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CONTRACTOR REPORT

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Intermediate Photovoltaic System Application Experiment Operational Performance Report

Volume 13
for Newman Power Station
El Paso, TX

Boeing Computer Services, Inc.
Seattle, WA 98124

Prepared by Sandia National Laboratories Albuquerque, New Mexico 87185
and Livermore, California 94550 for the United States Department of Energy
under Contract DE-AC04-76DP00789

Printed September 1982

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UC-63-d

INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT

for Newman Power Station, El Paso, Texas*

Boeing Computer Services Company
Seattle, Washington 98124

Prepared under contract No. 16-4997 for
Sandia National Laboratories
Albuquerque, New Mexico 87185

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ABSTRACT

This report presents the data accumulated during June at the intermediate photovoltaic project at Newman Power Station, El Paso, Texas. Generated energy and environmental (weather) data are presented graphically. Explanations of irregularities not attributable to weather are provided.

*This work, performed at Sandia National Laboratories, was supported by the U.S. Department of Energy under contract number DE-AC04-76DP00789.

Utility
El Paso, Texas
June 1982

FOREWORD

Explanation of Missing and/or Anomalous Data

- June 1-7 System inoperative part of time. Control malfunctioning. See item 1 of Report Module No. 2 for explanations.
- June 3 ODAS inoperative, the reason was not determined.
- June 14, 15, & 16 ODAS inoperative, see item 2 of Report Module No. 2.
- June 17 System awoke late, see item 3, Report Module No. 2.
- June 27 & 28 ODAS inoperative, the reason was not determined.
- June 30 System awoke late and stowed early. Insolation low.

The system can operate when the On-Site Data Acquisition System (ODAS) is down. A mechanical meter records the energy generated:

Energy on mechanical meter in June	2,580 kWh
Energy on mechanical meter since January 22, 1981	42,225 kWh

Utility
El Paso, Texas
June 1982

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Index of Available Reports for Photovoltaic System
at El. Paso Electric Co.--Newman Station

I. General

<u>Report</u>	<u>Contents</u>
1. DOE/ET/23062-1	Final contractor report, initial design
2. SAND81-7086/1	Project description, list of participants, system specifications

<u>Monthly Reports</u>	<u>Executive Summaries</u>	<u>Dates</u>
1. SAND81-7086/2	1. SAND81-7100/1	Data for June 1981
2. SAND81-7086/3	2. SAND81-7099/2	Data for Feb. through July 1981 (except June)
3. SAND81-7086/4	3. SAND81-7100/3	Data for August 1981
4. SAND81-7086/5	4. SAND81-7100/4	Data for Sept. & Oct. 1981
5. SAND81-7086/6	5. SAND81-7100/5	Data for Nov. 1981
6. SAND81-7086/7	6. SAND81-7100/6	Data for Dec. 1981
7. SAND81-7086/8	7. SAND81-7100/7	Data for Jan. 1982
8. SAND81-7086/9	8. SAND81-7100/8	Data for Feb. 1982
9. SAND81-7086/10	9. SAND81-7100/9	Data for March 1982
10. SAND81-7086/11	10. SAND81-7100/10	Data for April 1982
11. SAND81-7086/12		Data for May 1982
12. SAND81-7086/13		Data for June 1982

Photovoltaic Monthly Report

Report Module No. 1: Executive Summary

Utility
El Paso, Texas
June 1982

Project name	Uninterruptable Power Supply-Computer
Project address	El Paso Electric Co. - Newman Station War Hi-way North (off Texas Farm Road 2529) El Paso, Texas
Initial system capacity at standard operating condition of:	20 kW-peak 1000 W/m ² insolation 46°C cell temperature 1.5 air mass
Prime contractor	Solar Energy Institute Box 350L Las Cruces, New Mexico 88003 Vern Risser (505) 646-4245
System type	A 20-kWp photovoltaic flat panel power system for an uninterruptable power supply (UPS) load in El Paso, Texas.
Solar array optical type	Flat Plate
Load description	The DC load in this PV application is an uninterruptable power supply (UPS) which is used in the Newman Station.

Photovoltaic Monthly Report

Report Module No. 1: Executive Summary

Utility
El Paso, Texas
June 1982

1.	Solar insolation: Monthly average plane-of-array insolation during the month during daylight hours	479 W/m ²
2.	Solar insolation: Monthly average direct normal insolation during the month during daylight hours	539 W/m ²
3.	Solar energy: Total measured incident solar energy in the plane of the collector during the month	50117 kWh
4.	Solar energy: Total measured direct normal solar energy during the month	Not Applicable
5.	Electrical energy: Total electrical energy produced by PV array field during the month	2275 kWh
6.	Thermal energy: Total thermal energy produced by PV array field during the month	Not Applicable
7.	PV system-grid energy: Total electrical energy supplied by the PV system to the local utility grid during the month	Not Applicable
8.	Array efficiency: Average array field efficiency for the month, as a ratio of array electrical output energy to total measured incident plane-of-array solar energy	4.54%
9.	Array efficiency: Average array field efficiency for the month, as a ratio of array electrical output energy to total measured direct normal solar energy	Not Applicable
10.	PV system efficiency: As a ratio of net PV system output energy to total measured incident plane-of-array solar energy during the month	Not Applicable
11.	PV system efficiency: As a ratio of net PV system output energy to total measured direct normal solar energy during the month	Not Applicable
12.	Power conditioner efficiency: As a ratio of total power conditioner output to input energy for the month	Not Applicable
13.	Thermal efficiency: As a ratio of total array field thermal energy to total measured incident solar energy for the month at an average coolant temperature of 95°C	Not Applicable
14.	Capacity factor: As a ratio of the monthly PV array field output energy to the 15.5-kW system capacity for 24 h/d and 28 "System-Active" days of the month	21.84%

Report Module No. 2: Operations and Maintenance

Utility
El Paso, Texas
June 1982

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PHOTOVOLTAIC MONTHLY REPORT

Report Module No. 2: Operations and Maintenance

Utility
El Paso, Texas
June 1982

3. DATE	06/16-17/82
EVENT TYPE	Operations
CAUSE/PURPOSE	Technical/Hardware
SUBSYSTEM INVOLVED	Interface Subsystem/DC battery bus voltage
CHARACTERIZATION	<ul style="list-style-type: none">o Three GEI devices tripped when PV solar system was on-line.o PV solar system grounds.o Battery bus voltage no longer floats.
PROBLEM IS	Monitored
TIME OF OCCURRENCE	1000 on 06/16/82
DURATION	23.5 hours
SYSTEM DOWNTIME	23.5 hours
ACTION TAKEN	<ul style="list-style-type: none">o Checked battery bus with and without PV solar system.o Bus voltage is +128 and -7.5 to ground instead of <u>+65</u> V to ground.
LABOR USED	4 person-hours

Photovoltaic Monthly Report

Report Module No. 3: PV Array System

Utility
El Paso, Texas
June 1982

1. Electrical energy: Total electrical energy produced by PV array field during the month	2275 kWh
2. Thermal energy: Total thermal energy produced by PV array field during the month	Not Applicable
3. Solar energy: Total measured incident solar energy in the plane of the collector during the month	50117 kWh
4. Solar energy: Total measured direct normal solar energy during the month	Not Applicable
5. Array efficiency: Average PV array field efficiency for the month, as a ratio of array electrical output energy to total measured incident plane-of-array solar energy	4.54%
6. Array efficiency: Average PV array field efficiency for the month, as a ratio of array electrical output energy to total measured direct normal solar energy	Not Applicable
7. Parasitic energy: Energy used by the control, tracking, and cooling subsystems during the month	Not Available
8. Percentage parasitic loss: As a ratio of system parasitic energy (control, tracking, and cooling subsystems) to total power conditioning unit output energy	Not Applicable

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 3.0: DATA ACQUISITION MODE AND RECORDING INTERVAL PLOT

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 3.1: DAILY PV ARRAY FIELD ELECTRICAL ENERGY PRODUCTION
COMPARED WITH INCIDENT SOLAR ENERGY

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 3.2: DAILY PV ARRAY FIELD EFFICIENCY

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 3.3: PV ARRAY FIELD ENERGY PRODUCTION AS A FUNCTION OF
ARRAY FIELD POWER LEVEL FOR THE MONTH

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 3.4: PV ARRAY FIELD ENERGY PRODUCTION AS A FUNCTION OF
ARRAY FIELD VOLTAGE LEVEL FOR THE MONTH

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 3.5: PV ARRAY FIELD ENERGY PRODUCTION AS A FUNCTION OF
AVG. CELL TEMPERATURE FOR THE MONTH

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

— ARRAY FIELD ELECTRICAL ENERGY
----- PLANE-OF-ARRAY SOLAR ENERGY

PLOT 3.6: TOTAL MONTHLY PV ARRAY FIELD ELECTRICAL ENERGY PRODUCTION COMPARED WITH TOTAL MONTHLY INCIDENT SOLAR ENERGY BY HOUR OF DAY (LOCAL STANDARD TIME)

Photovoltaic Monthly Report

Report Module No. 4: Power Conditioning System

Utility
El Paso, Texas
June 1982

Total Power Conditioner Units

1. Power conditioner input: Total energy input into the power conditioner during the month	Not Applicable
2. Power conditioner output: Total energy output from the power conditioner during the month	Not Applicable
3. Power conditioner efficiency: As a ratio of total power conditioner output to input energy for the month	Not Applicable
4. Power conditioner output: Average output power factor	Not Applicable

Photovoltaic Monthly Report

Report Module No. 8: System Relationships

Utility
El Paso, Texas
June 1982

1.	PV system-load energy: Total electrical energy supplied by the PV system to the load during the month	2275 kWh
2.	Grid-load energy: Total electrical energy used by the load that was drawn from the local utility grid during the month	Not Available
3.	PV system-grid energy: Total electrical energy supplied by the PV system to the local utility grid during the month	Not Applicable
4.	PV system efficiency: As a ratio of total PV system output energy to total measured incident plane-of-array solar energy during the month	Not Applicable
5.	PV system efficiency: As a ratio of total PV system output energy to total measured direct normal solar energy during the month	Not Applicable
6.	Dollar value: Of electrical energy supplied by the PV system to the load during the month	\$113.76*
7.	Dollar value: Of net electrical energy supplied by the PV system to the local utility grid during the month	Not Applicable
8.	Dollar value: Of thermal energy produced by the PV system during the month	Not Applicable
9.	Dollar value: Of the base load peak demand supplied by the PV system to the load and grid during the month	Not Applicable
10.	Capacity factor: As a ratio of the monthly PV array field output energy to 15.5 kW system capacity for 24 h/d and 28 "System-Active" days of the month	21.84%

*5.0¢/kWh

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 8.2: DAILY PV SYSTEM AVAILABILITY

Photovoltaic Monthly Report

Report Module No. 9: Meteorological Data

Utility
El Paso, Texas
June 1982

1. Solar insolation: Monthly average solar insolation incident on a horizontal surface during the month during daylight hours	540 W/m ²
2. Solar insolation: Monthly average plane-of-array insolation during the month during daylight hours	479 W/m ²
3. Solar insolation: Monthly average direct normal insolation during the month during daylight hours	539 W/m ²
4. Solar insolation: Long-term average horizontal insolation for the month during daylight hours	605 W/m ²
5. Solar insolation: Long-term average direct normal insolation for the month during daylight hours	Not Applicable
6. Heating need: Total actual heating degree days for the month	0°C Days
7. Cooling need: Total actual cooling degree days for the month	241°C Days
8. Heating need: Long-term average heating degree days for the month	0°C Days
9. Cooling need: Long-term average cooling degree days for the month	255°C Days
10. Temperature: Average ambient temperature for the month	27°C
11. Wind: Average wind speed for the month	2.4 m/s
12. Number of freeze/thaw cycles during the month	0

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

— CELL TEMPERATURE °C
- - - AMBIENT TEMPERATURE °C
- - - WIND SPEED (M/SEC)
— ARRAY PLANE INSOLATION (W/M²)

PLOT 9.1: OPERATING ENVIRONMENT: AMBIENT TEMPERATURE, CELL TEMPERATURE, WIND SPEED AND INCIDENT SOLAR INSOLATION (LOCAL STANDARD TIME)

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 9.2: WIND DIRECTION DISTRIBUTION FOR THE MONTH

Photovoltaic Monthly Report

Report Module No. 10: Energy Summary

Utility
El Paso, Texas
June 1982

1.	Solar energy: Total measured direct normal solar energy during the month	Not Applicable
2.	Solar energy: Total measured incident solar energy in the plane of the collector during the month	50117 kWh
3.	Solar energy: Total measured incident solar energy on a horizontal surface during the month	56971 kWh
4.	Solar energy: Long-term average incident horizontal solar energy for the month	8.52 kWh/m ² -day
5.	Solar energy: Long-term average incident direct normal solar energy for the month	Not Applicable
6.	Electrical energy: Total electrical energy produced by PV array field during the month	2275 kWh
7.	Thermal energy: Total thermal energy produced by PV array field during the month	Not Applicable
8.	Power conditioner unit output: Total energy output from the power conditioner unit(s) during the month	Not Applicable
9.	PV system-load energy: Total electrical energy supplied by the PV system to the load during the month	2275 kWh
10.	Grid-load energy: Total electrical energy supplied to the load by the local utility grid during the month	Not Applicable
11.	PV system-grid energy: Total electrical energy supplied by the PV system to the local utility grid during the month	Not Applicable
12.	Energy use: Total load energy consumption during the month	Not Available

Photovoltaic Monthly Report

Report Module No. 11: Efficiency Summary

Utility
El Paso, Texas
June 1982

1.	Array efficiency: Average PV array field efficiency for the month, as a ratio of array electrical output energy to total measured incident plane-of-array solar energy	4.54%
2.	Array efficiency: Average PV array field efficiency for the month, as a ratio of array electrical output energy to total measured direct normal solar energy	Not Applicable
3.	Power conditioner efficiency: As a ratio of power conditioner output to input energy for the month	Not Applicable
4.	PV system efficiency: As a ratio of net PV system output energy to total measured incident plane-of-array solar energy during the month	Not Applicable
5.	PV system efficiency: As a ratio of net PV system output to total measured direct normal solar energy during the month	Not Applicable

Photovoltaic Monthly Report

Utility
El Paso, Texas
June, 1982

PLOT 11.1: DAILY PV ARRAY FIELD EFFICIENCY

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