nasa TM-83374

DOE/NASA/20485-15
NASA TM-83374

NASA-TM-83374
19830016770

DOE and AID Stand-Alone Photovoltaic Activities

Status Report

William J. Bifano and Anthony F. Ratajczak
National Aeronautics and Space Administration
Lewis Research Center

Work performed for
**U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Division of Photovoltaic Energy Technology**

and

**U.S. Agency for International Development
Bureau for Science and Technology
Office of Energy**

Prepared for
Annual Meeting of the American Solar Energy Society
Minneapolis/St. Paul, Minnesota, June 1–3, 1983

Printed in the United States of America

Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes[1]
Printed copy: A02
Microfiche copy: A01

[1]Codes are used for pricing all publications. The code is determined by the number of pages in the publication. Information pertaining to the pricing codes can be found in the current issues of the following publications, which are generally available in most libraries: *Energy Research Abstracts (ERA); Government Reports Announcements* and Index (*GRA* and I); *Scientific and Technical Abstract Reports (STAR);* and publication, NTIS-PR-360 available from NTIS at the above address.

54 1 1 RN/NASA-TM-83374
DISPLAY 54/2/1
83N25041*# ISSUE 14 PAGE 2247 CATEGORY 44 RPT#: NASA-TM-83374
E-1642 NAS 1.15:83374 DOE/NASA/20485-15 CNT#: DE-AI01-79ET-20485
83/00/00 9 PAGES UNCLASSIFIED DOCUMENT
UTTL: DOE and AID stand-alone photovoltaic activities
AUTH: A/BIFANO, W. J.; B/RATAJCZAK, A. F.
CORP: National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. AVAIL.NTIS SAP: HC A02/MF A01
Presented at the Ann. Meeting of the Am. Solar Energy Soc., Minneapolis, 1-3 Jun. 1983
MAJS: /*PHOTOELECTRIC GENERATORS/*PHOTOVOLTAIC EFFECT/*PUMPS/*REFRIGERATORS/*SOLAR ENERGY CONVERSION/*THERMAL STRESSES
MINS: / CRACKING (FRACTURING)/ DATA ACQUISITION/ FABRICATION/ MANUALS/ MICROPROCESSORS/ PROTOTYPES/ SOLAR HEATING/ TECHNOLOGY ASSESSMENT
ABA: Author
ABS: The NASA Lewis Research Center (LeRC) is managing stand-alone photovoltaic (PV) system activities sponsored by the U.S. Department of Energy (DOE) and the U.S. Agency for International Development (AID). The DOF project includes village PV power demonstration projects in Gabon (four sites) and the Marshall Islands, PV-powered medical refrigerators in six countries, PV system microprocessor control development activities and PV-hybrid system assessments. The AID project includes a large village system in Tunisia, a water pumping/grain grinding project in Upper Volta, five
ENTER:
DISPLAY 54/2/1
medical clinics in four countries, PV-powered remote earth station application. These PV activities and summarizes significant findings to data are reviewed.

DOE/NASA/20485-15
NASA TM-83374

DOE and AID Stand-Alone Photovoltaic Activities

Status Report

William J. Bifano and Anthony F. Ratajczak
National Aeronautics and Space Administration
Lewis Research Center
Cleveland, Ohio 44135

Work performed for
U.S. DEPARTMENT OF ENERGY
Conservation and Renewable Energy
Division of Photovoltaic Energy Technology
Washington, D.C. 20545
Under Interagency Agreement DE-AI01-79ET20485

and

U. S. Agency for International Development
Bureau for Science and Technology
Office of Energy
Washington, D.C.
Under AID Interagency Number DSB-5710-2-79

Prepared for
Annual Meeting of the American Solar Energy Society
Minneapolis/St. Paul, Minnesota, June 1-3, 1983

DOE AND AID STAND-ALONE PHOTOVOLTAIC ACTIVITIES: A STATUS REPORT

William J. Bifano and Anthony F. Ratajczak
National Aeronautics and Space Administration
Lewis Research Center
Cleveland, Ohio 44135

ABSTRACT

The NASA Lewis Research Center (LeRC) is managing stand-alone photovoltaic (PV) system activities sponsored by the U.S. Department of Energy (DOE) and the U.S. Agency for International Development (AID). The DOE project includes village PV power demonstration projects in Gabon (four sites) and the Marshall Islands, PV-powered medical refrigerators in six countries, PV system microprocessor control development activities and PV-hybrid system assessments. The AID project includes a large village system in Tunisia, a water pumping/grain grinding project in Upper Volta, five medical clinics in four countries, PV-powered medical refrigerator field tests in eighteen countries and one PV-powered remote earth station application. This paper reviews these PV activities and summarizes significant findings to date.

1. INTRODUCTION

The NASA Lewis Research Center (LeRC) manages two projects involving the deployment of small-scale, decentralized photovoltaic (PV) power systems. For the U.S. Department of Energy (DOE), LeRC manages the PV Stand-Alone Applications Project which is part of the National PV Program. This project consists of technology development and systems applications subprojects. The objective of the project is to expand the PV stand-alone application technology base in support of U.S. industry. For the U.S. Agency for International Development (AID), LeRC manages the PV Technology Project (formerly Development and Support Project), the objective of which is to determine the suitability (i.e., reliability and cost-competitiveness) of PV power systems for development assistance activities in rural areas of developing countries.

The DOE and AID projects are similar in that they are both ultimately aimed at demonstrating the applicability of stand-alone photovoltaic systems to a variety of users. LeRC, as technical manager for both projects, coordinates and integrates the activities to assure appropriate interaction, facilitate technology transfer and prevent duplication of effort.

This paper reviews the current status of the LeRC-managed DOE and AID PV activities and summarizes significant findings to date.

2. STATUS OF CURRENT FIELD TEST ACTIVITIES

A summary of DOE and AID photovoltaic activities currently being managed by NASA LeRC is presented in Table 1. With the exception of the Tangaye, Upper Volta field test project, which has been conducted primarily by NASA LeRC, these activities are being or will be implemented by U.S. industry through competitive contracts. For the field test activities, the contracts typically involve design, prototype fabrication and testing, preparation of user manuals, shipping and installation, and one to two years of operational support, performance evaluation and reporting. Complete design description packages are also to be provided to enable subsequent replication of the systems. In most cases, cost-sharing is included. The ongoing DOE and AID-sponsored PV activities are described briefly below:

2.1 Tangaye, Upper Volta PV-Powered Grain Mill and Water Pump

Under U.S. AID sponsorship, a PV system powering a grain mill and water pump was installed in the West African village of Tangaye, Upper Volta and became operational on March 1, 1979. A total of $110,000 of AID funds were allocated for the technical component of the project. The PV system, which initially consisted of a 1.8 kW (peak), nominal 120 volt PV array and 540 ampere-hours of battery storage, supplies DC electrical power to a hammer mill and a positive displacement water pump. During the second year of operation, degradation of the array output was observed which was increasing with time. This was subsequently determined to be due to a PV module design defect resulting in thermal stress-induced cracking of the cell electrical interconnects. Nearly 30% of the PV modules had failed (open-circuit) by the end of the second year of operation. As a result, and because the demand for ground grain exceeded capacity, the system was refurbished and increased in size in May of 1981 from 1.8 to 3.6 kW and an improved hammer mill was installed. Surplus modules from the DOE Program were used for the expansion.

To date, no further array degradation has been observed. In spite of the problems encountered with the PV modules installed initially, the system has proven to be very reliable, having been on-line 98% of the time during the first four years of operation. As of July of 1982, the cooperative, organized to operate the mill, had a bank account of $1500 and was grinding an average of 1.2 metric tons of finely ground flour per week. Water consumption averaged 74 m^3 per week during the past dry season. Additional information on the operation of this system is given in References (1-3).

Socio-economic impact studies relative to the Tangaye Project have been conducted by Dr. Allen F. Roberts of the University of Michigan under sponsorship of the AID Bureau for Africa.

2.2 PV-Powered Medical Refrigerators

As part of an activity involving both DOE and AID, PV-powered refrigerators for cold-chain preservation of vaccines will be field tested at 28 sites around the world, eight for DOE in conjunction with the Centers for Disease Control (CDC), and 20 for AID. It is estimated that approximately 30,000 rural health centers in developing countries currently use kerosene-fueled, absorption-type refrigerators for vaccine preservation. However, such units do not meet World Health Organization (WHO) requirements and exhibit a number of operational problems as well. In 1979, NASA LeRC, on behalf of DOE, entered into a joint cost-shared project with CDC to develop PV-powered medical refrigerators which meet the WHO requirements. Initially, contracts were awarded to the Solar Power Corporation (SPC) and Solavolt International (SVI) as part of a competitive procurement for the fabrication, testing and evaluation of prototype PV-powered refrigerator/freezer systems. Following successful completion of this activitiy, follow-on contracts were awarded to SPC and SVI for the deployment of field test systems. In January of 1982, SPC was awarded a contract for the installation of 19 PV-powered refrigerator systems (8 for CDC and 11 for AID) in 16 countries. The total contract cost for this effort was $313,472. In January of 1983, SVI was awarded a contract for the fabrication of 10 PV-powered refrigerator systems, 9 of which are to be installed in 8 countries with one being held as a spare. This contract, totalling $199,052, was funded solely by AID.

The locations and installation status of these refrigerator field-tests is summarized in Table 2. Of the 17 SPC refrigerator systems installed to date, 14 are functioning satisfactorily. The unit installed in the Maldive Islands never became operational apparently because of a loss of refrigerant. One unit in Indonesia appears to have a defective voltage regulator, and the unit in Guyana is experiencing unexplained automatic shutdown in early evening. All three systems are currently being investigated further to determine the appropriate corrective action.

2.3 PV-Powered Medical Clinic Systems

Under the AID PV Technology Project, PV power systems are being installed at rural health facilities in Guyana, Ecuador, Kenya (two systems), and Zimbabwe. These sites, representative of similar facilities in other developing countries, stress preventative health care and are staffed by paramedical health officers, interns and/or nurses. The provision of relatively modest amounts of electricity to such facilities is expected to result in a significant improvement in health delivery effectiveness. Characteristic uses of electricity include lighting, refrigeration, sterilizers and 2-way radios. A reimbursable, cost-shared contract was awarded to the Solarex Corporation to implement this activity. The total contract value was $830,000 (approx.). In addition, no fee was charged by the contractor.

The specific sites of the PV medical field tests are as follows: Waramuri, Guyana; Pedro Vicente Maldonado, Ecuador; Kibwezi, Kenya; Ikutha, Kenya; and Chikwakwa, Zimbabwe. The system at Waramuri became operational on January 17, 1983. All five systems are scheduled to be operational by May of 1983. The general characteristics and specifications of the PV medical system are presented in Table 3.

In conjunction with each of these field tests, seminars on PV technology are being held for host country personnel through a grant to the University of Michigan.

2.4 Tunisia Village PV Systems

Under a cooperative, cost-shared project between the Government of Tunisia and AID, PV, wind and solar heating units have been installed in the village of Hammam Biadha

Sud. This village (population 120) and the surrounding farm area (600 hectares) are situated 130 km southwest of Tunis. The PV portion of the project consists of the following: 1) a 27 kW, 220 volt, 50 Hz system to serve the domestic, public and commercial sectors of the village; 2) a 1.4 kWp system for a remote farm (for lighting, refrigerator, TV and radio); and 3) two 1.4 kWp systems to power drip irrigation for a greenhouse and an orchard. In September of 1981, a reimbursable, cost-shared contract was awarded to the Solar Power Corporation (SPC) to design, fabricate and install the systems and train the villagers in the use of photovoltaics. The total value of this contract was $1,015,942 including cost sharing. In addition, no fee was charged by the contractor.

All PV systems were installed in February of 1983 and are fully operational. All activities associated with the project are being coordinated with the Societé Tunisienne de L'Eléctricité et du Gaz (STEG), the designated host country agency for implementation.

STEG is providing meters to users who desire electrical service and will bill customers for electricity consumed. A STEG engineer is stationed in the village for operation and maintenance of the PV systems. The U.S. Peace Corps has supplied two volunteers for the project who will live in the village during the two-year demonstration phase and assist the residents of the region in the use of the solar power for agricultural applications.

Additional information on this project is given in reference 4.

2.5 Utirik Village PV Power System

As a result of a request from the President of the Marshall Islands, DOE recently authorized NASA LeRC to implement a jointly funded village PV power system project on Utirik Island. The 400 people of Utirik are contributing $100,000 in funds recently appropriated to them by the U.S. Congress under PL 96-126. DOE is providing a modular PV power system being designed and fabricated under an existing NASA LeRC contract with Hughes Aircraft Company. Utirik Island, comprising an area of less than one square mile, has approximately 400 residents. The Island's 46 dwellings and 7 community buildings will use PV power for lighting. In addition, electricity will be provided for village roadway lighting, and lighting, fans and refrigerators for some of the community buildings, including a medical dispensary, school, community house and church.

A conceptual design of the village PV power system was prepared by NASA LeRC based on the goals of the Utirik Village Council and the funding available. The overall system will consist of the modular PV power subsystem (8 kW peak array and battery capacity of 180 kWh), an underground power distribution subsystem and a connected load of about 4 kW with a daily energy consumption of approximately 22 kWh. System installation is scheduled for January-February 1984.

3. STATUS OF TECHNOLOGY AND SYSTEMS DEVELOPMENT ACTIVITIES

3.1 Microprocessor-Based Control Subsystem Development

As part of the technology development activity, a generalized microprocessor technology-based PV control subsystem is being developed under contract to the TriSolar Corporation of Bedford, Massachusetts. The total value of the contract is $341,000. The objective of this contract is to provide a low-cost control subsystem applicable to a wide range of PV systems and maximize the overall PV system efficiency by overall system energy management. The controller is to be designed to be commercially manufacturable using present hardware and manufacturing technology but be representative of a step increase in the state-of-the-art of control subsystem designs. The control subsystem is to consist of an intelligent microprocessor-based controller, power controlling PV system interfaces and control data acquisition PV system interfaces.

The contract consists of three primary tasks as follows: 1) Design Considerations Assessment, 2) Conceptual Designs and 3) Development Hardware. Parallel development efforts are included for software, firmware and hardware. The hardware will consist of two developmental control subsystems. A final report documenting all work under the contract will also be provided. To date work has focused on the design task. The contract is scheduled for completion in October 1983.

3.2 Assessment of PV Hybrid Energy Systems

On November 10, 1982, a contract entitled "Assessment of PV Hybrid Systems" was awarded to Engineering and Economics Research, Inc. of Vienna, Virginia, under a competitive procurement. Total value of the contract is $193,206. The goal of the contract is to provide a comprehensive assessment of the potential of PV hybrid energy systems for stand-alone applications. The contract consists of five major tasks. Tasks 1 and 2 deal with the identification, definition and evaluation of candidate PV hybrid concepts. Under these tasks, methodologies will be developed and utilized to evaluate the technical and economic merits of PV hybrid concepts. Screening procedures are now being developed to select the four most promising hybrid technologies for further study. Under Task 3, conceptual designs of the four selected hybrid systems will be developed while Task 4 will involve recommendations of technology development activities needed for successful implementation of the PV hybrid systems within the next 5 to 10 years. A final report documenting all work performed under the contract will also be provided.

The contract is scheduled for completion in September 1983.

4. PLANNED FIELD TESTS

PV field-test projects planned for implementation in 1983 are described below.

4.1 Remote Villages in Gabon

"Community service" PV packages will be installed in four remote villages in Gabon as part of a cooperative, cost-shared demonstration project between the Government of Gabon and the U.S. DOE. Selected as the test sites are Bougandji, Nyali, Donguila, and Bolossoville, four remote villages with populations of 1000-1500. Four complete PV-powered public service systems will be supplied to each village as follows: 1) health - lighting, ventilation, and medical refrigerator for the dispensary; 2) education - lighting and audio-visual teaching equipment for the school; 3) water supply - water pump, storage and distribution system; and 4) area lighting - outdoor pole light. Standard power packages and loads will be provided to all the villages for each public service application.

The socio-economic aspects of this project are being addressed by Dr. Allen F. Roberts under a University of Michigan grant.

Proposals received in response to a solicitation for the implementation of this project are in review. Award of a cost-reimbursable contract is scheduled for June-July, 1983.

4.2 Remote Earth Station Application

Under the AID Rural Satellite Project managed by the Academy for Educational Development (AED), Washington, D.C., a number of pilot projects will be implemented to demonstrate the economic feasibility of satellite communications for remote areas of developing countries. A key objective of this Project is the development and demonstration of low cost, low power earth stations. In conjunction with this effort, PV power systems will be designed, fabricated and field-tested at one or more remote earth station sites as part of the LeRC-managed PV Technology Project. Requests for proposals for the implementation of the PV power system component of this activity were issued on March 4, 1983. Award of a cost-reimbursable contract is tentatively planned for August 1983. The procurement of the earth stations is the responsibility of AED.

5. CONCLUDING REMARKS

The Tangaye, Upper Volta grain grinding and water pumping system, now in its fifth year of operation, has demonstrated the reliability of photovoltaic technology for remote applications. Other applications such as village power, rural health clinics and remote earth stations are now being implemented under AID and DOE sponsorship.

Results of these field tests, which will be distributed to the international development assistance community, are expected to further establish the technical and economic viability of PV technology for remote power applications.

6. REFERENCES

(1) Bifano, W. J., Ratajczak, A. F., and Martz, J. E., "A Photovoltaic Power System in the Remote African Village of Tangaye, Upper Volta," NASA TM-79318, November 1980.

(2) Martz, J. E., Ratajczak, A. F., and DeLombard, R., "Operational Performance of the Photovoltaic-Powered Grain Mill and Water Pump at Tangaye, Upper Volta," NASA TM-82767, February 1982.

(3) Martz, J. E., and Ratajczak, A. F., "Design Description of the Tangaye Village Photovoltaic Power System," NASA TM-82917, July 1982.

(4) G. Darkazalli, "Design and Installation of Three Photovoltaic Village Power Systems in Tunisia," Solar Power Corporation, presented at the 16th Photovoltaic Specialists Conference, San Diego, CA, Sept. 27-28, 1982.

TABLE 1

DOE and AID PV Activities Currently Managed by NASA LeRC

Project	Supplier/Implementer	Contract Value*	Contract Award Date	Operational Date(s)	Remarks
Tangaye, Upper Volta Grain Mill and Water Pump	NASA-LeRC	--- (A)	---	March 1, 1979	System transferred to Gov't of Upper Volta on April 1, 1983.
Medical Refrigerators	Solar Power Corporation	$313,472 (A)&(D)	1-19-83	Oct. 1981 (India) Oct. 82 - May 83	1 year field tests at 19 locations
Medical Refrigerators	Solavolt International	$199,052 (A)	1-27-83	June-Oct. 1983	1 year field tests at 9 locations
Medical Systems	Solarex Corporation	$829,684 (A)	12-15-81	Jan.-Apr. 1983	2 year field tests at 5 locations
Tunisia Village Systems	Solar Power Corporation	$1,015,942 (A)	9-4-81	March 1983	Operation managed by Tunisian elect. utility authority
Utirik Village System	Hughes Aircraft Co.	TBD (D)	TBD	TBD	Uses Modular PV system designed under contract DEN3-207
Gabon Public Service PV Systems	TBD	TBD (D)	TBD	TBD	Proposals under review as of March 1983
Remote Earth Station Application	TBD	TBD (A)	TBD	TBD	Site in Indonesia to be determined
Microprocessor-Based Control Subsystem Development	TriSolar Corporation	$341,000 (D)	1-26-83	---	Deliverables include software, firmware, and hardware
Assessment of PV Hybrid Systems	Engineering and Economics Research, Inc.	$193,206 (D)	11-10-82	---	Final Report to be issued in September 1983

*Includes cost sharing in some cases
TBD = to be determined

Funding Agency: (A)=AID, (D)=DOE

TABLE 2

NASA LeRC PV Medical Refrigerator Field-Test Summary

LATIN AMERICA/CARIBBEAN	AFRICA	NEAR EAST	ASIA
(CDC) Peru Pucara 14 Oct. 82 SPC/AB	(CDC) Gambia (2) 1. Kaur 2. Gunjur 27 Jan. 83 SPC/AB		(CDC) Maldives Kuluduffushi 6 May 82 SPC/AB
(CDC) Colombia Bocas Del Palo 11 Sep. 82 SPC/AB	(CDC) Ivory Coast (2) 1. Guiembe 2. Zaranou 5 Feb. 83 SPC/AB SPC/AB		(CDC) India Bhoorbaral 19 Oct 81 SPC/AB
(AID) Dominican Rep. Las Tablas 28 Aug. 82 SPC/AB	(AID) Ivory Coast Abidjan SVI/PP	(AID) Egypt (2) ? SVI/PP SVI/M	(AID) Indonesia (2) 1. Cibung Bulang 2. Batujaya 16 Apr. 82 SPC/AB
(AID) Guatemala Tierra Blanca 7 Oct. 82 SPC/AB	(AID) Upper Volta Orodara SVI/PP	(AID) Tunisia Es-Smirat (Siliana) SVI/PP	(AID) Thailand Tambon Thathong SVI/M
(AID) Honduras Aldea Las Selvas SVI/M	(AID) Liberia Suehn SPC/AB	(AID) Morocco Bouaboute Feb. 83 SPC/AB	(AID) Bangladesh ? SVI/M
(AID) Haiti Anse-A-Veau 2 Sep. 82 SPC/AB	(AID) Zaire Kionzo 11 Feb. 83 SPC/AB		
(AID) Guyana Schepmoed 30 Sep. 82 SPC/AB	(AID) Zimbabwe Chiota 15 Feb. 83 SPC/AB	LEGEND: SPC = Solar Power Corp. SVI = Solavolt International AB = Adler Barbour PP = Polar Products M = Marvel	
(AID) Ecuador Comuna Cobos 16 Sep. 82 SPC/AB			
(AID) St. Vincent New Sandy Bay SVI/M			

TABLE 3

General Characteristics and Specifications of PV Medical System

General Requirements

- Daily electrical energy output of 4000 watt-hours
- Nominal output voltage: 120V DC
- All DC loads hardwired
- Meets local electrical codes or U.S. National Electrical Code

	Baseline System
PV Array:	45-Solarex Modules, Type 5300EG or 1440 Watts
Battery Bank:	19-C & D Pb-Ca Batteries, Type 3QP75-7 or 30 kWh
Controller:	1-Solarex ACR-6 Controller/Regulator
Instrumentation:	1-Custom Design with LED Indicators, Meters and Alarms
Load System:	Priority Loads (3 groups) operated by Controller
ADAS:	1-Helion Data Acquisition System; Type 80
	Site Specific Equipment
Inverter:	1-Abacus Controls (2 KVA), DC-AC for Ecuador
Converter:	10-Wilmore Electronics, Model 1295-125-13-15, DC-DC for Radios and Refrigerators and External LPSV Lights
Ecuador System:	Baseline plus an additional 45-Solarex Modules, Type 5300EG or 2880 Watts (due to low insolation)
	Load Equipment Summary
Fluorescent Lamps:	STD, 40W Tubes & Fixtures with Bodine Trans-Bal, Type 120 RS408EB (Single Lamp)
Examination Lamps:	Luxo Model HLY-1 W/100 Incandescent Bulb on T-Stand
LP Sodium Vapor Lamps:	Thorn EMI Lighting, Model No. OFL 18/1, for Exterior Light with Bodine Tras-Bal (12 VDC)
Refrigerator:	Solarex Model RHC-100 without Batteries but Operating from Central Power Thru DC-DC Converter (120V-12V)
Sterilizer:	Halogen Products, Inc. Model MD-200
Two-Way Radio :	Stoner Model SSB-40A Thru DC-DC Converter (120V-12)
Dental Drill: (Ecuador only)	1 HP DC motor fitted with (Sears Catalog No. 30H17751N) single stage compressor rated at 5.35 SCFM at 90 psi with 2 cylinder pump
Water Pump: (Guyana only)	Shallow well piston pump (Sears Catalog No. 42H2925N) with 12 gal. steel tank (fitted with 1/2 HP DC motor)

1. Report No. NASA TM-83374	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle DOE and AID Stand-Alone Photovoltaic Activities: A Status Report		5. Report Date
		6. Performing Organization Code 776-54-01
7. Author(s) William J. Bifano and Anthony F. Ratajczak		8. Performing Organization Report No. E-1642
		10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio 44135		11. Contract or Grant No.
		13. Type of Report and Period Covered Technical Memorandum
12. Sponsoring Agency Name and Address U. S. Department of Energy, Division of Photovoltaic Energy Technology, Washington, D. C. 20545 and U. S. Agency for International Development, Office of Energy, Washington, D. C.		14. Sponsoring Agency ~~Code~~ Report No. DOE/NASA/20485-15

15. Supplementary Notes

Prepared under DOE Interagency Agreement DE-AI01-79ET20485 and AID Interagency Number DSB-5710-2-79. Prepared for Annual Meeting of the American Solar Energy Society, Minneapolis/St. Paul, Minnesota, June 1-3, 1983.

16. Abstract

The NASA Lewis Research Center (LeRC) is managing stand-alone photovoltaic (PV) system activites sponsored by the U.S. Department of Energy (DOE) and the U.S. Agency for International Development (AID). The DOE project includes village PV power demonstration projects in Gabon (four sites) and the Marshall Islands, PV-powered medical refrigerators in six countries, PV system microprocessor control development activites and PV-hybrid system assessments. The AID project includes a large village system in Tunisia, a water pumping/grain grinding project in Upper Volta, five medical clinics in four countries, PV-powered medical refrigerator field tests in eighteen countries and one PV-powered remote earth station application. This paper reviews these PV activities and summarizes significant findings to date.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Photovoltaics Terrestrial power systems Solar electricity	Unclassified - unlimited STAR Category 44 DOE Category UC-63d

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of pages	22. Price*
Unclassified	Unclassified	6	A02

*For sale by the National Technical Information Service, Springfield, Virginia 22161