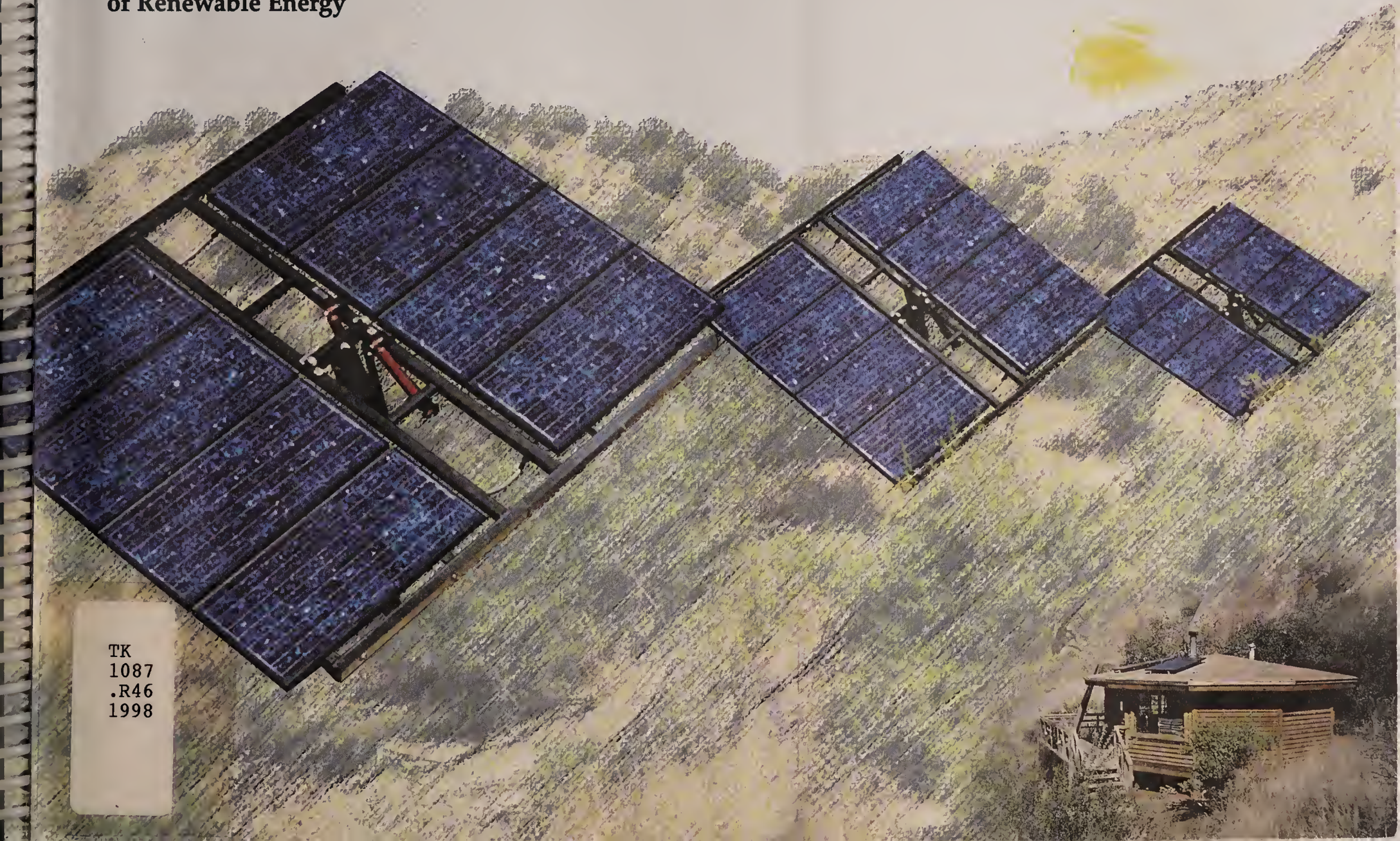
Renew the Government

Summary of Projects and Lessons Learned

U.S. Department of Energy • Sandia National Laboratories • Bureau of Land Management
National Park Service • USDA Forest Service

Partners in Expanding the use of Renewable Energy



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RENEW THE GOVERNMENT
SUMMARY OF PROJECTS AND LESSONS LEARNED

ACKNOWLEDGMENTS

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Photovoltaic Systems Assistance Center
Sandia National Laboratories

Trent Duncan
Utah State Office
Bureau of Land Management

Pat Fleming
Denver Service Center
National Park Service

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Tonto National Forest
USDA Forest Service

ABSTRACT

For the past several years, the Photovoltaic Systems Assistance Center at Sandia National Laboratories has maintained collaborative partnerships with the National Park Service, Bureau of Land Management, and USDA Forest Service. The purpose of these partnerships is to establish the sustainable use of photovoltaic technology in the agencies. Through the partnerships, assessments of applications and acceptance of photovoltaics were completed within each agency to establish benchmarks. Based on the results of these assessments, 122 new projects were developed and installed. This report documents these newer projects and identifies the lessons learned through these partnership activities.

INTRODUCTION

In October 1992, the National Park Service (NPS) released the document *Guiding Principles of Sustainable Design* to provide a framework for achieving sustainability in all national park operations and development activities. Energy management was identified as a major component of sustainable design. The NPS subsequently specified the use of renewable energy sources as a key strategy in the overall effort to develop sustainable energy management. In 1993, the NPS and the US Department of Energy Office of Photovoltaic and Wind Technology, through the Photovoltaic Systems Assistance Center at Sandia National Laboratories, entered into a collaborative partnership to promote energy conservation and increase the use of renewable energy at all NPS facilities.

Additional partnerships were developed with the USDA Forest Service in 1994 and the Bureau of Land Management in 1995, all with the central focus of expanding the use of renewable energy, specifically photovoltaics. The three partnerships – *Renew the Parks, Renew the Forests and Renew the Public Lands* – followed a common approach. Each agency conducted extensive surveys to assess existing applications, customer satisfaction, and barriers to increased usage. In addition, potential opportunities for photovoltaics to meet existing power needs as well as future power needs were identified. The findings were documented in three publications:

Renew the Parks –
Renewable Energy in the National Park Service – Photovoltaic Systems, 1995

Renew the Forests –
Photovoltaic Technology in the USDA Forest Service, 1996

Renew the Public Lands –
Photovoltaic Technology in the Bureau of Land Management, 1996

Pilot projects, representative of the power needs identified in the assessments, were developed to increase agency familiarization and acceptance. One hundred twenty-two projects are in various stages of deployment and on schedule to be completed as planned. The processes involved in these projects include all phases of system definition, design, procurement, installation, and acceptance, all of which are described in this report.

PILOT PROJECTS

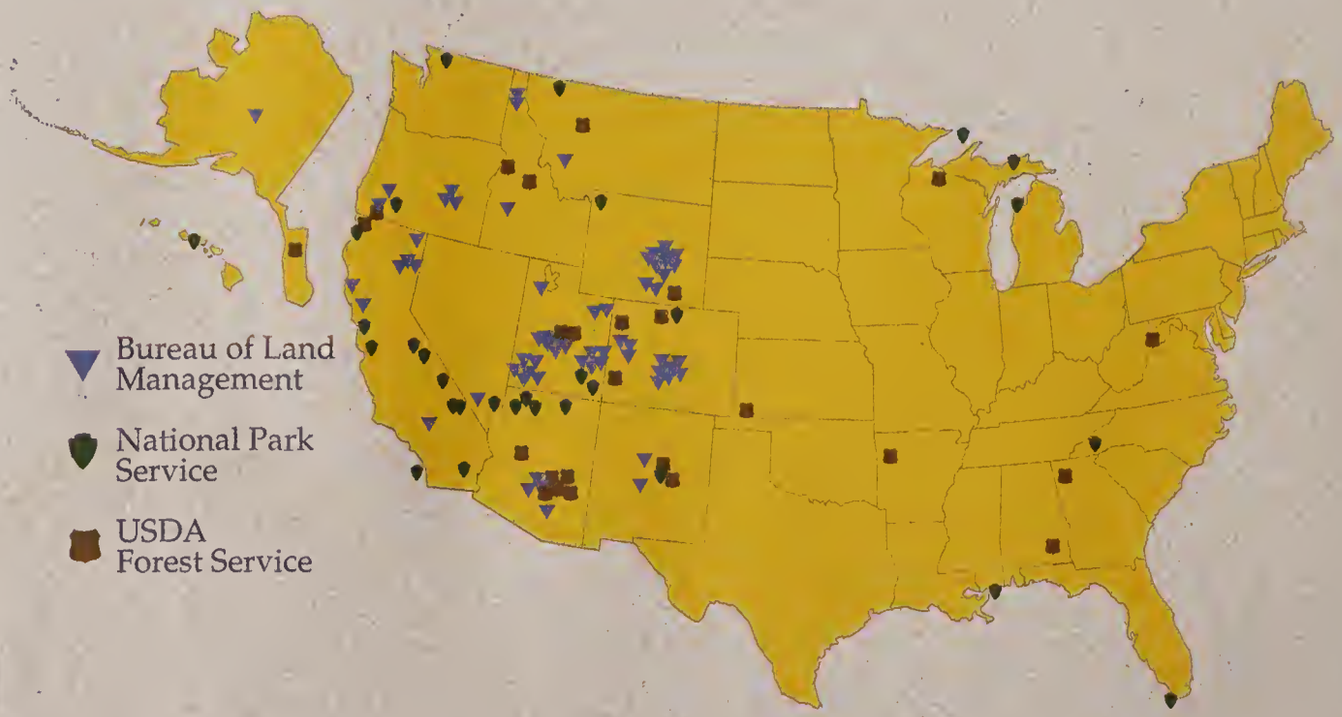
A total of 122 collaborative agency projects located in 23 states have been developed so far. These include 73 parks, forests, and BLM districts, as shown below. The projects are representative of the applications already being powered by photovoltaic systems, but with a focus on those applications that meet future agency needs. By agency, the numbers of projects are:

- National Park Service – 30
- USDA Forest Service – 27
- Bureau of Land Management – 65

The largest project is a 115-kW NPS facility power system at Dangling Rope Marina in Glen Canyon National Recreation Area, Utah. The smallest project is a 10-watt BLM water monitoring system on a Weather Station/Rain Gauge in Utah. The total rated photovoltaic array power for all projects is approximately 313 kW, broken down as follows:

- National Park Service – 247 kW
- USDA Forest Service – 20 kW
- Bureau of Land Management – 46 kW

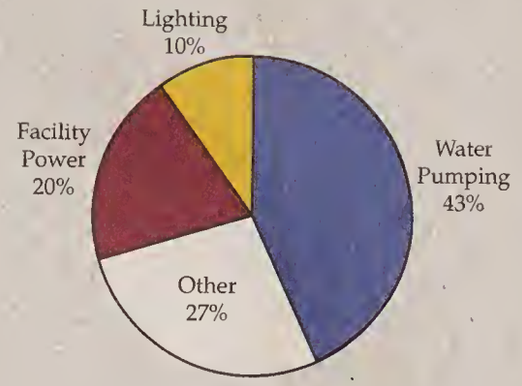
Most of the NPS systems are in the range of 5 to 20 kW and provide power to various park facilities. The primary goal of *Renew the Parks* is to replace existing diesel-fueled engine generators. This application accounts for the substantial number of photovoltaic systems installed at remote NPS facilities. The Forest Service and BLM systems are all less than 5 kW in size, typically 1 kW or smaller, and focus on recreational development/campground power and water pumping.



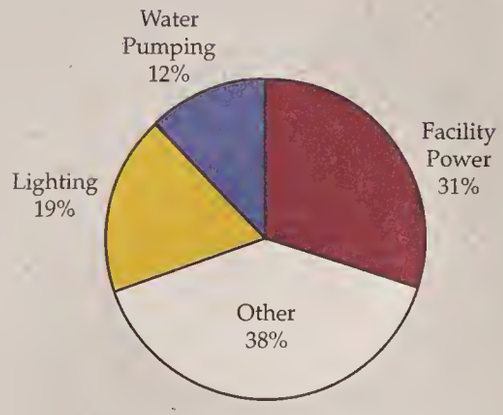
PROJECT SUMMARY

The projects in this document are divided into three major categories of applications: photovoltaics for *facility power, lighting,* and *water pumping*. These categories were selected based on information obtained from the BLM, USDA Forest Service, and NPS on the future applications for photovoltaics they anticipate, shown in the accompanying pie charts. The "other" category in the pie charts includes communications, remote monitoring, warning signs, gate openers, and other miscellaneous uses, none of which is numerically significant across the agencies.

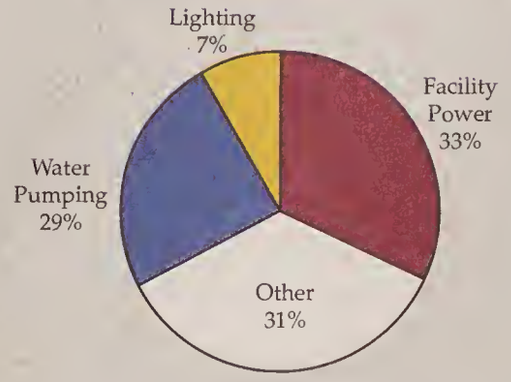
Project data sheets with general information and remarks are included in Appendix I for each system. The information provided includes the site, location, agency owner, installation date, system supplier, installer, system type, array size, types of components, component manufacturers, and information on the electrical load, system cost, and agency contact for the project. The general comments section contains operational information, such as data on the operation and maintenance of the system, performance assessment, unique features, etc. The projects are listed in an index in Appendix III, organized by application, agency, state and district.



Future Use of PV Power - BLM



Future Use of PV Power - NPS



Future Use of PV Power - USDA Forest Service

LESSONS LEARNED

Several lessons have been learned through the processes of implementing these projects. Some are associated with specific agency processes, such as procurement and installation. Others are relevant to photovoltaic systems in general, such as design, installation, maintenance, vandalism, and cost.

The lessons learned are grouped into four major categories:

- Feasibility
- Procurement
- Operation and Maintenance
- Value

Feasibility

The first question typically raised about any of the projects is very simply, "Does it make sense to use photovoltaics?" Each of the pilot projects went through a detailed assessment, many conducted on-site by a partnership team, to determine what was needed, what was available, and what could be done. The lesson learned is:

The agency must determine what it needs before it procures anything.

The experience of the *Renew* partnerships is that the agencies require significant technical assistance before they can make informed decisions. Although there has been increased familiarization with photovoltaic technology, and pockets of expertise within each agency do exist, continued assistance will be required before a sustainable process is in place.

In addition, without enthusiastic support from agency personnel, expanded use of photovoltaics within an agency will remain near zero. The lesson learned is:

A project advocate for photovoltaics must exist in the agency and must be in a position to affect decisions.

As a first step, each *Renew* partnership identified an agency coordinator as an advocate for the technology and a point of contact for other agency personnel. For *Renew the Parks*, the NPS Denver Service Center serves this role. Tonto National Forest serves the same role for *Renew the Forests*, and the Utah State BLM Office coordinates all activities for *Renew the Public Lands*. The experience gained through implementing the pilot projects provided more agency personnel with hands-on training.

Procurement

Although no one procurement process has proven to be best in all cases, experience with these projects shows a number of common features that are consistent with success and sustainability. In short, know

what you need, adequately specify it, standardize the procurement, and purchase multiple systems.

The procurement processes varied greatly on these projects. To emphasize sustainability, the *Renew* partnerships required that the projects be procured via typical agency processes. Nevertheless, the typical options encompassed various approaches, some more successful than others, including:

1. Photovoltaic industry competitively bids on design and building of systems.
2. Agency specifies systems and issues competitive general contract; photovoltaic industry sub-contractor supplies hardware and installation.
3. Agency specifies systems; GSA procures; agency installs systems.
4. Photovoltaic industry designs systems and uses agency-procured hardware and installation.
5. Agency uses an energy provider (utility) contract with a turn-key installation.

Early on in the partnership procurements, general functional system specifications were used with the idea that potential suppliers would have substantial flexibility in sizing, designing and providing photovoltaic systems. These elements are included in options 1, 4, and 5 above. These approaches did not work well, in part because of inappropriate systems being proposed, but more often because the specifications didn't really cover the agency's needs and desires. More success was seen in approaches 2 and 3, which required more agency interest and direct involvement. The lesson learned is:

A system should be adequately specified before it is procured, and the agency must be directly involved.

Standardizing the procurement of photovoltaic systems for smaller applications such as water pumping, campground host site power, and small remote facilities has resulted in substantial benefit; i.e., the agencies are able to get what they need at the least cost. The lesson is:

The procurement of standardized photovoltaic systems through standardized specifications and standardized processes greatly benefits the agency.

Sample procurement specifications that incorporate these lessons learned are included in Appendix II. Although each individual agency unit, such as a park or forest, can procure a system, the *Renew* experience with packaged procurements of multiple systems has been very positive. The lesson learned is:

Packaged procurements of standardized systems for multiple agency sites through a centralized office have proven to be very successful.

Operation and Maintenance

Although familiarity with photovoltaics among agency personnel is slowly increasing, a sizeable segment of the general public is quite aware of the value of photovoltaic modules, batteries, etc. In the past, vandalism such as breakage and other damage to photovoltaic systems was far too common, especially in remote areas. In today's world, theft is the problem. This issue is no different for photovoltaics than for any other improvements made at a remote site. Although the use of vandal-resistant hardware, coupled with elevated or difficult-to-access arrays, may slow down the dedicated thief, the BLM has noted that a host at a remote site can reduce vandalism to near zero. The BLM has a backlog of willing volunteer hosts. An attractive way to induce a host to locate at a remote campground is to install a photovoltaic system to provide the host with electrical amenities, with an almost immediate payback, a win-win situation.

The lesson learned is:

Providing power to a site host is an effective way to prevent theft and other vandalism at a remote site.

Another very important lesson concerns the cost of maintenance for photovoltaic systems. Detailed performance and economic analyses based on two years of actual operation have been conducted on three of the photovoltaic hybrid/engine generator systems documented in this report. These three systems are Rogers Peak, Figure 1; Pinnacles National Monument, Figure 2; and Dangling Rope, Figure 3. Conventional thinking is that the hybrid photovoltaic system has a high initial capital cost (compared only with an engine generator system) but the maintenance cost is very low. Although in general this argument is true, the use of batteries in hybrid photovoltaic systems cannot be overlooked in planning for future costs. For the three systems noted, recurrent maintenance and capital replacement cost represent 14% to 25% of the life-cycle cost of the hybrid system, primarily because of the batteries. The lesson learned is:

The cost of battery replacement in photovoltaic systems must be included in planning for future maintenance costs for the system.

Figure 1. Rogers Peak.

Figure 2. Pinnacles National Monument.

Figure 3. Dangling Rope.

Value

A frequently asked question is, "Should I use photovoltaics for this application?" Although photovoltaics offers significant advantages over competing power options in many cases, it may not always provide the best value for the agency. For the pilot projects documented in this report, photovoltaics was deemed to provide the best value to the procuring agency in every case. That doesn't necessarily mean it was the lowest cost option, or even the most convenient; however, it was the option with the most value. The lesson learned is:

Successful projects are those that are based on the best value, taking into consideration environmental concerns, quality of life, energy security, educational opportunities, lowest first costs, lowest life-cycle costs, etc.

An equally important lesson is:

Viable photovoltaic projects are typically for remote applications where the cost of photovoltaics is compared against other remote power options.

The *Renew* partnerships involve the NPS, BLM and Forest Service for one very important reason – these three agencies have jurisdiction over 25% of the land area in the USA. The opportunities are huge for photovoltaics to provide power for recreational development and resource management in this vast area. Federal agencies have a significant opportunity to expand their use of photovoltaics where they have needs for remote power and where photovoltaic systems can provide the best value option. Recent experience with grid-tied photovoltaic procurements shows that the levelized energy cost is $0.25 to $0.30 per kWh of electrical generation under the most favorable economic conditions. Costs for stand-alone hybrid photovoltaic systems, on the other hand, are $0.40 per kWh to more than several dollars per kilowatt-hour. Today's economics offer limited opportunity for photovoltaics to compete on a cost basis with conventional grid-tied electricity. Where photovoltaics can compete and offers the highest value is at sites off the utility grid or at sites where the existing engine generators are run very inefficiently and/or have significant environmental problems with fuel spills or atmospheric emissions. The lesson learned is:

Energy savings cannot be used to justify the cost of the photovoltaic project; economic justification must be based on comparison with alternative energy options.

CONCLUSIONS

The *Renew the Government* Program identified potential use of photovoltaic technology within the NPS, the BLM, and the USDA Forest Service that was consistent with the principles of sustainable design and would provide significant value to those agencies and the American public. Through the collaborative efforts of those agencies and the Photovoltaic Systems Assistance Center at Sandia National Laboratories, a large number of pilot systems are being used and evaluated by the agencies and the public. Our hope is that continued positive reaction, maintenance-cost reductions, and environmental benefits will eventually result in the sustained use of photovoltaics in these and other federal organizations where it makes sense.

"The agency must determine what it needs before it procures anything."

"A project advocate for photovoltaics must exist in the agency and must be in a position to affect decisions."

"A system should be adequately specified before it is procured, and the agency must be directly involved."

"The procurement of standardized photovoltaic systems through standardized specifications and standardized processes greatly benefits the agency."

"Packaged procurements of standardized systems for multiple agency sites through a centralized office have proven to be very successful."

"Providing power to a host site is an effective way to prevent theft and other vandalism at a remote site."

"The cost of battery replacement in photovoltaic systems must be included in planning for future maintenance costs for the system."

"Successful projects are those that are based on the best value, taking into consideration environmental concerns, quality of life, energy security, educational opportunities, lowest first costs, lowest life-cycle costs."

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Appendix I

Pilot Project Data Sheets

Facility Power

Bureau of Land Management • National Park Service • USDA Forest Service

FACILITY POWER

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ALASKA

Northern District

Chicken Field Station

Kent Davis
Contact Person

(907) 883-5121
Contact Number

$13,374 (hardware only)
PV System Cost

Solar Depot
System Supplier

Bureau of Land Management
System Installer

Under Construction
Installation Date

System Components:

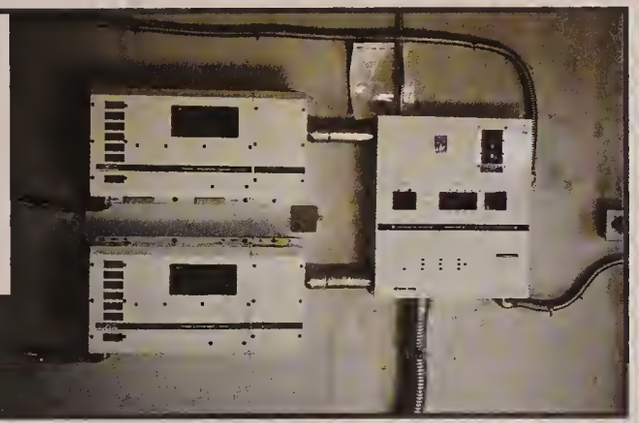
array	1,280 W Solarex
batteries	25 kWh Valve Regulated Deka
controller	Pulse Energy Systems
inverter	SW 4048 Trace Engineering
loads	Bunk Houses (3)

FACILITY POWER

ARIZONA

Arizona Strip District

Mt. Trumbull Administration Site



Ken Moore
Contact Person

(435) 628-4491
Contact Number

$30,169 (hardware only)
PV System Cost

Solar Depot
System Supplier

Bureau of Land Management
System Installer

October 1998
Installation Date

System Components:

array	2,560 W Solarex
batteries	62 kWh Valve Regulated GNB
controller	Pulse Energy Systems
inverter	SW 5548 (2) Trace Engineering
generator	6.5 kW Onan Propane
loads	Duplex, Shop, and Bunk House

ARIZONA

Tucson District

San Pedro

Dorothy Morgan
Contact Person

(520) 458-3559
Contact Number

$37,000
PV System Cost

Applied Power Corporation
System Supplier

Applied Power Corporation
System Installer

December 1997
Installation Date

System Components:

array	1,100 W Solarex
batteries	73 kWh Flooded C&D
controller	Ananda Power Technologies
inverter	SW 4048 Trace Engineering
generator	10 kW Kohler Propane

FACILITY POWER

CALIFORNIA

Bakersfield District

Chimney Peak

Glen Yamashita
Contact Person

Solar Depot
System Supplier

(805) 391-6046
Contact Number

Bureau of Land Management
System Installer

$30,169 (hardware only)
PV System Cost

Under Construction
Installation Date

System Components:

array	2,560 W Solarex
batteries	62 kWh Valve Regulated GNB
controller	Pulse Energy Systems
inverter	SW 5548 (2) Trace Engineering
generator	70 kW Kohler Propane
loads	Barracks, Office and Shop Buildings

CALIFORNIA

Eagle Lake Resource Area

Hobo Camp

Don Wannebo
Contact Person

Applied Power Corporation
System Supplier

(916) 257-0456
Contact Number

Bureau of Land Management
System Installer

$6,000 (hardware only)
PV System Cost

August 1996
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

FACILITY POWER

CALIFORNIA

Eagle Lake Resource Area

Rocky Point

Don Wannebo
Contact Person

(916) 257-0456
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

CALIFORNIA

Surprise Resource Area

Massacre Camps

Rudy Tafoya
Contact Person

(916) 279-6101
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

July 1997
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

FACILITY POWER

CALIFORNIA

Surprise Resource Area

Yellow Peak Lookout

Rudy Tafoya
Contact Person

(916) 279-6101
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

July 1997
Installation Date

System Components:

array	384 W Solarex
batteries	6.3 kWh Valve Regulated Deka
controller	Morningstar
inverter	1,500 W Trace Engineering

General Comments:

- Radio repeater and lookout.
- After the photovoltaic installation, there is now a waiting list of volunteers to man the lookout.

COLORADO

Canon City District

Five Points Campground

Dave Taliaferro
Contact Person

(719) 539-7289
Contact Number

$3,600
PV System Cost

Photocomm
System Supplier

BLM/Colorado State Parks
System Installer

August 1997
Installation Date

System Components:

array	120 W Uni-Solar
batteries	Valve Regulated Deka
controller	Trace Engineering
loads	Entrance Signs and Restroom Lighting

FACILITY POWER

COLORADO

Canon City District

Five Points Recreation Area

Dave Taliaferro
Contact Person

(719) 539-7289
Contact Number

$2,700
PV System Cost

Photocomm
System Supplier

BLM/Colorado State Parks
System Installer

August 1997
Installation Date

System Components:

array	90 W Uni-Solar
batteries	Valve Regulated Deka
controller	Trace Engineering
loads	Entrance Signs and Restroom Lighting

COLORADO

Canon City District

Hecla Junction Recreation Area

Dave Taliaferro
Contact Person

(719) 539-7289
Contact Number

$4,500
PV System Cost

Photocomm
System Supplier

BLM/Colorado State Parks
System Installer

August 1997
Installation Date

System Components:

array	150 W Uni-Solar
batteries	Valve Regulated Deka
controller	Trace Engineering
loads	Entrance Signs and Restroom Lighting

FACILITY POWER

COLORADO

Canon City District

Phantom Canyon

Gordon Gardunio
Contact Person

(970) 244-3186
Contact Number

$500 per system
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

September 1998
Installation Date

System Components:

array	20 W Solarex MSX-20
loads	100 CFM 12 Vdc Fan

General Comments:

- 4 systems installed on vault toilets.

COLORADO

Canon City District

Railroad Bridge Recreation Area

Dave Taliaferro
Contact Person

(719) 539-7289
Contact Number

$2,700
PV System Cost

Photocomm
System Supplier

BLM/Colorado State Parks
System Installer

August 1997
Installation Date

System Components:

array	90 W Uni-Solar
batteries	Valve Regulated Deka
controller	Trace Engineering
loads	Entrance Signs and Restroom Lighting

FACILITY POWER

COLORADO

Canon City District

Rincon Recreation Area

Dave Taliaferro
Contact Person

(719) 539-7289
Contact Number

$3,600
PV System Cost

Photocomm
System Supplier

BLM/Colorado State Parks
System Installer

August 1997
Installation Date

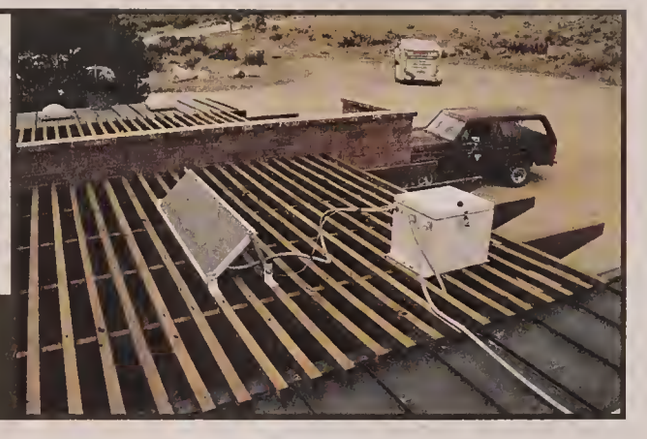
System Components:

array	120 W Uni-Solar
batteries	Valve Regulated Deka
controller	Trace Engineering
loads	Entrance Signs and Restroom Lighting

COLORADO

Canon City District

Ruby Mountain Recreation Area



Dave Taliaferro
Contact Person

(719) 539-7289
Contact Number

$5,400
PV System Cost

Photocomm
System Supplier

BLM/Colorado State Parks
System Installer

August 1997
Installation Date

System Components:

array	180 W Uni-Solar
batteries	Valve Regulated Deka
controller	Trace Engineering
loads	Entrance Signs and Restroom Lighting

FACILITY POWER

COLORADO

Grand Junction District

Mud Springs

Joe Ashor
Contact Person

(970) 224-3031
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

June 1997
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

COLORADO

Montrose District

Mill Creek

Gordon Gardunio
Contact Person

(970) 244-3186
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

FACILITY POWER

IDAHO

Boise District

Mud Flat

Bob Stucker
Contact Person

(208) 384-3300
Contact Number

$17,890 (hardware only)
PV System Cost

Solar Depot
System Supplier

Bureau of Land Management
System Installer

September 1998
Installation Date

System Components:

array	2,048 W Solarex
batteries	38 kWh Valve Regulated Deka
controller	Pulse Energy Systems
inverter	SW 5548 Trace Engineering
loads	Bunk Houses (2) and Well Pump

NEW MEXICO

Albuquerque District

Orilla Verde

Steve Jordan
Contact Person

(505) 438-7440
Contact Number

$4,000
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	231 W Solarex
batteries	Flooded GNB
controller	Morningstar
inverter	Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

General Comments:

- Two systems at site.

FACILITY POWER

NEW MEXICO

Socorro District

Fort Craig

Steve Jordan
Contact Person

(505) 438-7440
Contact Number

$45,000
PV System Cost

Socorro Electric Coop./PSN
System Supplier

Direct Power and Water
System Installer

January 1998
Installation Date

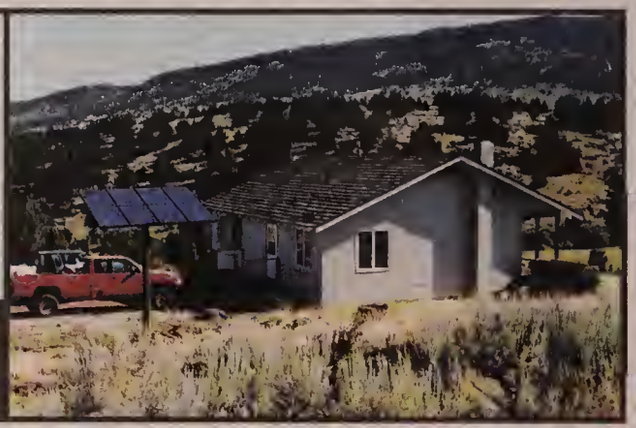
System Components:

array	2,000 W Solarex
batteries	56 kWh Flooded Deka
controller	Pulse Energy Systems
inverter	SW 5548 (2) Trace Engineering
generator	10 kW Kohler Propane
loads	Site Host, Restroom Lighting

OREGON

Burns District

Riddle Brothers Ranch



Fred McDonald
Contact Person

(541) 573-4453
Contact Number

$17,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

July 1997
Installation Date

System Components:

array	640 W Solarex
batteries	25 kWh Flooded Trojan
controller	Ananda Power Technologies
inverter	SW 4048 Trace Engineering
loads	Remote Residence

General Comments:

- Seasonal use.
- Sunfrost refrigerator.

FACILITY POWER

OREGON

Burns District

South Steens Campground

Fred McDonald
Contact Person

(541) 573-4453
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

OREGON

Medford District

Rogue River Ranch

John Bethea
Contact Person

(503) 770-2246
Contact Number

$26,788 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	1,326 W Siemens and Solarex
batteries	33.6 kWh Flooded Trojan
controller	Ananda Power Technologies
inverter	SW 4024 Trace Engineering
other	2-Nozzle Harris Hydroelectric Pelton Wheel
	300 W Southwest Wind Power Wind Generator
loads	Remote Residence and Contact Station

General Comments:

- Article in Issue #55, *Home Power Magazine*.

FACILITY POWER

UTAH

Cedar City District

Baker Dam Campground

R.J. Hughes
Contact Person

(801) 628-4491
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

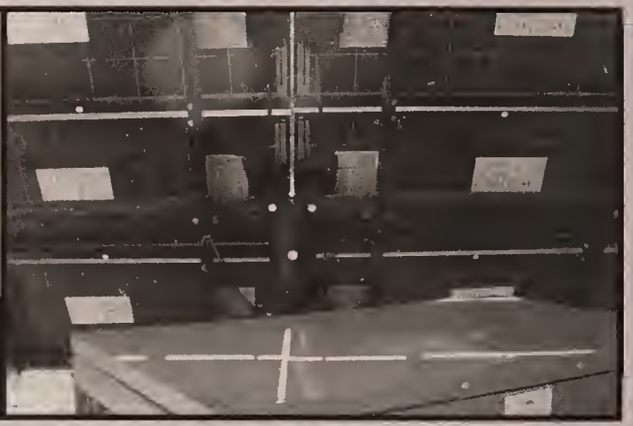
System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

UTAH

Cedar City District

Ponderosa Grove Campground



Janaye Byergo
Contact Person

(801) 586-2401
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

June 1997
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

FACILITY POWER

UTAH

Cedar City District

Red Cliffs Campground

R.J. Hughes
Contact Person

(801) 628-4491
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

UTAH

Moab District

Big Bend Campground

John Lewis
Contact Person

(801) 259-2100
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host site

General Comments:

- System provides year-round power for campground host.

FACILITY POWER

UTAH

Moab District

Goose Island Campground

John Lewis
Contact Person

(801) 259-2100
Contact Number

$6,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1996
Installation Date

System Components:

array	384 W Solarex
batteries	5.8 kWh Valve Regulated GNB
controller	Morningstar
inverter	1,500 W Trace Engineering
other	Trailer Mounted
loads	Campground Host Site

UTAH

Moab District

Kane Gulch

Trent Duncan
Contact Person

(801) 539-4090
Contact Number

$30,000
PV System Cost

Solar Power/Applied Power
System Supplier

Bureau of Land Management
System Installer

October 1995
Installation Date

System Components:

array	2,000 W Siemens
batteries	84 kWh Valve Regulated GNB
controller	Ananda Power Technologies
inverter	SW 4048 Trace Engineering
generator	12 kW
other	Zomeworks Tracker

General Comments:

- Remote residence/ contact station.
- Seasonal use. Trailer mounted array is removed from site during winter months.

FACILITY POWER

UTAH

Moab District

Sandwash Ranger Residence

Dennis Willis
Contact Person

(801) 636-3600
Contact Number

$20,000
PV System Cost

Solar Power/Applied Power
System Supplier

Bureau of Land Management
System Installer

July 1995
Installation Date

System Components:

array	1,320 W Siemens
batteries	84 kWh Valve Regulated GNB
controller	Ananda Power Technologies
inverter	1,500 W Trace Engineering
other	Zomeworks Tracker
loads	Remote Residence

General Comments:

- Daily energy use 5 kWh.
- Seasonal use.
- Trailer-mounted arrays are removed from site during winter months.
- Batteries installed in underground vault to moderate temperature.

UTAH

Vernal District

Pariette Administrative Site

John Wood
Contact Person

(435) 781-4400
Contact Number

$14,000
PV System Cost

Solar Depot
System Supplier

Bureau of Land Management
System Installer

September 1998
Installation Date

System Components:

array	1,024 W Solarex
batteries	25 kWh Valve Regulated Deka
controller	Pulse Energy Systems
inverter	SW 4048 Trace Engineering
loads	Remote Residence

General Comments:

- Year round use.
- Maintenance and lodging facility for the Pariette Wetlands.

FACILITY POWER

UTAH

Vernal District

South Camp

Gary Hunter
Contact Person

(801) 741-4400
Contact Number

$6,000
PV System Cost

Solar Power
System Supplier

Bureau of Land Management
System Installer

August 1995
Installation Date

System Components:

array	330 W Siemens
batteries	12.7 kWh Valve Regulated Deka
controller	Ananda Power Technologies
inverter	2,500 W Trace Engineering
generator	4 kW Onan Propane
loads	Remote Residence

General Comments:

- Seasonal use.
- Daily energy use 1 kWh.
- Water Pumping.

FACILITY POWER

ARIZONA

Grand Canyon National Park

Cottonwood

Curt Edlund
Contact Person

(520) 638-7730
Contact Number

$14,600
PV System Cost

Applied Power/Utility Power
System Supplier

National Park Service
System Installer

April 1995
Installation Date

System Components:

array	720 W Solarex MSX-60
batteries	25 kWh Trojan L-16
inverter	SW 4024 Trace Engineering
generator	300 W Pelton Wheel
other	Zomeworks Tracker
loads	Typical Residential, including Evaporative Cooler, and Sunfrost Refrigerator

FACILITY POWER

ARIZONA

Grand Canyon National Park

North Rim

Curt Edlund
Contact Person

(520) 638-7730
Contact Number

$27,500
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

October 1995
Installation Date

System Components:

array	1,440 W Solarex MSX-60
inverter	SW 5548 (2) Trace Engineering
other	Grid-Tied, Garfield-Kane County Rural Electric
loads	Area Lighting Display, Lighting and Computers

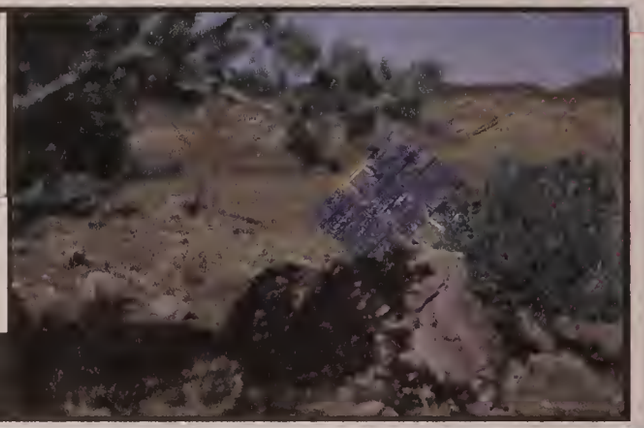
General Comments:

- Provides power to visitor center.
- Building heat and water heating use propane.

ARIZONA

Grand Canyon National Park

Tuweep



Curt Edlund
Contact Person

(520) 638-7730
Contact Number

$24,500
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

April 1995
Installation Date

System Components:

array	1,200 W Solarex MSX-60
batteries	33.6 kWh Trojan L-16
inverter	SW 4024 (2 stacked) Trace Engineering
generator	12 kW Propane
other	Wattsun Dual Axis Tracker
loads	Typical Residential, including Evaporative Coolers, and Sunfrost Refrigerator

General Comments:

- Lightning strike disabled one inverter. Prompt repairs by Trace Engineering.

FACILITY POWER

ARIZONA

Navajo National Monument

Keet Seel

Rose Clark
Contact Person

(520) 672-2366
-Contact Number

$10,000
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

October 1996
Installation Date

System Components:

array	512 W Solarex
batteries	Valve Regulated GNB
controller	Ananda Power Technologies
inverter	Trace Engineering
loads	Remote Ranger Residence and Contact Station

General Comments:

- Seasonal use.

CALIFORNIA

Channel Islands National Park

Santa Rosa Island

Kent Bullard
Contact Person

(805) 658-5745
Contact Number

$300,000
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

April 1997
Installation Date

System Components:

array	12,000 W Siemens
batteries	Flooded GNB
inverter	30 kW Abacus
generator	30 kW Diesel

General Comments:

- Project received Federal Energy Efficiency Fund Grant from U.S. DOE.
- Includes 2 10-kW Bergey wind turbines.
- All islands in the park are PV powered.

FACILITY POWER

CALIFORNIA

Death Valley National Park

Rogers Peak

Tom Ward
Contact Person

(714) 870-3175
-Contact Number

$287,000
PV System Cost

Applied Power Corporation
System Supplier

Applied Power Corporation
System Installer

July 1994
Installation Date

System Components:

array	12,840 W Solarex
batteries	Valve Regulated GNB
controller	Applied Power Corporation
generator	35 kW Onan Propane
charger	La Marche
loads	24 Volt Communication

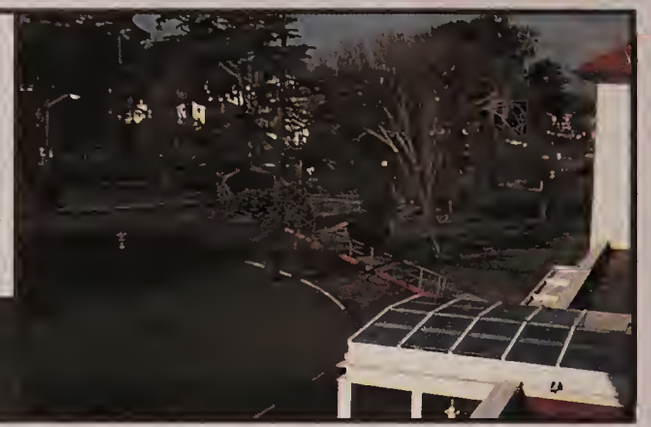
General Comments:

- Owned and operated by Southern California Edison.
- PV has produced 93% of site energy.
- 1,700 W of continuous load.
- No downtime in 3 years of operation.
- Engine run-time limited to 250 hours per year.

CALIFORNIA

Golden Gate National Recreation Area

Presidio, Thoreau Center



Jim Christianson
Contact Person

(415) 561-4352
Contact Number

$27,000
PV System Cost

Atlantis Energy
System Supplier

Atlantis Energy
System Installer

March 1997
Installation Date

System Components:

array	2,000 W Solarex
inverter	Trace Engineering
other	Grid-Tied
loads	All Building Loads for a Non-profit Organization

General Comments:

- Array was custom fabricated to fit inside glass canopy entry way.
- Collaborative project with Federal Energy Management Program.

FACILITY POWER

CALIFORNIA

Joshua Tree National Park

Cottonwood

Harry Carpenter
Contact Person

(619) 367-7464
Contact Number

$266,300
PV System Cost

Southern California Edison
System Supplier

Utility Power Group
System Installer

October 1998
Installation Date

System Components:

array	20,000 W Siemens
batteries	C&D Flooded
inverter	20 kW Trace Technologies
generator	30 kW Kohler Propane

General Comments:

- System provides power for a visitor center, maintenance facility, several residences and a campground.

CALIFORNIA

Kings Canyon National Park

Hole-in-the-Wall

Pete Lucero
Contact Person

(209) 335-2860
-Contact Number

$105,000
PV System Cost

BP Solar
System Supplier

Pro-Control
System Installer

September 1998
Installation Date

System Components:

array	8,000 W BP Solar
batteries	144 kWh Valve Regulated
controller	C40 Trace Engineering
inverter	SW 5548 (2) Trace Engineering
generator	20 kW Propane

General Comments:

- System powers a remote trail maintenance facility.

FACILITY POWER

CALIFORNIA

Mojave National Preserve

Hole-in-the-Wall Visitor Center

Dave Paulissen
Contact Person

(760) 255-8810
Contact Number

$106,020
PV System Cost

S. Cal. Edison/UPG
System Supplier

S. Cal. Edison/UPG
System Installer

Planned December 1998
Installation Date

System Components:

array	4,200 W Siemens
batteries	111 kWh C&D Valve-Regulated Lead-Acid
controller	Pulse Energy Systems
inverter	5548 (2) Trace Engineering
generator	10 kW Kohler Propane
other	K-rail Support Structure

CALIFORNIA

Pinnacles National Monument

Chaparral

Debby Simmons
Contact Person

(408) 389-4485
-Contact Number

$135,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

March 1996
Installation Date

System Components:

array	9,600 W Solarex
batteries	200 kWh Valve Regulated GNB
controller	Ananda Power Technologies
inverter	SW 4048 (6) Trace Engineering
generator	20 kW Kohler Propane
other	Southwest Technology Development Institute Data Acquisition System

General Comments:

- Engine run-time less than 800 hours per year.
- PV supplies 100% of energy needs during summer months.
- Daily energy use between 35 and 40 kWh.
- No downtime since system installation.

FACILITY POWER

MICHIGAN

Isle Royale National Park

Davidson Island

Andrew Bilton
Contact Person

(906) 487-7166
Contact Number

$10,000 (hardware only)
PV System Cost

SunWize Technologies, Inc.
System Supplier

National Park Service
System Installer

August 1998
Installation Date

System Components:

array	600 W Siemens
batteries	Valve Regulated Concorde
controller	Trace Engineering
inverter	Trace Engineering
generator	15 kW Onan Diesel Genset
loads	Lights, Computers, Water Pump, Laboratory, and Small Appliances

MICHIGAN

Pictured Rocks National Lakeshore

Au Sable Light Station

Chris Case
Contact Person

(906) 387-2607
Contact Number

$75,000
PV System Cost

Currin Corporation
System Supplier

National Park Service
System Installer

Under Construction
Installation Date

System Components:

array	4000 W Siemens SP75
batteries	65 kWh Valve Regulated GNB
inverter	SW 5548 (2) Trace Engineering

General Comments:

- Array located 750 feet away from historic lighthouse.
- System includes geothermal heating system.

FACILITY POWER

MICHIGAN

Sleeping Bear Dunes National Lakeshore

N. Manitou Island

Dan Kreiber
Contact Person

(616) 326-5134
-Contact Number

$110,000 (hardware only)
PV System Cost

Currin Corporation
System Supplier

National Park Service
System Installer

September 1996
Installation Date

System Components:

array	11,200 W Siemens Solar
batteries	Valve Regulated GNB
controller	Ananda Power Technologies
inverter	AES
generator	30 kW Diesel

General Comments:

- Seasonal operation.

MISSISSIPPI

Gulf Islands National Seashore

Horn Island

Joe Martin
Contact Person

(404) 562-3257
Contact Number

$60,000
PV System Cost

Applied Power Corporation
System Supplier

Applied Power Corporation
System Installer

September 1998
Installation Date

System Components:

array	3,600 W ASE
batteries	GNB Sunlyte, flooded
inverter	SW 5548 (2) Trace Engineering
generator	30 kW Kohler, Diesel (2)
other	Lightning Arrestor
loads	Residence, Maintenance Building, Water Pumping

General Comments:

- PV system designed to handle winter loads without generators.
- Air conditioning loads during the summer are impractical to handle with PV.

FACILITY POWER

MONTANA

Glacier National Park

Goat Haunt Visitor Center

Jerry Burgess
Contact Person

(406) 888-7974
-Contact Number

$45,800
PV System Cost

Applied Power Corporation
System Supplier

Quantum Electric
System Installer

October 1998
Installation Date

System Components:

array	1,280 W Solarex MSX-64
batteries	Valve Regulated GNB
controller	Pulse Energy Systems
inverter	Trace Engineering

General Comments:

- Roof-mounted array.
- Seasonal operation.

NEVADA

Lake Mead National Recreation Area

Shivwits

Richard Lassiter
Contact Person

(702) 293-8745
Contact Number

$23,000 (hardware only)
PV System Cost

Trace Engineering/Siemens
System Supplier

National Park Service
System Installer

August 1997
Installation Date

System Components:

array	1,200 W Siemens
batteries	350 A-h Flooded Lead Acid
inverter	120/240 V Trace 4024 (2)
generator	20 kVA Onan Propane Fueled
loads	Well Pump, Furnace Motors, and Lights

General Comments:

- Seasonal operation April through October.
- Users extremely satisfied.
- System installation provided training activity for NPS personnel.

FACILITY POWER

NEW MEXICO
Salinas Pueblo Missions National Monument

Gran Quivira Visitor Center

Mike Schneegas
Contact Person

(505) 847-2585
-Contact Number

$20,000
PV System Cost

Springer Electric Cooperative
System Supplier

Direct Power and Water
System Installer

June 1997
Installation Date

System Components:

array	1,440 W Solarex
batteries	Valve Regulated Deka
controller	Ananda Power Technologies
inverter	Trace Engineering
other	Grid-Tied

General Comments:

- System provides enough energy for the facility.
- Three-cycle (recycled) building material used throughout the visitor center.
- Interactive computer display in the visitor center.

OREGON
Crater Lake National Park

North Entrance Kiosk

Brian Coulter
Contact Person

(503) 594-2211
Contact Number

$8,000
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

September 1994
Installation Date

System Components:

array	360 W Solarex
batteries	Flooded, Interstate L-16
controller	Heliotrope (2)
inverter	Prostar
loads	Fans, Radios, Lighting (internal and external)

General Comments:

- Summer and Winter Modes (dual voltage).
- Specialty Concepts, Inc. Monitoring Panel.

FACILITY POWER

UTAH

Glen Canyon National Recreation Area

Dangling Rope Marina

Vic Knox
Contact Person

(602) 645-2471
-Contact Number

$1,350,000
PV System Cost

Applied Power Corporation
System Supplier

Applied Power Corporation
System Installer

August 1996
Installation Date

System Components:

array	115,000 W ASE 300-DG/50
batteries	24 MWh C&D 6-C125-25
controller	Kenetech Windpower
inverter	3ø 480 V Kenetech HY250
generator	250 kVA Caterpillar 3408 Propane
charger	Inverter-Charger
other	Southwest Technology Development Institute Data Acquisition System

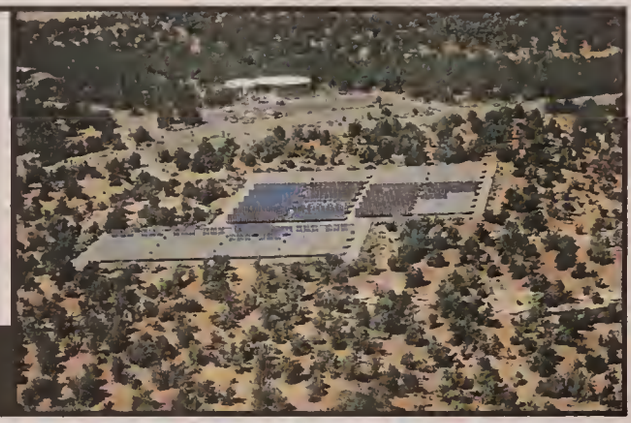
General Comments:

- Provides power to mini-grid/village power system.
- The loads are the fuel dock, marina store, refrigeration, and two dozen residence cabins.
- The total load for 1996/1997 was 438 MWh.
- Project developed in collaboration with Utah Energy Office, Federal Energy Management Program, and Utah Power and Light.

UTAH

Natural Bridges National Monument

Visitor Center



Bob Lovato
Contact Person

(435) 259-3911
Contact Number

$156,000
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

May 1995
Installation Date

System Components:

array	15,600 W Solarex
batteries	C&D Flooded
controller	MIT-Designed, Custom Intel
inverter	50 kVA Cyberex
generator	120 kW Onan Diesel
loads	Average 15 kW; 73,000 kWh/year, Includes 2 Deep Well Pumps, other Pumps

General Comments:

- Original system installed in 1980 was 100 kW.
- Battery replacement and array augmentation occurred in two phases: $86,000 in October 1992 and $70,000 in May 1995.

FACILITY POWER

WASHINGTON

North Cascades National Park

Hozomeen

Steve James
Contact Person

(360) 873-4590
-Contact Number

$168,000
PV System Cost

Applied Power Corporation
System Supplier

Dutton Electric
System Installer

May 1998
Installation Date

System Components:

array	7,200 W Solarex
batteries	48 kWh Absolyte - IIP GNB
controller	Ananda Power Technologies
inverter	SW 5548 Trace Engineering
generator	25 kW Generac Propane
loads	Two Duplex Housing Units, One Bunkhouse, and One Maintenance Building

General Comments:

- Roof mounted system, custom designed, working very well.
- Recommended for more roof systems

WYOMING

Yellowstone National Park

Lamar Buffalo Ranch

Harold Anderson
Contact Person

(307) 344-2332
Contact Number

$66,000
PV System Cost

Applied Power Corporation
System Supplier

National Park Service/NEOS
System Installer

July 1998
Installation Date

System Components:

array	6,500 W Solarex
batteries	Valve Regulated Absolyte-IIP GNB
controller	APT Power Center
inverter	SW 4048 (2) Trace Engineering
generator	12 kW Kohler Propane
loads	Residential (lighting and appliances)

General Comments:

- Cost sharing through Federal Energy Management Program.

FACILITY POWER

ALASKA

Tongass National Forest

Petersburg Ranger Dist. Crew Bldgs.

Tom Chittenden
Contact Person

(907) 772-5910
-Contact Number

$7,500
PV System Cost

Photocomm
System Supplier

Tongass National Forest
System Installer

September 1997
Installation Date

System Components:

array	768 W Uni-Solar
batteries	Valve Regulated Deka
controller	C40 Trace Engineering
inverter	DR 1524 Trace Engineering
other	Whisper 600 Wind Generator

General Comments:

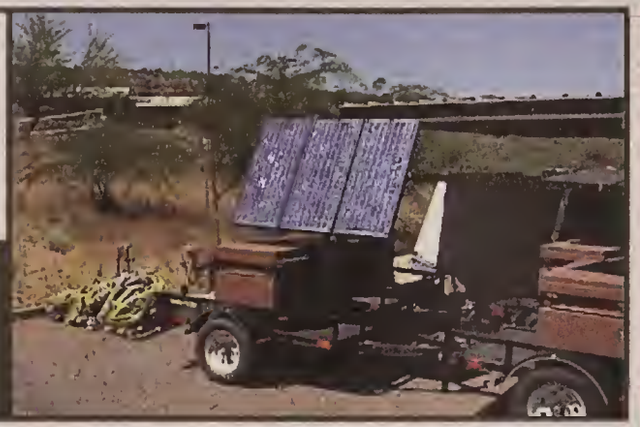
- This system provides power for crew buildings in a very remote area.

FACILITY POWER

ARIZONA

Tonto National Forest

Schoolhouse Grove and Indian Point Campgrounds



Andrew Dziobek
Contact Person

(602) 225-5319
Contact Number

$28,135
PV System Cost

Applied Power Corporation
System Supplier

Tonto National Forest
System Installer

September 1997
Installation Date

System Components:

array	180 W Solarex MSX-60
batteries	Sunlyte #12-5000X
controller	Prostar 30

General Comments:

- There are 7 systems at this site.

ARIZONA

Tonto National Forest

Sunflower Environmental Center

Andrew Dziobek
Contact Person

(602) 225-5319
Contact Number

$26,000
PV System Cost

Applied Power Corporation
System Supplier

Tonto National Forest
System Installer

Under Construction
Installation Date

System Components:

array	1,792 W Solarex MSX-64
batteries	Valve Regulated GNB
controller	Prostar-30 Morningstar; Grundfos Pump Controller
inverter	DR 1512 Trace Engineering
other	2 Zomeworks Trackers
loads	Lights, Small Appliances, and Audio-Visual Equipment; 1.5 HP Grundfos Submersible Pump

General Comments:

- Power system supplies energy to remote environmental education center.

FACILITY POWER

CALIFORNIA

Inyo National Forest

Schulman Grove Interpretive Site

John Louth
Contact Person

(760) 873-2514
-Contact Number

$3,700
PV System Cost

Applied Power Corporation
System Supplier

Inyo National Forest
System Installer

September 1998
Installation Date

System Components:

array	384 W Solarex MSX-64
controller	PPC-12-P Specialty Concepts Inc.
inverter	DR 2412 Trace Engineering
loads	Remote Visitor Center Lights and Cash Register

COLORADO

Arapaho and Roosevelt National Forests

Mount Evans

Chris Ida
Contact Person

(970) 498-2742
Contact Number

$4,000
PV System Cost

Comarco Wireless Technologies
System Supplier

Comarco Wireless Technologies
System Installer

August 1997
Installation Date

System Components:

array	18 W Solec
batteries	Panasonic 12 V
loads	Emergency Cellular Call Box

FACILITY POWER

COLORADO

White River National Forest

Maroon Lake

Rich Doak
Contact Person

(970) 925-3445
-Contact Number

$16,000
PV System Cost

Sunsense
System Supplier

Sunsense
System Installer

Under Construction
Installation Date

System Components:

array	896 W Solarex MSX-64
batteries	19 kWh Trojan L-16
controller	Pulse Energy Systems
inverter	SW 4024 Trace Engineering

General Comments:

- System provides power to an entrance station.
- Heavily visited area with over 200,000 visitors per year.
- PV provides only power in the Maroon Valley/Maroon Lake area.
- Other PV projects include a PV-powered access gate, PV-powered composting toilets, and portable host-site power system.

IDAHO

Payette National Forest

Krassel Work Center

Pat Trainor
Contact Person

(206) 253-0138
Contact Number

$6,000
PV System Cost

Applied Power Corporation
System Supplier

Payette National Forest
System Installer

October 1995
Installation Date

System Components:

array	360 W Solarex MSX-60
batteries	6V Trojan Pacer L-16 Deep Cycle
controller	5TM/APT Powercenter
inverter	U2512 SB Trace Engineering
loads	Office Equipment/Light

General Comments:

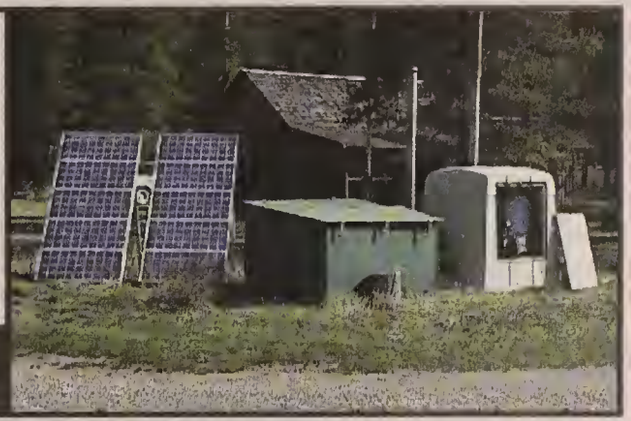
- The system replaced 20-kW propane generator.

FACILITY POWER

MONTANA

Lewis and Clark National Forest

Benchmark Cabin



Norm Kamrud
Contact Person

(406) 466-5341
-Contact Number

$8,000
PV System Cost

Photocomm
System Supplier

Lewis & Clark National Forest
System Installer

June 1996
Installation Date

System Components:

array	50 W Kyocera KC51
batteries	IBE 75N23 Flooded
controller	PSR-30 Photo Star
inverter	24-12 V Converter
loads	Water Pump-24 V

General Comments:

- This system provides power for a work station in a very remote area.
- This system is also a water pumping system.

NEW MEXICO

Cibola National Forest

Doc Long

Mary Dereske
Contact Person

(505) 761-4650
-Contact Number

$70,000
PV System Cost

AAA Solar
System Supplier

AAA Solar
System Installer

April 1996
Installation Date

System Components:

array	3,240 W Solarex
batteries	Flooded Trojan
controller	Bobier
inverter	Trace Engineering
loads	AC and DC Loads; Host Site Power

General Comments:

- PV systems provide power for multiple restrooms, host-site, area lights, and group picnic shelter.

FACILITY POWER

NEW MEXICO

Cibola National Forest

Sulphur Canyon

Mary Dereske
Contact Person

(505) 761-4650
Contact Number

$15,000
PV System Cost

Direct Power and Water
System Supplier

Direct Power and Water
System Installer

May 1997
Installation Date

System Components:

array	768 W Solarex
batteries	Flooded Trojan
controller	Heliotrope
inverter	Trace Engineering
other	SEPCO Light at Host Site
loads	AC and DC Loads; Host Site Power

OREGON

Siskiyou National Forest

Big Pine Sightless Interpretive Trail

Larry Cosby
Contact Person

(541) 471-6736
Contact Number

$2,000
PV System Cost

Energy Outfitters
System Supplier

Siskiyou National Forest
System Installer

October 1995
Installation Date

System Components:

array	53 W Siemens M55
batteries	2 Trojan T-105
controller	CC-10 Heliotrope General
loads	Digital Speech Module DM 1000 LP-1

General Comments:

- System provides power for digital speech module along interpretive path.

FACILITY POWER

UTAH

Manti-LaSal National Forest

Stuart Guard Station

Kathy O'Brian
Contact Person

(801) 637-2817
-Contact Number

$6,500
PV System Cost

Applied Power Corporation
System Supplier

Manti-LaSal National Forest
System Installer

September 1998
Installation Date

System Components:

array	384 W Solarex MSX-64
batteries	Gel Star
controller	C40 Trace Engineering
inverter	DR 1524 Trace Engineering
loads	Lights, Small Power Tools, and Appliances

Lighting

Bureau of Land Management • National Park Service • USDA Forest Service

LIGHTING

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

ARIZONA

Phoenix District

Burro Creek Recreation Site

Brenda Smith
Contact Person

(520) 757-3161
Contact Number

$4,000
PV System Cost

Sun Amp
System Supplier

Bureau of Land Management
System Installer

April 1996
Installation Date

System Components:

array	256 W Solarex
batteries	Flooded Trojan
loads	Restroom Lights

General Comments:

- Site use heaviest in winter months.

LIGHTING

IDAHO

Coeur d' Alene District

Mineral Ridge Boat Launch

Will Perry
Contact Person

Solar Outdoor Lighting
System Supplier

(208) 769-5000
Contact Number

Bureau of Land Management
System Installer

$4,000
PV System Cost

May 1997
Installation Date

System Components:

array	150 W Solarex
batteries	100 W Valve Regulated Deka
controller	Solar Outdoor Lighting
loads	Lights

General Comments:

- Lighting for boat tie-down area and ramp.

IDAHO

Coeur d' Alene District

Mineral Ridge Restroom

Will Perry
Contact Person

Solar Outdoor Lighting
System Supplier

(208) 769-5000
Contact Number

Bureau of Land Management
System Installer

$4,000
PV System Cost

May 1997
Installation Date

System Components:

array	150 W Solarex
batteries	100 W Valve Regulated Deka
controller	Solar Outdoor Lighting
loads	Lights and fan

General Comments:

- Restrooms' interior lights and vent fan.

LIGHTING

NEVADA

Las Vegas District

Red Rocks Vista

Sal Estrada
Contact Person

(702) 647-5000
Contact Number

$10,000
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

October 1996
Installation Date

System Components:

array	768 W Solarex
batteries	10 kWh Flooded
controller	Prostar
inverter	700 W Inverter
loads	Restroom & Area Lights

General Comments:

- Central system with lights in restrooms and area lighting in parking lot.
- Occupancy sensors control lights in restroom timer controls area lights.

UTAH

Cedar City District

Ponderosa Grove Campground

Janaye Byergo
Contact Person

(801) 586-2401
Contact Number

$1,200
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

Under Construction
Installation Date

System Components:

array	60 W
batteries	Valve Regulated GNB
controller	C-12 Trace Engineering
loads	7 W Flourescent

General Comments:

- Two systems.

LIGHTING

UTAH

Richfield District-Fillmore Field Office

Sand Mountain

Ferris Clegg
Contact Person

(435) 896-1500
Contact Number

$3,000
PV System Cost

SEPCO
System Supplier

Silverado Company
System Installer

April 1998
Installation Date

System Components:

array	150 W Siemens
batteries	120 A-h Valve Regulated Geltech
controller	SEPCO
loads	13 W Lights (5)

General Comments:

- Lights are used for 4 hours per night.
- Building is used for spring, summer, and fall.

WYOMING

Rawlins District

Split Rock Interpretive Site

Roy Hanson
Contact Person

(307) 328-4317
Contact Number

$1,000
PV System Cost

Solar Depot
System Supplier

Bureau of Land Management
System Installer

July 1996
Installation Date

System Components:

array	50 W Solarex
batteries	9 A-h Valve Regulated
loads	Lights and Vent Fan

General Comments:

- Vent fan operates daylight hours only.
- Three small commercial light packages operate on motion sensors.

LIGHTING

CALIFORNIA

Redwood National Park

Redwood Creek

Bill Vines
Contact Person

(707) 464-6101
Contact Number

$5,408
PV System Cost

Applied Power Corporation
System Supplier

National Park Service
System Installer

September 1998
Installation Date

System Components:

array	512 W Solarex
batteries	2.4 kWh Valve Regulated GNB
controller	Ananda Powercenter 3
other	Lightning Arrestor
loads	24 V Lights, Controlled by Photo Cells and Occupant Sensors

General Comments:

- Powercenter 3 controller is expandable.
- Total load capacity is 136 W.

LIGHTING

COLORADO

Rocky Mountain National Park

Bear Lake

Ben Hawkins Contact Person	Sunelco System Supplier
(970) 586-1239 Contact Number	National Park Service System Installer
$15,000 (hardware only) PV System Cost	Under Construction Installation Date

System Components:

array	1,500 W
batteries	Valve Regulated GNB
loads	Restrooms and Contact Station

LIGHTING

ARIZONA

Tonto National Forest

Rattlesnake Fishing Dock

Andrew Dziobek Contact Person	Applied Power Corporation System Supplier
(602) 225-5319 Contact Number	Tonto National Forest System Installer
$4,000 PV System Cost	Under Construction Installation Date

System Components:

array	240 W Solarex MSX-60
batteries	12-5000 Sunlyte GNB
controller	C-12 Trace Engineering
loads	13 W Lights (4)

General Comments:

- Lights provide night-time access to floating fishing dock on Bartlett Reservoir.

LIGHTING

CALIFORNIA

Mendocino National Forest

Letts Lake Campground

Fred Bell Contact Person	Applied Power Corporation System Supplier
(530) 934-3316 Contact Number	Mendocino National Forest System Installer
$5,000 PV System Cost	Under Construction Installation Date

System Components:

array	384 W Solarex MSX-64
batteries	12-5000 Sunlyte GNB
controller	ProStar-30C Morningstar
loads	13 W Lights (3) and 100-CFM Fans (2)

General Comments:

- Two systems installed on vault toilets.

COLORADO

Grand Mesa National Forest

Ward Creek

Jan Fenner Contact Person	Johnson Electric Ltd. System Supplier
(970) 874-6600 Contact Number	Grand Mesa National Forest System Installer
$1,000 PV System Cost	July 1995 Installation Date

System Components:

array	60 W Solarex MSX-30 Lite
controller	Sun Selector
loads	Fans (2)

LIGHTING

GEORGIA

Chattahoochee National Forest

Lake Conasauga

Steve Ray
Contact Person

Applied Power Corporation
System Supplier

(770) 536-0541
Contact Number

Chattahoochee National Forest
System Installer

$3,000 (hardware only)
PV System Cost

July 1998
Installation Date

System Components:

array	120 W Solarex MSX-60
batteries	12-5000 Valve Regulated GNB
controller	ProStar-12 Morningstar
other	Zomeworks Support Structure
loads	16 W Thinlite Lights

General Comments:

- The site has two identical systems, one per toilet building.

WYOMING

Medicine Bow National Forest

Little Brooklyn Guard Station

Dean Lebeda
Contact Person

Atlantic Solar Products
System Supplier

(307) 745-2362
Contact Number

Medicine Bow National Forest
System Installer

$5,000
PV System Cost

September 1998
Installation Date

System Components:

array	256 W Solarex MSX-64
batteries	1.3 kWh Valve Regulated
controller	ProStar-30C Morningstar
inverter	TR-812 SB Trace Engineering
loads	Lights and Small Appliances

Water Pumping

Bureau of Land Management • National Park Service • USDA Forest Service

WATER PUMPING

ARIZONA

Phoenix District

Burro Creek Recreation Site

Bruce Asbjorn Contact Person	Photocomm System Supplier
(520) 757-3161 Contact Number	Bureau of Land Management System Installer
$6,700 PV System Cost	March 1998 Installation Date

System Components:

array	768 W Solarex
controller	Solarjack
loads	Solarjack Pump SCS-10-230

General Comments:

- 200 feet of total dynamic head, 2,400 gallons per day.
- Photovoltaic water supply system replaces existing propane engine generator.

WATER PUMPING

CALIFORNIA

Eagle Lake Resource Area

Table Mountain Well

Don Wannebo
Contact Person

Photocomm
System Supplier

(916) 257-0456
Contact Number

Bureau of Land Management
System Installer

$4,000 (hardware only)
PV System Cost

July 1998
Installation Date

System Components:

array	384 W Solarex MSX-64
controller	Solarjack
loads	Solarjack Pump SCS-2-280

General Comments:

- 200 feet of total dynamic head, 750 gallons per day.

COLORADO

Grand Junction District

East Desert Well

Gordon Gardunio
Contact Person

Photocomm
System Supplier

(970) 244-3186
Contact Number

Bureau of Land Management
System Installer

$13,000 (hardware only)
PV System Cost

May 1998
Installation Date

System Components:

array	1,536 W Solarex MSX-64
controller	Solarjack
other	Tracker
loads	Solarjack Pump SCS-8-400

General Comments:

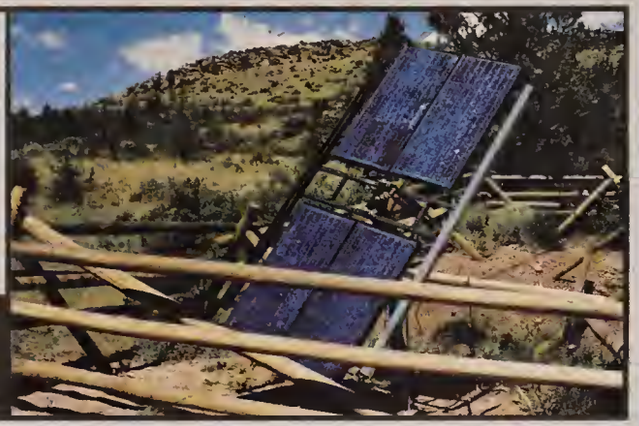
- 330 feet of total dynamic head, 3,200 gallons per day.
- Tracking array.
- Water for livestock use.

WATER PUMPING

MONTANA

Butte District

Mine Shaft Spring



Kent Satterlee
Contact Person

(406) 494-5059
Contact Number

$3,300 (hdwr. & pump only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

April 1996
Installation Date

System Components:

array	200 W Solarex
controller	Grundfos SA-100
loads	Grundfos Submersible Pump

General Comments:

- 15 feet of total dynamic head, 3000 gallons per day.
- Wildlife and livestock water pumping.
- System pumps water from abandoned mine shaft.

OREGON

Burns District

South Steens Campground

Fred McDonald
Contact Person

(541) 573-4453
Contact Number

$4,200 (hardware only)
PV System Cost

Photocomm
System Supplier

Bureau of Land Management
System Installer

July 1997
Installation Date

System Components:

array	200 W Duravolt
loads	Solarjack Pump

General Comments:

- Two identical systems in the campground.
- Pumps water from 200 ft. well.
- Water stored in a 600 gallon tank inside well house for camp ground use - no chlorination.

WATER PUMPING

OREGON

Spokane District

Washburn Lake

Gene Wehmeyer
Contact Person

(509) 665-2100
Contact Number

$6,000 (hardware only)
PV System Cost

Photocomm
System Supplier

Bureau of Land Management
System Installer

April 1996
Installation Date

System Components:

array	256 W Solarex
controller	Solarjack
other	Fixed Array
loads	Solarjack Pump SCS-18-160

General Comments:

- Water requirement 3,000 gallons per day at 30 feet total dynamic head. Trough storage 4,000 gallons for 3 days.
- Water is pumped from Washburn Lake and is stored in a ring trough system.
- Water is provided to livestock. By excluding livestock from the lakeshore, an endangered plant species is protected.

UTAH

Cedar City District

Holtz Creek

Paul Chamberlain
Contac Person

(801) 865-3053
Contact Number

$3,700 (hardware only)
PV System Cost

Photocomm
System Supplier

Bureau of Land Management
System Installer

September 1998
Installation Date

System Components:

array	384 W
controller	Solarjack
loads	Solarjack Pump SCS-10-90

General Comments:

- 65 feet total dynamic head, 4,500 per day.
- Seasonal use.
- This system pumps water out of a drainage for livestock consumption.

WATER PUMPING

UTAH

Cedar City District

Sheep Hollow

Mary Casady
Contact Person

Applied Power Corporation
System Supplier

(801) 644-2672
Contact Number

Bureau of Land Management
System Installer

$12,000
PV System Cost

May 1997
Installation Date

System Components:

array	1,024 W Solarex
batteries	1,590 A-h Gel-8-G-82
controller	20 Prostar
loads	Solarjack Diaphragm Pumps (2)

General Comments:

- 200 feet of total dynamic head.
- Low yield well–system pumps 2 gallons/minute, 24 hrs/day.
- Water is used by livestock and wildlife.
- Seasonal use.

UTAH

Moab District

Kane Gulch

Trent Duncan
Contact Person

Applied Power Corporation
System Supplier

(801) 539-4090
Contact Number

Bureau of Land Management
System Installer

$20,000
PV System Cost

Under Construction
Installation Date

System Components:

array	2,000 W Solarex
controller	Grundfos
loads	Grundfos Submersible Pump

General Comments:

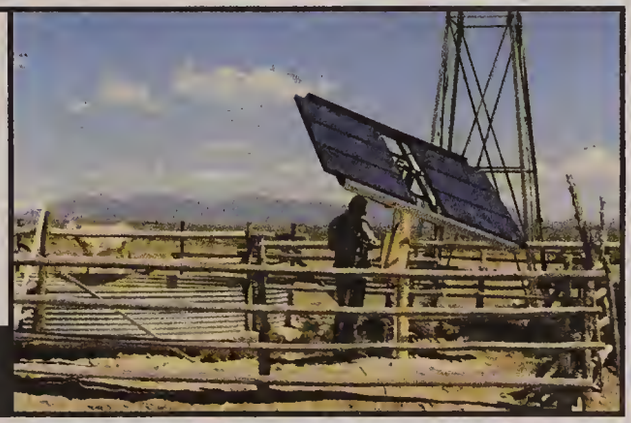
- 350 feet total dynamic head; 2000 gallons per day.
- 10,000 gallon storage tank.
- Seasonal use, April to November.

WATER PUMPING

UTAH

Richfield District-Fillmore Field Office

Delta #1



Tom Memmott
Contact Person

Photocomm
System Supplier

(435) 743-3100
Contact Number

Bureau of Land Management
System Installer

$3,900
PV System Cost

February 1998
Installation Date

System Components:

array	384 W Solarex
controller	Solarjack
loads	Solarjack Pump SCS-8-90

General Comments:

- 100 feet of total dynamic head, 2,000 gallons per day.
- Seasonal use for livestock water pumping.
- Mechanical wind pump replacement.

UTAH

Richfield District-Fillmore Field Office

Headquarters

Tom Memmott
Contact Person

Photocomm
System Supplier

(435) 743-3100
Contact Number

Bureau of Land Management
System Installer

$8,200
PV System Cost

Under Construction
Installation Date

System Components:

array	1,152 W Solarex
controller	Solarjack
loads	Solarjack Pump SCS-14-160

General Comments:

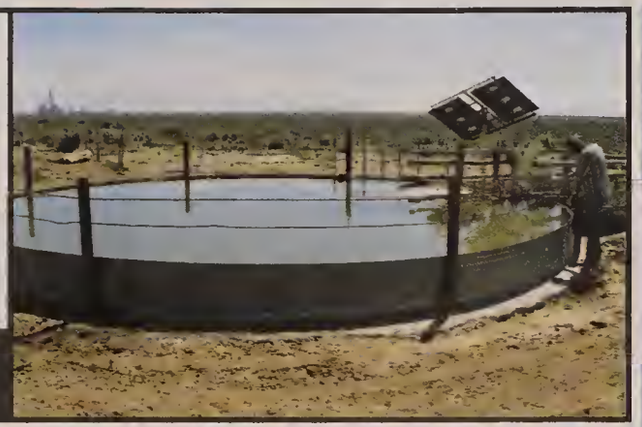
- 140 feet total dynamic head, 3,600 gallons per day.
- Two miles pipeline.
- Replaces propane engine generator.
- Water for livestock use.

WATER PUMPING

UTAH

Richfield District-Fillmore Field Office

IPA



Tom Memmott
Contact Person

Photocomm
System Supplier

(435) 743-3100
Contact Number

Bureau of Land Management
System Installer

$3,900
PV System Cost

September 1997
Installation Date

System Components:

array	384 W Solarex
controller	Solarjack
loads	Solarjack Pump SCS-8-190

General Comments:

- 100 feet of total dynamic head, 2,000 gallons per day.
- Seasonal use for livestock water pumping.
- Mechanical wind pump replacement.

UTAH

Richfield District-Fillmore Field Office

Sugarloaf

Tom Memmott
Contact Person

Photocomm
System Supplier

(435) 743-3100
Contact Number

Photocomm/BLM
System Installer

$3,000
PV System Cost

September 1997
Installation Date

System Components:

array	256 W Solarex
controller	Solarjack
other	Zomeworks Tracker
loads	Solarjack DC Submersible Pump

General Comments:

- Pumps 2,500 gallons per day from 50 feet of total dynamic head.
- Wind mechanical water pump replacement.
- Installation served as a training course for BLM personnel to install eight other pumping systems in BLM Districts.

WATER PUMPING

UTAH

Richfield District-Fillmore Field Office

Weather Station/ Rain Gauge

Larry Maxfield
Contact Person

Campbell Scientific
System Supplier

(801) 539-4059
Contact Number

Bureau of Land Management
System Installer

$200
PV System Cost

June 1997
Installation Date

System Components:

array	10 W Solarex
batteries	9 A-h Valve Regulated Gel
loads	Weather Station Rain Gauge

General Comments:

- Six identical systems provide power for data collecting equipment.

UTAH

Richfield District-Fillmore Field Office

12-A

Tom Memmott
Contact Person

Photocomm
System Supplier

(435) 743-3100
Contact Number

Bureau of Land Management
System Installer

$6,600
PV System Cost

Under Construction
Installation Date

System Components:

array	768 W Solarex
controller	Solarjack
loads	Solarjack Pump SCS-14-160

General Comments:

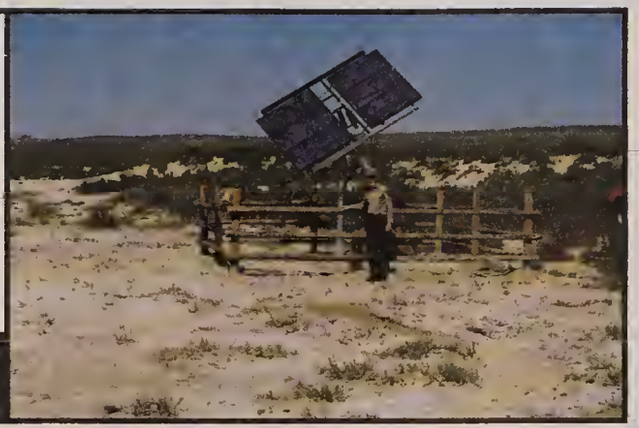
- 750 feet of total dynamic head, 3,000 gallons per day.

WATER PUMPING

UTAH

Salt Lake District

Salt Wells



Kirk Gardner
Contact Person

(801) 977-4397
Contact Number

$4,000 (hardware only)
PV System Cost

Photocomm
System Supplier

Bureau of Land Management
System Installer

September 1997
Installation Date

System Components:

array	384 W Solarex
controller	Solarjack
loads	Solarjack Pump SCS-14-70

General Comments:

- 20 feet total dynamic head; 10,000 gallons per day.

WYOMING

Casper District

Cottonwood Creek Drainage

Mike Brogan
Contact Person

(307) 234-1525
Contact Number

$4,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

September 1996
Installation Date

System Components:

array	120 W Solarex
batteries	12 V Valve Regulated GNB
loads	Groundwater Monitoring Equipment

General Comments:

- Project consists of six monitoring sites: one climate station, one large basin stream, and four small basin stream gauges.

WATER PUMPING

WYOMING

Casper District

Coyote Well

Mike Brogan
Contact Person

Photocomm
System Supplier

(307) 234-1525
Contact Number

Bureau of Land Management
System Installer

$6,000
PV System Cost

Under Construction
Installation Date

System Components:

array	800 W Solarex
controller	Solarjack
loads	Solarjack Pump

WYOMING

Casper District

Ed O. Taylor Game Range

Mike Brogan
Contact Person

Photocomm
System Supplier

(307) 234-1525
Contact Number

Bureau of Land Management
System Installer

$5,139 (hardware only)
PV System Cost

August 1997
Installation Date

System Components:

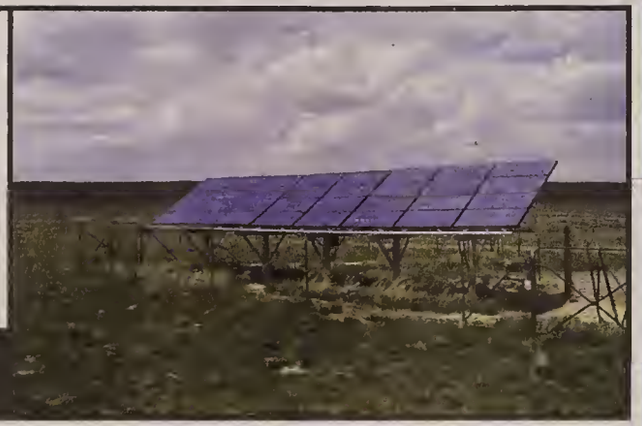
array	576 W Solarex
controller	Solarjack
loads	Solarjack Pump

WATER PUMPING

WYOMING

Casper District

Lonetree Well



Mike Brogan
Contact Person

(307) 234-1525
Contact Number

$15,000 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

August 1997
Installation Date

System Components:

array	1,920 W Solarex
controller	Grundfos
inverter	Grundfos SA-1500
loads	Grundfos Pump

General Comments:

- Groundwater pumping system with 230 feet of total head providing 6,000 gallons of water per day.
- Summer use for livestock and wildlife.
- Water distributed via 4 miles of pipeline to three pastures.

WYOMING

Casper District

Powder River Basin

Mike Brogan
Contact Person

(307) 234-1525
Contact Number

$1,200 (hardware only)
PV System Cost

Applied Power Corporation
System Supplier

Bureau of Land Management
System Installer

September 1996
Installation Date

System Components:

array	120 W Solarex
batteries	Valve Regulated GNB
loads	Groundwater Monitoring Equipment

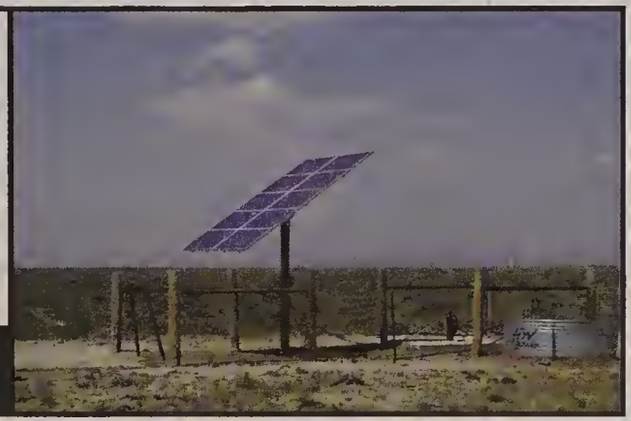
General Comments:

- Project includes solar powering of nine groundwater monitoring sites.
- Each site has a 10-watt panel and an 18 A-h battery powering datalogger equipment.
- Six sites are proposed to utilize radio telemetry, requiring additional 10-watt panel and a 10 A-h battery.

WATER PUMPING

WYOMING

Casper District



Rattlesnake #1

Mike Brogan
Contact Person

Photocomm
System Supplier

(307) 234-1525
Contact Number

Bureau of Land Management
System Installer

$7,615
PV System Cost

September 1997
Installation Date

System Components:

array	830 W Solarex
controller	Solarjack
loads	Solarjack Pump

General Comments:

- Groundwater pumping system with 430 feet total head providing 500 gallons of water per day.
- Summer use for livestock and wildlife.

WYOMING

Casper District

Rattlesnake #2

Mike Brogan
Contact Person

Applied Power Corporation
System Supplier

(307) 234-1525
Contact Number

Bureau of Land Management
System Installer

$12,000
PV System Cost

September 1997
Installation Date

System Components:

array	1,920 W Solarex
controller	Grundfos
inverter	Grundfos SA-1500
loads	Grundfos Pump

General Comments:

- Groundwater pumping system with 160 feet of total head providing 7,000 gallons of water per day.
- Summer use for livestock and wildlife.

WATER PUMPING

WYOMING

Casper District

Rattlesnake #3

Mike Brogan
Contact Person

Photocomm
System Supplier

(307) 234-1525
Contact Number

Bureau of Land Management
System Installer

$11,000
PV System Cost

August 1996
Installation Date

System Components:

array	1,328 W Solarex
controller	Solarjack
other	Zomeworks Trackers (2)
loads	Solarjack Pump

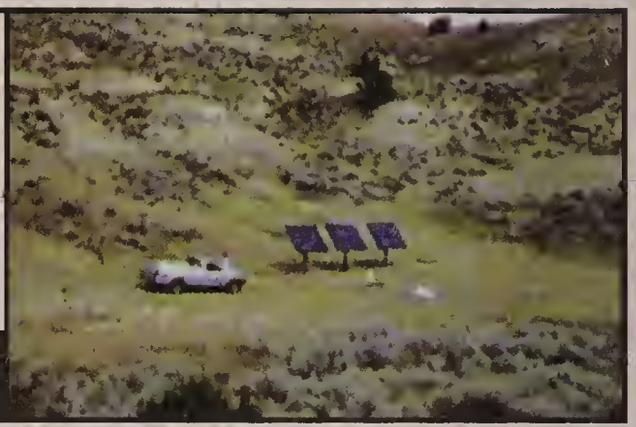
General Comments:

- Groundwater pumping system with 260 feet of total head providing 1,800 gallons of water per day.
- Summer use for livestock and wildlife.

WYOMING

Casper District

Wilderness Well



Mike Brogan
Contact Person

Southwest PV Systems
System Supplier

(307) 234-1525
Contact Number

Bureau of Land Management
System Installer

$10,000
PV System Cost

September 1997
Installation Date

System Components:

array	1,536 W Solarex
controller	USPC Aerovironment
loads	Grundfos Pump

General Comments:

- Groundwater pumping system with 160 feet total head providing 1,500 gallons of water per day.
- Winter use for livestock and wildlife.
- Project supporters also include Rocky Mountain Elk Foundation and Wyoming Game and Fish.

WATER PUMPING

WYOMING

Rawlins District

Chicken Springs

Andy Warren Contact Person	Applied Power Corporation System Supplier
(307) 328-4271 Contact Number	Bureau of Land Management System Installer
$7,000 PV System Cost	June 1997 Installation Date

System Components:

array	616 W Solarex MSX-77
controller	Grundfos SA-1500 Pump Controller
loads	Grundfos 1.5 HP Submersible Pump
other	Trailer Mounted

General Comments:

- Portable pumping system pumps from three different wells in the Red Desert of south-central Wyoming.
- Seasonal use from April thru October.
- Pumps 2,000 gallons of water per day.
- Supplies water for wild horses to improve riparian habitat on Stewart Creek.
- No problems during first two years of operation.

WATER PUMPING

CALIFORNIA

Yosemite National Park

Backcountry Trail Crew

Korwin Kirk Contact Person	Solar Electric Specialties System Supplier
(209) 372-0550 Contact Number	National Park Service System Installer
$4,600 PV System Cost	July 1996 Installation Date

System Components:

array	60 W Solarex MSX-30L
batteries	2.2 kWh Solar Cell Valve Regulated
controller	Prostar
loads	Shurflo 9300 Submersible Pump

General Comments:

- Two systems in use by trail maintenance crews in remote wilderness areas.
- Portable systems transported by mules.
- Systems avoid substantial damage to bank areas of lakes, streams and rivers associated with human and stock access.

WATER PUMPING

CALIFORNIA

Yosemite National Park

Merced Lake

Korwin Kirk
Contact Person

Solar Electric Specialties
System Supplier

(209) 372-0550
Contact Number

National Park Service
System Installer

$31,000
PV System Cost

October 1997
Installation Date

System Components:

array	660 W Siemens
batteries	Valve Regulated Gel-Type
inverter	U2624 Trace Engineering, 24 V
other	Tracker, Wattsun 12-Panel
loads	A.Y. McDonald Submersible Pump

General Comments:

- Total project cost was $51,000 including plumbing, pump, tankage, and hardware.
- Pump is used to pump septic tank effluent to disposal area.

FLORIDA

Biscayne National Park

Boca Chita

Sheryle Lindley
Contact Person

Benson Electric
System Supplier

(305) 247-7275
Contact Number

National Park Service
System Installer

$20,000
PV System Cost

April 1996
Installation Date

System Components:

array	900 W Solarex
batteries	Valve Regulated Johnson Controls
controller	Currin SPSC-36B
generator	2 kW Propane
loads	A.Y. McDonald Pump

WATER PUMPING

HAWAII

Haleakala National Park

Kipahulu

Frank Baublits Contact Person	Laf Young and Associates System Supplier
(808) 572-4420 Contact Number	Laf Young and Associates System Installer
$33,000 PV System Cost	August 1996 Installation Date

System Components:

array	2,000 W Siemens
loads	DC-Motor Driven Water Pump, 3 hp

General Comments:

- Pumps 3,000 gallons per day from head of 330 feet.
- Supplies water to visitor center and campground.

NORTH CAROLINA

Blue Ridge Parkway

Jeffress Park

Cliff Northrup Contact Person	Atlantic Solar Products System Supplier
(704) 298-2828 Contact Number	National Park Service System Installer
$15,000 PV System Cost	October 1997 Installation Date

System Components:

array	960 W Kyocera KC80
batteries	PVC-1295 Valve Regulated Sunmate
other	Solarjack PCB8-1208 Pump Controller
loads	Solarjack Well Pump, 1 hp

General Comments:

- Separate system for building lighting and chlorinator.

WATER PUMPING

ALABAMA

Tuskegee National Forest

Pine Glen Campground

William Yates Contact Person	Photocomm System Supplier
(334) 727-2652 Contact Number	Tuskegee National Forest System Installer
$20,000 PV System Cost	May 1996 Installation Date

System Components:

array	1,275 W Solavolt 8500
controller	A.Y. McDonald
loads	A.Y. McDonald Submersible DC 90 V Pump

WATER PUMPING

ARIZONA

Prescott National Forest

Antelope

Tim Mabery
Contact Person

Photocomm
System Supplier

(520) 567-4121
Contact Number

Tonto National Forest
System Installer

$8,000 (hardware only)
PV System Cost

August 1996
Installation Date

System Components:

array	1,080 W Solec S90
controller	SCS Solarjack
other	Zomeworks Solar Tracker
loads	Solarjack SCS II-210 Submersible Pump

ARIZONA

Tonto National Forest

Cholla Campground

Andrew Dziobek
Contact Person

Photocomm
System Supplier

(602) 225-5319
Contact Number

Tonto National Forest
System Installer

$40,000
PV System Cost

May 1990
Installation Date

System Components:

array	2,304 W Solarex MSX-64
controller	PCB8-180C Solarjack
other	Zomeworks Solar Trackers (3)
loads	3 H.P. 180 V DC Motor Jensen Pump

General Comments:

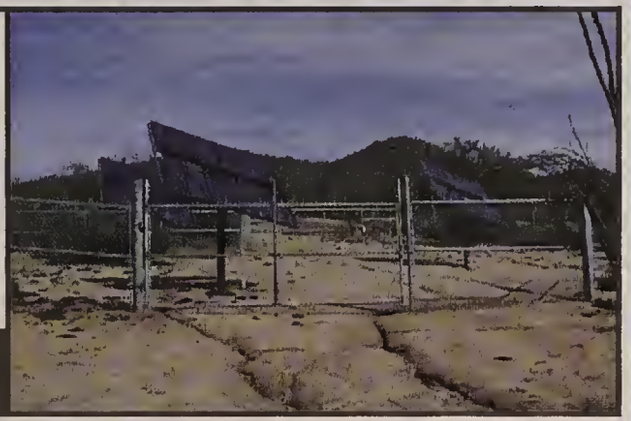
- The system provides water for full service campground: flush toilets, showers, hydrants for up to 2,000 people per day.

WATER PUMPING

ARIZONA

Tonto National Forest

Rattlesnake Cove



Andrew Dziobek
Contact Person

(602) 225-5319
Contact Number

$43,000
PV System Cost

Solar Exchange
System Supplier

Solar Exchange
System Installer

December 1995
Installation Date

System Components:

array	2,304 W Solarex MSX-64
controller	PCB8-180 Solarjack
other	Zomeworks Solar Trackers (3)
loads	Lights, Fans, Water Pump (Jack Pump)

General Comments:

- The system provides water for day use area site: flush toilets, hydrants for up to 420 people per day.

ARKANSAS

Ozark/St. Francis National Forest

Richland Creek Campground

Ken Clements
Contact Person

(501) 964-7251
Contact Number

$2,600
PV System Cost

Applied Power Corporation
System Supplier

Ozark/St. Francis National Forest
System Installer

May 1996
Installation Date

System Components:

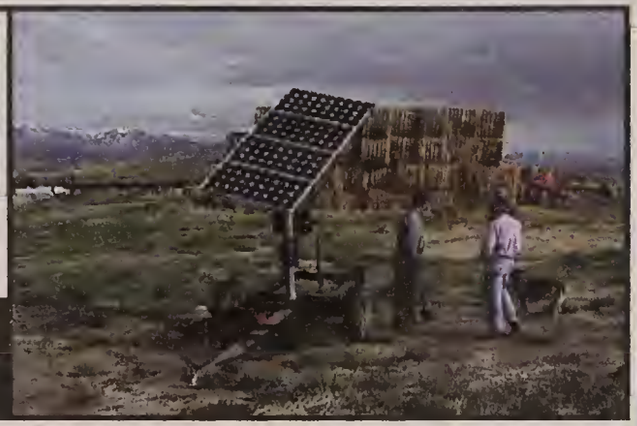
array	120 W Solarex MSX-60
batteries	12-5000 Valve Regulated GNB
controller	PPC-24 Specialty Concepts Inc.
other	Solarjack Pump SDS-D-228

WATER PUMPING

IDAHO

Sawtooth National Forest

Raft River Riparian Improvements



James Chard
Contact Person

(208) 678-0439
Contact Number

$6,000
PV System Cost

Dankoff Solar Products, Inc.
System Supplier

Dankoff Solar Products, Inc.
System Installer

October 1996
Installation Date

System Components:

array	280 W Solec S70
controller	#MK1/B Sunrise Submersible Solar Pump
other	Mechanical Tracker

KANSAS

Cimarron National Grassland

Cottonwood Picnic Ground

Tim Higgins
Contact Person

(316) 697-4621
Contact Number

$2,000
PV System Cost

Applied Power Corporation
System Supplier

Applied Power Corporation
System Installer

June 1996
Installation Date

System Components:

array	60 W Solarex MSX-60
batteries	12-5000X Valve Regulated GNB
controller	Prostar 20 Morningstar
loads	Shurflo 9300 Booster Pump

WATER PUMPING

UTAH

Manti-LaSal National Forest

Mammoth Station

Kathy O'Brian
Contact Person

(801) 637-2817
Contact Number

$12,000
PV System Cost

Applied Power Corporation
System Supplier

Applied Power Corporation
System Installer

October 1995
Installation Date

System Components:

array	462 W Solarex MSX-77
controller	Grundfos SA 400
other	Zomeworks Tracker
loads	Grundfos Submersible Pump

WEST VIRGINIA

Monongahela National Forest

Spruce Knob Campground

Mary Smakula
Contact Person

(304) 636-1800
Contact Number

$2,235 (hardware only)
PV System Cost

Atlantic Solar Products
System Supplier

Monongahela National Forest
System Installer

September 1998
Installation Date

System Components:

array	154 W Solarex MSX-77
loads	Shurflo 9300 Pump

General Comments:

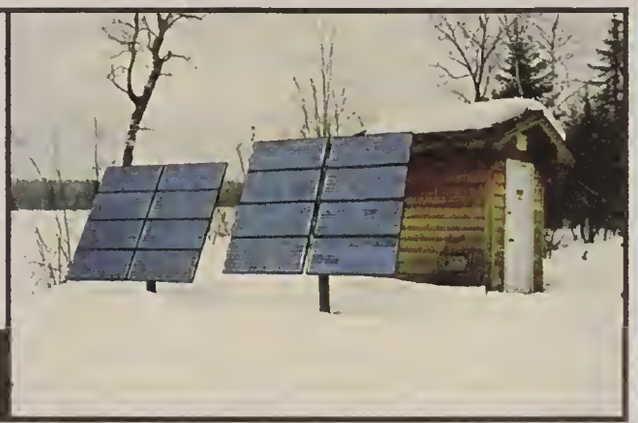
- System replaces water handpump.

WATER PUMPING

WISCONSIN

Chequamegon National Forest

Wilson Flowage



Art Johnston
Contact Person

Applied Power Corporation
System Supplier

(715) 762-5112
Contact Number

Chequamegon National Forest
System Installer

$10,000
PV System Cost

September 1996
Installation Date

System Components:

array	896 W Solarex MSX-56
batteries	1,600 A-h Absolyte IIP
controller	Powercenter 3 Ananda Power Technologies

General Comments:

- This system replaced diesel-powered lake aeration system.

Appendix II

Sample Procurement Specifications

Photovoltaic Power System
Photovoltaic Pumping System

PHOTOVOLTAIC POWER SYSTEM

PART 1: GENERAL

1.01 Summary:

A. Provide four photovoltaic (PV) power systems capable of supplying alternating current as specified complete with PV modules, support racks, power panel, inverter(s), equipment supports, related wiring and other items required ready for government installation. The PV power systems will be used to provide electrical power for remote field stations.

1.02 References:

A. National Fire Protection Association:

NFPA 70-96 National Electrical Code

1.03 Submittals:

A. General: Submittals include design computations, shop drawings, manufacturers' literature, as-built drawings, samples, and maintenance manuals. Deliver submittals to Trent Duncan, P.O Box 45155, Salt Lake City, UT 84145-0155, allow 5 working days for review.

B. Required submittals: Submit 2 copies of the following:

1. Electrical diagram and installation drawing of the complete photovoltaic power system showing all major components provided, conductor sizes, types and lengths.
2. Submit catalog data on all equipment with complete description of components; including photovoltaic modules, batteries, inverter, power panel, panelboard, mounting hardware, fuses, cables, conductors, connectors, and all other related equipment.
3. Detailed operation and maintenance manual of complete photovoltaic system as outlined in operation and maintenance data.

1.04 Quality Assurance:

A. Installation and equipment shall comply with all applicable codes, including but not limited to Articles 690, 480 and 250 of the 1996 NEC. All products that are listed, tested, identified, or labeled by UL, FM, ETL, or other national testing organization shall be used when available. Non-listed products are only permitted when listing does not exist.

1.05 Operation and Maintenance Data:

A. Data shall be on 8 1/2 inch by 11 inch sheet or manufacturer's standard catalog, suitable for side binding. Include full product documentation from manufacturer, installer, and/or supplier including, but not limited to, the following items:

1. POWER PANEL AND INVERTER:
   a. Owners manual with programming and installation instructions.
   b. Emergency operating procedures.
   c. Default program values and setpoints.
   d. Listing of field programmed variables and setpoints.
   e. Equipment wiring diagrams.
   f. Product model number, with name, address, and telephone number of local representative.
   g. Starting, operating, and shut down procedures. Include normal, seasonal, and emergency shut down procedures.
   h. Schedule of maintenance work, if any.
   I. Replacement parts list, including internal fuses.
   j. Warranty paperwork.

2. BATTERIES:
   a. Owners manual with installation, testing and charging instructions. Instructions shall be very specific as to how the batteries shall be maintained and operated in order to ensure long-life.
   b. Emergency operating procedures, including method of handling leaking or damaged battery.
   c. Recycling and salvage information.
   d. Product model number, with name, address, and telephone number of local representative.
   e. Starting, operating, shut down procedures. Include seasonal shut down and storage.
   f. Schedule of maintenance and testing.
   g. Warranty paperwork.
3. PHOTOVOLTAIC MODULES, PANELBOARDS, SWITCHES, CKT BREAKERS, AND BALANCE OF SYSTEM COMPONENTS:
   a. Owners manual or manufacturer's product data sheet, as applicable.
   b. Equipment wiring diagrams.
   c. Product model number, with name, address, and telephone number of local representative.
   d. Starting, operating, and shut down procedures. Include normal, emergency, and seasonal shut down procedures.
   e. Schedule of maintenance work, if any.
   f. Replacement parts list, including fuses, diodes, etc.
   g. Warranty paperwork.
   h. Cleaning agents and methods.

PART 2: PRODUCTS

2.01 Conductors:

A. As specified in this section, and as recommended by the equipment manufacturer. All conductors shall be sized based on a maximum 3% voltage drop.

2.02 Photovoltaic Modules:

A. General: Modules shall be UL, FM, or ETL listed. High-power type, with typical peak power of not less than 64 watts at standard test conditions. Voltage at peak power shall not be less than 17.5 Vdc. Current at peak power shall not be less than 3.66 amps. Model #MSX-64 as manufactured by Solarex or approved equal (see Equipment Summary Table for quantities).

B. Units shall have 20-year limited warranty guaranteeing:
   1. That no module will generate less than its specified minimum power when purchased.
   2. Continued power of at least 80% of guaranteed minimum power for twenty years.

C. Splices: All splices shall be made in approved junction boxes with an approved accessible splicing method. Terminal strips, and box-type pressure connectors are approved splicing methods. Twist-on "wire nuts" are not allowed.

D. Module Interconnections:
   1. Module interconnection wiring shall be 90°C type USE-RHH-RHW sunlight resistant, suitable for exposed use, tray cable, or liquid tight flexible metal conduit with appropriately rated conductors. Minimum size of #10 awg unless otherwise indicated.
   2. Interconnection wiring for series and parallel modules shall include a terminal strip, splicing block, or bus bar arrangement so that one source circuit can be disconnected without disconnecting the grounded conductor(s) of other source circuits. Daisy chaining modules together is not permitted.
   3. Array shall be divided into a minimum of two similar sized sub-arrays. Separate disconnects for each sub-array shall be provided at the powerpanel.
   4. A 6 amp bypass diode shall be provided for each module.
   5. Array grounding means shall be provided and shall be connected to the system ground.

E. Transition wiring: Wiring from the PV array (junction box of first module) to the combiner/jbox shall be 90°C type USE-RHH-RHW sunlight resistant wire as listed above. Minimum wire size of #10 awg unless otherwise indicated.

F. Mounting structure: Module mounting type shall be as specified in the Equipment Summary Table.
   1. Roof mounting structure shall be corrosion resistant and fabricated from aluminum alloys with stainless steel fasteners. Panel rails shall be as recommended by module manufacturer. Each structure shall be capable of holding 4 or 6 of the required modules at a tilt specified in the Equipment Summary Table.
   2. Pole mount structure: Module support structures shall be a fixed mount on the top of a SCH 40 pipe mast furnished and installed by the government. Each rack shall hold 8 or 12 modules in a fixed position. Mast spacing and size to be determined by the supplier. A combinerbox shall be affixed to each mast.

G. Array output wiring: Wiring from the combiner/J-box to the power panel shall be of the length specified in the equipment summary table and shall be 90°C type THHN. Required conduit size shall be specified by the supplier in the installation manual but need not be supplied.

2.03 Combiner/J-Box:

A. Hinged cover fiberglass NEMA 4X enclosure as manufactured by Hoffman or approved equal. Unit shall be sunlight resistant, and exhibit excellent chemical temperature, and weather resistance properties. Minimum size of 12" x 10" x 6" with screw cover, or as required per fill calculations.

2.04 Power Distribution Blocks:

A. As required for changing conductors sizes, combining multiple conductors, etc. Rated for voltage and current of system. As manufactured by ILSCO or approved equal.

2.05 Batteries:

A. General: The batteries shall have the following features and characteristics: (see Equipment Summary Table for quantities).

1. Deka 8G8D valve regulated battery or approved equal. 12 V per battery, minimum 265 amp/hour capacity at the 100 hour discharge rate, 400 cycles @ 50% depth of discharge.
2. Absolyte IIP 3-90A-23 valve regulated or approved equal. 6 V per battery, minimum 1300 amp/hour at the 100 hour discharge rate, 1200 cycles at 80% depth of discharge.

B. Cables: Factory crimped and soldered ring terminals for battery and inverter bolted connections. Cables shall have identification labels on each end for positive and negative terminal connections.

C. Terminals: Exposed battery terminals and cable connects must be protected with a cover against potential short-circuiting.

D. Rack: A battery rack(s) shall be provided which hold 4 batteries on a shelf and up to 3 shelves high (approximately 60" wide, 24" deep and 48" tall). Each shelf shall allow adequate clearance to access battery terminals. Rack shall be easily assembled in the field.

2.06 Disconnects/AC Panel Boards/Etc.:

A. General: Circuit breaker and switches shall be UL-Listed and DC rated for load controll. Disconnects and over current devices shall be mounted in approved boxes, enclosures, or panelboards. Requirements for internal configuration of these enclosures shall comply w/NEC Article 370, 373, 384 and applicable UL-Standards. Metal enclosures/ boxes shall be bonded to the grounding conductor.

1. Panelboards: Provide one AC panel board with each system. Provide equipment ground bar kit. Copper bus required. Provide a main disconnect consistent with inverter capacity and slots for 10 additional breakers. Provide conductors and conduit to facilitate panelboard mounting within 5 feet of powerpanel.
2. Circuit breaker enclosures: Breaker type "QO". Isolated neutral bus required. Include two 15 amp breakers in panelboard. Manufactured by Square-D or approved equal.

2.07 DC Load Center:

A. General: Model PAC-500AC-48 Vdc as manufactured by Pulse Energy Systems or approved equal. DC power center shall have at a minimum the following features:

1. Unit must be UL listed and compatible with 48 Vdc negative ground electrical system.
2. Unit shall comply with Article 690-5 of the 1996 NEC.
3. Battery/Inverter/Main disconnect: UL listed for up to 125 Vdc @ 250 amps per pole, 2 poles total.
5. Circuit breakers UL Listed, DC rated, 5K AIC at 65 Vdc.
6. PV charge controller & load disconnect contacts: Mercury displacement type, UL Listed,
7. Solar array disconnect with 30 amp breaker & red tripped indicator.
8. Battery cable terminal lugs up to 2-#250MCM.
9. Inverter cable terminal lugs up to 2/dual #250MCM.
10. Automatic array disconnect to eliminate night-time losses.
11. LED indicators for battery charging status.
12. Smartlight plus battery charge indicator.

B. ADDITIONAL FEATURES:

1. LCD digital display unit indicating array input current, load current, and battery voltage, PSM-3 or approved equal. Unit shall fit in door of DC load center cabinet.
2. Battery temperature compensator.
3. Lightning arrestor.
4. Factory calibration of battery charge controller for specified batteries.
5. Inverter bypass switch.
6. A permanent label shall be posted near the main PV disconnect switch that contains the following information per NEC 690-52:
   a. Operating current (system's maximum power current).

b. Open-circuit current.

c. Operating voltage (system's maximum power voltage)

d. Open-circuit voltage.

7. Furnish all other equipment, conductors, conduit, hardware and appurtenances as specified and/or required for a complete and operable system. A 3/4 inch sheet of exterior grade painted plywood shall be supplied with the mounting locations for DC load center and inverter clearly identified.

2.08 Inverter:

As manufactured by Trace Engineering, Arlington WA 98223 or approved equal. Inverter shall have at a minimum the following features:

1. ETL listed.
2. Nominal DC input voltage of 48 Vdc, AC output voltage (RMS) of 120 Vac @ 60 Hz.
3. Continuous power rating of 4000 VA or 5500 VA @ 20°C.
4. Peak efficiency of 96%.
5. Automatic AC transfer relay rated at 60 amps.
6. Maximum charging rate of 60 amps.

A. Programming: Unit shall be programmable, with separate user and setup menus. Unit shall have lighted back-lit LCD display on the control panel. The LCD display shall also indicate Inverter Amps, Input Amps, Load Amps, Battery Volts DC, and Inverter Volts AC. Control panel LED's shall report the status of Line-Tie, AC1-In, Bulk, Error, Inverting, AC2 IN, Float & Over current conditions. Recommended settings of each inverter set point shall be summarized in the operation and maintenance manual and on a laminated card to be placed near the inverter.

B. Operating modes: The inverter shall be capable of parallel operation with the existing AC generator. The inverter shall synchronize its output waveform with that of the AC input source. The inverter shall function in the following modes for this project:

1. Generator auto-start mode: Unit shall be capable of automatically starting the generator when battery voltage drops at or below 80% depth of discharge (as published by battery manufacturer). A "quiet-time" feature shall also be built into the unit to restrict generator operation during programmed time periods.
2. Generator support mode: When charging batteries from a generator, the inverter shall be capable of monitoring the generator's output voltage and current. If the voltage or current falls outside user adjustable limits, the inverter shall shed itself as a load and reverse power flow if necessary to assist the generator.
3. Battery charger mode: Unit shall have three stage temperature compensated charging algorithm for charging batteries. Unit shall have remote battery temperature probe. Unit shall operate in manual equalize mode with adjustable settings. Unit shall have automatic "Back-Off" system to prevent overloading of generator or nuisance tripping of input breakers.
4. Inverter mode: Unit shall have low battery cutout voltage with adjustable time delay to prevent damaging batteries. Unit shall have protection circuitry against over-current, short circuit, over temperature, low battery voltage and high battery voltage conditions.

2.09 Grounding:

A. Maintain a single point, negative ground throughout the PV system. Array shall be included in the grounding system.

B. System grounding shall be according to the NEC and include 15 feet of properly sized grounding conductor, ground rod and clamp.

2.10 Equipment Summary Table:

The following table provides a summary of the photovoltaic equipment required under this contract. Additional items and equipment are required to make the system complete and functional.

Site	Pariette	Chicken	Mt. Trumbull	Mud Flat
# Modules	16	20	40	32
Batteries Qty./ Model #	8/8G8D	8/8G8D	8/3-90A-23	12/8G8D
Inverter Size (continuous power rating)	4.0 kW	4.0 kW	11 kW (Dual Inverter)	5.5 kW
Output Voltage	120 Vac	120 Vac	120/240 Vac	120 Vac
Array Mount Tilt	Roof/20°[1]	Roof/64°[1]	Pole	Pole
Array Output Cable Length	50 feet	35 feet	60 feet	60 feet
Battery Cable Length	15 feet	10 feet	15 feet	10 feet
Delivery Location	Vernal Field Office 170 S. 500 East Vernal, UT 84078	Tok Field Office P.O. Box 309 Tok, Alaska 99780	Arizona Strip Field Office 345 E. Riverside Dr. St. George, UT 84790	Boise Field Office 3948 Development Ave. Boise, ID 83705-5389
Contact	John Wood (435) 781-4400	Kent Davis (907) 883-5121	Ken Moore (435) 628-4491	Bob Stucker (208) 384-3300

[1]Elevate mount 6 inches above roof to clear standing seam of metal roof.

PHOTOVOLTAIC PUMPING SYSTEM

C .1 GENERAL

C.1.1 Summary:

A. Provide photovoltaic (PV) water pump systems capable of supplying the specified quantities of water complete with modules, support rack, disconnects, controller, motor/pump unit, related wiring and other items required ready for government installation. The systems shall operate automatically, with no user attention during daylight hours. They shall pump water proportional to the amount of incident sunlight.

B. Work data: All pumps will be located within 50 miles of Delta, Utah except pump #6, Holtz Creek, which will be located near Cedar City, Utah, pump #7 which will be located near Grand Junction, Colorado, pump #8 which will be located near Salt Lake City, Utah, and pump #9 which will be located near Kingman, AZ.

Name	TDH	Minimum GPD	Season
1. 12-A	75'	3,000	Winter
2. Headquarters	20'	3,600	Summer
3. Sugarloaf	50'	2,500	Summer
4. Delta #1	100'	2,000	Summer
5. IPA	100'	2,000	Summer
6. Holtz Creek	65'	4,500	Summer
7. East Desert	330'	3,200	April-Sept.
8. Salt Wells	20'	10,000	Summer
9. Burro Creek	200'	2,400	Summer

C.1.2 Submittals:

A. General: Submittals shall be sent to Contracting Officer, P.O. Box 45155, Salt Lake City, UT 84145-0155. Submittals shall be approved by the Contracting Officer prior to delivery of systems.

B. Manuals: An installation, operating, maintenance and user manual shall be included with each system.

1. Installation, operating and maintenance instructions: Submit 1 copy of installation, operation and maintenance manuals, intended for service personnel. The manuals shall include recommended acceptance test procedures, a schedule of preventative maintenance procedures, a suggested spare parts list, a trouble shooting index, all component manufacturers specifications sheets, recommended drop caple and drop pipe size, and a set of mechanical drawings and electrical schematics. These drawings must include identification of all PV system components, electrical interconnections, conductor types, sizes, and color coding, fuse, circuit breakers and switch types/ratings, and any other related information. The system sizing and performance (estimated daily water output in gallons per day) calculations over a 12 month period shall also be included.

2. Users manual: Submit 1 copy of a separate users manual intended for system operator. The manual must include all information pertaining to the proper use of the system, including a basic system theory of operation, specific instructions on the use of the system monitoring equipment, a user trouble shooting guide, and a discussion on any load limitations.

C.2 PRODUCTS

C.2.1 Equipment:

A. General: PV pumping system shall meet the requirements of the NEC articles 690 and all other applicable articles to ensure installer/operator safety. Equipment shall be UL listed where available. All equipment and conductors shall be capable of operating in temperatures of -20°C to 45°C. PV pumping system shall also include the following:

1. A manual electrical disconnect (safety switch) that shuts off power from the PV power supply shall include hardware to attach to an array support pole above or below the pump controller.

2. System shall be grounded according to the NEC articles 250 and 690.

B. Photovoltaic power supply: Power supply shall be complete with PV array, mounting structure, controller, and any balance of system hardware and conductors required for "above ground" installation. The power supply shall be sized by supplier and be capable of supplying the pump controller proper current and voltage. In each case, the array will be installed within 30 feet of the well head.

1. Photovoltaic modules shall be UL listed and include a minimum 10 year 90% power rating warranty. System #7 shall include a minimum of 1920 rated array watts.
2. Module support structures shall mount either on the top or side of a SCH 40 pipe mast furnished and installed by the government. Either passive tracking or fixed array are acceptable except for system #7 which shall include passive tracking racks as manufactured by Zomeworks or equal. Mast spacing and size to be determined by the supplier.
3. Bypass diodes shall be installed in modules according to module manufacturers requirements.
4. Power supplies must display hazard warning signs where there is a high voltage danger to the installer/operator.
5. Controller shall be designed to work specifically with manufacturers motor/pump unit. Controller shall include hardware required to mount directly to array support pole and shall be in a raintight NEMA enclosure. Controller shall include on/off switch and connection for external float switch.

C. Submersible motor/pump unit: motor/pump unit shall be multistage, centrifuge type, brushless motor, capable of operating submersed in 50 feet of water. System #7 shall be capable of delivering a maximum of 9.7 gpm and shall include a Grundfos SP2A-15PM submersible pump/motor or equal.

1. Pump and motor materials exposed to water shall be corrosion resistant, and require no maintenance for a 10 year period or more.
2. The pump shall be internally threaded and have a built in check valve and pump inlet screen.
3. Provide two waterproof splice connection kits per pump to connect pump leads to government furnished drop cable.

C.3 DELIVERY

A. Delivery schedule: Systems shall be delivered acording to the following schedule:

System #	Location
1-5	Fillmore Field Office Attn: Tom Memmott (801) 322-3109 35 East 500 North Fillmore, Utah 84631
6	Cedar City Field Office Attn: Paul Chamberlin (801) 865-3014 176 D. L. Sargent Drive Cedar City, Utah 84720
7	Grand Junction District Office Attn: Gordon Gardunio (970) 244-3186 2815 H Road Grand Junction, CO 81506
8	Salt Lake District Office Attn: Riley Draper (801) 977-4300 2370 South 2300 West Salt Lake City, UT 84119
9	Kingman District Office Attn: Bruce Asbjorn (520) 692-4400 2475 Beverly Ave. Kingman, AZ 86401

Appendix III

Index

FACILITY POWER

BUREAU OF LAND MANAGEMENT

FACILITY POWER

FACILITY POWER

USDA FOREST SERVICE

LIGHTING

BUREAU OF LAND MANAGEMENT

NATIONAL PARK SERVICE

USDA FOREST SERVICE

WATER PUMPING

BUREAU OF LAND MANAGEMENT

WATER PUMPING

NATIONAL PARK SERVICE

USDA FOREST SERVICE

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