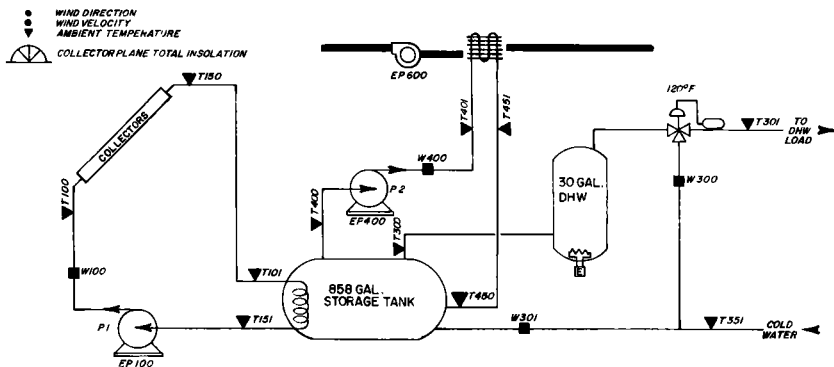
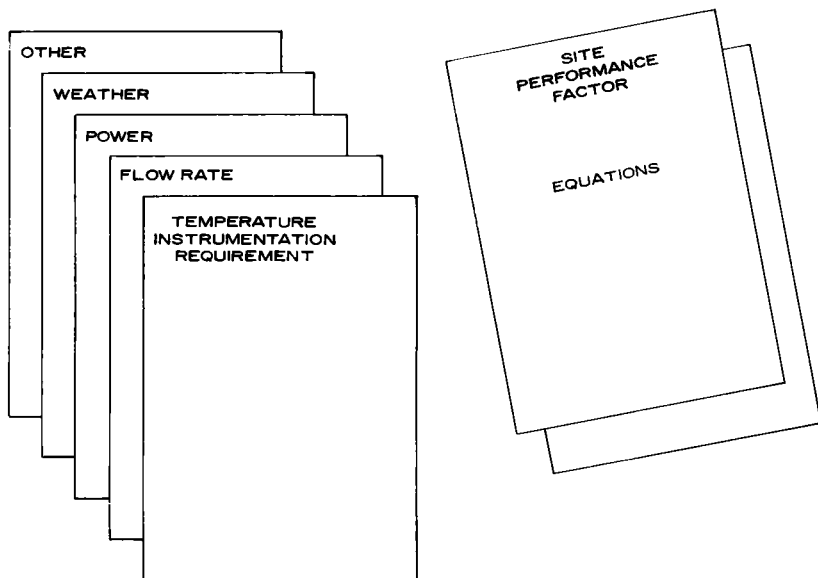
First, a careful study of the solar energy system design of each demonstration site is conducted. Using detailed information supplied by the solar system designer and the site contractor, the system and its environment are investigated to establish performance evaluation equations and associated site monitoring instrumentation requirements. (The performance evaluation techniques used follow general guidelines taken from NBSIR76-1137, which were established by a governmental interagency Performance Evaluation Committee for use in evaluating solar energy systems.) The details of the site instrumentation are documented in the Instrumentation Program and Installation Kit documents generated for each solar site.

Performance evaluation factors are determined using the energy balance concept. Simply stated, energy entering a system (or subsystem) is equal to the sum of energy leaving the system, energy accumulated in the system, energy transferred through thermal leakage, and conversion inefficiency. As stated in the Instrumentation Program, the sensors selected are those necessary to accurately and economically determine this energy balance.

Performance evaluation factors are used to:

1. Determine fossil fuel and electrical energy savings resulting from use of solar energy for space heating, space cooling, and hot water systems.
2. Determine total heating, cooling, and hot water thermal energy demands and the fraction of each supplied by solar energy.
3. Measure solar energy system efficiency for converting available solar energy into useful thermal energy.
4. Measure thermal performance of major subsystems or components and thermal interactions between collector array, storage, and energy conversion equipment.
5. Measure occupant's energy usage by means of parameters such as temperature level maintained and hot water demand.
6. Determine major system operational characteristics and degradation over life of the demonstration.
7. Obtain records of incident solar irradiation and other pertinent site environmental parameters that affect system performance over life of the site in the demonstration program.

Site Study—Generates Instrumentation Requirements and Performance Evaluation Equations



PERSONALIZATION OF STANDARD EQUIPMENT

The second step is to select sensors and personalize the standard data acquisition equipment to meet the requirements specified in the Instrumentation Program. Sensors are selected from a standardized set of sensors which has been established to ensure compatibility with the Site Data Acquisition Subsystem (SDAS) and to minimize software development. The SDAS is a microprocessor-controlled electronic unit which collects data from the sensors, stores the data, and on command transmits it to the central facility. The scanning process, data treatment procedure, and other functions of the SDAS are directed by a microprogram which is custom developed for each SDAS, according to the Instrumentation Program for a specific site. Additional personalization is provided through unique wiring of the SDAS and its associated junction box as described in the Installation Kit.

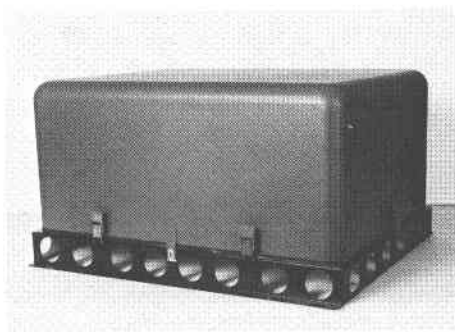
Site Data Acquisition Subsystem and Typical Sensors



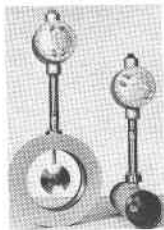
*Total Insolation Pyranometer
Diffuse Insolation Pyranometer*



*Wind Speed/
Direction Sensor*



Site Data Acquisition System Mod II



*Liquid
Flowmeters*



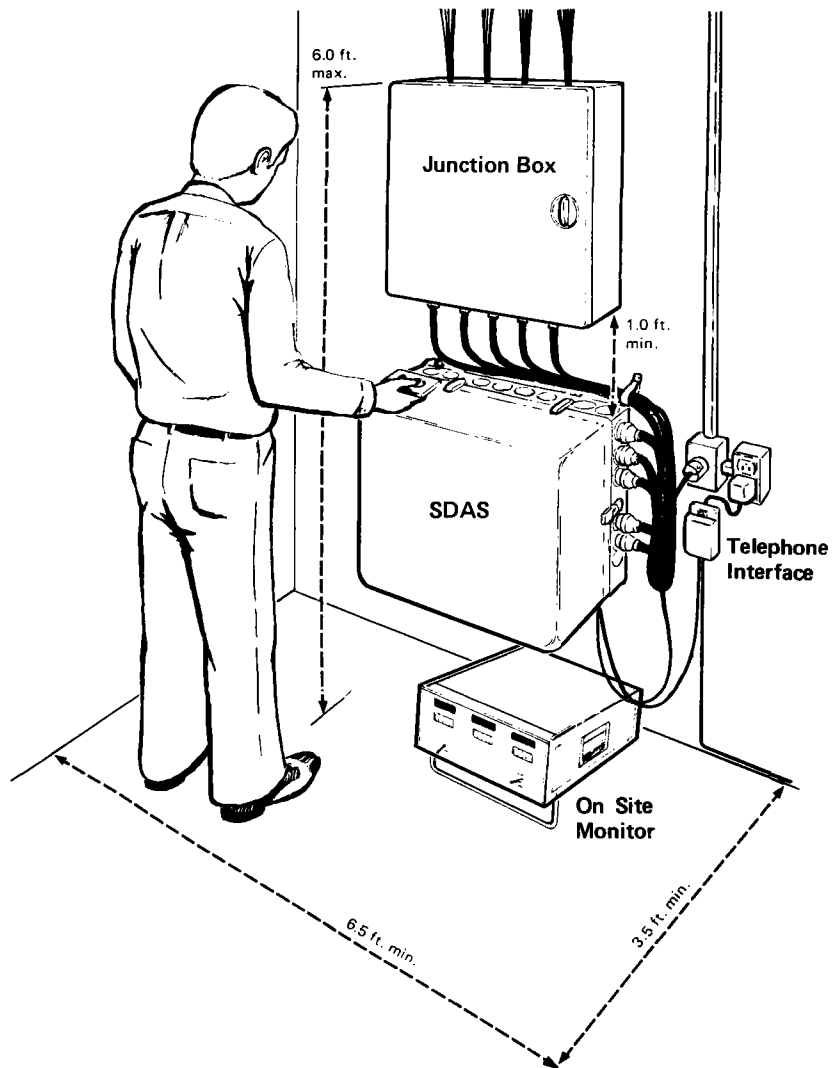
*Resistance Temperature
Detector*

ON-SITE INSTALLATION AND CHECKOUT

The third step is installation and checkout of the SDAS and the sensors specified in the Instrumentation Program. The site contractor installs the supplied sensors in accordance with specific installation procedures (Ref.: Instrumentation Installation Guidelines, DOE Report No. SOLAR/0001-77/15) and verifies that the wiring is correct before the SDAS is connected. Sensors are connected to the SDAS through a junction box which is wired according to the Installation Kit wire list and attached to the SDAS by standard interface cables. The SDAS is connected to the National Solar Data Network through a telephone interface installed by the local telephone company.

After the SDAS has been installed, checkout procedures are initiated to verify correct local operation of the sensors and data acquisition equipment. An On-Site Monitor or Digital Count Monitor is used to obtain a direct readout of the system measurements and thereby verify that the solar system and SDAS are performing correctly.

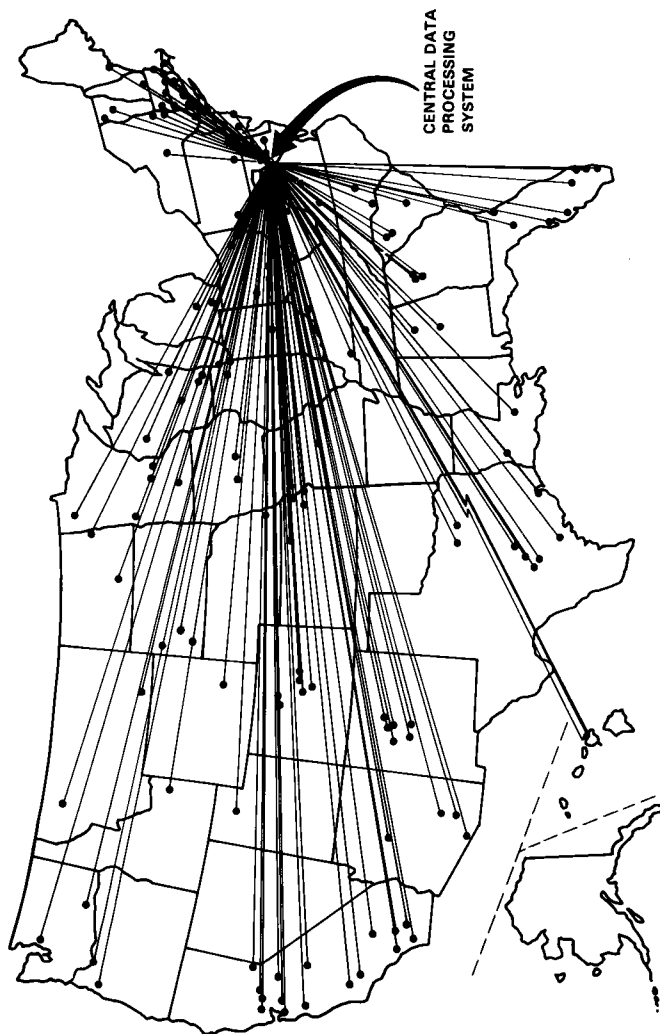
The final checkout step is to verify correct transmission of the data to the Central Data Processing System (CDPS).



RETRIEVAL OVER TELEPHONE NETWORK

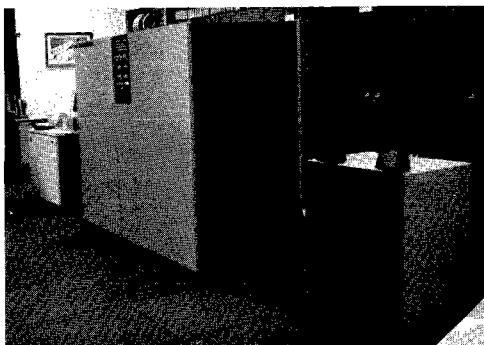
After the site data acquisition equipment has been installed and checked out, data retrieval begins. Data is transferred from the on-site SDAS to the Central Data Processing System (CDPS) using the standard commercial telephone network. Each SDAS scans sensor inputs every 5 minutes and stores the raw data on a cassette tape. The Communications Processor at the CDPS automatically calls each SDAS daily. The SDAS identifies itself and then rewinds and plays back the data stored on its cassette tape. The Communications Processor receives the data, performs error checking and formatting operations, and passes the data to a data storage tape. The SDAS cassette tape is then rewound and proceeds to gather new data. The data storage tape is transferred to the main computer for processing.

Collection of Demonstration Site Data



COMPUTERIZED DATA PREPARATION

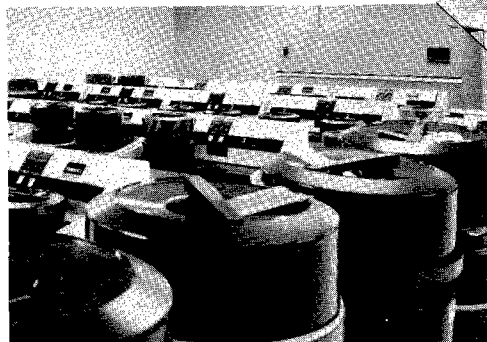
The Central Data Processing System (CDPS) prepares data retrieved over the telephone network for analysis. Within the CDPS, the Communications Processor directs data retrieval operations throughout the network, edits the retrieved data, and records it for further processing. The main computer checks the collected data, prepares error reports, and updates data files. These data are then available to the site analysts who review system performance and report anomalies on a daily basis. Monthly, the collected data is used to compute the performance evaluation factors applicable to each solar site.



Communication Processor



Main Computer



Data Storage Discs

ANALYSIS AND REPORTING

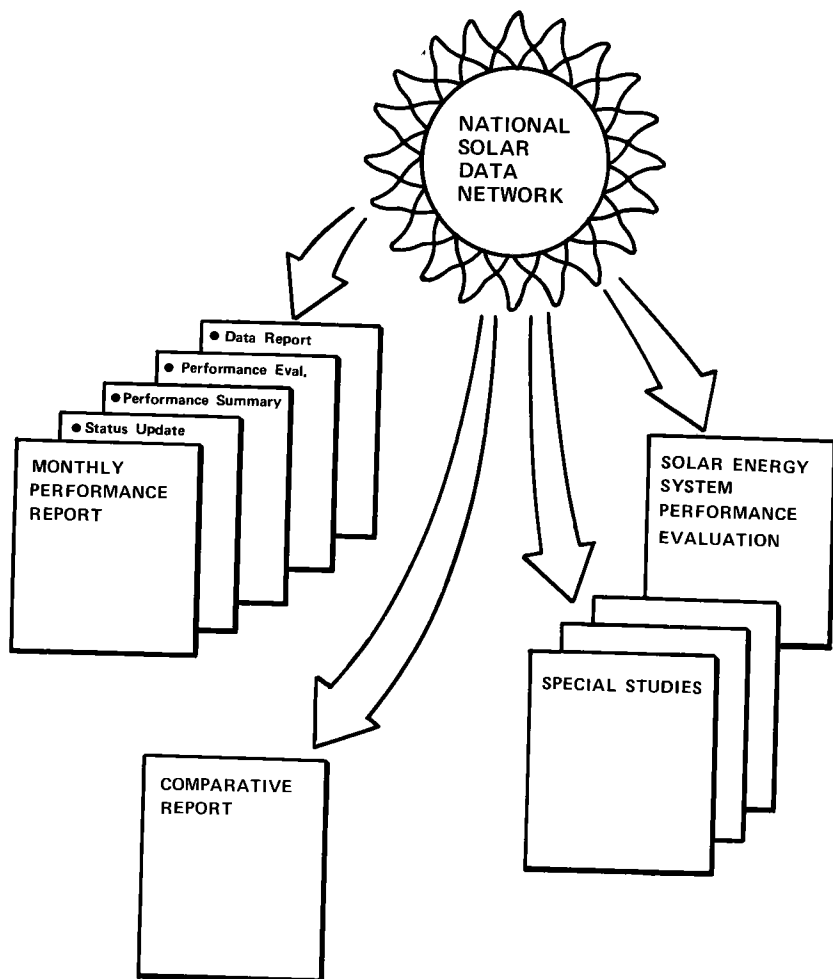
The following documentation and reports are available on the National Solar Data Network sites:

- A Monthly Performance Report which contains monthly performance data, performance evaluation, and system status for each site.
- Solar Energy System Performance Evaluation reports which are published periodically for each site and contain more comprehensive analyses of system performance.
- Data from the various sites and multiple site evaluations which are presented in the Comparative Reports.

As results become available, additional reports are issued which pertain to special studies defined for the National Solar Data Network.

These reports are available from the DOE Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee, 37830.

Documentation



SUMMARY

The National Solar Data Network, a program to establish a large body of data on the performance of diverse solar energy systems, has been implemented using a systems approach in which all steps from site study to report generation have been carefully planned. To date, approximately 150 solar sites have been incorporated into the network, producing an ever expanding accumulation of solar system performance data. This data is serving as an invaluable tool for establishing the direction to be taken by the nation in the energy field.