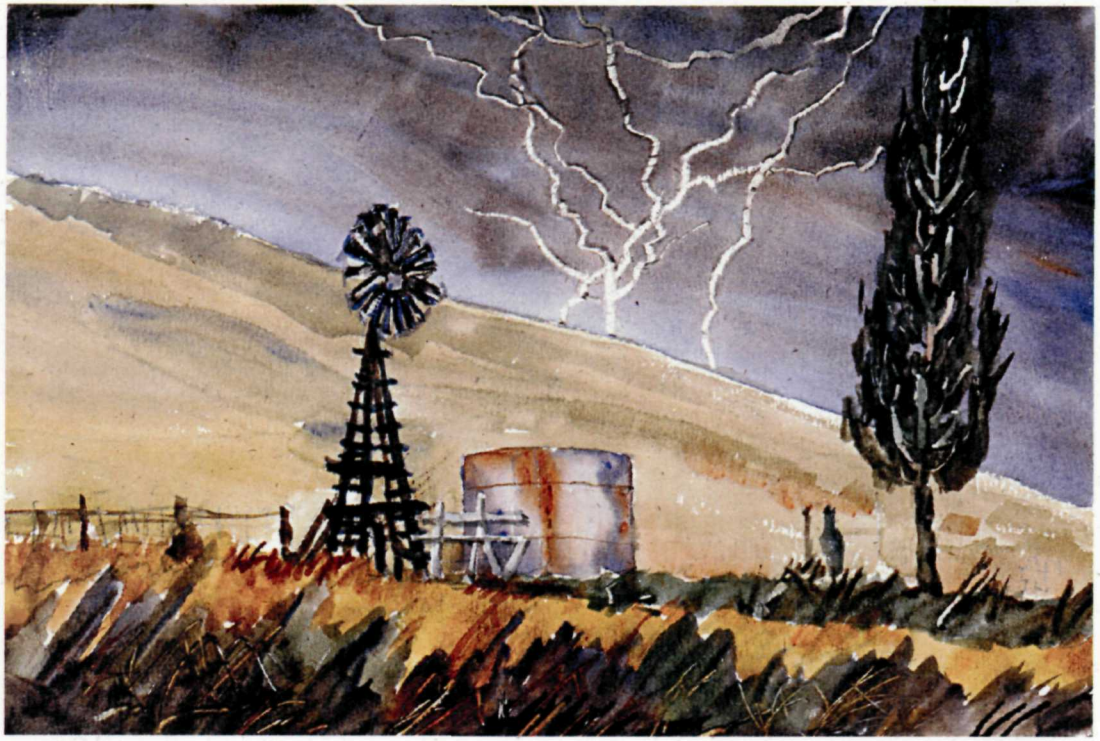


RENEW THE PARKS

Renewable Energy in the National Park Service

Photovoltaic Systems

PHOTOVOLTAIC DESIGN ASSISTANCE CENTER • SANDIA •

NATIONAL PARK SERVICE

Printed on Recycled Paper

Cover Watercolor by Rich Giamberdine

RENEW THE PARKS

Renewable Energy in the National Park Service

Photovoltaic Systems

May 1998

United States Department of the Interior • National Park Service • Denver Service Center

CONTENTS

RENEWABLE ENERGY IN THE NATIONAL PARK SERVICE

INTRODUCTION

The National Park Service is the steward of some of the world's finest natural and cultural resources and is regarded by many people as the premier resource conservation agency in the United States if not the world. The mission of the National Park Service is clearly defined in the organic act of 1916.

> *to conserve the scenery and the natural and historic objects and the wildlife therein, and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations.*

This strong mandate and policy direction has always emphasized protecting and conserving this country's cultural and natural resources while providing the visiting public with opportunities to learn about these resources. When the National Park Service celebrated its 75th anniversary in 1991, it charted a course for how it would accomplish its mission into the next century. The resulting vision document titled *National Parks for the 21st Century: The Vail Agenda*, provides strategic objectives and directions for the future management of the National Park Service. Incorporating sustainability and sustainable design was recommended in *The Vail Agenda* as one method of meeting challenges that currently face the National Park Service.

The Park Service defines sustainable design as a design that meets the needs of the present without compromising the ability of future generations to meet their own needs. Many people feel this definition bears a striking resemblance to the organic act — the founding legislation for the National Park Service.

Sustainability and sustainable design also have received commitment from the administration as evidenced by the establishment of the President's Council on Sustainable Development, the signing of the Climate Change Action Plan, the implementation of Executive Order 12902 ("Energy Efficiency and Water Conservation at Federal Facilities"), and the establishment of Technology for a Sustainable Future.

An important part of the recently approved NPS *Strategic Plan* is to achieve sustainability in all national park operations and development. In October 1992 the National Park Service released *Guiding Principles of Sustainable Design* to provide a framework for achieving sustainability in all activities.

One of the main components of sustainable design is energy management. The use of renewable energy sources, such as photovoltaics (PV), is a key strategy for energy management. In fall 1992 the Denver Service Center of the National Park Service contacted the Photovoltaic Design Assistance Center (PVDAC) at Sandia National Laboratories in Albuquerque, New Mexico, to provide technical training to interested NPS professionals. As a result of this initial session, a partnership was developed to promote energy conservation and increase the use of renewable energy at NPS facilities. An equally important objective was to provide educational opportunities to park visitors in the specific areas of energy conservation, renewable energy, and sustainability in general. In fall 1993 a partnership agreement was funded by the Photovoltaic Design Assistance Center to survey all national park system units to

- locate existing PV systems and determine their function
- assess the satisfaction with existing PV systems
- identify potential future PV projects
- identify barriers to the use of PV power and propose solutions

METHODOLOGY

In February 1994 NPS Deputy Director John Reynolds transmitted to each national park system field unit a survey questionnaire concerning existing PV use and other sustainable practices, the potential for future PV use, and barriers to that potential use. A sample survey questionnaire is included as appendix A. There are 368 field units, which include national parks, national monuments, national historic sites, national seashores, national recreation areas, etc. These field units will hereafter be referred to in aggregate as parks. However, a particular management unit might manage multiple field units. It is

estimated that for the 368 field units surveyed, 278 management units exist; 201 management units responded to the survey.

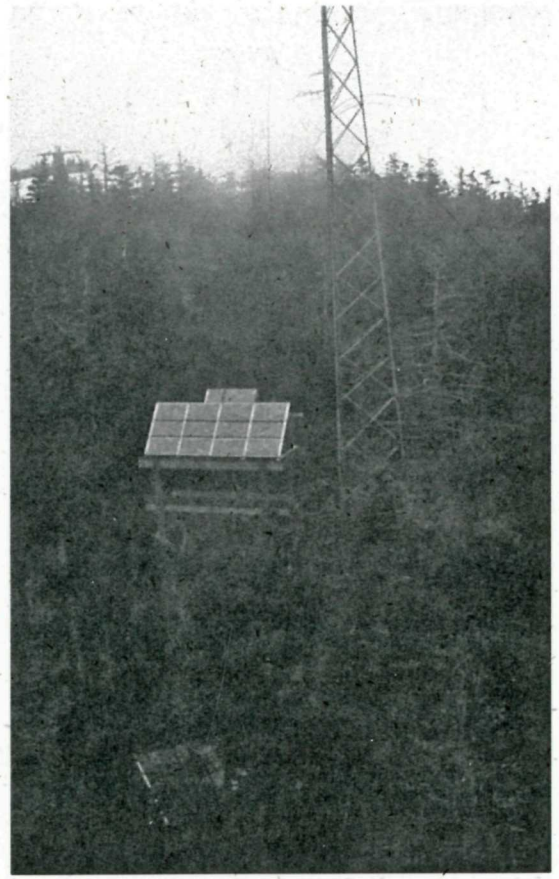
Information from the surveys was used to create a database and forms the foundation for this report. Information in the database concerning existing PV systems will be integrated into the National Park Service's Inventory and Condition Assessment Program (ICAP) once that program is deployed servicewide. The Denver Service Center will continue to update and maintain the listing for future PV projects.

Follow-up phase II surveys were sent to those parks that identified potential PV projects of a larger scale. The purpose of the phase II surveys was to roughly determine the size of potential PV projects so that a cost estimate for programming could be prepared by the Denver Service Center. The goal of this data collection and cost estimating effort is to formulate a five-year program to expand the use of renewable energy in the parks. Under this new program called "Renew the Parks," park personnel will be trained on renewable energy and the creation of partnerships will be encouraged.

EXISTING PHOTOVOLTAIC USE IN THE NATIONAL PARK SERVICE

According to the survey there are at least 455 existing PV systems in use today. Based on subsequent visits to parks, there is a likelihood that not all small PV systems were accurately included in the survey responses. It is estimated that more than 600 PV systems are currently in use in the Park Service. Appendix B contains a listing of all the reported PV systems currently in use.

The use of PV systems by the National Park Service is occurring over a broad geographical area and in many climatic conditions. Historically, PV energy was first used in communication systems at remote locations, such as radio repeater sites on mountaintops. Later PV energy was found to be effective in supplying power for resource monitoring equipment. Most recently PV systems have been used to meet larger power needs such as water pumping, remote facility power, and indoor/outdoor lighting. Using PV energy for ventilation at



Typical use of photovoltaic energy to power a radio repeater for Park Service radio communications, Great Smoky Mountains National Park

campground restrooms, composting toilets, and vault toilets also is a significant use.

One exception to this historical progression is the PV system at Natural Bridges National Monument. At the time of installation by the National Park Service and the Department of Energy in 1980, this 100kW system was the largest stand-alone system in the United States. This system provided reliable operation, meeting the electrical loads of the visitor center and ranger residences until 1989 when the useful life of the batteries ended. In 1992 the batteries were replaced, and the system returned to service as a PV hybrid, providing a clean and noiseless source of power that is compatible with the sustainable operation of the park.

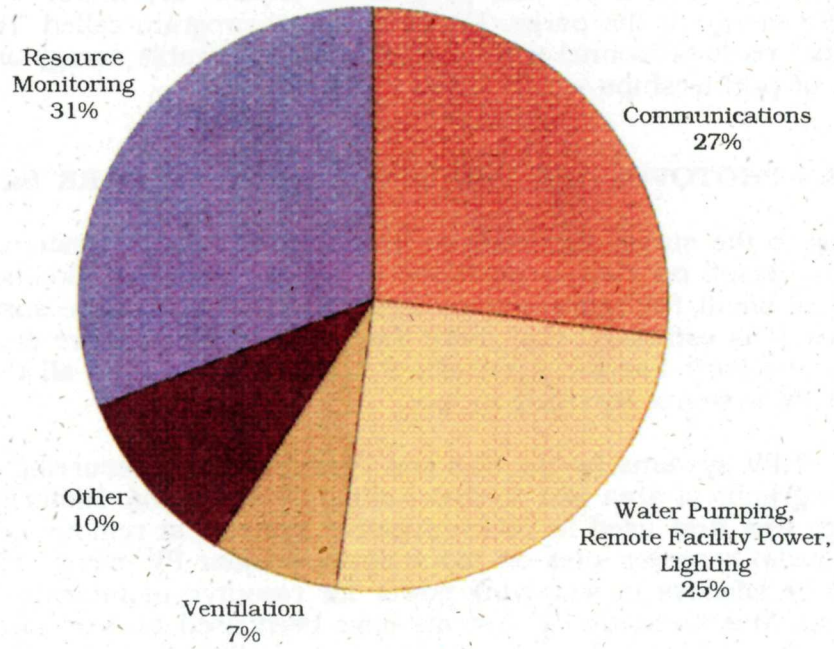


Figure 1: Distribution of Existing PV Uses in the National Park Service

The majority (61%) of the existing PV systems are used on a year-round basis; 34% are used seasonally, and the remaining systems (5%) have intermittent applications or have been abandoned. The ages of existing PV systems are listed below.

- 23% less than two years
- 28% two to less than five years
- 34% five to less than 10 years
- 15% 10 years or more

A majority of the power demands are less than 1 kilowatt (kW).

Remote monitoring is a very powerful tool in natural resource protection and management. Seismic, water level, water flow, snow depth, atmospheric conditions, and wildlife observations are some of the applications where PV energy is used.

. . . 97% of the existing PV systems met their use objectives.

Using PV power to pump water is an especially attractive option at NPS facilities. Photographs on the following pages depict some of these PV applications.

EVALUATION OF EXISTING PHOTOVOLTAIC SYSTEMS

As part of the survey, parks with existing PV systems were asked to evaluate each component of the PV system and the system as a whole (see appendix A).

Responses indicated that 97% of the existing PV systems met their use objectives. Problems associated with the remaining systems (3%) included

- operating errors (turning system off in winter)
- poor design (insufficient charging capacity and/or battery storage)
- component failure
- photovoltaic panels stolen and/or vandalized

At Everglades National Park, a 10-watt PV panel is used to power remote hydrologic monitoring equipment. The monitoring equipment shown measures water depth on an hourly basis and downloads the daily record to a central NPS research facility.

Only two cases of vandalism were reported; however, five cases of theft were reported. Theft of PV panels is a growing problem, especially at remote locations. As the monetary value of PV panels becomes increasingly known, theft is expected to increase unless mitigating measures are implemented. Measures may include carefully selecting locations at unsupervised sites and using vandal-resistant connectors and fasteners.

In addition to the 3% of PV systems that failed to meet their use objective(s), respondents indicated that another 3% of the PV systems evaluated performed poorly in one or more component areas. Even though these PV systems experienced component problems, the parks surveyed felt the use objectives for these slightly flawed systems were being met.

Component problems identified by the parks included battery problems (19 systems), PV panel problems (10 systems), and controller problems (eight systems).

There was no correlation between the age of the troubled systems and problems they were experiencing. It was originally thought that older systems would exhibit more problems; however, most of the problem systems were evenly distributed between the two- to four-year category and the five- to nine-year category. It should be noted that only three systems less than two years old were reported to have any problems.

Survey results concerning estimated annual operations and maintenance (O&M) costs for PV systems were broken into three categories: less than expected or no O&M costs (39%), expected O&M costs (60%), and greater than expected O&M costs (1%).

BARRIERS

Of the 201 PV survey responses received, 151 identified at least one barrier for using a PV system. Most respondents identified multiple barriers. Parks without existing PV systems had more concerns (38%) than those parks with existing PV systems.

The perceived barriers to the use of photovoltaic power are shown in figure 2.

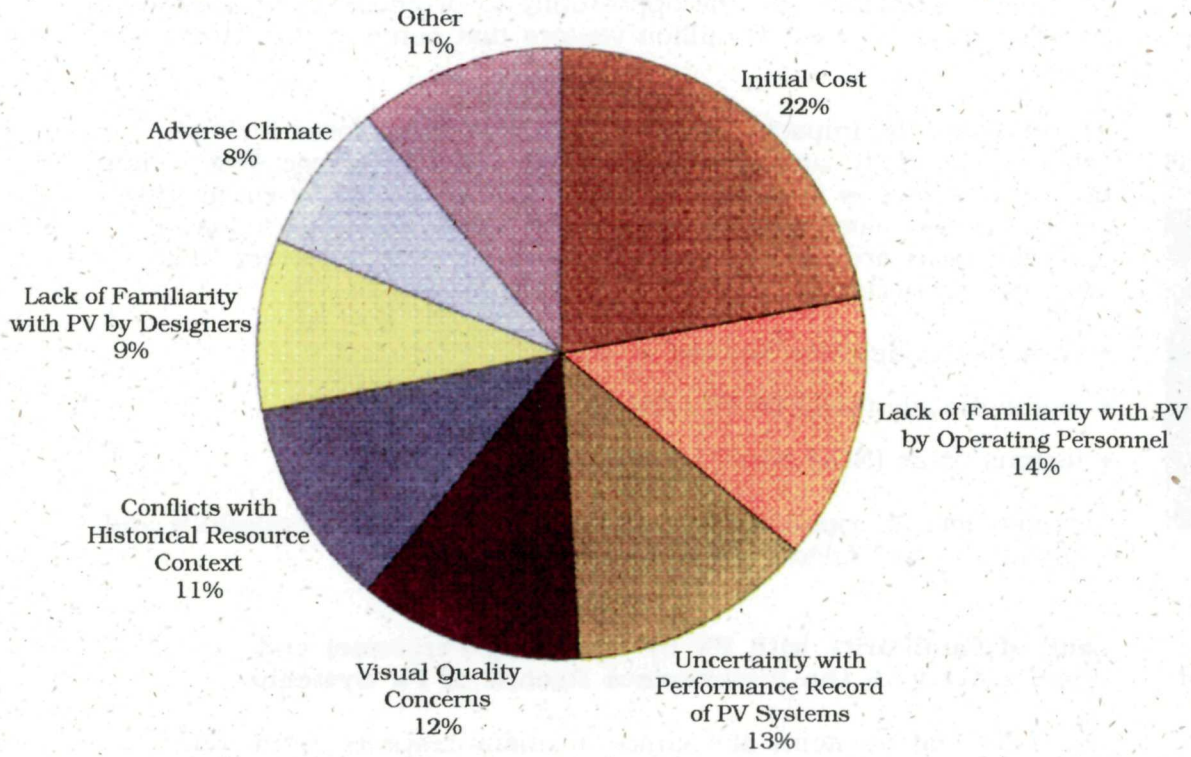


Figure 2: Barriers to the Use of Photovoltaic Power

Initial Cost

According to the survey, the initial cost of PV systems was the biggest concern. To overcome this barrier, the National Park Service will have to form partnerships with other agencies and groups. Potential partners include the Department of Energy, Sandia National Laboratories, the National Renewable Energy Laboratory, the Environmental Protection Agency, environmental groups, and the PV industry. The Department of Energy's Federal Energy Management Program has been established to

On the remote north rim of the Black Canyon of the Gunnison, photovoltaics is the primary power source for a combination visitor contact station and ranger residence. Note how the PV system has been integrated into the site to enhance visual quality.

fund viable energy and water conservation projects as well as renewable energy projects undertaken by federal agencies. The National Park Service brings to any potential partnership 75 years of environmental education experience and the opportunity to promote energy innovation and education to the 270 million visitors that come to the parks each year.

To reflect all the impacts (including costs) of using fossil fuels to generate electricity, and in support of the Climate Change Action Plan, the Park Service is interested in improving air quality by eliminating emissions associated with the burning of fossil fuels. The following emission costs are used as part of life-cycle costing for every NPS development decision:

- carbon dioxide (CO_2 $8 / ton
- sulfur dioxide (SO_2) $0.75 / pound
- nitrous oxide (NO_x) $3.40 / pound

For complete information on quantifying environmental emissions and applying the cost factors see appendix D.

Lack of Familiarity with PV by Operating Personnel and Uncertainty with the Performance Record of PV Systems

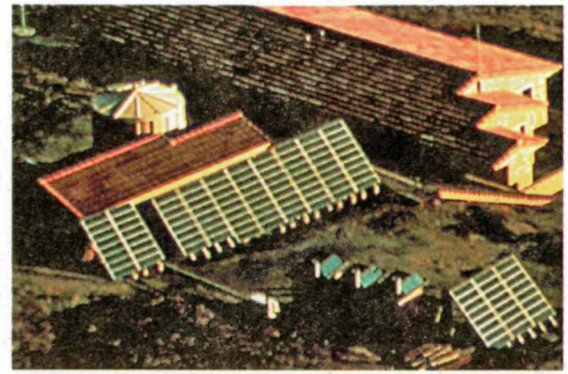
These two barrier items are similar in many respects. Common methods in achieving technology transfer can be applied here. Technical presentations at national, regional, and park conferences and meetings are an effective way to introduce PV technology in a general format. Sandia's Photovoltaic Design Assistance Center and the National Renewable Energy Laboratory can provide excellent overview presentations. These overview presentations need to feature park areas that are currently using PV energy. Personnel from the following areas have had good operating experiences with larger PV applications (remote facility power and water pumping) and are important in communicating the performance record of PV systems to their NPS colleagues.

Channel Islands	Natural Bridges	Rocky Mountain
Sleeping Bear Dunes	Glen Canyon	Great Basin
Death Valley	Capitol Reef	Yosemite
Black Canyon of the Gunnison	Crater Lake	Wrangell-St.Elias

Technical training is required to provide a fundamental technical foundation for design and O&M personnel. This formal training can be provided by a number of outside sources. Photovoltaic site assessments provide site-specific recommendations concerning system feasibility. Communications between NPS users and O&M personnel regarding PV power is also promoted in photovoltaic site assessments. Sandia's Photovoltaic Design Assistance Center has provided outstanding service in this area.

One final barrier that must be overcome in this category is the association of PV performance with the performance of early solar thermal for hot water heating. In the late 1970s and early 1980s the National Park Service undertook an initiative to expand the use of solar thermal for domestic hot water heating. This initiative was very similar to the current renewable energy initiative with hopefully one exception — results. Many of the solar hot water systems installed during this time are no longer functional and have been removed or disconnected and left on rooftops as a testament to an unsuccessful solar thermal program.

It is paramount that PV systems deliver the results promised on a sustained basis. Some field personnel are very skeptical of renewable energy based on this past experience with solar thermal.



Photovoltaic power is used on a large scale at Channel Islands National Park to provide electricity at several sites. On Santa Barbara Island, a 5 kW system provides power to a new building that contains a visitor contact station, maintenance shop, and residence.

This PV powered water pumping system at Sleeping Bear Dunes National Lakeshore provides several hundred gallons per day at system pressures of 20–40 psi. Because this is a pressure tank system, batteries are required to provide 24-hour water

This water pumping system at Capitol Reef National Park meets the peak season demand of 20,000 gallons per day at a total dynamic head of 35 feet. This system uses gravity water storage tanks, which eliminates the need for electrical battery storage. The system is further enhanced by the use of low-flow plumbing fixtures at facilities, which have significantly reduced the total volume of pumped water.

Visual Quality Concerns and Conflicts with Historic Resources

These two barriers are significant because they impact the basic management objectives of the National Park Service — "to leave them [cultural and natural resources] unimpaired for the enjoyment of future generations."

To overcome these barriers, several action plans are offered. Small PV systems associated with smaller electrical loads will have very little impact on visual quality. The installation of large PV systems in developed areas will have a visible impact. This impact needs to be viewed as an opportunity to interpret the use of renewable energy and the positive impacts this use has on the global environment. The National Park Service has a mandate as well as a tremendous opportunity to educate the 270 million visitors that enter the parks each year on the use of sustainable technologies such as renewable energy.

For large PV systems in the more sensitive developed areas, the Park Service has the capability, at the Denver Service Center, to use computer visual simulation to show how the developed area would look after the proposed PV system has been constructed. The process involved to achieve this depiction is to initially design (size) the PV system, obtain a real-time photograph of the developed area from a critical viewpoint, and superimpose, to scale, the PV system on the site photograph. This technique enables siting modifications to be enacted and provides park management with a clear perspective of what the completed facility would look like.

Not all PV systems need to be constructed on or near existing facilities; however, there are certain technical advantages in having the PV systems near the power use point. Photovoltaic systems can be located away from critical areas to reduce visual impacts and/or take advantage of increased exposure to the sun. Depending on the voltage used, the balance of system (BOS) components such as batteries, charge controllers, inverters, etc., may also have to be remotely located. Large PV systems may also be split into several smaller systems to mitigate visual quality concerns.

FUTURE USE OF PHOTOVOLTAIC POWER

As part of the survey, parks were requested to indicate proposed PV projects (see appendix A). It was anticipated that parks would identify about 100–150 future PV projects. After all the data was compiled, 643 future PV projects were identified by 125 parks. The breakdown by use category is shown in figure 3.

Figure 3 indicates that the percentage of proposed use anticipated for remote facility power (water pumping and lighting) is increasing compared to the historical big users of PV power (communication and resource monitoring). Remote facility power requires larger PV systems than communications and resource monitoring. The implication may be

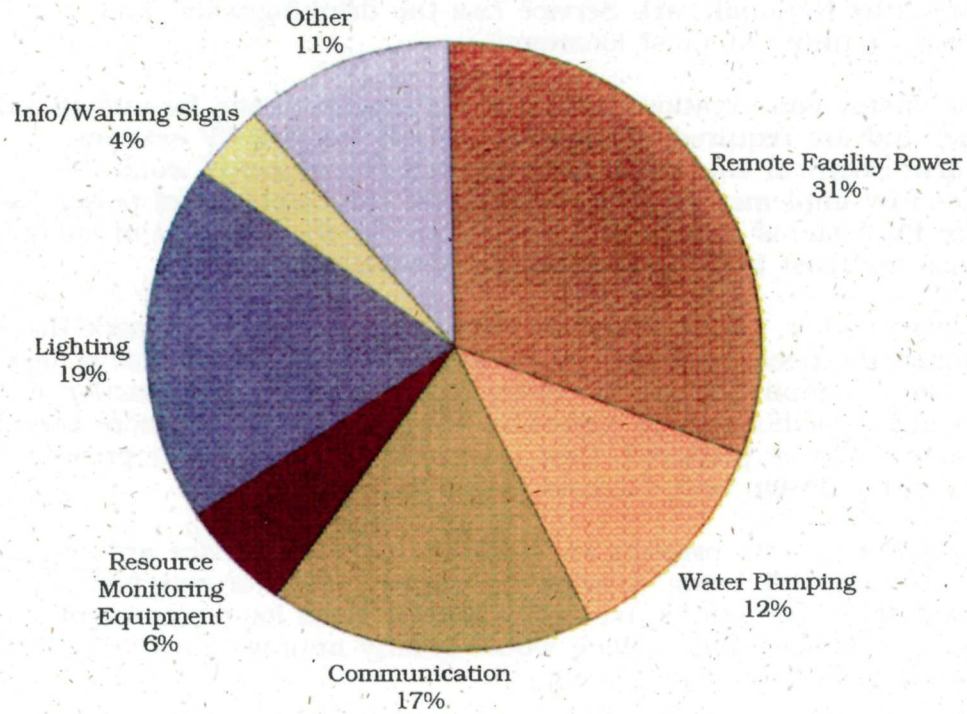


Figure 3: Future Use of Photovoltaic Power in the National Park Service

that PV users are becoming accustomed to this technology and want to move up to the next level.

Appendix C lists all the proposed PV projects by application and location and are compiled in a five-year action plan. Total cost of the 643 projects listed is estimated at $28 million. The survey identified current uses and potential future projects. More than a megawatt of new, cost-effective applications for photovoltaic energy are shown in appendix C, which represents only a fraction of the potential uses identified so far. Cost estimates for each application were prepared by the Denver Service Center and include not only direct PV construction costs but costs for implementing demand side management strategies such as converting to propane heating, installing energy efficient appliances and lighting, and converting to water-conserving plumbing fixtures (the National Park Service has the drinking water and wastewater utility at most locations).

. . . 643 future PV projects were identified by 125 parks.

These energy conservation strategies are a prerequisite for sustainable design and are required to optimize the efficiency of PV systems. Because electrical loads and maintenance requirements would be reduced by implementing these strategies, the estimates of power for future PV systems greatly underestimates the true amount of energy savings and cost benefits that could be achieved.

As stated earlier, phase II survey forms were sent to each park that identified the need for larger PV projects such as remote facility power and water pumping. Phase II survey results provided information on the scale of facilities to be served by PV power so that a more complete estimate could be prepared. Cost estimates for these larger projects also include design and contract preparation costs.

The highest priority projects for the National Park Service are where power is currently being supplied by engine generator sets (usually diesel fueled). The survey results indicate a need for replacement projects at 60 locations, which would greatly improve air quality by eliminating diesel fuel emissions.

Many of the locations where diesel fuel is currently stored have experienced moderate to severe spills. Fuel spills cleanup measures have been very costly, approaching several hundred thousand dollars

per site in some cases. The use of PV systems at these sites will eliminate these groundwater and soil pollution exposures.

Reducing noise pollution in pristine areas that results from 24-hour operation of engine generators is another reason to replace diesel fuel generators with environmentally friendly and quiet PV systems.

Finally, life-cycle cost analysis indicates that in most cases, engine generated power is more costly than PV power systems and does not provide the significant environmental benefits associated with PV power.

IMPLEMENTATION

The cost estimates in appendix C represent program formulation estimates. Cost estimates will be further refined at the site assessment stage. The site assessment is the first activity in the pre-design step of the NPS design process and consists of

- reviewing the existing power system (if power is available at site) and assessing existing and future electrical loads
- initially evaluating renewable resources
- evaluating the potential for energy conservation
- recommending renewable energy options and costs

An example of a site assessment recently conducted at Gulf Island National Seashore by the Photovoltaic Design Assistance Center is included in appendix E. The Photovoltaic Design Assistance Center conducts these site assessments at no charge to the National Park Service. Assessments can be scheduled by contacting Hal Post at (505) 844-2154 or Mike Thomas at (505) 844-1548. Private engineering firms and PV system integrators can also provide this service on a fee basis.

If the site assessment indicates PV or other renewables are feasible, additional pre-design activities such as implementing energy conservation practices, evaluating solar and/or wind resources at the site, and field monitoring of electrical and fuel loads can take place. The remaining design steps such as prelininary design, contract

PV powered emergency telephone at Lake Mead National Recreation Area.

documents, construction, and post-construction evaluation are outlined in NPS-70 (Interim Release, March 1994).

PARTNERSHIPS

The list of proposed PV projects shown in appendix C is large, and the National Park Service budget is small and heavily subscribed. The National Park Service is committed to operating and developing the parks in a sustainable manner for future generations. To accomplish even a portion of the listed projects will require entering into partnerships with other government departments and agencies, national laboratories, environmental groups, private and public associations, and the PV industry.

The Department of Energy's Federal Energy Management Program has established the Federal Energy Efficiency Fund to provide cost sharing grants to federal agencies for cost-effective energy conservation, water conservation, and renewable energy projects. All units of the national park system need to explore and actively participate in this partnership opportunity. Contact John Archibald at (202) 586-1613 for further information. Several units of the national park system have already partnered with the Department of Energy and received several hundred thousand dollars for various projects.

Sandia National Laboratories and the National Renewable Energy Laboratory have both provided outstanding technical and funding assistance to the National Park Service on many renewable energy projects. Contacts at Sandia's Photovoltaic Design Assistance Center in Albuquerque, New Mexico, are Hal Post (505) 844-2154 or Mike Thomas at (505) 844-1548. Contacts at the National Renewable Energy Laboratory in Golden, Colorado, are Bob Westby at (303) 275-6021 or John Thornton at (303) 384-6469.

Electrical utilities at both the local and national level are becoming more interested in energy conservation and renewable energy power systems. Many local utilities offer rebates or other financial incentives to implement energy conservation measures. Several utilities are currently investigating the use of PV energy at several parks in lieu of power line extension or replacement. The Western Area Power

Administration is very interested in promoting the use of energy conservation and renewable energy to member utilities and their customers. Contact Peggy Plate at 1-800-472-2306 for potential partnership information and details. At the national level, the Utility PhotoVoltaic Group can provide a variety of opportunities to accelerate the use of PV power by utilities. The contact person for the Utility PhotoVoltaic Group is Bethany Wills at (202) 857-0898).

APPENDIXES

United States Department of the Interior

NATIONAL PARK SERVICE
P.O. Box 37127
Washington, D.C. 20013-7127

IN REPLY REFER TO

17 FEB 1994

D5015 (610)
XN16 (DSC-MPG)

Memorandum

To: Regional Directors

Through: Acting Associate Director, Operations

From: Deputy Director

Subject: Photovoltaic Survey
Response Due: March 31, 1994

The Vail Agenda provided direction in meeting the management and protection challenges that face the National Park Service (NPS). Sustainability was one of the issues addressed in the Vail Agenda. Implementation of sustainability is now evidenced by the Director's recently announced goal "... to transform all park operations into world models of sensitive environmental management and sustainable design...." The recent NPS publication "Guiding Principles of Sustainable Design" will help to provide a basis towards achieving sustainability in the Park Service's activities.

A key component of sustainability is the use of renewable energy sources such as photovoltaic, wind, and small hydro-electric systems. The Climate Change Action Plan, recently announced by President Clinton, also places heavy emphasis on the use of renewable energy. In partnership with the Department of Energy and Sandia National Laboratories, the National Park Service has been provided funding to conduct a survey of existing photovoltaic (PV) use in the Parks and to identify locations and applications where PV can be utilized in the future. PV technology has made giant advances in the last several years. Many parks and regions have realized this improved technology and installed PV systems with very positive results.

By copy of this memorandum, the attached Photovoltaic Survey is being sent to each Park in your Region. The parks should complete and return the PV survey form by March 31,1994, to the address shown on the survey form. This initial survey has been structured to provide general information on existing and future PV applications. Detailed information will be obtained in a Phase II survey or site visit for those respondents expressing interest in future PV applications. Likewise, cost data and environmental benefits will be developed during this second phase.

Information collected by this survey will provide the basis for funding requests for future photovoltaic development in the National Park Service. There are strong indications that development funding can be obtained from sources other than NPS. Regions will be furnished a copy of survey results.

While the emphasis of the survey is on PV, Section IV inventories other sustainable practices that may be currently in use at park areas. This additional information will provide a barometer reading of the current integration of sustainable practice into NPS activities. If you have any questions, please contact Douglas DeNio, 303/969-2162, or Bob Lopenske, 303/969-5406 at the Denver Service Center.

Attachment

cc: Assistant Director, Design and Construction,
Denver Service Center Operations

PART I --- ASSESSMENT OF EXISTING PHOTOVOLTAIC SYSTEMS

Please reproduce this sheet to allow a separate sheet describing each existing (in-use or abandoned) photovoltaic (PV) system in your park.
If your park currently does not have a PV system, please move on to Parts II, III, and IV of this form.

(1) _ _ _ _ (org.code)

(2) _____ (location in park where system is located)

(3) _____ (park contact and phone)

(4) TYPE OF SYSTEM
(Check only one box to indicate primary function of this system.)
- [ ] Communication
- [ ] Water Pumping
- [ ] Facility Power
- [ ] Lighting
- [ ] Monitoring
- [ ] Residence Power
- [ ] Restroom Power
- [ ] Other: _____

(5) USAGE
- [ ] Seasonal
- [ ] Year-round
- [ ] Intermittent
- [ ] Abandoned

(6) AGE OF PV SYSTEM
- [ ] less than 2 years
- [ ] 2 to less than 5 years
- [ ] 5 to less than 10 years
- [ ] 10 years or more

(7) PV SYSTEM SIZE
- _ _ _ _ _ Total PV Power (watts)
- _ _ _ _ _ Number of Panels
- _ _ _ _ _ Number of Batteries
- _ _ _ _ _ Total Battery Capacity (Amp - hrs)

(8) ESTIMATED ANNUAL POWER PRODUCTION
_ _ _ _ _ kWh

(9) SYSTEM CONFIGURATION
Array Mounting Option
- [ ] Ground
- [ ] Rooftop
- [ ] Pole
- [ ] Portable
- [ ] Other _____

Battery Location
- [ ] Underground Enclosure
- [ ] Above Ground Enclosure
- [ ] In Building

(10) ESTIMATED ANNUAL O&M COST
- [ ] None
- [ ] Much Less Than Expected
- [ ] Expected
- [ ] Much Higher Than Expected

(11) EVALUATION OF COMPONENTS

COMPONENTS:	DAMAGE List letters for all that apply: (a) weather (b) vandalism (c) theft (d) no damage	SATISFACTION List number that expresses your experience: 5-very pleased | 2-disappointed 4-pleased | 1-very disappointed 3-satisfied | 0-not used	BRIEF DESCRIPTION OF PROBLEMS
PV PANELS			
CONTROLLER			
PV TRACKER			
INVERTER			
BATTERIES			

(12) OVERALL, DID THE PHOTOVOLTAIC SYSTEM YOU JUST DESCRIBED MEET YOUR INTENDED OBJECTIVES? [ ] YES [ ] NO

sheet ____ of ____

PART II --- POTENTIAL PHOTOVOLTAIC PROJECTS

Please reproduce this sheet as necessary to allow location-by-location description of potential future applications of photovoltaic systems.

(1) _____
(location in park)

(2) Is an engine generator the primary source of existing power at this location?
[ ] YES [ ] NO

(3) **PROPOSED APPLICATION OF PHOTOVOLTAICS AT THIS LOCATION:**
(Check all that apply:)

[ ] REMOTE FACILITY POWER
(estimated load = _____ watts)

[ ] WATER PUMPING
(estimated load = _____ watts)

[ ] COMMUNICATION
(estimated load = _____ watts)

[ ] RESOURCE MONITORING EQUIPMENT
(estimated load = _____ watts)

[ ] INFO/TRAFFIC WARNING SIGNS
(number = _____)

[ ] STREET LIGHTS
(number = _____)

[ ] AMPHITHEATER LIGHT'G/A-V EQUIP
(estimated load = _____ watts)

[ ] PORTABLE POWER STATIONS
(estimated load = _____ watts)

[ ] ELECT. VEHICLE RECHARGE STATION
(estimated load = _____ watts)

[ ] AUGMENTING DIESEL POWER SYSTEMS
(estimated load = _____ watts)

[ ] REMOTE CAMPGROUND DEVELOPMENT
(estimated load = _____ watts)

[ ] OTHER_____
(estimated load = _____ watts)

(1) _____
(location in park)

(2) Is an engine generator the primary source of existing power at this location?
[ ] YES [ ] NO

(3) **PROPOSED APPLICATION OF PHOTOVOLTAICS AT THIS LOCATION:**
(Check all that apply:)

[ ] REMOTE FACILITY POWER
(estimated load = _____ watts)

[ ] WATER PUMPING
(estimated load = _____ watts)

[ ] COMMUNICATION
(estimated load = _____ watts)

[ ] RESOURCE MONITORING EQUIPMENT
(estimated load = _____ watts)

[ ] INFO/TRAFFIC WARNING SIGNS
(number = _____)

[ ] STREET LIGHTS
(number = _____)

[ ] AMPHITHEATER LIGHT'G/A-V EQUIP
(estimated load = _____ watts)

[ ] PORTABLE POWER STATIONS
(estimated load = _____ watts)

[ ] ELECT. VEHICLE RECHARGE STATION
(estimated load = _____ watts)

[ ] AUGMENTING DIESEL POWER SYSTEMS
(estimated load = _____ watts)

[ ] REMOTE CAMPGROUND DEVELOPMENT
(estimated load = _____ watts)

[ ] OTHER_____
(estimated load = _____ watts)

(1) _____
(location in park)

(2) Is an engine generator the primary source of existing power at this location?
[ ] YES [ ] NO

(3) **PROPOSED APPLICATION OF PHOTOVOLTAICS AT THIS LOCATION:**
(Check all that apply:)

[ ] REMOTE FACILITY POWER
(estimated load = _____ watts)

[ ] WATER PUMPING
(estimated load = _____ watts)

[ ] COMMUNICATION
(estimated load = _____ watts)

[ ] RESOURCE MONITORING EQUIPMENT
(estimated load = _____ watts)

[ ] INFO/TRAFFIC WARNING SIGNS
(number = _____)

[ ] STREET LIGHTS
(number = _____)

[ ] AMPHITHEATER LIGHT'G/A-V EQUIP
(estimated load = _____ watts)

[ ] PORTABLE POWER STATIONS
(estimated load = _____ watts)

[ ] ELECT. VEHICLE RECHARGE STATION
(estimated load = _____ watts)

[ ] AUGMENTING DIESEL POWER SYSTEMS
(estimated load = _____ watts)

[ ] REMOTE CAMPGROUND DEVELOPMENT
(estimated load = _____ watts)

[ ] OTHER_____
(estimated load = _____ watts)

sheet ___ of ___

PART III --- BARRIERS TO THE USE OF PHOTOVOLTAICS

If you have considered PV power previously but have not implemented a system, please indicate your reason(s)

[ ] Initial cost
[ ] Lack of familiarity with PV by designers
[ ] Lack of familiarity with PV by operating personnel
[ ] Uncertainty with performance record of PV systems
[ ] Procurement restrictions/problems
[ ] Conflicts with historical resource context
[ ] Visual quality concerns
[ ] Inability to locate suppliers/contractors
[ ] Adverse climate
[ ] Other_____

PART IV --- OTHER EXISTING SUSTAINABLE PRACTICES

Please indicate all other sustainable practices, methods, products, and materials that are in use within your park context.

[ ] Green procurement requirements and procedures
[ ] Environmentally responsible building products
[ ] Environmentally responsible maintenance products
[ ] Recycling (indicate types) __aluminum __glass ___steel ___paper ___cardboard ___other_____
[ ] Passive solar heating/cooling
[ ] Solar domestic water heating
[ ] Super-efficient window glazings
[ ] Daylighting techniques
[ ] Integrated mechanical systems/waste heat recovery
[ ] Occupancy sensors
[ ] Energy-efficient lighting and lamps
[ ] Water conservation techniques (specify) ___low-flow plumbing fixtures ___water conserving planting ___other_____
[ ] Greywater irrigation systems
[ ] Composting
[ ] Composting toilets
[ ] Wetland wastewater treatment
[ ] Wind generators
[ ] Alternative fuel vehicles
[ ] Transportation systems
[ ] Other_____

RETURN TO: Douglas DeNio, DSC-MPG
National Park Service
PO Box 25287
Denver, CO 80225-0287

RETURN BY: March 31, 1994

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NATIONAL PARK SERVICE
EXISTING PV SYSTEMS (draft)

	PARK	LOCATION	SYSTEM TYPE
1	ANIAKCHAK NPRES	Anigaag Ranger Station	Communications
2	ANIAKCHAK NPRES	Kelly Ranger Station	Communications
3	ANIAKCHAK NPRES	Mount Moak	Communications
4	ANIAKCHAK NPRES	Old Man	Communications
5	ANIAKCHAK NPRES	Onion Portage Ranger Station	Communications
6	APOSTLE ISLANDS NL	Basswood Island	Water Pumping
7	APOSTLE ISLANDS NL	Cat Island	Water Pumping
8	APOSTLE ISLANDS NL	Devils Island	Water Pumping
9	APOSTLE ISLANDS NL	Manitou Island	Water Pumping
10	APOSTLE ISLANDS NL	Michigan Island	Security System
11	APOSTLE ISLANDS NL	Oak Island	Residence Power
12	APOSTLE ISLANDS NL	Oak Island	Water Pumping
13	APOSTLE ISLANDS NL	Otter Island	Water Pumping
14	APOSTLE ISLANDS NL	Outer Island	Security System
15	APOSTLE ISLANDS NL	Rocky Island	Water Pumping
16	APOSTLE ISLANDS NL	Sand Island	Residence Power
17	APOSTLE ISLANDS NL	Sand Island	Security System
18	APOSTLE ISLANDS NL	Sand Island	Water Pumping
19	APOSTLE ISLANDS NL	South Twin Island	Water Pumping
20	APOSTLE ISLANDS NL	Stockton Island, Presque Isle	Residence Power
21	APOSTLE ISLANDS NL	Stockton Island, Presque Isle	Water Pumping
22	APOSTLE ISLANDS NL	Stockton Island, Quarry Bay	Residence Power
23	APOSTLE ISLANDS NL	Stockton Island, Quarry Bay	Water Pumping
24	APPOMATTOX COURT HOUSE NHP	Historic Leased Pastures	Fencing
25	ASSATEAGUE ISLAND NS	Utm: 521360n 48123e	Monitoring
26	AZTEC RUINS NM	Trail	Lighting
27	BADLANDS NP	Pinnacles District	Monitoring
28	BALTIMORE-WASHINGTON PARKWAY	Baltimore-washington Parkway	Communications
29	BANDELIER NM	Base Camp	Facility Power
30	BANDELIER NM	Building #5 Gas & Oil House	Lighting
31	BANDELIER NM	Building 15, Admin Building	Lighting
32	BANDELIER NM	Quarters # 103	Water Heating
33	BANDELIER NM	Quarters #11 Stone House Area	Motion Sensor
34	BANDELIER NM	Quarters #43 White Housing Area	Motion Sensor
35	BANDELIER NM	Radio Battery Charging System	Communications
36	BANDELIER NM	Radio Battery Charging System	Communications
37	BANDELIER NM	Solar Water Heating System	Water Heating
38	BERING LAND BRIDGE NP	Hoodoo Hill	Raws
39	BERING LAND BRIDGE NP	Midnight Mountain	Communications
40	BERING LAND BRIDGE NP	Mt Bendeleben	Communications
41	BIG BEND NP	Bolt Springs Cabin	Residence Power
42	BIG BEND NP	Boot Springs Barn	Lighting
43	BIG BEND NP	Emory Peak	Communications
44	BIG SOUTH FORK NR		Electric Fence
45	BIG THICKET NPRES	Ranch House	Battery Chargin
46	BIGHORN CANYON NRA	Barry's Landing	Lighting Boat Dock
47	BIGHORN CANYON NRA	Bighorn Cnayon V C	Interpretive Display
48	BIGHORN CANYON NRA	Eye Of The Eagle	Communications
49	BIGHORN CANYON NRA	Lovell	Monitoring
50	BIGHORN CANYON NRA	Parkwide	Battery Charger
51	BIGHORN CANYON NRA	South Unit Sorenson	Communications
52	BISCAYNE NP	Boca Chita Key	Restroom Power
53	BLACK CANYON OT GUNNISON NM	North Rim Ranger Station	Facility Power
54	BLACK CANYON OT GUNNISON NM	South Rim Fire Box	Water Pumping
55	BLACK CANYON OT GUNNISON NM	South Rim Restrooms	Restroom Power
56	BLUE RIDGE PKWY	Craggy Gardens Visitor Center	Cash Register
57	BLUE RIDGE PKWY	Humpback Rocks Picnic Area	Water Pumping
58	BLUE RIDGE PKWY	Oteen Maint Area	Automatic Gate
59	BLUE RIDGE PKWY	Traffic Counters	Traffic Counter
60	BRYCE CANYON NP	Aqua Canyon Raws Station	Monitoring
61	BRYCE CANYON NP	Yovempa Point	Monitoring
62	BUFFALO NR	Hathaway Mountain	Communications
63	BUFFALO NR	Throughout Park	Communications
64	CABRILLO NM	Upper Maintenance Shop Roof	Water Pumping
65	CANYONLANDS NP	Maze District Rest Area	Residence Power
66	CAPE HATTERAS NS	Bodie Island	Monitoring
67	CAPE HATTERAS NS	Cape Point	Monitoring
68	CAPITOL REEF NP	Fremont Gorge	Water Pumping
69	CARLSBAD CAVERNS NP	Borman Cabin	Communications
70	CARLSBAD CAVERNS NP	Golf Cart	Transportation
71	CARLSBAD CAVERNS NP	Second Water Tank	Communications
72	CARLSBAD CAVERNS NP	Visitor Center	Pv Battery Charger
73	CATOCTIN MOUNTAIN PARK	Hog Rock Pit Toilet	Residence Power
74	CHANNEL ISLANDS NP	Anacapa Island	Residence Power
75	CHANNEL ISLANDS NP	San Miguel Island	Residence Power
76	CHANNEL ISLANDS NP	Santa Barbara Island	Residence Power
77	CHESAPEAKE & OHIO CANAL NHP	Kidwell Farm Tract	Water Pumping
78	CHIRICAHUA NM	Sugarloaf Mountain	Communications
79	CONGAREE SWAMP NM	Congaree River S. Boundary	Monitoring
80	CRATER LAKE NP	Cleetwood Cave Toilets	Restroom Vents
81	CRATER LAKE NP	Mt. Scott Fire Lookout	Communications
82	CRATER LAKE NP	Watchman Fire Lookout	Communications
83	CRATERS OF THE MOON NM	Top Of Sunset Cone	Communications
84	DEATH VALLEY NM	Wildrose	Residence Power
85	DENALI NP	14,200 Ranger Station	Communications
86	DENALI NP	8000' Kahiltna Glacier	Communications
87	DENALI NP	Lake Hinchumina Raws	Monitoring
88	DENALI NP	Rock Creek Ridge	Monitoring
89	DENALI NP	Savage Entrance Station	Communications
90	DENALI NP	Savage Repeater	Communications
91	DENALI NP	Slippery Slough Raws	Monitoring
92	DENALI NP	Thovofave Repeater	Communications
93	DENALI NP	Upper Rock Creek	Monitoring
94	DENALI NP	Wickersham Dome	Communications
95	DENALI NP	Wonder Lake Ranger Station	Communications
96	EVERGLADES NP	Park-Wide	Monitoring (73 Locations)
97	FORT LARAMIE NHS	Outdoor Toilet #225	Facility Power
98	FOSSIL BUTTE NM	Cundick Ridge Repeator Station	Communications
99	GLACIER NP	Cyclone Lookout/cyclone Mt	Communications
100	GLACIER NP	Huckleberry Lookout	Communications
101	GLACIER NP	Numa Lookout	Communications
102	GLEN CANYON NRA	Dangling Rope Marina #1	Lighting
103	GLEN CANYON NRA	Dangling Rope Marina #2	Lighting
104	GLEN CANYON NRA	Hall's Crossing Shore Lites	Lighting
105	GLEN CANYON NRA	Main Channel & Wahweap Bay	Lighting
106	GLEN CANYON NRA	Park-Wide	Navigation Aid (19 Buoys)
107	GLEN CANYON NRA	Rainbow Bridge Courtesy Dock	Vent Fans
108	GLEN CANYON NRA	Rainbow Bridge Junction	Lighting

109	GLEN CANYON NRA	Shore Lite #15	Lighting
110	GLEN CANYON NRA	Shore Lite #16	Lighting
111	GLEN CANYON NRA	South Lake Shore Drive	Monitoring
112	GLEN CANYON NRA	Warm Creek And Main Channel	Lighting
113	GRAND CANYON NP	Cottonwood Ranger Station	Facility Power
114	GRAND CANYON NP	Southgate Parking	Lighting
115	GRAND CANYON NP	Tuweep Ranger Station	Facility Power
116	GRAND TETON NP	Berry Creek Patrol Cabin	Communications
117	GRAND TETON NP	Portable Repeater #1	Communications
118	GRAND TETON NP	Portable Repeater #2	Communications
119	GREAT BASIN NP	Baker Creek Campground	Restroom Fan
120	GREAT BASIN NP	Baker Creek Campground Road	Monitoring
121	GREAT BASIN NP	Baker Flat Weather Station	Monitoring
122	GREAT BASIN NP	Bald Mountain Weater Station	Communications
123	GREAT BASIN NP	Burnt Mill Weather Station	Monitoring
124	GREAT BASIN NP	Entrance Gate Dump Station	Lighting
125	GREAT BASIN NP	Fremont Weather Station	Monitoring
126	GREAT BASIN NP	Lower Lehman Creek Cg	Exhaust Fan
127	GREAT BASIN NP	Nadp Site - Acid Rain Station	Monitoring
128	GREAT BASIN NP	Wheeler Peak Campground	Restroom Fan
129	GREAT SMOKY MOUNTAINS NP	Balsam Mountain	Lighting
130	GREAT SMOKY MOUNTAINS NP	Cades Cove Visitor Center	Facility Power
131	GREAT SMOKY MOUNTAINS NP	Clingmans Dome	Communications
132	GREAT SMOKY MOUNTAINS NP	Hazel Creek	Water Pumping
133	GREAT SMOKY MOUNTAINS NP	Newfound Gap	Communications
134	GREAT SMOKY MOUNTAINS NP	Shuckstack	Communications
135	GUADALUPE MOUNTAINS NP	Bowl Remote Area Raws	Monitoring
136	GUADALUPE MOUNTAINS NP	Bush Mountain Radio Repeater	Communications
137	GUADALUPE MOUNTAINS NP	Nadp Acid Rain Station	Monitoring
138	GUADALUPE MOUNTAINS NP	Transmissometer Station	Monitoring
139	HALEAKALA NP	Kipahulu	Restroom Power
140	HAWAII VOLCANOES NP		Electric Fence
141	HAWAII VOLCANOES NP	Mauna Loa	Communications
142	HAWAII VOLCANOES NP	Vennel	Facility Power
143	HERBERT HOOVER NHS	B52 Maintenance Shop	Fans & Vents
144	JOHN DAY FOSSIL BEDS NM	Blue Basin	Residence Power
145	JOHN DAY FOSSIL BEDS NM	Clarno	Residence Power
146	JOHN DAY FOSSIL BEDS NM	Sheep Rock	Communications
147	JOSHUA TREE NM	Lost Horse	Facility Power
148	JOSHUA TREE NM	Lost Horse	Water Pumping
149	KALOKO-HONOKOHAU NHP	Honokohau Beach	Residence Power
150	KATMAI NP	Backcountry	Communications
151	KENAI FJORDS NP	Aialik Bay Ranger Station	Communications
152	KENAI FJORDS NP	Exit Glacier Ranger Cabin	Communications
153	KENAI FJORDS NP	Mcarthur Pass Repeater Station	Communications
154	KENAI FJORDS NP	Nuka Bay Ranger Station	Communications
155	KENAI FJORDS NP	Rugged Island Repeater Station	Communications
156	KENAI FJORDS NP	Seal Rocks Repeater Station	Communications
157	KLONDIKE GOLD RUSH NHP - AK	Dyea Ranger Station	Cwater Pumping
158	KLONDIKE GOLD RUSH NHP - AK	Kalvik House	Residence Power
159	KLONDIKE GOLD RUSH NHP - AK	Sheep Camp Ranger Station	Communications
160	LAKE CLARK NP	Bonanza Hills	Communications
161	LAKE CLARK NP	Little Lake Clark	Communications
162	LAKE CLARK NP	Raws Field Headquarters	Weather Data
163	LAKE CLARK NP	Raws Telaquina Lake	Weather Data
164	LAKE CLARK NP	Telaquina Lake	Communications
165	LAKE CLARK NP	Twin Lakes	Communications

109	GLEN CANYON NRA	Shore Lite #15	Lighting
110	GLEN CANYON NRA	Shore Lite #16	Lighting
111	GLEN CANYON NRA	South Lake Shore Drive	Monitoring
112	GLEN CANYON NRA	Warm Creek And Main Channel	Lighting
113	GRAND CANYON NP	Cottonwood Ranger Station	Facility Power
114	GRAND CANYON NP	Southgate Parking	Lighting
115	GRAND CANYON NP	Tuweep Ranger Station	Facility Power
116	GRAND TETON NP	Berry Creek Patrol Cabin	Communications
117	GRAND TETON NP	Portable Repeater #1	Communications
118	GRAND TETON NP	Portable Repeater #2	Communications
119	GREAT BASIN NP	Baker Creek Campground	Restroom Fan
120	GREAT BASIN NP	Baker Creek Campground Road	Monitoring
121	GREAT BASIN NP	Baker Flat Weather Station	Monitoring
122	GREAT BASIN NP	Bald Mountain Weater Station	Communications
123	GREAT BASIN NP	Burnt Mill Weather Station	Monitoring
124	GREAT BASIN NP	Entrance Gate Dump Station	Lighting
125	GREAT BASIN NP	Fremont Weather Station	Monitoring
126	GREAT BASIN NP	Lower Lehman Creek Cg	Exhaust Fan
127	GREAT BASIN NP	Nadp Site - Acid Rain Station	Monitoring
128	GREAT BASIN NP	Wheeler Peak Campground	Restroom Fan
129	GREAT SMOKY MOUNTAINS NP	Balsam Mountain	Lighting
130	GREAT SMOKY MOUNTAINS NP	Cades Cove Visitor Center	Facility Power
131	GREAT SMOKY MOUNTAINS NP	Clingmans Dome	Communications
132	GREAT SMOKY MOUNTAINS NP	Hazel Creek	Water Pumping
133	GREAT SMOKY MOUNTAINS NP	Newfound Gap	Communications
134	GREAT SMOKY MOUNTAINS NP	Shuckstack	Communications
135	GUADALUPE MOUNTAINS NP	Bowl Remote Area Raws	Monitoring
136	GUADALUPE MOUNTAINS NP	Bush Mountain Radio Repeater	Communications
137	GUADALUPE MOUNTAINS NP	Nadp Acid Rain Station	Monitoring
138	GUADALUPE MOUNTAINS NP	Transmissometer Station	Monitoring
139	HALEAKALA NP	Kipahulu	Restroom Power
140	HAWAII VOLCANOES NP		Electric Fence
141	HAWAII VOLCANOES NP	Mauna Loa	Communications
142	HAWAII VOLCANOES NP	Vennel	Facility Power
143	HERBERT HOOVER NHS	B52 Maintenance Shop	Fans & Vents
144	JOHN DAY FOSSIL BEDS NM	Blue Basin	Residence Power
145	JOHN DAY FOSSIL BEDS NM	Clarno	Residence Power
146	JOHN DAY FOSSIL BEDS NM	Sheep Rock	Communications
147	JOSHUA TREE NM	Lost Horse	Facility Power
148	JOSHUA TREE NM	Lost Horse	Water Pumping
149	KALOKO-HONOKOHAU NHP	Honokohau Beach	Residence Power
150	KATMAI NP	Backcountry	Communications
151	KENAI FJORDS NP	Aialik Bay Ranger Station	Communications
152	KENAI FJORDS NP	Exit Glacier Ranger Cabin	Communications
153	KENAI FJORDS NP	Mcarthur Pass Repeater Station	Communications
154	KENAI FJORDS NP	Nuka Bay Ranger Station	Communications
155	KENAI FJORDS NP	Rugged Island Repeater Station	Communications
156	KENAI FJORDS NP	Seal Rocks Repeater Station	Communications
157	KLONDIKE GOLD RUSH NHP - AK	Dyea Ranger Station	Cwater Pumping
158	KLONDIKE GOLD RUSH NHP - AK	Kalvik House	Residence Power
159	KLONDIKE GOLD RUSH NHP - AK	Sheep Camp Ranger Station	Communications
160	LAKE CLARK NP	Bonanza Hills	Communications
161	LAKE CLARK NP	Little Lake Clark	Communications
162	LAKE CLARK NP	Raws Field Headquarters	Weather Data
163	LAKE CLARK NP	Raws Telaquina Lake	Weather Data
164	LAKE CLARK NP	Telaquina Lake	Communications
165	LAKE CLARK NP	Twin Lakes	Communications

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166	LAKE MEREDITH NRA	Arrowhead Island	Nav-aid
167	LAKE MEREDITH NRA	Capenter Shop	Heat
168	LAKE MEREDITH NRA	Harbor Bay	Nav-aid
169	LAKE MEREDITH NRA	Mechanic Shop	Heat
170	LASSEN VOLCANIC NP	Drakesbad	Cl2 Metering Pump
171	LASSEN VOLCANIC NP	Drakesbad	Restroom Power
172	LASSEN VOLCANIC NP	Headquarters	Wastewater - Magme
173	LASSEN VOLCANIC NP	Manzinita Lake	Wastewater - Magme
174	LASSEN VOLCANIC NP	Summit Lake	Cl2 Metering Pump
175	LASSEN VOLCANIC NP	Warner Valley R. S.	Cl2 Metering Pump
176	LITTLE BIGHORN BATTLEFIELD NM	Headquarters	Facility Power
177	LYNDON B JOHNSON NHP	North Fenceline	Fence Charger
178	LYNDON B JOHNSON NHP	Show Barn	Fence Charger
179	MESA VERDE NP	Park Point Lookout Tower	Communications
180	MOORES CREEK NB	Visitor Center	Lighting
181	MOUNT RAINER NP	Camp Muir	Communications
182	MOUNT RAINER NP	Camp Muir	Lighting
183	MOUNT RAINER NP	Camp Muir Solar Toilet	Other
184	MOUNT RAINER NP	Camp Schurman	Communications
185	MOUNT RAINER NP	Gobblers Knob Lookout	Communications
186	MOUNT RAINER NP	Mather "y"	Traffic Counter
187	MOUNT RAINER NP	Mount Freemont Lookout	Communications
188	MOUNT RAINER NP	Mystic Lake	Communications
189	MOUNT RAINER NP	Stevens Canyon Entrance	Cash Registers
190	MOUNT RAINER NP	Stevens Canyon Entrance	Fans
191	MOUNT RAINER NP	Summerland Toilet	Facility Power
192	MOUNT RAINER NP	White River Campground	Lighting
193	NATCHEZ TRACE PKWY	Mp204-hwy 82	Traffic Counter
194	NATCHEZ TRACE PKWY	Mp80 John Bell Williams Hwy	Traffic Counter
195	NATURAL BRIDGES NM	Maintenance Area	Facility Power
196	NORTH CASCADES NP	Easy Ridge	Communications
197	NORTH CASCADES NP	Mcgregor Mountain	Communications
198	NORTH CASCADES NP	Remote Backcountry (10 Each)	Communications
199	NORTH CASCADES NP	Ruby Mountain	Communications
200	OLYMPIC NP	Blue Mountain	Communications
201	OLYMPIC NP	Deer Park Ranger Station	Communications
202	OLYMPIC NP	Dosewallips Ranger Station	Communications
203	OLYMPIC NP	Elk Lick Mountain	Communications
204	OLYMPIC NP	Enchanted Valley Ranger Station	Communications
205	OLYMPIC NP	Graves Creek Ranger Station	Communications
206	OLYMPIC NP	Hayes River Ranger Station	Communications
207	OLYMPIC NP	Kloochman Rock	Communications
208	OLYMPIC NP	Low Divide Ranger Station	Communications
209	OLYMPIC NP	North Fork Ranger Station	Communications
210	OLYMPIC NP	Olympus Ranger Station	Communications
211	OLYMPIC NP	Peak Six	Communications
212	OLYMPIC NP	Queets Ranger Station	Communications
213	OLYMPIC NP	Remote Backcountry (8 Each)	Communications
214	ORGAN PIPE CACTUS NM	North Of Mount Ajo	Communications
215	OZARK NSR	Lower Current Dist Hawes Cg	Water Pumping
216	PETRIFIED FOREST NP	Entry Access Road	Lighting
217	PICTURED ROCKS NL	Buck Hill Radio Tower	Communications
218	PICTURED ROCKS NL	Chapel Beach Clivis Multrum	Composting Fan
219	PICTURED ROCKS NL	Little Beaver Campground	Water Pumping
220	PICTURED ROCKS NL	Lower Huricane River Campground	Water Pumping
221	PICTURED ROCKS NL	Twelvemile Beach Campground	Water Pumping
222	PICTURED ROCKS NL	Twelvemile Beach Cg West	Water Pumping

223	PICTURED ROCKS NL	Upper Huricane River Campground	Water Pumping
224	PU'UHONUA O HONAUNAU NHP	House #1	Lighting
225	RAINBOW BRIDGE NM	Rainbow Bridge	Monitoring
226	REDWOODS NM	Elam Camp	Water Pumping
227	REDWOODS NM	Lane Ranch	Lighting
228	REDWOODS NM	Rodgers Peak	Communications
229	REDWOODS NM	School House Fire Lookout	Facility Power
230	REDWOODS NM	School Peak Lookout	Communications
231	ROCKY MOUNTAIN NP	Loch Vale Acid Rain Station	Monitoring
232	ROCKY MOUNTAIN NP	Longs Peak Solar Toilets (4)	Bc Toilet Fan
233	ROCKY MOUNTAIN NP	Many Parks Curve Air Monitoring	Monitoring
234	ROCKY MOUNTAIN NP	Twin Sisters Peak	Communications
235	SAGUARO NM	Manning Camp	Water Pumping
236	SALEM MARITIME NHS	Derby Wharf Lighthouse	Lighting
237	SCOTTS BLUFF NM	Summit Area	Communications
238	SEQUOIA NP	Ash Mnt Headquarters	Monitoring
239	SEQUOIA NP	Atwell Mill Barn	Communications
240	SEQUOIA NP	Emerald Lake Comfort Station	Restroom Power
241	SEQUOIA NP	Evolution Park	Communications
242	SEQUOIA NP	Forgotten	Communications
243	SEQUOIA NP	Lookout Point	Facility Power
244	SEQUOIA NP	Milk Ranch Lookout	Communications
245	SEQUOIA NP	Mineral King	Monitoring
246	SEQUOIA NP	Mt. Gould	Communications
247	SEQUOIA NP	Palmer Mountain	Communications
248	SEQUOIA NP	Paradise Ridge	Communications
249	SEQUOIA NP	Peau Lake Comfort Station	Residence Power
250	SEQUOIA NP	Peau Lake Ski Hut	Restroom Power Fan
251	SEQUOIA NP	South Fork Campground	Restroom Power Fan
252	SEQUOIA NP	Windy Park	Communications
253	SLEEPING BEAR DUNES NL	Group Campground Mainland	Water Pumping
254	SLEEPING BEAR DUNES NL	North Manitou Isl Repeater	Communications
255	SLEEPING BEAR DUNES NL	Parkwide 26 Each	Vent Fans
256	SLEEPING BEAR DUNES NL	Route 669 Mainland	Water Pumping
257	SLEEPING BEAR DUNES NL	S Manitou Isl Weatherstation 1	Water Pumping
258	SLEEPING BEAR DUNES NL	S. Manitou Isl Popple Campgroun	Water Pumping
259	SLEEPING BEAR DUNES NL	S. Manitou Isl Weatherstation 2	Water Pumping
260	SLEEPING BEAR DUNES NL	South Manitou Isl Schoolhouse	Water Pumping
261	SLEEPING BEAR DUNES NL	South Manitou Island	Water Pumping
262	THEODORE ROOSEVELT NP	North Unit	Other
263	TIMPANOGOS CAVE NM	Park Boundary	Monitoring
264	TONTO NM	NPS/Boneyard, USFS/Sewage Pond	Monitoring
265	TUSKEGEE INSTITUTE NHS	Water Tower	Communications
266	WHISKEYTOWN-SHASTA-TRINITY NRA	Whiskey Creek Group Picnic Area	Exhaust Fans
267	WHITE SANDS NM	Dunes Picnic Sites	Facility Power
268	WRANGELL-ST ELIAS NP	Chisana Fuel Station	Fuel Dispenser
269	WRANGELL-ST ELIAS NP	May Creek Bunkhouse	Residence Power
270	WRANGELL-ST ELIAS NP	May Creek Fuel Station	Fuel Dispenser
271	WRANGELL-ST ELIAS NP	May Creek Operations	Facility Power
272	WRANGELL-ST ELIAS NP	Mountain Top Radio Repeaters 10	Communications
273	WRANGELL-ST ELIAS NP	Remote Area Weather Station	Monitoring
274	WRANGELL-ST ELIAS NP	Slana Ranger Residence	Residence Power
275	WRANGELL-ST ELIAS NP	Slana Ranger Station Bunkhouse	Facility Power
276	YELLOWSTONE NP	7 Mile Bridge	Communications
277	YELLOWSTONE NP	Beartooth Area	Communications
278	YELLOWSTONE NP	Clear Creek Cabin	Monitoring
279	YELLOWSTONE NP	Fire	Communications

280	YELLOWSTONE NP	Fire Hole Lake	Communications
281	YELLOWSTONE NP	Fishing Bridge	Monitoring
282	YELLOWSTONE NP	Fountain Flat Road Intersection	Communications
283	YELLOWSTONE NP	Hayden Valley	Communications
284	YELLOWSTONE NP	Heart Lake Cabin	Communications
285	YELLOWSTONE NP	Midway Geyser Basin	Communications
286	YELLOWSTONE NP	Moose Exhibit	Communications
287	YELLOWSTONE NP	Mt Holmes Lookout	Communications
288	YELLOWSTONE NP	Mt Sheridan Lookout	Communications
289	YELLOWSTONE NP	Mt Washburn Parking Lot	Communications
290	YELLOWSTONE NP	Mud Volcano	Communications
291	YELLOWSTONE NP	Park-Wide	Monitoring (31 Locations)
292	YELLOWSTONE NP	Pelican Cone	Communications
293	YELLOWSTONE NP	Portable Radio Repeater	Communications
294	YELLOWSTONE NP	Sheridan	Communications
295	YELLOWSTONE NP	Shoshone Lake Cabin	Communications
296	YELLOWSTONE NP	Small Brick Building	Monitoring
297	YELLOWSTONE NP	Thorofare Ck Cabin	Communications
298	YELLOWSTONE NP	Trail Creekd Cabin	Communications
299	YOSEMITE NP	Crane Flat (fire) Lookout	Communications
300	YOSEMITE NP	Emerald Pool	Restroom Power
301	YOSEMITE NP	Glen Aulin Backpacker Cg	Residence Power
302	YOSEMITE NP	Glen Aulin High Sierra Camp	Communications
303	YOSEMITE NP	Lyv Backcountry	Restroom Power
304	YOSEMITE NP	Lyv Ranger Station	Residence Power
305	YOSEMITE NP	May Lake High Sierra Camp	Facility Power
306	YOSEMITE NP	Merced Lake High Sierra Camp	Communications
307	YOSEMITE NP	Merced Lake Ranger Station	Communications
308	YOSEMITE NP	Mt. Hoffman	Communications
309	YOSEMITE NP	Murphy Creek Building 3115	Vent Fan For Vault
310	YOSEMITE NP	Murphy Creek Building 3116	Vent Fan For Vault
311	YOSEMITE NP	Nevada Falls	Restroom Power
312	YOSEMITE NP	North Mountain	Communications
313	YOSEMITE NP	Ostrander Ski Hut	Communications
314	YOSEMITE NP	South Entrance	Ventilation
315	YOSEMITE NP	Sunrise Backpacker	Restroom Power
316	YOSEMITE NP	Sunrise High Sierra Camp	Facility Power
317	YOSEMITE NP	Sunrise High Sierra Camp	Facility Power
318	YOSEMITE NP	Tamarac Flat Campground B 6240	Vent Fan For Vault
319	YOSEMITE NP	Tamarac Flat Campground B 6241	Vent Fan For Vault
320	YOSEMITE NP	Tamarac Flat Campground B 6242	Vent Fan For Vault
321	YOSEMITE NP	Tamarac Flat Campground B 6243	Vent Fan For Vault
322	YOSEMITE NP	Vogelsang Backpacker Cg	Restroom Power
323	YOSEMITE NP	Voglesang High Sierra Camp	Restroom Power
324	YOSEMITE NP	Yosemite Creek Cg B 6280	Vent Fan For Vault
325	YOSEMITE NP	Yosemite Creek Cg B 6281	Vent Fan For Vault
326	YOSEMITE NP	Yosemite Creek Cg B 6282	Vent Fan For Vault
327	YOSEMITE NP	Yosemite Creek Cg B 6283	Vent Fan For Vault
328	YOSEMITE NP	Yosemite Creek Cg B 6284	Vent Fan For Vault
329	YUKON CHARLEY RIVERS NP	Ben Creek Airstrip	Raws Weather St
330	YUKON CHARLEY RIVERS NP	Eagle Headquarters	Weather Station
331	YUKON CHARLEY RIVERS NP	Hillard Peak Repeater Site	Communications
332	YUKON CHARLEY RIVERS NP	Kathiel Mountain	Communications
333	YUKON CHARLEY RIVERS NP	Twin Mountain	Communications
334	YUKON CHARLEY RIVERS NP	Yukon Peak	Communications
335	ZION NP	Canyon Junction Bridge	Monitoring
336	ZION NP	Lava Point Cabin	Residence Power

NATIONAL PARK SERVICE
PROPOSED PV PROJECTS, 5 YEAR PLAN (DRAFT)

	APPLICATION	PARK	LOCATION	ESTIMATE
1	Amphitheater Light'g/a-v Equipment	ARCHES NP	Devils Garden	$12,000
2	Amphitheater Light'g/a-v Equipment	BIGHORN CANYON NRA	Garrys Landing Trail Creek	$12,000
3	Amphitheater Light'g/a-v Equipment	CARLSBAD CAVERNS NP	Bat Flight Amphitheater	$18,000
4	Amphitheater Light'g/a-v Equipment	CHAMIZAL NMEM	Park Grounds	$24,000
5	Amphitheater Light'g/a-v Equipment	CRATERS OF THE MOON N	Campground	$12,000
6	Amphitheater Light'g/a-v Equipment	GREAT BASIN NP	Lehman Creek Campground	$12,000
7	Amphitheater Light'g/a-v Equipment	GREAT BASIN NP	Wheeler Peak Campground	$12,000
8	Amphitheater Light'g/a-v Equipment	LASSEN VOLCANIC NP	Butte Lake Campground	$12,000
9	Amphitheater Light'g/a-v Equipment	LASSEN VOLCANIC NP	Summit Lake Campground	$12,000
10	Amphitheater Light'g/a-v Equipment	MOORES CREEK NB	Historic Bridge Site	$12,000
11	Amphitheater Light'g/a-v Equipment	NAVAJO NM	Development Area	$12,000
12	Amphitheater Light'g/a-v Equipment	NORTH CASCADES NP	Hozomeen Campground	$12,000
13	Amphitheater Light'g/a-v Equipment	ORGAN PIPE CACTUS NM	Campground Hq	$18,000
14	Amphitheater Light'g/a-v Equipment	SANTA FE NAT'L HISTORIC	Trails (4 Locations)	$47,000
15	Amphitheater Light'g/a-v Equipment	SCOTTS BLUFF NM	Amphitheater	$12,000
16	Amphitheater Light'g/a-v Equipment	WHISKEYTOWN-SHASTA-T	Oak Bottom	$18,000
17	Amphitheater Light'g/a-v Equipment	WHITE SANDS NM	Contact Station	$12,000
18	Amphitheater Light'g/a-v Equipment	WHITE SANDS NM	Program Site	$18,000
19	Amphitheater Light'g/a-v Equipment	WOLF TRAP FARM PARK - P	Filene Center	$119,000
20	Audio Station, Interpretive	PETERSBURG NB	Main Unit Five Forks	$1,000
21	Audio Station, Interpretive	WILSON'S CREEK NB	Bloody Hill	$1,000
22	Audio Station, Interpretive	WILSON'S CREEK NB	Price/pulaski	$1,000
23	Audio Station, Interpretive	WILSON'S CREEK NB	Ray House	$1,000
24	Audio Station, Interpretive	WILSON'S CREEK NB	Sigel's Final Position	$1,000
25	Audio Station, Wayside	BIG HOLE NB	Battle Overlook	$1,000
26	Audio Station, Wayside	BIG HOLE NB	Howitzer Site	$1,000
27	Audio Station, Wayside	BIG HOLE NB	Nez Perce Camp	$1,000
28	Audio Station, Wayside	BIG HOLE NB	Nez Perce Trail	$1,000
29	Audio Station, Wayside	BIG HOLE NB	Siege Area	$1,000
30	Audio Station, Wayside	BIG HOLE NB	Soldger Monument	$1,000
31	Audio Station, Wayside	GEORGE WASHINGTON BP	Burial Ground	$1,000
32	Audio Station, Wayside	RICHMOND NBP	Throughout The Park	$12,000
33	Audio Tour Guide	CARLSBAD CAVERNS NP	Cavern	$4,000
34	Augment Diesel Power Systems	LASSEN VOLCANIC NP	Butte Lake Campground	$100,000
35	Augment Diesel Power Systems	LASSEN VOLCANIC NP	Drakesbad Guest Ranch	$59,000
36	Augment Diesel Power Systems	YUKON CHARLEY RIVERS N	Coal Creek Camp	$82,000
37	Augment Propane Power System	NORTH CASCADES NP	Hozomeen Campground	$27,000
38	Battery Charger	BALTIMORE-WASHINGTON	Parkway	$1,000
39	Battery Charger	CAPE HATTERAS NS	Fort Raleigh Waterplant	$1,000
40	Battery Charger	CAPE HATTERAS NS	Hatteras Island Fire Cache	$1,000
41	Battery Charger	CAPE HATTERAS NS	Ocracoke Maintenance Shop	$1,000
42	Battery Charger	PRINCE WILLIAM FOREST P	Maint. Yard	$1,000
43	Comfort Station	MORRISTOWN NHP	Maintenance Area	$14,000
44	Comfort Station	PECOS NM	Backcountry Trails	$14,000
45	Comfort Station	PECOS NM	Gateway Overlook	$7,000
46	Comfort Station	PECOS NM	Glorieta Kiosk	$14,000
47	Comfort Station	PECOS NM	Parking Tp	$7,000
48	Comfort Station	PECOS NM	Ruins Picnic Area	$7,000
49	Communication	ACADIA NP	Cadillac Mt	$505,000
50	Communication	ACADIA NP	Isle An Haut	$17,000
51	Communication	BALTIMORE-WASHINGTON	Parkway	$4,000
52	Communication	BALTIMORE-WASHINGTON	Parkway	$4,000
53	Communication	BIG CYPRESS NPRES	Oasis Ranger Station	$17,000
54	Communication	BIG HOLE NB	Entrance	$17,000
55	Communication	BIGHORN CANYON NRA	South Unit	$17,000
56	Communication	BRYCE CANYON NP	Far View Point	$8,000
57	Communication	BRYCE CANYON NP	Rainbow Point	$8,000
58	Communication	CANYONLANDS NP	Maze District	$8,000
59	Communication	CAPE COD NS	Marconi Water Tower	$33,000
60	Communication	CASA GRANDE NM	Vc Audio Tape Station	$2,000
61	Communication	CATOCTIN MOUNTAIN PAR	Gym	$6,000
62	Communication	CORONADO NMEM	Montezuma Pass	$17,000
63	Communication	CRATER LAKE NP	Cleetwood Cove Trailhead	$8,000
64	Communication	CRATER LAKE NP	North Entrance Station	$8,000
65	Communication	CUMBERLAND GAP NHP	Pinnacle	$33,000
66	Communication	CURECANTI NRA	Blue Meas Reservoir	$17,000
67	Communication	DENALI NP	Cantwell Area	$33,000
68	Communication	EFFIGY MOUNDS NM	Radio Tower Pikes Peak	$17,000
69	Communication	EVERGLADES NP	Dry Tortugas/Ft. Jefferson	$25,000
70	Communication	EVERGLADES NP	Various Repeater Stations	$83,000
71	Communication	FIRE ISLAND NS	Lighthouse & Annex	$17,000
72	Communication	FORT STANWIX NM	Maintenance Building	$17,000
73	Communication	GLACIER NP	Belly River Ranger Station	$17,000
74	Communication	GLACIER NP	Bowman Ranger Station	$17,000
75	Communication	GLACIER NP	Cutbank Ranger Station	$17,000
76	Communication	GLACIER NP	Granite Park Chalet	$17,000
77	Communication	GLACIER NP	Kintla Ranger Station	$17,000
78	Communication	GLACIER NP	Logan Pass Visitor Center	$33,000
79	Communication	GLACIER NP	Logging Ranger Station	$17,000
80	Communication	GLACIER NP	Pole Bridge Ranger Station	$33,000
81	Communication	GLACIER NP	Sperry Chalet	$17,000
82	Communication	GLACIER NP	Waterton Ranger Station	$25,000
83	Communication	GOLDEN GATE NRA	Mt Tam	$41,000
84	Communication	GRAND CANYON NP	Pasture Washington South Rim	$17,000
85	Communication	GRAND TETON NP	Backcountry Sites	$17,000
86	Communication	GRAND TETON NP	Cascade Canyon Patrol Cabin	$17,000
87	Communication	GRAND TETON NP	Lower Saddle	$17,000
88	Communication	GRAND TETON NP	Tac Command Post	$17,000
89	Communication	GREAT BASIN NP	Lehman Creek Campground	$17,000
90	Communication	GREAT BASIN NP	South Of Park	$17,000
91	Communication	GREAT BASIN NP	West Of Park	$17,000
92	Communication	GREAT BASIN NP	Wheeler Peak Campground	$17,000
93	Communication	GREAT SMOKY MOUNTAIN	Chimneys Picnic Area	$17,000
94	Communication	GREAT SMOKY MOUNTAIN	Clingmans Dome Parking Area	$17,000
95	Communication	GUADALUPE MOUNTAINS N	Pine Backcountry Cabin	$17,000
96	Communication	GUADALUPE MOUNTAINS N	Pratt Lodge	$17,000
97	Communication	GUADALUPE MOUNTAINS N	Second Repeater Site	$33,000
98	Communication	KATMAI NP	Aniakchak	$33,000
99	Communication	KATMAI NP	Mountain Top Repeaters	$33,000
100	Communication	KENAI FJORDS NP	Aialik Bay Ranger Station	$33,000
101	Communication	KENAI FJORDS NP	Exit Glacier Cabins	$33,000
102	Communication	KENAI FJORDS NP	Nuka Bay Ranger Station	$33,000
103	Communication	KNIFE RIVER INDIAN VILLA	Radio Shack	$17,000
104	Communication	LAKE CLARK NP	Chiltnabay	$33,000
105	Communication	LAKE CLARK NP	Cresent Lake	$33,000
106	Communication	LAKE MEAD NRA	Boulose Beach	$4,000
107	Communication	LAKE MEAD NRA	Callville Bay	$4,000
108	Communication	LAKE MEAD NRA	Cottonwood	$4,000
109	Communication	LAKE MEAD NRA	Echo Bay	$8,000
110	Communication	LAKE MEAD NRA	Katherine	$4,000
111	Communication	LAKE MEAD NRA	Meadview	$17,000
112	Communication	LAKE MEAD NRA	Overton Beach	$4,000
113	Communication	LAKE MEAD NRA	Princess Cove	$4,000
114	Communication	LAKE MEAD NRA	Temple Bar	$8,000
115	Communication	LAKE MEAD NRA	Willow Beach	$4,000
116	Communication	MORRISTOWN NHP	Museum	$17,000
117	Communication	MORRISTOWN NHP	Visitor Center	$17,000
118	Communication	NAVAJO NM	Development Area	$17,000
119	Communication	NAVAJO NM	Keet Seel Ranger Station	$17,000
120	Communication	NEZ PERCE NHP	Buffalo Eddy	$8,000
121	Communication	NEZ PERCE NHP	Whitebird Site	$8,000
122	Communication	OLYMPIC NP	Dosewallips	$25,000
123	Communication	OLYMPIC NP	Graves Creek Ranger Station	$25,000
124	Communication	OLYMPIC NP	North Fork Ranger Station	$25,000
125	Communication	OLYMPIC NP	Queets Ranger Station	$25,000
126	Communication	OLYMPIC NP	Staircase	$25,000
127	Communication	PEA RIDGE NMP	Visitor Center Complex	$8,000
128	Communication	PECOS NM	Shooting Towers	$17,000
129	Communication	PETRIFIED FOREST NP	Ranger Office	$8,000
130	Communication	PICTURED ROCKS NL	Au Sable Light Station	$17,000
131	Communication	PINNACLES NM	Chaparral West District	$17,000
132	Communication	PRINCE WILLIAM FOREST P	Repeater Station	$17,000
133	Communication	REDWOODS NM	Howland Hill Outdoor School	$17,000
134	Communication	REDWOODS NM	Park-wide	$17,000
135	Communication	SEQUOIA NP	14 Back Country Ranger Stat	$116,000
136	Communication	SEQUOIA NP	Crystal Cave	$17,000
137	Communication	SEQUOIA NP	Hole In The Wall	$17,000
138	Communication	SEQUOIA NP	Pear Lake Ranger Station	$17,000
139	Communication	SEQUOIA NP	South Fork Campground	$8,000
140	Communication	THEODORE ROOSEVELT N	North And South Units	$70,000

141	Communication	TONTO NATIONAL MONUM	Entrance/Park General	$17,000
142	Communication	TONTO NATIONAL MONUM	Lower Ruins	$17,000
143	Communication	TONTO NATIONAL MONUM	Upper Ruins	$17,000
144	Communication	TUMACACORI NM	Calabazas Mission	$17,000
145	Communication	TUMACACORI NM	Guevavi Mission	$17,000
146	Communication	WHISKEYTOWN-SHASTA-T	South Fork Mountain	$17,000
147	Communication	WHITE SANDS NM	Contact Station	$8,000
148	Communication	YELLOWSTONE NP	Beartooth	$17,000
149	Communication	YELLOWSTONE NP	Parkwide	$59,000
150	Communication	YOSEMITE NP	Crane Flat Developed Area	$17,000
151	Communication	YOSEMITE NP	Lake Eleanor Ranger Station	$33,000
152	Communication	YOSEMITE NP	Wawona Point Repeater	$19,000
153	Communication	YOSEMITE NP	White Wolf Developed Area	$17,000
154	Communication	YUKON CHARLEY RIVERS N	Coal Creek Camp	$33,000
155	Composting/Pit Toilet Fan	ASSATEAGUE ISLAND NS	Composting Toilets	$2,000
156	Composting/Pit Toilet Fan	BIGHORN CANYON NRA	Barrys Landing Trail Creek	$6,000
157	Composting/Pit Toilet Fan	CAPE COD NS	Great Island Picnic Area	$2,000
158	Composting/Pit Toilet Fan	CAPE COD NS	Herring Cove Beach	$2,000
159	Composting/Pit Toilet Fan	CAPITOL REEF NP	Hickman Bridge Trailhead	$2,000
160	Composting/Pit Toilet Fan	GATEWAY NRA	Fort Tilden	$2,000
161	Composting/Pit Toilet Fan	GATEWAY NRA	Great Kill Marina	$2,000
162	Composting/Pit Toilet Fan	GATEWAY NRA	Sandy Hook	$2,000
163	Composting/Pit Toilet Fan	GRAND CANYON NP	Compost Toilet Rim Locations	$13,000
164	Composting/Pit Toilet Fan	GRAND CANYON NP	Compost Toilets-inner Canyon	$9,000
165	Composting/Pit Toilet Fan	GUADALUPE MOUNTAINS N	Pine Backcountry Cabin	$2,000
166	Composting/Pit Toilet Fan	LASSEN VOLCANIC NP	Drakesbad Guest Ranch	$2,000
167	Composting/Pit Toilet Fan	OZARK NSR	Parkwide Restroom Exhausts	$21,000
168	Composting/Pit Toilet Fan	REDWOODS NM	Park-wide	$2,000
169	Elect. Vehicle Recharge Station	AZTEC RUINS NM	Maintenance Area	$23,000
170	Elect. Vehicle Recharge Station	CARLSBAD CAVERNS NP	Maintenance Yard	$23,000
171	Elect. Vehicle Recharge Station	CHAMIZAL NMEM	Park Grounds	$23,000
172	Elect. Vehicle Recharge Station	CRATERS OF THE MOON N	Headquarters	$23,000
173	Elect. Vehicle Recharge Station	FORT LARNED NHS	Maintenance Area	$23,000
174	Elect. Vehicle Recharge Station	GRAND TETON NP	Tac Command Post	$23,000
175	Elect. Vehicle Recharge Station	GUADALUPE MOUNTAINS N	Electric Vehicles (3)	$23,000
176	Elect. Vehicle Recharge Station	HERBERT HOOVER NHS	B52 Maint. Shop	$23,000
177	Elect. Vehicle Recharge Station	KNIFE RIVER INDIAN VILLA	Cushman Electric Cart	$23,000
178	Elect. Vehicle Recharge Station	MOORES CREEK NB	Visitor Center	$23,000
179	Elect. Vehicle Recharge Station	SLEEPING BEAR DUNES NL	Dh Day Campground	$23,000
180	Elect. Vehicle Recharge Station	SLEEPING BEAR DUNES NL	Platte River Campground	$23,000
181	Electric Fence Charger	BADLANDS NP	Badlands Wilderness	$2,000
182	Electric Fence Charger	GOLDEN SPIKE NHS	Headquarters	$2,000
183	Electric Fence Charger	ROCKY MOUNTAIN NP	Horseshoe Park	$2,000
184	Info/traffic Warning Signs	BALTIMORE-WASHINGTON	Parkway	$80,000
185	Info/traffic Warning Signs	BIGHORN CANYON NRA	Black Canyon	$4,000
186	Info/traffic Warning Signs	BIGHORN CANYON NRA	Park Lane	$4,000
187	Info/traffic Warning Signs	BIGHORN CANYON NRA	Park Lane Docks/comf Station	$4,000
188	Info/traffic Warning Signs	CARLSBAD CAVERNS NP	Helicopter Landing Pad	$4,000
189	Info/traffic Warning Signs	CRATER LAKE NP	Cleetwood Cove Trailhead	$4,000
190	Info/traffic Warning Signs	CRATER LAKE NP	North Entrance Station	$4,000
191	Info/traffic Warning Signs	CRATERS OF THE MOON N	Campground	$8,000
192	Info/traffic Warning Signs	CURECANTI NRA	Blue Mesa Reservoir (see Wk)	$4,000
193	Info/traffic Warning Signs	CURECANTI NRA	Elk Creek Cg	$4,000
194	Info/traffic Warning Signs	GREAT BASIN NP	Baker Hw 487 & 488	$4,000
195	Info/traffic Warning Signs	HERBERT HOOVER NHS	Parkside Drive	$8,000
196	Info/traffic Warning Signs	KATMAI NP	Lake Camp	$4,000
197	Info/traffic Warning Signs	LAKE MEAD NRA	Temple Bar	$8,000
198	Info/traffic Warning Signs	LAKE MEAD NRA	Willow Beach	$8,000
199	Info/traffic Warning Signs	MINUTE MAN NHP	Parkwide	$8,000
200	Info/traffic Warning Signs	NEZ PERCE NHP	Whitebird Site	$4,000
201	Info/traffic Warning Signs	NORTH CASCADES NP	Hwy 20 Colonial Campground	$4,000
202	Info/traffic Warning Signs	NORTH CASCADES NP	Hwy 20 Gorge Creek	$8,000
203	Info/traffic Warning Signs	NORTH CASCADES NP	Hwy 20 Tunnel 1	$8,000
204	Info/traffic Warning Signs	ORGAN PIPE CACTUS NM	North Entrance	$4,000
205	Info/traffic Warning Signs	PADRE ISLAND NS	Park Road	$8,000
206	Info/traffic Warning Signs	TONTO NATIONAL MONUM	Entrance/Park General	$4,000
207	Info/traffic Warning Signs	ZION NP	Headquarters Area	$8,000
208	Information Center	CAPITOL REEF NP	Burr Trail Notom Rd -(P)	$18,000
209	Irrigation Control Valves (ea)	JEFF NATIONAL EXPANSIO	Gateway Arch Grounds	$11,000
210	Lighting	BIG SOUTH FORK NR	Charit Creekd Lodge	$18,000
211	Lighting	FORT DAVIS NHS	B-68 Bally Bldg	$6,000
212	Lighting	WILSON'S CREEK NB	Park General	$15,000
213	Lighting, Basketball Court	CARLSBAD CAVERNS NP	Basketball Court/picnic Area	$21,000

214	Lighting, Boat Ramp	LAKE MEREDITH NRA	Harbor Bay	$8,000
215	Lighting, Building Dock	BIGHORN CANYON NRA	Park Lane Docks/comf Station	$8,000
216	Lighting, Building/Shelter	BIGHORN CANYON NRA	Park Vault Toilets	$11,000
217	Lighting, Building/Shelter	CURECANTI NRA	Various-20	$21,000
218	Lighting, Bulletin Board	GREAT BASIN NP	Lehman Creek Campground	$3,000
219	Lighting, Bulletin Board	GREAT BASIN NP	Wheeler Peak Campground	$3,000
220	Lighting, Cave System	CARLSBAD CAVERNS NP	Cavern	$181,000
221	Lighting, Contact Station	GRAND CANYON NP	North Rim	$3,000
222	Lighting, Dock	EVERGLADES NP	Dry Tortugas/Ft. Jefferson	$9,000
223	Lighting, Emergency Restroom	GREAT BASIN NP	Lehman Creek Campground	$2,000
224	Lighting, Emergency Restroom	GREAT BASIN NP	Wheeler Peak Campground	$2,000
225	Lighting, Navigation on Bridge	NATCHEZ TRACE PKWY	Tenn River Bridge	$16,000
226	Lighting, Recycle Station	NORTH CASCADES NP	Colonial Campground	$7,000
227	Lighting, Recycle Station	NORTH CASCADES NP	Newhalem Campground	$7,000
228	Lighting, Residential	CARLSBAD CAVERNS NP	Park Housing	$38,000
229	Lighting, Security	PU'UHONUA O HONAUNAU	Pu'uhonua Nhp	$8,000
230	Lighting, Security	SITKA NHP	Curatorial	$8,000
231	Lighting, Security	SITKA NHP	Rbh	$8,000
232	Lighting, Security	SITKA NHP	Visitor Center	$8,000
233	Lighting, Spotlights	LINCOLN BOYHOOD NMEM	Parkwide	$23,000
234	Lighting, VC/Admin Bldg.	CARLSBAD CAVERNS NP	Visitor Center	$6,000
235	Lighting, VC/Admin Bldg.	PUUKOHOLA HEIAU NHS	Pu'ukohola Heiau NHS	$6,000
236	Lighting/interp Display	CARLSBAD CAVERNS NP	Underground Concession	$23,000
237	Lighting; Path, Trails, Walkway	AZTEC RUINS NM	Visitor Center	$6,000
238	Lighting; Path, Trails, Walkway	BADLANDS NP	Cedar Pass Developed Area	$6,000
239	Lighting; Path, Trails, Walkway	BIG BEND NP	Amphtheater Walking	$6,000
240	Lighting; Path, Trails, Walkway	CARLSBAD CAVERNS NP	Entrance Trail	$6,000
241	Lighting; Path, Trails, Walkway	NORTH CASCADES NP	Stehekin District	$6,000
242	Other	GEORGE WASHINGTON BP	Gift Shop	$18,000
243	Other	GEORGE WASHINGTON BP	Visitor Center	$18,000
244	Other	GUILFORD COURTHOUSE	Visitor Center	$18,000
245	Other	SANTA MONICA MOUNTAIN	Circle X Ranch	$18,000
246	Phone Patch	GREAT BASIN NP	Wheeler Peak Campground	$4,000
247	Portable Power Stations	CAPE HATTERAS NS	Parkwide	$21,000
248	Portable Power Stations	CARLSBAD CAVERNS NP	Recreation Complex	$21,000
249	Portable Power Stations	GREAT BASIN NP	Baker Creek Vip Site	$21,000
250	Portable Power Stations	GREAT BASIN NP	Lehnam Creek Vip Site	$21,000
251	Portable Power Stations	GREAT BASIN NP	Wheeler Peak Vip Site	$21,000
252	Portable Power Stations	HOMESTEAD NM OF AMERI	Residence Quarters	$21,000
253	Portable Power Stations	HOMESTEAD NM OF AMERI	Residence Quarters	$21,000
254	Portable Power Stations	HOMESTEAD NM OF AMERI	Visitor Center	$21,000
255	Portable Power Stations	PEA RIDGE NMP	Visitor Center Complex	$21,000
256	Portable Power Stations	YELLOWSTONE NP	Clear Creek Fish Trap	$21,000
257	Power Tools	SEQUOIA NP	Hole In The Wall	$14,000
258	Quarters Areas	OLYMPIC NP	Dosewallips	$39,000
259	Quarters Areas	OLYMPIC NP	Staircase	$39,000
260	Ranger Station	LASSEN VOLCANIC NP	Butte Lake Campground	$19,000
261	Remote Campground Development	ARCHES NP	Devils Garden	$12,000
262	Remote Campground Development	BIGHORN CANYON NRA	Black Canyon	$12,000
263	Remote Campground Development	BIGHORN CANYON NRA	Garrys Landing Trail Creek	$12,000
264	Remote Campground Development	BRYCE CANYON NP	North Campground Info Board	$6,000
265	Remote Campground Development	BUFFALO NR	Backcountry (13 Each)	$26,000
266	Remote Campground Development	CURECANTI NRA	Dry Gulch Cg	$12,000
267	Remote Campground Development	CURECANTI NRA	East Elk Creek Cg	$12,000
268	Remote Campground Development	CURECANTI NRA	Elk Creek Cg	$12,000
269	Remote Campground Development	CURECANTI NRA	Gateview Cg	$12,000
270	Remote Campground Development	CURECANTI NRA	Ponderosa Cg	$12,000
271	Remote Campground Development	CURECANTI NRA	Red Creek Cg	$12,000
272	Remote Campground Development	GREAT BASIN NP	Baker Creek Campground	$12,000
273	Remote Campground Development	GREAT BASIN NP	Lehman Creek Campground	$12,000
274	Remote Campground Development	GREAT BASIN NP	Snake Creek	$12,000
275	Remote Campground Development	GREAT BASIN NP	Strawberry Creek	$12,000
276	Remote Campground Development	GREAT BASIN NP	Wheeler Peak Campground	$12,000
277	Remote Campground Development	GREAT SMOKY MOUNTAIN	Balsam Mountain	$12,000
278	Remote Campground Development	GUADALUPE MOUNTAINS N	Backcountry Toilets (10)	$21,000
279	Remote Campground Development	KATMAI NP	Aniakchak	$19,000
280	Remote Campground Development	KATMAI NP	Lake Camp	$19,000
281	Remote Campground Development	KENAI FJORDS NP	Exit Glacier Cg	$19,000
282	Remote Campground Development	LAKE MEAD NRA	Meadview	$19,000
283	Remote Campground Development	LAKE MEAD NRA	Overton Beach	$12,000
284	Remote Campground Development	LAKE MEAD NRA	Princess Cove	$19,000
285	Remote Campground Development	LASSEN VOLCANIC NP	Butte Lake Campground (5ea)	$24,000
286	Remote Campground Development	LASSEN VOLCANIC NP	Summit Lake Campground (2ea)	$12,000

287	Remote Campground Development	NAVAJO NM	Development Area	$12,000
288	Remote Campground Development	YOSEMITE NP	White Wolf Develped Area	$12,000
289	Remote Facility Power	ACADIA NP	Isle An Haut	$36,000
290	Remote Facility Power	ARCHES NP	Devils Garden	$88,000
291	Remote Facility Power	BIG BEND NP	Basin Restrooms	$12,000
292	Remote Facility Power	BIG BEND NP	Castolon	$381,000
293	Remote Facility Power	BIG BEND NP	Chisos Basin	$381,000
294	Remote Facility Power	BIG BEND NP	Packer Barn	$6,000
295	Remote Facility Power	BIG BEND NP	Panther Junction	$1,876,000
296	Remote Facility Power	BIG BEND NP	Persimmon Gap	$41,000
297	Remote Facility Power	BIG BEND NP	Rio Grande Village	$328,000
298	Remote Facility Power	BIGHORN CANYON NRA	South Unit	$59,000
299	Remote Facility Power	CANYONLANDS NP	Maze District	$293,000
300	Remote Facility Power	CAPITOL REEF NP	East Boundry Hwy 24 (P)	$4,000
301	Remote Facility Power	CAPITOL REEF NP	Hickman Bridge Trailhead (P)	$4,000
302	Remote Facility Power	CAPITOL REEF NP	West Boundary Hwy 24 (P)	$4,000
303	Remote Facility Power	CATOCTIN MOUNTAIN PAR	Catoctin Mnt. Park Hog Rock	$2,000
304	Remote Facility Power	CHANNEL ISLANDS NP	San Miguel Island	$176,000
305	Remote Facility Power	CHANNEL ISLANDS NP	Santa Cruz Island	$176,000
306	Remote Facility Power	CHANNEL ISLANDS NP	Santa Rosa Island	$586,000
307	Remote Facility Power	CRATER LAKE NP	Cleetwood Cove Trailhead	$18,000
308	Remote Facility Power	CURECANTI NRA	Blue Mesa Reservoir (see Wk)	$1,000
309	Remote Facility Power	CURECANTI NRA	Various-20	$12,000
310	Remote Facility Power	FIRE ISLAND NS	Lighthouse & Annex	$205,000
311	Remote Facility Power	FIRE ISLAND NS	Old Inlet	$41,000
312	Remote Facility Power	FIRE ISLAND NS	Sailors Haven	$141,000
313	Remote Facility Power	FIRE ISLAND NS	Simth Point	$117,000
314	Remote Facility Power	FIRE ISLAND NS	Talisman	$96,000
315	Remote Facility Power	FIRE ISLAND NS	Watch Hill	$279,000
316	Remote Facility Power	FORT DAVIS NHS	B-104 Church Camp	$82,000
317	Remote Facility Power	FORT STANWIX NM	Maintenance Building	$94,000
318	Remote Facility Power	GILA CLIFF DWELLINGS NM	Contact Station	$23,000
319	Remote Facility Power	GILA CLIFF DWELLINGS NM	Residences	$59,000
320	Remote Facility Power	GILA CLIFF DWELLINGS NM	Visitor Center	$94,000
321	Remote Facility Power	GLACIER NP	Belly River Ranger Station	$3,000
322	Remote Facility Power	GLACIER NP	Granite Park Chalet	$4,000
323	Remote Facility Power	GLACIER NP	Sperry Chalet	$1,000
324	Remote Facility Power	GLEN CANYON NRA	Bullfrog	$1,759,000
325	Remote Facility Power	GLEN CANYON NRA	Halls Crossing	$1,759,000
326	Remote Facility Power	GLEN CANYON NRA	Hite	$1,173,000
327	Remote Facility Power	GOLDEN GATE NRA	Pedestrial Trails	$6,000
328	Remote Facility Power	GRAND CANYON NP	Cottonwood R.S.	$23,000
329	Remote Facility Power	GRAND CANYON NP	Pasture Washington South Rim	$9,000
330	Remote Facility Power	GRAND TETON NP	Lower Saddle	$3,000
331	Remote Facility Power	GUADALUPE MOUNTAINS N	Park Housing	$56,000
332	Remote Facility Power	GUADALUPE MOUNTAINS N	Pine Backcountry Cabin	$6,000
333	Remote Facility Power	GUADALUPE MOUNTAINS N	Pratt Lodge	$12,000
334	Remote Facility Power	GUADALUPE MOUNTAINS N	West Sede Raws	$12,000
335	Remote Facility Power	GULF ISLANDS NS	Horn Island	$29,000
336	Remote Facility Power	GULF ISLANDS NS	Ship Island	$53,000
337	Remote Facility Power	HALEAKALA NP	Kipahulu Maint Facility	$106,000
338	Remote Facility Power	HALEAKALA NP	Kipahulu Ranger Station	$82,000
339	Remote Facility Power	HAWAII VOLCANOES NP	Eruption Site	$41,000
340	Remote Facility Power	ISLE ROYAL	Windigo	$1,407,000
341	Remote Facility Power	JOSHUA TREE NM	Lost Horse	$41,000
342	Remote Facility Power	KALOKO-HONOKOHAU NHP	Kaloko Comfort Station	$53,000
343	Remote Facility Power	KALOKO-HONOKOHAU NHP	Kaloko Contact Station	$53,000
344	Remote Facility Power	KENAI FJORDS NP	Aialik Bay Ranger Station	$14,000
345	Remote Facility Power	KENAI FJORDS NP	Coastal Public Use Cabins 4	$29,000
346	Remote Facility Power	KENAI FJORDS NP	Exit Glacier Cabins	$35,000
347	Remote Facility Power	KENAI FJORDS NP	Nuka Bay Ranger Station	$12,000
348	Remote Facility Power	LAKE CLARK NP	Chiltnabay	$12,000
349	Remote Facility Power	LAKE CLARK NP	Cresent Lake	$12,000
350	Remote Facility Power	LAKE CLARK NP	Twin & Telaquina Lakes	$12,000
351	Remote Facility Power	LAKE MEAD NRA	Meadview	$4,000
352	Remote Facility Power	LAKE MEAD NRA	Princess Cove	$4,000
353	Remote Facility Power	LAKE MEAD NRA	Shivwits	$26,000
354	Remote Facility Power	LAKE MEAD NRA	Temple Bar	$4,000
355	Remote Facility Power	LAKE MEAD NRA	Willow Beach	$2,000
356	Remote Facility Power	LASSEN VOLCANIC NP	Butte Lake Campground	$352,000
357	Remote Facility Power	LASSEN VOLCANIC NP	Drakesbad Guest Ranch	$76,000
358	Remote Facility Power	LASSEN VOLCANIC NP	Summit Lake Campground	$41,000
359	Remote Facility Power	LITTLE BIGHORN BATTLEFI	Reno-benteen Site	$6,000

360	Remote Facility Power	MAMMOTH CAVE NP	Backcountry	$18,000
361	Remote Facility Power	MESA VERDE NP	Wetherill Mesa	$18,000
362	Remote Facility Power	MORRISTOWN NHP	Maintenance Area	$12,000
363	Remote Facility Power	MORRISTOWN NHP	Museum	$12,000
364	Remote Facility Power	MORRISTOWN NHP	Visitor Center	$12,000
365	Remote Facility Power	NAVAJO NM	Keet Seel Ranger Station	$52,000
366	Remote Facility Power	NORTH CASCADES NP	Ross Lake - Lightning Float	$18,000
367	Remote Facility Power	NORTH CASCADES NP	Stehekin District	$23,000
368	Remote Facility Power	OLYMPIC NP	Deer Park Ranger Station	$82,000
369	Remote Facility Power	OLYMPIC NP	Dosewallips	$82,000
370	Remote Facility Power	OLYMPIC NP	Graves Creek Ranger Station	$82,000
371	Remote Facility Power	OLYMPIC NP	North Fork Ranger Station	$70,000
372	Remote Facility Power	OLYMPIC NP	Queets Ranger Station	$82,000
373	Remote Facility Power	OLYMPIC NP	Staircase	$82,000
374	Remote Facility Power	PADRE ISLAND NS	Down Patrol Facility	$26,000
375	Remote Facility Power	PICTURED ROCKS NL	Au Sable Light Station	$199,000
376	Remote Facility Power	PINNACLES NM	Chaparral West District	$150,000
377	Remote Facility Power	REDWOODS NM	Howland Hill Outdoor School	$35,000
378	Remote Facility Power	SAGUARO NM	Manning Cabin	$18,000
379	Remote Facility Power	SALINAS PUEBLO MISSION	Abo Visitor Center	$106,000
380	Remote Facility Power	SALINAS PUEBLO MISSION	Gran Quivira Visitor Center	$106,000
381	Remote Facility Power	SALINAS PUEBLO MISSION	Quaral Visitor Center	$106,000
382	Remote Facility Power	SEQUOIA NP	14 Back Country Ranger Stat	$131,000
383	Remote Facility Power	SEQUOIA NP	Hole In The Wall	$35,000
384	Remote Facility Power	SEQUOIA NP	Pear Lake Ranger Station	$20,000
385	Remote Facility Power	SEQUOIA NP	South Fork Campground	$26,000
386	Remote Facility Power	SLEEPING BEAR DUNES NL	Boales Farm	$223,000
387	Remote Facility Power	SLEEPING BEAR DUNES NL	South Manitou Island	$519,000
388	Remote Facility Power	THEODORE ROOSEVELT N	South Unit Group Camping	$18,000
389	Remote Facility Power	TONTO NATIONAL MONUM	Entrance/Park General	$18,000
390	Remote Facility Power	TONTO NATIONAL MONUM	Lower Ruins	$23,000
391	Remote Facility Power	TONTO NATIONAL MONUM	Upper Ruins	$23,000
392	Remote Facility Power	TUMACACORI NM	Calabazas Mission	$59,000
393	Remote Facility Power	TUMACACORI NM	Guevavi Mission	$59,000
394	Remote Facility Power	WHITE SANDS NM	Contact Station	$12,000
395	Remote Facility Power	YELLOWSTONE NP	Beartooth	$141,000
396	Remote Facility Power	YELLOWSTONE NP	Clear Creek Fish Trap	$47,000
397	Remote Facility Power	YELLOWSTONE NP	Lamar (100KWH/Day)	$188,000
398	Remote Facility Power	YOSEMITE NP	Bridalveil Falls Restroom	$18,000
399	Remote Facility Power	YOSEMITE NP	Cathedral Beach Restroom	$18,000
400	Remote Facility Power	YOSEMITE NP	Church Bowl Restroom	$18,000
401	Remote Facility Power	YOSEMITE NP	Crane Flat Developed Area	$733,000
402	Remote Facility Power	YOSEMITE NP	Devils Elbow Restroom	$18,000
403	Remote Facility Power	YOSEMITE NP	El Capitan Restroom	$18,000
404	Remote Facility Power	YOSEMITE NP	Lake Eleanor Ranger Station	$94,000
405	Remote Facility Power	YOSEMITE NP	Lambert Dome Restrooms	$18,000
406	Remote Facility Power	YOSEMITE NP	Merced L. Ranger Station	HYDRO
407	Remote Facility Power	YOSEMITE NP	Mirrow Lake Restroom	$18,000
408	Remote Facility Power	YOSEMITE NP	Muir Tree Restroom	$18,000
409	Remote Facility Power	YOSEMITE NP	Sentinel Beach Restroom	$18,000
410	Remote Facility Power	YOSEMITE NP	Swinging Bridge Restroom	$18,000
411	Remote Facility Power	YOSEMITE NP	Tenaya East Water System	$82,000
412	Remote Facility Power	YOSEMITE NP	Valley View Restroom	$18,000
413	Remote Facility Power	YOSEMITE NP	White Wolf Develped Area	$821,000
414	Remote Facility Power	YUKON CHARLEY RIVERS N	Slavens Cabin	$12,000
415	Remote Facility Power	ZION NP	Fire Pit Knoll Cabin	$18,000
416	Remote Facility Power	ZION NP	Lower Kolob Terrace Cabin	$18,000
417	Residential	CAPITOL REEF NP	Peek-a-boo Area -(P)	$39,000
418	Residential	CHANNEL ISLANDS NP	Santa Rosa Island (4ea)	$158,000
419	Residential	NAVAJO NM	Housing Area	$39,000
420	Residential	PINNACLES NM	Chaparral West District	$39,000
421	Resource Monitoring Equipment	CHESAPEAKE & OHIO CAN	Parkwide	$3,000
422	Resource Monitoring Equipment	CONGAREE SWAMP NM	Congaree River	$3,000
423	Resource Monitoring Equipment	CORONADO NMEM	Parkwide	$3,000
424	Resource Monitoring Equipment	DENALI NP	Mt Mckinley Met Station	$3,000
425	Resource Monitoring Equipment	DENALI NP	Rock Creek Lower Site	$3,000
426	Resource Monitoring Equipment	DENALI NP	Rock Creek Treeline Site	$3,000
427	Resource Monitoring Equipment	EVERGLADES NP	Dry Tortugas/Ft. Jefferson	$3,000
428	Resource Monitoring Equipment	EVERGLADES NP	Various	$3,000
429	Resource Monitoring Equipment	GOLDEN GATE NRA	Mt Tam	$3,000
430	Resource Monitoring Equipment	GRAND CANYON NP	Compost Toilet Rim Locations	$3,000
431	Resource Monitoring Equipment	GRAND CANYON NP	Compost Toilets-inner Canyon	$3,000
432	Resource Monitoring Equipment	GRAND CANYON NP	Pasture Washington South Rim	$3,000

433	Resource Monitoring Equipment	GRAND TETON NP	Lower Saddle	$3,000
434	Resource Monitoring Equipment	GRAND TETON NP	Parkwide	$3,000
435	Resource Monitoring Equipment	GUADALUPE MOUNTAINS N	West Sede Raws	$3,000
436	Resource Monitoring Equipment	HAWAII VOLCANOES NP		$3,000
437	Resource Monitoring Equipment	HOT SPRINGS NP	Administration Building	$3,000
438	Resource Monitoring Equipment	KATMAI NP	Aniakchak	$3,000
439	Resource Monitoring Equipment	KENAI FJORDS NP	Aialik Bay Ranger Station	$3,000
440	Resource Monitoring Equipment	KENAI FJORDS NP	Exit Glacier Cabins	$3,000
441	Resource Monitoring Equipment	KENAI FJORDS NP	Nuka Bay Ranger Station	$3,000
442	Resource Monitoring Equipment	KNIFE RIVER INDIAN VILLA	Proposed Weather Station	$3,000
443	Resource Monitoring Equipment	LAKE MEAD NRA	Echo Bay	$3,000
444	Resource Monitoring Equipment	LAKE MEAD NRA	Katherine	$3,000
445	Resource Monitoring Equipment	LAKE MEAD NRA	Shivwits	$3,000
446	Resource Monitoring Equipment	MAMMOTH CAVE NP	Backcountry	$5,000
447	Resource Monitoring Equipment	MINUTE MAN NHP	Parkwide	$3,000
448	Resource Monitoring Equipment	MOORES CREEK NB	Historic Bridge Site	$3,000
449	Resource Monitoring Equipment	MORRISTOWN NHP	Maintenance Area	$3,000
450	Resource Monitoring Equipment	NORTH CASCADES NP	Stehekin District	$3,000
451	Resource Monitoring Equipment	TIMPANOGOS CAVE NM	Air Quality Site	$3,000
452	Resource Monitoring Equipment	TIMPANOGOS CAVE NM	Cliffs Behind Admin Building	$3,000
453	Resource Monitoring Equipment	TONTO NATIONAL MONUM	Entrance/Park General	$3,000
454	Resource Monitoring Equipment	TONTO NATIONAL MONUM	Lower Ruins	$3,000
455	Resource Monitoring Equipment	TONTO NATIONAL MONUM	Upper Ruins	$3,000
456	Resource Monitoring Equipment	TUMACACORI NM	Calabazas Mission	$3,000
457	Resource Monitoring Equipment	TUMACACORI NM	Guevavi Mission	$3,000
458	Resource Monitoring Equipment	YELLOWSTONE NP	Parkwide	$3,000
459	Resource Monitoring Equipment	YUKON CHARLEY RIVERS N	Various Locations	$12,000
460	Restroom Lighting, Pwr, or Venting	CAPE HATTERAS NS	Coquina Beach Bathhouse	$18,000
461	Restroom Lighting, Pwr, or Venting	CAPE HATTERAS NS	Pea Island Overlook	$15,000
462	Restroom Lighting, Pwr, or Venting	GREAT BASIN NP	Lehman Creek Campground	$7,000
463	Restroom Lighting, Pwr, or Venting	HERBERT HOOVER NHS	B68 Comfort Station	$2,000
464	Restroom Lighting, Pwr, or Venting	ORGAN PIPE CACTUS NM	Campground Hq	$41,000
465	Restroom Lighting, Pwr, or Venting	SLEEPING BEAR DUNES NL	Esch Road	$8,000
466	Restroom Lighting, Pwr, or Venting	SLEEPING BEAR DUNES NL	North Bar Lake	$8,000
467	Restroom Lighting, Pwr, or Venting	SLEEPING BEAR DUNES NL	Outpost Campground	$9,000
468	Restroom Lighting, Pwr, or Venting	SLEEPING BEAR DUNES NL	Peterson Road	$9,000
469	Restroom Lighting, Pwr, or Venting	SLEEPING BEAR DUNES NL	Trails End	$9,000
470	Restrooms / Rest Area	CAPITOL REEF NP	East Boundry Hwy 24	$18,000
471	Restrooms / Rest Area	CAPITOL REEF NP	West Boundary Hwy 24	$18,000
472	Restrooms / Rest Area	CORONADO NMEM	Parkwide	$18,000
473	Restrooms / Rest Area	YOSEMITE NP	Tamarak Flat Cg (4 Each)	$18,000
474	Restrooms / Rest Area	YOSEMITE NP	Tuolumne Meadows Cg (8 Each)	$18,000
475	Restrooms / Rest Area	YOSEMITE NP	Yosemite Creek Cg (5 Each)	$18,000
476	Sewage Lift Station	COLONIAL NHP	Jamestown Visitor Center	$21,000
477	Sewage Lift Station	COLONIAL NHP	Yorktown Maintenance	$12,000
478	Sewage Lift Station	GUADALUPE MOUNTAINS N	Mckittrick Canyon Vc	$14,000
479	Sewage System	FIRE ISLAND NS	Lighthouse & Annex	$23,000
480	Sewage System	FIRE ISLAND NS	Sailors Haven	$29,000
481	Sewage System	FIRE ISLAND NS	Talisman	$26,000
482	Sewage System	FIRE ISLAND NS	Watch Hill	$35,000
483	Street Lights	CAPE HATTERAS NS	Canadian Hole	$13,000
484	Street Lights	CAPITOL REEF NP	East Boundry Hwy 24 - (P)	$6,000
485	Street Lights	CAPITOL REEF NP	West Boundary Hwy 24 - (P)	$6,000
486	Street Lights	CAPULIN VOLCANO NM	Maintenance Yard	$13,000
487	Street Lights	CARLSBAD CAVERNS NP	Housing Area	$26,000
488	Street Lights	CATOCTIN MOUNTAIN PAR	Catoctin Mnt. Park Hog Rock	$26,000
489	Street Lights	CATOCTIN MOUNTAIN PAR	Gym	$26,000
490	Street Lights	CATOCTIN MOUNTAIN PAR	Round Meadow	$39,000
491	Street Lights	CHAMIZAL NMEM	Park Grounds	$129,000
492	Street Lights	CORONADO NMEM	Maintenance Yard	$6,000
493	Street Lights	COULEE DAM NRA	Evans Launch Ramp	$6,000
494	Street Lights	COULEE DAM NRA	Giifford Laurch Ramps	$6,000
495	Street Lights	COULEE DAM NRA	Hunters Launch Rays	$6,000
496	Street Lights	COULEE DAM NRA	Lincoln Launch Ramp	$6,000
497	Street Lights	CRATER LAKE NP	North Entrance Station	$13,000
498	Street Lights	CRATERS OF THE MOON N	Headquarters	$39,000
499	Street Lights	CUYAHOGA VALLEY NRA	B & U Parking Lot	$26,000
500	Street Lights	CUYAHOGA VALLEY NRA	Cvc Parking Lot	$45,000
501	Street Lights	CUYAHOGA VALLEY NRA	Duplexes Parking Lot	$13,000
502	Street Lights	CUYAHOGA VALLEY NRA	Happy Days N. Parking Lot	$39,000
503	Street Lights	CUYAHOGA VALLEY NRA	Headquarters Parking Lot	$13,000
504	Street Lights	CUYAHOGA VALLEY NRA	Hines Hill Conference Ctr	$19,000
505	Street Lights	CUYAHOGA VALLEY NRA	Homestead	$6,000

506	Street Lights	CUYAHOGA VALLEY NRA	Hunt Farm Contact Station	$13,000
507	Street Lights	CUYAHOGA VALLEY NRA	Indian Mound Trailhead	$26,000
508	Street Lights	CUYAHOGA VALLEY NRA	Lock 39 Trailhead	$26,000
509	Street Lights	CUYAHOGA VALLEY NRA	N. D. Ranger Station	$6,000
510	Street Lights	CUYAHOGA VALLEY NRA	S. D. Ranger Station	$13,000
511	Street Lights	CUYAHOGA VALLEY NRA	Vk Lake Parking Lot	$52,000
512	Street Lights	CUYAHOGA VALLEY NRA	Vk Maintenance Lot	$19,000
513	Street Lights	FORT CLATSOP NMEM	Entrance Gate	$6,000
514	Street Lights	LAKE MEAD NRA	Boulose Beach	$193,000
515	Street Lights	LAKE MEAD NRA	Callville Bay	$193,000
516	Street Lights	LAKE MEAD NRA	Cottonwood	$19,000
517	Street Lights	LAKE MEAD NRA	Echo Bay	$39,000
518	Street Lights	LAKE MEAD NRA	Katherine	$39,000
519	Street Lights	LAKE MEAD NRA	Las Vegas Bay	$129,000
520	Street Lights	LAKE MEAD NRA	Meadview	$77,000
521	Street Lights	LAKE MEAD NRA	Overton Beach	$64,000
522	Street Lights	LAKE MEAD NRA	Princess Cove	$64,000
523	Street Lights	LAKE MEAD NRA	Temple Bar	$64,000
524	Street Lights	LAKE MEAD NRA	Willow Beach	$26,000
525	Street Lights	LAKE MEREDITH NRA	Chimney Hollow	$13,000
526	Street Lights	LAKE MEREDITH NRA	Harbor Bay	$13,000
527	Street Lights	LINCOLN BOYHOOD NMEM	Parkwide	$32,000
528	Street Lights	MINUTE MAN NHP	Parkwide	$26,000
529	Street Lights	MOORES CREEK NB	Patriots Hall	$39,000
530	Street Lights	MOORES CREEK NB	Visitor Center	$39,000
531	Street Lights	MORRISTOWN NHP	Visitor Center	$26,000
532	Street Lights	NATCHEZ TRACE PKWY	Comfort Stations	$64,000
533	Street Lights	NAVAJO NM	Development Area	$19,000
534	Street Lights	NAVAJO NM	Housing Area	$13,000
535	Street Lights	NEZ PERCE NHP	Buffalo Eddy	$6,000
536	Street Lights	NEZ PERCE NHP	Spalding Headquarters	$13,000
537	Street Lights	PIPESTONE NM	Parkwide	$19,000
538	Street Lights	SAN FRANCISCO MARITME	Aquatic/Victoman Park	$77,000
539	Street Lights	SEQUOIA NP	Hole In The Wall	$13,000
540	Street Lights	VANDERBILT MANSION NH	Elro Nhs Historic Core	$52,000
541	Street Lights	VANDERBILT MANSION NH	Hofr Nhs Parking Lot	$52,000
542	Street Lights	VANDERBILT MANSION NH	Vama Nhs Parking Lot	$39,000
543	Street Lights	WHISKEYTOWN-SHASTA-T	Hq, Brandy, Oak Bottom, Whis	$129,000
544	Street Lights	WOLF TRAP FARM PARK - P	Filene Center	$129,000
545	Street Lights	YELLOWSTONE NP	Clear Creek Fish Trap	$19,000
546	Tis Transmitter	CARLSBAD CAVERNS NP	Tis Transmitter	$4,000
547	Tis Transmitter	CRATER LAKE NP	Annie Springs	$4,000
548	Traffic Arrow Board	BALTIMORE-WASHINGTON	Parkway	$7,000
549	Traffic Counter	BLACK CANYON OT GUNNI	North Rim	$1,000
550	Traffic Counter	BLACK CANYON OT GUNNI	South Rim	$1,000
551	Traffic Counter	CARLSBAD CAVERNS NP	Traffic Counters	$1,000
552	Traffic Counter	EFFIGY MOUNDS NM	Sny Magill	$1,000
553	Traffic Counter	GREAT BASIN NP	Snake Creek Canyon Road	$4,000
554	Traffic Counter	GREAT BASIN NP	Strawberry Creek Canyon Rd	$4,000
555	Traffic Counter	GREAT BASIN NP	Wheeler Peak Scenic Drive	$4,000
556	Traffic Counter	KATMAI NP	Lake Camp	$1,000
557	Traffic Counter	MESA VERDE NP	Hovenweep	$1,000
558	Traffic Counter	NATCHEZ TRACE PKWY	Mp 415	$4,000
559	Traffic Counter	PADRE ISLAND NS	Park Road	$1,000
560	Traffic Counter	PRINCE WILLIAM FOREST P	Traffic Counter	$1,000
561	Water Filter	GREAT BASIN NP	Lehman Creek Campground	$9,000
562	Water Filter	GREAT BASIN NP	Wheeler Peak Campground	$9,000
563	Water Pumping	ACADIA NP	Cadillac Mt	See Remote Communication
564	Water Pumping	ACADIA NP	Isle An Haut	See Remote Faciliy Pwr
565	Water Pumping	BADLANDS NP	Badlands Wilderness	$14,000
566	Water Pumping	BIG BEND NP	K-Bar Wells	$76,000
567	Water Pumping	BIG BEND NP	Oak Springs	$47,000
568	Water Pumping	BIG SOUTH FORK NR	Charit Creekd Lodge	$14,000
569	Water Pumping	BLUE RIDGE PKWY	Cascades Comfort Station	$35,000
570	Water Pumping	BLUE RIDGE PKWY	Craggy Gardens Vc & Picnic A	$48,000
571	Water Pumping	BLUE RIDGE PKWY	Waterrock Knob	$43,000
572	Water Pumping	BRYCE CANYON NP	Yovempa Water System	$21,000
573	Water Pumping	CANYONLANDS NP	Maze District	$26,000
574	Water Pumping	CAPULIN VOLCANO NM	Well House	$63,000
575	Water Pumping	CHAMIZAL NMEM	Park Grounds	$88,000
576	Water Pumping	CHANNEL ISLANDS NP	San Miguel Island	$18,000
577	Water Pumping	CHANNEL ISLANDS NP	Santa Rosa Island	$106,000
578	Water Pumping	COLONIAL NHP	Jamestown Visitor Center	$27,000

579	Water Pumping	GUMBERLAND GAP NHP	Pinnacle	$84,000
580	Water Pumping	CURECANTI NRA	Dry Gulch Cg	$13,000
581	Water Pumping	CURECANTI NRA	East Elk Creek Cg	$13,000
582	Water Pumping	CURECANTI NRA	Gateview Cg	$13,000
583	Water Pumping	CURECANTI NRA	Ponderosa Cg	$18,000
584	Water Pumping	CURECANTI NRA	Red Creek Cg	$13,000
585	Water Pumping	DENALI NP	Savage Campground	$27,000
586	Water Pumping	DENALI NP	Teklanika Campground	$42,000
587	Water Pumping	DENALI NP	Wonderlake Campground	$47,000
588	Water Pumping	FIRE ISLAND NS	Lighthouse & Annex	$33,000
589	Water Pumping	FIRE ISLAND NS	Old Inlet	$21,000
590	Water Pumping	FIRE ISLAND NS	Sailors Haven	$59,000
591	Water Pumping	FIRE ISLAND NS	Simth Point	$53,000
592	Water Pumping	FIRE ISLAND NS	Talisman	$47,000
593	Water Pumping	FIRE ISLAND NS	Watch Hill	$88,000
594	Water Pumping	FORT DAVIS NHS	Pump House	$35,000
595	Water Pumping	GILA CLIFF DWELLINGS NM	Contact Station	$9,000
596	Water Pumping	GILA CLIFF DWELLINGS NM	Residences	$26,000
597	Water Pumping	GILA CLIFF DWELLINGS NM	Visitor Center	$16,000
598	Water Pumping	GLACIER NP	Bowman Ranger Station	$21,000
599	Water Pumping	GLACIER NP	Granite Park Chalet	$26,000
600	Water Pumping	GLACIER NP	Sperry Chalet	$6,000
601	Water Pumping	GRAND CANYON NP	Compost Toilet Rim Locations	$7,000
602	Water Pumping	GRANT-KOHRS RANCH NH	North Irrigation Pump (feas.)	$12,000
603	Water Pumping	GRANT-KOHRS RANCH NH	South Irrigation Pump (feas.)	$12,000
604	Water Pumping	GUADALUPE MOUNTAINS N	Mckittrick Canyon Vc	$16,000
605	Water Pumping	GUADALUPE MOUNTAINS N	Pratt Lodge	$5,000
606	Water Pumping	HALEAKALA NP	Kipahulu Maint Facility	$15,000
607	Water Pumping	JOSHUA TREE NM	Lost Horse	$12,000
608	Water Pumping	KENAI FJORDS NP	Aialik Bay Ranger Station	$7,000
609	Water Pumping	KENAI FJORDS NP	Coastal Public Use Cabins 4	$12,000
610	Water Pumping	KENAI FJORDS NP	Exit Glacier Cabins	$35,000
611	Water Pumping	KENAI FJORDS NP	Exit Glacier Cg	$12,000
612	Water Pumping	KENAI FJORDS NP	Nuka Bay Ranger Station	$7,000
613	Water Pumping	LASSEN VOLCANIC NP	Butte Lake Campground	$38,000
614	Water Pumping	NAVAJO NM	Development Area	$35,000
615	Water Pumping	NAVAJO NM	Housing Area	$4,000
616	Water Pumping	OLYMPIC NP	Dosewallips	$64,000
617	Water Pumping	OLYMPIC NP	Staircase	$64,000
618	Water Pumping	OZARK NSR	Ebb & Flow Spring	$9,000
619	Water Pumping	PECOS NM	Gateway Overlook	$9,000
620	Water Pumping	PECOS NM	North Pasture	$9,000
621	Water Pumping	PECOS NM	Trading Post Parking	$9,000
622	Water Pumping	PICTURED ROCKS NL	Au Sable Light Station	$19,000
623	Water Pumping	PINNACLES NM	Chaparral West District	$40,000
624	Water Pumping	REDWOODS NM	Howland Hill Outdoor School	$25,000
625	Water Pumping	SALINAS PUEBLO MISSION	Abo Visitor Center	$23,000
626	Water Pumping	SALINAS PUEBLO MISSION	Gran Quivira Visitor Center	$23,000
627	Water Pumping	SALINAS PUEBLO MISSION	Quarai Visitor Center	$23,000
628	Water Pumping	SEQUOIA NP	Hole In The Wall	$21,000
629	Water Pumping	SLEEPING BEAR DUNES NL	Esch Road	$16,000
630	Water Pumping	SLEEPING BEAR DUNES NL	North Bar Lake	$16,000
631	Water Pumping	SLEEPING BEAR DUNES NL	Peterson Road	$16,000
632	Water Pumping	SLEEPING BEAR DUNES NL	Trails End	$16,000
633	Water Pumping	THEODORE ROOSEVELT N	North And South Backcountry	$16,000
634	Water Pumping	TUMACACORI NM	Calabazas Mission	$14,000
635	Water Pumping	TUMACACORI NM	Guevavi Mission	$9,000
636	Water Pumping	YOSEMITE NP	Crane Flat Developed Area	See Remote Facility Pwr
637	Water Pumping	YOSEMITE NP	Lake Eleanor Ranger Station	$18,000
638	Water Pumping	YOSEMITE NP	Ostrander Ski Hut	$18,000
639	Water Pumping	YOSEMITE NP	Tenaya East Water System	$41,000
640	Water Pumping	YOSEMITE NP	White Wolf Develped Area	See Remote Facility Pwr
641	Water Pumping	YUKON CHARLEY RIVERS N	Coal Creek Camp	$18,000
642	Weather Station	FOSSIL BUTTE NM	Remote Ridge	$3,000
643	Weather Station	INDIANA DUNES NL	Parkwide	$3,000
			TOTAL:	**$28,612,000**

A5639 (DSC-VET) JAN 12 1994

Memorandum

DSC GUIDELINE 82-1, AMENDMENT NO. 3

To: Managers, Division, Office, Branch, and Section Chiefs, Denver Service Center

From: Assistant Director, Design and Construction, Denver Service Center Operations

Subject: Environmental Emissions - Electrical Power Generation

As part of the planning and design functions of the Denver Service Center, energy costs are always calculated for each development project. The anticipated energy consumption for all development alternatives is documented in various planning documents and in the design analysis. To date, energy costs have been quantified in monetary terms (dollar cost to energy user). No easy method of accounting was available to quantify the cost to the environment associated with electrical power production and the resulting emission releases of carbon dioxide, sulphur dioxide, and nitrous oxide gases. These gases are of prime concern in the global warming phenomena.

Effective with the date of this guideline, the Denver Service Center will implement the following procedures to quantify environmental emissions on all energy projections involving electrical power generation from the grid. The quantification of environmental emissions will provide input data for life cycle cost analysis and provide data that may be required as part of the President's recently announced Climate Change Action Plan.

The attachment itemizes environmental emissions per kilo-watt hour (kWh) for carbon dioxide (CO2), sulphur dioxide (SO2), and nitrous oxide (NOx) for each state. The values are different depending on each state's "mix" of fuels (such as low sulphur coal, high sulphur coal, natural gas, and hydro) used to generate the electrical power. The attachment will permit an easy conversion from annual electrical consumption as expressed in kilo-watt hours to pounds or grams of the gases discharged into the atmosphere.

The cost data shown in the first two columns on the attachment is general in nature and not always reflective of electrical costs at isolated National Park Service facilities. Electrical energy costs should continue to be calculated on actual utility charges for that specific location since this site-specific information is readily available.

Efforts will be made to gather more data on environmental emissions from other power sources such as on-site generators and internal combustion engines.

Renewable energy sources such as solar, wind, photovoltaic, and hydro-electric do not produce environmental emissions as described above. Likewise, alternatives utilizing energy conservation practices produce less environmental emissions than standard practices. Consequently, these alternatives may prove more cost effective than in the past because more inclusive environmental ramifications and subsequent costs associated with more traditional energy sources can now be quantified. Therefore, in all life cycle cost analyses, including those produced by an Architect/Engineer, environmental emission costs will be part of the analysis. Although the data base for environmental emission costs is currently not very large, the following conservative environmental emission costs will be used at the Denver Service Center until new information becomes available:

Emission	Environmental Emission Cost
CO2	$8/Ton
SO2	$0.75/Pound
NOx	$3.40/Pound

Information in this guideline will be incorporated into the next revised Life Cycle Costing Manual.

For further information or assistance regarding this guideline, please contact Howard Haiges, Jr. at (303) 987-6600, Office of Value Engineering and Technical Assistance, or Douglas DeNio at (303) 969-2162 in the Division of Engineering Services, Denver Service Center.

Please circulate a copy of this guideline to each designer and place a copy in your organizational set of DSC GUIDELINES.

/s/ David A. Aitken

Charles P. Clapper, Jr.

Attachment

LIGHTING MANAGEMENT/Variables and Multipliers 2

STATE	AVERAGE COMMERCIAL COST PER kWh ($)	AVERAGE INDUSTRIAL COST PER kWh ($)	ENVIRONMENTAL EMISSIONS PER kWh CO2 POUNDS	SO2 GRAMS	NOx GRAMS	CITY	COOLING SEASON IN WEEKS
ALABAMA	$0.068	$0.043	1.6	7.0	2.5	Birmingham	32.9
						Huntsville	30.9
						Mobile	38.4
						Montgomery	35.3
ALASKA	0.088	0.077	0.2	0.2	0.2		
ARIZONA	0.081	0.054	1.2	2.0	1.9	Flagstaff	18.6
						Phoenix	41.3
						Tucson	40.1
ARKANSAS	0.067	0.049	1.4	1.8	2.1	Blytheville	29.7
						Fort Smith	30.5
						Little Rock	29.7
CALIFORNIA	0.091	0.071	0.6	0.1	1.0	Barstow	32.2
						Bishop	30.4
						Los Angeles	32.6
						Sacramento	28.4
						San Diego	29.8
						San Francisco	22.2
						Santa Barbara	12.2
COLORADO	0.058	0.045	2.3	3.7	3.4	Colorado Springs	21.6
						Denver	22.6
						Grand Junction	23.7
						Trinidad	25.4

LIGHTING MANAGEMENT/Variables and Multipliers 3

STATE	AVERAGE COMMERCIAL COST PER kWh ($)	AVERAGE INDUSTRIAL COST PER kWh ($)	ENVIRONMENTAL EMISSIONS PER kWh CO2 POUNDS	SO2 GRAMS	NOx GRAMS	CITY	COOLING SEASON IN WEEKS
DELAWARE	$0.067	$0.044	2.5	11.1	3.6	Dover	23.6
						Wilmington	23.7
DISTRICT OF COLUMBIA	0.063	0.051	2.6	8.2	2.7	Washington	26.0
FLORIDA	0.066	0.051	1.7	5.4	2.5	Jacksonville	41.6
						Miami	50.1
						Orlando	46.2
						Pensacola	38.4
						Tampa	46.0
GEORGIA	0.073	0.047	1.5	8.9	2.3	Atlanta	30.0
						Augusta	35.1
						Macon	34.8
						Savannah	38.0
						Valdosta	38.9
HAWAII	0.092	0.066	1.9	3.3	1.7		
IDAHO	0.043	0.026	0.0	0.0	0.0	Boise	19.7
						Lewiston	18.9
						Pocatello	18.8
ILLINOIS	0.078	0.054	1.1	7.2	2.6	Champaign	23.6
						Chicago	20.9
						Peoria	24.0
						Rockford	21.0

LIGHTING MANAGEMENT/Variables and Multipliers 4

STATE	AVERAGE COMMERCIAL COST PER kWh ($)	AVERAGE INDUSTRIAL COST PER kWh ($)	ENVIRONMENTAL EMISSIONS PER kWh CO2 POUNDS	SO2 GRAMS	NOx GRAMS	CITY	COOLING SEASON IN WEEKS
INDIANA	$0.061	$0.041	2.4	15.5	4.8	Fort Wayne	22.5
						Indianapolis	23.9
						South Bend	21.4
						Terre Haute	24.8
IOWA	0.064	0.040	2.2	7.0	3.7	Council Bluffs	23.0
						Mason City	19.7
						Sioux City	22.2
KANSAS	0.065	0.048	2.0	5.2	3.3	Dodge City	25.6
						Goodland	23.6
						Kansas City	25.7
						Wichita	27.0
KENTUCKY	0.053	0.043	2.2	10.3	4.3	Covington	24.4
						Hopkinsville	28.4
						Louisville	26.6
LOUISIANA	0.070	0.043	1.4	1.4	2.0	Alexandria	37.2
						Lake Charles	39.2
						New Orleans	39.6
						Shreveport	35.2
MAINE	0.074	0.054	0.5	1.3	0.3	Portland	15.5
MARYLAND	0.066	0.047	2.0	8.9	3.0		
MASSACHUSETTS	0.081	0.073	1.6	6.3	2.3	Boston	19.8
						Springfield	20.1

LIGHTING MANAGEMENT/Variables and Multipliers 5

STATE	AVERAGE COMMERCIAL COST PER kWh ($)	AVERAGE INDUSTRIAL COST PER kWh ($)	ENVIRONMENTAL EMISSIONS PER kWh CO2 POUNDS	SO2 GRAMS	NOx GRAMS	CITY	COOLING SEASON IN WEEKS
MICHIGAN	$0.079	$0.056	1.7	4.4	3.1	Detroit	19.2
						Grand Rapids	19.0
						Lansing	19.5
						Sault St Marie	12.8
						Travarse City	17.0
MINNESOTA	0.060	0.041	1.8	3.6	2.7	Duluth	12.7
						Internat'l Falls	14.1
						Minneapolis	18.8
MISSISSIPPI	0.072	0.048	1.3	5.5	2.2	Biloxi	37.6
						Columbus	33.8
						Jackson	35.3
MISSOURI	0.065	0.049	2.0	13.4	4.4	Columbia	25.7
						Kansas City	25.7
						Springfield	26.9
						St. Louis	26.3
MONTANA	0.046	0.031	1.5	1.6	2.2	Billings	18.4
						Glasgow	17.5
						Great Falls	16.9
						Helena	15.5
NEBRASKA	0.057	0.042	1.5	2.3	3.4	Grand Island	22.7
						North Platt	22.0
						Omaha	23.0

LIGHTING MANAGEMENT/Variables and Multipliers 6

STATE	AVERAGE COMMERCIAL COST PER kWh ($)	AVERAGE INDUSTRIAL COST PER kWh ($)	ENVIRONMENTAL EMISSIONS PER kWh CO2 POUNDS	SO2 GRAMS	NOx GRAMS	CITY	COOLING SEASON IN WEEKS
NEVADA	$0.060	$0.044	2.2	3.1	3.2	Ely	20.2
						Las Vegas	35.4
						Reno	21.0
						Winnemucca	22.3
NEW HAMPSHIRE	0.088	0.067	1.2	6.3	2.2	Manchester	19.0
NEW JERSEY	0.088	0.072	0.7	2.1	1.5	Trenton	22.9
NEW MEXICO	0.082	0.053	2.4	2.3	3.0	Alburquerque	27.3
						Alamogordo	32.5
						Clovis	29.4
NEW YORK	0.099	0.053	1.2	3.8	1.3	Albany	19.5
						Buffalo	18.8
						New York City	20.0
						Syracuse	19.4
NORTH CAROLINA	0.063	0.047	1.3	4.2	2.0	Greensboro	28.1
						Raleigh	30.0
						Wilmington	33.6
NORTH DAKOTA	0.065	0.049	2.5	6.5	4.0	Bismarck	18.3
						Fargo	17.0
						Grand Forks	16.9
						Minot	16.2

LIGHTING MANAGEMENT/Variables and Multipliers 7

STATE	AVERAGE COMMERCIAL COST PER kWh ($)	AVERAGE INDUSTRIAL COST PER kWh ($)	ENVIRONMENTAL EMISSIONS PER kWh CO2 POUNDS	SO2 GRAMS	NOx GRAMS	CITY	COOLING SEASON IN WEEKS
OHIO	$0.072	$0.039	2.2	17.6	4.0	Cincinnati	24.2
						Cleveland	21.0
						Columbus	23.8
						Dayton	24.3
						Toledo	21.3
OKLAHOMA	0.059	0.037	1.8	2.3	2.8	Altus	31.2
						Enid	28.4
						Oklahoma City	29.5
						Tulsa	29.7
OREGON	0.048	0.033	0.1	0.1	0.1	Burns	17.3
						Eugene	15.0
						Medford	21.2
						Pendleton	20.0
						Portland	15.8
PENNSYLVANIA	0.078	0.058	1.4	7.4	2.2	Philadelphia	23.7
						Pittsburgh	21.9
						Scranton	20.1
						Williamsport	21.0
RHODE ISLAND	0.080	0.075	1.9	1.7	3.3	Providence	18.7
SOUTH CAROLINA	0.062	0.043	0.8	2.5	1.2	Charleston	36.0
						Columbia	33.4
						Myrtle Beach	32.3
SOUTH DAKOTA	$0.067	$0.047	1.1	4.8	2.9	Huron	20.4
						Rapid City	19.6
						Sioux Falls	20.5
TENNESSEE	0.061	0.050	1.5	10.6	2.6	Knoxville	29.0
						Memphis	30.4
						Nashville	28.4
TEXAS	0.061	0.041	1.8	2.5	2.5	Amarillo	28.4
						Corpus Christi	43.0
						Dallas	34.6
						Houston	42.0
						Lubbock	30.8
						San Antonio	41.3
UTAH	0.068	0.040	2.2	2.8	2.8	Salt Lake City	19.9
						Wendover	21.6
VERMONT	0.081	0.065	0.1	0.8	0.2	Burlington	16.7
VIRGINIA	0.060	0.042	1.0	3.3	1.5	Richmond	26.8
						Roanoke	26.3
WASHINGTON	0.041	0.027	0.2	0.7	0.4	Seattle	9.4
						Spokane	15.6
WEST VIRGINIA	0.054	0.036	2.2	12.4	3.9	Charleston	26.1
						Clarksburg	22.5
WISCONSIN			1.8	6.2	3.1		
WYOMING			2.5	2.2	3.7		

AN ENGINEERING ASSESSMENT OF THE POTENTIAL FOR RENEWABLE ENERGY POWER SYSTEMS AT GULF ISLANDS NATIONAL SEASHORE

Prepared for Gulf Islands National Seashore
3500 Park Road
Ocean Springs, MS 39564

Prepared by Hal Post and Mike Thomas
Photovoltaic Design Assistance Center
Sandia National Laboratories
Albuquerque, NM 87185-0753

Draft Report
November 1994

OBJECTIVE

At the request of Jack Wilburn, Chief of Maintenance at Gulf Islands National Seashore, the Photovoltaic Design Assistance Center (PVDAC) conducted an engineering assessment of the electrical loads and a preliminary evaluation of the renewable resources at two locations in the park: Horn and Ship Islands. This report presents the analyses of the initial data collected from our site visit and reviews the existing power system operation at each site. The report also presents recommendations on renewable energy options and costs.

SITE ASSESSMENT

Mike Thomas and Hal Post of the PVDAC, accompanied by Doug DeNio, NPS Denver Service Center, and Leon Folsom, Energy Coordinator at the NPS Southeast Region, assessed Park Service facilities at both Horn and Ship Islands on November 8, 1994. Our island visits were guided by Warren Marts, park electrician, and Paul Hicks, park plumber. Bill Wilson, Resident Ranger on Horn Island, described site usage at the Horn Island facility. Similarly, Steve Buxton, Resident Ranger on Ship Island, provided a tour and described facility usage on Ship Island. Facility operations at both island locations were discussed and loads inventoried.

The information collected during our visit was presented to park staff at the Ocean Springs maintenance headquarters building on November 9, along with a description of possible renewable energy options.

DESCRIPTION OF FACILITIES

Horn Island

Horn Island is a small barrier island located approximately 12 miles off the coast from Ocean Springs. The park administrative facility on Horn Island is open year-round and includes a residence building as well as a maintenance and storage building. The island has no visitor facilities but allows primitive camping year-round. Facility power is provided 24 hours a day year round by two diesel engine generators (an Onan 25-kW generator with 14067 hours of run time and a relatively new 20-kW Kohler with 695 hours of run time) housed in a generator building approximately 150 feet from the residence toward the dock. The 1000-gallon, diesel-fuel storage tank is also located inside the generator building. The engine generators are alternately cycled on-off every seven days, thereby permitting maintenance on the off engine. Propane is used for a number of loads at the facility including space heating, cooking, refrigeration, and hot water. Diesel fuel is delivered to the site by a park boat (the same boat on which we visited the island) that can carry up to 300 gallons per trip. Fuel is pumped via an underground pipe from the dock to the above-ground storage tank.

The facility electrical load is dominated by air conditioning for the seven hot months of the year, April through October. The residence air conditioner has a rated load of 2.4 kW and typically operates 24 hours a day during this season. With the exception of an electric clothes dryer, the electrical loads during the other five months (cool season) are small and consist primarily of lighting, ceiling fans, small kitchen appliances, two TV/VCRs, and water pumping. At the time of our visit, the existing well was having problems with sand blockage and a new well was planned. The existing water pumping system uses a 1-hp motor and pumps to a 100-gallon pressurized tank located in a small shed at the east end of the residence. We expect the new pumping system to have similar energy requirements as that currently used.

The park facilities on Horn Island currently have two small PV battery charging applications. The covered dock uses a battery driven electric winch to lift small park boats out of the water. The batteries for this lift system are charged using a small PV panel (20 watts) mounted to the dock roof. A second battery system is used for radio communications in the residence. A 60-watt PV module mounted to the residence roof provides the charging current.

The National Guard has installed a major communications facility on Horn Island. This facility was installed in 1989 by Integrated Power Corp. and is powered by a 5.7-kW PV array consisting of 110 Siemens M-55 modules. The array and 100-foot tower are located in a cleared area approximately 75 feet south of the residence. Two sea-train shipping containers house the batteries, charge controller, and radio equipment. The system includes a 112-kWh battery bank of Absolyte 3-75A-25 valve-regulated batteries and an Integrated Power charge controller. The radio transmitters operate on 24-volt dc power. The electrical load for the communications equipment is unknown but, on the basis of similar facilities, we estimate that the load is 1-kW continuous or 24 kWh daily, year-round.

Ship Island

East Ship and West Ship Islands are located approximately 6 miles west of Horn Island and, like Horn, are small barrier islands. Concession boat trips to West Ship Island run from Biloxi, April through November, and from Gulfport, March through October. Unlike Horn, West Ship Island has extensive facilities including park personnel housing, resident ranger offices, public restrooms, and a concessionaire's store and eating area. In addition, Fort Massachusetts, one of the last masonry coastal fortifications to be built in the U.S., sits at the west end of West Ship Island and is a popular tourist attraction.

Electrical loads on West Ship Island are dictated by the operating seasons, corresponding to very high loads during the hot, visitors' season from April through October, and low loads (excluding electrical heaters) during the cool, off season from November through March. Facility power to the Park Service buildings is provided via two diesel generators (an Onan 50-kW three-phase generator operated in single phase only at 30 kW and a Powerguard 30-kW generator). The concession area on the south side of the island is

powered by two 30-kW diesel generators, one a Kohler and the other a Powerguard. The concession area is closed November through February and the engine generators are shut down during this four month period. The engine generators for the Park Service facilities are operated 24 hours a day year-round. The fuel delivery system on West Ship Island is much like that on Horn Island in that the fuel is pumped from the dock to above-ground, 1000-gallon storage tanks at each genset location via buried pipe.

Electrical loads in the concessionaire's store are extensive, including freezers, coolers, air conditioning, lights, water heating, and other appliances. We expect the power demand for the store, restrooms, and adjacent concession areas to be near the full capacity of the engine generators during the hottest months.

Electrical loads in the Park Service facilities are also extensive during the park visitors' season, and, like Horn Island, are dominated by air conditioning. We counted at least 12 window air conditioning units (estimated at 1 kW each) in the housing and office buildings. We expect that the peak power demand during the hot season is a high percentage of the engine generator's capacity. During the off season, however, only two park personnel are on the island full time and, for two months, staffing is reduced to only one full time resident. Loads in the ranger residence (building 41) during this period are dominated by the use of electric heaters, both baseboard and portable.

West Ship Island uses a small PV module to charge a battery driven winch for lifting small park boats at the covered dock near Fort Massachusetts. No other PV use was noted on the island.

LOAD MANAGEMENT AND ENERGY EFFICIENCY

Horn Island

Prior to the use of renewable technologies for the production of electricity, electrical power and energy requirements should be reduced as much as possible. The Horn Island facilities' load is dominated by air conditioning during the hot season. The high temperatures and high humidity on the island during this period require air conditioning. Unless the residence building is remodeled to encourage increased ventilation and cooling via the prevailing breezes, an option that appears to be unlikely, then the only possible reduction in this load is through a more energy efficient cooling unit. We expect that the current air conditioner load represents approximately 30 kWh daily during the hot season. As noted earlier, the residence building is equipped with an electric clothes dryer. This 5-kW load could be replaced with a propane unit to reduce the electrical demand. We noted that most rooms in the residence were equipped with lighted ceiling fans. These fans include up to five incandescent bulbs each, most with 75-watt bulbs but a few with 25-watt bulbs. Replacement with fluorescent units would reduce the energy usage for lighting by a factor of four.

The residence on Horn Island actually consists of two living units and a common area containing the washer and dryer. The park meters both living units but not the washer/dryer, air conditioning, or water pumping loads. Nevertheless, energy usage for each unit would establish a baseline for potential renewable energy options. The following table presents energy usage for each unit over the period December 1992 to November 1993.

Table 1. Residential Unit Energy Usage for Horn Island

Month	Unit A (kWh)	Unit B (kWh)	Total (kWh)	Daily(kWh)
Dec 92	36	28	64	2.1
Jan 93	51	7	58	1.9
Feb 93	50	8	58	2.1
Mar 93	56	19	75	2.4
Apr 93	84	184	268	8.9
May 93	90	40	130	4.2
Jun 93	113	66	179	6.0
Jul 93	252	101	353	11.4
Aug 93	41	197	238	7.7
Sep 93	23	306	329	11.0
Oct 93	61	124	185	6.0
Nov 93	74	11	85	2.8

It is important to note that the daily residential load during the months of November through March (a period when the air conditioner is turned off) ranges from 1.9 to 2.8 kWh/day. During this same period, we expect the water pumping load to be less than 0.5 kWh/day thereby giving a total daily facility load (assuming a propane clothes dryer) in the off season of 3.3 kWh/day.

Assuming a 2-kWh daily water pumping load in the summer season combined with a 30-kWh daily air conditioning load (assumes 50% compressor duty cycle) and the maximum residential load of nearly 12 kWh from the above table gives a total daily summer load of 44 kWh. Obviously, either of the 25 or 30-kW engine generators would have little difficulty in supplying that amount of energy.

Ship Island

Because of the extensive facility development on West Ship Island, energy demands during the summer season are much higher than those on Horn Island. The use of electric heaters on Ship Island dominates the off season electrical demand. Park Service records were examined for metered energy consumption information on West Ship Island. The following table presents the metered loads from December 1992 through November 1993 for three locations on West Ship Island: (1) Concessionaire's Store, (2) Building 41A (year-round ranger residence), and (3) Building 41B (year-round ranger residence). Note that the loads are listed as daily averages based on monthly usage.

Table 2. Energy Usage on West Ship Island

Month	Store (kWh/day)	Bldg. 41A (kWh/day)	Bldg. 41B (kWh/day)
Dec 92	0	20.2	3.2
Jan 93	0	21.8	14.1
Feb 93	0	5.5	4.5
Mar 93	43.5	8.6	9.9
Apr 93	74.2	5.5	4.2
May 93	124.6	4.8	4.1
Jun 93	203.0	11.0	9.4
Jul 93	223.4	19.6	14.6
Aug 93	233.1	11.4	17.5
Sep 93	165.1	9.6	11.6
Oct 93	87.2	13.8	3.6
Nov 93	0	17.5	1.1

As expected, the concessionaire's store is the primary user of electricity on West Ship Island during the summer months. We anticipate that the 30-kW engine generators are running near load capacity during several hours of the day in June, July, and August just to keep up with the demand. We also expect that considerable opportunities exist to reduce this demand by improvements in the mode of operation as well as the energy efficiency of the store appliances. Nevertheless, the daily demand is so large that we see little potential for renewable energy usage at the concessionaire's facility.

The total load usage in both sides of the ranger residence (building 41) shows a double peak during the year of almost the same magnitude of 35 kWh/day. Electricity usage during the winter months is dominated by electrical heaters, unlike the Horn Island residence that uses propane heaters. Similarly, air conditioning accounts for the vast majority of electrical demand during the summer peak. With the help of Warren Marts, we made measurements of the peak demand for building 41A (the only side that was occupied during our visit), the ranger office building, a service building containing an ice maker next to building 41, and Fort Massachusetts. This configuration represents a typical maximum off-season usage pattern for the park facilities. We turned on all lights, small appliances, and other loads, including the ice maker, in the noted buildings. We did not turn on the electric heaters. We measured a peak demand at the generator building distribution panel of 2.4 kW. We also toured Fort Massachusetts to quantify electrical usage. We identified a total of 800 watts of incandescent lights in the stair wells. These lights are on 24 hours a day, even though the fort is now closed for the season. By turning these lights off, we reduce the peak demand to 1.6 kW during the winter season, assuming no electrical heater usage.

ON-SITE POWER OPTIONS

Current Operation

Before looking at each site for specific options, we'll examine the current operation and maintenance costs of the diesel gensets on both islands. Park records for total diesel fuel usage over the period of October 1993 through September 1994 show the following:

Location	Total Usage (gal.)	Daily Usage (gal./day)
Horn Island	7504	21
Ship Island (south)	6310	26
Ship Island (north)	10206	28

The Ship Island south location is for the gensets powering the concessionaire's area over an eight-month period. Gensets at Horn Island and Ship Island north are operated continuously, year-round. We also looked at the cost of this fuel. Average annual park cost for the fuel before delivery is $0.60 per gallon. Delivery to all three island storage sites follows the same process whereby the park boat (45-ft. cabin cruiser) can carry up to 300 gallons of fuel per trip for the genset operation. Delivery to each site is at least a 4-hour round trip on the boat. With two people on the boat (8 person-hours) and two people assisting at the storage site for one hour each (2 person-hours) per delivery gives 10 person-hours per 300 gallon of delivered fuel. At park estimates of $20 per person-hour, this gives $200 per 300 gallons, or $0.67 per gallon delivered. In addition, we estimated the operating costs of the boat (excluding personnel) at $50 per hour of operation, or $200 per round-trip for delivery. This gives an additional cost of $0.67 per gallon of fuel. All totaled, each gallon of fuel delivered to the island sites costs $1.94.

We also examined the park records for genset maintenance costs over the past year. These costs totaled $23,788 for all six engine generators at the three sites or $4460 per genset on Horn and Ship Island north (year-round operation) and $3000 for each genset on Ship Island south (eight months operation). We were also told by maintenance personnel that each genset is replaced after three to four years of operation. Assuming a four-year park lifetime for a 30-kW genset and a new installed purchase cost of $10,000 each requires an annual escrow cost of approximately $2500 per genset.

Before proceeding, we'll make one more point concerning diesel-powered generators and their fuel efficiency. Diesel gensets that are operated at very low fractions of their load capacity have very poor fuel efficiencies. A typical 30-kW genset operated continuously at 3 kW or 10% load capacity would have a fuel efficiency of 2-3 kWh per gallon of fuel. On the other hand, that same genset operated at 24 kW or 80% load capacity would provide 12-14 kWh per gallon of fuel. In addition, running gensets continuously in a lightly loaded condition contributes to increased maintenance. As a point of guidance, gensets should be closely matched to the intended load to maximize fuel efficiency.

Using the above cost information for genset operation and maintenance (O & M) and estimated annual energy usage at each site (note that actual metered energy usage for the concessionaire's area at Ship Island south is used), we calculate the following table of fuel efficiency and energy cost for each genset location.

Table 3. Annual Energy Cost and Fuel Efficiency

Location	O & M Cost ($)	Energy Usage (kWh)	Energy Cost ($/kWh)	Fuel Efficiency (kWh/gal.)
Horn Island	23,400	12,500	1.87	1.7
Ship Island (south)	18,240	34,500	0.53	5.5
Ship Island (north)	28,700	36,000	0.80	3.5

Horn Island

Other than continuing the current genset mode of operation, we have identified at least three additional on-site power options for the Horn Island facility. Any of the options should be preceded by reducing the existing electrical load through conservation and the use of high efficiency lighting and air conditioning. The existing electric dryer should also be replaced with a propane dryer to minimize the electric load.

Tie In to the National Guard Power System

One option is to tie in to the existing PV system installed by the National Guard. This option is, of course, contingent on National Guard agreement. The National Guard PV system, including batteries, is five years old and appears to be operating well. We were told by park personnel that an offer to couple this system to the park facility was made at the time of installation in 1989. However, no action was taken, and since that time park facility loads have increased primarily by the addition of air conditioning. This option would utilize the existing battery bank of the National Guard system to supply energy to both the communications site and the Horn Island facility. Normally, the existing engine generators would be turned off. During the day, the PV array would charge the batteries as it does now. As the state of charge in the battery bank drops in response to the electrical demand, perhaps to a 40% depth of discharge, a transfer switch/control unit would sense a preset battery voltage limit and automatically start the engine generator. The genset would meet the electrical demand and any additional energy generation would go to charging the battery bank. At another preset battery voltage corresponding to perhaps 85% state of charge, the engine would be turned off. This cycle of battery charging and discharging and engine on and off would be used to meet both the communications and facility loads. The improvement for the engine generator is that its fuel efficiency would be increased to reflect its operation at a higher load capacity.

Additional hardware including an automatic transfer switch, a battery charger, and an inverter for the park facilities would be required. We estimate the cost of the modifications to be approximately $12,000 to $15,000, approximately half of which

would go for an inverter to provide ac service for the park facilities. Savings in fuel and maintenance for the genset would accrue to the park but would be offset by a reduction in the lifetime of the National Guard battery bank and a corresponding annual escrow amount to be set aside by the park to help pay its share for a new battery bank. We estimate that the replacement cost of the battery bank would be $20,000. The battery bank would be cycled significantly more under this scenario than in its current operation and lifetime is directly related to the number of charge/discharge cycles and the depth of the discharge during these cycles. We anticipate that the battery bank operating in a cycle mode as described above would need to be replaced within five years or less. If this approach could save half the annual fuel usage or 3750 gallons per year, the park would save approximately $7300 in fuel costs alone. If the genset run time is cut by two-thirds, the park would save an additional $6000 per year in maintenance costs and triple the useful life of the genset before replacement.

However, on the downside, we don't know the daily communications load; if this load coupled with our estimate of the summer load for the facility significantly taxes the current PV system and battery bank, then our estimates in savings and costs to the park could be significantly altered. We expect the 5.7-kW PV array should generate approximately 28 kWh per day during the summer months based on solar insolation availability data for New Orleans. Similar output for December would be approximately 17 kWh per day. If, as we expect, the communications load is constant year-round and on the order of the PV output, then this option offers little more than the battery augmentation option presented next. Furthermore, we expect that the coordination issue with the National Guard coupled with their requirements that the reliability of their current power system not be jeopardized will preclude any benefits to the park.

Augmentation with Energy Storage

In a similar approach to the previous option, the energy efficiency at the site could be significantly improved by the addition of batteries and an ac-dc inverter/charge controller. For this scenario, the existing generator size would be fine and, in fact, downsizing the generators would be a disadvantage. One could run the existing engine for only 3 to 4 hours at 80% load capacity to produce enough energy (60 kWh @ the equivalent of 2.5-kW constant load) for the entire 24 hour period. If enough battery storage existed at the site, the excess energy would be stored and used during the non-operational hours of the generator.

A simple approach is to run the generator 8 hours during the day when temperatures are at their highest (maximum water pumping and air conditioning loads). If one day of energy storage is available on-site, it can be charged during the operational hours. For the other 16 non-operational hours, the batteries would meet the load. The required energy during the summer months appears to be about 50 kWh/day of usable battery storage. Deep cycle, industrial grade batteries that can be expected to provide at least five years of useful life cost about $200/kWh of usable capacity. The inverter/charger needed for this system would be about 10 kW and would cost about $10,000. Thus, for about

$20,000, the operation could be modified sufficiently that the fuel usage would be decreased by at least 50%, and the maintenance would be reduced by two-thirds because the operational time of the engine would be reduced by that amount. The park savings would be identical to the previous option, $7300 in fuel costs and $6000 in maintenance costs. The escrow amount to be set aside each year to purchase new batteries would be offset almost entirely by the savings to the park in extending the useful life of the genset. This leaves a potential savings of $13,300 each year to offset the initial cost of $20,000 for the battery augmentation. The simple payback period would be 18 months.

Augmentation with Photovoltaics

As noted earlier, the electrical load at the site is dominated by the summer air conditioning load. During the cool season, the facility loads are quite small, typically less than 3.3 kWh/day (with a possible maximum of 6 kWh/day) for the months of November through March. The engine genset spends most of the day in idle while still using approximately 20 gallons of diesel fuel. This option uses a PV system to satisfy the load during these five months and allows the engine gensets to be shut off during the entire period.

A conservative design using a 2-kW array mounted on the residence roof would easily meet the expected maximum daily load of 6 kWh. Solar insolation data for New Orleans show availabilities of 3.5 sun hours (7 kWh daily output) in December, increasing to 5 sun hours (10 kWh daily output) in March. The proposed system would include a 40 kWh battery bank, a sine wave inverter, and a charge controller. The anticipated installed cost for the system is approximately $30,000. Fuel savings during these five months is 3150 gallons or $6100. An additional savings of $3700 in genset maintenance over this period gives a total potential savings of $9800 annually to offset the initial system cost of $30,000. The escrow cost set aside each year for battery replacement is totally offset by the savings realized in extending the useful life of the genset. This option has a simple payback of slightly over three years.

Perhaps a combination of this option with the battery augmentation approach described earlier would serve the park needs at Horn Island best. Such an approach would displace a majority of the diesel fuel use on the island and would significantly reduce the environmental risk of a spill associated with the handling and storage of the fuel.

Ship Island

The loads associated with the concessionaire's operation on West Ship Island, although quite large, appear fairly well matched to the 30-kW gensets. We expect improvements could be made but we see little opportunity for renewable energy systems for this facility.

Energy needs for the park facilities on West Ship Island are significantly greater than those on Horn Island. However, the usage pattern appears similar and the same options as proposed for Horn Island may offer some opportunity for energy savings here also.

Augmentation with Energy Storage

Although we have energy usage records for building 41 year-round, we have little information on the other buildings or the water pumping load. We would expect the water pumping load to grow dramatically during the summer months with heavy public restroom use, concession activities, and the four public showers at the south beach. The peak summer daily load for both units of building 41 is 34 kWh. Including the other park residences and dormitory as well as the administration building in this total (including the use of at least 12 window air conditioning units), energy usage could easily exceed 200 kWh daily during the summer season. Before assessing this option further, measured data on total facility loads including day/night variations are needed.

Augmentation with Photovoltaics

As noted earlier, electrical usage at the park facilities during the winter months is dominated by electric space heaters. On-site power measurements show that facility operation during the winter season could be reduced to 1.5 to 2 kW peak by converting these heaters to propane and turning the lights off in Fort Massachusetts. Including an expectation that both units of building 41 are occupied and the water pump is operating could produce a peak of 4 to 5 kW. We expect the maximum daily energy usage at the facility, assuming both units of building 41 are occupied, to be approximately 13 kWh during the months of November through March. As with the operation on Horn Island, the genset is operating barely above idle during much of day while continuing to burn approximately 28 gallons of fuel. This option includes the installation of a PV system to meet the daily off-season housekeeping load and allows the genset to be turned off during the entire five-month period except during infrequent daytime periods when construction/repair activities on the island could require heavy power demand.

A 4-kW PV array installed on the roof of the generator building would meet the maximum daily load. Using solar insolation data for New Orleans, we would expect the daily system output for December to be 14 kWh, increasing to 20 kWh per day in March. An 80-kWh battery bank, a sine wave inverter, and a charge controller would complete the system. The anticipated installed cost for the system is approximately $60,000. Fuel savings during these five months is 4200 gallons or $8100. An additional savings of $3700 in genset maintenance over this period gives a total potential saving of $11,800 annually to offset the initial system cost of $60,000. The escrow cost set aside each year for battery replacement would be offset by the savings realized in extending the useful life of the genset. This option has a simple payback of slightly over five years. During the summer season, the PV system output is large enough so that it could be dedicated to powering the lights in Fort Massachusetts. This also provides an opportunity for the park to incorporate photovoltaics into its interpretive program.

RECOMMENDATIONS

Park facilities on Horn Island and West Ship Island can benefit from a number of proposed actions that will reduce the electrical load, improve power system fuel efficiency, and reduce maintenance.

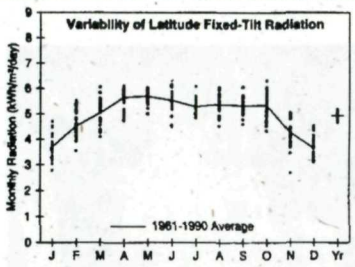
Before proceeding with specific recommendations, we'll address the question of solar resource on Horn and Ship Islands. As noted earlier, we have used solar data for New Orleans (reduced by 10% to account for local weather uncertainties on the islands) to size our proposed PV systems. We examined solar data for both Mobile and New Orleans (see Attachments 1 and 2). These data show almost identical daily solar availabilities. However, some concern regarding actual solar resource on the islands was expressed by park personnel. To help answer these concerns, we're prepared to loan the park an instrumentation package to monitor solar resource on the islands.

On Horn Island, we recommend that the park proceed on a combination approach that includes augmentation of the existing gensets with battery storage and the installation of a PV system to displace all engine usage during the winter months. This approach has an expected payback of less than three years and will substantially reduce the use of diesel fuel on the island. The environmental risk of ground and water pollution associated with diesel fuel spills will be significantly reduced and the facility power system will move toward sustainable operation.

Opportunities on West Ship Island for renewable energy usage are not as favorable due to the extensive facility development. However, we recommend that the park initiate an activity to better define the winter-season electrical loads at the facility. This activity should emphasize conservation and load reduction through efficiency improvements and conversion to other appliances as appropriate. Preliminary information indicates that a PV system on Ship Island would offer the park a reasonable payback and would displace all diesel fuel usage on the island during the winter months. If the load definition activity confirms our estimates, then we recommend that the park proceed to install a PV system. The PV system would also offer the park a unique opportunity to expand its interpretative activities to include a highly visible renewable energy system.

If the park concurs with our recommendations, the DOE PV Program through the PVDAC is prepared to offer cost sharing up to $10,000 for the installation of battery augmentation and a PV system at Horn Island and an additional amount up to $10,000 for the installation of a PV system on West Ship Island. Improvements at these facilities would prove quite valuable to the park, the National Park Service and the DOE PV Program as power system options that could be replicated at many other sites within the federal agency sector. We also recommend that the park prepare a proposal to the DOE/FEMP Federal Energy Efficiency Fund for supplemental funding for these projects. The PVDAC is prepared to offer continuing technical assistance to the park to implement what we feel are very worthwhile projects.

Attachment 1



New Orleans, LA

WBAN NO. 12916

LATITUDE: 29.98° N
LONGITUDE: 90.25° W
ELEVATION: 3 meters
MEAN PRESSURE: 1017 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.7	3.6	4.5	5.5	6.1	6.1	5.7	5.5	4.9	4.3	3.1	2.6	4.6
	Min/Max	2.3/3.2	3.0/4.2	3.8/5.2	4.7/6.6	5.3/7.0	5.0/7.1	5.3/6.6	4.7/6.1	4.3/5.5	3.7/5.0	2.3/3.6	2.3/3.0	4.3/4.8
Latitude -15	Average	3.3	4.2	4.9	5.7	6.0	6.0	5.7	5.6	5.3	5.0	3.8	3.2	4.9
	Min/Max	2.6/4.1	3.3/5.0	4.0/5.8	4.8/6.9	5.3/7.0	4.8/6.9	5.2/6.5	4.7/6.3	4.6/6.0	4.1/5.8	2.5/4.4	2.8/3.9	4.6/5.1
Latitude	Average	3.7	4.5	5.0	5.6	5.7	5.5	5.3	5.4	5.3	5.3	4.3	3.7	5.0
	Min/Max	2.8/4.7	3.5/5.5	4.1/6.1	4.7/6.8	5.0/6.6	4.5/6.3	4.8/6.1	4.5/6.1	4.6/6.1	4.3/6.3	2.7/5.1	3.1/4.6	4.7/5.2
Latitude +15	Average	3.9	4.6	4.9	5.3	5.1	4.8	4.7	4.9	5.1	5.4	4.5	3.9	4.8
	Min/Max	2.8/5.1	3.6/5.7	4.0/6.0	4.4/6.3	4.4/5.8	4.0/5.4	4.3/5.3	4.1/5.5	4.4/5.9	4.3/6.5	2.7/5.4	3.3/4.9	4.5/5.0
90	Average	3.3	3.5	3.2	2.7	2.1	1.8	1.9	2.3	3.0	3.9	3.7	3.4	2.9
	Min/Max	2.3/4.4	2.7/4.4	2.6/3.9	2.3/3.0	1.9/2.2	1.7/1.9	1.8/2.0	2.1/2.5	2.7/3.5	3.0/4.7	2.1/4.5	2.7/4.4	2.7/3.0

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	3.6	4.7	5.8	7.1	7.7	7.6	7.0	6.8	6.3	5.8	4.2	3.5	5.8
	Min/Max	2.7/4.6	3.6/6.0	4.5/7.2	5.7/9.1	6.5/9.3	5.8/9.3	6.3/8.3	5.5/7.9	5.2/7.4	4.6/7.1	2.6/5.0	2.8/4.3	5.5/6.2
Latitude -15	Average	4.0	5.2	6.1	7.3	7.7	7.5	6.9	6.9	6.6	6.3	4.7	3.9	6.1
	Min/Max	3.0/5.2	3.9/6.6	4.8/7.6	5.8/9.3	6.5/9.3	5.8/9.1	6.2/8.2	5.5/8.0	5.4/7.7	4.9/7.8	2.8/5.7	3.2/5.0	5.7/6.5
Latitude	Average	4.3	5.5	6.3	7.3	7.4	7.2	6.7	6.7	6.6	6.6	5.1	4.3	6.2
	Min/Max	3.1/5.7	4.1/7.0	4.8/7.8	5.8/9.3	6.3/9.0	5.5/8.8	6.0/7.9	5.4/7.9	5.4/7.8	5.1/8.1	2.9/6.1	3.4/5.5	5.8/6.6
Latitude +15	Average	4.5	5.6	6.2	7.0	7.0	6.7	6.2	6.4	6.5	6.7	5.3	4.5	6.0
	Min/Max	3.2/6.0	4.1/7.1	4.7/7.8	5.5/8.9	5.9/8.5	5.1/8.1	5.6/7.4	5.1/7.5	5.3/7.6	5.1/8.2	2.9/6.4	3.6/5.8	5.6/6.4

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	4.5	5.6	6.3	7.3	7.8	7.7	7.0	6.9	6.6	6.7	5.3	4.5	6.4
	Min/Max	3.2/6.1	4.2/7.2	4.8/7.9	5.9/9.4	6.6/9.4	5.8/9.4	6.3/8.4	5.5/8.1	5.4/7.8	5.2/8.2	2.9/6.4	3.6/5.9	5.9/6.8

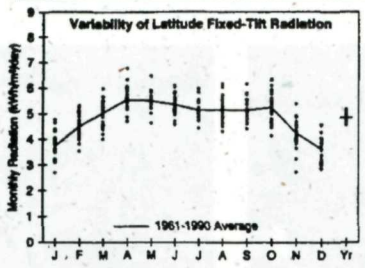
Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	2.4	2.9	3.0	3.5	3.6	3.5	3.0	3.0	3.0	3.6	2.9	2.6	3.1
	Min/Max	1.2/3.8	1.8/4.2	1.9/4.2	2.2/5.1	2.7/5.0	2.0/4.9	2.4/4.2	1.8/3.9	2.1/4.0	2.4/4.9	1.0/4.0	1.8/3.7	2.8/3.5
1-Axis, N-S Horiz Axis	Average	2.1	3.0	3.6	4.5	4.8	4.5	3.9	3.9	3.8	3.9	2.7	2.1	3.6
	Min/Max	1.1/3.3	1.9/4.4	2.2/5.1	2.9/6.8	3.5/6.7	2.6/6.3	3.1/5.3	2.3/5.1	2.5/5.0	2.6/5.4	0.9/3.7	1.4/3.1	3.1/4.0
1-Axis, N-S Tilt=Latitude	Average	2.7	3.6	4.0	4.6	4.6	4.2	3.6	3.8	4.0	4.5	3.4	2.8	3.8
	Min/Max	1.4/4.2	2.3/5.3	2.5/5.6	3.0/6.9	3.4/6.4	2.4/5.9	2.9/5.0	2.3/5.1	2.7/5.3	3.0/6.3	1.1/4.6	1.9/4.1	3.4/4.3
2-Axis	Average	2.9	3.7	4.0	4.7	4.8	4.5	3.9	3.9	4.1	4.6	3.6	3.0	4.0
	Min/Max	1.5/4.6	2.3/5.4	2.5/5.7	3.0/7.1	3.6/6.7	2.6/6.4	3.2/5.3	2.4/5.2	2.7/5.3	3.0/6.3	1.2/4.9	2.0/4.4	3.5/4.5

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	10.7	12.4	16.4	20.3	23.8	26.7	27.7	27.5	25.6	20.6	16.2	12.5	20.1
Daily Minimum Temp	5.4	6.9	10.9	14.7	18.4	21.6	22.8	22.7	20.8	14.8	10.6	7.1	14.7
Daily Maximum Temp	16.0	17.8	22.0	25.8	29.1	31.8	32.6	32.3	30.3	26.3	21.7	17.9	25.3
Record Minimum Temp	-10.0	-7.2	-3.9	0.0	5.0	10.0	15.6	15.6	5.6	1.7	-4.4	-11.7	-11.7
Record Maximum Temp	28.3	29.4	31.7	33.3	35.6	37.8	38.3	38.9	38.3	33.3	30.6	28.9	38.9
HDD, Base 18.3°C	250	176	90	16	0	0	0	0	0	17	99	194	841
CDD, Base 18.3°C	14	9	31	74	169	250	291	284	218	87	34	13	1475
Relative Humidity (%)	76	73	73	73	74	76	79	79	78	75	77	77	76
Wind Speed (m/s)	4.0	4.3	4.2	4.1	3.6	3.0	2.6	2.6	3.1	3.3	3.8	4.0	3.5

Attachment 2



Mobile, AL

WBAN NO. 13894

LATITUDE: 30.68° N
LONGITUDE: 88.25° W
ELEVATION: 67 meters
MEAN PRESSURE: 1010 millibars

STATION TYPE: Secondary

Solar Radiation for Flat-Plate Collectors Facing South at a Fixed Tilt (kWh/m²/day), Uncertainty ±9%

Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	2.7	3.5	4.4	5.4	5.9	5.9	5.6	5.2	4.7	4.2	3.1	2.5	4.4
	Min/Max	2.2/3.2	2.9/4.0	3.7/5.2	4.7/6.6	4.9/6.9	5.0/6.8	4.8/6.5	4.5/6.2	4.1/5.5	3.5/5.0	2.3/3.7	2.2/3.0	4.2/4.7
Latitude -15	Average	3.3	4.1	4.9	5.6	5.8	5.8	5.5	5.3	5.1	4.9	3.8	3.2	4.8
	Min/Max	2.5/4.1	3.3/4.8	4.0/5.8	4.8/6.9	4.9/6.9	4.9/6.6	4.7/6.4	4.5/6.4	4.4/6.0	3.9/5.9	2.5/4.7	2.6/3.9	4.5/5.1
Latitude	Average	3.7	4.5	5.0	5.6	5.5	5.4	5.1	5.2	5.1	5.2	4.3	3.6	4.9
	Min/Max	2.7/4.8	3.5/5.3	4.0/6.0	4.7/6.8	4.6/6.5	4.6/6.1	4.4/6.0	4.3/6.2	4.4/6.2	4.1/6.4	2.7/5.4	2.8/4.6	4.6/5.2
Latitude +15	Average	4.0	4.6	4.9	5.2	4.9	4.7	4.5	4.7	4.9	5.3	4.5	3.9	4.7
	Min/Max	2.7/5.1	3.6/5.5	3.9/5.9	4.4/6.3	4.2/5.7	4.0/5.3	3.9/5.2	4.0/5.6	4.2/6.0	4.1/6.5	2.8/5.8	3.0/5.0	4.4/5.0
90	Average	3.3	3.6	3.2	2.7	2.1	1.9	1.9	2.3	3.0	3.9	3.7	3.4	2.9
	Min/Max	2.2/4.5	2.8/4.3	2.5/3.8	2.3/3.1	2.0/2.3	1.8/2.0	1.8/2.1	2.1/2.6	2.5/3.6	2.9/4.8	2.1/4.9	2.5/4.5	2.7/3.1

Solar Radiation for 1-Axis Tracking Flat-Plate Collectors with a North-South Axis (kWh/m²/day), Uncertainty ±9%

Axis Tilt (°)		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
0	Average	3.6	4.7	5.8	7.0	7.4	7.4	6.8	6.5	6.1	5.7	4.2	3.4	5.7
	Min/Max	2.6/4.6	3.6/5.8	4.5/7.1	5.7/9.1	5.8/9.2	6.0/8.8	5.6/8.3	5.2/8.1	5.0/7.4	4.4/7.1	2.7/5.4	2.7/4.4	5.3/6.2
Latitude -15	Average	4.1	5.2	6.1	7.2	7.4	7.3	6.7	6.6	6.3	6.2	4.7	3.9	6.0
	Min/Max	2.8/5.3	3.9/6.3	4.7/7.5	5.8/9.4	5.8/9.2	5.9/8.7	5.6/8.2	5.2/8.2	5.3/7.8	4.8/7.8	2.9/6.2	3.0/5.1	5.5/6.5
Latitude	Average	4.4	5.5	6.2	7.1	7.2	7.0	6.5	6.5	6.4	6.5	5.1	4.2	6.1
	Min/Max	2.9/5.8	4.1/6.7	4.7/7.7	5.7/9.4	5.6/8.9	5.7/8.3	5.3/7.9	5.1/8.1	5.3/8.0	4.9/8.1	3.0/6.7	3.2/5.6	5.6/6.6
Latitude +15	Average	4.6	5.5	6.2	6.9	6.7	6.5	6.1	6.2	6.2	6.6	5.3	4.4	5.9
	Min/Max	3.0/6.1	4.2/6.8	4.6/7.6	5.5/9.0	5.2/8.4	5.3/7.7	5.0/7.4	4.8/7.7	5.1/7.8	4.9/8.2	3.0/7.0	3.3/5.9	5.5/6.4

Solar Radiation for 2-Axis Tracking Flat-Plate Collectors (kWh/m²/day), Uncertainty ±9%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
2-Axis	Average	4.6	5.6	6.3	7.2	7.5	7.4	6.8	6.6	6.4	6.6	5.3	4.5	6.2
	Min/Max	3.0/6.1	4.2/6.9	4.7/7.7	5.8/9.5	5.8/9.3	6.0/8.9	5.6/8.4	5.2/8.3	5.3/8.0	4.9/8.2	3.1/7.0	3.4/6.0	5.8/6.8

Direct Beam Solar Radiation for Concentrating Collectors (kWh/m²/day), Uncertainty ±8%

Tracker		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
1-Axis, E-W Horiz Axis	Average	2.5	3.0	3.0	3.4	3.4	3.2	2.8	2.7	2.8	3.5	3.0	2.6	3.0
	Min/Max	1.1/3.8	2.0/4.0	1.8/4.2	2.3/5.2	2.0/4.9	2.2/4.3	2.0/4.1	1.6/4.1	1.8/4.2	2.3/4.9	1.2/4.6	1.5/3.8	2.6/3.5
1-Axis, N-S Horiz Axis	Average	2.2	3.0	3.6	4.5	4.4	4.2	3.6	3.6	3.6	3.8	2.7	2.1	3.4
	Min/Max	1.0/3.3	2.0/4.2	2.1/5.1	3.0/7.0	2.6/6.5	2.8/5.7	2.6/5.3	2.1/5.4	2.4/5.2	2.5/5.4	1.1/4.1	1.2/3.2	3.0/4.0
1-Axis, N-S Tilt=Latitude	Average	2.9	3.6	4.0	4.5	4.2	3.9	3.4	3.6	3.8	4.5	3.4	2.8	3.7
	Min/Max	1.3/4.3	2.4/5.0	2.3/5.6	3.0/7.1	2.5/6.3	2.6/5.3	2.4/4.9	2.1/5.3	2.5/5.6	2.9/6.3	1.4/5.1	1.6/4.2	3.2/4.3
2-Axis	Average	3.1	3.7	4.0	4.6	4.5	4.2	3.6	3.7	3.8	4.5	3.6	3.0	3.9
	Min/Max	1.3/4.6	2.5/5.2	2.3/5.6	3.1/7.2	2.6/6.6	2.8/5.7	2.6/5.3	2.2/5.5	2.5/5.6	2.9/6.3	1.5/5.4	1.8/4.6	3.3/4.5

Average Climatic Conditions

Element	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Temperature (°C)	9.9	11.8	15.8	19.9	23.6	26.9	27.9	27.7	25.5	20.2	15.4	11.7	19.7
Daily Minimum Temp	4.4	5.9	10.1	13.9	18.0	21.5	22.9	22.7	20.4	14.1	9.5	6.2	14.1
Daily Maximum Temp	15.4	17.6	21.6	25.8	29.2	32.2	32.9	32.5	30.5	26.4	21.3	17.2	25.2
Record Minimum Temp	-16.1	-11.7	-6.1	0.0	6.1	9.4	15.6	15.0	5.6	0.0	-5.6	-13.3	-16.1
Record Maximum Temp	28.9	27.8	32.2	34.4	37.8	38.9	40.0	38.9	37.2	33.9	30.6	27.2	40.0
HDD, Base 18.3°C	273	191	98	27	0	0	0	0	0	29	109	218	946
CDD, Base 18.3°C	13	8	21	73	164	257	298	289	215	87	22	12	1459
Relative Humidity (%)	72	70	71	70	71	73	76	78	75	71	73	74	73
Wind Speed (m/s)	4.5	4.7	4.7	4.6	3.9	3.4	3.0	2.9	3.4	3.6	4.1	4.4	3.9

Figure 1: Horn Island Residence Building

Figure 2: Horn Island Generator Building

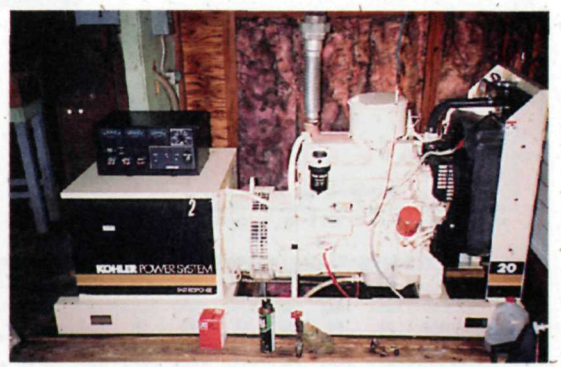


Figure 3: Kohler Engine Generator in Generator Building on Horn Island

Figure 4: Fuel Storage Tank in Generator Building on Horn Island

Figure 5: Horn Island Dock Area Showing PV Modules

Figure 6: Horn Island Residence Showing PV Module

Figure 7: National Guard PV System on Horn Island

Figure 8: View of Park Service Complex on Ship Island

Figure 9: Concession Store Area on Ship Island

Figure 10: North Generator Building on Ship Island

Figure 11: Fuel Storage Tank Adjacent to North Generator Buildings

Figure 12: View of Dock Area on Ship Island Showing PV Modules

ACKNOWLEDGMENTS

In a project this large, there are many contributors. From the National Park Service, Butch Street (Washington Office) assisted in the formulation of the field survey, established the database, and entered all survey data. Doug Richards (Denver Service Center) provided invaluable service in retrieving and compiling pertinent data from the database, providing cost estimates, and conducting numerous field site assessments for the use of PV power. In providing overall direction in the umbrella area of sustainability, Bob Lopenske (Denver Service Center) again demonstrated keen insight and a strong vision. Jon Nickolas and Mary Ryan from the Branch of Publications and Graphic Design (Denver Service Center) brought everything together into a pleasing format.

Hal Post and Mike Thomas at Sandia's Photovoltaic Design Assistance Center have provided extremely valuable technical assistance not only on this project, but to many park staffs on specific PV applications. The National Park Service looks forward to continuing this partnership with the Photovoltaic Design Assistance Center as we enter the implementation phase of expanding the use of renewable energy in the parks.

Park managers that responded to the survey also deserve recognition and appreciation for stepping up to the plate and exploring the use of new technology that enables "present needs to be met without compromising the ability of future generations to meet their own needs."

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☆ U.S. Government Printing Office 1998-673-136-42001

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NPS D-1009, February 1995

Printing History
Printed February 1995
Second Printing August 1995
Third Printing May 1998

United States Department of the Interior ◆ National Park Service