10-16-2006

Green power in green spaces: Policy options to promote renewable energy use in U.S. National Parks

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Green Power in Green Spaces:
Policy Options to Promote Renewable Energy Use in U.S. National Parks

Masters in Public Policy Thesis Submitted in
Fulfillment of the Graduation Requirements for the

College of Liberal Arts/Public Policy Program at
ROCHESTER INSTITUTE OF TECHNOLOGY

Rochester, New York

March 2006

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Acknowledgements

Thank you to the National Park Service and to the U.S. Department of Energy for providing me the resources and information I needed to complete the research.

Sincere thanks to Roxanne Dempsey at the United States Department of Energy for funding the research as part of an internship, for providing indispensable insight and guidance, and for trusting and encouraging me to work independently.

My appreciation to Steve Butterworth of the National Park Service, for revealing to an academic the difference between policies ("what we say") and action ("what we do"). Steve also provided endless support, and provided necessary information in a matter of hours that would have taken me weeks to uncover through conventional research.

Thank you to the many NPS employees who took their valuable time to speak with me during the busy summer months. Thanks also for providing me with understanding of ground-level renewable energy issues while brightening my days with an overarching positive attitude which is distinctive to the NPS.

My sincere appreciation goes to my thesis committee members Ann Howard and Franz Foltz, who provided alternative perspectives, encouragement, and constructive criticism, and thoroughly enriched the research as a result.

Thank you to Andrew Herbert, who provided indispensable assistance for the statistical analyses.

Thank you to my family and friends who provided endless support.

This completed thesis would not have been possible without Miss Lyndsey Fisher, who in addition to providing moral support provided endless reminders about deadlines; without her, I might still be writing today.

Finally, the utmost gratitude and appreciation goes to Dr. Jamie Winebrake, my principal thesis advisor. Jamie has certainly fulfilled his role as an advisor, unfailingly providing guidance, insight, encouragement and direction. More importantly, Jamie has been a mentor and a role model in the truest sense, with his determination, integrity, adherence to admirable principles and endless concern for others. I leave RIT knowing that Jamie's example is one I will always aspire to achieve, though will never quite attain.

Abstract

The National Park Service (NPS) has a mission of sustainability: to conserve its resources for the enjoyment of future generations. The mission implies the use of sustainable technologies. In order to best make use of sustainable energy technologies, the NPS must have an understanding of the most significant barriers inhibiting such technologies' use. The purpose of this research is to identify barriers to renewable energy technologies (RETs) at U.S. national parks located in the Pacific West Region (PWR), and to develop recommendations for appropriate policy interventions to address the barriers. A survey of energy managers representing the approximately 50 parks in this region identified and ranked key barriers from the perspective of those initializing projects and maintaining the RET systems.

To validate the significance of barriers identified by park personnel, parks with RET systems were compared with parks without systems according to relevant attributes such as funding and staffing. To gain a further understanding of the barriers to RET use and of underlying issues, the comments of park personnel were analyzed to establish common themes and concerns. The barriers identified through qualitative analysis were then validated through comparison of barrier ratings in relation to RET ownership and experience with unsuccessful attempts to obtain RETs. Finally, the strategies of park energy managers to overcome central barriers, and the factors assisting them in this regard were examined to determine opportunities for overcoming what were established as the strongest barriers to RET implementation.

The results of this research are a set of policy recommendations that could be used by the federal government to incentivize and encourage park decision makers to undertake cost-effective renewable energy projects in the future.

1 Introduction

The units of the National Park System— including National Parks, National Recreation Areas, National Seashores, National Historic Sites and Parks, National Monuments, National Preservations and Historic Preservations—have a mission to conserve their resources for the enjoyment of future generations (U.S.C. 16). The natural resources of the parks include vast expanses of unique and pristine landscapes—with unparallel scenery, rivers, lakes, deserts, forests, fish and wildlife; cultural resources include monuments, historic landscapes, historic homes and other buildings. The parks' mission to conserve their resources is inherently one of sustainability; the mission would imply sustainable use of resources and technologies. Renewable energy technologies are an example of technologies which employ resources in a sustainable manner.

Renewable energy technologies (RETs) harness energy from the sun and the earth to generate electricity; they include solar, wind, geothermal, and micro-hydropower technologies. Unlike fossils fuels and nuclear power RETs are virtually inexhaustible and produce no harmful emissions or other serious environmental impacts. Therefore, RETs are inherently more sustainable than conventional energy technologies.

The National Park Service (NPS) has the mandate to promote and regulate the nearly four hundred park units, which span more than 84 million acres (U.S.C 16, NPS n.d.). The NPS also has a mission of public education, entailing that the NPS not only promote the parks, but educate the nearly 300 million annual visitors about the resources within (NPS n.d. NPS 1991, NPS 1999).

The 2005 Energy Policy Act (EPACT) requires that a specified percentage of the energy consumed by Federal agencies be generated by renewable resources. The mandates have a goal of increasing the market for RETs and facilitating diffusion of the technologies, as well as decreasing the Federal Government's use of conventional energy. Under these requirements ""to the extent economically feasible and technically practical" no less than 3% of the energy consumed by the NPS must be generated from renewable resources in 2007; no less than 7.5% must be renewable by 2013 (Sec.203).

EPACT's goals fit well with the NPS objectives of sustainability and public education. By using RETs the NPS can make greater use of sustainable energy technologies and contribute to the conservation of the parks' resources. By promoting the use of RETs the NPS can facilitate public education and diffusion of the technologies.

With so many benefits to RETs one would expect their use to already be widespread, particularly in pristine areas such as national parks. However there exist many barriers to the technologies' use, including market, social, economic, and technical constraints (Painuly 2001). This study attempts to examine the barriers to RETs in the NPS, a division of the federal government with the potential to attain benefits exceeding those gained by other potential users. By examining the barriers and their underlying factors, policy interventions can be developed to address the barriers and increase the use of RETs in the parks. Further, this research attempts to identify whether the foremost barriers to RETs in the NPS are also those which result in exemptions under EPACT 2005—economic and technical barriers. If so, the EPACT strategy to increase the market for renewable energy and facilitate diffusion of the technologies may not be successful.

2 Background

2.1 Renewable Energy Technologies and National Parks

Conventional energy sources contribute to some of the most significant environmental problems of present times. Acid precipitation, particulates, smog, ground-level ozone formation, and forest destruction result from combustion of fossil fuels, and nuclear power produces radioactive waste which persists for generations (U.S. EPA, 2005a, b; Dincer, 2000). For example, acid deposition has been linked to damage to fish and aquatic life, damage to plants and forests, and deterioration of buildings, monuments, and other structures (Dincer 2000; U.S. EPA 2005b). The impacts of acid rain are of particular consequence to National Parks, which have the mandate of preserving the cultural and natural resources within.

Further, combustion of fossil fuels produces greenhouse gas emissions which contribute to global climate change, the foremost environmental problem facing the world today (IPCC, 2001). Energy-related carbon dioxide constitutes more eighty percent of the greenhouse gases produced in the United States, based on global warming potential[1] (EIA 2005). The world's average temperatures have increased by about .6 degrees Celsius in the past century (Dincer, 2000); overwhelmingly the scientific community attributes this increase to the greenhouse effect. Global climate change is expected to alter weather patterns, increase sea levels—displacing populations of both

[1] Global warming potential refers to the comparative effect of the greenhouse gas on global warming over a 100-year period. If longer timeframes are considered (i.e. 500 years), the global warming potential for carbon dioxide is even greater.

humans and wildlife, alter and displace agricultural zones, and alter patterns and habitat of the world's animals and plants (Dincer, 2000).

In contrast to conventional energy sources, renewable energy sources are clean and essentially inexhaustible. Renewable energy technologies (RETs) can create energy from the Earth's renewable resources including sun, wind, water and geothermal energy; the technologies harness the sun's or the Earth's energy and convert it to electricity. For the purposes of this study, RET systems include solar photovoltaic (PV), geothermal, wind turbines, fuel cells, and micro-hydro systems.

Photovoltaic Systems (PV)

Photovoltaic systems use photovoltaic solar cells to convert the energy from sunlight directly into electricity. There are numerous and various applications for PV systems, which are commonly used to power single homes or buildings. PV can be stand-alone, which produce power independent of the electricity grid; systems can be grid-connected, which feed excess electricity production back to the grid to the utility; and, building-integrated systems which are concurrently energy producers and building materials such as shingles or skylights (EERE 2005a).

Wind Turbines

Wind turbines capture the wind's energy with propeller-type blades to produce electricity. Turbines, just as PV systems, are of various sizes and have numerous applications. Small wind turbines generate electricity for applications such as powering single homes or buildings and pumping water; these technologies can also be used as stand-alone or as grid-connected systems (EERE 2006).

Geothermal

Geothermal energy technologies harness the earth's heat for various uses; they include geothermal heat pumps, direct applications, and electricity production technologies. Heat pumps use the near-constant temperature of soil near the ground surface for heating buildings in cold weather and cooling during hot weather. Direct-use applications use hot surface water for heating buildings. Electricity can be produced by tapping underground reservoirs of hot water and steam. (EERE 2006b) Most geothermal resources in the United States are found in the western states, Hawaii, and Alaska. (NREL, 2006)

Micro-Hydropower

Micro-hydro systems are hydropower systems up to 100 kW in size; flowing water from streams or other water sources is captured to create electricity. (EERE 2006c)

Fuel Cell

Fuel cells use hydrogen—or a hydrogen-rich fuel such as methane—and oxygen to create electricity; when hydrogen is used in a fuel cell the only byproducts are heat and water. (EERE 2005b) Though not necessarily "renewable", fuel cells can be considered RETs when the hydrogen used is produced from renewable energy.

2.2 RETs and Distributed Generation

Another distinction between conventional energy sources and RETs is the size and location of the power production facilities. Conventional power plants—using coal, oil, gas, and nuclear fuel—are highly centralized: power is produced in an enormous power plant and is distributed to the user via countless power lines nationwide. In contrast, RET systems can be used as distributed generation, which provides energy directly to the consumer and does not require access to the electric grid. The many benefits of distributed energy production are directly applicable to the National Parks. First, distributed generation of energy allows independence from the national grid and therefore provides energy security to its users. Second, many remote locations would face prohibitive costs to connect to the electric grid—for instance costs of extending power lines to a location can reach millions of dollars. Many park units have facilities in remote locations, and could benefit from the use of RETs.

Third, some parks use diesel generators for energy production in remote locations. Diesel generators produce harmful emissions and deteriorate the air quality in areas which are intended to be unspoiled. Many parks with generators must store fuel onsite—up to tens of thousands of gallons per generator. There have been several spills at storage sites which have caused groundwater and soil pollution; cleanup costs of these spills have reached hundreds of thousands of dollars per site (NPS 1995). Moreover, diesel generators can be extremely loud, heard from hundreds of feet away, "polluting" the natural soundscape of National Parks. According to staff members at a major national park, native wildlife has been known to avoid the areas surrounding diesel generators in the parks, and has returned to the area only once the generators were replaced with alternative energy sources (personal communication, July 2005).

Finally, RETs' life-cycle costs can be extremely low compared to conventional energy technologies, particularly in remote locations where the only alternative options for energy are diesel generators—which have very high fuel costs—and brining power lines to a location, the costs of which can exceed one million dollars. To illustrate, a recent life-cycle cost assessment at Haleakala National Park found that the cost of grid extension is more than twice that of the renewable energy option: $857,170 for grid extension compared to only $414,970 for an RET system (P. Malte, personal communication, November 2005). The lower lifecycle cost of RETs is not only beneficial in that it makes additional money available in the park budget for other discretionary projects, but the savings also accrue to United States taxpayers.

2.3 National Park Service Mission, Mandate, and Objectives

The National Park Service is unique in that it has the explicit purpose of what is essentially sustainability of its resources. As noted in an International Institute for Sustainable Development report (Bossel 1999), the definition of sustain is "to maintain; keep in existence; keep going; prolong", while the commonly referenced definition of sustainable development is "…development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. (p.2)" Acknowledging these definitions of sustainability, the NPS mission statement virtually reads as an alternative definition of sustainability:

> "***The service thus established shall promote and regulate the use of areas known as national parks, monuments and reservations…by such means and measures as conform to the fundamental purpose of said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such a manner as will leave them unimpaired for the enjoyment of future generations***." (U.S.C. 16)

The mission inherently implies the use of the most sustainable and environmentally-beneficial technologies by the parks; it also implies that the NPS encourage and require park units to use such technologies and that the NPS promote such activities in the parks.

As noted by Dincer (2000), in addition to incorporating environmental considerations, the notion of sustainability also involves additional parameters including innovative energy strategies and promoting renewable resources. Dincer also notes additional considerations which can direct society towards sustainable development, including the public sector facilitating public awareness, information, and environmental education and training.

The National Park Service has made many strides in incorporating similar notions of sustainability into policy and planning. In 1991, a NPS report summarized the vision of the agency for the future with strategic objectives including resource stewardship and protection, access and enjoyment, education and interpretation, and proactive leadership (NPS 1991). The report advocated that the NPS should: protect park resources from internal and external impairment; convey park values to the public with facilities which are "based on… sustainable use of resources…and a full accounting of environmental impacts (p.84)"; expand interpretation that enhances visitor enlightenment; lead by example by using state-of-the-art technologies which minimize resource demands; facilitate public understanding of major environmental issues and take a proactive role in protecting parks from internally and externally caused environmental degradation; engage in management that "looks beyond artificial boundaries at environmental concerns, whether they originate locally, regionally, nationally, or internationally (p.106)"; and most relevantly, minimize adverse impacts to park resources and the environment by taking advantage of opportunities in energy use (p.111).

The NPS established further objectives in 1999 with the *Natural Resource Challenge* (US DOI 1999). The document highlights challenges and strategies for the

Service in upcoming years. For environmental stewardship—one of the first challenges identified—recommended strategies include application of the highest standards of environmental stewardship to operations. Resource planning is another highlighted challenge; recommended strategies are: management with an in-depth understanding of…impacts of in-park or external actions on resources and actions which protect park resources. Finally, use of the parks for learning is another highlighted challenge; it is recommended that the NPS involve the public in preserving and restoring the parks.

2.4 Air Quality in the NPS

Congress has given the Park Service the task of repairing and protecting the air quality in the parks (US DOI 1999). Accordingly it would be expected that the air quality in the NPS would, over time, be improving or at the very least remain stable. However, according to the NPS Natural Resource Challenge:

> "More than a decade of monitoring in parks has shown that air quality is degrading. Air pollution is decreasing visibility, injuring vegetation, changing water soil and chemistry, contaminating fish and wildlife, damaging monumental and other stonework, and endangering employee and visitor health" (US DOI 1999 p.8).

Polluted air is having negative effects on virtually *all* of the resources which are of importance to the mission of the Park Service: natural resources including vegetation and soil, wildlife which are the main attraction at many of the parks, and even cultural monuments and buildings are subject to the ill effects of air pollution.

Clearly, a step taken to improve the air quality in the parks can be beneficial to essentially all of the valued resources within the parks. Certainly replacing diesel generators within parks with RETs would improve air quality; however, replacing conventional energy generation outside the parks can be of benefit as well. As noted earlier, NPS policies have moved away from considering only environmental concerns within the parks boundaries. Instead, emphasis has shifted to include concerns of external activities' impacts on park resources.

2.5 Renewable Energy Policies for Federal Agencies and EPACT 2005

Several mandates and Executive Orders encourage or require the use of renewable energy in federal facilities, including *Executive Order 13123* and the Department of the Interior's *Buildings/Facilities Energy Management & Water Conservation Plan*. Section 204 of the 2005 Energy Policy Act (EPACT) established a program with the objective of installing 2010 PV systems on Federal Buildings by 2010.

Most importantly, Section 203 of EPACT (2005) requires the use of renewable energy by Federal buildings. Beginning in 2007 it will be required that 3.0% of the energy consumed by federal agencies is renewable; the requirement will increase incrementally, reaching 7.5% in 2013. Renewable energy generated on federal land receives double credit towards filling the requirement.

The EPACT renewable energy mandates have the objectives of decreasing the negative impacts of use of conventional fuels by the federal government, as well as facilitating widespread use of the technologies. In theory, the use of RETs by federal agencies will create a demand for these technologies which will result in all of the benefits of a larger market. For instance, as the production of RET systems increases, increasing economies of scale will result, thereby decreasing the price of the technologies for consumers. Indeed, as noted by Neij (1997), experience curves indicate that significant investments in RETs are required to achieve desired cost reductions in the technologies. Similarly, as the number of locations with RETs increases, the necessary infrastructure for servicing and installing the technologies will develop to handle the increased demand and the experience with the technology— "learning-by-doing"—will increase as well. Demand for PV in particular has been predominantly driven by government procurement (Anderson and Jacobson 1997 as cited in Jacobson and Johnson 2000).

However, EPACT 2005 only requires that the federal government meet this requirement "to the extent economically feasible and technically practical" (Sec. 203), which presumably allows federal agencies to refrain from using renewable energy if there are barriers to their use such as a lack of availability or if the technologies are unaffordable. Considering that these barriers are some of the main barriers to use of RETs (Geller 2003; Gouchoe, Everette and Haynes 2002), it seems futile to attempt to increase the demand for these technologies through federal agencies while simultaneously exempting the agencies if the barriers are a factor.

By examining the main barriers to using RET systems in national parks, it can be ascertained whether those barriers that are the most substantial for the general public are also of issue to those in the federal government—or at least to one agency. If the barriers found to be most of issue in the NPS are indeed those that allow for exemptions from the EPACT requirement—for instance cost and access to the technology—perhaps the exemptions should be reconsidered. EPACT's intents of decreased conventional energy use by the federal government and increase in demand for RETs cannot be expected if the very barriers which result in exemptions from the requirements are prevalent, because federal agencies will not be required to use renewable energy.

2.6 Renewable Energy Technology Diffusion and the NPS

As is indicated above, currently the diffusion of RETs is not self-sustaining, and many challenges need to be overcome to reach the stage where policy interventions are no longer required (Jacobsson and Johnson, 2000).

The NPS is similar to other United States Federal government agencies in that the increased use of RETs by the agency as an early adopter could potentially increase the diffusion of RETs through increased economies of scale and learning-by doing, as recognized above. However, the NPS has a significant distinction from other federal agencies in its ability to facilitate diffusion of the technologies through several other avenues as well.

First, the NPS is distinct from most other federal agencies in that a significant proportion of the American population has direct contact with the agency. Every year, nearly 300 million people–the equivalent of the United States population—visit NPS parks (NPS 2005). In contrast, many other Federal agencies have buildings which are inaccessible to the public, or buildings to which few people would have the desire to visit. The ability to directly communicate with hundreds of millions of people allows the NPS to potentially have a valuable role in the diffusion of RETs.

A principal model of technology diffusion is the epidemic model, where non-users of the technology come in contact with users, become aware of the technology, and become adopters (Geroski 2000). Under the epidemic model, the greater the number of initial users, the faster the rate of technology diffusion will be; as more non-users come in contact with current users, the rate of diffusion increases. Therefore the NPS—with the equivalent of the United States population and millions of international visitors coming to its units each year—is an ideal organization to facilitate word-of-mouth diffusion.

An expansion on the epidemic model acknowledges that people must not only be aware that a technology exists in order to adopt it. Non-users must also communicate with current users who have experience with it, in order to obtain knowledge about how to use the technology (Rogers, 1995 as cited in Geroski 2000). The NPS is accordingly more capable than other Federal agencies to facilitate the diffusion of RETs. The NPS has a mission of public education, and fulfills this role in part through interpretation materials including brochures, signage, and direct interpersonal communication between interpreters and visitors. Interpretation can allow visitors to not only become aware of RETs, but to learn of the parks' experience with the technologies and about technological performance and environmental benefits, among other information.

Another key variable in the epidemic model is the probability of a non-user adopting the technology once informed (Geroski 2000). By educating the public on the many positive aspects of RETs, perhaps the NPS can help to increase the probability that an informed non-user will adopt the technologies. As noted in Geroski (2000) the diffusion of technologies is likely to be faster for technologies when early users spread the word with enthusiasm.

Finally, Jacobsson and Johnson, (2000) acknowledge in RET diffusion the importance of "prime movers" which fulfill four important roles: raising awareness, undertaking investments, providing legitimacy, and diffusing the technology. According to Jacobsson and Johnson, usually prime movers are from the capital goods industry. However, the NPS is ideally suited for the role of prime mover as well. With the infrastructure already in place to raise awareness and provide legitimacy, the NPS need only to undertake investments in RETs and assist in diffusing the technology to play what could be a central role in the increased use of RETs by the general public.

2.7 Pacific West Region National Parks

This research focused on the Pacific West Region (PWR) of the NPS; primarily due to access to the population. However, the PWR region is distinct in the NPS as being particularly suited for RET use. This section discusses the PWR's qualities related to RETs.

The PWR has responsibility for over 50 areas including national parks, monuments, and historic sites, and encompasses over 12 million acres of land, which is nearly 40% of the NPS acreage excluding Alaska (NPS 2001a; NPS 2001b). Over 54 million people—20% of NPS visitors and the equivalent of nearly one out of five American citizens—visit the region's parks annually (NPS 2005).

The Pacific West Region has an abundance of renewable energy resources. The Western United States are often called the "Saudi Arabia of Renewable Energy" (AWEA 2001, Reid 2003, Reid 2004), as the region has considerable amounts of solar, geothermal, and wind resources. Under EPACT requirements, the NPS as an entire agency is required to consume specified percentages of its energy from renewable resources. However, many of the parks are located in areas with minimal renewable resource availability: for instance Northeastern states have minimal solar resource availability, and considerable wind resource availability is limited to western and mid-western states (Green and Winebrake, in press). For the NPS to reach its targets of renewable energy use, likely some parks and regions will have to consume more renewable energy to offset trivial use in other regions. The PWR is a prime candidate as a region for this task for above-mentioned reasons of popularity, resource availability, and energy use.

2.8 Green Energy Parks Program

In 1999, the Department of the Interior (DOI) and the Department of Energy (DOE) entered into an agreement with the purposes of furthering the goals of public education and use of sustainable energy sources and environmental protection; the program was designated the Green Energy Parks Program (GEPP). The expected benefits of the agreement included saving energy costs and taxpayer dollars, reducing air pollution, reducing dependence on foreign oil, creating jobs, encouraging technological innovation, transforming the marketplace, and enhancing park visitors experiences (Memorandum, para.11).

Per the agreement, the DOE was responsible for providing technical assistance, for identifying financing opportunities, for assessing technical and economic feasibility of projects, and for assisting with dissemination of educational materials. (Memorandum, para.15) The DOI assumed the responsibilities of analyzing sustainability activities, inventorying projects, recommending specific projects with maximum education potential, implementing projects, ensuring ongoing maintenance, and ensuring that the parks' visitors are aware of the value and benefits of the projects (Memorandum, para.16) Through GEPP, numerous RET and alternative fuel projects have been implemented at national parks.

However, in recent years funding for the program has been decreased significantly. At this point, use of RETs of an appreciable size in the NPS is still limited, and most parks still do not have substantial RET systems(i.e. more than 1 kW). With the decrease and support from GEPP, the acquisition of RETs by park personnel will presumably be more challenging.

2.9 Barriers to Renewable Energy

With so much rationale for the use of RETs, one would expect that their use would be widespread and extensive. However, there are numerous impediments to the use of RETs. Many barriers are nearly universal, while others are more applicable to a particular population or location. Barriers to renewable energy can be divided into several categories: market failure/market imperfection, market distortions, economic and financial issues, institutional barriers, technical constraints, social, cultural, and behavioral, and other barriers. This section provides a brief overview of the central barrier categories and their importance.

2.9.1 Market Barriers

Market barriers refer to issues such as imperfect information, restricted access to technology, misplaced incentives, preference to conventional energy, and failure to consider the negative and positive externalities of energy generation (Painuly 2001, Brown 2001, Geller 2003).

Imperfect information refers to consumers not having the necessary information to make the best decision related to energy purchases, such as the benefits of RETs or the costs of conventional energy over time. As noted by Geller (2003), consumers may even be unaware that the technologies may exist, or if the technologies are available in the area; they may also be wary of any claims made by suppliers. A market failure exists because obtaining the information can be prohibitively time-consuming or expensive. Finally, architects and builders may lack the necessary knowledge and expertise to properly design and build energy-efficient buildings (Geller, 2003)

Restricted access to technology refers to potential consumers' inability to obtain the technology or the services necessary to use the technology, such as energy service companies that provide energy products and expertise (Painuly 2001, Geller 2003). This obstacle can be somewhat reinforcing. If demand is low in a region in response to limited availability of the technology, suppliers are hesitant to make products or services available, and thus demand continues to be low in an area (Geller, 2003). This barrier is particularly relevant to rural areas, where RETs may be most economically viable.

Misplaced incentives are frequently a barrier to energy efficient technologies, but also RET use. In this case, the benefits of using a RET do not accrue entirely—or at all—to the party responsible for purchasing or maintaining the system. A common example used to illustrate this issue is the apartment renter/owner dilemma. While the owner of an apartment is responsible for making investments in energy technologies, the renters are responsible for paying the energy bills. There is no incentive for the owner to invest the initial up-front cost in energy-efficient technologies as any cost savings resulting from the purchase will accrue to the renters in the form of reduced energy bills (Geller, 2003; Brown, 2001.)

Another misplaced incentive is that of the lowest-price bid: buildings and energy technologies are not designed to minimize overall lifecycle costs, but are chosen according to the lowest upfront cost (Geller, 2003). This issue is of particular relevance in the federal government, where decision makers are *required* to accept the lowest reasonable bid for such projects.

The external costs and benefits of energy production present barriers to use of renewable energy. If the costs of conventional energy generation are not internalized into the price of the energy, essentially an incentive is provided for the use of conventional fuels. Similarly, if the benefits of using RETs are not internalized into the price, a disincentive is presented. This barrier is the most significant when conventional energy sources are given preference through subsidies or preferential policies (Geller 2003, Brown 2001).

2.9.2 Financial/ Economic Barriers

Financial and economic barriers refer to such impediments as RETs being economically unviable, high upfront costs of RETs, high payback periods, lack of access to capital, high discount rates, high up-front capital costs, and lack of financing institutions to support RETs (Painuly 2001, Brown 2001, Geller 2003, Gouchoe, Everette and Haynes 2002). Lack of money or financing is essentially a universal barrier to RET use. Lenders have been reluctant to provide financing for RET projects, due to small project size and lack of familiarity with the technology (Geller 2003).

2.9.3 Technical Barriers

Technical barriers refer to inadequate performance or quality of RETs, failure for the technologies to meet consumers' expectations, or any technical problems resulting from manufacturing flaws, installation problems, or improper use (Geller 2003). Also, technical barriers include limited availability of skilled personnel or training facilities and a lack of operations and maintenance facilities, or even lacking knowledge on the part of architects and builders to properly design and build energy-efficient buildings (Geller 2003).

2.9.4 Behavioral or Social Barriers

Behavioral barriers refer to a lack of consumer acceptance of the product and lack of social acceptance for some RETs (Painuly 2001). Purchasing procedures of consumers present barriers to use of RETs as well; in the United States, consumers are primarily concerned with reliability, features, performance, capacity, and cost rather than being concerned with efficiency when buying appliances (Shorey and Eckman, 2000 as cited in Geller, 2003). The same types of factors are likely concerns when considering RETs, as well.

2.9.5 Institutional/Organizational Barriers

Institutional barriers to RETs include a lack of mechanisms to disseminate information, a lack of regulatory framework, and a lack of involvement of stakeholders in decision making (Painuly 2001). Organizational barriers include limited support and willingness of the firm or organization to invest in the technologies (DeCanio 1998). Additionally, a hierarchical structure of an organization tends to present barriers to the use of energy-efficient technologies (Worrell et al. 2001).

2.9.6 Policy Barriers

Policy barriers refer to governmental, utility, and institutional policies which present barriers to using RETs by potential consumers (Painuly 2001 and Geller 2003).

Governmental policies can be directly in opposition of RETs. When governments or others in positions of authority favor conventional energy over RETs, use of the technologies can be obstructed. There are vested interests in conventional energy which have political clout and influence and can oppose any initiatives or policies to promote RETs; utilities constitute a vested interest of this sort. In the U.S., most utilities oppose requirements for RETs and oppose their adoption (Geller, 2003).

As noted by Geller (2003), utilities can present burdensome interconnection requirements and procedures, can refuse to pay fair amounts for the electricity generated by RETs, and can require application procedures so tedious and time-consuming that they themselves are barriers; many people interested in developing small RET projects don't have the resources to negotiate with utilities; siting and approval for projects can also be difficult.

2.10 Research Questions and Objectives:

The primary purpose of this research is to establish the barriers to using RETs in National Parks and to identify appropriate policy interventions to address the barriers. To determine the relative importance of barriers to RETs in PWR parks, the perspectives of energy managers, superintendents, and other decision makers in these parks were obtained through telephone surveys/interviews.

Though many studies have investigated barriers to RETs in various regions and nations, research has primarily concentrated on non-governmental organizations and citizens, and there are fewer studies examining public sector barriers to alternative energy.

The interest in barriers to RETs in National Parks has several motivations. The practical considerations of the research relate to the 2005 EPACT, which requires that a specific percentage of the energy consumed by federal agencies be generated from renewable resources. Presumably the findings will be of interest to NPS and other federal policymakers intending to increase the use of RETs and meet the goals set by EPACT. By understanding not only which barriers to RETs exist in the NPS, but also the underlying factors related to the barriers, NPS officials can better target policy instruments to address and overcome the barriers.

From a theoretical viewpoint, this research seeks to add to the currently available literature on barriers to RETs in several respects. First, this research seeks to determine potential barriers to RETs in the public sector, particular in an agency dedicated to the preservation of resources for future generations. Previous research has centered on barriers to sustainable energy technologies by private firms, and has tended to neglect the single largest consumer of energy in the world—the United States Federal Government. Second, the research seeks to build on the current methodology used to evaluate barriers to RETs by examining attributes of a population in conjunction with tendency to possess RETs, and identifying methods to overcome the barriers which have been used successfully by members of the population. Third, this research uses the study of barriers to RETs as a case study of sorts of barriers to the use of RETs in the federal government, and applies the findings to the potential success of the EPACT 2005 mandates.

3 Literature Review

This section discusses the literature as it relates to barriers to use and implementation of RETs. Findings of previous research are considered to establish barriers which may be applicable to national parks.

Barriers to RETs and similar products such as energy-efficient technologies and green power purchases have been investigated extensively, although most research has focused on issues of private citizens and organizations. Surveying and interviews of potential consumers and other stakeholders have been the predominant methods for establishing barriers and determining the relative importance of barriers to a population, though alternative methods including case studies have been used as well. Analysis of the relative importance of barriers has focused on comparison of barrier ratings by respondents, in addition to correlation analyses to determine underlying issues or factors associated with barriers.

Studies using surveys and interviews of stakeholders to determine barriers to RETs and comparable products include Wiser (2000), Wiser (1998), Wiser, Fowlie, and Holt (2001), De Groot, Verhoef, and Nijkamp (2001), and Reddy and Painuly (2004).

Wiser (2000) surveyed green power marketers to determine the barriers to market entry from their perspectives. Several barriers were identified, including regulatory and legislative policies, lack of consumer education, and lack of renewable energy supply.

Wiser and Pickle (1998) reviewed five renewable energy policy case studies, and address differences in policy objectives, incentives and constraints from the perspective of financers; a survey of seven financers was performed as part of the research. Identified barriers to financing RETs were: perceived risks of RET projects such as technological, performance and resource risks; investors feeling that the work necessary to promote RETs was not worth the effort; the small size of many RET projects compared to conventional energy generation; high transaction costs per MW—that is, the same steps for funding and development must be followed regardless of the size of the project; and, policy impediments.

Several of the identified barriers are applicable to this research, and demonstrate the difficulties of obtaining funding for RET projects. Additionally, Wiser and Pickle demonstrate that renewable energy policies have not always fulfilled their potential because policy instruments are not always matched with barriers and constraints. The research indicates that even with policies to encourage RETs in the parks, the potential of the programs may not be fulfilled if the significant barriers to RETs in the parks are not being addressed.

Wiser, Fowlie and Holt (2001) examined the drivers to RETs from the non-residential consumers' perspective; however, the absence of drivers could be perceived as barriers to RET use. Voluntary green power customers in the United States—including businesses, non-profit, and public sector customers—were surveyed to explore motivations influencing their decision to purchase green power.

Wiser, Fowlie and Holt found that altruistic factors such as civic responsibility and organizational values were the dominant motivations to use renewable energy. In finding that altruism is a motivator for green power purchases, the study demonstrates that those who are educated about the societal benefits of RETs may be more inclined to purchase green power.

Interestingly, the study also found that *private interest* motivations were more common among public and non-profit organizations than in for-profit organizations. Implicated here is that public sector organizations such as NPS may be motivated by private interest motivations such as public image and marketing. In absence of these motivations—i.e. in parks where use of RETs will not satisfy these factors to a great extent—the acquisition of RETs may be more difficult.

The authors also recognize that previous research has found that larger organizations with sizeable budgets are often more likely to volunteer for environmental programs. This finding demonstrates that perhaps those parks with more funding and staffing resources available—i.e. larger organizations—may be more inclined to pursue RETs and other environmental programs.

De Groot, Verhoef, and Nijkamp (2001) surveyed Dutch firms to determine the factors behind investment behavior in energy saving technologies, as well as attitudes and responsiveness to environmental policies. Survey respondents rated a list of barriers to energy efficient technology on a five-point scale, according to importance. The average ratings given by the firms were compared according to the sector of the firm and firm characteristics such as size, competition and energy use. The study found statistically significant differences between firms according to the characteristics of size, profitability, and competition.

The study also had the intent of determining whether certain factors vary over firm characteristics and sectors. The analysis revealed that small firms with minimal investments in energy-efficient technologies had particularly large information gaps. Correspondingly, the study found a positive correlation between knowledge of energy-efficient technologies and overall investment in the technologies.   These findings suggest that parks with limited knowledge and expertise related to RETs will be less likely to have acquired or have attempted to acquire any systems.

DeCanio (1998), while assessing the barriers to energy-efficient investments, found that internal organizational structures in bureaucracies—both public and private—can tend to provide disincentives for the use of energy-efficient technologies. Factors identified as barriers include rationing of capital in the organizations and a lack of rewards for energy managers who do take the initiative to reduce utility bills.

DeCanio (1998) also found that public sector organizations' energy investments have a payback period which is on average several months faster than that of private organizations, which suggests that public organizations are less willing to accept longer paybacks than are private organizations. Additionally, the study found that increases in organizations' square footage were associated with longer payback periods, suggesting that larger organizations are more willing to accept longer paybacks as well.

These findings suggest that funding may be a major barrier to RET use, and that a lack of support for energy managers attempting to obtain RETs—or a lack of incentives for them to do so—may be a significant barrier to the use of RETs in the parks.

Reddy and Painuly (2004) is yet another study employing surveys to determine barriers to RETs; several stakeholders including residential, commercial, and industrial consumers, wind energy developers, policymakers and experts in Maharashtra, India were surveyed. The study found that the importance of barriers varied considerably among sectors, with the perceptions of policymakers and experts being considerably different than those of many stakeholders of the stakeholders.

Reddy and Painuly's findings are worthy of note because they indicate that policymakers may not have the same perception of barriers to RETs as all consumers or stakeholders. Perhaps the policy makers and energy planners in the NPS have perceptions of the barriers to RET use in the parks that are quite different from the perceptions of those making decisions in each individual park or in parks with certain characteristics.

In addition to surveys of potential consumers and stakeholders, other approaches to establishing barriers to RETs have been used. Xiaojiang and Gilmour (1996) employed case studies of five countries to identify issues limiting development of RETs in the South Pacific. Major issues identified were shortage of skilled human resources, inappropriate institutions and scarcity of capital resources. The findings indicate that the remote, isolated parks—particularly those located on remote islands in the Pacific—may particularly face issues of resource and staffing concerns.

Bird et al. (2005) examined issues surrounding wind energy technology diffusion. Factors identified as barriers in the study included quality of the wind resource, the cost of conventional energy, the willingness of power companies to integrate wind power into their systems, and ease of citing and permitting wind facilities. The findings suggest that wind power will particularly have strong barriers to its use in National Parks, as citing of wind power facilities is difficult in general.

In addition to recognizing the barriers to wind power, the authors acknowledge that policy functions in the center of drivers and barriers, and alternative policies will succeed or fail in certain areas according to the drivers and barriers. The authors conclude that no individual policy mechanism can be considered superior for all scenarios. The findings suggest that the current policy scheme to promote RETs in

National Parks may not be addressing all of the barriers which are of concern in all of the many park units. Given that the parks of the NPS Pacific West Region can be found in extremely diverse locations and environments with a variety of circumstances and attributes, the barriers to RET use at the parks are anticipated to be correspondingly diverse.

Gouchoe (2000) reported on local and community programs promoting RETs, and recognized that there are many barriers to RET projects, despite an increase in support for RETs from federal and state governments and utilities. The barriers include limited government staff resources and limited access to technical expertise. Consumers also face financial, regulatory, and informational barriers to RET use. The report's findings suggest that even with federal government and NPS support for RETs, several barriers to RETs will nonetheless be of concern for parks.

In their examination of several state financial programs for RET deployment, Gouchoe, Everette and Haynes (2002) identified many overarching factors which have encouraged or discouraged the deployment of small-scale RETs in different states. First, the authors recognize that the primary barrier to RET use is the per-watt incremental cost of small-scale RETs compared to conventional energy sources. The study also found that: utility interconnection process could either facilitate or hinder interconnection to the grid depending on the support offered by the utility; a shortage of qualified installers and inspectors could deter consumers from using RETs; RET users tend to have interest in non-economic aspects of energy use; consumer education is still a major barrier to RET use; uncertain funding can disrupt the progress and planning of RET projects; and, burdensome application processes deter potential program participants.

Gouchoe, Everette and Haynes's findings demonstrate that many barriers to the use of small-scale RETs exist, and that these barriers are of concern even with numerous policy mechanisms to promote the technologies.

Weisser (2004), while examining the role and economics of RETs for small-island developing states, highlights three barriers to RET use which have been documented extensively. These include: lack of knowledge of RETs; limited institutional and human resource capabilities; and, inadequate financing structures and programs. These barriers have been found to be of particular concern for small-island developing states related to replacement of diesel generators for energy production. These findings suggest that limited knowledge and expertise, limited staffing capabilities, and funding issues may be of particular concern to smaller, isolated and remote parks—such as those located on Pacific islands—which may face similar issues to those encountered in small-island developing states.

Worrell et al. (2001) present a review of issues related to technology transfer of energy efficient technologies to developing countries. Identified here as barriers to transfer and use of these technologies are: the decision-making processes of organizations, particularly if the organizational structure is strictly hierarchical and dependent on the status quo; lack of information by the consumer and/or high transaction costs to obtain information; limited capital availability due to capital rationing in organizations, and emphasis on allocating capital to projects with certain returns; and, shortage of trained personnel—particularly for small-to-medium-sized enterprises—which leads to difficulty installing technologies, and instead emphasis on purchasing energy. These recognized barriers suggest that: decisions of higher-ups in the NPS may present barriers to RETs use in the parks; lack if information and expertise may be significant issues, particularly for smaller parks; and, funding availability may be a major concern, particularly if decision-makers feel that funds could be better spent on alternative types of projects.

Tsoutsos, Frantzeskaki, Gekas (2005) present an overview of impacts of solar energy technologies. A main impact identified is that of visual impacts of the systems on buildings' aesthetics and on landscapes. In addition to incorporating the systems into the design of buildings, recommended techniques to address these concerns are locating the systems away from buildings of historic interest, from conservation areas, and from areas of natural beauty. These findings and recommendations suggest that issues of visual quality will be of the utmost importance to parks, as they are essentially comprised of historic resources and areas of conservation and natural beauty.

Alderfer, Eldridge and Starrs (2000) carried out case studies of distributed generation project participants' attempts to interconnect to the electrical grid, and the barriers which were of issue to participants. About ninety percent of participants reported experiencing significant barriers to interconnection, including: utility interconnection requirements, business practice barriers such as lengthy and complex contract procedures, and regulatory restrictions from the state or federal level. More than half of all projects encountered utility and regulatory barriers, and approximately two-thirds reported business practice barriers. These findings indicate that parks attempting to interconnect RETs to the electric grid are likely to encounter even more barriers than are parks with stand-alone systems, particularly policy and utility-related barriers.

Finally, and most relevantly, a 1994 study done in collaboration with Sandia National Labs and the NPS sought to identify the barriers to PV use in the parks. A survey questionnaire was administered to the 278 management units of the parks; 201 management units responded. The survey simply asked whether respondents had attempted to obtain a PV system unsuccessfully, and to identify from a list any barriers which had been an issue. About 75 percent of survey respondents indicated that there was at least one barrier to the use of PV. In order of prevalence, the identified barriers were: initial cost (22%), lack of familiarity with PV by operating personnel (14%), uncertainty with performance record (13%), visual quality concerns (12%), conflicts with the historical resource context (11%), lack of familiarity with PV by designers (9%), adverse climate (8%), and other (11%). However, there is no indication of the comparative significance of these barriers to respondents. Also, it was not established what types of parks were having concerns, and to what extent.

The report supplies several recommendations to overcome the identified barriers. To overcome initial cost, it is recommended that NPS enter in to partnerships and take into account all of the social costs of energy generation. To overcome lack of familiarity with PV and uncertainty with the performance record, it is recommended that presentations, meetings, conferences and training be provided. Finally, visual quality concerns and conflicts with historical resources were recommended to be overcome through purchase of small systems, locating systems away from existing facilities or critical areas if necessary, or remotely locating systems.

Though this study was completed over a decade ago, it is expected that many of the identified barriers are still an issue at national parks. Though recommendations were provided, it is expected that the recommendations for the most part were not implemented in entirety—or at all—by the NPS due to budgetary and other constraints. It is also expected that the importance of some barriers has changed since the study was performed. Also, as the study only inquired about barriers to PV systems—the vast majority of which were less than 1 kW in size—it is expected that additional barriers to RETs may exist. Finally, although the report provided recommendations for overcoming the identified barriers, the experience of those who have successfully overcome barriers was not established.

The barriers identified in previous studies which may be relevant to national parks are summarized in Table 1. The general theme of the literature of renewable energy barriers is that the barriers to RETs and other energy-efficient technologies vary according to the region and market analyzed and the characteristics of the potential consumers of the technologies; the perception of barriers differs considerably between stakeholders and even from consumer to policy maker.

However, as is demonstrated in Table 1 there are barriers which are prevalent throughout the literature, including: cost and financing concerns; lack of information, knowledge, expertise and education; and, lack of support mechanisms for the technology in organizations. This research attempts to identify barriers to RETs in a targeted population with exceptional renewable resource availability whose use of the technologies has benefits to society exceeding those attained by most users.

Table 1: Summary of Barriers with Potential Significance to National Parks

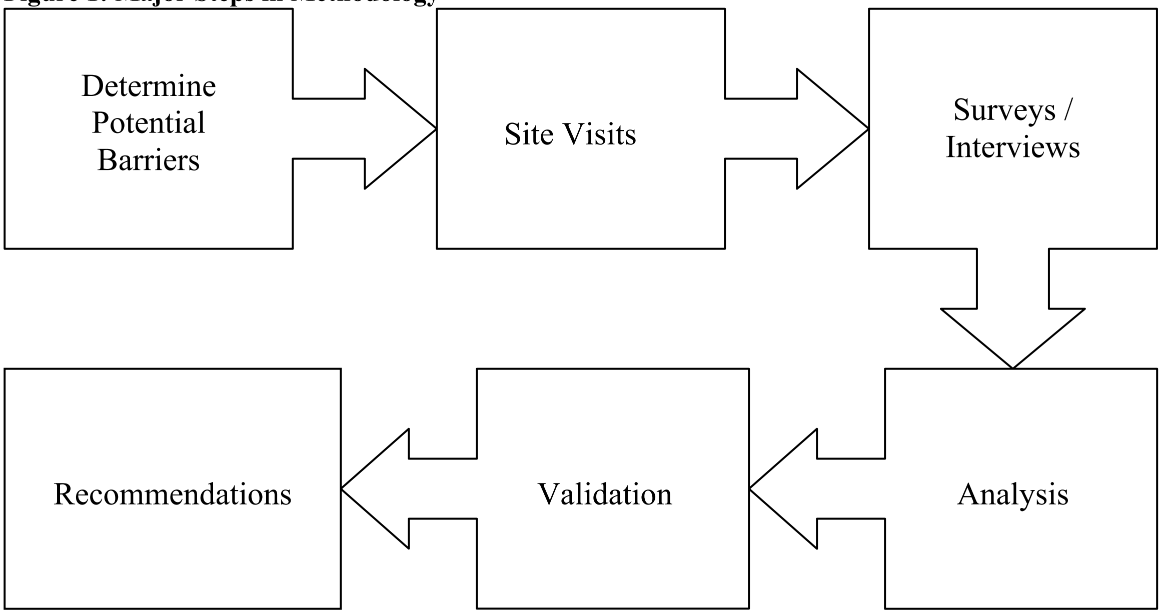
Barrier	**Reference**
Knowledge and Expertise, Consumer Education	Wiser 2000; DeGroot, Verhoef, and Nijkamp 2001; Xiaojiang and Gilmour 1996; Gouchoe 2000; Gouchoe, Everette and Haynes 2002; Weisser 2004; Worrell et al 2001
Initial Cost and Funding	Wiser and Pickle 1998; DeCanio 1998; Xiaojiang and Gilmour 1996; Gouchoe 2000; Gouchoe, Everette and Haynes 2002; Worrell et al. 2001
Limited Staff Resources	Gouchoe 2000; Weisser 2004; Worrell 2001
Size and Budget of Organization	Welch et al 2000; Arora and Cason 1996; DeGroot, Verhoef, and Nijkamp 2001
Organizational Structure and Decision-making Process	DeCanio 1998; Worrell et al. 2001
Insufficient Payback	DeCanio 1998; Worrell et al 2001
Utility Policy	Bird et al 2005; Gouchoe, Everette and Haynes 2002; Alderfer, Eldridge, and Starrs 2000
Uncertainty with Performance Record	NPS 1995; Geller 2003
Lack of Familiarity with Technologies by Designers	NPS 1995; Gouchoe, Everette and Haynes 2002
Visual Quality Concerns	Tsoutsos, Frantzeskaki, and Gekas 2005; NPS 1995
Conflicts with Historical Resources	Tsoutsos, Frantzeskaki, and Gekas 2005; NPS 1995
Policy Impediments	Wiser and Pickle 1998; Alderfer, Eldridge, and Starrs 2000
Adverse Climate	NPS 1995; Bird et al 2005
Private Interest vs. Altruistic Motivations	Wiser, Fowlie and Holt 2001

4 Methodology

This thesis used surveys and interviews of energy managers in the PWR parks to examine barriers to RET use in national parks. Surveys have been used in several studies to determine barriers to RETs and energy-efficient technology in various regions; most have used rating or ranking of barriers to quantify respondents' perceptions of barrier strength or importance. For instance, Wiser (2000) surveyed green power marketers, and asked that respondents rank listed barriers from least to most significant. In De Groot, Verhoef, and Nijkamp's (2001) survey of Dutch firms, respondents rated a list of barriers to energy efficient technology on a five-point scale according to importance. Reddy and Painuly (2004) surveyed stakeholders in India to rank their perceptions of barriers to use of RETs.

For this study, additional approaches to identify barriers to RETs were employed, including site visits and consulting with the PWR Regional Energy Coordinator. In this section I outline the steps taken to investigate RET barriers for national parks. These steps are shown in Figure 1.

Figure 1: Major Steps in Methodology



4.1 Determine Potential Barriers

In order to determine which barriers to include in survey, a review of the existing literature regarding barriers to renewable energy was performed. In his framework for analysis of barriers to RETs, Painuly (2001) recommends that the researcher review the literature of similar projects, barriers, and case studies at a regional, national, and international level. The National Parks have a distinct position as individual units which are a part of a federal agency. Therefore, many barriers which are relevant in the literature are not as relevant to the parks; correspondingly, many obstacles may arise in the parks which are not of relevance elsewhere. Therefore, in addition to the general literature on barriers to RETs, a Sandia National Lab study of the barriers to RET use in the parks (NPS 1995) was referred to, as was an unpublished study of twenty-four parks performed for the University-National Park Energy Partnership Program (Brennan and Winebrake, 2004). Finally, Steve Butterworth, the Regional Energy Coordinator for the

PWR parks was consulted to determine any barriers which had been an issue in the past for parks in the region.

4.2 Site Visits

In presenting a framework for analysis of barriers to RETs, Painuly (2001) recognizes that site visits should be performed because insights gained from field study can be of assistance in barrier identification. Painuly's framework also calls for interaction with stakeholders such as manufacturers, experts, policymakers, and professional associations. Adhering to the recommendation, site visits to two PWR National Parks were performed prior to beginning the survey. Here, in addition to gaining hands-on knowledge of issues at the parks, I interacted with several relevant stakeholders.

In July 2005, I joined the NPS PWR Regional Energy Coordinator, Steve Butterworth, an assessor from the National Renewable Energy Laboratory, Otto Van Geet, and an employee of PV-supplier Sunwize, David Love, for visits to two PWR National Parks. The purpose of the visits was to examine the feasibility and economic viability of RET use at the sites. During the visits, in addition to interacting with the experts, I interacted with energy managers, maintenance personnel and other park employees.

The primary purpose of the site visits was to assess each of the parks' potential for specific RET projects. Both parks had remote locations where power was required to be produced onsite.

During the visits, many constraints to RET use were made apparent. First, there are considerable seasonal and hourly fluctuations in energy requirements in the parks due to fluctuations in visitation. Second, staff constraints and concerns about maintenance requirements were made apparent. Personnel had many obligations throughout the park, while the parks spanned hundreds of thousands of acres and trips to remote locations could take several hours. Third, concerns about the visual interference of the systems were made apparent. Locating RET systems in ideal locations is challenging, as locations which are most exposed to the elements—i.e. renewable resources—are also most visually intrusive into the natural or cultural landscape. Finally, it was made clear that there were considerable concerns about funding being available and about approval for systems from above.

Following the literature review, discussion with the Regional Energy Coordinator, and site visits, a list of twenty-two (22) potential barriers to RET use was developed.

4.3 Surveys/Interviews

During August 2005 park energy managers, chiefs of maintenance, superintendents, and other relevant park personnel in the PWR were contacted via telephone.

The sample of National Park units was primarily a convenience sample; access to the population was obtained during an internship with the DOE and the NPS. The contact information for the most appropriate person at each park was obtained from the PWR Regional Energy Coordinator, Steve Butterworth. The survey sample is almost entirely inclusive of the population; participants representing 48 of the approximately 52 park units were contacted. The response rate exceeded 90 percent, resulting in a sample which represents the population well. The sample includes parks with extreme variations in geographic distribution, size, popularity, climate, proximity to population centers, and park purpose, etc., indicating that the results may be generalized to the entire NPS population to an extent.

The structure of the survey was as follows. First, participants were asked whether or not there were any “renewable energy systems” at their park. The technologies that are considered as RETs for the purpose of the study were listed for participants. The participants were asked about the number, type, and size of the systems at the park. Survey participants at parks with RETs were asked to indicate their satisfaction with their systems(s).

Next, park contacts were asked whether they had ever unsuccessfully attempted to obtain an RET for use at the park. Survey participants were then read the list of twenty-two potential barriers to obtaining/using RETs at their park, and were asked to rate each barrier on a six-point scale of zero (0) to five (5) according to importance of impeding the use of RETs at their park, with zero being a non-issue and five being barrier of greatest importance. Participants were invited to elaborate or comment on any of the listed barriers, to allow respondents to express their real issues of concern. I assumed that those issues which were of the most concern to park personnel—or those that they felt were misunderstood by decision makers—would be discussed as a result. Additionally, park contacts were invited to disclose any other barriers of importance at their park, which were absent from the list. Painuly (2001) recommends that provisions should be kept for additional barriers to be added into surveys, as respondents’ opinions are useful beyond items covered in structured questions.

Survey respondents with RET systems in their parks were also asked a) how the barriers that they ranked as being the strongest were overcome to obtain and use the system(s) that they currently have; and b) what particular factors helped them in being able to obtain and use the system(s).

Finally, survey participants were asked to indicate what changes might be made by the NPS or the federal government which would make them more inclined to use RETs, or which would make it easier for them to do so. The exact wording and structure of the survey can be found in Appendix A.

4.4 Analysis

The analysis involved both quantitative and qualitative methods to address the many different research questions and types of information acquired. Quantitative methods included simple data analysis techniques such as computing means and medians, and more complex approaches such as correlation analysis, t-tests, and tests for homogeneity using chi-squared. Qualitative analysis consisted of coding responses and determining prevalence of themes and underlying issues.

4.4.1 Designation of Parks with RET Systems: Qualification

The question of whether a park has an RET system is not straightforward as may be imagined. Many types, sizes and applications of RET systems exist. Passive solar systems do not generate "energy" per se, while extremely small RETs provide a trivial amount of power for most purposes. Some small RETs are used only because there are no other options as the area is remote and neither power lines nor generators can be brought to the area—these systems are commonly used for lighting, water pumping, or telemetry, for instance. For the purpose of this research, for a park to be qualified as having an RET at least 1 kW installed capacity was required; the cutoff value was established by examining the sizes and applications of systems in the parks. At the 1 kW level, a clear separation existed between parks with smaller, obligatory systems and parks with larger RET systems used for power generation.

4.4.2 Data Entry

Following the surveys and discovery of park attributes, all of the relevant data were entered into Microsoft Excel spreadsheets. Entered values for each park included: numbers representing park contacts' perception of barriers[2] (0-5); funding, visitation, employees, and acreage data; and, dummy variables representing qualitative attributes such as fee-collection status, historic status, and whether the park has an RET system.

4.4.3 Aggregate Average Ratings of Barriers

The aggregate ratings of barriers were examined to determine the foremost barriers to RETs across the PWR region. The descriptive statistics for the barrier ratings were determined, including range of ratings. The mean and median ratings for each barrier were calculated using Microsoft Excel, and the barriers were sorted in order of importance.

4.4.4 Attributes of Parks with RETs versus Parks without RETs

In order to validate the barriers identified by park contacts and to determine key characteristics of parks with RETs, the attributes of parks with RETs were compared with

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[2] Three of the survey respondents were the energy managers for more than one park unit. In these cases, respondents were asked whether the barriers were comparable for both/all park units, and the same barrier ratings were entered for the separate park units.

those of parks without RETs. Included in the attributes analyzed are: park annual budget, park FTEs (full-time employee equivalent), park acreage, historic designation, fee collection status, and visitation.

A two-tailed t-test was performed to compare the quantitative characteristics of parks with RETs to those without (i.e. funding, employees). The descriptive statistics including means and medians were established, as was the statistical significance of the results.

To compare qualitative attributes of parks (i.e. fee collection and historic status), a test for homogeneity within a population was performed using chi-squared. The descriptive statistics and statistical significance were determined as well.

4.4.5 Park Contacts' Comments Regarding Barriers

Respondents' comments were coded to analyze the number and percentage of respondents who felt it important to comment on or discuss certain barriers, and to determine prevalent and underlying themes to responses.

4.4.6 Average Rating of Barriers, Parks with vs. without RETs

In order to validate the findings of earlier sections of analysis, the respondents' perception of barriers at parks with and without RETs was compared.   A two-tailed t-test was performed as a preliminary analysis to determine any significant difference between barrier ratings of the two groups. Next, barriers which were shown to be significantly different in the t-tests were then analyzed with a test for homogeneity using chi-squared.

In the chi-squared tests, barrier ratings were grouped into two categories (0-2 and 3-5) so that use of chi-squared was appropriate.[3]

4.4.7 Barrier Ratings, Unsuccessful Attempts to Obtain RETs

In order to validate the findings of previous sections of analysis, the perception of barriers of park personnel who had unsuccessfully attempted to obtain RETs was compared to that of parks that had made no unsuccessful attempts. The statistical analysis approach was the same as that described in Section 4.4.6.

4.5 Methodological Limitations

As is an issue for any research, this research has several limitations. First, the results are not especially generalizable; though the PWR population is well represented, all of the results may not be generalized to the entire NPS population or to the federal government in its entirety. For instance, as was recognized earlier, the PWR in general has climates more suited to RET use; therefore the significance of this barrier cannot be assumed to be of the same importance to all NPS units. Second, the research depends on honest discussion of actions and measurement of concerns by respondents; if respondents were not entirely candid in answering survey questions, the actual barriers to RET use may not be established. Third, the survey took place as part of an internship with both the NPS and the U.S. DOE Office Energy Efficiency and Renewable Energy; respondents' knowledge of my affiliation with these organizations may have influenced the answers of respondents.

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[3] Chi-square analysis is deemed to be appropriate when the expected value for each cell is greater than or equal to 5. If barrier ratings remained separate, at least one cell would have an expected value of less than 5.

5 Results and Discussion

5.1 Barriers to RETs in Pacific West Region National Parks

Through review of the literature, site visits, and discussion with NPS personnel, the recognized potential barriers to RET use in National Parks were:

- Initial Cost
- Insufficient Payback
- Funding
- Inadequate Design
- Insufficient Technology
- Staff Availability
- Staff Expertise
- Park Size
- Maintenance Requirements
- No Access to Technology
- Utility Policy
- State Net Metering Policy
- Other Policy or Regulations
- Support from Above/External Support
- Lack of Familiarity by Designers
- Lack of Familiarity by Operating Personnel
- Uncertainty with the Performance Record
- Procurement Problems or Restrictions
- Conflicts with the Historical Resource Context
- Visual Quality Concerns
- Inability to Locate Suppliers or Contractors
- Adverse climate
- Other

Descriptions of the barriers are available in Appendix B.

5.2 Experience with RETs in PWR Parks

An understanding of the experience of park personnel related to RETs is useful prior to examining barrier issues. If park personnel have predominantly had negative experiences with the technologies and the systems have not met their objectives, then consideration of the barriers to RETs is unwarranted, as obviously the further use of the technologies would not be desired due to technological limitations. However, if RETs have tended to meet their objectives and park personnel are predominantly pleased with RETs, then the question of barriers to RETs is still warranted.

Park energy managers overwhelmingly indicated a positive experience with RET systems. As shown in Table 2, 88%[4] of respondents with RETs indicated that they were "very pleased", 29% said that they were "pleased", and 13% indicated that they were "satisfied". In contrast, no-one indicated that they were "very disappointed". Two people, or 8% of respondents indicated that "all" categories applied to them, while one person indicated that a system was not used, so none of the categories applied.

Table 2: Experience with RETs	
Satisfaction with RETs	**Percentage of Respondents**
Very Pleased	88%
Pleased	29%
Satisfied	13%
Disappointed	8%
Very Disappointed	0%
Not Used	4%
"All"	8%

Furthermore, when asked whether the RETs had "met the intended objectives", the response was almost unanimously "yes". Ninety-six percent of respondents said that, yes, the RET(s) had met the intended objectives, while four percent—one person—said "yes and no". Therefore, none of the respondents revealed that an RET had entirely failed to meet its intended objective, and the vast majority demonstrated that RETs had fulfilled their objectives in the parks.

The results demonstrate that RETs are acceptable—and advantageous—energy options for use in PWR parks.

[4] Percentages do not add up to one hundred because several respondents indicated that more than one category applied.

5.3 Park Characteristics/Profiling Parks

An understanding of the range of characteristics and profiles of the parks is useful prior to explaining the results of the survey and analysis. Pacific West Region National Parks are extremely diverse, ranging from those with vast land area, enormous annual budgets, high visitation, and numerous employees, to parks with few acres, minimal budgets, fewer visitors and essentially zero FTEs. Charts illustrating the disparity and distribution of park attributes are available in Appendix C.

5.4 Overall Average Ratings of Barriers

Collectively, park respondents rated the twenty-two barriers as having quite diverse importance in impeding the use of RET systems in the parks. Several factors were perceived as being of significant importance, while others were largely considered inconsequential. As shown in Figure 2, the barriers assigned the strongest ratings were—in descending order of importance—funding, initial cost, staff expertise, visual quality concerns, conflicts with the historical resource context, and staff availability. The barriers considered to be least significant were—in descending order of importance—utility policy, lack of familiarity by designers, state net metering rules, and policy/regulations.

Table 3 shows the frequency of ratings for barriers, and the percentage of respondents which rated each particular barrier at each value of importance; barriers are presented in order of greatest to least importance.

Figure 2: Overall Average Ratings of Barriers to use of RET Systems

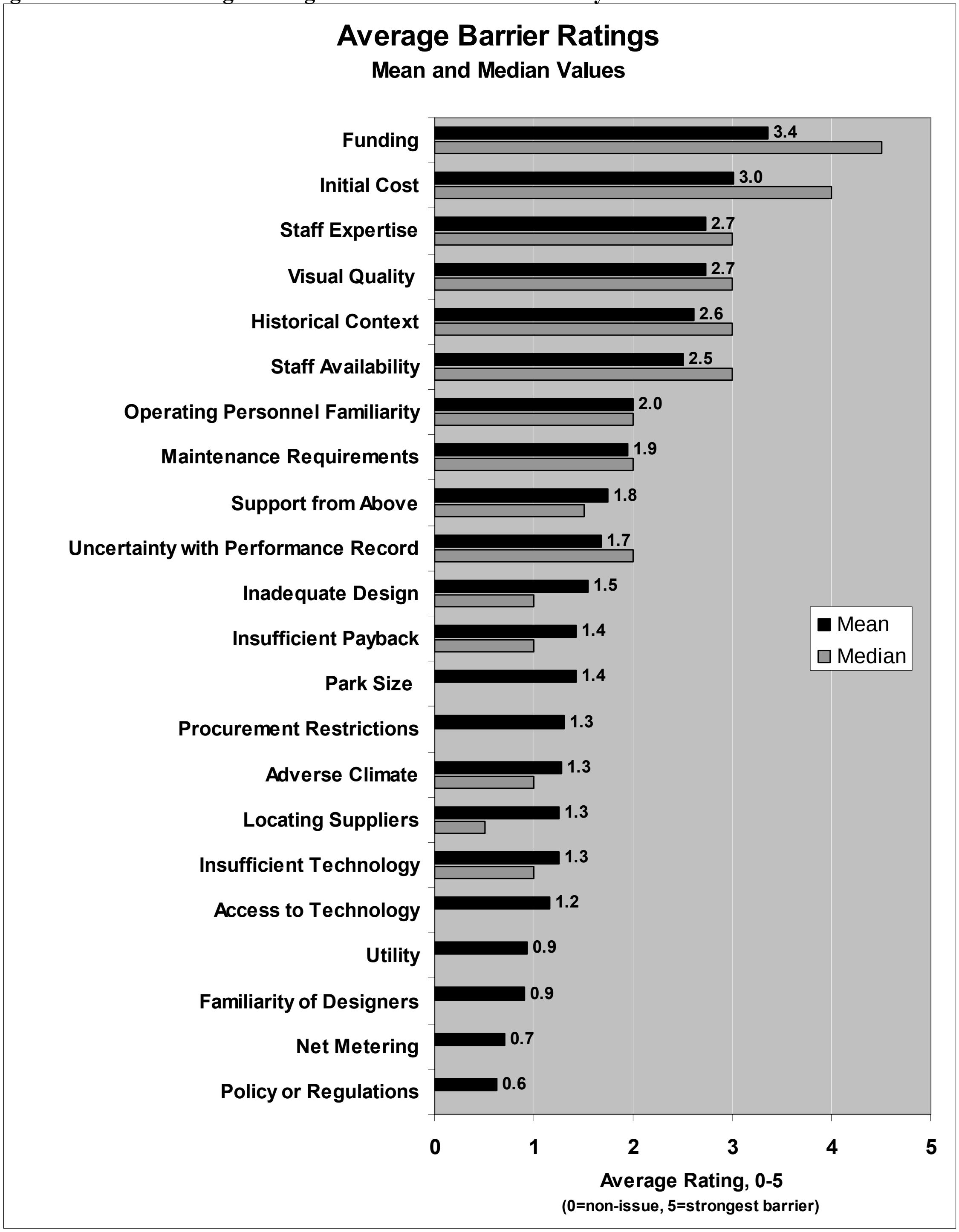

Table 3: Barriers to RETs, Summary Statistics

Barrier	Number Responses/Percentages					
	Non-Issue					Strong/Very Important
	0	1	2	3	4	5
Funding	9/19%	3/6%	1/2%	9/19%	2/4%	24/50%
Initial Cost	11/23%	3/6%	2/4%	6/13%	11/23%	15/31%
Staff Knowledge/ Expertise	8/17%	8/17%	6/13%	5/10%	9/19%	12/25%
Visual Quality Concerns	8/17%	2/4%	10/21%	12/25%	7/15%	9/19%
Conflicts with Historic Resource	14/29%	2/4%	5/10%	8/17%	6/13%	13/27%
Availability of Personnel	10/21%	6/13%	5/10%	11/23%	9/19%	7/15%
Familiarity by Operating Personnel	16/33%	3/6%	7/15%	12/25%	7/15%	3/6%
Maintenance Requirements	14/29%	5/10%	8/17%	16/33%	3/6%	2/4%
Support from Above	23/48%	1/2%	3/6%	11/23%	7/15%	3/6%
Uncertainty with Performance	17/35%	5/10%	9/19%	10/21%	5/10%	2/4%
Inadequate Design	19/40%	9/19%	4/8%	10/21%	3/6%	3/6%
Insufficient Payback	20/42%	7/15%	11/23%	8/17%	2/4%	1/2%
Park Size	25/53%	5/11%	3/6%	6/13%	4/9%	4/9%
Procurement Restrictions	25/52%	2/4%	8/17%	8/17%	4/8%	1/2%
Adverse Climate	23/48%	9/19%	4/8%	7/15%	3/6%	2/4%
Inability to Locate Suppliers	24/50%	5/10%	10/21%	4/8%	3/6%	2/4%
Insufficient Technology	23/48%	9/19%	2/4%	11/23%	2/4%	1/2%
No Access to Technology	27/56%	7/15%	2/4%	7/15%	2/4%	3/6%
Utility Policy	27/56%	7/15%	4/8%	10/21%	0/0%	0/0%
Familiarity by Designers	29/60%	5/10%	6/13%	7/15%	1/2%	0/0%
Net Metering	34/71%	4/8%	2/4%	7/15%	1/2%	0/0%
Policy or Regulations	36/75%	4/8%	4/8%	1/2%	0/0%	3/6%

5.4.1 Strong/Prevalent Barriers:

Mean Rating ≥ 2.5; Median Rating ≥ 3

Six barriers were deemed to be the most important to park contacts due to the high mean of responses and the high frequency of ratings of 3 or above by respondents. Each of these barriers has an average rating greater than 2.5, and at least half of respondents rated each barrier at 3 or above. The results indicate that these barriers are of the most significance for park personnel, and that developing approaches to address these barriers would encourage the increased use of RETs in the parks. Therefore, discussion and analysis will focus on these barriers.

Funding

Funding was rated as the strongest barrier to parks' acquiring RE systems. As shown in Figure 2, the mean rating for funding was 3.4, and the median rating was 4.5. As shown in Table 3, funding was given the highest rating of 5 by fully half of the respondents; nearly three quarters of respondents rated funding at 3 or above.

Funding was expected to be rated as one of the strongest barriers, as parks have limited budgets which must be used to provide many services and to pay for regular maintenance projects. The allocation of limited park funds to RET systems is extremely difficult, and acquiring funding from above or outside the organization is challenging as well.

The high importance of funding—rather than simply initial cost—was also anticipated given that there are so many impediments to financing alone. As Wiser and Pickle (1998) found, potential financers of RET projects are deterred due to concerns about the technological quality and performance, beliefs that the work necessary for RET projects is not worthwhile, and high costs per unit of energy, among others.

The dominance of funding—actually the lack of funding—as a barrier supports DeCanio (1998) which found that a lack of capital within an organization presents barriers to those within the organization who may be pursuing efficient energy technologies. Worrell (2000) also found that capital rationing in organizations is a barrier use of energy technologies. Weisser (2004) found that inadequate financing structures and programs inhibit the use of RETs. Finally, Wiser and Pickle (1998) identified numerous barriers to financing RETs, including perceived risks of RET projects, technological, the small size RET projects, and high transaction costs.

The high rating of funding and the frequency of high ratings for funding in comparison to all of the other identified barriers indicates that the lack of funding is a central barrier to use of RETs in PWR parks, and that the availability of additional funding or additional financing mechanisms would facilitate increased use of the technologies in the parks.

Initial Cost

Initial cost was rated as the second most important barrier overall. As Figure 2 shows, the mean rating for initial cost was 3.0, and the median rating was 4. Nearly one-third of respondents gave initial cost the highest rating of 5, and more than half of respondents rated initial cost as either a 4 or 5. Initial cost was ranked nearly as high as funding, but was not given the same average rating overall or by many individual park contacts. This indicates that while park respondents' acknowledge initial cost as a strong barrier, they might be willing to overcome the barrier if funding were available. It was expected that initial cost would be a top-rated barrier, as the initial cost of RETs is one of the most prominent barriers in the literature, and as mentioned earlier, parks have limited budgets with which to perform essential duties, tasks, and services. Additionally, there are several underlying explanations for the high importance of initial cost to park contacts.

Gouchoe, Everette and Haynes (2002) identified the incremental cost of RETs as the principal barrier to their use. The authors, along with Brown (2001) acknowledge that the failure to account for the externalities of conventional and alternative energy production is a contributing factor to the importance of initial cost as a barrier.

As noted in Brown (2001) and Geller (2003), many times there is another market failure associated with initial cost of RETs and energy-efficient equipment: misplaced incentives. Here, the benefits of using RETs do not accrue entirely—or at all—to the party responsible for purchasing or maintaining the system. A common example used to illustrate this issue is the apartment renter/owner dilemma. While the owner of an apartment is responsible for making investments in energy technologies, the renters are responsible for paying the energy bills. There is no incentive for the owner to invest the initial upfront cost in the equipment, as any cost savings resulting from the purchase will accrue to the renters in the form of reduced energy bills (Geller, 2003; Brown, 2001).

The same sort of quandary can be said to exist for the national park personnel investing in RETs and energy efficient technologies. The capital for the initial cost of the systems will come directly from the park base budgets, and any large expenditure in one area will result in lesser funds available for other important functions of the park. The benefits of energy savings will accrue over a longer period of time, though. The savings will not be as noticeable for park personnel in allowing additional services to be provided, as they will be incremental savings over the lifetime of the system. Most importantly, energy savings accrue to taxpayers, not to those responsible for acquiring and maintaining the systems. Similarly, many of the environmental benefits will accrue to society as a whole, not only to those installing and investing in the system.

The high rating of initial cost indicates that this is a fundamental barrier to use of RETs in the parks. Acknowledging the underlying issues of initial cost at the national parks indicates that there is potential for addressing this central barrier through incentives and internalization of costs and benefits.

Finally, it should be noted that both funding and initial cost were identified as the most significant and prevalent barriers to RET use. The high importance of these financial barriers demonstrates that, indeed, financial barriers may be as prevalent in the Federal government as they are in the private sector. As mentioned earlier, EPACT 2005 requires the use of renewable energy by Federal agencies "to the extent economically feasible". Given that funding and initial cost are the most prevalent and strong of the barriers to RET use, the NPS may be exempted from the EPACT requirements; accordingly EPACT's goals of increased demand for RETs and decreased conventional energy use would not be achieved.

Staff Knowledge and Expertise

As shown in Figure 2, *staff knowledge and expertise*—or lack thereof—was rated as being a strong barrier to RET systems in parks. The mean rating was 2.7, while 3 was the median rating. Staff knowledge and expertise was given a rating of 5 by one-quarter of respondents, and nearly half of respondents rated this barrier with either a 4 or a 5.

The comparatively high rating of staff knowledge and expertise in comparison to the other identified barriers was expected, as RETs—unlike conventional electricity services—require acquisition, installation, maintenance and repair. Without expertise in these areas, the installation of systems can be hindered, and the repair of systems can seem to be daunting tasks. Without knowledge of the benefits of RETs, or of procedures to locate and acquire systems, park personnel are not likely to pursue RET projects.

The importance of staff knowledge and expertise supports previous research related to barriers to sustainable energy technologies. Several studies have documented the importance of both consumer education and technical expertise. Reddy and Painuly (2004) found that stakeholders in the industrial sector felt that lack of expertise within the firms to operate systems was a significant barrier. Xiaojiang and Gilmour (1996) found that shortages of skilled human resources such as project organizers and engineers and technicians were a central barrier. Worrell (2001), Weisser (2004), and Gouchoe, Everette and Haynes (2002) identified consumer education and shortage of trained personnel as major barriers to energy technologies. These studies, spanning almost a decade, and a better part of the globe, demonstrate the prevalence and persistence of this barrier.

Indeed, a previous study (NPS 1995) which identified the barrier of staff limitations and education recommended that the NPS hold presentations and conferences and that training be provided for park personnel. Unfortunately, as demonstrated by the results here, staff knowledge and expertise continue to be significant barriers in the parks.

The Federal Energy Management Program (FEMP) has developed numerous training and educational programs to address the well-acknowledged barrier (FEMP

2006a, b). However, FEMP—like all government programs—has limited resources and cannot train and educate all of the employees in the United States Federal government. Therefore, many Federal employees—including those in the parks—are less knowledgeable and skilled related to RETs than is desired.

Staff knowledge and expertise is also of particular importance to national parks because many park units are remote, and staff onsite are required to install and care for RETs. In contrast, consumers in more densely populated areas have the opportunity to use energy service providers to install and care for RETs.

The comparatively high rating of staff knowledge and expertise as a barrier to RETs in parks indicates that issues of education and skill are of the utmost importance in inhibiting the use of RETs, and that the addressing of this barrier through appropriate training and education would make possible the acquisition and use of more RETs in the parks.

Visual Quality Concerns

Visual quality concern was rated as being one of the strongest barriers to using RET systems in the parks. As shown in Figure 2, visual quality concern was given a mean rating of 2.7; its median rating was 3. Nine respondents gave visual quality concerns a rating of 5; more than half of respondents gave the barrier a rating of 3 or above.

Visual quality concerns were expected to be a significant barrier, as this was a central barrier recognized in a 1995 assessment of barriers to RETs throughout the NPS (NPS 1995), and as Tsoutsos, Frantzeskaki, Gekas (2005) demonstrated that visual intrusion is the major negative impact of many RETs. Additionally, the NPS mandate to conserve the scenery in parks poses genuine constraints related to use of RETs. Though there are many approaches to mitigate visual impacts, in many cases the use of RETs is simply too visually intrusive. Park energy managers must choose between working to preserve the pristine air quality in a park and furthering public education, or working to preserve the scenery; frequently, the scenery is a higher priority.

The importance of visual quality concerns as an impediment is demonstrated by the comparatively high ranking that the barrier received compared to other barriers. In the NPS and Sandia National Labs report, *Renew the Parks* (1995) it was recommended that this barrier be overcome by using small systems, locating systems away from facilities, or incorporating systems into the design of buildings. Unfortunately, the results of this study tend to indicate that these recommendations have not entirely addressed the visual quality concerns issues; therefore, additional measures may be required to overcome the barrier.

Conflicts with the Historical Resource Context

As shown in Figure 2, *conflict with the historical resource context* was given a mean rating of 2.6 and a median rating of 3. More than one-quarter of respondents gave the barrier a rating of 5, and more than half of respondents rated the barrier as 3 or above. Interestingly, more than one-quarter of respondents gave conflicts with the historical resource context a rating of 0, illustrating the variation in importance for this barrier.

The importance of conflicts with historic resources was expected, as many facilities, buildings, landscapes, and entire parks themselves are designated as being historic or are under the historic register. Furthermore, this barrier was recognized as being of significance in the NPS in a 1995 study of RET use in the parks (NPS 1995).

As discussed earlier, the rules related to disturbing or impacting cultural or historical resources are quite strict, and RETs often fail to pass the test to be permitted under these rules. Furthermore, many park-level decision makers do not feel that RETs have a place in historical parks or near historic facilities.

As with visual quality concerns, a previous study (NPS 1995) recommended that conflicts with the historical resource context be overcome by using small systems located away from existing facilities. However, the results here indicate that these recommendations have not been successful in addressing the barrier; additional measures to address the barrier may be required.

Staff Availability

Overall, *staff availability* was rated as a strong barrier to use of RET systems by park contacts. As shown in Figure 2, the mean rating of staff availability was 2.5, and the median rating was 3. As shown in Table 3, seven people gave this barrier a rating of 5, while more than half of respondents rated staff availability at 3 or above.

These results reinforce the findings of Worrell et al. (2001), which identified shortage of personnel—particularly for small-to-medium-sized enterprises—as a barrier to the use of energy efficient technologies. Also, Gouchoe (2000) found that limited government staff resources was a barrier to RET projects, while Weisser (2004) highlighted limited human resource capabilities as barriers to RETs.

Staff availability was expected to be a barrier of significance, as there are only a limited amount of employees at the parks which must fulfill almost limitless duties. Especially at smaller parks with few FTEs, personnel at National Parks have multiple responsibilities, from grounds keeping to visitor interpretation to security. There is simply too little time for acquisition, purchase, and installation—let alone regular care for operations—of RETs in some parks.

The high importance of staff availability indicates that staff time constraints are a major impediment to obtaining and using RETs in the parks, and that addressing this barrier would facilitate the increased use of RETs in the region.

5.4.2 Intermediate Barriers: 1 < Mean Rating ≤ 2

Twelve barriers were established as being intermediate in importance and prevalence. These barriers were given mean ratings between 1 and 2 on a scale of 0 to 5; less than half of participants rated the barriers at 3 or above. The distribution of ratings for these barriers was diverse, indicating that these are issues which are of great concern to a portion of contacts while they are of minimal concern to others. The results indicate that certain sub-populations within the PWR may require that these impediments are addressed in order to facilitate the increased use of RETs in the parks.

Lack of Familiarity by Operating Personnel

As shown in Figure 2, *lack of familiarity by operating personnel* was given a mean rating of 2.0; the median rating was 2 as well. As shown in Table 3, though only three contacts rated this barrier at 5, nearly half of all respondents rated it at 3 or above. One-third of respondents rated the barrier at 0.

The importance of this barrier reinforces findings of Worrell (2001), Weisser (2004), and Gouchoe, Everette and Haynes (2002), who established a shortage of trained personnel as central barrier to RET use. This barrier was expected to be of importance to a considerable portion of park contacts, as lack of familiarity by operating personnel was identified as a central barrier in a 1995 study of RET use in national parks (NPS 1995); the study established lack of familiarity as being the second most prevalent barrier after initial cost. [5]

Worthy of note is the distinction in ratings between staff knowledge and expertise and lack of familiarity by operating personnel. While one-quarter of respondents rated knowledge and expertise at 5 almost half rated it at 4 or 5, only six percent of respondents rated lack of familiarity by operating personnel at 5, about one-fifth rated it at 4 or 5. The distinction here indicates that the underlying issues of staff capabilities are not primarily related to staff using the technologies, but are more so related to staff education related to the technologies, and to requirements for proficiency related to installation and repair, etc.

The relative importance of familiarity by operating personnel to many respondents indicates that addressing this barrier through training and education may encourage the use of RETs in the parks.

Maintenance Requirements

As shown in Figure 2, the barrier *maintenance requirements* was given a mean rating of 2.0; the median rating was also 2. Only two respondents rated this barrier at five, though more than forty percent of respondents rated the barrier at 3 or above.

It was expected that maintenance requirements would be of significant concern to park personnel, given that the most prevalent alternative for electricity delivery—transmission through the grid—requires essentially no maintenance. As noted earlier, the apartment renter/owner dilemma (DiCicco et al. 1995, as cited in Geller, 2003;

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[5] In the 1995 study, lack of familiarity by operating personnel was the only personnel-related barrier, and so likely included the issue of staff knowledge and expertise as well as other issues such as maintenance requirements.

Brown, 2001) is of particular concern in national parks. In the case of apartment rentals, the owner is responsible for purchasing and maintaining the systems while the renter would receive the benefit of reduced energy bills. Here, park personnel are responsible for acquiring, and maintaining the systems, while taxpayers and the general public receive the cost savings and environmental benefits of the technologies. Therefore, there is no real incentive for park personnel to pursue RET projects.

It should be noted that maintenance requirements are generally rated as being less of an issue than is staff availability—34 percent of respondents rated availability at 4 or 5, compared to only 8 percent for maintenance. This indicates that the issues related to staff availability are not primarily related to maintenance requirements. Suggested here is that staff availability may pertain to a large extent to the acquisition and installation of RET systems rather than to the maintenance of systems.

Nonetheless, maintenance requirements were considered be of importance to a considerable portion of park contacts. These findings suggest that in order to encourage park personnel to pursue RET projects, incentives must be provided to overcome the current disincentive of increased workload for park personnel with limited benefits.

Support from Above/ External Support

As shown in Figure 2, *support from above or external support*—or a lack thereof—was given a mean rating of 1.8 with a median of 1.5. Only three respondents rated the barrier at 5, though nearly half of respondents rated support from above at 3 or above. Interestingly, in contrast nearly half of respondents rated the barrier at 0; the discrepancy indicates that a portion of parks are receiving far more support than others.

The distinction in distribution of ratings for support from above was expected, as it was presumed that some park units—i.e. high-profile parks—were receiving support and guidance from above while others were less likely to do so. Additionally, it is probable that many park units have never attempted to pursue an RET project, and so have not encountered any issues related to support from above.

Support from above appears to be a concern for a large portion of respondents; this reinforces the findings of DeCanio (1998) who found that bureaucratic organizational structures and a lack of rewards for energy managers who take the initiative to pursue energy-saving equipment can be significant barriers. Worrell et al. (2001) also identified the decision-making processes of organizations as a barrier to the use of energy efficient technologies, especially if the organization is hierarchical.

The results indicate that support from above has been an underlying factor inhibiting the use of RETs for a large portion of park personnel; suggested here is that by providing more assistance and support—or less resistance—to park personnel, the NPS can facilitate the increased use of RETs in the parks.

Uncertainty with Performance Record

As shown in Figure 2, *uncertainty with the performance record* of RETs had a mean rating of 1.7, with a median rating of 2. More than one-third of respondents rated this barrier at 3 or above, while more than one-third gave a rating of 0.

The variation in ratings between park contacts was expected, as many respondents already have experience with RETs and would therefore have fewer concerns about the technologies' performance. In contrast, many respondents have had no experience with the technologies and can only rely on outside information, which may provide a negative picture of RET performance. In a previous study of RET use in the NPS, uncertainty with the performance record was the third most prevalent barrier identified, indicating that many park personnel have qualms about the use of RETs in the parks.

The high rating of uncertainty with the performance record by a sizable portion of the respondents supports the findings of Wiser (2000) and Gouchoe, Everette and Haynes (2002), that consumer education is a significant barrier to the use of renewable energy. Wiser and Pickle (1998) also found that concerns about RETs technological performance deterred people form investing in the technologies. De Groot, Verhoef, and Nijkamp (2001) found that uncertainty was an important determinant in investing in energy efficient technologies, and that uncertainty varied considerably among firms.

A previous study identified uncertainty with performance as a key barrier to RET use in parks (NPS 1995); it was recommended that NPS have meetings and conferences to overcome the barrier. However, it appears that the barrier is still an issue to many park personnel. Therefore, increased focus on these programs—or additional measures—may be required to encourage uncertain park personnel to pursue RET projects.

Inadequate Design

As shown in Figure 2, *inadequate design* had a mean rating of 1.5, and a median rating of 1. Approximately two-thirds of respondents rated the barrier at 2 or below, and fully forty percent of respondents rated the barrier at 0.

Concerns about the design of RETs were expected to be less of an issue for park personnel, given the many advances in this area in recent years (Tsoutsos, Frantzeskaki, and Gekas 2005). However, inadequate design appears to be of concern to a good portion of respondents—three respondents even rated the barrier at 5. To most respondents, though, the barrier is quite insignificant.

There are three main explanations for the issue of inadequate design. First, the extreme significance of concerns about visual quality and conflicts with the historic resources might render to be undesirable what would be a satisfactory design elsewhere. Second, the quality of designers and service providers likely varies considerably among the region; where one park may have access to the best design options, another might be more limited. Third, the requirements for design of systems might vary considerably from park to park. Where in one park an RET may be permitted to be conspicuous for educational purposes, in another park the concealment of the system may be required.

Though *inadequate design* is not a top-rated barrier, the results do indicate that it is a significant issue to a good portion of park contacts; by addressing this barrier through design assistance or other avenues, perhaps the use of RETs in the park can be facilitated.

Insufficient Payback

Insufficient payback of RET systems had a mean rating of 1.4 and a median of 1, as shown in Figure 2. Slightly less than one-quarter of respondents gave the barrier a rating of 3 or above, while more than forty percent rated insufficient payback at 0.

Insufficient payback was expected to be an important barrier to parks pursuing RETs, as financial issues are some of the most prevalent in the literature. A good amount of discrepancy in the ratings was expected as well, as parks which had not pursued RETs would not likely have encountered the barrier. Furthermore, in many cases RETs have excellent payback times—particularly in national parks where expensive diesel generators or expensive electricity costs are being replaced.

Many respondents did perceive insufficient payback to be of significant concern, however, reinforcing the findings of DeCanio (1998) who found that public organizations are less willing to accept long payback times in energy investments. Also, Worrell et al. (2001) found that emphasizing investment in projects with certain returns can hinder the use of energy technologies. Perhaps the requirements for payback of systems in the NPS are preventing some potential projects from being implemented.

However, the rating of insufficient payback is quite low in comparison to initial cost and funding: while over half of respondents rated initial cost and funding at 4 or 5, only six percent of respondents did so for insufficient payback. Indicated here is that that the actual financial issue related to acquiring RETs is not the life-cycle cost of the systems but rather is the inability to pay the upfront costs.

The results indicate that *insufficient payback* is of minor significance to most respondents, but of more importance to a small minority.

Park Size

As shown in Figure 2, *park size* had a mean rating of 1.4 and a median rating of 0. *Park size* was rated at 3 or above by nearly one-third of respondents; more than half rated park size as 0.

The rating of *Park size* was anticipated to be very different among park contacts, as the size of parks very considerably in many ways. The majority of respondents indicated that park size was of no concern whatsoever; while one-third of respondents indicated that the barrier was at least of relatively strong significance.

There are two main reasons why park size may be perceived to be an issue in the parks. First, park personnel may believe that the park is lacking in the necessary resources to obtain and care for the systems, such as capital and staff. Second, park personnel may feel that the park is not being given assistance from above because the park is not high-profile or popular.

The overall rating of importance of park size indicates that most respondents do not feel that it is a considerable barrier. However, a significant proportion of respondents –presumably those in small parks with limited resources—do perceive park size to be an issue. Indicated here is that providing necessary assistance to smaller parks could encourage the use of RETs in the parks.

Procurement Restrictions

As shown in Figure 2, *procurement restrictions* had a mean rating of 1.3 and a median rating of 0. More than half of respondents rated *procurement restrictions* as 0; about one-quarter rated it at 3 or above.

This barrier's ratings were anticipated to be highly divergent, as any parks which had not attempted to pursue RET projects would likely not have encountered this barrier. In general, procurement restrictions were not perceived to be an issue to park personnel. However, to one-quarter of respondents procurement restrictions were seen as being of significance.

The results indicate that in general, procurement restrictions are not of real consequence in inhibiting parks from pursing RETs. However, as several respondents felt that procurement restrictions were a strong barrier, perhaps the examination of procurement rules and elimination of any significant obstacles would make the process to obtain RETs easier for park personnel.

Adverse Climate

Adverse climate had a mean rating of 1.3 and a median rating of 1, as shown in Figure 2. Nearly half of all respondents gave adverse climate a rating of 0; one-quarter rated it as 3 or above.

The distribution of ratings for the barrier was anticipated, as most of the parks in the PWR region are located in climates well-suited for RETs, while a smaller number are located in less-ideal climates. Also, it was anticipated that *adverse climate* would not be a considerable issue in the parks, as a 1995 study of RETs in the NPS identified adverse climate as having less prevalence than all other identified barriers.

The results indicate that while *adverse climate* may be of concern for a small minority of parks, it is not a determining factor for most respondents. Indicated here is that by identifying the parks with climates most suitable for RETs, the NPS can facilitate the greatest use of the technologies.

Inability to Locate Suppliers or Contractors

As shown in Figure 2, *inability to locate suppliers or contractors* had a mean rating of 1.25 and a median rating of 0.5. Exactly half of respondents rated the barrier as 0, while only about twenty percent rated it at 3 or above.

Inability to locate suppliers or contractors was expected to be less of an issue for many parks, given that such information can likely be obtained using the internet. However, a few contacts felt that the inability to locate suppliers was of considerable importance.

The finding that inability to locate suppliers and contractors has been an impediment to a several park contacts supports the findings of Xiaojiang and Gilmour (1996), who found that a lack of engineers and technicians and project organizers can deter the use of RETs. Also, Gouchoe (2000) found that limited access to technical expertise can pose barriers to RET projects, while Gouchoe, Everette and Haynes (2002) found that a shortage of qualified installers could deter consumers. Geller (2003) also notes that consumers may not know if the technologies are available in their area (Geller, p.41).

The results indicate that in general, park personnel are able to locate the necessary suppliers and contractors. However, for several contacts—presumably those in remote areas—location of suppliers is a significant issue. The results indicate that by assisting parks in locating service providers and suppliers, the use of RETs in the parks may be facilitated.

Insufficient Technology

Insufficient technology had a mean ranking of 1.3 and a median of 1, as shown in Figure 2. Nearly half of respondents gave the barrier a rating of 0, while more than a quarter rated insufficient technology as 3 or above.

The distribution of ratings was expected, as many parks have had experience with RETs and thus have informed opinions about the quality of the technology, while other parks may have uncertainties about the technology. Furthermore, some of the park contacts have likely attempted to use RETs and found that the technology does not suit their needs, while others have found RETs to be adequate for their energy requirements.

A significant portion of park contacts perceived RETs' technological limitations to be a considerable barrier. These contacts' perceptions support Wiser and Pickle (1998) who found that perceived technological risks were barriers to investing in RETs. Geller (2003) also notes that consumers tend to be more concerned with reliability, performance, capacity, and cost rather than efficiency concerns when buying equipment (Shorey and Eckman, 2000 as cited in Geller, 2003).

The variation in rating of inadequate technology indicates that park contacts' *perception* of technological inadequacies and individual concerns are significant underlying factors associated with technological inadequacy, rather than being entirely related to problems with the technology. Furthermore, the comparatively low rating of insufficient technology in comparison to uncertainty with performance record of RETs also indicates that perceptions are a central issue.

The results indicate that technological inadequacies of RETs are not perceived to be a significant barrier by most park personnel. However, several contacts did rate this barrier as being of considerable importance. In the case that RETs are inadequate for a park's needs, there is little that can be done in the NPS to address the issue. However, the results indicate that issues related to technological inadequacies may primarily be individual's perceptions; presumably addressing this barrier through education would encourage park personnel to pursue the use of RETs in the parks.

Access to Technology

As shown in Figure 2, *access to technology* had a mean rating of 1.2 and a median of 0. Three park contacts rated the barrier at 5, and one-quarter rated access to technology at 3 or above. More than half of respondents rated the barrier at 0.

As Geller (2003) observes, limited supply infrastructure is a reinforcing barrier. Demand is low in a region because there is limited availability of the technology. Suppliers are in no rush to make products available because demand is so low, and thus demand continues to be low in an area (Geller, 2003 p.41). Geller notes that the barrier is particularly relevant to rural areas, where RETs may be most economically viable.

The distribution of ratings for this barrier indicates that access to technology is of considerable importance to a minority of the parks—presumably those in remote areas—but is not an issue at all to the majority.

The results indicate that while most parks have access to RETs, there are many who do not, and who perceive the lack of access to technology as being a fundamental barrier to their use. By addressing this barrier, perhaps the NPS could facilitate the use of RETs in some of the most remote areas, where presumably the use of RETs would be more cost-effective.

5.4.3 Minor Barriers: Mean Rating ≤1

Four barriers were determined to be weak overall: *Utility policy, lack of familiarity by designers, net metering,* and *other policy/regulations*. With a mean rating of less than 1 and a median rating of 0, these barriers were deemed to be of little significance to the vast majority of park contacts.

Utility Policy

As shown in Figure 2, *utility policy* had a mean rating of 0.9 and a median of 0. No contacts rated utility policy at 4 or 5; however more than twenty percent rated the barrier at 3.

The results here point to two conclusions. First, most respondents had not yet attempted to connect an RET system to the grid, and thus had not yet encountered this barrier. Second, the utilities serving the parks have not presented any barriers to connecting to the grid. The distribution of the ratings tends to support the former conclusion: though most contacts rated the barrier at 0, one-fifth of contacts rated it at 3. This indicates that many park contacts have encountered resistance from the utility when attempting to connect to the grid. The fact that the barrier was not rated as a 4 or 5 by any contacts indicates that the barrier is not insurmountable, however.

The relatively high incidence of a rating of 3 for utility policy tends to support Alderfer, Eldridge and Starrs (2000), who studied attempts to interconnect distributed generation projects to the electrical grid and found that more than half of all projects encountered utility and regulatory barriers.

These findings indicate that utility policies can indeed present challenges for park personnel attempting to connect to the electric grid; however the absence of ratings of 4 or 5 indicates that these barriers are not truly preventing the use of RETs in the parks.

Lack of Familiarity by Designers

Lack of familiarity by designers had a mean rating of .9 and a median of 0, as shown in Figure 2. Sixty percent of respondents rated the barrier at 0, while less than one-fifth of park contacts rated *lack of familiarity by designers* at 3 or above.

The respective low importance of designers' familiarity with the technologies seems to indicate that this barrier may be of significantly less importance than it was in 1995 for the NPS and Sandia National Labs report, *Renew the Parks.* Lack of familiarity by designers was identified as being a barrier inhibiting the use of the technologies by many of the survey participants in 1995.

These findings indicate that progress has been made in the area of outside expertise with the technologies. However, the few respondents who rated the barrier as being of significance may have encountered designers with minimal experience; in these cases perhaps outside expertise may be required.

Net Metering

Net metering had a mean rating of .7 and a median of 0, as shown in Figure 2. More than seventy percent of respondents rated the barrier as 0, while less than one-fifth rated net metering as 3 or above.

The results indicate that, though state net metering policies were considered to be issues in the past, in general they are not an issue in the parks and are likely facilitating the use of RETs.

Other Policy/Regulations

Other policy/regulations was rated as weakest in the perception of park contacts. The barrier had a mean rating of .63 and a median of 0, as shown in Figure 2. While three-quarters of respondents rated the barrier at 0, three contacts gave policy/regulations the highest rating of 5. The results indicate that policies in general are not inhibiting the use of RETs in the parks.

Section 5.4 Summary

The results here indicate that the central barriers to RET use in the parks are those of funding and staff limitations. However, the importance of many barriers varies considerably among parks. The vast majority of barriers have a range of ratings from 0-5; several barriers have a distinct split where a significant proportion of the parks believe the barrier to be of considerable importance, while many others believe the barrier to be insignificant. Therefore, these barriers are of more concern to some parks, and thus are presenting substantial obstacles to using RETs in the parks.

5.5 Validation: Attributes of Parks with RETs vs. without RETs

As recognized in the two previous sections, park contacts indicate that funding and employee constraints are significant factors inhibiting the use of RETs in the parks, as are visual quality concerns and concerns about RETs conflicting with the historical context of parks. According to respondent's perceptions, then, these barriers should be addressed to encourage the use of RETs in the parks. However, a commonly recognized limitation of surveys and interviews as research tools is the reliance on subjective information as data. Researchers using surveys take for granted that survey respondents are answering questions candidly and honestly. For this research, attempting to address the limitation, I validated the barriers which were identified as being strongest using quantitative analysis.

In order to validate the survey respondents' perception of barriers, several attributes relevant to barrier ratings were compared between parks with RETs and those without. The results of the analysis provide support for park contacts' perceptions: parks with RET systems greater than 1kW in size are extremely dissimilar from parks without systems in several aspects related to the identified barriers. These include: annual funding, full-time employee equivalent, acreage, historic status, and fee collection.

Acknowledging that separately analyzing each attribute fails to recognize relationships between the variables (and therefore fails to recognize any "double-counting" of variable influence), a simple Pearson correlation analysis was performed. As shown in Table 4, park attributes including acreage, visitation, funding, FTEs, historic status, and fee collection status were analyzed to determine any notable correlations between the variables. The Pearson correlation analysis not only identifies significant relationships between park attributes, but is also useful in supporting and/or discounting alternative conclusions related to the findings.

Table 4: Pearson Correlation between Parks Attributes

Attribute	*Acreage*	*Visitation*	*Funding*	*FTEs*	*Historic*	*Collect fees*
Acreage	1					
Visitation	0.15 (.02 R^2)	1				
Funding	0.45 (.20 R^2)	0.72 (.52 R^2)	1			
FTEs	0.41 (.17 R^2)	0.59 (.35 R^2)	0.96 (.92 R^2)	1		
Historic	-0.30 (.09 R^2)	-0.16 (.03 R^2)	-0.42 (.18 R^2)	-0.46 (.21 R^2)	1	
Collect fees	0.28 (.08 R^2)	0.19 (.04 R^2)	0.32 (.10 R^2)	0.38 (.14 R^2)	-0.52 (.27 R^2)	1

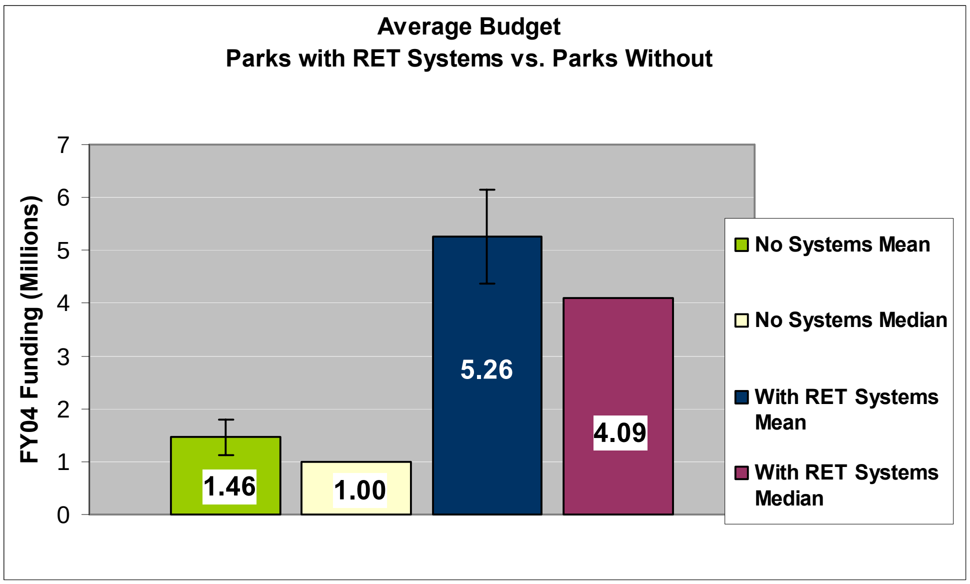
5.5.1 Annual Budgets

In order to validate the two barriers identified as being of most concern—funding and initial cost—the average annual budgets of parks with and without RETs were compared using a t-test in Excel. Fiscal Year 2004—the most recent budget data available—was used. Parks with larger budgets were assumed to be more likely to have RET systems, as a larger budget would allow more opportunity for a large sum of money to be allocated to RET projects. The data for FY04 budgets was obtained from the National Park Service FY 2006 Budget Justification (NPS n.d.).

The annual funding at PWR National Parks ranges from a minimum of $178,000 to $14,085,000—more than eighty times the smallest annual budget for the region. With such an enormous disparity in available funding, clearly certain issues may be more of concern for parks with limited funding, as will the ability for parks with smaller budgets to obtain RETs be more limited. A chart illustrating park FY04 funding and distribution is available in Appendix C.

A t-test was used to compare the average budgets of parks with and without RETs. As shown in Figure 3, parks without RETs have a mean annual budget of 1.46 million dollars, compared to 5.26 million dollars for parks with RETs ($p < .0001$). The median budgets for these sub-groups are 1 million and 4.09 million dollars, respectively.

Figure 3: Comparison of Annual Budgets, Parks with RETs vs. Parks Without



The correlation between park funding and tendency to own RETs, which was expected, points to one or more of several conclusions. First, presumably parks with larger budgets simply have more room for opportunity in their budgets to produce the necessary investment for an RET project—this idea was confirmed by the PWR Regional Energy Coordinator (Personal Communication, September 2005). Second, parks with more funding likely have access to more of the necessary resources for RET projects such as staff and facilities. Indeed, as shown in Table 4, Pearson correlation analysis demonstrated that funding and FTEs at PWR parks are very highly correlated (R-squared

= .92). Third, parks with larger budgets are more likely to be popular or larger parks which are sought out by decision makers above in pursuing RET projects, for public education purposes. This idea is also supported by correlation with visitation (R-squared = .52), though not to the extent of correlation with funding and FTEs.

The finding that parks with RETs are more inclined to have higher budgets helps validate park contacts' perceptions that funding and initial cost are barriers to RET use. The results tend to support previous research which has found that organizations with larger budgets are often more likely to volunteer for environmental programs (Welch et al. 2000; Arora and Cason, 1996, as cited in Wiser et al 2001).

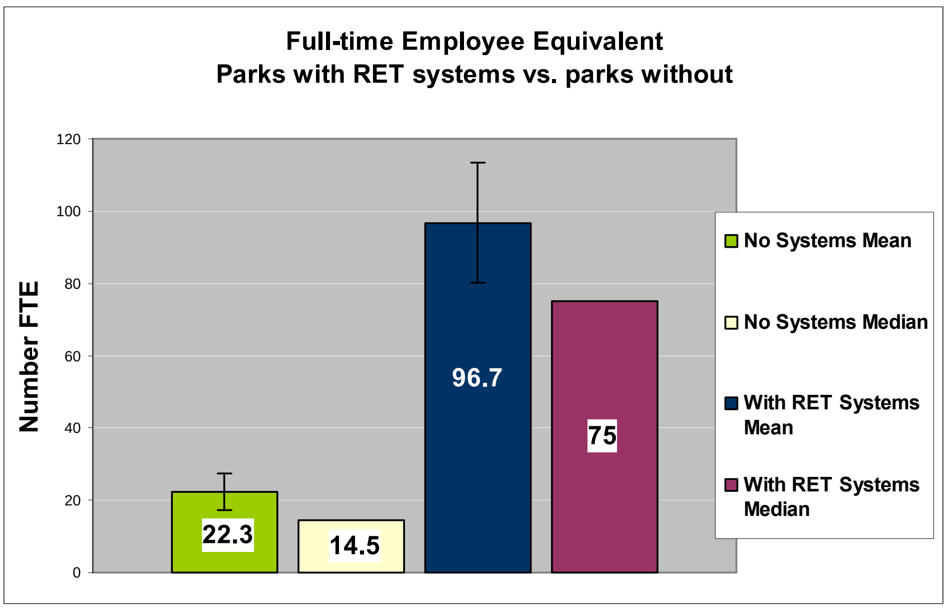
5.5.2 Full-time Employees

In order to validate the staff-related barriers which were identified as being of the most concern to park personnel—staff knowledge and expertise and staff availability—the average number of FTEs of parks with and without RETs were compared using a t-test in Excel. Fiscal year 2004 FTE data, the most recent employee data available, was used. Parks with greater numbers of FTEs were assumed to be more likely to have RETs, as they would have more employees available for acquisition, installation, operation, and maintenance. Also, parks with more FTEs are more likely to have a greater number and variety of specialized positions; for instance, parks with more FTEs are more likely to have an electrician on staff. The data for FY04 FTEs was obtained from the National Park Service FY 2006 Budget Justification (NPS n.d.).

The number of employees at PWR National Parks varies from zero FTEs (no official NPS FTEs employed at the park) to 293 FTEs. With such a discrepancy between the numbers of employees at parks in the region, surely there will be a disparity in the availability, skill level, and expertise of employees and their ability to acquire and maintain RET systems. A chart illustrating park FY04 FTEs and distribution is available in Appendix C.

As shown in Figure 4, on average there are far fewer FTEs at parks without RETs than there are at parks with RET systems ($p < .0001$). The mean number of employees at parks without RETs is 22.3, and the median number of FTEs is 14.5. In contrast, the mean and median numbers of FTEs at parks with RETs are 96.7 and 75, respectively.

Figure 4: Comparison of FTEs at Parks with RETs vs. Parks Without



The correlation between number of employees and tendency to own RETs supports park contacts' perceptions that staff availability and staff expertise are issues impeding the use of RETs in the parks. Not only are parks with fewer employees constrained by staff availability—there are simply fewer people available to perform necessary responsibilities for acquiring, operating and maintaining the systems—but also parks with fewer FTEs have a limited variety of staff related to expertise and specialization. To illustrate, Mount Rainier National Park has listed 162 employees on the NPS People and Places directory website. Included in employee descriptions are electrician, chief of maintenance, maintenance worker, engineering equipment operator, and utility systems operator. Eugene O'Neill National Historic Site has only 5 employees listed; maintenance and all related duties are apparently covered by one employee, the "maintenance worker" (NPS People and Places, 2005).

As noted earlier parks with many FTEs are extremely likely to have larger budgets, and hence are more likely to have flexibility for purchasing systems. Visitation and FTEs are correlated to an extent (R-squared = .35), though not highly correlated, so it is unlikely that the tendency to have RETs is mostly attributable to being targeted from above for public education projects.

With fewer staff available and with those who are available being less skilled in matters related to RETs, the finding that parks with fewer FTEs do not have RET systems is not a surprise. These results reinforce the findings of de Groot, Verhoef, and Nijkamp (2001), who found that investment in energy efficient technologies was positively correlated with knowledge related to the technologies, and those of Gouchoe (2000), who found limited government staff resources and limited access to technical expertise to be significant barriers to RET use. Finally, Worrell et al. (2001) identified the shortage of trained personnel—particularly for small organizations—as presenting a barrier to energy efficient technologies.

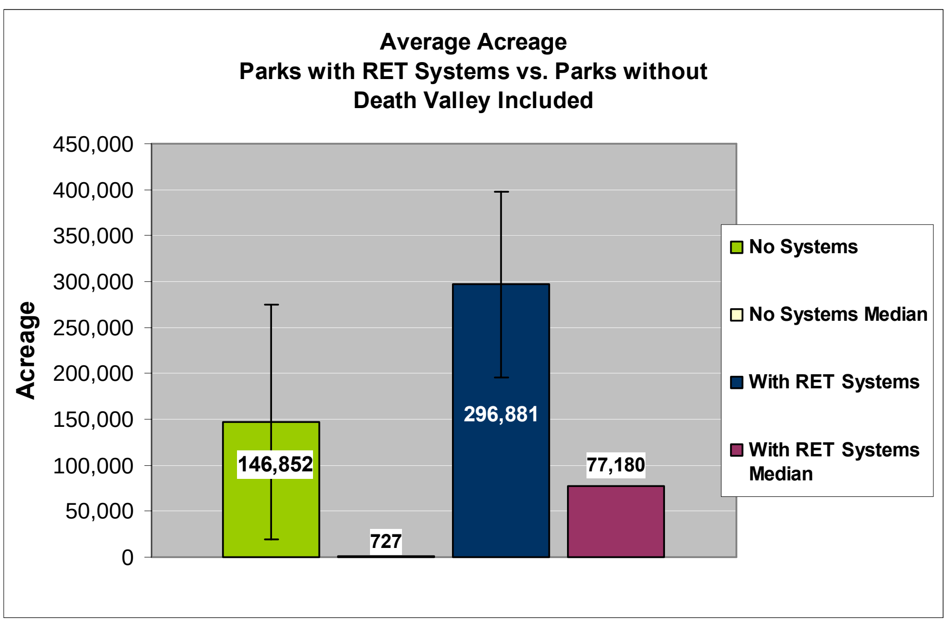
5.5.3 Acreage

In order to validate the existence of barriers related to visual quality concerns and conflicts with the historic resource context, the average acreage of parks with and without RETs were compared using a t-test in Excel. Fiscal year 2004 acreage, the most recent acreage data available, was used. Parks with fewer acres were assumed to be less likely to have RETs, as there would be less land available to conceal the RET systems from view in a natural or cultural landscape. The data for FY04 acreage was obtained from the National Park Service FY 2006 Budget Justification (NPS n.d.).

Acreage of the PWR National Parks varies from less than eleven acres to more than 3 million acres, or three hundred thousand times the acreage of the smallest park in the region. A park with only eleven acres would clearly have less flexibility related to citing an RET system and mitigating any visual impacts of the system. A chart illustrating park FY04 acreage and distribution is available in Appendix C.

As shown in Figure 5, parks without RET systems have on average about 150,000 fewer acres than do parks with RETs. The mean acreage of parks without RETs is 146,852, with a median value of only 727 acres. Parks with RETs in contrast have a mean acreage of 296,881 with a median of 77,180 acres.

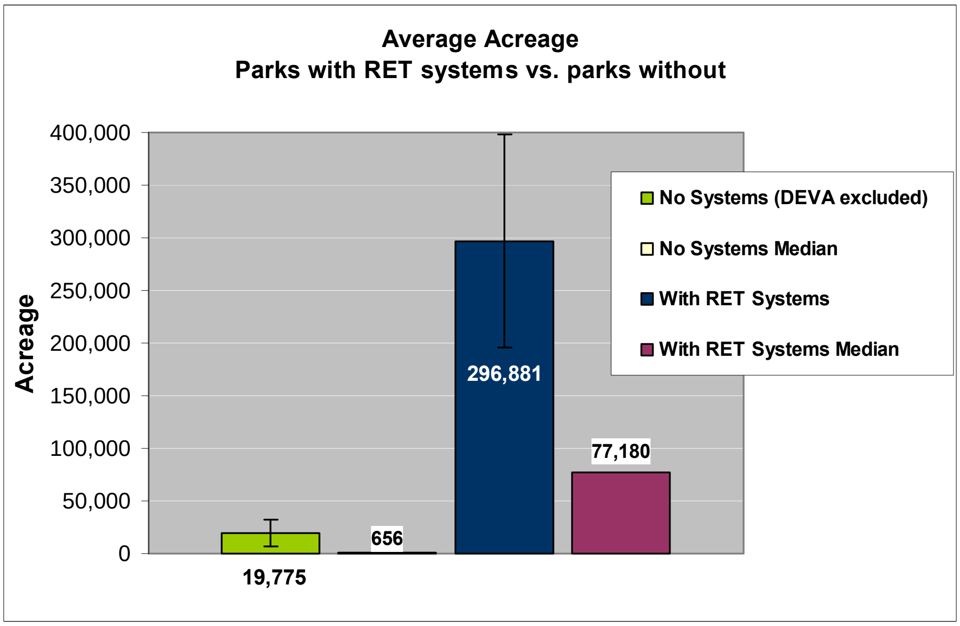
Figure 5: Comparison of Park Acreage, Parks with RETs vs. Parks without (DEVA Included)



However, Death Valley National Park (DEVA) —an extreme outlier with more than 3 million acres—has no RETs and is included in the analysis; when including

DEVA the results are skewed and not statistically significant. If DEVA is excluded, as shown in Figure 6, a more accurate depiction of the difference in parks with and without RETs is realized. Figure 6 demonstrates that on average the acreage of parks with RETs is many times that of parks without systems ($p < .01$). Here, the mean and median acreage for parks without RETs are 19,775 and 656, respectively. The mean and median values for parks with RETs—296,881 and 77,180—are each more than ten times the corresponding values for parks without RETs.

Figure 6: Comparison of Park Acreage, Parks with RETs vs. Parks without (DEVA Excluded)



The correlation between park acreage and RET ownership, which was expected, validates the perceptions of park contacts that visual quality concerns and conflicts with the historic resource context are significant barriers. There are several explanations as to why parks with more land area would be more inclined to have RETs. First, parks with hundreds of thousands of acres are more likely to be able to conceal any RETs from visitor view or mitigate any visual impacts of the systems. Tsoutsos, Frantzeskaki, and Gekas (2005) note that sometimes the only way to mitigate the visual intrusion of RETs is to locate them in isolated areas away from many people. Second, parks with vast land areas may be more likely to have facilities in remote locations, where RETs are a more practical energy option. Third, parks with many acres may be more popular parks with higher visitation and so are targeted from above for RET projects. Finally, parks with many acres may be inclined to have larger budgets, and thus RETs are easier to acquire.

The Pearson correlation analysis seems to support the first two and discount the two latter conclusions. Visitation and acreage almost have no correlation whatsoever (R-squared = .02), indicating that the use of RETs at PWR parks with many acres is not related to projects being targeted from above for educational purposes. Funding and acreage are not correlated to a great extent either (R-squared = .20), pointing to other explanations for the tendency for larger parks to have RETs.

5.5.4 Fee Collection Status

To further validate the barriers of initial cost and funding, fee-collection parks were compared with non-fee collection parks to establish any difference in tendency to have RETs. Fee collection status of the parks was made available by Steve Butterworth, the Regional Energy Coordinator. Several parks in the PWR region are part of a program which allows parks to collect entrance fees and retain a large portion of the revenue for park level projects. The 2004 Federal Lands Recreation Enhancement Act (FLREA) allows parks collecting fees to keep no less than 80% of fee revenues. The revenues are kept by the park for repair, maintenance, and enhancement of facilities and other visitor-related projects. The remaining 20% of the fee revenue collected at each park is dispersed agency-wide for projects in non-fee collection parks (Fee Information, 2006). Only a portion of parks collect fees and are thus eligible for the additional form of revenue for the park. Parks collecting fees were assumed to be more likely to have RETs, as these parks have an additional source of financing for the systems. Thirty parks in the PWR collect entrance fees, while eighteen parks do not, and must depend on the income of the fee collection parks for additional revenue.

As shown in Figure 7 and Table 5, parks that collect fees are far more likely to have RETs than are parks which do not collect fees. While fifty-seven percent of parks that collect fees have RETs, only twenty-two percent of parks that do not collect fees have systems; using chi-squared, this difference was determined to be significant at the $p < .02$ level.

The findings support park contacts' perceptions that initial cost and funding are barriers by demonstrating that an alternative source of funding—specifically a source of funding which allows discretion in choosing projects at the park level—is correlated with RET ownership. When acknowledging that fee collection is not highly correlated[6] with any of the other analyzed attributes (as shown in Table 4)—funding, employees, visitation, etc.—this conclusion is further supported.

In the parks where the hierarchical decision-making process was eliminated—or at least many layers were removed—the likelihood of having acquired an RET is much greater; the parks with the ability to use funds at their own discretion seem to be more likely to acquire RETs. These results support the findings of Worrell (2000), who established that organizational decision making processes can present barriers to energy efficient technologies, particularly if is hierarchical, and DeCanio (1998) who found that bureaucratic organizational structures can inhibit such technologies use.

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[6] I acknowledge that the Pearson correlation analysis is not appropriate to use with qualitative variables such as fee collection and historic status. However, the analysis is not intended to provide a definitive answer to this question but rather is used as secondary support for the findings.

Figure 7: Percentage of Parks with RETs, Fee Collection versus Non-Fee Collection

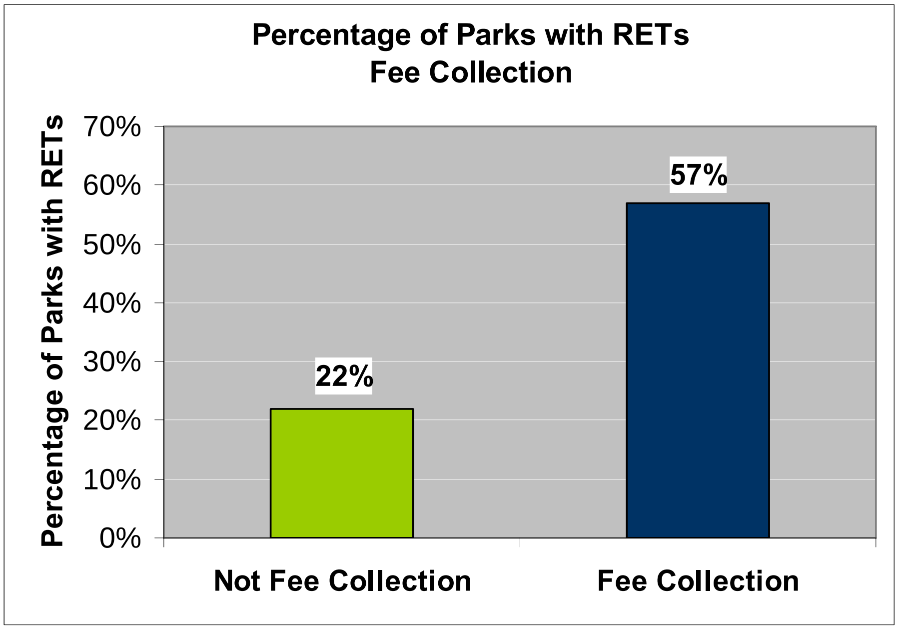


Table 5: Fee Collection and RET Ownership

Fee Collection and RETs			
P < .02	*Number /Percentages*		
Rating	Not Fee Collection	Yes Fee Collection	*Total*
RET System	4/22%	17/57%	*21/100%*
No RET Systems	14/78%	13/43%	*27/100%*
Total	*18/100%*	*30/100%*	*48*

5.5.5 Historic Parks

In order to further validate the barrier of conflicts with the historic resource context, the tendency to own RETs was compared between historic and non-historic parks using chi-squared. It was assumed that parks with historic designations would be less likely to have RETs, as the systems would pose a conflict with the historical resources and landscapes, and as these parks are more likely to face regulatory barriers. Section 110 of the National Historic Preservation Act (NHPA) (U.S.C. 470) specifies the requirements of Federal agencies related to preservation of all historic assets including facilities and landscapes. The NHPA, along with DOI's Standards for Treatment of

Historic Properties (36 CFR 68) require strict compliance to rules related to historic preservation. In many cases, RETs are not compatible with these regulations. Historical parks were presumed to be more likely to face these restrictions and conflicts with the historic resource context. Parks with *National Historic Park, National Historic Preservation, National Historic Site, National Memorial,* and *National Battlefield* designations were classified as "historic" parks. Also included in this category were parks having strong historical significance, even if the park title did not indicate the historic significance. Of the parks surveyed in the region, nineteen were determined to be primarily historic in nature and twenty-nine were not.

As shown in Figure 8 and Table 6, historic parks are far less likely to have RETs. Only sixteen percent of historic parks have RETs, while fully sixty-two percent of non-historic parks have RETs; the difference in historic parks' proportions of parks with and without RETs is significant at the $p < .005$ level.

Figure 8: Comparison of Percentage of Parks with RETs, Historic vs. Non-historic

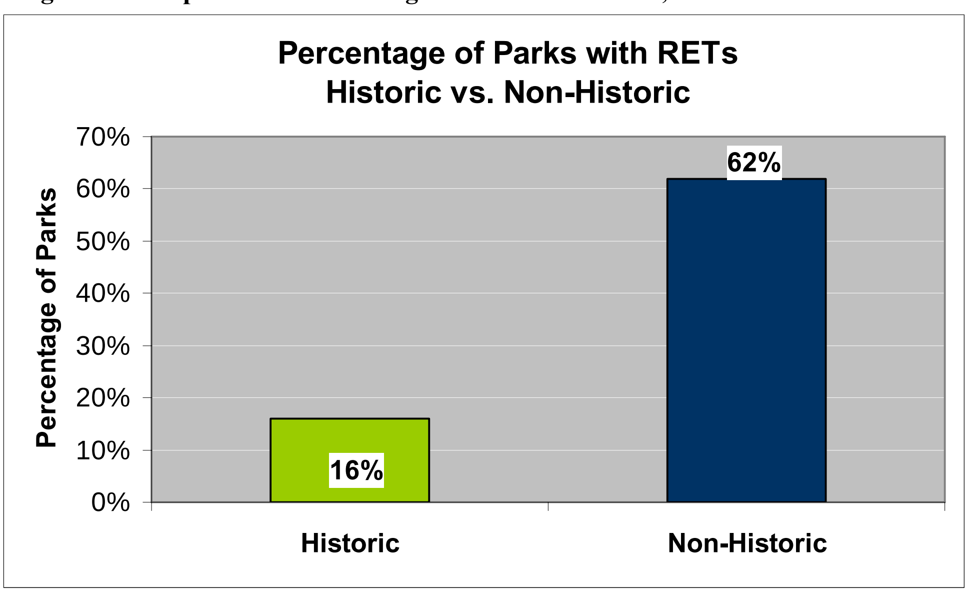


Table 6: Historic Parks and RET Ownership

Historic Parks and RETs			
P < .005	*Number /Percentages*		
	Historic	**Not Historic**	***Total***
No Systems	16/84%	11/38%	*27/100%*
Systems	3/16%	18/62%	*21/100%*
Total	*19/100%*	*29/100%*	*48*

The negative correlation between historic parks and RET ownership validates park contacts concerns about conflicts with the historical resource context. This difference was expected, as historic parks tend to have strict regulations related to retaining historical landscapes and historical resources. In addition to supporting the ideas that historic preservation rules and the land area present significant barriers to RETs, an alternative explanation is that personnel at historic parks may be less inclined to pursue RET projects due to their own concerns about preservation of the park's historic context. Finally, historic parks are negatively correlated[7] with acreage (R-squared = .09), funding (.18), and FTEs (.21), indicating more of a tendency to have the resource problems addressed earlier, even if these correlations are minimal.

As noted by Tsoutsos, Frantzeskaki, Gekas (2005), RETs can certainly be incompatible with historic buildings and landscapes; they recommend refraining from locating RETs near historic resources. These results indicate that the NPS has tended to abide by these recommendations, as there are few instances where RETs are used in historic parks.

Section 4.5 Summary

The results validate the findings of Section 4.4, that funding, staff, visual and historic resource issues are of central barriers to using RETs in the parks:

[7] See footnote 5

- Parks that do not collect fees—and therefore are denied a discretionary budget—and parks with lower budgets are less likely to have RETs, supporting the perception that funding and initial cost are significant barriers.
- Parks with RETs have far more FTEs, supporting the perception that staff availability and staff expertise are barriers of importance, as parks with more FTEs not only have more staff available, but staff are more highly specialized.
- Parks with RETs on average have hundreds of thousands more acres than do parks without systems, supporting the perception that visual quality concerns and conflicts with the historical resource context are barriers, as parks with vast land area have more opportunity to locate the systems away from view.
- Finally, non-historic parks are far more likely to have RETs, supporting the perception that conflicts with the historic resource context are barriers of significance.

5.6 Respondents' Comments

Given the results of Sections 4.4 and 4.5, addressing the six identified barriers would seem sufficient to effectively increase the use of RETs in the parks. However, as was addressed in Section 4.4, there is a considerable disparity among park contacts as to the importance of many barriers. While on average respondents indicated that certain barriers were of little consequence, a small number were highly concerned about specific barriers. Therefore, a greater understanding of park-specific barriers is required to ensure that the most significant concerns of park personnel will be addressed.

In order to gain insight into respondents' concerns, respondents were invited to elaborate on any of the barriers and to add to the list of barriers any which were not mentioned that they felt were of concerns.

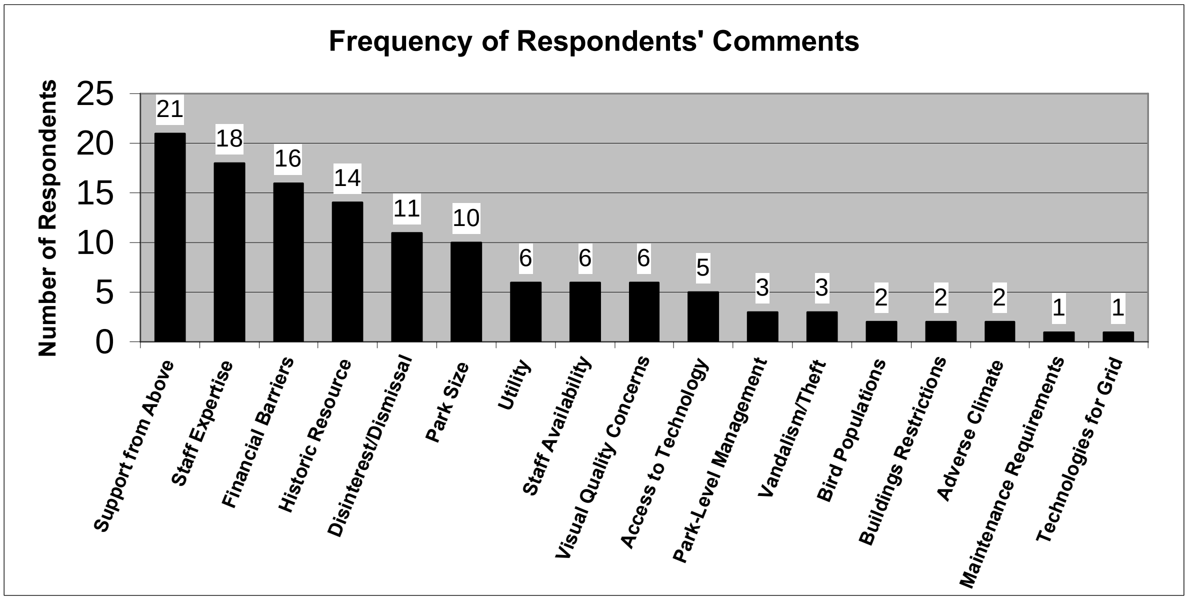
Survey respondents' comments in many ways reinforced the average ratings described in the previous section; many of the barriers which were consistently rated as being strong or of great importance were also commented on frequently. However, many barriers which were not rated as strongly overall were commented on more frequently by a vocal proportion of the population.

Furthermore, a few respondents indicated that some barriers were of the utmost importance to them, though these barriers were largely insignificant to other parks. The reasoning for barrier ratings and the underlying situation of these parks were made apparent by examining park contacts' responses.

Finally, through discussion with park contacts, a central barrier which was not explicitly identified in the survey was established: disinterest in or lack of acceptance of the technologies. The barrier was not identified when parks were asked to identify "other" barriers, but rather was established through analysis of comments.

The barriers and issues which were discussed by survey respondents are presented below in order of prevalence and frequency, and are displayed in Figure 9.

Figure 9: Frequency of Respondents' Comments Relating to Barriers



5.6.1 Support from Above

Nearly one-half of all respondents—twenty-one out of forty-four—chose to elaborate on the issue of support for RET projects in the NPS from above. Major issues discussed included surface support for RETs, but minimal support once a project is proposed; RETs being a low priority for funding; and, the need for assistance from above at all levels of project development.

Several respondents felt that the NPS was very supportive of RETs with policy, but less supportive once concrete projects were proposed. Comments related to support which diminished once projects were proposed included: "*Everyone agrees it's good to do until we get a design and then they say, 'oh, we can't do that, it costs too much'… Even those who most advocate it, once they see the cost they say we can't do it";* and, *"Philosophically the support from above is there. But when it comes to securing funding and having money available the support is not there".*

Several park contacts indicated that RETs are a very low priority for decision makers above, and that if RETs were placed on a higher priority related to funding and implementation, the use of the technologies would be increased. Comments on the subject included: "*We are thinking of installing an [RET system]… but it is a bid-additive item so it will probably not happen. Those things are usually some of the first to get cut*" and "*I think that renewable energy resources are not placed on a high priority.*"

Finally, the need for assistance and support at all levels of RET project development was mentioned by several park contacts. Comments and insights included: *"We are trying to get a partnership together [which is] difficult to figure out, and we aren't getting much help"; "…Until we had it all together and put together some packages, we didn't get much support";* and *"We need more representation from the top down as far as us trying to do it."*

Together, these insights demonstrate that the availability of additional support and assistance at all levels of RET project implementation from superiors in the NPS would help encourage the use of RETs. These findings reinforce those of DeCanio (1998) who found that a lack of rewards for energy managers who take the initiative to pursue energy-saving equipment can be significant barriers, and those of Worrell et al. (2001) who identified the decision-making processes of organizations as a significant barrier.

5.6.2 Staff Knowledge and Expertise

More than forty percent of the park contacts commented on the issue of staff knowledge and expertise, and the implications for pursuing RET projects in the parks. Prevalent issues discussed included: staff education related to RETs; lack of familiarity with the technology; inability to recognize the steps necessary to obtain and use RETs in the park; and, limited staff expertise related to energy and operations.

Several contacts expressed concerns about the lack of technical expertise at their particular park. As one respondent said, "…*there is not a good familiarity of the opportunities that may exist…we don't have somebody who is devoted to access the technology*"; another noted, "*It's a problem of education…I am the only one who knows about this stuff.*" Another respondent expressed concern about the know-how of current staff: "*We're not up on the technology here. We're all middle aged or past middle aged and we are just not up on the technology. We don't have the information or the know-how to make the decisions—to make the right decision*"

Interestingly, one respondent indicated a lack of knowledge about currently available programs, highlighting that education is required to even inform park energy managers about training opportunities. As the respondent said "*We just don't know how to do it all. I mean, it's not like they go around and have workshops"*

Together, these comments indicate a real need for training and education of park personnel; from initial education related to the benefits of RETs and the opportunities for training, to more elaborate training related to acquiring, installing, and maintaining RETs. These comments further reinforce the findings Reddy and Painuly (2004), Xiaojiang and Gilmour (1996), Worrell (2001), Weisser (2004), and Gouchoe, Everette and Haynes (2002) all of whom identified issues of education and expertise as being central barriers to use of RETs.

5.6.3 Financial Barriers: Funding, Initial Cost, Insufficient Payback

About one-third of the survey respondents elected to elaborate on the issue of funding in one form or another. Sixteen of the forty-four respondents discussed funding—or a lack thereof—and its implications for obtaining RETs for use in the PWR parks.

Prevalent themes discussed were the lack of money available in base park funds and money being scarce for uses other than regular operations; denial of funding from above in the NPS; difficulty obtaining funding from inside and outside the NPS; concerns about justifying systems with extensive payback periods; and, the prolonged process to obtain funding for RET projects.

Several respondents indicated that there was simply not enough money available in the park budget to obtain RETs. One respondent said, *"We don't have [the money in the park]…the only way to cover the cost of the systems is through NPS or outside partners";* while another expressed concern that "*We would have to come up with the money and take it from something else".*

Several respondents were concerned about the inability to obtain funding for systems from above in the organization. One park contact said, *"In our region money is short if you are trying to put a solar system in";* while another commented*"…they are just not funding it…;* another respondent would likely agree, having said*"…when it comes to securing funding and having money available, the support is not there"*

More respondents indicated that it was difficult to obtain funding from any sources, inside or outside the park. Comments in this regard included: *"[our superintendent] is concerned about funding, and says that it will be hard to get. He's like,* *'where are we going to get the funding?'", and "No one [outside partners] wants to put the money or time in, because we look into doing things, but then we don't come through*

Finally, a few respondents indicated annoyance with the drawn-out process to acquire funding. One respondent's comments provide insight into the lengthy process: *"I had a request for a parking lot array, [it's been so long] I don't remember if anything came out of it… I don't know if it's still there or not."*

A few respondents elaborated on the issue of insufficient payback, and the importance of payback for decision makers above. The insight from one park contact clarifies the issue: *"Insufficient payback isn't a barrier for me, but it is for those approving a system. If a system has a long payback, then it will be denied. Money is tight and it is difficult justifying a payback of many years".* Another respondent indicated concerns that a hypothetical system at the park would have insufficient payback: "*I'm sure the payback would be forever because we don't use much energy here".*

Together, these comments provide insight into issues of funding, cost and insufficient payback. First, it seems that the additional availability of discretionary money in park base funding would facilitate the increased use of the technologies. It appears that the additional availability of funding from above—within a reasonable timeframe following the request of a system—would certainly increase the use of RETs in the parks. Further, it appears that larger parks are being targeted at the expense of smaller parks which may be interested in pursuing projects; perhaps by providing similar levels of support to smaller parks, significant advances in RET use overall can be made. Finally, insufficient payback, rather than being an issue for park-level energy managers, appears to be more of a concern for those above, supporting the findings of DeCanio (1998), that public organizations are less willing to accept long payback times in energy investments, and Worrell et al. (2001), that emphasizing investment in projects with certain returns can hinder the use of energy technologies. Perhaps the requirements for payback of systems in the NPS are preventing some potential projects from being implemented. This indicates that by changing the definition of what constitutes an acceptable payback period, the implementation of RET projects can be facilitated.

5.6.4 Historical Resource Considerations

Nearly one-third of respondents—fourteen contacts—elaborated on the topic of historic resource concerns during the survey. Common themes discussed were cultural compliance and historic rules which were perceived by park contacts to be too strict; the process of cultural compliance is time-consuming and tedious; and, simply park contacts believing that RETs are not compatible with the historic landscape of the park.

Several respondents expressed concerns or annoyance with the strictness of historic rules in relation to installing RETs. At one park where the current energy source is a diesel generator, the energy manager attempted to replace the generator with PV but was unable to: *"…we were all ready to put [a system] on the roof of a building. We had a… space on the building to put it on…We went through a lot to do it…. But the cultural compliance people did not want us to do it. They said the stations were too high. We said that we would lower them, but people did not want us to do it".*

The experience at another park highlights an apparent dichotomy in historical regulations related to energy equipment: *"they put in 6 ft tall, pole-mounted transformers and switch gear outside the building. But when [the park people] wanted to put solar* *there, they said no, that it was a conflict with the historical nature of the park. What message are you sending out [by supporting having the transformers there, but not solar]?"*

Many respondents simply expressed annoyance with the *process* of historical preservation procedures. One respondent said that *"To use the... PV panels…we had to go through compliance, and make an agreement that we could use them as long as it didn't exceed [specific time frame]. That was a big hurdle, though. We are [approaching the time limit] now, so we are going to have to go through the paperwork process again"* and, "*I have tried to get systems, but I can't get them through the process*".

Many respondents either felt that the need to preserve historic resources presented a barrier to their pursuits of RETs, while others simply felt that RETs did not have a place in their historic park. For instance, one contact demonstrated his own qualms with using RETs: "*Basically it's a small [historic park]. We couldn't have…solar on the roof of a house or on the ground because it interferes with the cultural landscape"*

General comments related to RETs conflicting with the historic resources included: *"We were thinking about the visitor center, but it is in a historic landscape"; "One glitch is the historical ambiance. Whatever is installed must fit into it… everything must comply";* and, *"We talked about photovoltaics, but they could easily be seen and it changed the historic [nature]…compliance is our big issue"*.

Together, the comments of park contacts seem to indicate that while true conflicts with historic resources may be presented by RETs in many cases, there are several instances where the reliance on historic rules is excessive. Given that there are potentially more significant conflicts with natural resources arising from the use of conventional energy technologies, and that conventional energy tends to receive exemptions from historic rules, perhaps there is room for improvement in assessing the acceptability of RETs in the parks related to historic rules.

5.6.5 Motivations and Attitudes

During the surveys, an underlying barrier to RET use was identified: when asked to elaborate on barriers to RETs in the parks and other issues, more than half of the park contacts—twenty-three—made comments related to motivations and purpose of using disinterest or resistance to the technologies. When compared to the comments of parks with enthusiasm for RETs, the significance of this barrier can be realized. While these comments were not in response to any structured questions, they do reveal discrepancies in park contacts attitudes towards RETs and inclination to pursue these projects without direction from above in the organization.

Eleven park contacts—twenty-five percent of those surveyed—made comments indicating a lack of interest in RETs, little support or concern about the technology. As one respondent said, *"If they tell me that I have to then I will. I try not to use things until they have been proven to me"*. Two others indicated that they were not interested in pursuing the technologies: *"We aren't looking at PV yet"*, and *"We haven't started down that road yet"*. Related to the smaller systems in one park (which were not designated as RETs for the purpose of this study), one contact said, "*Most of it is because it is so remote we more or less had to do it"*, demonstrating a lack of interest in pursuing larger-scale projects.

In contrast, twelve survey respondents—twenty-seven percent of park contacts—made comments indicating enthusiasm and support of RETs, and related to altruistic motivations for using the technologies. One respondent said: *"We are demonstrating our commitment to the public our commitment to renewable energy…It's the right thing to do",* while another expressed the intent that *"We want [the park] to be 100% PV sustained eventually"*. Yet another respondent highlighted his own support for RETs while acknowledging the lack of enthusiasm in other parks: *"Our park is very much in support of it… There are lazy park people who are not willing to take it forward".*

Together, these comments demonstrate that a major factor pushing—and inhibiting—the use of RETs in the parks is the attitudes of the decision makers within each park. Indeed, these findings support those of Wiser, Fowlie and Holt (2001), who found that altruistic factors such as civic responsibility were the dominant motivations to use renewable energy. These results here indicate that even if all of the identified *barriers* were addressed, a need would still exist for incentives or directives to coerce some energy managers to obtain the technologies.

5.6.6 Park Size

Ten park contacts elaborated on issues related to park size. The prominent themes here were limited resource availability, which was confirmed in earlier sections, and neglect from above in favor of high-profile parks.

Related to priority being given to larger parks and larger projects, comments included: "*They are so competitive, and our park may not be able to compete with [high-profile] parks like Yosemite*"; *"Grant money ran out for small and medium size projects…it is only going for huge projects",* and, *"The park size issue has a lot to do with funding. It's more difficult to get funding for these types of things when you are a smaller park".*

Together, these comments indicate that not only are smaller parks limited in their ability to obtain RETs due to their own resource constraints, but *additionally* smaller parks are being neglected from above in favor or larger parks. The findings that the NPS tends to support RET projects with greater public exposure were expected, as there are Federal programs with the explicit purpose of supporting projects with public education potential. However, these comments also tend to support the findings of Wiser, Fowlie and Holt (2001), that public organizations are frequently more interested in private interest motivations such as public image and marketing when purchasing renewable energy.

These findings indicate that by providing assistance and necessary resources to smaller parks, the use of RETs in the parks can be increased significantly.

5.6.7 Utility

Six park contacts elaborated on utility policy and the impediment that the policies can present to RETs in parks. As one respondent said, "*Power companies are resistant to allow [RETs]… We could not feed any project back into the grid. We had to spend $30,000 on a switch we didn't need because [our utility] didn't trust the engineering of the system*".

Not only are utilities presenting policy barriers to interconnecting to the grid, as was expected, but they are presenting additional barriers such as additional financial burdens and procedural barriers. The findings support those of Alderfer, Eldridge and Starrs (2000), who found that the majority of distributed generation projects attempting to connect to the grid encountered utility and regulatory barriers.

The comments indicate that in order for parks to use grid-connected systems, the NPS will have to collaborate with utilities serving the parks.

5.6.8 Staff Availability

Six contacts—or about thirteen percent of respondents—expanded on the issue of staff availability. One respondent indicated not having enough personnel available to even obtain necessary knowledge about RETs, saying: "*There may be knowledge in other agencies—DOI, DOE, etc. They probably have the expertise but we haven't tapped into their resources… we have a lack of capacity on staff…*" Other respondents simply indicated that the limited numbers of staff are preventing them from pursuing the technologies, for instance as one respondent said, *"We only have [few] FTEs, very limited staff, very limited time..."*

These results reinforce the findings of Worrell et al. (2001), who identified shortage of personnel as a barrier to use of energy technologies. However, the specific comments seem to indicate that issues related to staff availability are not necessarily related to operation and maintenance of the systems, but rather may be more related to initially attempting to obtain the systems.

Perhaps if park personnel were given more support in this regard, the use of RETs in the parks could be encouraged.

5.6.9 Visual Quality Concerns

Six respondents commented on the issue of visual quality concerns. Comments included: *"Some if it looks like crap"* and, "*We are an urban park—we have visual quality concerns for our neighbors"*. One respondent chose to explain why visual quality issues should not be as much of a concern, saying: "*I think that the public is willing to look at [an RET] if they understand why its there.*"

Together, these comments indicate that visual quality concerns are not only barriers from above, but are concerns of park personnel themselves. The comments suggest that park personnel should be educated as to ways to potentially mitigate the visual impacts. The results suggest that by addressing visual quality concerns, the use of RETs in the parks can be facilitated.

5.6.10 Access to Technology/Inability to Locate Suppliers

A small minority of park contacts mentioned issues related to limited access to RETs, suppliers, and service providers. However, these five respondents expressed sincere concerns related to the limited availability of RETs; these were of the utmost concern to some remote parks. To demonstrate the significance of the barrier, when asked to rate "Access to technology" on a scale of zero to five, one contact said, "*That is probably the biggest barrier. I'd call that a '10' ...the technology would probably be cost effective here…our electricity is [very expensive], but it's just the problem of getting access to it*" Another remarked, *"Where this park is located is [very difficult to access] …we have to have supplies delivered...it is difficult to get this stuff… If we replaced with solar, it would be great for the park. We would be getting rid of the generator, and [the diesel] tanks that are right on our water table. It is a big concern for us."*

The results indicate that, though access to technology is of limited importance to most parks, it is of extreme significance to a few parks, particularly where RETs could be most useful and cost effective. These comments support Geller (2003), who noted that the barrier of limited supply infrastructure is particularly relevant to rural areas, where

RETs may be most economically viable. Suggested here is that RETs should be made available to these parks to allow realization of the potential benefits of the systems.

5.6.11 Park-Level Management

Three park contacts indicated that the management at the park level has much influence on the decision to obtain RETs, and correspondingly has much power in rejecting the projects. One respondent highlighted the problem at his park, saying "*One of our biggest concerns is the superintendent. We have had meetings…to discuss solar. The feedback is zero. We keep telling him… [He] didn't want to do it"*. Another said, "*One barrier is that the park management doesn't support it. We are very much in support if it here"*.

These comments indicate that support or resistance from park-level management can have a significant role in encouraging or inhibiting the use of RETs in the region, and by educating park management about the importance of RETs, the use of the technologies can be facilitated.

5.6.12 Vandalism/Theft Concerns

When asked if there were any other barriers which had not been addressed in the survey, three park contacts indicated that vandalism and theft concerns were presenting barriers to the use of RETs. As one respondent elaborated, "*We've had problems with theft because energy prices are so high around here. We don't have insurance because we are a federal agency…We would have to come up with the money or take it from somewhere else if a system is damaged or stolen"*. Two other respondents indicated concerns about vandalism because, "*We don't have any law enforcement around here*".

Though these concerns do not present barriers to obtaining RETs, they do identify park personnel's hesitation to acquire the systems, and demonstrate potential problems which may occur if systems are acquired. These comments suggest that if the issues of vandalism and theft were addressed, the cost-effective use of RETs would be facilitated.

5.6.13 Bird Populations

Two respondents identified conflicts with bird populations in their respective parks as presenting barriers to using RETs. In one park, the respondent expressed annoyance at the inability to install a system because park personnel would not be allowed to maintain it for several months out of the year because there were bird populations nearby which could not be disturbed. Interestingly, he noted that the power at that location was being supplied by a diesel generator, with all of its associated impacts. Another respondent acknowledged that "*Because of the [bird populations] we would never be able to put wind turbines here*".

These comments suggest that conflicts with bird populations and perhaps other wildlife may be of concern in the parks—specifically for wind turbines. However, the first comment also suggests that perhaps the policy barriers related to bird populations may be more of a concern than are the actual potential impacts on the birds themselves. The results indicate that actions must be taken to address any impacts on wildlife; for instance by choosing the appropriate type of RET—not wind power—or by taking precautions to not disturb wildlife—so that RETs may be used with no negative impacts on animal populations.

5.6.14 Buildings

Two park contacts indicated that the type of buildings in the park were not conducive to using RETs. One respondent mentioned that the buildings in the park were not park-owned, while another indicated that the temporary-quality of the buildings was an issue. These comments demonstrate that in some instances, the use of RETs for facility power is simply not possible currently. However, the use of RETs in the park for other applications may still be a possibility.

5.6.15 Adverse Climate

Two respondents expressed concerns about the climate at the park, which they felt would present a challenge for using RETs. The comments were: *"We get [several] feet of snow] each year"*, and, "*We are frequently hit by [severe storms] every year"*.

The low incidence of comments related to climate in the region demonstrates the suitability of most parks in the region for RETs. However, climate is of a significant concern at these locations. Though clearly nothing can be done to alter the climate, perhaps if actions were taken to address the concerns about climate (i.e. location and protection of systems) the use of RETs could be possible.

5.6.16 Maintenance Requirements

One respondent elaborated on the topic of maintenance requirements, expressing concern that the maintenance staff at the park was resistant to RETs due to increased responsibilities: "*We have been looking at adding additional entrance stations, and solar has been encouraged, but there has been resistance from maintenance staff… [They] want to run hard wires to places where solar is having problems"*.

Though only one respondent mentioned resistance from maintenance staff, the comment reinforces the idea that there is truly no real incentive for many parks to acquire RETs. Indeed there is a disincentive for many park personnel: that of increased workload with no real benefits resulting to the individual. As noted earlier and highlighted by Brown (2001) and Geller (2003), there is often a market failure related to energy technologies, where those who benefit from the use of a system are not the same people who must make time or resource investments into the technologies. Indicated here is that park personnel may require incentives to undertake RET projects.

5.6.17 Technologies Designed for Grid Applications

Finally, one respondent indicated that the design of many RETs was not suitable for the park's needs: *"Most of the technologies are made to supplement or augment grid connections. We are off the grid here."*

This comment is of concern, seeing as the most cost-effective and suitable applications of RETs are usually those in remote locations—particularly if these locations are served power with a diesel generator. The comment suggests that if knowledge of or access to appropriate off-grid technologies were made available, the cost-effective and beneficial use of RETs would be facilitated.

Section 5.6 Summary

By analyzing the comments and concerns of respondents, a greater understanding of the earlier-identified barriers is achieved, as is an identification of additional barriers of concern for the parks. In Sections 5.4 and 5.5, resource limitations and restrictions were established as being foremost barriers to parks using RETs. Here, new barriers of apparently considerable importance are recognized: limited support from above in the NPS, disinterest and dismissal of RETs by park personnel, and limited support for smaller parks in the region. Additionally, the insights of park personnel have leant more weight to the barriers of utility policy and access to technology.

There are several inferences which can be made from respondents' insights. First, a lack of support from above is a problem for those who have attempted to pursue RET projects, but not as much so for those who have not made attempts. As the respondents mentioned, the NPS is highly supportive of RETs *philosophically*, but less supportive when concrete projects have been proposed.

Second, smaller parks may be less inclined to have RET systems. The size difference of parks with and without RETs has been supported by analysis of park attributes in Section 5.5. The relationship between annual visitation of parks and tendency to own RETs has not yet been established, though.

Third, the comments suggest that enthusiasm for RETs at the park level would result in increased use of the technologies. The enthusiasm of some respondents at parks with RETs compared to the lack of interest at some parks without systems would indicate that attitudes towards the technologies may be a contributing factor.

Finally, utility policy was identified as having been an issue for respondents who have attempted to connect to the electric grid. Though overall utility policy was rated as being of low importance to respondents, the comments suggest that utility policy is more of an issue to those who have acquired RETs and have attempted to connect to the grid.

In order to support validate the findings, further analysis is warranted to establish relationships between the attributes discussed above.

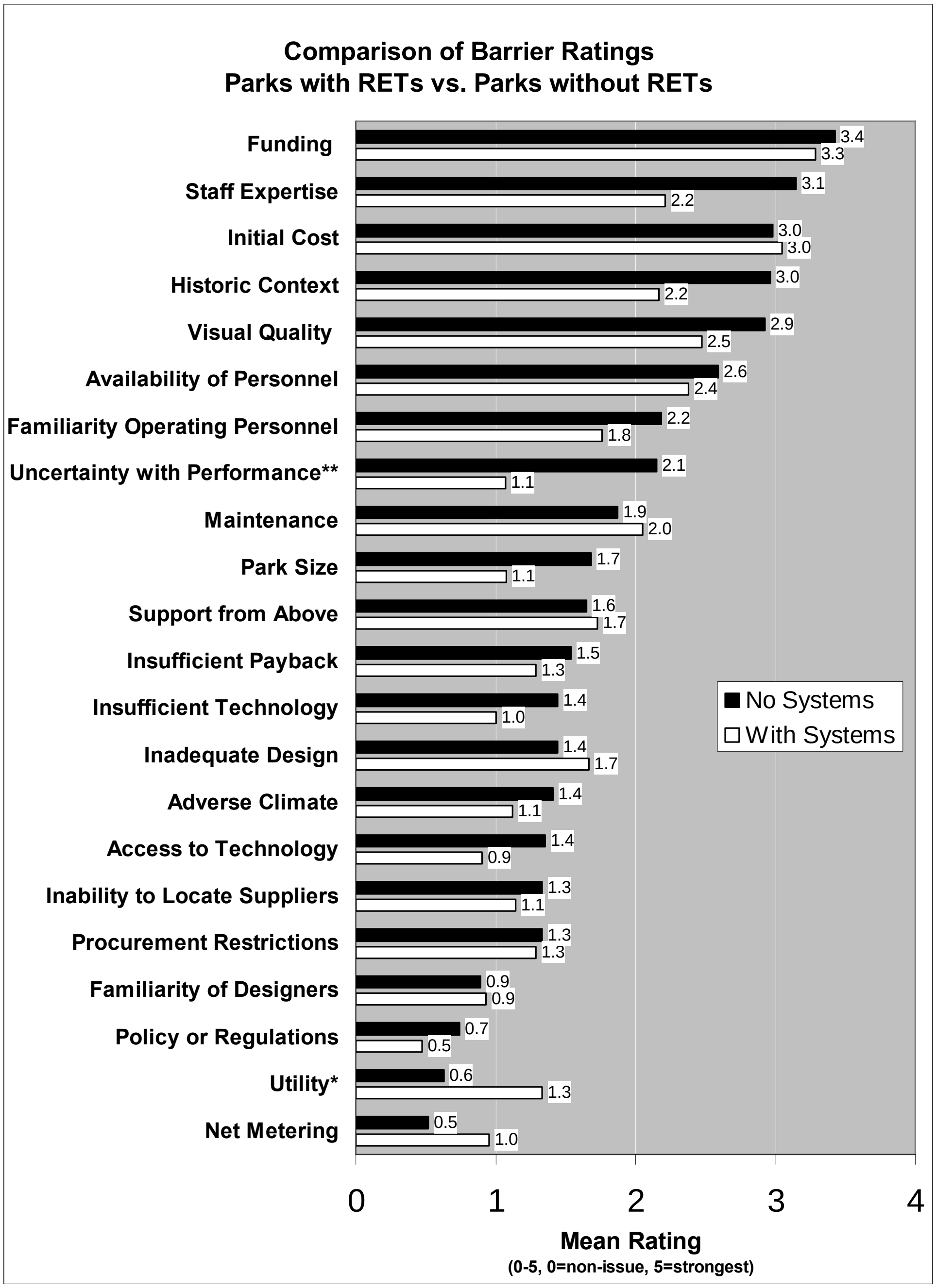
5.7 Validation: Barriers at Parks with RETs vs. without

In order to validate the suppositions made in Section 5.6, the ratings of barriers for parks with and without RETs were compared to determine contributing factors to the parks' tendency to have RETs. As noted earlier, twenty-seven parks have RETs, while twenty-one do not. I assumed that any significant differences between subgroups' barrier ratings might indicate potentially important perceptions or issues at parks without RETs that may be inhibiting the use of RETs.

As shown in Figure 10, parks without RETs predominantly rated barriers to RETs as being stronger or more important on average than did parks with RET systems. Fifteen of the twenty-two barriers were rated as being more important by parks without RETs. These include: funding; staff expertise; conflicts with historical resource context; visual quality concerns; availability of personnel; familiarity of operating personnel; uncertainty with performance record; park size; insufficient payback; insufficient technology; adverse climate; access to technology; inability to locate suppliers; procurement restrictions; and, other policy or regulations.

However, most of the differences between the mean ratings were not statistically significant. The only barrier for which a statistically significant higher rating by parks without RET systems existed was uncertainty with performance record ($p = .016$). Subsequent analysis using the chi-square method found that the differences in ratings were indeed significant for uncertainty with performance record; it was significant at the $p < .01$ level.

Figure 10: Comparison of Barrier Ratings, Parks with RETs vs. Parks without



Note: ** denotes significance at the .05 level for t-test and chi-square, * denotes significance at the .05 level for t-test only

Table 7: Uncertainty with Performance Rating; Parks with and without RETs

Uncertainty with Performance Record			
P < .01	Number Responses/Percentages		
Rating	Without RETs	With RETs	*Total*
0 to 2	13/48%	18/86%	*31*
3 to 5	14/52%	3/14%	*17*
Total	*27/100%*	*21/100%*	*48*

The findings support the idea that the park personnel's attitudes towards RETs are a determining factor in acquiring the technologies, as they suggest that parks may not be pursuing RET projects due to uncertainty about the technology and to concerns about any problems arising from their use. The results simply demonstrate that a correlation between uncertainty with performance and tendency to own RETs exists, though, and do not demonstrate that uncertainty with the technologies causes parks to not pursue RET projects. Indeed, an alternative explanation for the findings exists. The parks that currently have RETs overwhelmingly indicate a positive experience with the systems, and therefore would have no uncertainty about the performance of RETs; any uncertainty about RETs would accordingly be more prevalent in parks without use of the technology.

As revealed above, seven of the twenty-two barriers were actually rated as being stronger by parks that have RET systems. These barriers include: initial cost, maintenance requirements, support from above, inadequate design, familiarity by designers, utility, and, state net metering policy. One explanation for a barrier being rated as stronger by parks with RETs is that these were barriers which only those parks that had pursued RET projects had confronted. This explanation holds true for most, if not all of the barriers rated as being stronger by parks with RETs. Parks that had not pursued RET projects might not be aware of the maintenance requirements of the systems, the need for RETs to meet certain design parameters, the impediments utilities' policies present to interconnecting to the electric grid, or the problems that states' net metering policies can present. Some parks without RETs which also have never pursued RET projects may be less aware of lack of support from above in the organization, as addressed earlier.

The only barrier for which the difference was even close to being statistically significant was utility policy, which was rated on average as only .6 out of 5 for parks without RETs, while parks with systems gave an average rating more than double that, 1.3 ($p = .047$). Subsequent analysis using chi square established significance at the $p < .08$ level, which is not considered statistically significant for the chi-squared statistic.

The results support the conclusion that utility policy may present significant barriers to connecting to the grid. Presumably these parks have had more experience dealing with utilities' interconnection requirements, while parks without systems have not yet had to deal with the restrictions. The collective rating of utility policy by parks with grid-connected RETs is likely even higher, as many parks have RETs which are not grid connected, and so they too have yet to encounter this barrier.

These results suggest that the perceived barriers to RETs are quite uniform among parks with RETs and without RETs; certain parks have simply been able to overcome the barriers through different and use of resources. The findings indicate that the individual persistence of park personnel has a significant impact on whether or not RETs are obtained, as it appears that respondents at parks without RETs were less certain about RETs, and so were less inclined to pursue the technologies. The earlier discussed comments of park personnel indicate that there is much variation in attitudes towards RETs and in inclination to pursue the technologies. These results tend to reinforce Wiser, Fowlie, and Holt's (2001) findings that factors such as altruistic motives and organizational values may be important determinants for the use of RETs. Also supported are the findings of Alderfer, Eldridge and Starrs (2000) who found that a large portion of distributed generation projects attempting to connect to the grid encountered utility and regulatory barriers.

Section 5.7 Summary

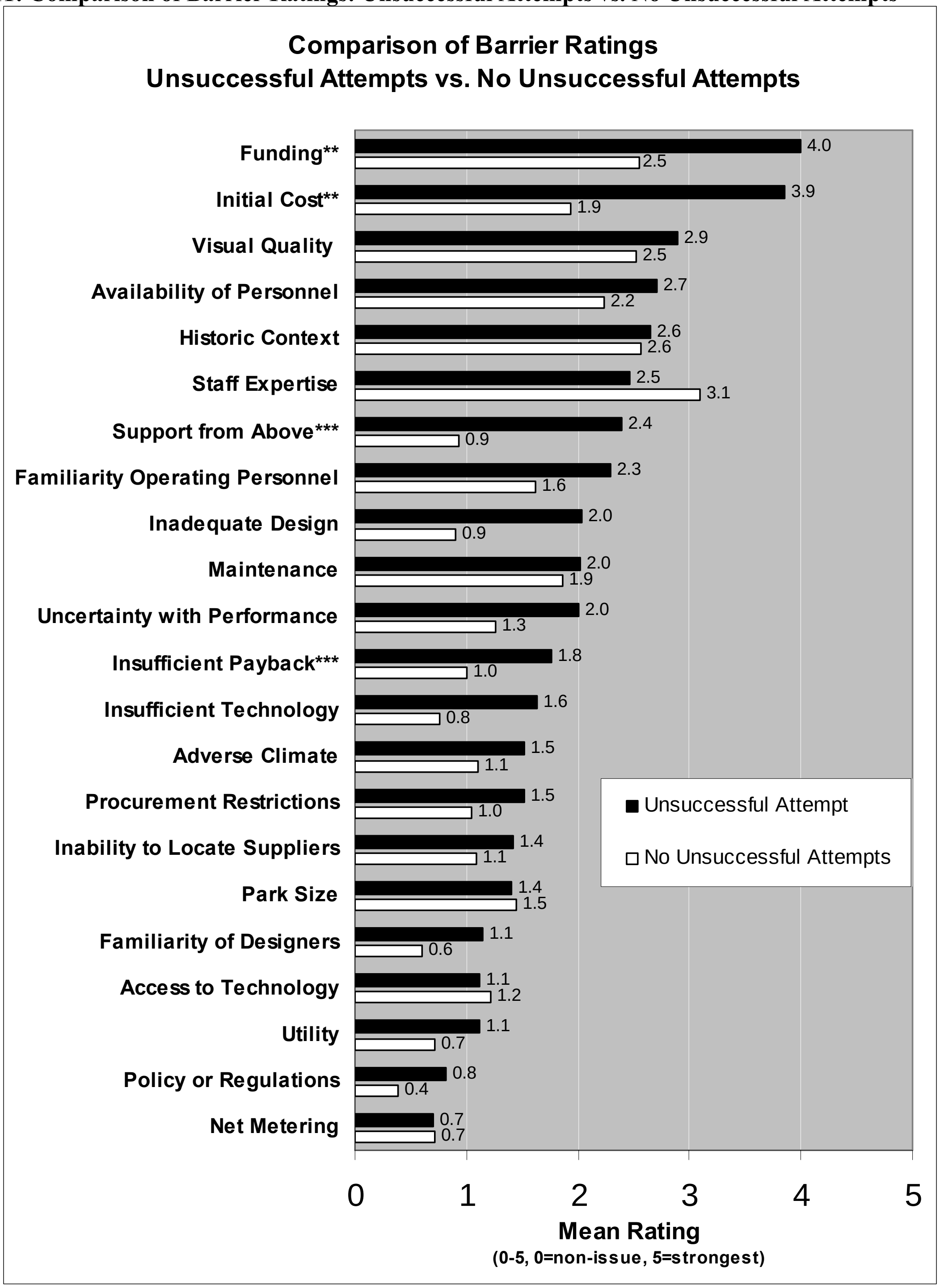
The results here support the findings in Section 5.5 related to the attitudes of park personnel having an influence on the tendency to acquire RETs, and related to the relative significance of utility policy for those projects attempting to connect to the grid. However, the findings do not validate the presumptions related to support from above and park size; therefore, further analysis is warranted.

5.8 Validation: Barriers, Unsuccessful Attempts at RETs

In order to validate the findings of Section 5.6, the respective barrier ratings of parks which had made unsuccessful attempts and those which had made no unsuccessful attempts were compared. During the survey, respondents were asked whether or not they had ever attempted to obtain an RET system for use at the park, but were unsuccessful; twenty-seven parks disclosed that they had made unsuccessful attempts, and twenty-one parks did not. The two groups' perceptions of barriers were compared with the intent of establishing which barriers were of more importance to those who had been interested in obtaining an RET system, but were unable to. Earlier analysis demonstrated that the average quantitative ratings of individual barriers did not adequately indicate the concerns of park personnel that were established during the qualitative analysis portion.

Respondents at parks that had made unsuccessful attempts were expected to rate barriers to RET use as being more important for two reasons. First, park contacts that have made unsuccessful attempts have more likely encountered barriers which parks with no unsuccessful attempts have not encountered. Second, park contacts making unsuccessful attempts would likely perceive the barriers to be much more substantial, as they have prevented obtaining an RET system in at least one case.

Figure 11: Comparison of Barrier Ratings: Unsuccessful Attempts vs. No Unsuccessful Attempts



Note: ** denotes p < .05 significance; *** denotes p < .01

As shown in Figure 11, on average parks which had unsuccessfully attempted to obtain RETs rated most barriers as being more important than did parks which had not unsuccessfully attempted to do so. In fact, the only barriers which were not rated as being more important by parks which had made unsuccessful attempts were staff expertise, access to technology, and net metering.

Of those barriers which were perceived as being stronger by park contacts which had made unsuccessful attempts, four were statistically significant. These include: funding, initial cost, support from above, and insufficient payback.

Table 8: Comparison of Barrier Ratings; Unsuccessful Attempts

		Number Responses/Percentages		
Barrier	**Rating Category**	No Unsuccessful Attempts	Yes Unsuccessful Attempts	Total
Insufficient Payback P < .01	0 to 2	20/95%	16/59%	36
	3 to 5	1/5%	11/41%	12
Support from Above P < .01	0 to 2	17/81%	10/37%	27
	3 to 5	4/19%	17/63%	21
Initial Cost P < .015	0 to 2	11/52%	5/19%	16
	3 to 5	10/48%	22/81%	32
Funding P < .03	0 to 2	9/43%	4/15%	13
	3 to 5	12/57%	23/85%	35

Parks which had made unsuccessful attempts on average rated funding as 4.0; in comparison parks not making unsuccessful attempts rated the barrier as 2.7 ($p = .016$). Subsequent analysis using chi-squared established the significance at $p < .03$. As shown in Table 8, eighty-five percent of park contacts at park making unsuccessful attempts rated funding at 3 or above, while only fifty-seven percent of parks not making unsuccessful attempts did so.

Initial cost was rated as 3.9 by parks with unsuccessful attempts, compared to only 2.0 for parks which had not made unsuccessful attempts ($p < .001$). Subsequent analysis using chi-squared determined that the difference was significant at the $p < .015$ level. As shown in Table 8, eighty-one percent of park contacts making unsuccessful attempts rated initial cost at 3 or greater, while less than half of parks making no unsuccessful attempts did so.

Insufficient payback was rated on average as 1.8 by unsuccessful parks, compared to 1.1 for parks with no unsuccessful attempts ($p = .10$). Subsequent analysis using chi-squared established significance at the level of $p < .005$. As shown in Table 8, only 5% of respondents making no unsuccessful attempts rated insufficient payback at 3 or above, while more than forty percent of contacts at unsuccessful parks did so.

These findings further reinforce the results of Sections 5.4 to 5.5, that financial constraints are of the utmost importance to parks pursuing projects. Parks are working with extremely limited budgets; funding cannot be made available for all potential projects, especially discretionary projects. Further, financial issues are some of the most recognized barriers in the literature (Geller 2003; Painuly 2001 DeCanio 1998; Reddy and Painuly 2004; Gouchoe, Everette and Haynes 2002; Worrell 2001).

Worthy of note is the significantly higher rating of insufficient payback by parks who had unsuccessfully attempted to pursue RET projects. This barrier has been less prominent in previous analysis, and was perceived to be less of an issue by respondents. However, the results indicate that insufficient payback is more of an important issue.

Two conclusions are supported here. First, park personnel, in their attempt to obtain RETs, have discovered that the payback time for systems was too lengthy and deemed the purchase as being not worthwhile. Second, park personnel were denied funding for the project from above due to what was deemed a lengthy payback time by decision makers above. Together with the identified significance of support from above, and survey respondents' comments, the second conclusion is more strongly supported.

The results here seem to reinforce DeCanio's (1998) findings that payback times on energy equipment are significantly shorter for public organizations, indicating less willingness to accept longer payback times. Worrell (2000) also found that organizations' emphasis on allocating capital to projects with certain returns was a significant barrier to use of energy efficient technologies. The results suggest that perhaps the requirements for duration of payback for RETs may be too stringent for those attempting to acquire RETs in the parks.

Support from above was given a mean rating of 2.4 by parks which had made unsuccessful attempts, compared to only 1.1 by park contacts with no unsuccessful attempts ($p = .01$). Subsequent analysis using chi squared established the significance of the difference at a level of $p < .005$. As shown in Table 8, only 19% of respondents from parks making no unsuccessful attempts rated support from above at 3 or above; in contrast more than sixty percent of respondents from unsuccessful parks rated the barrier this strongly.

These findings support the supposition of Section 5.5, that support from above—or the lack thereof—is of central importance as a barrier to parks attempting to pursue RET projects. Parks which have unsuccessfully attempted to pursue RET projects have collectively rated support form above as being more than two-and-one-half times more important than did parks which have not made unsuccessful attempts; the rating of support from above by the former group is next-in-line to the previously identified barriers of resource constraints. The results here indicate that a lack of assistance from above in the NPS—or even resistance from above—is a key factor inhibiting interested park personnel from obtaining RETs.

The results support DeCanio (1998), who found that a lack of incentives and support for those who take the initiative to pursue efficient energy technologies to be significant barrier; also recognized as a barrier was the limited support and willingness of an organization to invest in the technologies. The findings of Worrell (2000) are also supported: organizational decision making processes can present barriers to energy efficient technologies, particularly if the organization is dependent on the status quo and is hierarchical as is the National Park Service.

The NPS certainly *encourages* the use of sustainable technologies and RETs in policies. Once an RET system in proposed and the costs to the agency are concrete, however, in many cases support for the projects is less than enthusiastic as the cost of RETs would draw off funds from other areas in need of financial support, such as repairs, operations, and maintenance. In many cases higher-level decision makers may reject projects proposed from below. Parks have limited resources and staff limitations to work with. Without assistance from above, park-level energy managers are likely to be unsuccessful in their attempts to obtain RETs.

Section 5.8 Summary

These results support park contacts' perceptions that key barriers for parks pursuing RET projects are related to financial limitations and to a lack of support and assistance from superiors, and support the findings of earlier sections. However, as of yet the perception of smaller parks of a lack of support from above has yet to be supported quantitatively, apart from the earlier findings that parks with RETs are on average of a larger size. Therefore, further analysis related to park visitation—presumably most important aspect of parks which are targeted from above—is warranted.

5.9 Validation: Park Size—Visitation

In order to validate park contacts' perception that smaller parks receive less support from above due to the lack of popularity of the parks, the visitation of parks with and without RETs were compared using a t-test in Excel. The annual visitation at PWR National Parks varies considerably. FY04 visitation[8] varies from only 2,684 people at Eugene O'Neil National Historic Site to more than 13 million visitors at Golden Gate National Recreation Area. With nearly five thousand times the public education potential, clearly Golden Gate may be more likely to be targeted from above for educational RET projects. A chart illustrating park FY04 visitation and distribution is available in Appendix C.

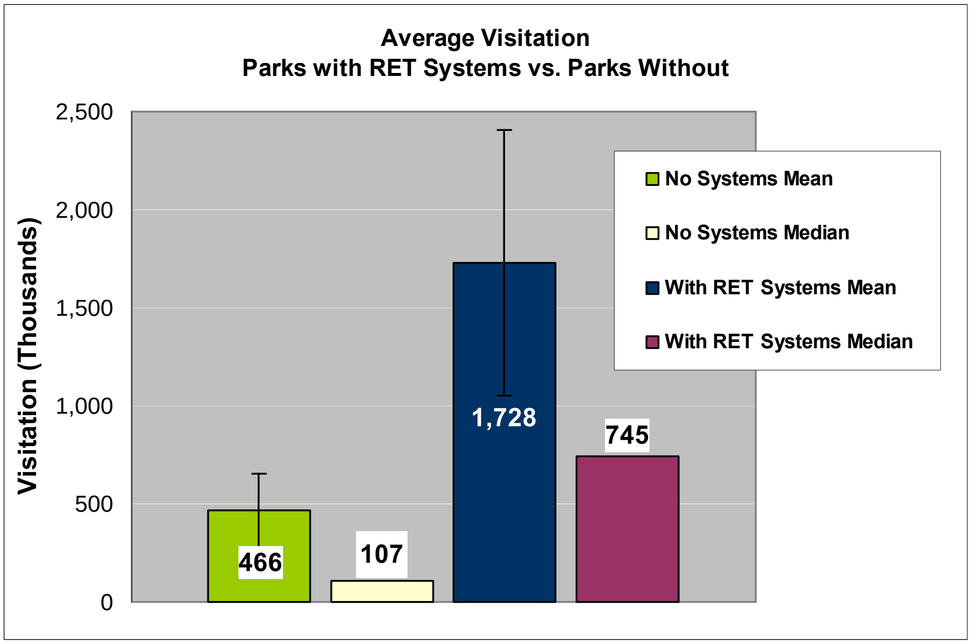
As shown in Figure 12, parks with RETs receive far more visitors each year than do parks without systems. The mean visitation at parks without RETs is 466,000, with a median visitation of only 107,000. Parks with RETs in contrast have a mean annual visitation of over 1,728,000 and a median of 745,000 ($p = .057$).

The findings seem to support the notion that smaller parks are less inclined to receive support from above. As discussed earlier, parks with many visitors are more likely to be targeted from above by officials and decision makers for educational RET projects. Indeed, the as per the 1999 agreement between the DOI and the DOE, the DOI

[8] The visitation numbers for all parks in the region are not available.

was given the responsibility of identifying projects with the most potential for pubic education (Memorandum, 2001, para.16).

Figure 12: Comparison of Visitation, Parks With RETs vs. Parks Without



Additionally, the Federal Energy Management Program prioritizes the public education potential of RET projects when determining which project will receive assistance (FEMP 2005a, para.3). However, park-level decision makers may also realize the opportunity for visitor education due to the vast number of visitors to the parks each year.

The difference in average annual visitation could have one or more of various explanations. As recognized in Section 5.5, visitation is positively correlated with funding to a large degree (R-squared = .52), which was discussed as being an attribute of parks which had acquired RETs. This indicates that a significant portion of the tendency for high-visitation parks to acquire RETs is attributable to funding.

It should be noted that the difference in visitation levels at the parks is not as significant as is the difference between other attributes of parks (i.e. $p < .057$ versus $p < .0001$). The lower significance and greater correlation between other attributes and tendency to possess RETs together indicate that park visitation is not one of the most dominant variables related to RET ownership. That is, the NPS and the DOE's prioritization of projects with high public education potential is not the only factor influencing whether parks obtain RETs or not, though the analysis indicates that it certainly is a contributing factor.

Section 5.9 Summary

The results here support the perception of respondents that smaller parks receive less support for RET projects than do high-visitation parks; however, the results also indicate that support from above alone is not likely singularly responsible for parks with RETs being those with higher visitation.

5.10 Summary of Barrier Identification Analysis:

Section 5 has identified and validated the existence of several barriers which are of considerable importance in impeding the use of RETs in the parks. The identified barriers include funding, initial cost, staff expertise, visual quality concerns, staff availability, support from above, attitudes of park personnel towards RETs, and finally, utility policy.

The existence and significance of these barriers has been supported here. However, these barriers are presumably surmountable in some cases. In order to gain an understanding of the opportunities and potential to overcome the identified barriers, the insight of park personnel who have been successful in acquiring RETs for the parks is necessary.

5.11 Overcoming Barriers

The analysis thus far has revealed that there are many strong obstacles for park personnel pursuing the use of RETs; funding, initial cost, staff knowledge and expertise, staff availability, and historical and visual quality concerns have been identified as being of particular concern. Additionally, support from above and insufficient payback are significant barriers to those attempting to pursue RETs, while utility policy may present strong obstacles to connecting systems to the grid.

By asking survey respondents from parks with RETs how the barriers that they perceived to be most important—given a rating of 4 or 5—were overcome to obtain the RETs, several approaches to defeat the barriers were established. Many park personnel through determination and ingenuity were able to obtain RETs or their parks in spite of several strong barriers. Approaches to overcome the main barriers included educating and training park personnel, obtaining funds from unique sources, and creatively concealing RET systems, among others. By recognizing the successful approaches taken by park personnel in the past, opportunities for potentially successful policy interventions can be established.

5.11.1 Funding/Initial Cost

Funding and initial cost were certainly the dominant barriers established in the survey and analysis. Fortunately, many parks have overcome this barrier by using fee-collection revenue, by obtaining outside funding, finding resourceful ways to finance RET projects, and by forming partnerships with private and public partners.

5.11.1.1 Fee-Revenue Financing

One identified alternative financing option was the use of fee collection money. In these cases, the income generated from visitor fees was spent to finance the RET projects. According to one survey respondent, "*We are a fee-revenue park. As long as the project has a visitor connection, we can use the fee money for projects.*"

This approach presents a real opportunity for parks pursuing RET projects, and for the NPS in attempting to encourage these projects. Many parks depend on distant decision makers to allocate funds for specific projects; these decision makers must weigh the requests of each park against the requests of many other parks, all of which have important needs. As noted by DeCanio (1998) and Worrell et al (2001), bureaucratic organizational structures, the decision-making processes of organizations, and hierarchical organizational structures can present barriers to the use of energy technologies.

In competition with larger, more popular parks, there is less likelihood of small parks' aspiring projects getting attention—and funding—from decision makers above, as was recognized by park personnel during the surveys. As was demonstrated earlier, fee-revenue parks are far more likely to have RETs. With park contacts indicating that fee revenues have been used to finance RET projects, the relationship between fee collections and RET ownership is established as not being simply coincidental. Rather, when designated as a fee-revenue park, an alternative—and considerable—financing option for RETs and other sustainable technologies is made available to the park.

By removing the organizational barriers and allowing park-level decision makers to have discretion in determining which projects to finance, the use of RETs has been facilitated.

5.11.1.2 Outside Funding

Several respondents indicated that they had pursued funding from organizations and agencies outside the NPS—such as the BPA and the DOE—after attempting unsuccessfully to obtain funding from above in the Park Service. Indeed, the BPA and the DOE have very proactive programs to finance RETs projects in the region.

Several respondents indicated that funding for RET systems was made available by the Bonneville Power Administration (BPA). According to one park contact, "*Funding was given to us…through BPA. We asked for systems [unsuccessfully]… finally we had to apply outside the NPS*". Park contacts indicated that BPA had provided at least partial financing for numerous PV systems in the region.

The United States Department of Energy (DOE) has also been instrumental in financing RETs, according to several park contacts; this would be expected given the earlier-mentioned 1999 agreement between the DOI and the DOE (Memorandum 1999).

As has been demonstrated here and in previous research, the ability to obtain funding is a major barrier to RET projects. Indeed, there are exist many barriers even to potential financers of RET projects (Wiser and Pickle 1998). By taking the time to discover financing opportunities, many park personnel were able to overcome the barrier of lack of financing and obtain RETs for their respective parks.

5.11.1.3 Cost Savings/ Life-Cycle Cost Analysis

Another method to overcome financial barriers to RETs was analysis of the long-term costs and benefits of RETs compared to other current or potential energy sources. By analyzing the life-cycle costs of RETs compared to conventional energy sources, many park contacts determined that the cost of the RETs was significantly lower, which provided enough justification to obtain funding from above.

Two respondents mentioned that the overall cost of fueling and operating diesel generators was significantly higher than the overall cost of RET systems. At both parks, tens of thousands of dollars were being spent annually to operate a diesel generator. By comparing the cost of RET systems to diesel generator, park personnel found that RETs systems were far less expensive, which allowed the parks to justify the high initial cost of RETs.

Several other respondents mentioned that by analyzing the costs of providing power to remote areas, RETs were found to be far more economical. According to two separate respondents, the cost to trench power lines to locations in their respective parks would have cost upwards of one million dollars; the initial cost of RETs was insignificant in comparison.

The initial cost of RETs is by far one of the most significant barriers to the widespread use of the technologies, as has been demonstrated here and in previous research. However, the life-cycle cost of RETs can be significantly less expensive, as these survey respondents have demonstrated. By comparing the costs of conventional energy generation versus RETs, these park personnel were able to realize the life-cycle benefits of RETs and overcome the barrier of initial cost.

5.11.1.4 Initial Design/ Capital Improvements

Another identified approach to overcome the barriers of initial cost and funding was to incorporate RETs into the cost of designing new buildings or capital improvements. Several respondents indicated that this was a cost-effective option for acquiring RETs; as one said, *"With PV it was easy because we designed them into the new buildings, so it was part of construction costs. Also, we had proof of payback from electricity costs"*.

By integrating RETs into new buildings or building improvements, the cost of systems—and the lifetime cost of the building—can be reduced significantly. First, retrofitting costs can be avoided. Second, new buildings can be positioned to maximize the renewable resource (i.e. solar radiation, wind) available to the system. Third, RETs can be assimilated into the design of the building or facility so as to minimize visual intrusion. Finally, though the initial cost of the building will likely be more expensive, the lifetime cost will be reduced through energy savings, particularly if other sustainable energy design practices such as day-lighting are incorporated.

The initial cost of RETs is certainly a substantial barrier; however, when incorporating these costs into necessary building projects, the initial cost of RETs can be diminished while life-cycle costs of the buildings are simultaneously decreased as well. As these respondents have demonstrated, by integrating the two substantial expenditures together, the overall costs of both are decreased.

5.11.1.5 Support from PWR Office

Finally, several respondents indicated that support from the PWR Regional Office—Steve Butterworth in particular—was instrumental in providing funding and/ or assistance for RETs.

5.11.2 Staff Knowledge/Expertise

As is demonstrated by the survey results and analysis, many park contacts have concerns about personnel constraints related to availability, knowledge and expertise of park employees. Indeed, respondents' comments seem to indicate that these are concerns which are preventing park personnel from even *attempting* to obtain RETs for the parks. However, some park contacts have been able to overcome this barrier through education and training programs, bringing in outside experts to the parks, or taking advantage of expertise of skilled personnel in the park or from other parks.

5.11.2.1 Training/Education

Virtually all of the park contacts who had rated staff knowledge and expertise as being important had employed some sort of training or educational program to address and overcome this barrier.

At one park, many avenues for overcoming the lack of knowledge and expertise were pursued. First, the park had an agreement with BPA for the design of the systems. Next, a training and educational course was held at the park for personnel to learn about RET systems. Park staff also took advantage of outside expertise including support from the PWR Regional office, support from another PWR park with knowledgeable personnel, and Sandia National Laboratory At another park, challenges with staff knowledge and expertise are overcome through training, education, and constant reminders to staff of RET benefits and system requirements.

Also, several parks brought in outside experts, including experts from Sandia National Labs and even knowledgeable staff from other parks to train staff about RET systems, operations, maintenance, etc. At one park, experts were brought in to install the RET systems, and while onsite the experts worked to train park personnel to a small degree.

One respondent, from one of two parks where RET systems with identical configurations will be installed in the near future, mentioned an especially promising arrangement. The arrangement is as follows: an RET system will be installed in the first park, where the employees will be trained about system installation and operation. One staff member from the second park will travel to the first park for the installation and training. The employee from the second park will then return to his park to help with the installation there. This arrangement presents a unique opportunity for parks to collaborate, and for personnel to learn about installation, operations, and maintenance of RETs.

Once employees are trained and knowledgeable, the installation and operation of RETs is much more straightforward. One park contact said that installation of RETs was certainly a challenge at first. However, during the installation park staff learned a great deal and when they later decided to install additional RETs, the installation was quick and efficient.

Finally, support from the PWR regional office—specifically Steve Butterworth—was recognized by several contacts as being instrumental in addressing the barrier of limited staff expertise.

The barriers of limited education and expertise are among the most prevalent in the literature, and among the most considerable identified here. However, many park personnel have demonstrated that they have been able to overcome these barriers through initiating training and education programs; the programs seem to be instrumental in facilitating the use of the technologies in the parks.

5.11.3 Visual Quality/Conflict w/ Historical Resource Context

Visual quality concerns and conflicts with the historical resource context are some of the foremost concerns impeding the use of RETs in the PWR parks, particularly in National Historic Sites, National Historic Parks, and National Memorials where many buildings and entire landscapes can be designated as being historical. As demonstrated earlier, historic parks and parks with fewer acres are far less likely to have acquired RET systems. Fortunately, many parks have been able to overcome these barriers by locating and designing RET systems in ways which minimize the visual impacts, and even by locating RETs outside park borders.

Many park contacts who have overcome the barrier of conflicts with the historical resource context have done so by locating systems away from historically-designated areas. Though historic parks have many historically-registered and protected areas, there are areas and facilities in the parks which are not as protected.

For instance, at one historic site, an RET system was located at a facility where it *"did not compromise the historic scene"*; it was the most isolated place in the park that could be found. At another park, systems were located on the side of the park where there aren't any historic landscapes or buildings. Finally, one park located a sizeable RET system on a maintenance facility where there would be minimum visual intrusion and away from historically designated areas.

Visual quality concerns—those not related to historic designation of a landscape or facility—have been overcome at many parks through creativity in design, mitigation of the visual impact, and, again, locating systems away from visitors' view. One identified solution deserves particular attention: locating park-owned systems outside park borders.

For instance, at one park, personnel mitigated the visual impact of their RET system by strategically planting trees nearby to conceal the system but also to allow enough sunlight to the system.

At several parks, the RET systems were configured into the design of buildings as part of a capital improvement project. For instance, at one park, solar PV systems were positioned at an angle on the roof of buildings so that visual intrusion was minimized and the solar resource available to the PV panels was maximized

In one park, RET systems are ground-oriented instead of being located on the buildings, so they are out of sight for most visitors. Another park contact mentioned that in the past, their solar systems were pole-mounted and visually obtrusive. When the systems were replaced they were positioned on the roofs of buildings where they would be less conspicuous.

Finally—and most interestingly—instead of locating their grid-tied solar system within the park boundaries where it might conflict with the historical landscape of the park or create visual quality concerns—one historic park located their system on land owned by the utility serving the park. In this arrangement the park has ownership of the system and the electricity generated from the system is deducted from the park's utility bills. As the survey respondent from this park mentioned, the system generates electricity for the entire park.

Visual quality concerns and conflicts with the historic resource context are among the most important identified in this survey. By mitigating the visual impacts of the systems through siting or design of RETs, though, park personnel have demonstrated that these are surmountable barriers.

5.11.4 Staff Availability

Staff availability was another major barrier identified by park personnel, which was validated by acknowledging the number of FTEs at parks with and without RETs. Though it might seem that this barrier would be insurmountable unless additional FTEs were hired by parks, the barrier has been overcome by parks with a sincere interest in obtaining the systems. As one respondent said, "*We used all available staff and we had to let some things go. But we learned through trial-and-error and the next time it went much quicker.*" Here, the respondent is referring to overcoming the barrier of staff availability to *install* RETs, which further supports the earlier supposition that staff availability issues relate mostly to acquisition and installation of the systems as opposed to operations and maintenance.

Though staff availability was identified as a central barrier in the study, the analysis seems to indicate that availability issues are mostly related to the early stages of RET ownership. As this respondent demonstrates, the barrier can be overcome by applying available staff to get the job done. However, also indicated here is that the barrier can be overcome in many cases if assistance were provided during stages of acquisition and installation.

5.11.5 Technology and Design Issues

Though insufficient technology, lack of familiarity by designers and inadequate technology were not identified as some of the most significant barriers overall, a few respondents did rate them as being of high importance. When asked how they overcame these barriers to obtain the systems in their park, the respondents indicated that these barriers were defeated relatively easily. By working with designers or acquiring necessary expertise, RETs that are suitable for the park needs can be developed and used. As one respondent said, "*We needed to work with designers and figure out the appropriate system for maximum power output and generation for our needs*".

The barriers of insufficient design and technology, though a significant concern of some of the park personnel, seem to be overcome rather simply, by taking the time to identify the appropriate systems and incorporating the systems into the design of existing facilities, as recognized earlier.

5.11.6 Adverse Climate

As recognized earlier, adverse climate is less of a concern in the PWR parks; most survey respondents indicated that the barrier was of little importance to them. However, one respondent who had indicated adverse climate as being a significant barrier had acquired a system for use in the park. In order to overcome the barrier of adverse climate—here the adverse climate was related to excess snowfall—personnel at the park *"…put it in a place where we have lighter snowfall, and where we have staffing year round so we can manage around the snow*".

Though adverse climate is not a major issue in the PWR region, it is of importance at some parks. As this respondent has acknowledged, the barrier may be overcome by locating an RET where it can be maintained more easily. Additionally, in regions where the climate is unsuitable for most of the year, but appropriate in the summer months, RETs have been located where staff will be available all year long to care for the systems, but also where there are additional energy needs in the summer months due to increased visitation.

5.11.7 Insurmountable Barriers

The survey identified many barriers which were of different levels of importance to respondents. Most of the identified barriers have been overcome in one way or another. However, some barriers have not been discussed as being overcome by any respondents. Seeing as nearly every barrier was identified as being a 4 or a 5 by at least one respondent, an obvious conclusion can be made: some of the barriers have been insurmountable thus far. Some respondents indicated that the barriers rated as being 4 or 5 were truly preventing them from obtaining systems. Furthermore, some of the barriers were never addressed as being overcome because no parks rating these barriers as 4 or 5 had RET systems. For instance, the barriers "no access to technology", "inability to locate suppliers", "park size", and "policy or regulation" were never addressed for this reason. Therefore, by truly addressing these barriers—for instance through making RETs available in remote areas—the use of RETs will be made possible where it was not before.

Section 5.11 Summary

The results of this section demonstrate that the most significant barriers to RETs in the parks have been overcome in many cases through diligence and creativity. Funding and initial cost can be overcome by acquiring outside funding, taking into account the life-cycle costs of alternative energy options, and incorporating RETs initial costs into planned building and capital improvement projects. Visual quality concerns and conflicts with the historical resource context can be overcome through mitigation of visual impacts and locating systems away from park facilities or even away from the park itself. Staff knowledge and expertise can be addressed through training and education and bringing in outside expertise. Staff availability constraints can be overcome by using all available staff for a short period of time. Finally, even technology, design, and climate issues can be addressed by taking the time to establish the most appropriate location and configuration of RETs.

However, this section simply recognized approaches to overcoming barriers which park contacts indicated were of the utmost importance to them. The section does not identify what factors may be behind the acquisition of RETs for those park contacts that did not identify barriers as being of great significance. It does not identify what the drivers were to certain parks being able to acquire RETs without much difficulty. Therefore, in order to identify additional approaches for increasing the use of RETs in the parks, knowledge of the factors assisting the parks in being able to acquire RETs is required.

5.12 Factors Assisting Parks / Drivers

In order to gain an understanding of the drivers and factors assisting parks in their pursuit of RET projects, contacts from parks with RETs were asked which factors particularly helped them in being able to obtain the systems for the park. Though the question is similar to that of overcoming barriers, this question attempts to identify contributing factors from respondents who may not have indicated that barriers were of great importance to them.

5.12.1 Support from Above

The factors varied somewhat between respondents, however a significant portion of respondents indicated that support from above was indispensable. Comments related to receiving support from above included, *"support from above helped", "Steve Butterworth [PWR Regional Energy Coordinator] has been coordinating a spearheading effort", "Steve Butterworth is the biggest supporter. He had a study done…that recommended the site for solar. That has helped us get projects done"* One respondent demonstrated that support from above at the park level was instrumental.

"Cooperation with the superintendent, he has been the coordinator. He's the cooperative, friendly type. He's open to suggestions from experts and other agencies and those in other fields".

Though support from above—or lack thereof—was identified earlier as a significant barrier for those who had unsuccessfully attempted to pursue RET projects, these responses indicate that indeed support is being provided for many parks pursuing projects. These results coupled with earlier analysis support the supposition that particular parks are being offered support and assistance, while others have been largely neglected. Further, these comments indicate that by providing increased support to the parks, the use of RETs in the parks can be facilitated.

Finally, these comments demonstrate that support from above in an organization can be instrumental in the realization of RET projects. Clearly, without the level of support which has been provided by the PWR office thus far, the projects that have been accomplished would not have been realized.

5.12.2 External Support/ Partnerships

As can be expected from the answers provided related to overcoming barriers, several park contacts indicated that financial assistance and support from the DOE and BPA were essential to the realization of the projects. A few respondents indicated that outside organizations or decision makers—such as the BPA, DOE, or from above in the NPS—were responsible for initiating the RET projects, rather than park-level staff doing so. Comments related to external support included "*They came to us—BPA as a matter of fact,* and *"DOE persistence and cooperation- they give us a lot of help"*. One respondent indicated that support from several external partners has played an instrumental role in the park's RET acquisition, saying: "*…a lot of partners. Federal agencies and other agencies in the area are supportive. The DOE, NREL, BPA. All of the* *players are very important… They are all supportive. Everyone bought into doing this, so it could happen"* Finally, one respondent mentioned a partnership with a university as being of assistance in realizing the potential for use of RETs in the park. The university faculty and students provided feasibility assessment and design assistance to the park.

These comments demonstrate that support for the parks from external organizations and agencies has been instrumental in the realization of many RET projects. These comments demonstrate that many projects would not have even been initiated, as it was not the park-level decision makers who initiated the projects but rather was the outside funding entity. Therefore, without external support and partnerships, many of the RET systems that are in place in the region would not have been acquired.

5.12.3 Energy/Cost Savings

Several respondents indicated that potential energy and cost savings of the RET systems compared to other energy options were instrumental in getting the projects approved and implemented; this would be expected given the similar responses related to overcoming barriers. Cost savings at parks resulted from displacement of fuel, energy, and operations costs. As one respondent said, "*In general what we are doing is pushed by the electricity prices around here"*. Additionally, other parks avoided costs related to bringing conventional energy to the area, such as trenching lines to a location to provide grid power.

As discussed earlier, RETs can very often be lower in cost on a life-cycle basis than are conventional technologies. By taking into account the overall costs of alternative technologies, these parks have provided incentive to undertake RET projects.

5.12.4 Altruism/ Advocacy

As indicated in earlier discussion of park contacts' comments during the surveys, several respondents demonstrated an interest in RETs for altruistic reasons and some were singularly determined in pursuing RET projects in the face of many obstacles. Several park contacts indicated that a concern for the environment, public education, and *'doing the right thing'* were factors prompting the use of RETs in the parks. Additionally, a few respondents revealed that their lone, determined pursuit of the technologies was a key factor behind acquiring RETs for the park.

Comments related to altruism and advocacy included: "*In general what pushes what we try is doing the right thing"*, and *"We had many doubting Thomases, but after years of operation, now they are all believers. The operator uses the systems and there is a change in behavior—a change in paradigm… Anything with NPS, whatever it is, needs to have an internal advocate. Someone needs to be the squeaky wheel. That gets things happening. If the park mentality is to be naysayers then not much will happen"*

These comments indicate that many of the projects which are in place in the PWR region are due mostly to the determined efforts of those at the park level. Without these notions of altruism and advocacy, many of the projects in the parks would not have been implemented. These comments support those of Wiser, Fowlie and Holt (2001), who found that altruistic factors such as civic responsibility were important motivations to use renewable energy.

It should be noted that these responses demonstrate that in many cases there is no incentive for park-level decision makers to initiate RET projects other than their desire to do good. In absence of their internal altruistic motives and notions of "*doing what's right*", the park personnel likely would not have undertaken the RET projects. This suggests that many of the RET systems in the PWR region would not be in place if it had not been for park-level energy managers taking the initiative.

5.12.5 Remote Locations

Two contacts indicated that the driving factor behind the decision to acquire RETs was the fact that there were no other options available at the site for energy production, because the site was so remote. As one respondent said, *"the main engine was that it was an isolated area with no utility".*

These comments reinforce the idea that RETs are an energy option particularly suited for national parks. Also reinforced here is the idea that some park personnel are not as supportive of RETs in general, but have only acquired the technologies because they were necessary for certain applications. These comments suggest that the RET systems would not have been acquired had there existed other energy options.

5.12.6 Lacking Assistance

Finally, a few respondents indicated that there were no factors that assisted them in being able to obtain RETs, or that they had attempted to receive assistance but that none had been available. As one respondent said, "*We didn't get much help… there are battles over everything… it was back and forth".* Another said, *"No, we just did it"*

While many respondents indicated that support from above was imperative in their pursuit of RETs, these contacts indicated a lack of support. This discrepancy seems to support the ideas that selected parks are receiving more support and attention from above, and/or certain parks are unaware of the opportunities for assistance and support.

Section 5.11 Summary

The results of this section demonstrate that there are many factors driving the use of RETs in the parks. The same factors which were identified as assisting in overcoming barriers were identified here, including cost savings, partnerships, and support from above. However, additional factors—including altruism and the need for energy in a location where it cannot otherwise be provide—were established as being driving factors. These results provide direction towards policy mechanisms which can be developed to capitalize on the existing drivers and create avenues to recreate these drivers elsewhere. This and the previous section have identified methods to overcome barriers and factors driving the use of RETs in the parks in order to recognize potential policy mechanisms which can be developed to encourage RET use. However, it would also be helpful to have an understanding of the policy mechanisms which park energy managers believe would make them more inclined to use or RETs or which would make their acquisition more straightforward.

5.13 Respondents' Policy Suggestions

In concluding the survey, park contacts were asked what policy changes would make them more inclined to use RETs, or that would make it easier to do so. The responses varied considerably: some respondents believed that no changes were necessary as the NPS was already doing its best to promote the technologies; others felt that more support was needed and more emphasis and priority should be placed on RETs and other sustainable technologies. Many contacts felt that more funding should be made available; and, some respondents felt that only the mandating of these technologies would induce many parks—or themselves—to use RETs.

5.13.1 Funding

Fifteen respondents said that increases in funding or financial incentives for the use of RETs would make them more inclined to use RETs, or would make it easier for them to obtain systems. Comments included: *"They are currently changing the management policies. That would be a great place to include incentives for parks to use renewable energy and to revise policy to encourage people to take that step"*; "*If there were more funding I would have more systems in place or larger systems in place"; "If there was funding directly available"*, and one respondent quoted George Herzog—former NPS Director—saying, "'*Policy without funding is just conversation*' ".

When recognizing that the barriers established as being most significant were funding and initial cost, it is logical that the policy mechanisms most mentioned were those of financial support in the form of incentives or funding. However, these responses do demonstrate that the increased availability of funds would greatly facilitate the increased use of RETs in the parks.

5.13.2 Historical Rules

Seven respondents said that changes in historic regulations and compliance would make it easier for them to pursue RET projects. Comments related to historical compliance and rules included: *"It's the historic rules";* and *"If there were some sort of categorical exclusion for renewable energy and historical regulations.*

When recognizing that conflicts with the historical resource context was established as being a central barrier to RETs by respondents and that historic parks are far less likely to have RETs, the desire for changes to historic rules would be expected. These responses demonstrate that some park personnel would be willing to use RETs in the parks if they were permitted to do so.

5.13.3 Mandates

Five respondents indicated that mandates to use RETs would encourage them and other park energy managers to acquire RETs. One respondent elaborated on the subject: *"If there was a funded mandate. That's the way it always works. What's important to one park—being green, environmentally-friendly, even recycling—may not be important to another. If it was not optional, then you would have to do it. Ten times more would be done. But there would have to be funding with it. Otherwise, if the mandate is not funded, then you have to make cutbacks elsewhere against the mission of the park. You would have a great solar system on the roof, but no interpretive staff, for example."*

The need for mandates of some sort to increase the use of RETs to the fullest extent would be expected when recognizing the attitudes of some park personnel related to RETs. As earlier sections have demonstrated, some energy managers and decision makers simply have no interest in pursuing RET projects or are too uncertain about the technologies to feel confident initiating a project. Of course, if parks were mandated to use RETs, the attitudes of park-level decision makers would not be of concern.

5.13.4 Training / Assistance

Five respondents said that assistance, training and education would support them in their pursuit of RETs in the parks. Considering the relative importance that the barriers of staff knowledge and expertise, staff availability, and support from above, it would be expected that park personnel would call for these policy interventions. Comments included: *"We need new people to help"; "I think that we tend to put renewable energy resources…they are not placed in a high priority. It would seem to me that if we are trying to educate the public we ought to give more priority to these projects…not only that but have people available to do the installing, etc."* and, *"You have to show the people, and then they will believe that this will work…It's a paradigm shift, its education"*

As was demonstrated earlier, many park energy managers have concerns related to both limited availability of staff to initiate and implement projects, and related to staff limitations related to knowledge and expertise. Without assistance from above in these respects, many potential projects will likely not be realized.

5.13.5 Federal Administration

Two respondents indicated that current Federal policies and the Presidential administration were hampering the use if RETs in the Federal government in general, and that a change in the federal policies would facilitate increased use of RETs in the parks.

One respondent said, *"The current administration's energy plan still relies on fossil fuels. If a future administration would be more environmentally friendly and promote alternative energy…. NPS is caught with DOI, we are with BLM and other more extractive agencies. We are the only one with a mission to conserve resources. If future administrations…would push more for renewable energy--like past administrations like Clinton--it wouldn't be so politically charged to be doing this."*

These comments tend to indicate that concerns about support from above may extend to higher levels in the government; these respondents feel that if there were more support from the highest levels of the Federal Administration, than decision makers in the NPS would be more inclined to pursue and support use of the technologies.

5.13.6 Utility

One respondent felt that the relationship—or lack thereof—between the utility serving the park and the BPA made the acquisition of RETs difficult. The park contact said, *"The relationship between [a funding partner] and [our utility]. I know that they don't like each other; one is federal and one is private. Problems exist between the two entities…makes it difficult. If [our utility] would allow [the funding partner's] money to be used it would eliminate some of the bureaucracy."*

Utilities were demonstrated earlier as presenting barriers to parks interconnecting to the grid. This comment suggests that the utility also presents barriers to parks receiving funding from other entities. This comment indicates that by forming relationships with the utilities serving the parks, the NPS can facilitate increased use of RETs in the parks.

5.13.7 Procurement Guidelines

One respondent mentioned procurement guidelines as a policy which, if changed might make it easier for parks to obtain RETs: *"Procurement guidelines….We have rules about buying American. This prevents us from using the latest, state-of-the-art technology. Our converters are from Germany. We were almost not able to buy them, but since a certain portion of the rest of the system was American, then we could buy them. "*

In general, procurement restrictions were not established as being significant concerns to park personnel. However, this respondent's comment seems to indicate that there may be procurement issues which are preventing parks from obtaining the best technologies to suit their needs.

5.13.8 Sale of Surplus Energy

One park contact mentioned a program focused on the expansion of the conventional use of RETs in parks to include sale of surplus energy generation and location of RETs outside park borders. The respondent said, *"…additional opportunities for multiple-park solar, expended park and internal and external projects…There have been questions as to whether NPS has the authority to produce energy—selling it, selling the surplus. I'd love to see us create a public lands system of energy production. I don't know what policy and regulatory constraints there are"*.

As mentioned earlier, one park already has a partnership in place where an RET system is located outside of park borders. If an expansion such a program were possible, the use of RETs could be greatly facilitated as the NPS could reallocate the revenue from energy sales back to investments in RETs and energy-efficient technologies. As this study has demonstrated, issues of funding, initial cost and insufficient payback are of significant importance in preventing the acquisition of RETs. By generating an alternative stream of revenue and therefore a new financing mechanism, this type of program could overcome what are perceived to be the most significant barriers to use of RETs in the parks.

Section 5.12 Summary

This section has demonstrated that park personnel believe there are many policy mechanisms which can be used to facilitate the increased use of RETs in the parks. Policy options which park personnel believe to be most promising for facilitating the use of RETs include increased financial support such as funding and incentives, mandates, training and education, support from above, partnering with utilities serving the parks, and a program to sell excess electricity generated and use revenue for additional RET projects. These comments demonstrate that there exist many mechanisms which the NPS can use to encourage park personnel to use RETs in the parks.

6 Policy Implications

The experience with RETs in the parks has been overwhelmingly positive: the vast majority of respondents at parks with RETs have reported being pleased or very pleased with the technologies, and 96% reported that the intended objectives had been met by the RETs.

As discussed earlier, the increased use of RETs in the parks is desirable for many reasons including providing clean power to remote locations, public education, and long-term cost savings. However, this study demonstrates that there exist many significant barriers to the increased use of RETs in the parks—particularly those related to resource constraints, expertise, support from above, and the lack of interest in RETs by many park-level decision makers.

Park personnel have revealed many opportunities to overcome several of the central barriers; the avenues park personnel have taken provide direction towards policy interventions which can capitalize on and encourage these opportunities.

Some of the identified barriers have not been established as having been overcome by park personnel; these barriers including access to technology and inability to locate suppliers indicate the need for NPS intervention to facilitate the use of RETs where they are arguably most needed.

Many factors have been identified as being central to parks being able to implement RET projects; these barriers including support from above and energy cost savings reveal that there are additional opportunities to increase the use of RETS which can be taken advantage of through policy interventions.

Survey respondents have reveled that there are many policy options which would serve to increase the use of RETs in the parks, including funding mechanisms, education and assistance.

Collectively, the information provided by park personnel produces a clear picture of the policy mechanisms which are necessary to encourage and incentivize energy managers to increase the use of RETs in the parks. To overcome the central barriers, the NPS must not only *encourage* the use of RETs (as is the current situation), but must also provide the parks with the needed resources and assistance. Further, as it has been recognized that many park personnel have no desire to use RETs, use of the technologies—or the systematic consideration of their use—may need to be mandated in some cases to facilitate the use of RETs to the greatest potential.

Several recommendations for policy interventions follow; these mechanisms collectively will address all of the central barriers identified by park energy managers.

6.1 Develop and Strengthen Partnerships

Through examination of all of the identified barriers and approaches to overcome the most significant barriers, an overarching approach to increase the use of RETs is apparent: partnerships. Some of the major barriers to using RETs in the parks are financial issues, staff availability and expertise, conflicts with the historical resource context, visual quality concerns, support from above, and utility policy. As survey respondents have demonstrated, though, each of these barriers can be addressed in some way through agreements with outside partners.

It should be noted that in a previous study of RET use in the parks—*Renew the Parks* (NPS 1995)—partnerships were recommended to address the barriers of financial constraints and staff expertise. Partnerships with the DOE, NREL, Sandia National Labs, and utilities were recommended. Though it appears that this recommendation has been followed (successfully) in many cases, this study demonstrates that cost and expertise barriers have persisted to a great extent; further, comments of park personnel indicate that there are many additional opportunities for partnerships which will address even more of the identified barriers.

6.1.1 Utilities

As demonstrated earlier, many utilities present barriers to parks' interconnecting to the grid. Some utilities are receptive to the idea of RETs being connected to the grid, though, as the utility gains installed capacity. The energy production of solar PV systems also generally coincides with the peak demands for energy—during daytime hours—providing utilities with additional benefits. Therefore, utilities sometimes offer financial incentives to those pursuing the use of RETs (NPS 1995), which could address the barrier of initial cost.

Also, some utilities are willing to perform a line-extension analysis to remote locations to determine whether the costs of extending power lines to a location exceeds the costs of installing an RET system (NPS 1995); this service could also help overcome cost barriers. As noted earlier, in many cases the cost of RET systems is far less than that of extending power lines to a location.

By taking advantage of the opportunities already provided by utilities, the NPS can facilitate the use of RETs in parks. There may be additional opportunities for partnership between the NPS and utilities, though.

As demonstrated by the successful arrangement between the historic park and its utility, utilities may be willing to provide a site for RETs if a park is not an ideal location for historical or visual reasons. The arrangement between the historic park and the utility overcomes the barriers of historic resource conflicts and visual quality concerns while realizing the benefits of the use of RETs, including reduced emissions and reduced electricity bills. Public education potential could exist at the parks as well, if interpretation regarding the parks' use of renewable energy—including electricity cost savings and environmental benefits—were set up in popular areas in the park.

It is recommended that this type of arrangement be expanded to include numerous park-to-utility partnerships. As individual parks in the NPS are served by different utilities, the partnerships would need to be implemented by individual parks, or by groups of parks which are served by the same utility.

Often utilities present barriers to, rather than encourage, interconnecting to the grid. Therefore, in many cases the utility may need incentive to enter into such an arrangement. In return for utilities assisting the parks, perhaps the parks could acknowledge the utility in interpretive materials.

Partnering with utilities has the potential to provide many benefits to both parties, while overcoming the currently considerable barriers of initial cost, conflicts with historical resources, and visual quality concerns.

6.1.2 Federal Agencies

The Green Energy Parks Program partnership between the Department of Energy and the National Park Service has already been recognized here; it has resulted in the installation of many RETs in the parks since its beginning. The past performance of the partnership indicates that by combining their assets, Federal agencies can be successful in pursuing joint goals.

An obvious approach to increase the use of RETs in the parks would be to expand the GEPP partnership and to allocate more funding and resources to the program; this approach is encouraged, of course. However, there are additional opportunities for NPS to partner with other Federal agencies that have different assets which could be of use to the parks. These partnerships could be developed between the entire National Park Service and other agencies, as was the case with GEPP, or could be implemented by individual park units and adjacent units of other agencies.

For instance, a partnership with the Bureau of Land Management (BLM) could be instrumental to increasing the use of RETs in the parks, as the BLM generally has fewer land use restrictions than NPS lands. Where NPS lands and BLM lands are in close proximity to one another, these agencies could enter into partnerships similar to the park-utility arrangement mentioned earlier: RETs could be sited on BLM lands, but the park units or the NPS would own the systems and the electricity generated. Furthermore, this type of partnership could be developed between the NPS and any other Federal agency with fewer visual quality concerns. For instance, one survey respondent indicated that there might be an opportunity to locate an RET system on nearby Navy-owned land, while the park would own the energy generated.

As highlighted earlier, the EPACT renewable energy requirements for Federal agencies permit renewable energy generated on federal lands to receive double-credit towards filling the requirement. Therefore, this type of arrangement is more beneficial to the NPS than is the purchase of renewable energy from private green energy providers. Furthermore, the system is owned by the NPS, and so in time the initial cost of the system will be paid back, whereas when green energy is purchased, energy expenditures are a constant draw on parks' resources and budgets.

Perhaps other Federal agencies may not be inclined to pursue these partnerships with the NPS, though, and an incentive may be required to encourage the arrangements. In these cases perhaps the NPS could offer a portion of the renewable energy credits to the partner agency, to assist in fulfilling the other agency's EPACT goals.

6.1.3 Private Organizations

Another promising partnering opportunity is that between the agency and private organizations. Both the NPS and private companies could gain through such partnerships. To illustrate, in the past Ford has donated electric and hybrid electric vehicles to parks (Ford Escape, para.1-2; Ford Donates, para.1-2); in return for the generous contribution, Ford receives publicity both through press recognition and through brochures in the parks. Certainly, similar partnerships could be developed with renewable energy companies and energy service providers. Such partnerships could be developed between the entire NPS and a national or global company, or between park regions and a company. Some states and regions have more air quality problems than others and so public support for and recognition of RETs in these regions may be stronger. For instance, California has some of the worst air quality problems in the country and has some of the most stringent regulations and progressive policies to address air quality. In the partnership between Ford and the NPS, Ford donated electric vehicles to only California parks (Ford Donates, para.1). Partnerships between RET providers and the NPS may be similarly developed.

Here, private organizations would provide services, discounts or even equipment donations to parks, addressing the central barriers of funding and initial cost. In return, the park could acknowledge the company in interpretive materials discussing the RET(s), without explicitly endorsing the company, of course. Interpretive materials would include information about the park's annual savings from their utility bills, payback time and other pertinent information, potentially prompting visitors to acquire an RET system for use in their own home—perhaps from the partner company. This approach would also fulfill the education and enthusiasm component of the NPS' role in technology diffusion.

EPACT 2005 extended the authority for Energy Service Performance Contracts (ESPCs) between the government and private energy service providers (FEMP 2005 para.2). ESPCs allow for federal energy managers to upgrade buildings and install equipment at no cost to the government; in return, the company shares the government's cost energy cost savings over time until the end of the contract period. After that time, all savings accrue to the government.

This type of arrangement is beneficial to both partners over time—the energy service provider receives payment at least equal to the cost of the service and equipment, and the government avoids the initial cost of the systems and avoids energy costs. However, it should be noted that the initial cost of the RETs is simply transferred to the private partner, which inherently provides a disincentive for the private partner to engage in these partnerships. Therefore, the NPS should capitalize on the ability to provide incentive for the private company by acknowledging the company in interpretive materials, as discussed above.

6.1.4 Universities

The University-National Park Energy Partnership Program (UNPEPP) (http://www.energypartnerships.org/) began in 1997; UNPEPP partners faculty and students at universities with individual national parks to perform energy audits, install renewable energy systems, perform feasibility studies for renewable energy and alternative fuel use in the parks, and even providing training seminars for park personnel. UNPEPP projects in the PWR have included the design of solar thermal systems for Redwoods National Park, an energy audit of several buildings at Yosemite National Park, and most recently a project between the University of Washington and Haleakala National Park, which involved the design and analysis of solar PV systems at the park.

As mentioned earlier, UNPEPP assistance was acknowledged by one respondent when discussing factors assisting the parks in acquiring RETs. As with the other partnership opportunities discussed, university-national park partnerships provide benefits for both partners: students can apply their academic knowledge and gain practical experience, while parks are offered services at a minimal cost compared to professional services.

This partnership opportunity has the ability to overcome many of the identified barriers, including initial cost, funding, staff availability, staff expertise, and no access to the technology—as UNPEPP partners provide the technologies.

6.1.5 Park-to-Park "Big Brother" Partnerships

Lack of expertise and availability of personnel were identified as central barriers to RET acquisition; as recognized earlier several respondents felt that the staff expertise related to RETs was essentially non-existent. However, at the larger parks with experience dealing with the technologies, some of the staff are essentially experts on the installation and maintenance of RETs.

The earlier-highlighted arrangement between two parks presents a perfect example of such a partnership. Identical RET configurations will be installed in both of the parks in the near future. An employee of one park will visit the other park during their installation process; while at the park, the employee will learn about installation, operations, and maintenance of the system. The employee will then return to his park with the newly-acquired knowledge to assist with the installation.

This type of partnership could be expanded to include many parks; likely, the program would be best implemented within a state or smaller region to conserve costs and to take advantage of similarities in policies and climates in the regions. Larger, more experienced "big brother" parks in a region could partner with smaller parks with comparatively less expertise. Personnel from the experienced parks could travel to less experienced parks to assist with installation and to train personnel, or personnel from less experienced parks could travel to the larger parks to learn about their current systems and to learn from the park experts. This "big brother" program would address the central barriers of staff availability and knowledge and expertise, and has the potential to distribute expertise and the use of RETs throughout the NPS.

According to the *epidemic* technology diffusion model, the rate of technology diffusion is dependent on the number of non-users who are exposed to enthusiastic current users. For the epidemic model to function properly, another preferred element is the exchange of knowledge related to operation of the technologies (Geroski, 2000). According to the principles of the epidemic model, the park-to-park partnerships could have a significant role in facilitating technology diffusion among park units, as non-users are increasingly exposed to current, knowledgeable and enthusiastic users of RETs. Partnerships in general certainly have the ability to address many barriers to RET use in the parks. However, there are also many other policy interventions that the NPS management can use to address specific barriers and increase the use of RETs.

6.2 Funding and Initial Cost

Funding and initial cost were identified as being the most critical barriers to RET acquisition; not only were the barriers rated as being of the most importance overall, but it was also demonstrated that parks with more funding and alternative streams of revenue were more likely to have acquired RETs. Finally, funding and initial cost were identified as a central barrier to those who had unsuccessfully attempted to acquire RETs. Clearly, any policy interventions to address these barriers will facilitate the increased use of renewable energy in the national parks.

6.2.1 Incentives and Financial Assistance

There are no real incentives for parks to use RETs at present; a disincentive of sorts actually exists because the acquisition of RETs requires more work from park personnel. When it comes to moving away from the status quo, a lack of incentives is effectively a disincentive. The parks that are taking the initiative to use RETs are doing so out of a sense of responsibility to the public good; the benefits which accrue to the parks are not equal to the costs of the systems to the parks. As one respondent observed, if money is taken out of the park budget to acquire RETs, they have to let other things go.

Many survey respondents said that financial incentives or funding—rather than "encouragement" from above—would make them more inclined to use RETs; indeed, "policy without funding is just conversation".

A solution is evident, though difficult: more funding should be provided for RET projects. The NPS has far from an unlimited budget, though. Over last two decades, the NPS real budget has decreased by 25 percent while visitation has increased by 50 percent, and park acreage has increased by 166 percent (Competitive Sourcing Effort 2003, p. 47). Therefore, a clear solution for the increased the use of RETs in the parks is the allocation of more funding to the NPS by Congress. Unless Congress allocates more funds to the NPS, alternative sources of funding must be established.

Last year, the NPS spent nearly 29 million dollars on facilities' energy costs (does not include vehicles), over 20 million of which was spent on electricity. Approximately 2% of park budgets are spent on energy costs related to facilities. Using a back-of-the-envelope calculation, the average annual facilities energy expenditures at PWR parks is found to range from $3,500 to over $280,000. Though 2% of a park's budget does not initially seem to be significant, since ninety-five percent of park budgets are spent on salary and benefits, energy expenditures make up approximately 40% of parks' discretionary budgets (Steve Butterworth, Personal Communication). Furthermore, the documented energy expenditures do not fully account for all of the energy expenditures in the parks. The NPS does not quantitatively track the energy consumption of the concessionaires housed in the parks' facilities; unfortunately the NPS does pay for the concessionaires' energy consumption, though. The real energy costs for the parks are much higher then, as concessionaries operate 24 hours a day while park facilities are only open for 8 to 10 hours (Steve Butterworth, Personal Communication).

Even so, energy expenditures are a relatively small portion of the NPS's entire budget. Therefore even doubling park energy budgets would have a minimal impact on the total NPS operating budget. In distinction to other outlays of funding for energy consumption, funding allocated towards RETs has the potential to be paid back over time. That is, this past year the NPS paid nearly thirty million dollars for facilities' energy, twenty million of which was for electricity. The expenditures on fuel and electricity are costs which can never be recovered; the energy has been purchased and consumed. However, if the same amount of funding were made available for purchase of RETs, on average every two years there would be $150,000 for each park in the NPS, enough to purchase a 15 kW solar PV system which is larger than needed to power an average visitor center (Solar Module Price Environment, para.1-14; Personal Communication, Steve Butterworth and Otto Van Geet of National Renewable Energy Laboratory). These expenditures towards RETs would not be continual outlays, but rather would pay back the NPS (and taxpayers) over time by offsetting electricity and fuel costs.

Even though the portion of the NPS budget allocated for energy expenses is small in comparison to employee expenditures, it is a major portion of the remaining discretionary budget for parks. Therefore, if Congress does not allocate more funds to the NPS, increasing the energy budget significantly would either require taking funds from other areas of the budget (such as maintenance), or would require that parks find alternative sources of revenue.

One option to generate necessary funds would be the program that was mentioned by one survey respondent—sale of the excess electricity generated by the existing NPS-owned systems. This type of program would not only provide funding necessary to acquire new RETs for the parks, but would also allow for a shorter payback time for RETs and a better return on taxpayers' investments. Such a program could be implemented on a state-by-state or regional basis, as individual states have dissimilar interconnection standards and net metering policies. The revenue could be shared with all of the parks in the region according to a formula, or parks could compete for funds according to the feasibility and appeal of their project proposals.

Another option to finance systems will simultaneously create an incentive to use RETs and a disincentive against conventional energy use: a "tax" for the parks. A tax system could be implemented by the entire NPS or on a regional level. Parks annually submit energy reports that include fuel use, electricity used and generated, carbon emissions resulting from energy use, renewable electricity use, and fuels and conventional and alternative fuel use. The information from these reports could be used to incentivize park energy managers to use RETs and undertake energy-efficiency projects, if the parks' emissions were "taxed" according to a formula that distinguishes between parks according to size, visitation, vehicles, required energy use, etc. The funds generated from the emissions tax could then be used to finance renewable energy and energy efficiency projects in the parks. Additionally, parks that are below a given threshold in emissions and energy use could be rewarded with the tax revenue; the funds could be used for projects at the parks discretion.

This type of program would allow parks who are currently taking the initiative to use RETs to benefit from their actions, while discouraging the use of conventional energy and wasting energy.

6.2.2 Life-cycle Cost Analysis

The initial cost of RETs is a well-recognized barrier to their use, even though in many cases the technologies are less expensive in the long term. As many respondents have demonstrated, RETs can be much more cost-effective than conventional energy technologies; this information has been acquired through life-cycle cost analysis of alternative technologies.

In a previous study of use of RETs in the parks, life-cycle costing was discussed as an option to overcome the barrier of initial cost; here it was discussed that the external costs of electricity generation (emissions costs) should be taken into account in all development decisions (NPS 1995). However, life-cycle costing is not always used by park personnel, particularly if they have already decided which technologies they wish to acquire (Personal Communication, Steve Butterworth, July 2005).

By truly requiring that parks perform a life-cycle cost analysis of energy options, the NPS can be guaranteed that energy is being obtained at the least cost. A mandate for life-cycle cost analysis would be implemented by the entire NPS to account for differences in attitudes and support for RETs among park units and among regions. Situations where mandates for life-cycle costing would be most appropriate include:

energy being provided to a new area in the park; parks where electricity costs are currently higher than a given threshold (i.e. 20 cents per kWh); and, of course, parks where diesel generators are being used a primary power source. In light of increasing fuel and energy costs, this requirement will continue to save the NPS more and more over time.

To further level the playing field between conventional and renewable energy, the NPS can mandate that *all* of the important costs and benefits of both forms of energy use be taken into account. As Geller (2003) and Brown (2001) have observed, one of the greatest barriers to RET use is the failure for the externalities of the technologies to be taken into account. If the NPS were to monetize aspects of the energy which were deemed to be of importance to the parks (i.e. impact on air quality, public education potential), the use of RETs in the parks is certain to increase.

By requiring that the life-cycle cost of energy options be considered, the considerable barriers of initial cost and funding can be addressed, as the lower long-term costs of the technologies will become more apparent. As an additional benefit, the barrier of staff knowledge may be addressed as energy managers will be educated about the comparative benefits of RETs during the analysis.

6.2.3 New Buildings/Capital Improvement Projects

As noted above, one option to increase the use of RETs is to require life-cycle cost analysis for RETs compared to other energy options. This option is particularly suited for new buildings and capital improvement projects, as there are additional benefits to incorporating RETs into new facilities, above those of cost savings.

Mandating the evaluation of RETs as energy options for new buildings and capital improvement projects would be implemented by the entire NPS to account for differences in attitudes and levels of encouragement for RETs in different regions and individual parks.

By requiring that new buildings and facilities and capital improvement projects consider RETs as an energy production option, RETs can be obtained at the least expensive phase in the facilities' existence. Furthermore, many buildings in the NPS are placed on the historic register many years after the park has been established. For instance, one park contact mentioned that a visitor center from the mid-twentieth century was about to be placed on the historic register at the park. If RETs are integrated into the initial design and improvement of buildings and facilities, then a building being placed on the historic register will no longer be an impediment for RET use. Finally, integrating RETs into new buildings and improvement projects will address the visual quality concerns related to RETs, as the systems will be a part of the building design rather than detracting from it.

Unfortunately, the current NPS construction budgetary process is not providing required funds to incorporate RETs into new facilities; allowing RETs is the exception, rather than the norm (Personal Communication, Steve Butterworth, September 2005). Perhaps by acknowledging the benefits and decreased costs resulting from incorporating RETs into new buildings, the allocation of funds for these projects can be encouraged.

6.2.4 Fee Collection Revenue

Survey respondents have indicated that the use of fee collection revenue for discretionary projects allowed them to obtain RETs, and as earlier analysis demonstrated, fee-collection parks are far more likely to have acquired RETs. These results indicate that by providing parks with an alternative source of funding such as fee collection revenue, the use of RETs can be facilitated. Furthermore, it is likely that an alternative funding stream will also allow parks to pursue other sustainable technologies such as energy efficient equipment.

Conceivably the NPS could expand the fee collection program to include all parks. Another option would be for the NPS to increase the amount of revenue sharing among the parks, so that those parks without fee collection programs could also be provided with an additional discretionary funding source. This policy option would address the barriers of initial cost and funding, while presumably facilitating the use of the most appropriate technologies for each specific park, as the park-level decision makers would have discretion in determining which projects to fund.

6.2.5 Outside Funding

Many respondents indicated that outside funding was instrumental in allowing them to overcome the barriers of funding and initial cost and to realize RET projects in the parks.

Though there is little that the NPS can do to ensure that specific park projects will obtain funding from outside sources, the NPS can work to educate park personnel about the funding opportunities provided by BPA and DOE, and to educate and assist park personnel in the process of pursuing funding.

For instance, DOE's Federal Energy Management Program (FEMP) prioritizes projects with a clear project implementation plan (FEMP 2005b, para.4); park energy managers may need assistance in developing clear, realistic plans for their projects.

Parks which have never implemented an RET project in the past may particularly need assistance in this regard.

FEMP uses competitive ranking to determine which projects will be given assistance; projects are ranked according to energy savings potential, public education and ability to be replicated (FEMP 2005a, para.1-4). Presumably these rankings can result in smaller parks' projects being ignored in favor of larger parks. Therefore, the FEMP approach may not be appropriate for promotion of RETs in smaller parks. Providing parks with assistance related to grant applications and project implementation plans may facilitate parks in obtaining funding from elsewhere, however.

Another option for the NPS to increase the availability of outside funding is to actively recruit financers. As observed earlier, partnerships with private organizations can provide many benefits to both partners. If the NPS were to exchange funding for RET projects with gratitude in interpretive materials, the funding available for RETs and other sustainable technologies may be increased substantially.

By assisting parks in obtaining outside funding, the NPS can address the barriers of funding and initial cost at the least cost to the agency. Additionally, the barriers of staff knowledge and expertise and staff availability will be addressed by providing assistance as will, of course, support from above.

6.3 Staff Knowledge & Expertise

One of the strongest identified barriers to using RETs is knowledge and expertise of personnel. Indeed, parks with many FTEs—and therefore more highly specialized FTEs—were far more likely to have acquired RETs. Training and education programs could address this barrier and also many of the most significant challenges preventing parks from using RET systems, including cost and funding, visual quality concerns, and staff uncertainty with the technologies.

6.3.1 Outside Training and Education

Outside experts from private and government organizations could be brought into parks to teach personnel about installation and maintenance requirements of RETs. This recommendation was provided in a previous study of RET use in the parks (NPS 1995); however it appears that the recommendation has not been abided by to the fullest extent, seeing as many respondents expressed concern about lacking expertise, and some even demonstrated a lack of awareness of currently available programs. NPS authorities could establish a program to bring in outside experts, or regional authorities could establish such a program, to account for similarities in the region related to political climate and renewable resource availability.

The Federal Energy Management Program (FEMP) offers many training programs and services. Training curricula include financing of RET projects, and technical programs focused on specialized areas, including integrating RETs into the design of buildings and implementing renewable energy projects (FEMP 2006c, para.1-10); clearly these programs could address issues of visual quality concerns and the need for assistance, as well.

FEMP also offers technical and design assistance for projects, with a focus on new technologies, novel applications, or innovative implementation, rather than providing assistance for routine projects. FEMP does not have unlimited resources, and thus uses competitive ranking to determine which projects will be given assistance; projects are ranked according to energy savings potential, public education and ability to be replicated (FEMP 2006a, para.1-4). Presumably these rankings result in projects in smaller parks to "losing" to larger parks' projects, which would contribute to the explanation of larger, more popular parks being more likely to own RETs. Additional assistance may be required for parks with fewer resources, less energy use, and lower visitation.

Furthermore, though FEMP offers many forms of training, education, many park contacts were apparently unaware of these opportunities, or unaware of how to access them. Earlier-mentioned comments highlight this: "*There may be knowledge in other agencies—DOI, DOE, etc. They probably have the expertise but we haven't tapped into their resources…we have a lack of capacity on staff…there is not a good familiarity of the opportunities that may exist…we don't have somebody who is devoted to access the technology"*; *"We just don't know how to do it all. I mean, it's not like they go around and have workshops*". Respondents even indicated that they were unaware of how to begin a project or that they received no assistance until they had developed a complete project proposal.

Although many training programs and opportunities are available in the Federal government, these programs have not been entirely successful in educating park personnel, as is demonstrated by the relative importance of staff knowledge and expertise by survey respondents.

6.3.2 NPS Training and Education

In order to encourage RETs, then, it is imperative that the NPS establish its own program to train and educate park employees. To educate park personnel about currently available options, the NPS can play a key role in educating park personnel in how to access FEMP's programs, how to develop project implementation plans, how to proceed with projects if obtaining FEMP assistance is not feasible, and how to obtain expertise from elsewhere.

The NPS can set up its own training and education program related to technical training, but also to the benefits of RETs. As noted earlier, a program could be developed where already 'expert' park personnel could be brought into other parks to teach about project implementation and to provide technical assistance. This type of program could overcome the barriers of staff availability and staff expertise at a minimal cost to the agency, as the people providing the training are already on NPS payroll. Furthermore, park personnel have an understanding of NPS-specific issues that outside experts are lacking.

6.4 Visual Quality Concerns

Visual quality concerns were identified as being one of the most important barriers to use of RETs in the parks. Parks with more land area were far more likely to have acquired RETs, which demonstrates that the ability to hide RETs and mitigate their visual impacts may facilitate use of the technologies.

In a previous study of RET use in the parks (NPS 1995), visual quality concerns were identified as a major barrier to their use. The authors of that report recommended mitigating the visual impacts by: incorporating RETs into the design of buildings; remotely locating systems; and, taking advantage of visual impacts by viewing the impact as public education potential. Though these recommendations have been followed by some of the parks—as is demonstrated by the comments related to overcoming barriers—the issue of visual quality concerns remains as being one of the most central barriers.

As mentioned earlier, park personnel should not only be trained about the social and technical aspects of RETs, but also about the opportunities for mitigating the visual impacts. As noted by Tsoutsos, Frantzeskaki, Gekas (2005), the issue of visual impacts of solar technologies on buildings has changed. Where in the past, designers attempted to hide the systems and the fact that they were different that the rest of the building, now architects are using the solar elements to enhance designs of buildings. The systems are highlighted in designs to showcase the fact that the building is using renewable energy; this is important for national parks which are working to educate the public.

Additionally, there are newer concealable technologies such as PV roof shingles, which are virtually undetectable. The use of these technologies would not only address issues of visual quality concerns, but if interpretive materials were provided it would help fulfill the NPS' role in education and technology diffusion, as most people are unaware of these technologies. In fact, one survey respondent mentioned that PV shingles would be ideal for use in the park, but that they were too expensive. By entering into the above-mentioned partnerships, however, the expense of the technologies may not be such an issue.

Finally, partnerships between the NPS, other Federal agencies, and/or utilities—where RETs are located outside NPS lands but interpretation materials are retained—

would also address visual quality concerns in the parks while increasing their use of renewable energy.

6.5 Conflicts with the Historical Resource Context

Conflict with the historic resource context was identified as being one of the most significant barriers to using RETs in the parks. Indeed, historic parks are far less likely to have acquired RETs for use in the parks.

According to the survey respondents' comments, most of the historic resource barriers are related to rules and regulations. Of course, in most cases there is good reason for the historic rules, particularly in light of the requirement that the parks *'conserve the scenery and the…historic objects…therein'* (U.S.C. 16). However, according to some of the park energy managers, there seem to be instances where the rules are excessive or there is a double standard of sorts. One respondent highlighted the apparent dichotomy of the rules related to historic preservation when mentioning that large pole-mounted transformers were allowed by historic rules, but solar PV systems were not.

Perhaps rules regarding historical preservation could be examined to determine whether there is opportunity for allowing RETs in certain cases, particularly in cases where other types of energy equipment are allowed. If opportunities for exemptions are identified, the NPS could work with the Advisory Council on Historic Preservation, and with other stakeholders, to determine whether rules can be shaped to accommodate the parks' energy requirements.

6.6 Insufficient Payback

Insufficient payback was identified as being a more significant barrier to those who had unsuccessfully attempted to acquire RETs; respondents' comments indicated that issues of insufficient payback were related to decision-makers above rather than park-level perceptions of appropriate payback times.

One option to address the barrier of insufficient payback is to extend the acceptable payback time for an RET system. The policy would most suitably be implemented at the agency level, to allow for equity in agency-wide competition for funding among regions and states. The distinction of the national parks compared to private organizations and even many Federal government facilities is that the parks are here to stay: the NPS has a mission of maintaining them for the enjoyment of *future generations.* Therefore, by extending the acceptable payback time of RETs, the lifetime benefits of the systems will be realized. By incorporating the externalities of energy generation into calculating returns-on-investment, the payback time of RETs will be decreased further.

Though insufficient payback was not identified as a major barrier to the use of RETs, it has been more of an issue to those who have unsuccessfully attempted to use RETs. By extending the allowable payback time of RETs and incorporating the entire costs of energy generation, not only will the barrier of insufficient payback be addressed, but the barriers of initial cost and funding will be addressed to an extent as well.

6.7 Park-level Uncertainty / Disinterest

Several park contacts indicated that the leadership and management at a particular park had an instrumental role in using RETs or in discouraging their use; several respondents mentioned that the RETs were used in the park not because of people in positions of leadership, but because of "champions" for the cause. In contrast several respondents themselves showed a disinterest in RETs. In many cases it is not necessarily NPS policy or PWR policy determining the use of RETs systems, but rather it is the priorities and goals of the park-level decision makers.

6.7.1 Mandates

Respondents have indicated that decision makers in their own and in other parks are not supportive of the technologies, and that attitudes of park level decision makers are a central barrier to use of RETs. Therefore, in order for the NPS to realize the greatest extent of RET use, mandates for the use of RETs may be required. In fact, many of the survey respondents indicated that only mandates would coerce them or others to pursue RETs for use in the parks.

In most cases, feasible policy options to facilitate technology diffusion do not include mandates. However the NPS, being a federal agency, has the unique position of being able to mandate the use of RETs, particularly given that Congress has required the use of renewable energy by Federal agencies under EPACT. The NPS could establish agency-wide mandates for the use of RETs by individual parks; however, as the availability of renewable resources among the parks is certainly not uniform, equal requirements for use of RETs would be inequitable among regions and states. Therefore the NPS could require more use of RETs in regions where it is likely to be more cost-effective (such as the Pacific West Region), or could allow RET credit trading, where parks that have exceeded their RET quotas could "sell" their RET credits to parks that have not met the quota, thereby balancing out any park-level budget inequities among the parks.

There are several potential avenues which can be used to mandate the use of RETs in the NPS. As mentioned earlier, parks could be mandated to perform life-cycle cost analysis of alternative energy options in many situations; this option would guarantee that RETs would be used in the most cost-effective applications. Similarly, parks could be required to incorporate RETs in to the design of new buildings or into capital improvement projects, which would result in the implementation of the most cost-effective projects.

Another potential avenue for mandates would be to require that a specified percentage of the energy consumed at each park be generated from renewable resources; the percentage could be equal or greater to the percentage required by EPACT 2005.

Finally, parks could be required to place RETs near or on specific types of facilities—such as non-historic visitor centers—with the intent of maximizing the potential educational benefits of RETs.

6.8 Access to Technology

As acknowledged earlier, the barriers of access to technology and inability to locate suppliers appear to have been insurmountable thus far, as none of the parks who rated this barrier as being of great importance had acquired RETs. Seeing as the parks with no access to RETs and suppliers are also remote parks and parks with extremely high electricity costs, addressing this barrier would facilitate the cost-effective use of RETs in the parks.

Obviously the NPS does not have the capability to make suppliers available to remote parks; however, the NPS can provide the technologies to the parks. Conceivably the NPS could start a program where many RET systems are purchased in bulk, and distributed to remote parks with high energy costs. The program could be implemented on a national or regional level. The funds for such a program could be generated through the earlier-mentioned programs such as the emissions tax or through the sale of excess electricity generation.

6.9 Support from Above

Support from above was identified as being a significant barrier to respondents who had unsuccessfully attempted to obtain RETs, and was identified as being an issue through evaluation of respondents' comments. Clearly, any of the policy interventions suggested here would provide additional support to the parks in their pursuit of RET projects.

However, it should be noted that many of the parks who have obtained RETs recognized support from the PWR Regional Office as being instrumental in being able to acquire the systems. According to respondents, the office has: provided assistance in acquiring funding from outside the NPS; made NPS funding available for projects; initiated projects; provided technical assistance; provided knowledge and expertise, and even provided moral support and encouragement. The respondents' insights demonstrate the importance of the office in the realization of existing RET projects, many of which apparently would not have been established without support from the PWR office.

Many of the policy recommendations offered here would address the identified barriers to RETs; however the PWR office has the power to address many barriers as well. The regional energy leaders do not have explicit authority to undertake many necessary actions; they are energy *coordinators* rather than managers or directors. The regional offices have a greater understanding of region-specific issues such as climate and state-level energy policies which could encourage or inhibit the use of RETs in the parks. Therefore in order to provide the support that park energy managers feel is necessary to achieve their sustainable energy goals, in addition to providing more funding for RET projects in the NPS in general, additional funding and authority should be provided to the NPS regional offices.

Federal Government Implications

EPACT 2005 requires that a specified portion of the energy consumed by Federal agencies be renewable; renewable energy generated and consumed on federal lands receives double credit towards fulfilling the percentage requirements. EPACT requires the use of renewable energy to meet these requirements to the extent economically and technically feasible.

As this study has demonstrated, though, the foremost barriers to acquisition of RETs are economic—funding and initial cost. These barriers are of more concern for initial acquisition of RETs than they are for the purchase of green energy from private energy providers. However, over time the cost of purchasing renewable energy from outside sources will end up being more expensive for the government in most cases.

The implications here are that in order to fulfill the EPACT goals of increased renewable energy use by the federal government in the most appropriate manner, perhaps economic exemptions from the requirements should not be allowed.

To illustrate the potential failure of exemptions for mandates, the 1992 Energy Policy Act required that a specified percentage of vehicles purchased by federal agencies be alternative fuel vehicles. The act required only that federal fleets use alternative fuels in the vehicles to the “maximum extent practicable” (Section 304) rather than explicitly requiring their use (many alternative fueled vehicles are bi- or dual-fuel vehicles which can run on both conventional fuels and alternative fuels). As a result, the government owns countless alternative fuel vehicles, a small portion of which regularly use alternative fuels; Section 701 of the recent Energy Policy Act sought to address this issue by requiring that all dual- and bi-fuel vehicles actually use alternative fuel unless they qualify for a waiver (2005).

Therefore, this study’s findings imply that the Federal government’s goal of increasing the market for RETs through mandates may not be achieved if exemptions are allowed if projects are economically unfeasible. Perhaps in order to initially stimulate the market through Federal acquisition of the technologies, the purchase of renewable energy and/or RETs should be required without exception, and funds should be allocated to cover the incremental costs of the technologies/electricity.

Conclusion

The National Park Service has what is essentially a mandate and mission of sustainability, which implies the use of the most sustainable and environmentally benign energy sources. The current experience with RETs in the parks has been overwhelmingly positive. Unfortunately, there exist several barriers to using RETs, most importantly lack of funding, initial cost, staff availability and expertise, visual quality concerns and conflicts with the historical resource context of parks, attitudes of park-level decision makers, and support from above.

Survey respondents have demonstrated that many of the barriers can be overcome, though; they have also demonstrated that there are many driving factors which can assist in realization of RET projects. In order to facilitate the increased use of RETs in the NPS should capitalize on these available opportunities. The NPS should also proactively promote the use of RETs through policy interventions including providing funding, assistance, and training to park personnel, and entering into partnerships with other organizations to provide necessary assets that the NPS may be lacking. Also, current rules and funding procedures may require reexamination to address the many concerns of survey respondents.

This thesis demonstrates that financial, expertise, and visual issues are the foremost barriers to use of RETs in the PWR parks. While this thesis examined the concerns of a specific population in the NPS, many of the results are likely generalizable to the entire NPS population. The validation portion of the thesis analyzed attributes of parks which are relevant to all of the NPS parks, not just PWR parks. Issues of park-level funding, employee expertise and availability, historic rules, and park size vary considerably throughout the NPS, not simply in the PWR region. Furthermore, the thesis identified that park-level decision makers have extremely divergent attitudes related to RETs. The findings can also likely be generalized to the entire National Park System. Therefore, many of the findings and policy implications care likely applicable for the NPS as a whole, not simply on a regional basis.

Many of the findings are likely applicable to other federal agencies as well. For instance, common themes identified here are financial constraints and staffing limitations. Acknowledging the established body of literature related to barriers to RETs, financial issues and knowledge and education have been identified to a great extent in many sectors and regions of the world. The predominance of financial and expertise concerns demonstrate that units of the federal government are faced with the same barriers to RET use as are private companies and citizens. Implied here is that to increase the use of RETs, the federal government must address the barriers rather than create exemptions for them, as is the case with EPACT 2005.

This thesis also identified the hierarchical organizational structure (i.e. *support from above*) as posing barriers to use of RETs. Organizational impediments to RETs and energy-efficient equipment have been identified in studies of bureaucratic organizations, both public and private, though I did not encounter any such studies of the United States federal government. This thesis has reinforced earlier studies' findings, and suggests that perhaps the federal government may have more success pursuing RETs if ground-level employees were given more leeway and discretion in deciding to purchase RETs.

The research also has implications for the general public, as well. Though the barriers identified represented the concerns of a very specific population, many of the concerns have been identified throughout the literature. Therefore many of the strategies to overcome the barriers may be applicable to private consumers. For instance, applicable strategies to overcome the barriers include performing a life-cycle cost analysis to determine whether RETs are more cost-effective than conventional energy use, or providing training programs to educate consumers about operation and maintenance and benefits of RETs.

This thesis indicates that visual quality concerns, though particularly relevant to national parks, may also be of more significance than previous research has indicated. Respondents, rather than expressing concern about visual quality concerns in a national park specifically, made comments that could be of concern for any consumer (i.e. "some of it looks like crap" and "…We have visual quality concerns for our neighbors"). The results indicate that perhaps some of the approaches taken by the parks to overcome the visual quality barrier may also facilitate the increased use of RETs by the general public. For instance, having the ability to locate RETs in neighborhood power parks or unusable local areas such as brown fields might increase consumers' inclination to purchase RETs.

Though this research has identified many barriers to RETs, many of which may be applicable to the entire NPS, to the federal government, and even to the general public, there are limitations to the research and its implications.

First, the comparative significance of all of the identified barriers cannot be generalized to the entire NPS population. For instance adverse climate, though a minimal issue in most PWR parks, may be of considerably more importance in other NPS regions where renewable energy resources may not be as highly available. Access to technology, suppliers and contractors may be of more concern in other regions as well, depending on the development of RETs' infrastructure elsewhere. Support from above may be of differing importance in other NPS regions as well. The PWR respondents' indicated that support from above was an issue at the agency level, and at the park management level. However many respondents mentioned that support from the PWR office was instrumental in helping them obtain their RET systems, and the regional energy coordinator in the PWR was frequently identified as being a "champion" for RETs. Conceivably issues related to support from above may be of more importance in other regions if the regional energy coordinators do not provide as much assistance.

The generalizability of the results to the entire federal government is limited as well, as the NPS is distinct from other federal agencies in many respects. For instance, the NPS is highly decentralized and decision makers at the park unit level have a considerable amount of discretion. Also, many national parks are located in remote areas, whereas many other federal facilities are located in highly populated cities. National parks house stand-alone facilities, while many other federal offices are located within office buildings. Finally, the NPS has the mandate to conserve the scenery and resources within the parks, while other federal agencies have no such requirement. As these distinctions illustrate, the issues of concern in the NPS may be quite different than those which may be important to other federal energy managers. Therefore, though this research has demonstrated that cost and staffing issues are of major concern within the federal government, all of the findings are not necessarily applicable to other agencies.

The majority of the results are also not applicable to the general populace. Though many of the barriers identified have also been identified in the literature pertaining to the general public and are therefore applicable, the relevance of many of the findings do not have universal implications. For instance, this thesis identified strategies to overcome many of the barriers by exploring previously successful approaches among the population. Many of the strategies may be applicable to the general public (i.e. mitigating visual impacts, training and education, financial incentives, etc). However, many of the strategies are entirely irrelevant to the general populace. The average citizen, in all likelihood cannot enter into partnerships with utilities, other federal agencies, or private companies. An average citizen certainly cannot produce an alternative source of revenue to finance RET projects by collecting fees. And certainly most consumers do not own enough land to locate a RETs away from visible facilities (i.e. their homes).

Therefore many of the findings and policy implications are appropriate only for the examined population, the United States National Parks. The distinction between the NPS and other potential markets for RETs highlights that the NPS has many unique opportunities for policy avenues with which to facilitate the use of RETs, which are not available to other potential consumers.

This research has identified many possible policy interventions to address the recognized barriers to RET implementation. By targeting a specific population and identifying approaches to overcome what are perceived to be the strongest barriers to RETs by the population, and by asking members of the population what policies they believed would make them more inclined to use RETs, unique and distinctive policy interventions were revealed. Therefore, the methodology employed here has implications for future research. In the future, perhaps a similar methodology could be used to identify strategies to overcome barriers and potential policy interventions for a more generalizable population, such as a random sample of United States residential or commercial consumers. In the future, perhaps researchers could ask in more detail what interventions might make a person more inclined to use RETs. For instance, respondents could be asked the minimum amount of financial incentive that would encourage them to actually purchase as RET system, or the type and length of training program that they would be comfortable attending. Many previously enacted policies to encourage RETs have been unsuccessful, likely because in most cases the targeted population has little to no input into the policy formulation. Instead, policies are formulated using cost-benefit analysis, forecasting, or any of an almost limitless array of policy analysis methods, which take into account the potential impacts of policy interventions.

The distinction between conventional means of policy formulation and aspects of this methodology highlights one final limitation of this research, and the need for further research. Though many policy instruments have been identified here, the feasibility of the interventions and their potential impacts have not been studied. Therefore, further research is recommended to identify which policy interventions have the most potential for success at the least cost to the NPS and taxpayers.

This research has identified numerous policy options to encourage the use of RETs in national parks by addressing identified barriers to RETs' use. The use of RETs in the parks would certainly help the NPS fulfill its mandates of resource conservation and environmental sustainability, by decreasing air pollution within and outside parks' borders. Perhaps even more importantly, the use of RETs will help the NPS fulfill its mission of public education. The National Park Service, through fulfilling its objective of public education and by employing already established interpretation avenues, can have an important role in the diffusion of renewable energy technologies and is uniquely suited to take on this role.

To illustrate the potential widespread impacts of RET use in the parks, when discussing the use of a photovoltaic system in his park, one respondent said, *"… It is a great educational tool… We receive a lot of questions… People ask about how to put one in their own house".* The epidemic model of technology diffusion requires that non-users of a technology interact with enthusiastic, knowledgeable current users. Nearly three hundred million people visited the United States National Parks in 2004. How many people went home knowing the advantages of renewable energy and "how to put one in their own house"? How many will know next year?

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Appendix A: Sample Survey/Interview

1. Are there currently any renewable energy systems in your park?—this would include solar photovoltaic, solar water or solar thermal, wind, small hydropower, geothermal and hydrogen fuel cells.
2. How many systems?
3. What is the size of the system(s) in watts or kilowatts? What is the system's annual power generation? Is the system grid-connected?
4. For what is the system used?—for example facility power, communications, water pumping, etc.
5. What would you say your experience with the system(s) has been?—has the system not been used, have you been very disappointed, disappointed, satisfied, pleased, or very pleased?
6. Overall, has the system met your intended objectives?
7. Have you attempted to obtain a renewable energy system for use at the park but were unable to?
8. What are some of the challenges or barriers that are preventing or inhibiting the use of renewable energy systems in your park? I will read you a list of potential barriers. Please rate each of the barriers from 0 – 5, with 0 being a non-issue at your park, and 5 being one of the strongest or most important barriers.

Barrier	No State Net Metering Policy
Initial cost	Other Policy / regulations
Insufficient payback	Support from above/ external support
Funding	Lack of familiarity by designers
Inadequate design	Lack of familiarity by operating
Insufficient technology	Uncertainty with performance record
Availability of personnel	Procurement restrictions/Problems
Expertise of personnel	Conflicts with historical resource context
Park size	Visual quality concerns
Maintenance requirements of system	Inability to locate suppliers/contractors
No access to technology	Adverse Climate
Utility Policy	Other :

9. (If park has RE systems): How did you overcome the strongest barriers to obtain the systems you have now?
10. Were there any specific factors that particularly helped you in being able to obtain the systems in your park?
11. Finally can you think of any policy changes that would make you more inclined to use renewable energy systems, or would make it easier for you to do so?
12. Any other comments?

Appendix B: Definitions of Barriers

- *Initial Cost* refers to the high, perhaps prohibitive, initial investment required to purchase RETs. While over time continual electricity costs can be extremely expensive—indeed, in many cases more expensive than RETs on a life-cycle cost basis—there is more room in park budgets for lesser energy expenses over time than there is for one-time, substantial payments.

- *Insufficient payback* refers to the time required for the energy production of the RET systems to pay off the initial investment. System size and location, resource availability, energy prices, and energy use at the site all factor into the duration of time required for a system to payback the initial investment. If the time period required for payback is too lengthy—for instance fifty years—RET systems are less feasible as an energy option.

- *Funding* refers to parks inability to acquire funding for the RET systems from the NPS or outside party. Lack of financing is essentially a universal barrier to RET use, as RETs high upfront costs and lengthy payback times discourage investment in the technologies. Lenders are frequently reluctant to finance RET projects due to small project size and unfamiliarity with the technology (Geller, 2003. p. 42). The same types of concerns may be present with outside parties or internal NPS parties agreeing to fund RET projects.

- *Knowledge and expertise of personnel* refers to the knowledge and expertise of park staff being inadequate for location, acquisition, installation, maintenance, or operation of RET systems. As noted in Geller (2003), insufficient knowledge of consumers can present significant barriers to use of RETs because consumers may be unaware of the technologies, of the availability in the area, or even of RETs' benefits. Obtaining the necessary information requires considerable time and resources (Geller 2003). Moreover, in the parks, additional knowledge and expertise are required. Not only do park personnel need to be knowledgeable about locating and acquiring systems, but personnel will primarily be responsible for operations and maintenance as well, so knowledge is required in these areas. Though a park may have many people on staff with ample time for attending operation and maintenance of RETs, personnel may not be adequately trained or educated as how to do so. Staff at some parks may not be educated regarding the benefits of RETs or how to locate, purchase, acquire, and install RET systems. Without this information, park personnel are not likely to pursue RET projects, let alone be successful in obtaining, using, and maintaining the systems.

- *Availability of personnel* refers to staff constraints which result in limited availability of staff for acquisition, installation, maintenance, or operation of RET systems. Though park staff may be adequately trained and educated about RETs, personnel may simply be too limited to spare time to attend to RETs. Parks with few FTEs and parks with many FTEs with extensive duties and obligations would be expected to have concerns about staff availability. This barrier also measures park contacts' perceptions of staff needs related to RET acquisition and maintenance.

- *Maintenance requirements* refers to many RETs' continual needs for maintenance. Centralized energy production for the most part requires little to no maintenance from the end user, as the facility producing energy—and therefore any maintenance or operations problems—are far removed from the end user. In contrast, RETs are located near or at the point of use. Typically, the end user is responsible for maintenance, which of course requires maintenance time and resources to be directed away from other areas while attending to the RETs. At National Parks maintenance requirements are particularly barriers, as those who are burdened with the maintenance requirements of the system are not those who directly benefit from the energy savings that the systems provide. Maintenance staff may be unwilling to install the system because they will have that much more maintenance to do, and there would be no real benefit to them—energy cost savings are to the taxpayer. This barrier is distinct from *knowledge an expertise, staff availability,* and familiarity by operating personnel in that it isolates the issue of maintenance to determine true concerns of park staff. Furthermore this barrier measures park contacts' perceptions of the maintenance requirements of RETs.

- *Lack of familiarity by operating personnel* refers to concerns about the staff operating the RET systems—or making use of the systems—being unfamiliar with the technology and its constraints and requirements. If, for instance, staff are not aware of the load limitations of a system and continue to consume energy in the same manner as they had with conventional energy, there may be concerns. Some park energy managers and decision makers may be hesitant to acquire RETs if they believe that those operating the RETs will potentially damage the systems, or that park personnel will place excessive burdens on the systems.

- *Inadequate design* refers to the design of the RET systems not meeting the needs of the parks in aesthetics or functional purposes. This barrier also measures the park contacts' perception of RETs in this regard.

- *Insufficient technology* refers to RET systems failure to meet the energy requirements of parks in some way. According to Geller (2003) technological problems include RETs' failing to meet performance claims or consumers' expectations or requirements, and can result from manufacturing flaws, inadequate assembly, installation problems, or improper use. Additionally, RETs may not meet parks' energy requirements in terms of energy use, energy use patterns, or load requirements. This barrier also measures park contacts' perception of the quality of RETs and their perceptions of problems with the technologies.

- *Uncertainty with performance record* refers to park contacts being wary of using RETs due to concerns about past performance of the technologies. As noted in Geller (2003), one barrier to RETs is that consumers may be wary of the potential performance of the technology. Moreover, in the past in the NPS there have been problems with solar thermal systems, which have led some in the parks to be wary of renewable energy systems (NPS 1995). This barrier is also an indicator of park contacts' reluctance to use RETs due to these concerns.

- *Lack of familiarity by designers* refers to concerns that designers of buildings and capital improvements are not familiar enough with the technologies to properly incorporate them into NPS facilities. As noted by Geller (2003), architects and builders can lack the knowledge required to properly design and build energy-efficient buildings.

- *Access to technology* refers to park units being located in remote areas, where access to vendors and equipment is extremely limited. Unfortunately, this barrier is particularly relevant to rural areas, where RETs may be most economically viable (Geller, p.40). Furthermore, limited supply infrastructure presents a reinforcing barrier; demand is low in a region because the technology available is limited, which leads suppliers to be hesitant to make products or services available, so demand continues to be low in an area (Geller, 2003). Many National Parks are in remote, outlying areas without access to technologies. This barrier also measures park contacts' perceptions about access to RETs at the park.

- *Inability to locate suppliers and contractors* refers to park personnel being unable to locate vendors and service providers of RETs. As noted in Geller (2003), limited infrastructure and a lack of energy service companies that provide products and expertise can present a significant barrier to RETs use. This barrier also measures park contact perceptions of suppliers' proximity to the area, and whether park contacts have attempted to locate these suppliers and service providers.

- *Adverse climate* refers to the park being located in a region with an unsuitable climate for certain RETs. RETs produce different amounts of energy depending on the amount of resource available to the system; for instance, the same photovoltaic system located in a very sunny region such as southern Nevada would produce more energy each year than would the same system located in a usually overcast region such as western Washington. Parks with unsuitable climates could be located in areas with limited sunlight, excess snowfall, limited wind resource, or excessive heat, for example. This barrier also measures park contacts' perceptions of the climate at the park, i.e. if they believe that the park climate is appropriate for RET viability.

- *Support from Above* refers to a lack of support from superiors in the park unit or in the NPS for acquiring RETs. Though many park personnel may be interested in obtaining and using RETs in their parks, they may be encountering institutional or park-level resistance from those in higher positions. For instance, project proposals may be denied, necessary assistance may not be offered, or ideas for RETs in parks may be refused before any real progress is made. As noted in

Geller (2003), when those in positions of authority favor conventional energy over RETs, their use can be obstructed. This barrier also serves as a measure of park contacts perception of assistance from above: that is, if certain parks are receiving assistance from above, they will be inclined to rate this barrier as being a non-issue.

- *Park Size* refers to park contact's belief that RET projects are less possible at their park due to the size of the park in resource availability or popularity.

- *Procurement restrictions* refers to any procurement rules which present barriers to purchasing RETs. For instance, procurement restrictions would apply to rules which require that equipment be purchased from the lowest bidder, or from vendors with particular characteristics.

- *Utility policy* refers to the rules and requirements of the utilities serving the park units. Utility and regulatory policies can also hinder the adoption of RETs. As noted in Geller (2003), utilities can require burdensome interconnection rules and procedures, can refuse to pay fair prices for the electricity generated by RETs, and can require tedious and time-consuming application procedures. Park energy managers interested in developing RET projects may not have the resources or know-how to dispute with utilities (Geller, 2003).

- *State net metering policy* refers to the net metering policy in the state which the park is located, or the lack thereof. Gouchoe et al. (2002) found that policy instruments such as net-metering and buy-downs are necessary for RET market penetration (as cited in Menz, 2005). Some states have net metering policies which require that electric meters at the RET site gauge both the electricity generated and consumed at the site; RET owners are reimbursed for excess electricity generated by the system. Depending on the strength of the net metering policy, the RET owner can be reimbursed at for the wholesale or retail value of the energy. Net metering policies provide a strong financial incentive for parks to pursue RET systems, as the overall cost and payback time of the system are reduced. Without a net metering policy, the ability for parks to obtain cost-effective RETs is hindered. Steve Butterworth, the PWR Energy Coordinator, identified the lack of net metering policies as a barrier to parks in the past.

- *Other policy and regulations* refers to any policies or rules that have restricted the parks' abilities to acquire RET systems, or which have failed to assist parks in this regard. For instance, the NPS currently lacks an explicit policy for RET systems: parks are encouraged but not mandated to use sustainable technologies. Additionally, there are many rules and regulations related to historical property and natural resource concerns which must be followed by parks pursuing RET projects.

  - *Visual quality concerns* refers to the visual impacts that RET systems may create in the parks. Conventional energy sources produce power at a site distant from where the energy is consumed and are therefore unseen by consumers and park visitors. RETs, in contrast are onsite and must be exposed to an extent to harness renewable resources such as solar radiation or wind. Visual intrusion of RET systems are of essentially universal concern (Tsoutsos, Frantzeskaki, Gekas 2005) though they are of the utmost importance at national parks. The NPS mission explicitly requires that in addition to conserving and protecting the resources in the parks, the *scenery* within the parks must be conserved as well (16 U.S. Code 1, the National Park Service Organic Act). The requirement to conserve scenery can sometimes be in direct conflict with the requirement of sustainability of natural resources and wildlife, at least in regards to RET use in the parks. Often concerns about the scenery at the park can override environmental sustainability concerns.

- *Conflicts with the Historical Resource Context* refers to RETs being incompatible with the historic and cultural resources at the park. Many parks have buildings, facilities, and landscapes—even the entire park—which are under the historical register. The NHPA requirements and DOI's Standards for Treatment of Historic Properties together require strict compliance to rules related to historic preservation. In many cases, RETs are not compatible with these regulations. RETs at these sites are not only a violation of the NPS mission to conserve the scenery; historic preservation rules often preclude the installation of RETs either due to the compliance process or simply through refusal of the projects.

Appendix C: Park Attributes

Figure 13C: FY04 Enacted Budgets of PWR National Parks

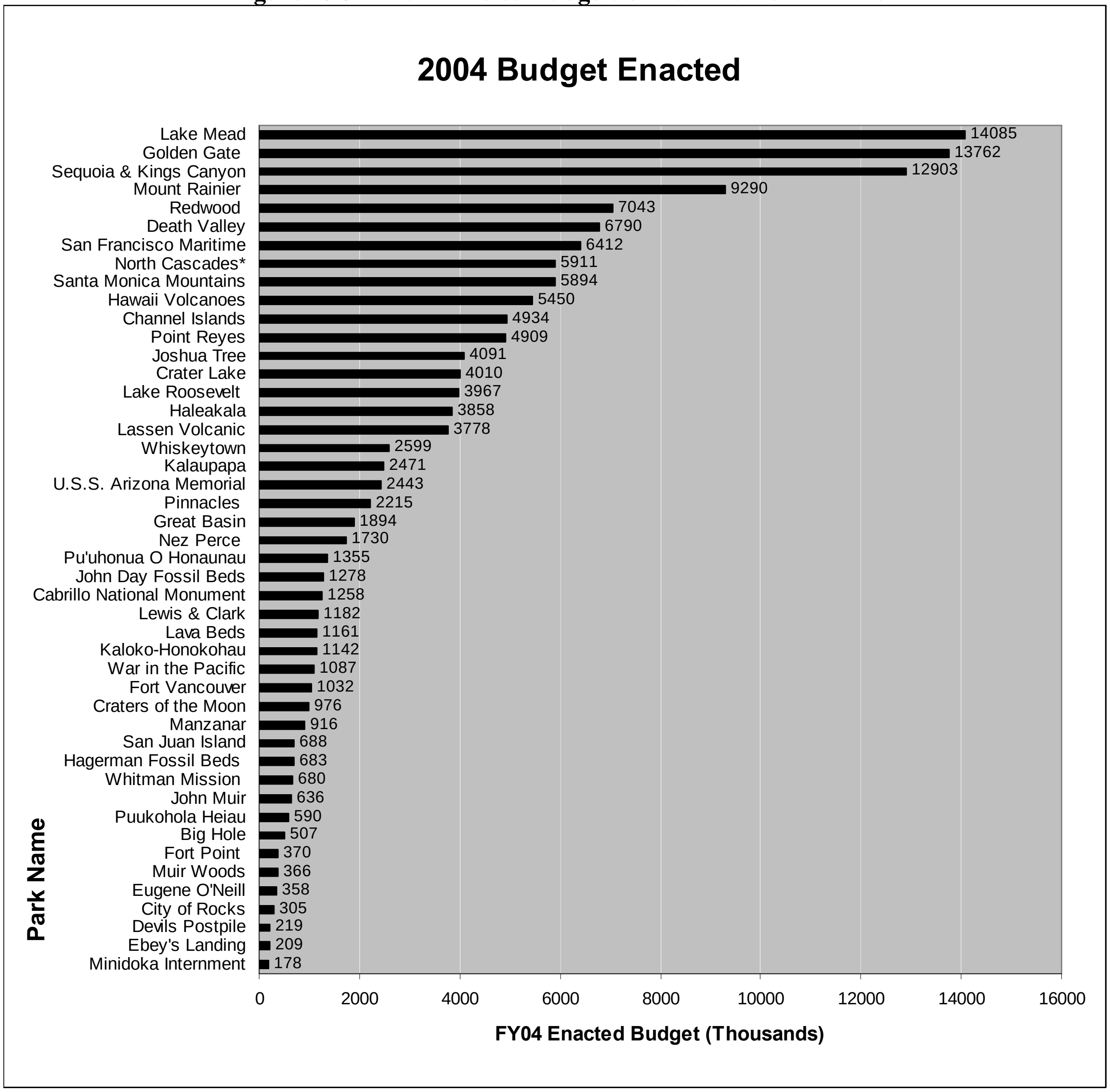


Figure 14C: Full-time Employees at PWR National Parks

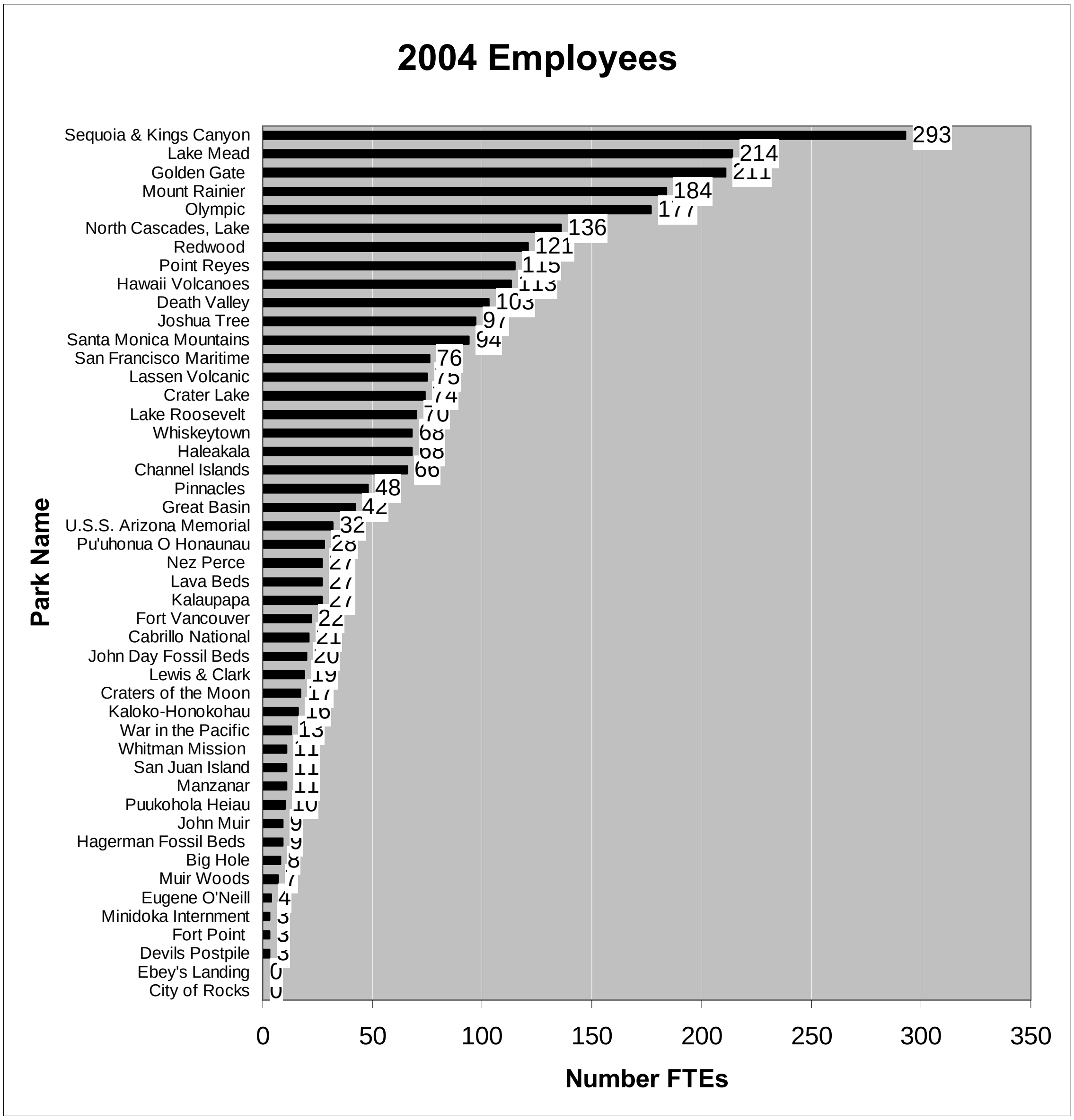


Figure 15C: Acreage of PWR National Parks

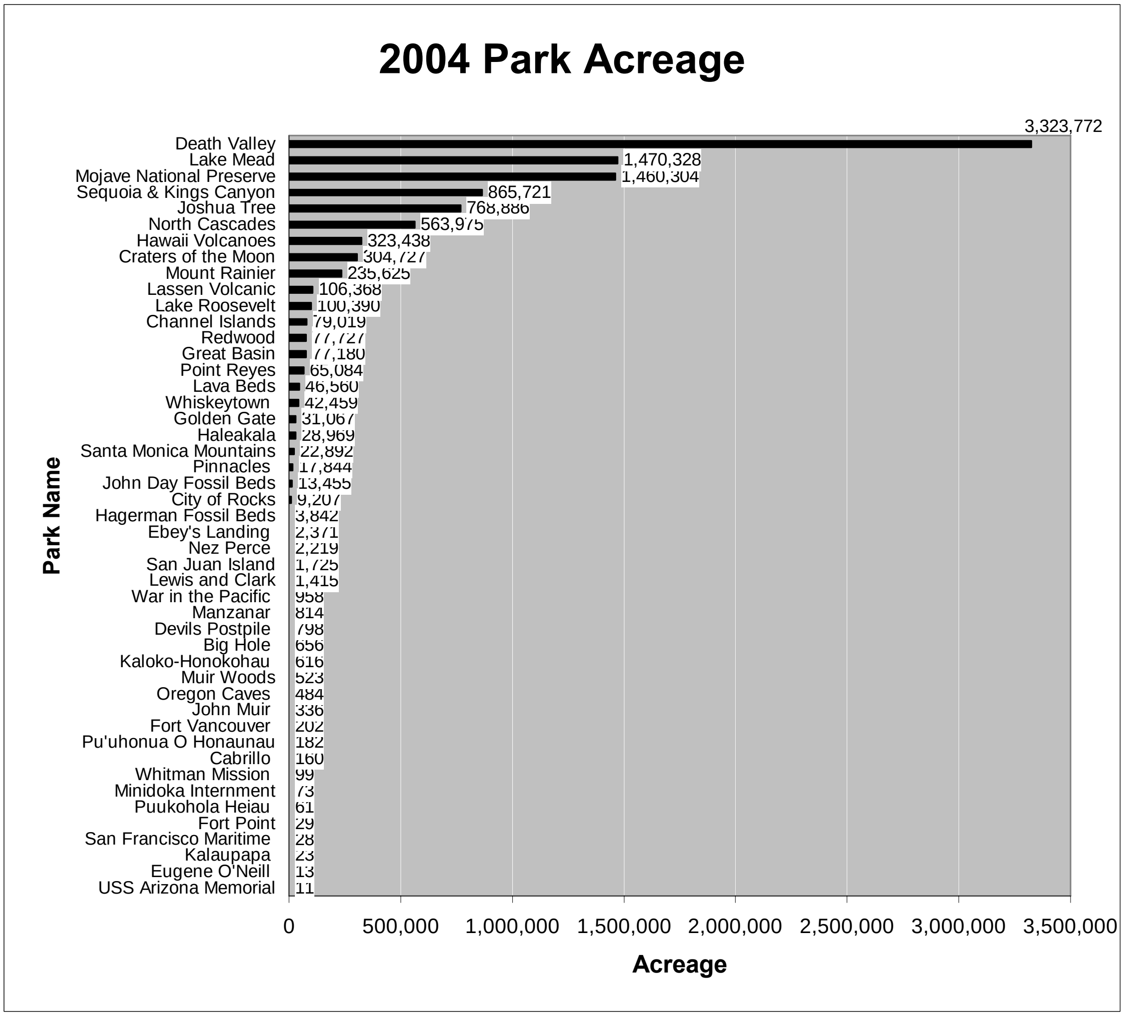
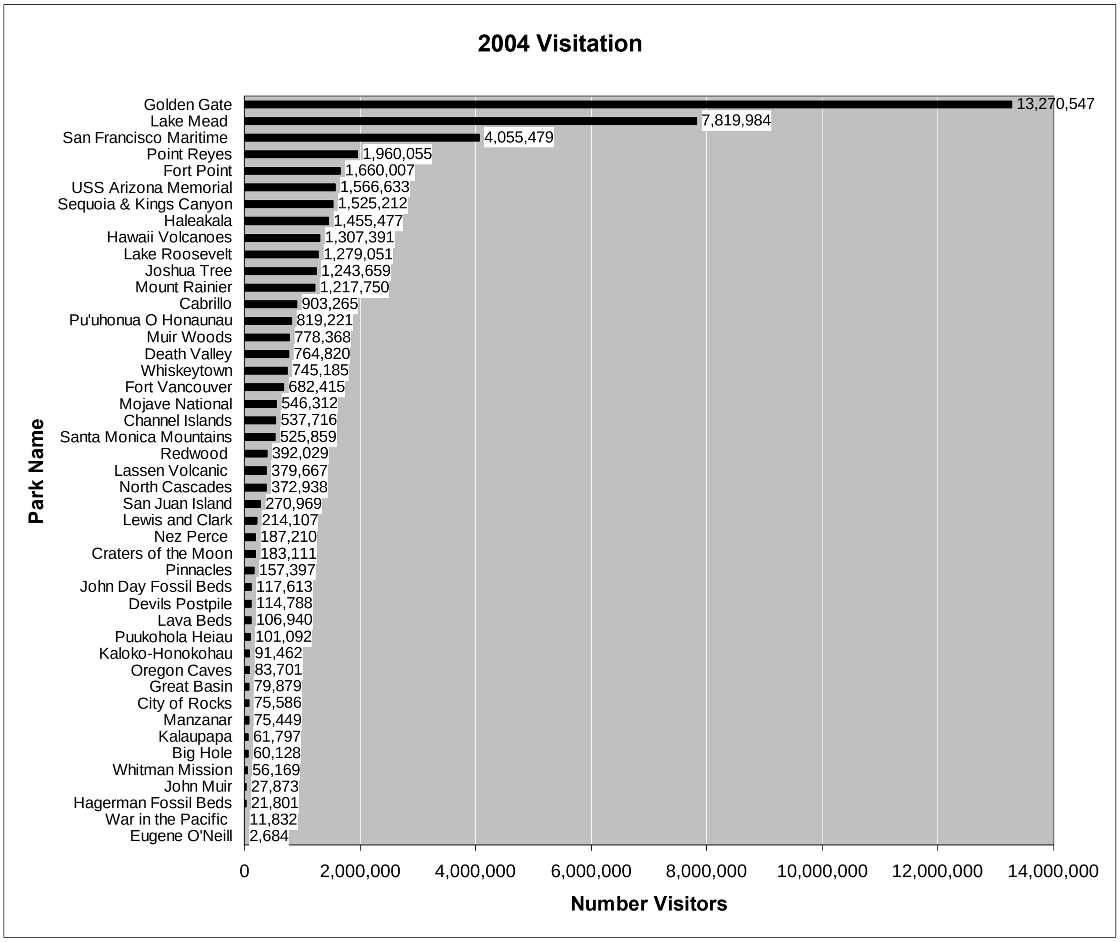


Figure 16C: Visitation at PWR National Parks



Appendix D: Survey Respondents

Park Alpha code	Park Name	Contact Name
AMME	American Memorial Park	Dwayne Minton
BIHO	Big Hole National Battlefield	Wayne Challoner
CABR	Cabrillo NM	Charles Schultheis
CHIS	Channel Islands NP	Kent Bullard
CIRO	City of Rocks	Randy Farley
CRMO	Craters of the Moon NM	Dwayne Moates
DEPO	Devils Postpile NM	Deanna Dulen
DEVA	Death Valley NP	Wayne Badder
EBLA	Ebey's Landing NHRES	Leigh Smith
EUON	Eugene O'Neill NHS	William Solis
FOPO	Fort Point NHS	Jim Christensen
FOVA	Fort Vancouver NHS	Gary Bickford
GOGA	Golden Gate	Jim Christensen
GRBA	Great Basin NP	Mike Allison
HAFO	Hagerman Fossil Beds NM	Fran Gruchy
HALE	Haleakala NP	Frank Baublits
HAVO	Hawaii Volcanoes NP	Bob Dunkley
JODA	John Day Fossil Beds NM	Scott Rittner
JOMU	John Muir Historic Site	Brian Garrett
JOTR	Joshua Tree NP	Marilyn Lutz
KAHO	Kaloko-Honokohau NHP	Stan Sakamoto
KALA	Kalaupapa NHS	Albert Pu
LABE	Lava Beds NM	Jim Deshayes
LAME	Lake Mead NRA	Bill Dickenson
LARO	Lake Roosevelt NRA	Ray Dashiell
LAVO	Lassen Volcanic NP	Daniel Jones
LEWI	Lewis and Clark	Ron Tyson
MANZ	Manzanar NHS	John Slaughter
MIIN	Minidoka Internment NM	Fran Gruchy
MOJA	Mojave National Preserve	Allan Hurd
MORA	Mount Rainier NP	Jim Fuller
MUWO	Muir Woods	Jim Christensen
NEPE	Nez Perce NHP	Dennis Groseclose
NOCA	North Cascades	Steve James
ORCA	Oregon Caves NM	John Cavin
PINN	Pinnacles NM	Debbie Simmons
PORE	Point Reyes NS	Nick Dirr
PUHE	Pu'ukohola Heiau NHS	Peter Amerling
PUHO	Pu'uhonua O Honaunau NHP	Stan Sakamoto
REDW	Redwood NP	Tony Henkelman
SAFR	San Francisco Maritime NHP	Rob Kier
SAJH	San Juan Island	Jerry McElyea
SAMO	Santa Monica Mountains	John Williams
SEKI	Sequoia & Kings Canyon	Dan Blackwell
USAR	USS Arizona Memorial	Merry Petrossian
WAPA	War in the Pacific NHP	Dwayne Minton
WHIS	Whiskeytown NRA	Jerry Wheeler
WHMI	Whitman Mission NHS	Bruce Hancock