4210-059

SURVEY REPORT ON THE USE OF PHOTOVOLTAIC ENERGY FOR RURAL HEALTH SERVICES IN DEVELOPING COUNTRIES

by

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SURVEY REPORT ON THE USE OF PHOTOVOLTAIC ENERGY FOR RURAL HEALTH SERVICES IN DEVELOPING COUNTRIES

1.0 Introduction

One component of the U.S. AID Photovoltaic Development and Support Project managed by the NASA Lewis Research Center (LeRC) includes the demonstration and documentation of the use of photovoltaic (PV) energy to facilitate rural health services in developing countries.

To determine practical uses of PV energy, those institutions actively involved in health related projects in developing countries were recognized to be the most appropriate sources of accurate information.

To obtain such information, a Photovoltaic Information Request Form was developed (Appendix A), approved by AID and the NASA-LeRC, and sent throughout the developing world. Results of the survey are noted in this report.

The survey was recognized as comprising one segment of a sequence of events and activities whose ultimate purpose was to enhance and facilitate the use of new technologies - appropriate to the needs, resources and conditions of poor countries - which will be of value to both the process of development and to the enhancement of the welfare and well being of the people.

2.0 Survey

2.1 Purpose

The purpose of the survey was to:

- o determine, in priority ranking, the most important uses of solar electricity to enhance rural health services in developing countries
- o solicit recommendations for development/modification of specific, practical technologies perceived to be valuable, but not now in existence
- o determine level of interest by directors of rural health programs in receiving further information about uses of photovoltaic energy for rural health systems
- o identify organizations which would be interested in participating in the NASA/AID sponsored pilot-demonstration projects
- o obtain information about present electricity use.

2.2 Approach

The approach adopted in performing the survey was to distribute the information request form henceforth refered to as questionnaire along with other descriptive information to:

- o Government institutions, i.e., U.S. AID overseas missions
- o Non-government institutions, i.e. private and voluntary organizations (PVO) engaged in heath care delivery throughout the world
- o other individuals active in the rural health field.

2.3 Implementation

2.3.1 Distribution to U.S. AID Missions

Questionnaires were sent to personnel from U.S. AID Missions identified by the AID Bureau for Development Support/Health Office. Extra questionnaires were also included for transmittal to directors of government and non-government rural health programs.

Questionnaire packets were sent to 55 overseas AID offices.

2.3.2 Distribution to Non-government Institutions

Using the Technical Assistance Information Clearing House (TAICH) list of private and voluntary organizations (PVOs) working in health throughout the developing world, 115 organizations were identified as probably involved in rural health programs. Each organization received an explanatory letter and an option to (a) send questionnaires to field teams directly from their U.S. headquarters, or (b) send a list of addresses of overseas field units - to which questionnaires were sent directly.

125 questionnaires were sent to the field by PVO headquarters
64 questionnaires were sent to the field directly

2.3.3 Distribution to Specific Health Personnel

18 questionnaires were sent to selected individuals active in rural health activities in developing countries.

2.4 Results

Response: 28 completed questionnaires were returned as of February 10, 1981.

Questionnaire Results (a)

	Priority Rank					Cumulative Ratings (b)
	1	2	3	4	5	
2.4.1 Health Technologies						
Possible uses of solar electricity were ranked in priority order of importance. (Ranking methods used by respondents were not consistent. However, priority ranking within each questionnaire was quite clear.)						
Regrigeration						
General Use	4	3	4		1	45
Stationary Vaccine Storage	15	3	3	3		102
Portable Vaccine Transport	4	6	1	1		49
					total	196
Lighting						
General	13	4	6	2		103
High Intensity		4	2		1	23
					total	126
Lab Equipment						
Centrifuge	3	1	3		1	29
Incubator	1	2	1		1	17
Colorimeter	1	1	1	1		14
Microhematocrit	2		2	2	1	21
Water Bath	1		1			9
					total	90
Two-Way Radio						
	9	1	1	5	2	64
Fans						
	2	1		3	1	21

(a) See Appendix A for questionnaire (Photovoltaic Information Request Form)
(b) Cumulative Rating was determined by giving weight of 5 to priority 1; 4 to priority 2; 3 to priority 3; 2 to priority 4; 1 to priority 5.

Other types of equipment

Responses to the open question seeking recommendations for other useful technologies were as follows:

- "water pump"
- "pumping safe water"
- "electric coagulator for surgery"
- "water heating"
- "electric blanket; winter is terrible without them"
- "otoscopes, cassette players (for health education)"
- "pump operation for bore hole portable water supply"
- "sterilization of instruments"
- "air conditioner"
- "sterilizer"
- "small equipment sterilizer"
- "adapters to charge NiCad flashlight batteries for flashlights"
- "electric heaters for cold weather use"

Category ranking in priority order from analysis of all questionnaires:

1. Refrigeration
2. Lighting
3. Two-Way Radio
4. Laboratory Equipment
5. Sterilizers
6. Fans

2.4.2 New Technologies

Suggestions were requested for: (a) electrically driven equipment or (uses) which was believed to be important to health care but is not now available, or appropriate for use in rural areas of the developing world, and (b) equipment that should be redesigned or modified to make its use more practical and possible.

The responses were as follows:

- "Solar driven water pumps would be a great asset"
- "Autoclave to be used in photovoltaic system would have to be made for DC current"
- "Water supply or filtration"
- "Water heating"
- "Dehumidifier for use in medical store area"
- "Combined solar voltaic pump and sterilizer to obtain water from average depths of 100 meters"
- "In addition to refrigerator for vaccine storage, also needed is ice-making capability to provide ice for mobile cold pack"

- "Solar deep well pumps; cooler/heater for dry areas"
- "All instruments that require electricity for use in rural hospitals should be designed to convert AC to stabilized DC electricity so that function will not be disturbed during current or voltage fluctuations and so they can be used with a battery during time of power failure"
- "Water pump"
- "The major pressing need is for cooling of the vaccine cold chain. Most health centers equipped to provide laboratory and domiciliary services also need electricity"
- "Night light for delivery room, water pump, water still"

2.4.3 Information

In response to the question:
'Are you interested in receiving information periodically about uses of photovoltaic power systems for rural health services?'

27 yes
1 no

2.4.4 Use of Photovoltaic Power Systems

In response to the question:
'Would your project be considering the use of photovoltaic systems for power during the next 3 years?'

25 yes
3 no

'What kind of assistance would be helpful to begin this use?' (All responses are included.)

- "Information on solar energy refrigeration"
- "I think that to start out, a 12 volt system could supply necessary current for one of these clinics. It is my plan to re-establish all of these clinics again with the very real possibility of several others as well" (Zimbabwe)
- "Would need complete information on units and battery life expectancy and size of units available, equipment availability to go with units"
- "Units to provide lighting, refrigeration and (possibly) radio communication to those health centers" (Zambia)

- "3 Pilot Demonstration units: 1 installed here at Karawa Base as a control unit to gain experience on how best to operate and utilize the equipment; 1 unit installed at a village dispensary to the south in a forested area; 1 unit to the northwest in the grasslands at another village dispensary; 2 units would be a minimum to have a difference of operating conditions in field exposure to be compared with the central unit operating under more ideal conditions" (Zaire)
- "Pumps and panels and pipes"
- "Units to provide lighting, refrigeration and (possibly) radio communication to three health centers" (Zambia)
- "Information on the size of equipment you recommend, cost, installation factors, and shipping possibilities" (Honduras)
- "List of available equipment with prices and addresses of sources"
- "Demonstration of how much wattage could be produced, type of current, cost of appliances which use the power, specific costs of photovoltaic cells and systems"
- "We currently have 4 remote dispensaries where we would like to put radios. We would like to receive aid to buy or to be recipients of actual equipment to charge batteries, for these dispensaries" (Tanzania)
- "Information on equipment available and help to bring it to Bangladesh"
- "Provision of solar cell array, batteries, high efficiency refrigerators would, in my opinion, be our priority" (Sudan)
- "The kind that has been planned in our U.S. AID RET Project: water pump; cold vaccine chain; and PV driven rural health centers" (Botswana)
- "We are building a health center in a Primary Health Care Program within the next 2 years. We would like to make the total facility solar powered. We seek some expertise to help realistically assess the size of PV system needed in light of present growth. Good information on what is currently available at the most competitive price" (Sudan)
- "We have 5 locations right now where it is really needed. We need technical and financial advice." (Sierra Leone)
- "Initial cost? Name and address of supplier? We are interested now, do we need the help of a technician or can we 'do it yourself?'" (Indonesia)
- "Technical and actual demonstration" (Philippines)

- "A survey of 3 provinces indicated that 2 of them have a large number of health posts (more than 10) without electric power. Some have gasoline generators, but are unable to obtain gasoline. Photovoltaic cells would help to make these units more self-sufficient and offer better services. (We need) technical and financial assistance to test units" (Guatemala)
- "The vast majority of Indonesia's 4000+ public health centers have no electrical supply, yet most are included in the immunization program. Kerosene refrigerators are not working well under true field conditions"
- "Project obligated in 1980 includes pilot equipping 2 remote health services centers with PV power systems" (Botswana)
- "Bangladesh has a natural resource of sunlight. There is no time when there is not sun at least 6 hours/day. Power failures are frequent and may last for weeks - even rechargeable batteries cannot be recharged during this time. Is it cost effective? How difficult is it to repair?"
- "Technical assistance for the proper design, installation and operation of this type of facility" (Brazil)
- "We are now trying to find supplies of suitable PV battery chargers, batteries and small refrigerators. Please suggest supplies and give an evaluation of their equipment" (Zaire)
- "For rural vaccination programs, two solar-powered items would be of revolutionary importance (1) solar power refrigerator and (2) solar-powered sterilizer for needles and syringes (assistance needed). Details on any such items for sale, plans for solar cookers, which could be built here and tested - such as sterilizers"

2.4.5 Pilot Demonstration Systems

Indications of interest in participating in pilot demonstration projects came from the following countries:

3	Bangladesh	1	Liberia
		1	Ecuador
2	Zambia	1	Zaire
2	Tanzania	1	Senegal
2	Honduras	1	Sudan
2	Botswana	1	Sierra Leone
2	Indonesia	1	Pnilippines
		1	Zimbabwe
		1	Guatemala
		1	Brazil
		1	Upper Volta

2.4.6 Electricity Use

Very few respondents had sufficient data on which to determine the unit cost (i.e., per kilowatt-hour) of electricity. Comments related to 'present electricity use and cost' were illuminating. All responses are quoted below:

- "Presently using kerosene refrigerators provided by UNICEF. Problems obtaining kerosene make most non-functional much of the time"
- "Figure diesel plant (12 kW) good for 10 years. Run it 16 hours/day; supplies our house, too. Fuel has to be moved on river 45 miles one way in 55 gallon drums"
- "There is no source of electricity at our rural health centers - and no prospect in the immediate future" (Zambia)
- "If a small diesel generator with 4-5 kW would be considered as a power source for such a health center, its original cost would be about $4000 (U.S.). The monthly cost on the basis of running it 8 hours per day including fuel, maintenance, repair and depreciation would be about $400 to $500 (U.S. per month)" (Tanzania)
- "Present electricity useage is minimal due to high cost of fuel in the area and the scarcity of fuel that is sent to the area" (Zaire)
- "We do not have any except flashlights. At night we use gas because it is cheaper here (Senegal). We have radio but await permission. We also have loan of a battery-operated projector for which we use the car battery as it is charged while we go from village to village"
- "Acquisition of diesel fuel is becoming more difficult and expensive; alternate means of producing electricity are almost a necessity for the future, considering the world petroleum situation" (Honduras)
- "With the rising cost of diesel internationally, the cost in Ahuas is rising astronomically, through pilfering as well as legitimate charges"
- "Are using 5,000 watt diesel generator approximately 3 hours/day - gasoline generators @ 2,000 watts for occasional portable use"
- "When we do have electric connection, it is a very irregular supply and we lose many light bulbs because of sudden surges of voltage" (Bangladesh)
- "We've got one of the highest energy costs per kWhr in the world and we obtain petroleum through S. Africa. Our vulnerability to energy cutoff is great since we are a front line state" (Zimbabwe)

- "As for rural health centers that have no electricity, a PV panel would have to be huge to satisfactorily meet demands if no other standby were assured - further, X-ray machines would be hard to operate. I personally wait for the day when PV current is about 10% of present cost, then it might be a feasible roof-top source for both health centers and homes"
- "The (power) unit is part of the compound and refrigeration is by kerosene refrigerator. These must be turned off during absence of staff which makes it very difficult to store these drugs" (Sierra Leone)
- "We do not yet know the cost of diesel generated power. The Health Center is located in jungle area - no road - walk one day to river or use small Cessna - both are prohibitive in cost" (Indonesia)
- "Most public health centers have no access to electricity at present"
- "Few rural health centers have electricity. If they do, electricity cost is near world's highest" (Botswana)
- "Batteries are usually charged by swapping with one in a car. Since the cars rarely run nowadays with gasoline unavailable at any price, this doesn't work anymore. When available, flashlight batteries are sometimes used to power the radios!" (Zaire)

2.4.7 General Comments

At the end of the survey, general comments were requested. The following selected responses are direct quotes:

- "Am interested in all types of equipment presently available for PV systems - What can system produce? DC only? 12 V/24 V DC?"
- "I am just in the process of training for the position I will be serving in Ahuas, Honduras in April of 1981. I am not aware of all the information you request in this form, but would welcome any further correspondence"
- "We are very interested. This area is especially suited for PV power as a day never goes by without plenty of sunshine. Thanks for sending me the information"
- "There should be a U.S. AID RFP to encourage U.S. contractors to tender for our RET Project, keep your eyes peeled"
- "We will greatly appreciate any information and recommendations

3.0 Observations

Related to the survey, the following observations supplement the individual questionnaire responses:

(1) It is difficult to determine accurately the percentage of questionnaires returned because: a) mail to developing countries is often quite slow; returns are still arriving 7 months after the questionnaires were distributed; b) cost of mailing completed questionnaires back to the U.S. was a significant expense for a church-sponsored health program; and c) AID Missions were given extra questionnaires whose essential distribution is not known.

(2) The questionnaires which were returned and tabulated were a biased segment of the total group surveyed. Because of time involved in completing the questionnaire in some cases, cost of mailing the response, and the general level of interest in the subject, the responses were positive, in many cases, enthusiastic and encouraging.

(3) The degree of interest in receiving general information periodically about photovoltaics was quite high.

(4) Many institutions indicated the need for specific guidance and assistance in evaluating the practicality of using photovoltaics in their rural health programs.

(5) The present high cost of electrical energy and the expectation of continuing escalation of costs of energy in the next decade is a strong concern of a number of institutions.

(6) Technical information of the type required to estimate energy consumption of electrical equipment is extremely difficult for project directors to obtain.

(7) A number of respondents suggested the use of high energy equipment such as sterilizers and air conditioners and indicated interest in PV energy to provide all the energy requirements for small hospitals.

4.0 Conclusions

For clarity, conclusions are divided into two parts: a) those specifically related to the results of the questionnaire and b) those which relate to the questionnaire and also include observations, contacts and experience of the author over the past 5 years.

4.1 Conclusions based on Survey Results

(a) Rural health facilities in developing countries can benefit from small quantities of electricity for certain critical services.

(b) Critical services requiring electricity were identified in order of priority as follows: refrigeration, lighting, 2-way radio, laboratory equipment, sterilizers and fans.

(c) Photovoltaics appears to be an appropriate, cost-effective, alternative to conventional sources, however, accurate, objective, readily available information is needed to enable health program planners to determine the practicality of this form of energy.

(d) Respondents perceive that technical information related to types and sources of equipment, costs, installation, etc., is inadequate and incomplete.

4.2 Additional Conclusions based on Survey Results and Personal Observations of Author

(a) As rural health services extend to more remote areas of developing countries as a consequence of government health priorities, the need for photovoltaic electricity to provide power to isolated health centers will increase considerably.

(b) Since the cost of electrical energy increases directly with the amount of electricity used, electrical equipment/load devices which are used in rural health services must be energy efficient.

(c) As photovoltaic energy alternatives become more practical, more institutions will be seeking information on which to make decisions about use of photovoltaics for their isolated health centers.

(d) There will be increasing need to provide electrical equipment for health centers which is designed or modified to be energy efficient, low cost and appropriate for uses and conditions of rural areas.

(e) Rising costs of: a) traditional forms of electricity; and b) transportation reinforce the need to develop, test and document alternative forms of energy.

5.0 Recommendations

(a) For certain settings photovoltaic energy should be accepted as a practical source of electricity for rural health services. Once such a premise is accepted, appropriate activities should be planned to encourage the further development and use of photovoltaics.

(b) To respond to requests for periodic information about photovoltaic energy and efficient electrical equipment, a mechanism for communication with developing world health institutions should be devised and implemented as a public service.

(c) Low cost, small-scale PV power systems should be made available to selected health centers in a number of developing countries to permit them to install, use, document and evaluate this form of alternative energy. The technical ability and ingenuity of certain PVO-operated rural health programs in developing countries should be recognized. Their motivation and skills can be used to provide realistic information, assessment, and evaluation of PV innovations.

(d) Electrical equipment which is most essential for rural health services should be evaluated for its electrical efficiency and when necessary, appropriate modifications made. In some instances it will be necessary to design equipment in response to unique needs and conditions.

(e) Production by U.S. industry of low power (low cost) photovoltaic systems should be encouraged because of the anticipated widespread use of photovoltaics in many countries throughout the developing world.

(f) U.S. AID should continue to facilitate/support the development, deployment, and evaluation of PV units for rural health centers. Such activities appear to fall within the context of development support.

(g) To increase awareness by key officials for the potential, benefits and constraints of PV energy for rural health services, a 1-day workshop, held in Washington, DC, should be considered. The workshop program should include: review and discussion of the results of this survey; PV devices could be demonstrated and explained; comments and recommendations for future activities could be discussed.

(h) Electrical equipment, as well as energy sources, must be carefully assessed and evaluated if photovoltaic energy is to become a useful adjunct for rural health services. Such assessment is essential since most electrical equipment available today was not designed with energy efficiency as an important factor.

(i) Recommended electrical equipment (technologies) for rural health services which could be used with photovoltaic energy are noted below in priority order of importance:

1. Refrigeration

   a) 3-5 cubic foot refrigerator used primarily in rural health centers for storage of vaccines and selected medicine. Ice making should be an option available for some units to be used where ice for cooling portable vaccine carriers is required.

b) 1-3 cubic foot refrigerator for storage of vaccine and selected medicine. This would be used in several ways: stationary - in small health centers; portable - for transportation and storage of vaccine and medicine during periodic field visits and vaccination programs; combination of fixed and portable.

2. Lighting

a) For general illumination, fluorescent lights would be useful for services required after dark and for emergencies.

b) For patient care, small focused lights are required for physical examination, surgery and obstetrics.

c) For health education - electricity is necessary for audio/visual equipment.

3. Two-Way Radio

For communication with district hospitals and other health centers, 2-way radios - where permitted - are useful for patient care, consultation, administration, and continuing education. Both High Frequency (HF) and Very High Frequency (VHF) equipment have been used quite successfully in isolated settings in a number of countries. Energy requirements are quite low. The major deterrent at this time to more widespread use is the cost of the radio equipment. (Apparently the anticipated demand for 2-way radios for this special use in developing countries is too low to justify development of special units and communication systems.)

4. Laboratory Equipment

To provide basic laboratory services in health centers, the following equipment - designed for energy efficiency - is recommended: colorimeter, microscope (light), incubator, microhematocrit, and water bath.

(j) A number of requests were made through the questionnaire for technical information and assistance. Accurate, objective information - in a form understandable by those involved with rural health services - is necessary to permit planners to make rational decisions about the practicality of using PV energy.

(k) Since photovoltaic energy is sunlight dependent, for practical purposes it must be stored. Besides the solar arrays, which generate electricity, battery charging equipment, batteries, distribution (wiring) within the health center, repair and maintenance of all types of equipment must also be considered as essential components of a PV energy system.

(l) Because of the interdependence and interrelationships of all the components of PV systems, the rational response of efforts to increase and facilitate the use of photovoltaics for rural health services should be through an integrated, coordinated approach.

(m) Since problems of availability and costs of energy for rural health services will no doubt increase in magnitude in the future, a special emphasis on energy for rural health services should be considered. A one-day seminar on Energy Sources for Rural Health Services would be timely. The use of photovoltaics would fall within that context. However, other appropriate energy sources should be considered. Such a seminar would be the initial step in a series of responses to a need and a problem that has been identified as serious and worthy of response.

6.0 Appendices

Appendix A-1: Photovoltaic Information Request Form

Appendix A-2: PV Demonstration Site Selection Criteria

Appendix A-3: The Use of Photovoltaic Power for Rural Health Services

Appendix B: Cover Memo to AID Missions

Appendix C: Cover Memo to International Health Colleagues

Appendix D: List of Respondents to the Survey

UNIVERSITY OF WISCONSIN-MADISON
CENTER FOR HEALTH SCIENCES

APPENDIX A1

Ned Wallace, M.D., M.P.H.
Director

International Health Affairs
610 North Walnut Street
Madison, Wisconsin 53706
Telephone: 608/263-2864

PHOTOVOLTAIC INFORMATION REQUEST FORM

Photovoltaic Technology for Rural Health Center Application

The United States Agency for International Development (AID) has initiated a program to encourage and facilitate the development of photovoltaic (PV) power for rural health application. The information requested below will assist me in identifying relevant needs, priorities and interests in support of this program. (Please print.)

1. Health Technologies

   The following uses of solar electricity already have been suggested as a result of a preliminary survey. Please add other uses you would recommend, and indicate priority ranking. Since more uses are noted on the other side of this page, please consider all uses before setting priorities.

Priority Rank ("1" is highest)	Equipment/Uses		
	Refrigeration		
	Type	Volume (cu. ft.)	Temperature
_____	General use	_____	_____
_____	Stationary vaccine storage	_____	_____
_____	Portable vaccine transport	_____	_____
	Lighting		
	Type	Number	Watts Total
	General		
_____	Fluorescent	_____	_____
_____	Incandescent	_____	_____
	Specific		
_____	High Intensity	_____	_____
	Other		
_____	_____	_____	_____

Priority Rank	Basic Laboratory Equipment
_____	Centrifuge (Laboratory)
_____	Incubator (Bacteriology)
_____	Colorimeter (Includes Hemoglobinometer)
_____	Microhematocrit
_____	Water Bath (Constant Temperature)
_____	Other _____
_____	_____
_____	Fans (for General Cooling)
_____	Two-Way Radios

Please recommend other uses below:

_____ _____

_____ _____

_____ _____

Note: Charging batteries is recognized as an essential component of all these uses, hence need not be noted.

2. New Technologies

Please suggest any electricity driven equipment (or uses) which you believe to be important to health care but is not now a) available, or b) appropriate for use in rural areas of the developing world. Include suggestions for equipment that should be redesigned or modified to make its use more practical and possible.

_____

_____

_____

_____

_____

3. Information

Are you interested in receiving, periodically, information about uses of PV power systems for rural health services?

_____ Yes _____ No

If "yes" is indicated, your name will be included on a mailing list for future material.

4. Use of PV Power Systems

Based on the modest information about photovoltaic technologies available to you at this time, do you think your next project would be considering use of PV power systems during the next three years?

_____ Yes _____ No

Comments:

_____ _____

_____

_____

If "Yes," what kind of assistance would be useful to you to begin this use?

_____

_____

_____

_____

5. Pilot Demonstration Projects

In a few countries (which have AID Missions), small-scale pilot demonstration projects using PV energy for rural health work are planned as part of an AID Development Support/Energy PV project. Selection will be based on criteria available from the AID country Mission. If you are interested in the possibility of participating in this demonstration project, please complete the following.

Country: _____

Town/Region: _____

Project Name: _____

Project Director: _____

Potential Uses of PV Energy in Your Project: _____

_____

_____

_____

_____

_____

_____

6. Identification (who completed this questionnaire?)

Please check one:

_____ Directly involved (in rural health care field work)

_____ Indirectly involved (in planning, management, evaluation, funding)

Please print:

Name: _____

Title: _____

Organization: _____

Address: _____

7. For Voluntary Agencies Only, please indicate name and address of organization(s) that funds your Rural Health Program:

NAME	ADDRESS
(1) _____	_____
	_____
	_____
	_____
(2) _____	_____
	_____
	_____
	_____

8. For AID Missions, please indicate below names and addresses of health organizations to whom you plan to send these PV packets:

NAME	ADDRESS
(1) _____	_____
	_____
	_____
	_____

NAME	ADDRESS
(2) _____	_____
	_____
	_____
	_____
(3) _____	_____
	_____
	_____
	_____
(4) _____	_____
	_____
	_____
	_____
(5) _____	_____
	_____
	_____
	_____

9. Electricity Use

To determine relative cost of electricity please complete the following to the extent that you have the information for a typical rural health center which you operate.

a) Size of Health Center

_____ Inpatient beds

_____ Average outpatient visits per day

b) Source of Electricity

If purchased from supplier:

Cost per month (U.S. dollars) _____

Cost per kilowatt hour (U.S. dollars) _____

9. (continued)

If self generated:

TYPE	OUTPUT (Kilowatts)
_____ Water	_____
_____ Wind	_____
_____ Diesel	_____
_____ Gasoline	_____
_____ Other _____	_____

Total cost per month—including fuel, maintenance, repair and depreciation:

$ _____ (U.S. Dollars)

Consumption per month in kilowatt hours _____

(c) Comments about your present electricity use and cost:

_____

_____

_____

_____

Please return this information by September 30, or as soon thereafter as possible, to:

Ned Wallace
University of Wisconsin-Madison
Center for Health Technologies
601 North Walnut Street
Madison, Wisconsin 53706

Many thanks for your cooperation.

Please feel free to add further comments below.

UNIVERSITY OF WISCONSIN-MADISON
CENTER FOR HEALTH SCIENCES

Ned Wallace, M.D., M.P.H.
Director

APPENDIX A2

International Health Affairs
610 North Walnut Street
Madison, Wisconsin 53706
Telephone: 608/263-2864

PV DEMONSTRATION SITE SELECTION CRITERIA

PV Demonstration Projects in a few countries are planned. Selection of project sites will be based on the following criteria established by NASA-Lewis Research Center and AID/Energy Office, Washington, D.C.:

Remoteness - The site does not have access to conventional electrical power (i.e., either utility grid or large diesel generator.) This factor is an initial index of prospects for cost competitiveness of photovoltaics for this application.

Accessibility - Personnel and equipment can be readily transported to the site via surface transportation.

User Involvement

This criterion consists of the following factors:

a) users recognition of a need for and acceptance of PV systems;

b) ability and willingness to be involved in the design, development and deployment of a demonstration project, technical assistance in data collection and assistance in training of eventual users;

c) willingness to provide assistance in transportation;

d) commitment to facilitate visits;

e) ability to deal with authorities of the host country, local AID missions.

Timeliness

This criterion consists of the following factors:

a) probability that the PV-powered activity can become either entirely functional or about to become functional within the time frame of the Development and Support Program Master Schedule (i.e., in 1981-83 time period);

b) consideration whether the PV system can be deployed on the schedule called for by the on-going project (approximately one year for PV system design, fabrication, installation, and check out.)

Value of Demonstration

The following factors are included in this criterion:

a) potential beneficial impact the proposed project could have on general welfare of the population of the host country;

b) applicability beyond the deployment of a demonstration project, i.e., potential for replication in similar areas of need;

c) opportunity to collect important information for evaluation of PV systems as a viable alternate energy source;

d) Likelihood that the PV systems will receive attention by the host country authorities, communication media, health community within the country and abroad;

e) likelihocd that the installation will receive attention in other countries which may be good candidates for similar projects.

NOTE: All PV demonstration projects will be subject to approval of AID Washington and the respective AID Mission.

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APPENDIX A3

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Director

International Health Affairs
610 North Walnut Street
Madison, Wisconsin 53706
Telephone: 608/263-2864

The Use of Photovoltaic Power for Rural Health Services

Introduction

In the decade of the 1980's, one of the major objectives within the health sector of most developing countries will be to increase access of rural populations to basic health services within the context of Primary Health Care.

Most rural areas of the developing world have no access to electricity readily available from power lines. It is necessary, therefore, for a large number of isolated health facilities to use small size gasoline or diesel generators to provide needed electricity. Already high, the costs of electricity from these sources are projected to continue to increase in the years ahead. At the same time, the cost of transporting this fuel to remote sites will also increase.

It is essential and appropriate that alternative sources of electricity be examined in efforts to seek the least expensive means of generating electricity for rural health purposes.

In certain instances, renewable resources, locally available, promise to be very practical alternatives. Such resources would include sunlight, wind, water, and bioresources.

Photovoltaics

Photovoltaic (PV) devices absorb sunlight and convert it directly into electricity. When light energy, or photons, strike certain material called "semiconductors", they create internal voltages. Wires can be attached to draw off the resulting electricity.

Although photovoltaics were applied to such uses as rural telephone systems as early as the mid 50's, the first major use of solar cells was in the space program. Their initial cost was too high for widespread use on earth. However, with constant research into the development of solar cells, prices have dropped rapidly.

The major component in all photovoltaic systems is the "array" that collects the sunlight and converts it into electricity. This array is composed of a number of electrically inter-connected sealed panels (modules), each panel containing many solar cells. These arrays can be produced in any size that will fit the needs of different types of users.

Other system components include a storage battery and controls. A typical system configuration including possible load devices is depicted in figure 1.

Photovoltaic (solar cell) power systems are one of the few sources of electricity whose cost has decreased considerably during the past 5 years as new production methods have evolved. Projections for the next decade indicate a continued drop in PV module cost from $10.00 per peak watt in 1980 to $0.50 per peak watt by 1990.

Photovoltaic energy systems are extremely versatile. They are modular, hence a wide range of sizes and types can be designed to fit almost any need. They require very little maintenance, most of which is concerned with assuring water level in the storage battery and replacing the batteries at the required intervals. There are examples of unattended PV systems that have been operating continuously for up to 5 years.

The use of solar electricity in some situations in developing countries is considered cost effective even today. For example, the cost of a PV 12 Volt battery charging unit for a low power 2-way radio is approximately $70. Amortized over the life of the PV charger of 20 years, the cost would be $11.20 per year assuming a 15% discount rate.

Potential Uses of PV Power in Rural Health Services

The potential applicability of photovoltaic power for isolated health centers, clinics and community health posts prompts increased consideration of possible uses of this technology in these settings.

Suggestions of potential uses from health workers with experience in rural areas include:

- medium and small-size refrigerators used at the end of the cold chain for immunization programs
- lights for health posts - both for general illumination and for minor surgery, obstetrics and physical diagnosis
- basic laboratory equipment for hemoglobin determination and microscope illumination
- 2-way radios for patient care, consultation, administration, planning and continuing education

Other uses are being elicited as part of an on-going survey of selected members of the international health assistance community.

Ned Wallace

July, 1980

SCHEMATIC DRAWING OF A PHOTOVOLTAIC POWER SYSTEM

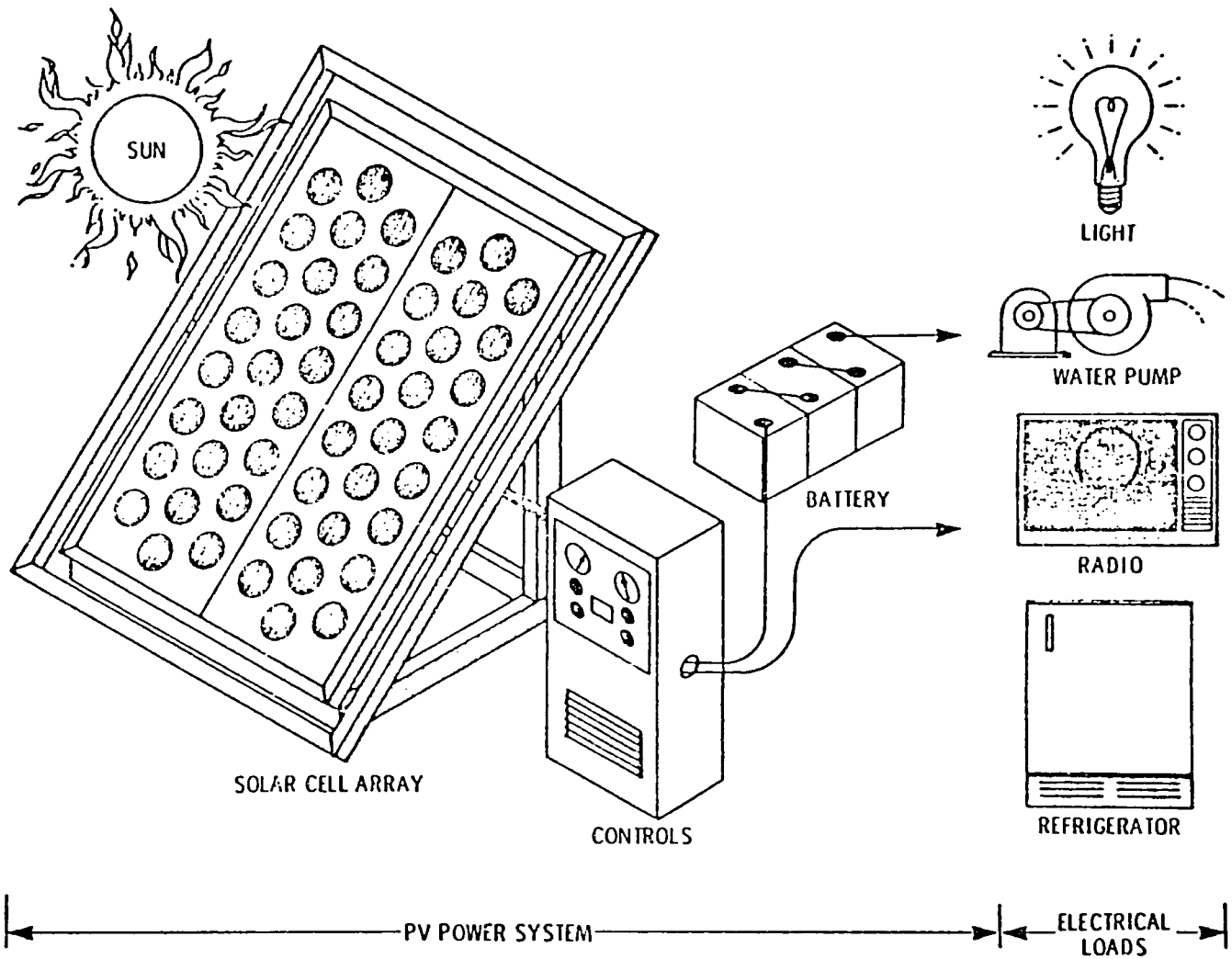

FIGURE 1

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APPENDIX B

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July 30, 1980

MEMO

TO: AID Missions: Health, Nutrition, Population and Energy Officers

FROM: Ned Wallace, MD, Health Advisor to AID/NASA

RE: US AID Bureau for Development Support/Office of Energy (DS/EY) Photovoltaic Project

Under a program sponsored by USAID DS/EY, the NASA-Lewis Research Center (LeRC) is managing a renewable energy project involving the application of photovoltaic (solar cell) technology for rural development. The first phase of this multi year project relates to rural health services and is being conducted with the collaboration of AID Regional Health Bureaus.

A copy of the Operating Plan for the first year (which contains the PASA as an appendix) is enclosed for your review.

At present, I am serving as an advisor to AID/NASA for the health component of the project and in that capacity seeking guidance and assistance from AID Missions.

One of the major activities of this project is to identify high-priority uses of electricity for rural health services for which photovoltaic (PV) technology might be an appropriate power source.

Another major project activity involves the field testing and assessment of various classes of PV power systems at selected sites.

If your Mission is interested in the application of PV technology and possibly participating in the subject project, I would appreciate your completing, to the extent possible, the enclosed PV information Request Form to provide:

a. Suggestions for appropriate uses of solar energy within the health sector, and;

b. Suggestions of AID related projects in your country whose directors might be interested in working with NASA in the use and demonstration of PV Systems.

Note: I recognize that the requested information will not always be available and that some posts may not be able to fully respond to all the questions. In such cases, please provide whatever information is available.

In addition, it would be most helpful if you would distribute the extra enclosed packets to US related health organizations within your country which the Mission believes to be potential project participants or information sources. This fall, recommendations obtained from AID Missions and selected PVOs will be reviewed and project sites for the next year will be selected by DS/EY and NASA. Thus it would be appreciated if you could respond by September 15, 1980.

Thank you for your consideration of this note.

NW/cw

Encl.

- Use of PV power for Rural Health services.
- Information Request Form.
- Demonstration site selection criteria.
- PV development and support project operating plan.
- 5 extra packets for PVO distribution.

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APPENDIX C

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Director

International Health Affairs
610 North Walnut Street
Madison, Wisconsin 53706
Telephone: 608/263-2864

July 30, 1980

MEMO

TO: International Health Colleagues

FROM: Ned Wallace, MD, MPH - Health Advisor to AID/NASA

RE: AID Bureau for Development Support/Office of Energy (DS/EY) Photovoltaic Project

Under a program sponsored by USAID/DS/EY, the NASA-Lewis Research Center (LeRC) is managing a renewable energy project involving the application of photovoltaic (solar cell) energy for rural development. The first phase of this multi-year project relates to rural health services and is being conducted with the collaboration of AID Regional Health Bureaus.

At present, I am serving as an advisor to AID/NASA for the health component of the project and in that capacity seeking guidance and assistance from organizations and individuals in the health sector.

To assure the appropriateness of future activities, I am inviting input from health workers and health officials closely involved with rural health services.

The purpose of this letter is to:

1. inform health workers about the potential of photovoltaics (PV);
2. seek suggestions about possible uses of PV power systems in rural health delivery settings;
3. identify individuals and organizations who:
   a. have special interest in the application of PV systems;
   b. desire to be kept informed about PV utilization and projects.

The following material is enclosed for your review:

1. A general discussion of the use of PV power for Rural Health Services.
2. PV Information Request Form.

If your organization is interested in the application of PV technology and providing recommendations for its use, please complete the information request form and return it to me by September 30, 1980, or as soon as convenient thereafter.

Your assistance and support in this matter will be much appreciated and will help in providing AID and NASA with relevant inputs from the international health assistance community.

Thank you.

NW/cw

Encl. Use of PV for Rural Health Service
PV Information Request Form
Demonstration Site Criteria

APPENDIX D

LIST OF RESPONDENTS TO THE SURVEY

ARRANGED BY REGIONS

AFRICA

Botswana:	Louis A. Cohen, Mission Director U.S. AID
Liberia:	Dr. J. Stephen Robinson, Public Health Consultant CARE
Magadascar:	Dr. Stanley Quambeck, Project Director Rural Primary Health Care
Senegal:	William R. Lapworth World-Wide Evangelisation Crusade
Sierra Leone:	Eugene Ponchot, Director of Overseas Missions Missionary Church, Inc.
Sudan:	J. Roger Schrock, Field Coordinator Sudan Council of Churches
Tanzania:	Dr. Glen Brubaker, Coordinator Regional TB/Leprosy Control
Upper Volta:	Dr. David C. Sokal, Medical Epidemiologist CDC/AID
Zaire:	Dr. John K. Miller, Director Community Health Services Christian Medical Institute of Kasai
Zaire:	Robert S. Thornbloom, Engineer Eglise du Christ au Zaire
Zambia:	Dr. Graham Calvert, Chief Medical Officer Salvation Army
Zimbabwe:	Dr. David J. Drake, Medical Director The Evangelical Alliance Mission

ASIA

Bangladesh:	Dr. Walter Kuhn, Medical Director Presbyterian Fellowship
Bangladesh:	Dr. Martin S. Schweiger, Medical Advisor RDSS Health Programme/Bangladesh
Indonesia:	Dr. David H. Calder, Health Officer U.S. AID Mission
Indonesia:	Dr. C. Beth Ferrell Conservative Baptish Mission

Nepal:	Dr. Maynard Seaman, Medical Director Team Hospital
Philippines:	Grey L. Federis, Jr., Chairperson Bicol Ecumenical Council

NEAR EAST

Jordan:	Dr. Wesley Ulrich, Physician World Presbyterian Church Mission
Lebanon:	Prof. Aftim Aera American University of Beirut

SOUTH AMERICA/CARIBBEAN

Brazil:	Dr. Aldo Villas Bôas, President Fundaqâo SEPS
Ecuador:	Rev. Lester Meisenheimer Missionary Church, Inc.
Guatemala:	Dr. E. Croft Long, Region Director Project HOPE
Guatemala:	Loran N. Veith, Jr., Project Manager CAM International
Guatemala:	Neil Woodruff, Health & Population Officer U.S. AID Mission
Haiti:	Dr. Jerry Russell, Chief, Public Health Office U.S. AID Mission
Honduras:	James A. Christensen, President La Buena Fe Association
Honduras:	Rev. Milton A. Maly, Clinic Administrator Moravian Church