Sold on Solar? Perceptions of Solar Panels in Grand Canyon National Park:

An Analysis of the Implementation of Renewable Energy Technologies in National Parks

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Abstract

The National Park Service (NPS) is an iconic institution that preserves natural and cultural resources for the enjoyment, education, and inspiration of current and future generations. Today, the NPS is situated at the heart of the discourse on sustainability, renewable energies, and climate change. This study focuses on the implementation of renewable energy technologies (RET) in national parks and visitors' reactions to these manmade structures in an outdoor recreation space. Our case study of Grand Canyon National Park explored visitors' perceptions of solar panels as well as the effectiveness of the panels as a public education tool. Our survey and interview results suggest that visitors and park officials are overwhelmingly supportive of the solar arrays within this park. These views support the NPS's Climate Change Response Strategy and the conservation-minded educational initiatives that are inherently tied to renewable energy technologies.

Introduction

Project Overview

In the current era of rapid climate change, one of the most pressing issues facing the United States is minimizing our energy consumption and greenhouse gas emissions. The widespread use and acceptance of renewable energy technologies (RET), such as wind, solar and micro-hydro are important steps towards addressing these issues and promoting a more sustainable future. One iconic American institution that is embracing sustainability through renewable energy technologies is the National Park Service (NPS). Their newly established Climate Change Response Strategy requires each park to reduce its energy consumption. Grand Canyon National Park has taken initiative to adhere to this strategy with the installation of solar panels around the visitor center in 2009. This action embodies the park's commitment to sustainability; however, it may be incongruent with the park's wilderness aesthetic and could potentially conflict with visitor expectations of a national park. Since the inception of the NPS, there has been a tension between the priorities of preserving wilderness and creating a recreational ground for public use. This tension arises, in part, from the energy-intensive facilities and resources that accompany the construction and maintenance of recreational space within wilderness. This conflict has resurfaced through the implementation of renewable energy technologies.

In order to address this conflict, we conducted a case study in Grand Canyon National Park in December 2012. Our study included a visitor survey, interviews with park administrators, and an assessment of educational aspects surrounding the implementation of solar panels. Through the visitor survey, we sought to discover whether visitors consider the solar panels to be intrusive or perhaps impede upon an innate wilderness aesthetic within the Grand Canyon. The interviewees explained the administrative decisions behind how and why the solar panels were implemented. Finally, the educational assessment allowed us to explore whether the National Park Service is successfully educating visitors about sustainable practices, as outlined in their Climate Change Response Strategy. The questions raised here relate to several modes and disciplines of literature and highlight the various angles that this project took into account. Although the existing literature proved to be exceptionally valuable, no previous study has specifically queried national park visitors on their aesthetic opinion of renewable energy technologies in national parks. Therefore, we conducted this case study and developed a survey that would theoretically be the first documentation of the public's perceptions of the solar panels located in Grand Canyon National Park. Along with the Climate Change Response Strategy, the Green Parks Plan, which is specific to each park, holds park administrators accountable for combating climate change by reducing each park's energy consumption. Both of these plans guide park administrators' decisions regarding sustainable development. An important facet of this dialogue is the idea of visual management of landscape design and park architecture. Our study seeks to understand how visitors respond to these projects, specifically the implementation of solar panels in Grand Canyon National Park.

Original Mission and Mandate of the National Park Service

The national park system encompasses over 375 preserved areas that display the scenery, history, archaeology, and cultural artifacts of the United States. These preserved areas attempt to "explain America's history, interpret its culture, represent and preserve its varied ecosystems, and provide, incidentally, for the recreation of its [300] million people" (Dilsaver 1994, 1). The

National Park Service's dual-mandate of preservation and recreation has led to an enduring tension between balancing the natural aspects of the parks with the built environment necessitated by accommodating park visitors.

The national park movement began with the founding of Yellowstone National Park on March 1, 1872 as a "pleasuring ground for the benefit and enjoyment of the people" (Yellowstone Act 1872). The preservation of America's scenic places continued piecemeal until the National Park Service was established in 1916. The creation of the National Park Service marked an unequivocal recognition of a changing land ethic in the American people. The national park mission statement professes the National Park Service to be a "guardian of our diverse cultural and recreational resources; environmental advocate; world leader in the parks and preservation community; and pioneer in the drive to protect America's open space" (NPS Organic Act 1916). The creation of an administrative system for the national parks also represented a shift towards the notion that these new parks should be managed and shaped to reflect the evolving expectations of the American people.

In the nascent national park movement, one of these expectations was the chance to experience wilderness. According to John Muir (1838-1914), one of the first advocates for the national park system, national parks offer Americans a chance to experience a "pristine" wilderness, wilderness preserved in its natural state, removed from humankind. National parks were seen as a respite from the increasingly chaotic, industrialized urban centers, and as a way to revitalize spiritual and democratic ideals in the face of a rapidly changing nation. Muir was also a fervent believer in wilderness's ability to combat aesthetic irreverence (Muir 1992).

National parks have continued to be a quintessential component of America's outdoor experience. They are a tourist destination, a wilderness experience, and a symbol of the nation's important historic and scenic landscapes. Their enduring popularity makes them iconic and an important thread in the history of the United States, yet challenges the NPS to maintain the mission statement's dual mandate to preserve and to provide unimpaired enjoyment for future generations.

Preservation and Recreation

The mission of the National Park Service is "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for future generations" (NPS Organic Act 1916). This means that the NPS is inherently caught between preserving scenic, historic landscapes while creating opportunities for people to access and experience this scenery. Historian Richard Sellars describes the value of having and maintaining a National Park Service for the preservation of wilderness and the aesthetic values it sustains in the American people:

> Beyond the sheer enjoyment of scenery, a heightened aesthetic sensibility may have inspired in many a deeper understanding of and concern for the natural environment… This benefit defies quantification, but surely it has had consequences of immense value, both for individuals and for the nation (Sellars 2009, 5).

However, he complains that this aesthetic appreciation has often been subsumed by consumptive tourism; the NPS measured success by annual visitor counts, increasing program breadth, park size, the number of new campgrounds, and visitor centers (Sellars 2009). Creating access allows more people to experience this heightened connection with nature, yet complicates the NPS'

ability to preserve these areas; trails must run through the landscape, campsites are established, bathrooms, lodges and restaurants are needed to accommodate visitors.

In response to America's changing land ethic regarding wilderness and wildlife, three were enacted. The 1964 Wilderness Act, the Wild and Scenic Rivers Act of 1968, and the Endangered Species Act of 1973 were measures that, in part, responded to growing public concern that expansion of facilities and trails was happening at the expense of the ecological health of the wild areas and wild animals that many parks were created to protect (Dilsaver 1994, Winks 1997). The Wilderness Act and the Wild and Scenic Rivers Act limited the amount of development and the type of activities that can occur in designated waterways and wilderness areas. The Endangered Species Act required a greater effort to preserve the lands and waters essential to the survival of endangered animals.

Not only were parks expected to preserve the ecological integrity of their lands, but they were also meant to safeguard culturally and historically important sites. As such, many national parks, including the Grand Canyon, have designated historical sites. This designation restricts the number and type of architectural changes that can be made. As of 1997, over half of the 375 NPS units have cultural/historical preservation as their primary goal, demonstrating the difficulty of altering these historic landmarks (Winks 1997). Ethan Carr's book, *Wilderness by Design: Landscape Architecture and the National Park Service,* speaks to the juxtaposition of roads, parking structures, and other human constructions with the opportunity to view and appreciate these historic landmarks (Carr 1998). The architectural landscape present in national parks plays a large role in facilitating ways in which visitors observe the natural beauty of wilderness.

Management and History of Park Infrastructure

It is often assumed that the scenery visitors observe is an intrinsic aspect of a national park; however, the picturesque vistas that viewers appreciate are often the product of careful visual management. Visual management addresses the aesthetic aspects of architecture, infrastructure and landscape design. Jane A. Ruchman notes in her thesis, "Since the greatest portion of almost any visitor's experience of a park is visual, the care with which the visitors and the visitor facilities are interfaced with the scenery; natural, cultural or historic, becomes paramount" (Ruchman 1990, 10). The NPS has struggled for decades with how to balance scenery and the built environment. An appreciation of the history of visual management by the National Park Service is an important part of contextualizing visitors' perceptions of renewable energy technologies. Visitors need facilities, but they also have specific expectations for how a national park and its architecture should look. It is important to assess the extent to which the addition of solar panels fit in with the historical aesthetics promoted by the NPS.

Figure 1. El Tovar Lodge in Grand Canyon National Park. Photo courtesy of Xantera Parks and Resorts, Inc.

The architectural styles endorsed by National Park Service has consistently oscillated between creating rustic designs that reflect a romantic notion of wilderness and creating an efficient, functional optimum that addresses the needs of burgeoning visitor populations. El Tovar at the Grand Canyon is an example of the romantic mindset. As Mark Neumann notes in *On the Rim: Looking for the Grand Canyon*, "El Tovar's interior gestured toward a rustic, western, frontier ambiance" (Neumann 1999, 26). The lodge's essential elements, rough-hewn logs and craggy stones, allowed visitors to enjoy the "rugged" aspects of the natural world from the comfort of a fireplace or ladies' sitting room (Ruchman 1990, Neumann 1999). This aesthetic has been an important component of Grand Canyon National Park's architecture since its inception. This rustic style stands in stark contrast to the aesthetic of renewable energy technologies, thus complicating the implementation of RET in Grand Canyon National Park.

Once the NPS was established, it began developing the facilities needed for the surging numbers of visitors. Demand for outdoor recreation boomed in the years between WWI and WWII. In response to Herbert Hoover's 1933 commission on "Recent Social Trends," educator and scholar, Jesse Steiner noted the development of participation in outdoor recreation during the interwar period. "One of the significant trends in modern recreation is the increasing demand for great open spaces set apart for the enjoyment of those outdoor diversions which have become so eagerly sought as a means of escape from the noise and confusion of urban life" (Steiner 1933, 34). Increased leisure time and the demand for wilderness experiences resulted in national parks increasing in popularity as tourist destinations. The growing popularity of cars and the improvement of highway systems also facilitated this interwar boom. Steiner details that "with the improvement of means of travel, people are finding it possible to go even further afield in their search for recreation and readily travel long distances during week-ends and vacations to places of scenic interest…" (Steiner 1934, 34).

The buildings and amenities created during this interwar period reflect an enduring visual emphasis on a natural ambiance. This was the era of "Parkitecture," or National Park Service Rustic Architecture. This aesthetic favored buildings that housed the modern amenities needed for increasing visitor numbers, but featured a traditional, non-intrusive exterior that harmonized with its surroundings (Ruchman 1990). As national park historian William C. Tweed, eloquently states,

> Successfully handled, [rustic] is a style which, through the use of native materials in proper scale, and through avoidance of rigid, straight lines, and over-sophistication, gives the feeling of having been executed by pioneer craftsmen with limited hand tools. It thus achieves sympathy with natural surroundings, and with the past (Tweed 1981, 93).

The Great Depression marked the peak of Parkitecture because the Civilian Conservation Corps provided ample labor for energy-intensive projects. Parkitecture became unfeasible when WWII decreased the monetary and manpower resources allotted to the NPS.

Mission 66, which began in 1956, was a 10-year plan initiated to respond to a park service that was languishing under a WWII-era austerity budget. Its goal was to rapidly update parks and to build facilities needed to house the influx of visitors. This project resulted in a style of architecture that was markedly different from Parkitecture. Functionalism and simplicity were the guiding ethics, resulting in modernist buildings featuring concrete, glass and steel. This new aesthetic was a shock to people accustomed to the stone and log construction of other amenities. Enduring criticisms of this period mention the "die-cut employee residences, sterile administration buildings and visitor facilities that are functional and easy to produce, yet completely lack a sense of the particular park in which they are situated**"** (Ruchman 1990, 36).

The NPS has clearly been conflicted about the relationship between the built and natural environment. However, the idea of non-intrusiveness is a constant theme that remains in the parks' architecture. The NPS has emphasized non-intrusiveness in terms of building location, scale of development, natural building materials and line, form, and texture (Ruchman 1990). Infrastructure design is still concerned with accommodating the expansion of nature tourism and creating aesthetically pleasing facilities. Currently, there is the added challenge of designing infrastructure while incorporating greener design practices. These greener practices will help mitigate climate change and preserve the park for future generations.

Climate Change Response Strategy

Part of this transition into greener infrastructure is tied to new mandates regarding climate change from the Department of the Interior and the National Park Service. These mandates recognize that climate change will fundamentally alter the NPS's capacity to adhere to its founding documents.

> The effects of climate change will impact the ability of the NPS to meet its mission and comply with legal mandates. Most resource protection laws that the NPS must comply with were not written considering a changing climate. For decades, we have been striving for "natural" or "historical" conditions in the national parks, but such conditions may be more difficult or impossible to maintain under climate change. Even the concept of naturalness becomes convoluted in an era where human activities play a role in shaping global climate. Should our mandate to leave parks "unimpaired" for future generations reference a historical state, or a future one under an altered climate? As the scope and intensity of climate change increases, these kinds of questions will strain the current policy framework unless revisions are made (NPS 2012c).

As a response to these queries, the NPS released a Climate Change Response Strategy (CCRS) with the goal of better addressing the original mission of leaving "park resources unimpaired for future generations" due to the threat of climate change to park resources ((NPS Organic Act 1916). The strategy is subdivided into four components: Science, Mitigation, Adaptation and Communication. For the mitigation part of the strategy, the NPS aims to "reduce [its] carbon footprint (the amount of greenhouse gases emitted through NPS activities) through energy-efficient and sustainable practices and integrate these practices into planning and operations (NPS 2010, 3).

The Climate Change Response Strategy has numerous goals to guide each park to accomplish the overall mission of the strategy, including enhancing the sustainable design, construction, and maintenance of park infrastructure (NPS 2010, Goal 8). Two objectives of this goal are to "incorporate sustainable designs in new construction and substantial restoration or rehabilitation of facilities where feasible," as well as in the "maintenance and operation of existing facilities and programs" (NPS 2010, Objectives 8.4 and 8.5, 18).

Goal 9 of the CCRS is to "substantially reduce the National Park System's carbon footprint from 2008 levels by 2016 through aggressive commitment to environmentally preferable operations" (NPS 2010, Goal 9, 19). This "aggressive commitment" includes an objective to "develop Climate Friendly Action Plans so that every park, park concession, and administrative office promotes energy and water conservation; supports alternative transportation, infrastructure, programs, and policies; and eliminates waste" (NPS 2010, Objective 9.2, 19). It is significant that this objective includes *every* park and park concession, a

huge undertaking. One of the most important objectives is that the Park Service will "support the development and application of renewable energy and the use of renewable energy technology in a manner consistent with the NPS mission" (NPS 2010, Objective 9.4, 20).

The NPS acknowledges that through its visibility within the United States and the world it is capable of exerting a significant influence over public opinion regarding sustainability. The NPS aims to "create interpretive products and programs that educate general audiences about the impacts of climate change and climate friendly technologies and practices" (NPS 2010, Objective 14.2, 22). Furthermore, they want to "demonstrate how the public can reduce the impacts of climate change in their own lives and in national parks by interpreting NPS sustainable practices including agency operations, facilities, and use of technologies" (NPS 2010, Objective 15.1, 22). As an institution that often highlights an educational commitment in the design of its facilities, programs, and signage, these objectives are a salient component of the CCRS. Not only do the parks need to meet their own sustainability goals, but they must also demonstrate that their actions are having a meaningful effect on people who visit. According to these new mandates, the NPS wants to highlight the educational potential of the CCRS. Well-designed signage and engaging displays are crucial to the success of this part of the CCRS. In order to accomplish their stated goals, it is vital that the NPS adopts climate-friendly initiatives and demonstrates to their visitors that these initiatives are possible and necessary to combat climate change.

The NPS is taking this CCRS seriously. Ken Salazar, the former Secretary of the Interior went to the Senate on February 29, 2012 and requested $5 million for the Climate Change Adaptive Management Program from the 2013 Presidential Budget. In addition, Salazar requested $25.3 million for green construction in the parks (Salazar 2012).

Jonathan B. Jarvis, the Director of the United States National Park Service issued a memorandum addressing the Climate Change Response Strategy on March 6, 2012 reinforcing that

> The pervasiveness of climate change requires that we reexamine our approaches to park management and consider what a larger magnitude of change means for our responsibilities to conserve natural systems, processes, and native biodiversity; protect our cultural and historic heritage; and provide for the enjoyment of the same (Jarvis 2012).

Here, Jarvis is reminding park superintendents that attention needs to be drawn towards mitigating climate change and becoming a leader in sustainable practices. These two actions demonstrate the serious commitment that the Department of Interior and the National Park Service are making to the CCRS, even if such an initiative requires significant changes in park management and an increase in the funding needed by each park.

Green Parks Plan

The National Park Service's Green Parks Plan (GPP) outlines how the park service will "reduce our impact on the environment, mitigate the affects of climate change, and integrate sustainable practices into every aspect of our operations" (NPS 2012b). The CCRS outlines a broad plan for addressing many of the facets of climate change, while the Green Parks Plan is specifically about sustainability in the NPS. One of the goals of the GPP is to "be energy smart," which states that the NPS will improve facility energy performance (7,600 buildings total) and increase reliance on renewable energy. The plan states that the NPS will reduce building energy

use by 35% by 2016 from the 2003 baseline. The NPS will conduct energy audits at the most energy-consuming facilities (as required by the Energy Independence and Security Act of 2007) every four years. In addition, the GPP states that the NPS will "prioritize the use of energy sources that are renewable and appropriate" (NPS 2012b).

Renewable Energy Technology Implementation in Parks

Spurred by the Green Parks Plan, parks have begun to address climate change issues through the use of renewable energy technologies. In order to implement RET in national parks, there has to be public support. The number of people who are invested in the lands controlled by the NPS is both an opportunity and a possible limitation. As the GPP notes, "a critical component of the implementation of the GPP will be informing and engaging park staff, visitors, and community partners about climate change and sustainability to broaden opportunities to foster change" (NPS 2012b, 3). Implementing RET in parks might favorably affect how the public views solar, wind, geothermal, and hydrogen cell technologies. On the other hand, a potential obstacle to phasing in RET is a negative reaction from visitors. For parks, money generated from entrance fees provides an essential source of income. Thus, visitor satisfaction is a facet that parks must constantly bear in mind. RET can often have high start-up costs and require staff that is knowledgeable about their maintenance (Green 2006). Despite federal mandates, the combination of economic/technical impediments and visitor resistance could be enough to stall or shelve any renewable energy technology projects. Therefore, an in-depth study of public perceptions of RET in national parks is a crucial component of any policy recommendations. On a national scale, leadership in using renewable energies and educating the public about sustainability is admirable, but visitor perceptions of RET in parks will be influential to management on a local scale.

A seminal work for our paper is Erin Green's 2006 masters thesis "Green Power in Green Spaces: Policy Options to Promote Renewable Energy Use in U.S. National Parks" which provides a model methodology for analysis of RET potential in the Grand Canyon. Green's research focuses on the market, social, economic, and technical restraints that hamper the internal adoption of RET in the Pacific West Region. Green found that visual quality concerns and conflicts with the historical context of parks were barriers to RET implementation. Strict management rules regarding the changes that can be made to historical park buildings or sites often interfere with attempts to install RET. Her paper provides an excellent overall methodology, but only indirectly addresses how visitors perceive RET in national parks. She addresses viewshed issues and the perception that RET are incompatible with historic sites from the point-of-view of managers and conservation groups while excluding other stakeholders such as visitors. Visitors are not concerned with the technical or economic issues associated with implementing RET, rather their focus is mostly likely to be aimed at their aesthetics and context within the park. Understanding how these components affect visitors' perceptions of the RET will add to the existing scholarly discussion.

Aesthetics of RET

Despite the increasing popularity of renewable energy technologies, studies have shown that the public still views aesthetics as a factor limiting the implementation of solar panels (Simon 2009, Faiers and Neame 2006). Adam Faiers and Charles Neame looked at why the installations of domestic solar systems were not growing at expected rates. They surveyed households in central England to determine common attitudes towards characteristics of solar

panels. It was found that although the majority of people "demonstrate a positive perception of the environmental characteristics of solar power," they were held back by two main concerns: economic and aesthetic quality (Faiers and Neame 2006, 2). Because the panels at Grand Canyon were donated, the initial cost was not an issue to the park. We were curious about the extent to which aesthetic concerns were prevalent amongst visitors to Grand Canyon National Park and how these opinions affected visitors' overall perceptions of solar power.

Psychologically, an aesthetic experience is described as a cognitive process paralleled by constantly updating affective states (emotions, moods) (Leder et al. 2004). The brain is assessing an object or view, an affective response is initiated, and the resulting emotion is incorporated into the cognitive assessment. In terms of general aesthetic preference, psychologists have found several key components of this process. Perceptual analysis includes the complexity, contrast, symmetry, order, and grouping of the object or view being assessed (Leder et al. 2004). In addition to purely observational aspects, previous exposure to the object or scene being analyzed also affects aesthetic perception. People seem to prefer looking at things that are familiar, or prototypical (an archetypal form or design), yet novelty can also be desirable (Leder et al. 2004, Hekkert et al. 2003). These findings have two potential positive implications to visitors in national parks. As solar panels become more ubiquitous, people's familiarity with them will positively affect their perceptions. Alternatively, the novelty of solar in a national park may also increase visitors' appreciation of the solar panels. However, there might be a limit to the appeal of novelty. If solar panels are too obtrusive, visitors may react negatively to their presence.

Research by Torres-Sibille et al. (2009) came to similar conclusions about the importance of complexity, contrast, symmetry, order, and grouping in terms of the aesthetics specific to solar panels. These researchers found that visibility, color, fractality (extent to which manmade parts distracts from the natural), and concurrence between fixed and mobile panels were key factors in determining how viewers responded to industrial-scale solar power plants. They studied the differences in public perception, and preference between the initial landscape and the landscape once solar panels had been implemented. With these studies in mind, we attempt to gauge visitor's perceptions of and reactions to solar panels in Grand Canyon National Park. The paper by Torres-Sibille et al. (2009) will provide a valuable framework for assessing whether visitor reactions are influenced by location, geometry, or color-related aspects of the solar panels. In addition, we examine if their perceptions are affected by their familiarity with solar panels, similar to the reactions suggested by Leder et al. (2004) and Hekkert et al. (2003).

Filling a ~~Canyon~~ Gap

Our study, addressing public perceptions of solar panels in Grand Canyon National Park, is filling a larger gap in the current literature. Although there have been many studies that analyze consumers' perceptions of solar panels for personal use, as well as studies about large-scale solar power plants, we have not found sources that address how the general public perceives solar panels that are at an intermediate scale or placed within a publically owned and protected environment. Documenting the public's thoughts and reactions to seeing solar panels in a national park will shed light upon America's interest and acceptance of implementing new, technologically advanced structures in preserved wilderness landscapes, such as Grand Canyon National Park. If the public reacts positively, the case can be made that more renewable energy technologies could be implemented in various similar settings throughout the country.

Study Area

One of the largest and most iconic national parks is Grand Canyon National Park, visited by five million people annually, categorized as a UNESCO world heritage site, and commonly referred to as one of the seven natural wonders of the world (NPS 2012d, CNN 1997). It is one of the most prominent national parks to embrace a broad range of sustainable practices including a compressed natural gas shuttle, elimination of plastic water bottles, and a gray water recycling system. Furthermore, in May 2009, Arizona Public Services worked with the park to install 84 photovoltaic (PV) solar panels at the South Rim Visitor Center, the hub of visitor education (Figure 2). The 18-kilowatt system offsets 30% of the power used in the visitor center complex. We were curious to see if the implementation of these photovoltaic panels in Grand Canyon National Park would raise questions and concerns from visitors, who presumably traveled to the park for a historical wilderness experience, with limited exposure to man-made buildings or structures. We surveyed visitors and interviewed park employees over the span of five days to better understand the reaction to these new, large, and technologically advanced structures. In our project, we sought to discover whether visitors consider the solar panels to be intrusive: does their technological look and/or glossy reflection detract from the nature around them? Do they represent a Mission 66-like foray into over-functionality? Alternatively, are they seen as a functional, yet integrated necessity for the park?

Figure 2. Freestanding solar panels in foreground and rooftop panels in background at Grand Canyon National Park South Rim Visitor Center. Photo by Michael Quinn (NPS).

History of the Grand Canyon

The Grand Canyon began its time as an official national treasure in 1893 when Theodore Roosevelt declared it a Forest Reserve. After much turmoil, it was changed to a National Monument in 1908, and then finally in 1919, Woodrow Wilson signed the Grand Canyon National Park Act, preserving its 1,217,262 acres under National Park Service jurisdiction (Anderson 2000). The Grand Canyon has attracted interest from the American people since the 1800's. As early as 1902 there was a train service that ran into the park, highlighting its significance as a tourist destination. The amenities for tourism came at a cost, however. By 1919, 100,000 gallons of water were being shipped by rail into the park each day (Anderson 2000). This is a staggering quantity and a reminder that with convenience comes intensive resource consumption. The park service must accommodate an extraordinary amount of people and provide for these visitors during their visit.

Energy Use in Grand Canyon National Park

The needs of five million annual visitors translate into exorbitant resource consumption. In 2008, a greenhouse gas emission audit was conducted for the park. It found that the total emissions from Grand Canyon National Park, including concessions and visitor usage, were 55,471 metric tons of carbon dioxide equivalent ($MTCO_2E$) (Grand Canyon National Park [GCNP] 2010). As a reference point, a typical single-family American home produces about 11 $MTCO_2E$ per year. This means that the emissions from the park are approximately equal to electricity emissions from 7,694 households a year. Energy is the biggest contributor to the Grand Canyon's greenhouse gas emissions, accounting for almost 35% of the park's overall emissions (GCNP 2010). A rough estimate of the park's energy usage can be gleaned from a 2010 energy audit conducted for the park. The NPS buildings (not including the concessions) used 8,771,403 kWh of electricity and 49,589 dekatherms of gas energy (Hines et al. 2010). In comparison, the average annual electricity demand for an American household is 11,496 kWh (Energy Information Administration 2011). If the concessions in the park were included in this audit, this usage would be greatly increased. The energy audit included only 54 buildings that are owned exclusively by the NPS, but not any of the lodges or stores within the park.

Energy in the Grand Canyon is provided by Arizona Public Service (APS). APS is Arizona's largest and longest running electrical utility company, serving 1.1 million customers in almost 75% of Arizona's counties **(**APS 2009). In 2008, they proposed a collaborative project with Grand Canyon National Park. In a press release in May 2009, APS announced that they were "bringing together two of the state's most recognizable features – the Grand Canyon and the sun," as they helped Grand Canyon National Park go solar **(**APS 2009). APS President and Chief Operating Officer, Don Robinson, stated that

> This project is symbolic of the commitment we have at APS to environmental protection, sustainability and to make Arizona the solar capital of the world. We selected the Grand Canyon for this project because of the opportunity that exists there to educate so many people from around the world about renewable energy (APS 2009).

Funding for the project came from APS' customers and Arizona Corporation Commission's Renewable Energy Standard (APS 2009). This collaboration provides positive publicity for APS and free solar panels for the Grand Canyon visitor center. For a detailed description of how a solar panel functions, see Appendix A.

Methods

We chose Grand Canyon National Park as a case study because it is archetypal. It is one of the top ten most visited national parks in the country, eleventh largest, and one of the most famous national parks in the world. For these reasons, Grand Canyon National Park is an influential example for all national parks. The Grand Canyon is the home of the Albright Training Center. The Albright Center trains many long-term (3+ years) NPS employees from various national parks and monuments throughout the year (Allen, pers. comm.). The Albright Center is significant because it allows employees from other national parks to experience the Grand Canyon and how it is managed. This heightens the Grand Canyon's ability to influence the diffusion of information with regards to park management and sustainability strategies. With almost five million visitors entering its gate each year, Grand Canyon National Park has much higher revenue from entrance fees compared to other parks, and thus has more financial flexibility to pursue new projects and set the standard for others.

As mentioned previously, the Grand Canyon has recently completed the installation of photovoltaic cells on and near the visitor center. We chose to gauge visitors' perceptions of the panels at Grand Canyon National Park because of the high visibility of these solar panels. We are using this case study as a proxy for acceptance of renewable energy technologies in national parks in America.

Interdisciplinarity

Our work on visitor perceptions of solar energy in Grand Canyon National Park is undoubtedly an interdisciplinary project. Our relevant literature draws on the history of national parks, the conservation movement, architecture, and ecological management. We tip our hats to Aldo Leopold, John Muir, and other prominent scholars in the field of environmental advocacy. Other areas of intense study include environmental sociology, education, ethics, aesthetic theory, the psychology of aesthetics, and tourism psychology. Economics, physics, and anthropology also played roles in our research. The methods of our study spanned disciplines, as we utilized expert interviews, participant observation, surveys, and historical analysis in order to assess visitor perceptions of solar energy in Grand Canyon National Park.

Survey Protocol

Figure 3. When surveying respondents we ensured that both the freestanding (left) and rooftop panels (right) were always in view. The arrows indicate the placement of the solar panels.

We surveyed visitors to Grand Canyon National Park in order to understand perceptions of solar energy within the park. We surveyed 149 visitors and employees over the course of four

days between the hours of 10am and 3pm. Our survey site was the South Rim Visitor Center near the Northwest bathrooms just outside of the Bright Angel Bicycles coffee shop. This survey was twenty questions, consisting of yes/no questions, ranking on a 1-3 or 1-5 scale, and free response, and took approximately five minutes. We approached subjects in pairs with one person asking questions while the other recorded on paper, or individually with one researcher performing both tasks. The survey was prefaced with "Hi, are you willing to complete a survey for our undergraduate thesis? We are not in any way associated with Grand Canyon National Park and your answers will be held in confidence." All of our surveys were done within twenty yards of the freestanding solar panels and within sight of the rooftop solar panels so subjects could easily reference the panels throughout the entirety of the survey. A copy of the survey is attached in the Appendix B. It is important to note that the NPS expressly asked us not to ask specific questions about "climate change," "global warming," or any questions resulting in an opinion or suggestion about the management of the national park.

The program TIBCO Spotfire S+ was used to analyze our data. Most statistics are simple frequencies or percentages. T-tests, correlation tests, and chi-squared tests were used as necessary to elucidate conclusions. Chi-square tests of association were used to determine if differences between people of differing genders, ages, or origins were significant. We also compared every possible combination of questions to determine if there was a significant association. Due to the intended audience of this comprehensive exercise, significant differences are discussed only when the chi-square is significant at the .05 level.

Interview Protocol

During November 2012, we made contact with a variety of park personnel relevant to our study–the Superintendent, the Chief of Interpretation, the Green Team leader, and a landscape architect. While we were in GCNP, we met with and conducted semi-structured, open-ended oral interviews with the Chief of Interpretation, Judy Bryan-Hellmich, and Superintendent David Uberuaga. We also informally spoke with on-duty rangers and an assortment of other park staff members. We obtained consent to tape-record our interviews with Bryan-Hellmich and Uberuaga, and to use their statements in the completion of our final paper. With the people we informally talked to, we described our project and asked if they were willing to answer our questions. Our focus was different with each interviewee depending upon their area of expertise. When talking with Bryan-Hellmich, our main objectives were to understand the process through which the park obtained the PV panels and the extent to which she feels that the panels have achieved the interpretive and educational goals of the park. When we talked to Superintendent Uberuaga we were interested in broader themes: how does he interpret the park's mission, what is the role of sustainable practices in the park, how does he deal with the tension between recreation and preservation, and what are some of his ideas for the future? We did not maintain a standard list of questions for the two interviews because we were interested in deriving different information from each source.

We recorded our interviews via an Apple iPhone 4S and transcribed them completely so no data was omitted. We transcribed the interviews with Bryan-Hellmich and Uberuaga and took notes during conversations with other park personnel. These interviews helped round out our understanding of the circumstances that helped Grand Canyon National Park acquire solar panels. In other ways, the subjective information shared by Bryan-Hellmich and Uberuaga was useful in assessing perceptions of solar power and its role in a national park. Based on our survey results, both quantitative and qualitative, we were able to understand visitors' opinions and appreciations of the PV panels and direct aims of the park administrators.

Results

Survey Demographics

We surveyed 149 people outside the Grand Canyon National Park Visitor Center from 10am to 3pm, between the dates of December 15, 2012 to December 18, 2012. Of the 220 people asked, 68% responded to our survey. We surveyed 80 males, 53 females, and 16 people of undisclosed gender. The average age of people surveyed was 38 (standard deviation 14 years), with age 18 as the youngest respondent, and 79 as the oldest respondent (**Figure 4**). The average distance traveled by respondents was 1,905 miles to visit the Grand Canyon. On average, our respondents spent 50 hours within the park, and 77% of respondents spent the night within the park, whereas 23% spent the night outside the park (**Figure 5**). Out of the 149 people surveyed, 110 stayed in a lodge, motel, cabin, rented condo/home or bed & breakfast, 9 stayed in a personal residence, 5 camped in an RV, and 5 camped in a tent. The most common reason for visiting was sightseeing, with 110 people saying that was their main reason for visiting. Sixty-two percent of people surveyed were visiting Grand Canyon National Park for the first time.

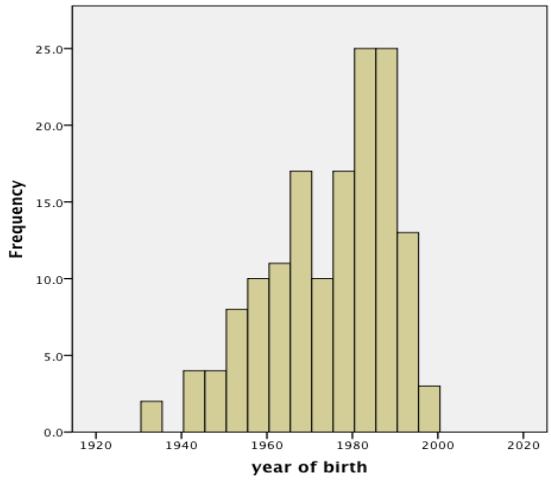

Figure 4. Histogram of number of survey respondents by age.

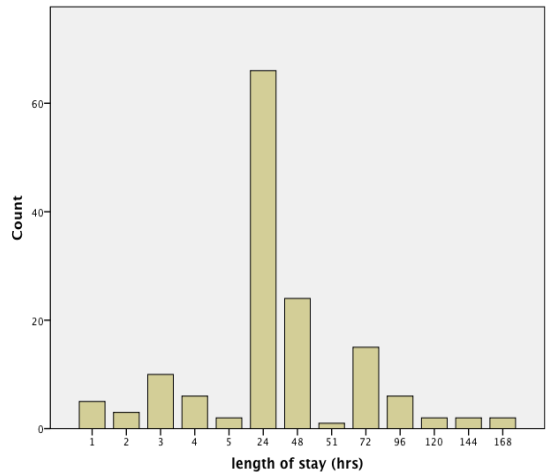

Figure 5. Histogram display of number of survey respondents by length of stay.

To analyze whether our survey respondents aligned with representative Grand Canyon National Park visitors, we compared the demographics of our survey respondents to a survey conducted by the University of Idaho's Park Studies Unit in June of 2003. We acknowledge that we visited the park at one of the slowest times of the year, and thus might have a biased sample of survey respondents because of that. The University of Idaho survey distributed one thousand questionnaires and had a 73.5% response rate while we had 68% response rate (Littlejohn and Hollenhorst 2004).

The respondents to the University of Idaho survey spent less time in the park on average than the respondents in our survey. In general, the Idaho Parks Study Unit survey had more short-term visitors. The majority of Idaho study respondents (65%) spent 6 or more hours in GCNP, whereas 79% of respondents in our survey spent 6 or more hours. This could be due to the weather, with difficult driving conditions people may have spent more time in each place and less time driving. Our study was also conducted solely at the Visitor Center, whereas the Idaho group distributed surveys to visitors in their vehicles at two locations, the junction of Main Park Road and Center Road and at the Desert View gas station, which may explain the difference in our survey sample. Twenty-six percent of the Idaho survey respondents spent 2 to 4 hours in the park, whereas only 8% of our respondents spent 2 to 4 hours in the park.

Long-term visitors for our survey and the Idaho parks survey were similar. Of those who visited for 24 hours or more, 77% of the Idaho respondents spent between 24 and 72 hours in the park, and 70.4% of our respondents spent 24 to 72 hours. Seventy-four percent of our respondents said that their main reason for visiting the park was sightseeing, compared to 90% of the Idaho Study respondents. Seventy-seven percent of visitors stayed in a lodge, motel, cabin, rented condo/home or bed & breakfast according the Idaho study, and 74% of respondents in our survey stayed in these accommodations. During our survey, we did not discriminate if someone worked or lived in the Grand Canyon, which may account for some discrepancies in the Idaho Park Studies unit survey and ours. We surveyed 6 people (4% of our survey respondents) who gave the Grand Canyon Village as their zip code.

The number of annual visitors in Grand Canyon National Park increased 10.6% from 1991 to 2011. There was a 14.5% increase in overnight stays within the park during this period; however, there was a 10.3% decrease in hours spent in the park. This follows the nationwide trend that Americans are spending more time and money on outdoor recreation (Outdoor Foundation 2011), but less time on average doing those activities (GCNP 2012).

Survey Results

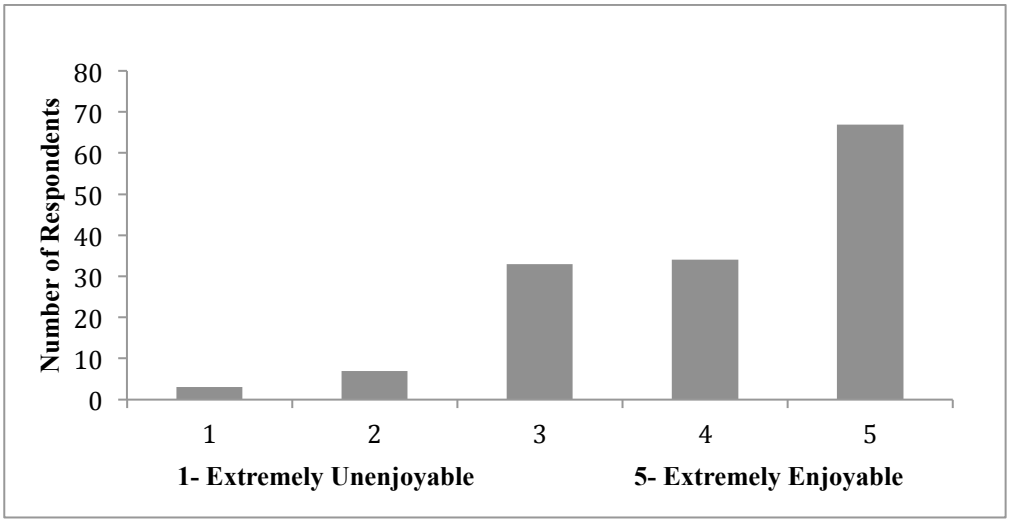

Figure 6. Survey respondents' answers to question 2, "Overall, how enjoyable has your visit to the Grand Canyon been?" Respondents answered on a 1 to 5 scale, with 1 signifying that their visit was extremely unenjoyable and 5 signifying that their visit was extremely enjoyable.

Only 10 survey respondents answered that their trip was unenjoyable (question 2). Thirty-three survey respondents answered that their trip was a 3, denoting that they would rank it as falling in the middle of "very unenjoyable" and "extremely enjoyable." The overall distribution of the responses was unimodal and tended towards an "enjoyable" trip (Figure 6).

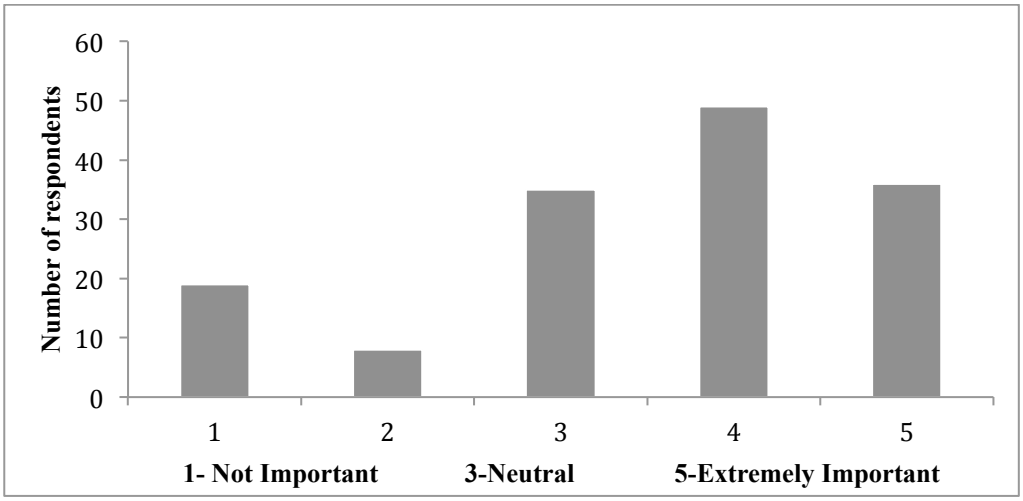

Figure 7. Survey respondents' answers to question 3, "During your visit how important was it to you to be in an area where human influence was not noticeable?" Respondents answered on a 1 to 5 scale, with 1 signifying it was not important and 5 signifying that it was extremely important.

The distribution of answers to the question 3 "During your visit how important was it to you to be in an area where human influence was not noticeable," was bimodal and skewed towards 5, extremely important (Figure 7). The majority of survey respondents (85) said that it was important to them to be in an area where human influence was not noticeable. Thirty-five

people responded that it neither unimportant nor important (rank of 3), and 27 people said that it was not important to them to be in an area where human influence was not noticeable.

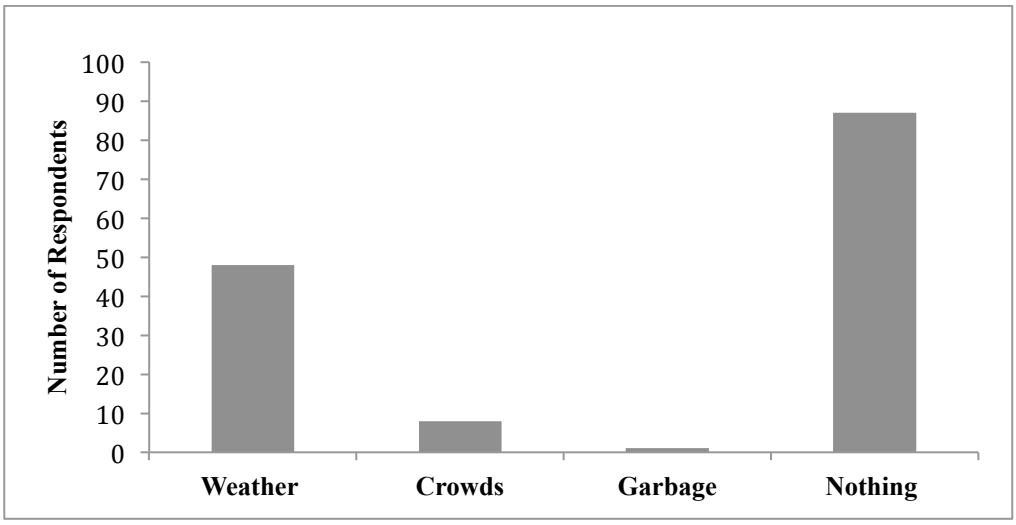

Figure 8. Survey respondents' answers to question 4, "During your visit was there anything that detracted from your nature experience?"

When asked the open-ended question 4, "During your visit was there anything that detracted from your nature experience?" 48 people responded that the weather detracted from their experience. Eight people responded crowds detracted from their experience and one responded that garbage diminished his experience. Most importantly to our study, no respondents said that the solar panels detracted from their nature experience (Figure 8).

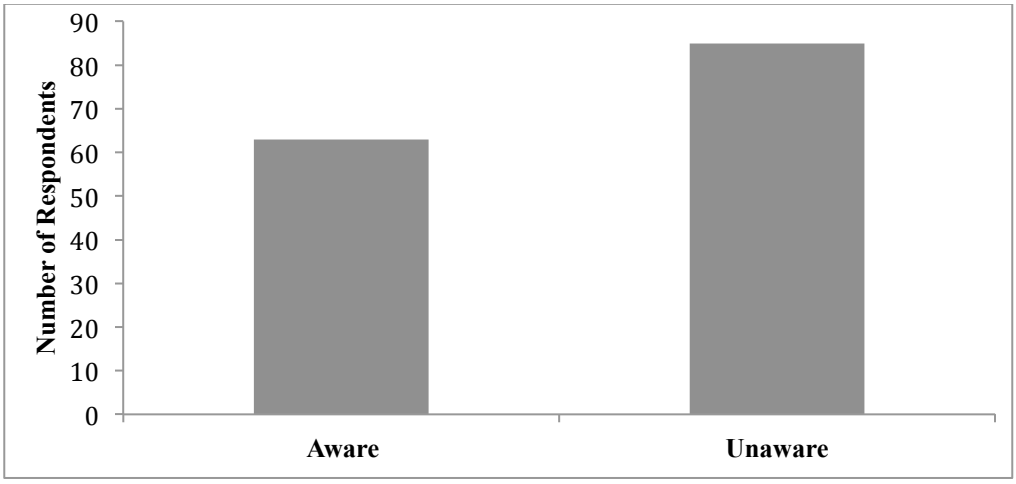

Figure 9. Number of respondents who were aware that the Grand Canyon is trying to be a leader in sustainability. "aware" denotes the number of survey respondents that said 'yes' to question 5, "Are you aware that the Grand Canyon is trying to be a leader in sustainable practices?" and "unaware" denotes the number of survey respondents that said no to this question.

In response to question 5, 63 respondents were aware that the Grand Canyon was trying to be a leader in sustainable practices, while 85 were not. Knowing that the Grand Canyon was

trying to be a leader in sustainability was not associated with any of the other answers to the survey questions (p-value >> .05) (Figure 9). In response to question 6, "did you notice the solar panels around the visitors center?" approximately half of the people surveyed said that they did notice the solar panels (49.4%).

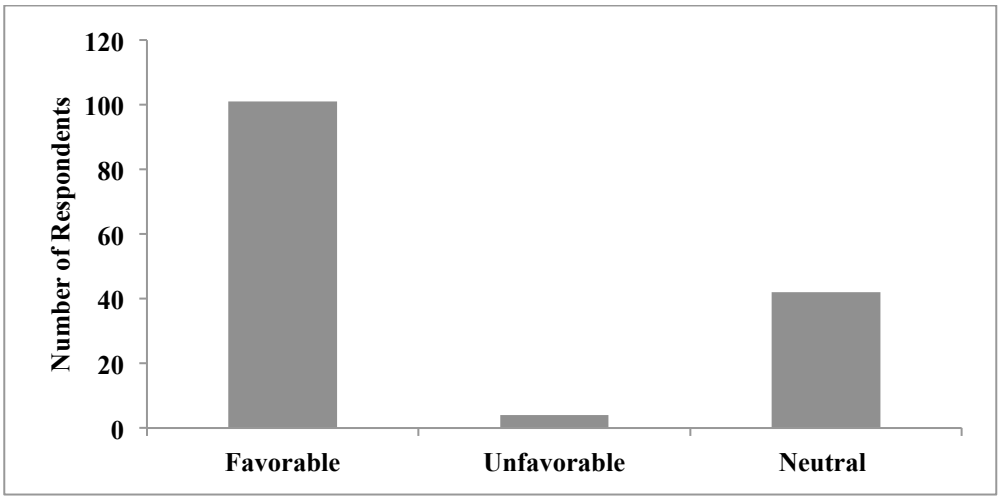

Figure 10. Survey respondents' answers to question 7, "Overall do you have a favorable or unfavorable impression of the appearance of solar panels?"

Prior to asking survey respondents about their opinion of solar panels at the visitor center, we posed question 7 "Overall do you have a favorable or unfavorable impression of the appearance of solar panels?" A striking 101 respondents said they had a favorable impression of the appearance of solar panels, whereas 42 said they had a neutral opinion, but only 4 said they had an unfavorable impression of the appearance of solar panels (Figure 10).

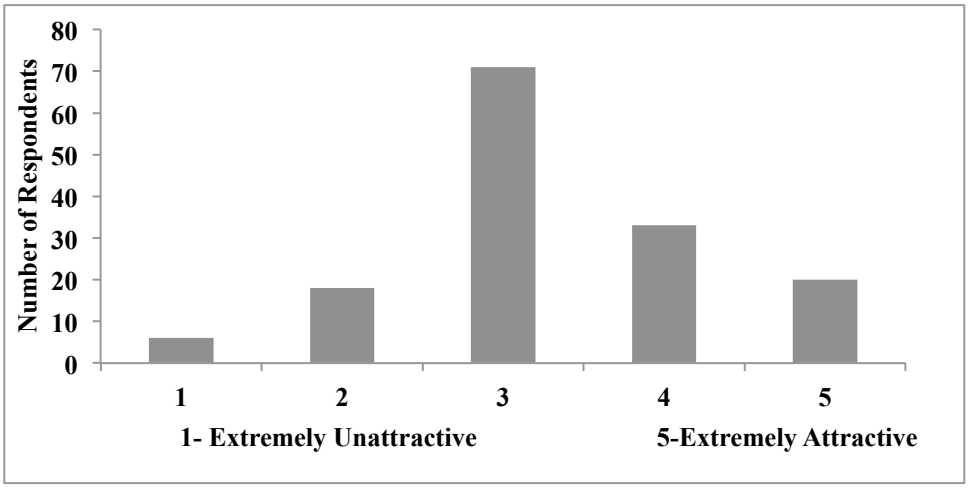

Figure 11. Survey respondents' answers to question 8, "How attractive are the freestanding solar panels?" Respondents answered on a 1 to 5 scale, with 1 signifying extremely unattractive and 5 signifying that it was extremely attractive.

Survey respondents were asked how attractive they thought the freestanding solar panels looked in question 8, with 1 being very unattractive and 5 being very attractive. The distribution of answers was a normal curve with the majority of respondents answering "3" on the scale (Figure 11).

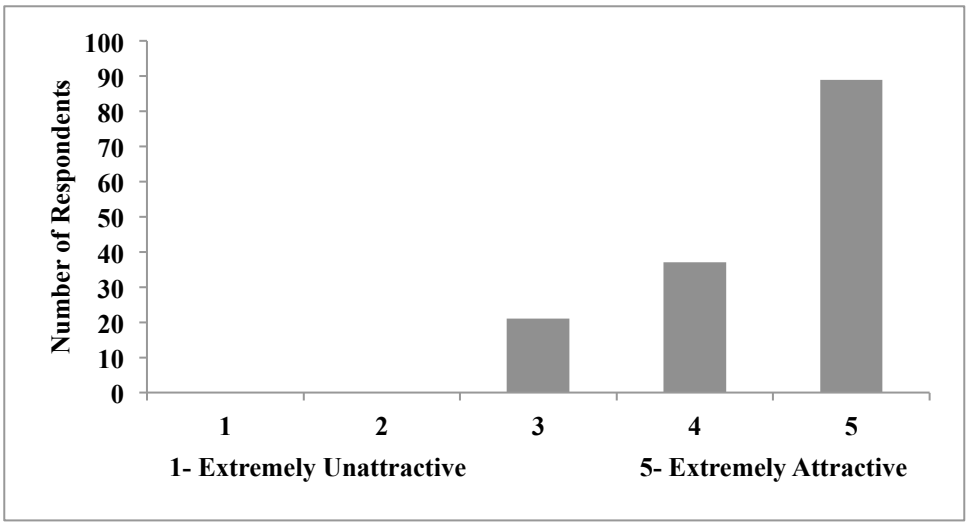

Figure 12. Survey respondents' answers to question 9, "How attractive are the roof-top solar panels?" Respondents answered on a 1 to 5 scale, with 1 signifying extremely unattractive and 5 signifying that it was extremely attractive.

Survey respondents answered the same attractiveness questions about the rooftop-mounted panels for question 9. No respondents thought the rooftop panels were unattractive. The majority of respondents (89) said that the rooftop panels were extremely attractive. The distribution of the answers to this question was unimodal and strongly skewed towards extremely attractive (Figure 12). There was not a significant difference between the average attractiveness ratings of the freestanding and rooftop solar panels. A chi-squared test detected an association between the two rankings; a respondent's answer to one influenced the other (p-value = .0001). However, we are unable to determine causality. There was also an association between respondent's feelings toward solar energy and the attractiveness of freestanding panels when a chi-squared test was conducted (p-value = 0.0126), but not the rooftop solar panels.

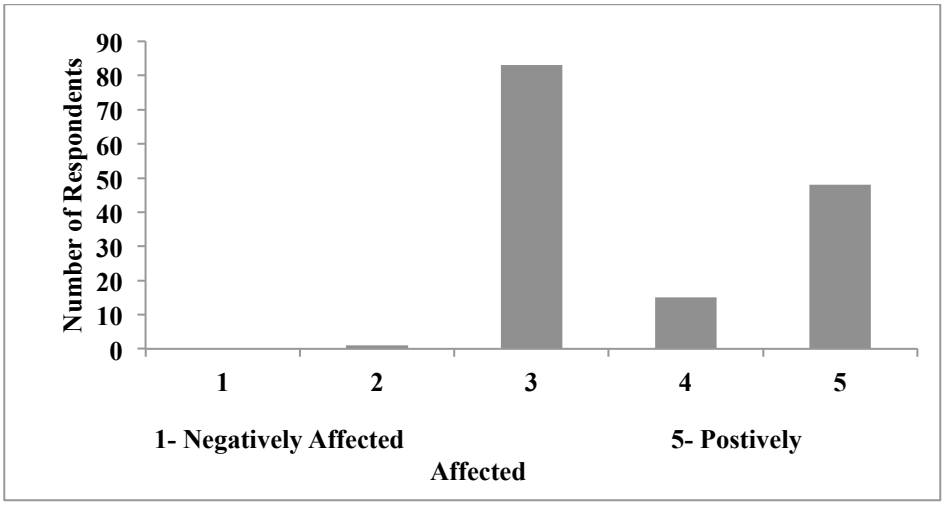

Figure 13. Survey respondents' answers to question 10, "How did seeing solar panels affect your experience in the park?" Respondents answered on a 1 to 5 scale, with 1 signifying that seeing the panels negatively affected their experience and 5 signifying that seeing the panels positively affected their experience.

In response to question 10, only one person said that seeing the solar panels negatively affected their experience in Grand Canyon National Park. The responses were bimodal, with the

majority, 57%, of respondents giving a 3, or the equivalent of the solar panels not having an effect on their experience in the park. Whereas, 42% of respondents said seeing the solar panels positively affected their experience in the park (Figure 13).

When asked question 14, "Have the solar panels affected the way you think about what the Grand Canyon and what the National Park Service represent?" 38.5% of respondents said "yes," it did affect the way they think about the park and the National Park Service. A chi-squared test showed an association between responses to how seeing solar affected a visitor's experience (question 10) and whether or not this would change how they thought about what the National Park Service represents (p-value = .05).

When asked question 15, "After seeing the solar panels, will you think differently about renewable energy practices?" 38% of respondents said "yes," 8% said "maybe," and 53% answered "no." A number of people who responded "no" to this already had a strong positive opinion about renewable energy practices, and seeing these panels didn't change their views.

We were curious to see if people would respond differently to seeing solar panels outside of a national park. Therefore, we asked them question 16, "How would your opinion about the look of these solar panels change if you were seeing them outside of the Grand Canyon National Park?" Thirty percent of respondents said they would have a more favorable opinion of the appearance of the solar panels if they were *outside* the park, whereas 5% preferred the look of them *inside* the park. The remaining respondents thought the same of the appearance of the panels, regardless if they were inside or outside the park.

We were interested in how our presence and prompting visitors to answer questions about the solar panels would affect their future thoughts about solar panels and renewable energy technology. In response to question 18, 37% of respondents said "yes" they will think differently about solar panels and renewable energy technology after taking the survey, and 12% said they might, while 51% said that our survey would not affect the way they would think about solar panels and renewable energy technology.

Interview Results

During our five-day research window at Grand Canyon National Park, we were fortunate enough to meet with the Superintendent of the park, David Uberuaga, and the Chief of Interpretation, Judy Bryan-Hellmich. We spent just under two hours talking with Uberuaga about the solar panels and renewable energy technologies inside the park and the importance of such implementations. He addressed the importance of renewable energy technologies and is doing "everything possible" in order to further the implementation of such technologies inside Grand Canyon National Park. "I'd like to convert all these buildings to solar, and we will, we're doing an assessment of each of the buildings and saying, 'what do we have here?'" (Uberuaga, pers. comm. 2012). His motivation for further implementation of solar seems to be coming from an energy-saving mindset with public education in mind. He emphasized the importance of where these solar panels are placed; the fact that they are at the heart of much visitor activity brings about a whole new dialogue. As Uberuaga put it, "we look at it as an education responsibility, an opportunity to demonstrate [renewable energy technology]. And that's really what the visitor center is about, it's not like we're producing a lot. It is a conversation; it's an example of what people should be thinking about" (Uberuaga, pers. comm. 2012).

Uberuaga also brought up the many limitations on various project ideas discussed in the Green Parks Plan, such as further implementation of photovoltaic panels on many solar-ready rooftops. These restrictions include the disruption of viewsheds, historic preservation sites, and

budget limitations. Many of the lodges along the rim are historic buildings and there would be limits on the extent to which buildings could be redesigned to accommodate solar. Uberuaga explains that it is "a matter of being sensitive to the historic integrity and you have to have your state historic preservation officer on board, and your cultural and historic landscape architects [involved]." In addition to building limitations and restrictions, Grand Canyon National Park must be sensitive to where they implement panels because viewpoints should not be impinged upon. Furthermore, over 1.1 million acres of GCNP are designated wilderness land, meaning that NPS expects that "Wilderness areas are to be primarily affected by the forces of nature" (NPS 2013). This limits the amount of construction and development that can occur in many areas of the park. Solar is also very expensive, "We want to be good stewards, we want to demonstrate these things, but at the same time, we're just barely able to pay the bills" (Uberuaga, pers. comm. 2012).

Uberuaga hopes that in 2016 he can "use the one-hundredth anniversary [of the NPS] and our mission of educating the public on sustainable practices, and having a need to reduce our footprint… to have a solar array assessment." He seems hopeful that the future holds a great deal of potential for the expansion of renewable energy technologies within the park, and left us with this final pledge: "So, when you're done with school and you're on a family vacation, I think you should come back and your expectations should be to see a lot more solar. I think you'll find it" (Uberuaga, pers. comm. 2012).

Our conversation with Bryan-Hellmich helped us to better understand the process of how and why the solar panels were placed both within the Grand Canyon National Park and in the specific location that they are.

> We were approached by Arizona Public Service, which is the largest state electrical company… they have a renewable energy program where certain customers pay a higher rate for their power and that money goes towards the establishment of alternative energy sources – wind, solar, hydro. They approached us and asked if we would be willing to put in a photovoltaic system in the park, which they would donate. [They wanted it] in a public place because the whole idea was that they wanted to promote alternative energy and they wanted it to be in a place where they would be seen as the good guy. We agreed to do it and we wanted to do it here at the visitor center because that is the primary arrival spot. We also agreed as part of the project to have interpretive information both inside and outside the visitor center that provided the visitors with an understanding of renewable energy (Bryan-Hellmich, pers. comm. 2012).

As stated, the entire system was a donation from APS, allowing the park the benefits without the initial costs. Bryan-Hellmich discussed the public's reception of the newly installed photovoltaic system. She said that she has not heard of any strong opposition to the solar panels, and on the contrary, she has seen excitement and interest. She explained, "visitors seem to be very positive… when construction was going on, I would get a lot of questions about what was happening, and they would say 'oh that's really cool that you are doing that'" (Bryan-Hellmich, pers. comm. 2012). Because the panels are positioned in such a public place, the public education aspect of seeing and understanding how the solar panels function is a large part of their purpose. She asserted, "We are educating the public about these things more so than any other public entity in the nation because there are so many national parks and it's a nation wide unit" (Bryan-Hellmich, pers. comm. 2012). This specific set of panels located on and around the visitor center "offset the electricity in the [visitor center] by about 50%" (Bryan-Hellmich, pers. comm. 2012). This is a large reduction for the visitor center but is quite minimal when

addressing all of Grand Canyon National Park's energy consumption. She seems hopeful that the future holds more potential for the implementation of renewable energy technologies within the park.

Discussion

Visitors to national parks are nature tourists and visit national parks to experience wilderness and historical landmarks or landscapes. Nature tourists utilize their leisure time to experience an iconic wilderness destination. The majority of park-goers may value places where human influence is not noticeable. People may be apprehensive about seeing renewable energy technologies in national parks, which are places with substantial aesthetic and cultural value. With regards to this case study, the solar panels in close proximity to the rim of the Grand Canyon could be aesthetically displeasing to nature tourists. However, our results from a small, convenience sample in December, contradicted our initial hypothesis. Due to the positive feedback to perceptions of solar panels in GCNP that we received from both our survey respondents and interviewees, we conclude that the implementation of more RET in national parks would be beneficial to all parties.

Survey

Overall, people felt either indifferent or positive towards the use of solar energy, sustainability, and renewable energy sources within the park. The number of survey respondents who had an overwhelmingly enjoyable experience in the park outweighed the small proportion of survey respondents who had an unenjoyable visit. Additionally, although many respondents expressed disappointment about the weather, they all seemed excited to be at the Grand Canyon. In addition to general enthusiasm, another trend was that the majority of visitors arrived with a pre-existing appreciation of solar power. Overwhelmingly, 68% of survey respondents said that they had a favorable impression of the appearance of solar panels. This shows that our survey population already had a positive impression about the presence and use of solar panels in general.

Several surveys have shown that many Americans have a very favorable view of solar power, even more favorable than their impression of wind power (Culley 2011, Reiner et al. 2006, Opinion Research Corporation 2006). Reiner et al. found that of the 1205 American responses to their internet-based survey, solar power was the most popular answer to the question, "If you were responsible for designing a plan to address global warming, which of the following technologies would you use?" Over 75% of the American respondents said that they would use solar (2006, 5). The Civil Society Institute's telephone survey of 1,016 American adults found similar results, with 85% of respondents favoring solar power over increased nuclear power development (2006, 15). Culley et al. (2001) used an online survey to gather responses from 287 university students; participants in the study "indicated that solar and wind energy production should increase somewhat or increase a lot (87% and 84%, respectively)" (223). Although our question only asked about the appearance of solar panels in general, the support we found for solar in general is consistent with national attitudes.

When asked to describe the attractiveness of the rooftop panels versus the freestanding panels, respondents overwhelmingly preferred the look of the rooftop panels. Not one respondent said that the rooftop panels were unattractive. We were surprised that almost 60% of respondents ranked the panels as a 5, signifying that they thought they were "extremely attractive." Although many respondents ranked the rooftop panels as more attractive than the free standing panels, the majority still said that their function as both as a renewable energy source and as a educational display strongly outweighed any unattractiveness.

Although, no one came to the Grand Canyon specifically to experience state-of-the-art photovoltaic cells, but visitors appreciated them nonetheless. Common comments were that "It

is great that they're helping the earth," or "Green is sexy! I like to see [the solar panels] in use. We Americans are too big of consumers," or "The rooftop ones are not noticeable. What they do outweighs out the unattractiveness" (question 11, survey respondents 54, 11, 103). Moreover, approximately half of the respondents were unaware that the Grand Canyon was crusading for a greener park via solar energy. Many only noticed the park's water conservation strategies and only saw the solar panels after our prompting of "Did you know Grand Canyon is trying to be a leader in sustainable practices?" It is likely that most visitors would've left without giving solar panels a thought had we not asked or pointed them out.

Before our arrival in Grand Canyon National Park, we expected solar energy to be controversial. We predicted that these manmade structures would infringe on the aesthetic, historical, and cultural identity of the park. We thought that being in a place where human influence was not noticeable would be more important to visitors than our survey results indicated. About half of the survey respondents answered that being in an area where human influence was not noticeable was important to them. The other half of the respondents said that it was either not important to them, or they were indifferent with regards to being in an area where human influence was not noticeable. This is significant because historically, visiting a national park was seen as a chance to experience wilderness. However, the responses to our survey suggest that there is a paradigm shift regarding the importance of a wilderness experience in national parks.

This supposed paradigm shift is intimately wrapped up in the notion that the Grand Canyon is indeed a wilderness experience. However, the Grand Canyon is not a wilderness experience, but a "nature tourism" experience (Sutter 2002). According to Sutter, "Tourism is a site-specific activity; nature tourists are usually out to see particular places, such as the Grand Canyon, and to acquire the experience of having done so" (Sutter 2002, 27). The Grand Canyon is a town full of neighborhoods, hotels, cabins, a grocery store, a post office, school, and a bank – far from a wild, untouched place. "Outdoor recreation," on the other hand, is activity specific. Hiking, swimming, and bouldering are all popular within the canyon. One can go to the Grand Canyon for outdoor recreation, but only 5% of our respondents indicated that they were at the Grand Canyon for outdoor recreation purposes and not only sightseeing (nature tourism). Experiencing tourism in an active sense (hiking, rafting, etc) was clearly not a priority to most. However, it is important to remember that our survey was taken during December, not an ideal time to participate in these activities.

When asked if there was anything that detracted from their nature experience, no survey respondent answered "solar panels." This is significant because we were curious whether the presence of both the rooftop and freestanding solar panels would interfere with the survey respondents' experience in the park. Furthermore, only one person said that seeing the solar panels negatively affected their experience in the park. In fact, nearly half of the respondents said that seeing the solar panels positively affected their experience in the park. This is noteworthy because it is clear that people get satisfaction out of seeing the use of renewable energy in a national park. When prompted, 39% of respondents said that seeing the solar panels changed the way they thought about what the Grand Canyon and the National Park Service represents. Although this is not a majority of visitors, it is comparable to what other studies have found in regards to the amount of information retained from park displays (Littlejohn and Hollenhorst 2004). Clearly some visitors are receiving the intended message and thus the implementation of more renewable energy technologies in national parks would perpetuate familiarity with sustainable practices.

Thirty-seven percent of the survey respondents said that after seeing the solar panels in the park they would think differently about renewable energy technology in general. This shows that by having RET in Grand Canyon National Park, visitors are thinking about the use and function of RET. Inspiring visitors to think about sustainability initiatives accomplishes the NPS' goal of educating visitors about sustainable practices (NPS 2010, Objective 15.1). The NPS Climate Change Response Strategy states they aim to "Demonstrate how the public can reduce the impacts of climate change in their own lives and in national parks by interpreting NPS sustainable practices including agency operations, facilities, and use of technologies" (NPS 2010, 22). Based on our results, Grand Canyon National Park's actions are having a positive educational impact on visitors.

Interview

The conversation with Superintendent David Uberuaga was incredibly informative and hopeful. He believes that Grand Canyon National Park has the potential for widespread implementation of solar power and recognizes that most of this resource potential has been untapped so far. The main barrier in such implementations is a limited budget and ensuring that historical buildings and viewsheds are not impacted by new installations. Grand Canyon National Park is one of the largest and most visited national parks; there are many amenities and buildings that must be maintained. This upkeep uses most of the park's generated income, leaving little for extra projects.

When we interviewed Judy Bryan-Hellmich, we learned that the electric company, Arizona Public Service was responsible for both approaching Grand Canyon National Park about the project as well as funding the installation of the photovoltaic system. Although Grand Canyon was thrilled to be the recipients of such a project, they did not initiate it. The cost of solar panels was too great for Grand Canyon National Park to pay for alone.

We were excited to learn that the educational aspect of such implementation was highly emphasized. The decision to install the panels on and around the visitor center was made so that the park could spark a discussion about climate change and address the individual actions that visitors could take to help the park be more sustainable. The ideal outcome of this educational component was to inform visitors of the effects of their actions on the environment and to inspire them to be more sustainable even after they'd left the park.

Bryan-Hellmich brought up the balance between preservation and recreation. Although it is important to remember that the goal of the park is to preserve land for future generations, preservation may only be possible with the integration of renewable energy sources as continual recreational use by the public is energy intensive. Bryan-Hellmich explains this: "We are a conservation agency and our mission is to preserve and protect these places and to educate visitors about the importance of that preservation... we are going to need to conserve those fossil fuels. To use renewable energy is huge in terms of preserving all of our resources" (Bryan-Hellmich, pers. comm. 2012).

Aesthetics: Form over function?

The Grand Canyon was a scenic destination even before the park was established, therefore an idealized landscape aesthetic is associated with the area. Scenic landscapes are often characterized by "order, pattern, balance, and most importantly perhaps, scale" (Brittan, Jr. 2001, 171). Influenced by 16th and 17th century landscape painters, this visual ethic prizes the balance between the natural and the man-made. In his essay, "Wind, Energy, Landscape: Reconciling Nature and Technology," Gordon Brittan, Jr. struggles with a way to reconcile wind

turbines and our conception of beauty. Although the small solar panel display at Grand Canyon National Park does not struggle with the issue of scale as turbines do, his piece offers a thoughtful way to incorporate renewable energy technologies into our idea of "beautiful" (Brittan Jr., 2001). His basis for this new ethic is Aldo Leopold's Marshland Elegy, in which Leopold describes why a marsh should not be considered a wasteland. Instead of a visual ethic, Leopold offers a conception of beauty based on function, as the swamp is a home for the sandhill crane. The sandhill crane is valuable because of its ecological and evolutionary history. As Brittan notes, "the appropriateness of objects in landscapes has to do with their respective histories, the ways in which they evolved or failed to evolve, together" (Brittan, Jr. 2001,176). In the instance of wind turbines, Brittan points out that wind is more than just an energy source, it has helped "determine the character of local plant, animal, and human communities" (Brittan, Jr. 2001,178). This idea is especially relevant to Arizona, an arid state that has been prominently characterized by the abundance of sun. People come to see its sun-baked deserts and rocks, the cacti, and various desert animals. Although glossy, industrial-looking solar panels may seem incongruous with the desert, they are actually building on a long history of utilizing solar in Arizona. As the solar panel display notes, Puebloans designed their houses to make use of the sun, a millennia before PV panels were invented. Ancient peoples in the southwestern United States utilized the sun in order to determine the timing of planting and harvesting crops, construction of buildings, cardinal layouts of houses, baking, and warmth (NASA's Sun-Earth Connection). Archeoastronomists have done extensive work into the worship and study of the sun by people of the Chacoan Pueblo and of the Grand Canyon (Mickle 2005). Visitors to the Grand Canyon seemed to subconsciously embrace a Brittan-like landscape ethic. The majority of free-response comments were positive. Even when we pressed people to respond solely to the aesthetics, they qualified their answers with such responses as, "but the purpose is more important than the aesthetic" (question 11, survey respondent 77).

Figure 14. Side-view of freestanding solar panel. Some visitors mentioned that the support poles stood out.

Although there was an overwhelmingly positive attitude towards the aesthetic of solar panels, we did receive negative comments or critiques that dovetailed work by Torres-Sibille et al. (2007). Torres-Sibille et al. have conducted extensive research on objective aesthetic assessments of wind and solar farms. Their main indicators of aesthetic impact are visibility, color, climatology, fractality, and concurrence (Torres-Sibille et al. 2007). We found that some of these indicators reflected in visitors' responses. For example, many commented on the color of the poles of the freestanding solar panels. The rust-colored poles stood out against the white snow and the evergreen trees. It is likely that these poles would blend in better in the summer, when the rust-colored dirt is exposed, but during our visit, there was fairly high contrast (Figure 14). We also noticed that climatology (the likelihood the panels would be obscured by weather) had an effect on responses; many visitors commented that because of the snow and the fog, they didn't notice the solar panels.

Seventy-five out of 149 respondents said that they did not notice the solar panels until after our prompting (see Appendix, Question 6). Approximately half of the respondents were unaware that the Grand Canyon was aiming to be a leader in sustainable practices. This raises the question, is the Grand Canyon accomplishing the educational goals it set out in its Climate Friendly Action Plan? Grand Canyon National Park is in an interesting predicament; noticing the panels is an important part of visitor education, but there is also the intuition that panels should not stand out enough to detract from the views.

Superintendent Uberuaga mentioned one area where solar panels are more problematically visible is on the outhouses located along the trails into the canyon. Their ventilation system is powered by rooftop solar panels. He expressed his frustration with these panels due to the reflective glare visible from the canyon rim, revealing the outhouses to the viewers above, calling attention to a manmade structure in a supposed wilderness. Uberuaga continued,

> Depending on where [the solar panels are located] we look at it as an educational responsibility, an opportunity to demonstrate. That's really what the visitor center is about. It's not like we produce a lot. It's a conversation. It's an example of what people should be thinking about. And those elements in terms of our educational goal, that's part of our Green Parks Plan. We need to advance the thought and application of these [RET] (Uberuaga, pers. comm. 2012).

Judy Bryan-Hellmich, Chief of Interpretation at Grand Canyon National Park, stated that "[APS] wanted [the solar panels] to be a little bit more visible because the ones on the roof seem to blend in and as you can tell, those [freestanding] ones out there stand out a lot more." She went on to discuss design details. The panels are arranged with the Navajo spiral pattern in mind, creating a more pleasing effect. At the visitor center, arranging the freestanding panels in this manner and mounting them on poles, they stand out, and thus serve as an educational tool. Superintendant Uberuaga echoed this sentiment, "We're always open to how better to educate or inform people of sustainability [initiatives] and what we're working on." By installing freestanding panels in this particular design, the park is calling attention to the implementation in national parks and thus advancing their mission of educating visitors and becoming a leader of sustainable practices in the United States.

Educating Visitors

The Green Parks Plan and the Climate Change Response Strategy both include an educational mandate. The Climate Change Response Strategy states that parks need to

> Demonstrate how the public can reduce the impacts of climate change in their own lives and in national parks by interpreting NPS sustainable practices including agency operations, facilities, and use of technologies. Finally, through clear, directed communication, the NPS will raise employees' and the public's awareness of the implications of climate change and inspire them to take steps to address this challenge (NPS 2010, 22).

Part of the purpose of Green Parks Plan is to "Increase climate change education and outreach: best practices can be communicated through this program to encourage action and resource stewardship" (NPS 2012b, 13). The solar panels present an opportunity for the Grand Canyon to demonstrate best practices through the use of solar energy and to educate the public about the benefits of solar power technology.

Previous studies in the Grand Canyon have shown that visitors don't always receive or retain information from park visits. The University of Idaho Park Studies Unit found that "about two-thirds of the visitor groups (66%) did not learn about any of these topics [formation of the canyon and its layers, ancient human history, modern human cultures, and plants and animals] on their visit. Thirty-two percent learned about the topics and 3% were "not sure" (Littlejohn and Hollenhorst 2004, 35). Interestingly, many respondents to our survey did not connect seeing the solar panels with overall sustainability goals by the park. This finding parallels research about how people perceive RET and climate change in general. Ansolabehere and Konisky (2012) found "That [the] weak correlation [between concerns about climate change and energy preference] suggests that raising the alarm and public education about global warming are unlikely to lead to radical changes in public opinion about energy production and use" (69). Americans like RET for local benefits–less pollution, no nuclear power plants in their town–not because they connect them with a global fight against climate change. By taking on this mandate, Grand Canyon National Park is fighting an uphill battle against the way that Americans process the relationship between clean energy and climate. This means that their interpretive material must be especially persuasive and well designed.

Although a direct analysis of the effectiveness of the interpretive material about solar panels was limited by the weather, as the signage was covered in snow, it is still valuable to assess the educational potential of the signage at the Grand Canyon. A vast body of literature exists about the effectiveness of interpretive displays that can be used indirectly to assess the strengths and limitations of the displays that we encountered at the visitor center. Assessing these signs is particularly important, as the most dynamic part of the exhibit has been rendered impotent due to an inability to show real-time power generation. Furthermore, that display has been obscured by new construction and is now in an unlit nook of the visitor center. The potential for educational possibilities is limited by this minimal outdoor signage regarding the solar panels.

The Basis of Effective Interpretation

Several factors must be considered in order to have an effective interpretive display. These include gaining attention, content, and using effective interpretive technique. Gaining visitors' attention is one of the key challenges of any sign. When Hall et al. (2005) looked at the effectiveness of signs warning about bears in Yosemite National Park, they found that many visitors didn't even stop to look at the signs. In addition to unawareness, they also found that visitors' movements through parks tend to be highly scripted, there are established routines that visitors enact when at certain places.

Figure 15. Sign A located below freestanding solar panels adjacent to the visitor center.

The sign about the installation, application, and use of solar in GCNP (Sign A) is located in a throughway to and from the parking lot and visitor center (Figure 15). We noticed that visitors tended to move in established patterns towards the rim or visitor center without acknowledging the signage and solar panels along the path. Although the location may increase the number of people who *see* the sign, they still may not stop to read it if they are in a hurry to get somewhere else.

Another issue is visitors' familiarity with the topic. If visitors feel that they "already know the message," they are much less likely to stop and process the content of the sign (Hall et al. 2010). Although we did not ask visitors if they read or thought about the signs, our survey results indicate that most visitors are familiar with and supportive of solar panels in general. Many people may superficially notice the panels, but do not stop to read the sign. The title of Sign A, "Solar Panels Power Visitor Center," does not indicate that the sign has more to teach viewers, unless they're self-motivated to learn about how much energy is being provided to the visitor center (Bitgood 2000). It is likely that a more exciting title might entice more visitors to stop and read Sign A. Informing visitors about how much energy the visitor center uses might get the public to consider the energy use of the park as a whole.

Finally, an overarching challenge to gaining visitor attention to Sign A is that many visitors come with a recreational, social, or leisure-time mindset rather than a focus on learning (Evans 2005). As Jenny Evans points out in her thesis, "In the task of moving people from a recreational agenda to a learning-centered agenda, there is no better motivator than a powerful

aesthetic experience" (Evans 2005, 9). Sign A is bright and is symmetrically centered on a colorful map. Hall et al. (2005) found that park visitors appreciated vividness.

Figure 16. Authors Karlie Haug, Madeleine Koski and Jasmine Cutter in front of Sign B, "Have A Green Visit" display outside the visitor center.

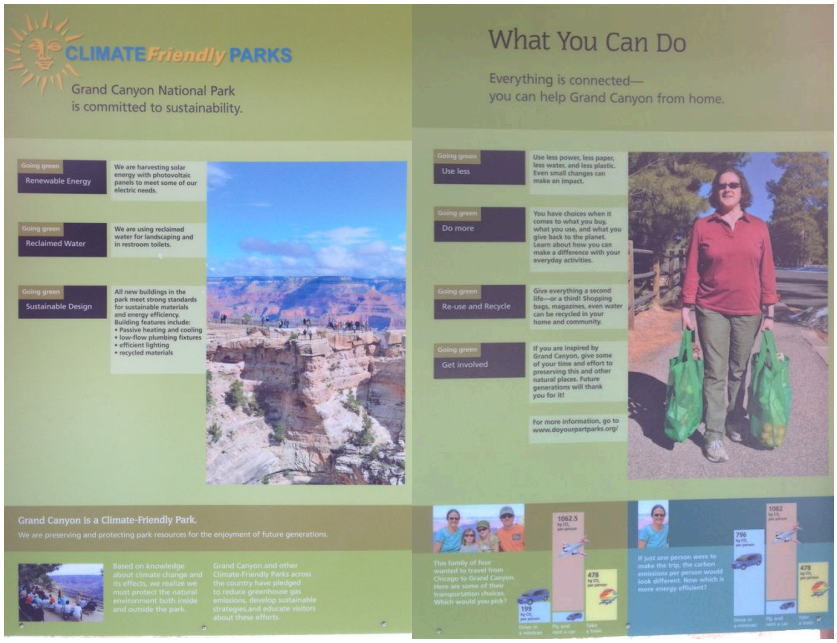

Figure 17. "Climate Friendly Parks" display and "What You Can Do" display outside the visitor center. Sign B close up.

Sign A lacks certain vital content. There is no mention of the panels' contribution to the Climate Friendly Parks Program. Sign B, directly outside the visitor center, (Figure 16 and Figure 17) mentions the solar panels as the first point under the Climate Friendly Parks section (Figure 17). Sign A would be the perfect opportunity to introduce the Program and talk about climate change. The annual solar radiance map on Sign A powerfully demonstrates the solar potential in Arizona (Figure 15). Although the timeline of humankind's use of solar near the bottom is vaguely interesting, it seems that the section about the Puebloans does a better job of contextualizing solar in the history of the Grand Canyon, rendering the timeline redundant. The

space used by the timeline could be better used to connect this sign to Grand Canyon National Park's overall mission of sustainability.

Despite the limitations of Sign A adjacent to the freestanding solar panels, Sign B does a much better job of utilizing these interpretive techniques. Sign B describes the park's stance on climate change; states the actions the park is undertaking, and appeals to visitors to participate in these actions. Sign B makes it apparent that although solar is a component of their Climate Friendly Parks Strategy, Grand Canyon National Park is more focused on alerting visitors to their recycling program, water stations, and compressed natural gas shuttle bus service.

Incorporating the institution's mission is an important component of compelling interpretative planning (Evans 2005). The "Have a Green Visit" (Figure 17) display (Sign B) does an effective job of showing how sustainability is tied to the park's overall mission, unlike Sign A. The primary concept guiding interpretation is that interpretation is not just facts; rather, it is a way of conveying information so that it resonates with the audience's experience and creates an emotional and intellectual connection between the viewer and what they are observing (National Association for Interpretation, Tilden 1957). One typical suggestion for successful interpretive materials is to "increase cognitive-emotional arousal (provoke interest in the subject matter if it is not already there)" (Bitgood 2000, 34). If someone was not already interested in the solar panels, it is unlikely that Sign A would rouse interest. It helps that the panels are in close proximity to Sign A and thus, it is not describing some abstract concept.

All together, these displays are addressing the issue that interpretation, especially about cultural or historical topics, often overlooks the opportunity to connect the meanings that visitors are developing to the conservation and resource management goals of the park (Tubb 2003; Eubanks 2008). The NPS states that effective interpretation "creates the opportunity for audiences to ascribe meanings to resources, leading to concern for the protection of the resource. This revelation is the seed of resource stewardship. This is the goal of interpretation, not simply information or facts" (NPS 2003). Sign A lacks creative ways to connect the solar panels to visitors' own experiences. Perhaps commenting on the fact that coal-powered plants are one of the main contributors to the summertime smog that can obscure canyon views is one way to get visitors more enthused about solar panels. Encouraging visitors to think about the implications of using solar is another opportunity to connect this one piece (the panels) to the overall sustainability mission of the NPS.

Sign B does a much better job of incorporating effective interpretive techniques. Its limitations lie in its ability to attract visitors. Based on our observations (though it was winter) many people are interested in heading directly for the visitor center and looking around inside, rather than loitering outside. The second limitation is that the solar panels are not visible from the "Have a Green Visit" display (Sign B). When people see the solar panels they will be able to connect them to the signage, but research shows that people are more interested in looking at objects than at signs (Tubb 2003). Overall, some education is better than no education. Sign B does more to further the educational goals that the NPS lays out than Sign A.

On the other hand, PV industry groups have noted that "potential customers must hear consistent message about merits of PV from many sources so they are confident to make the purchase; accessible demonstration projects should be used to communicate PV information to the public" (Dymond 2002, 8). Grand Canyon National Park has achieved a basic level of success. They have solar panels, which makes them more familiar to visitors whether or not they actually read the signage. The positive perceptions of our respondents indicate that it is time for the park to take the next step: improve the interpretive displays that they have in response to

what is known about how visitors process messages about climate change and energy, and to install more solar panels and corresponding interpretive displays in more locations so that more visitors can become familiar with the appearance and function of solar panels.

Limitations

A case study is an ideal methodology when a "holistic, in-depth investigation is needed" (Feagin et al. 1991, 6). However, our case study could have been more successful if we had been able to conduct our survey in the summer, during a period with more visitors and perhaps a higher percentage of visitors coming to the park intending to spend time in an area where human influence was not noticeable. Because it was snowing and overcast everyday we surveyed, our data could have been skewed due to the fact that the solar panels were at times partially covered by snow. In addition, we had a large number of respondents who were from outside the United States. This could have skewed our data because foreigner's perceptions of the aesthetics of solar panels could be different from those of Americans. Additionally, we had a convenience sample that may not have been as representative as possible. A convenience sample saves time, money, and effort, which was necessary given our short sampling period in the park. However, this comes at the expense of information and credibility. Our survey also displayed characteristics of a random purposeful sampling, which adds credibility. Extrapolating our data from solar panels at Grand Canyon National Park to the larger question of energy efficient technology at all parks is made more difficult by the fact that we have a convenience sample.

Our interviews with Bryan-Hellmich and Uberuaga were also sources of "restrictive weaknesses" (Locke et al. 1993, 16). While interviews are targeted and insightful, and provide perceived casual inferences, they also have several downsides (Tellis 1997). Bias can arise due to poor questions and/or response biases. In this vein, oftentimes the interviewee expresses what he or she thinks the interviewer wants to hear. This can lead to issues when analyzing data or extrapolating larger implications. There can also be issues with incomplete recollection, but our recording methods avoided this.

Although both of our data collection methods are sources of error, the diversity of information allows us to better triangulate our data, thereby increasing reliability. Through triangulation, we were able to corroborate the data from multiple sources.

As this is a single case study, it is hard to generalize to a larger context of other national parks across the country or across the world. It is also important to note that single-unit case studies are generally one small piece in the puzzle and rarely definitively prove or disprove a hypothesis; conflicting opinions exist as to whether case study work provides a basis for postulating broad principles of social behavior (Gerring 2004). However, our opportunity to examine phenomena such as visitor's perceptions of solar technologies in national parks enables us and other scientists to advance our empirical understanding of social behaviors of nature tourists. Ideally, our work will inform other researchers and policy decisions of the National Park Service.

Conclusion

Overarching Findings

Our study is significant because it demonstrates to the National Park Service that visitors enjoy seeing the use of renewable energy technologies inside Grand Canyon National Park and that it makes their visit to the park more enjoyable. An overwhelming percentage of visitors surveyed had positive reactions about the newly implemented photovoltaic panels on and around the visitor center. Although this is exceptionally progressive and exciting for the future implementation of renewable energy technologies, only half of the visitors knew that the park was trying to be a leader in sustainable practices. We found that the signage indicating who donated the solar panels, how much energy they are offsetting, and their importance in this movement towards energy conservation within the park could be displayed in a more effective manner. The preservation of historic architectural buildings is important to the National Park Service and presents a constant battle between the maintenance of recreation and preservation within the park, thus influencing all new implementations within Grand Canyon National Park. Although the modern design of the solar panels contrasts with the rustic lodges of the 1900's, the functional value that these panels generate is of greater significance to the park visitors than their appearance on and around the visitor center.

The Next Step

Our findings suggest that the National Park Service has the support for continued implementation of photovoltaic panels within national parks because there is widespread approval from visitors regarding the function and aesthetic qualities of the solar panels located within Grand Canyon National Park. The expanding implementation and acceptance of renewable energy technologies is crucial to America's energy future and the mitigation of energy-intensive consumption habits. An important part of preserving designated wilderness lands, such as the Grand Canyon is a shift away from an energy intensive lifestyle that contributes to high greenhouse gas emissions. One clear way to offset the over utilization of resources is through the practice of renewable energy technologies. Grand Canyon National Park is devoted to preserving its land for the enjoyment of generations to come, and to ensure this, has taken action through the implementation of photovoltaic panels, which, although not a final solution to the broader issue, is a daring and pioneering installation that will hopefully set the stage for a greater crusade against the growing catastrophe of climate change.

Appendix A – Solar Panels

Solar panels are made of paper-thin silicon, one of the most abundant elements on earth. The panels are treated to form an electric field–the side of the solar panel facing the sun is negatively charged while side away from the sun is positively charged. The photovoltaic material absorbs radiation from the sun. Upon absorbing sunlight, electrons in the material are bumped up to a higher energy state. Now highly energized, they are freed and capable of traveling through the electric field (SEIA 2012). This occurs because they are attracted to the positively charged side and will travel in that direction. This flow of electrons is what we call electricity. The electricity produced can flow into a device to power it or to the grid for future use (SEIA 2012).

According to the Solar Energy Industries Association "most modern solar cells are made from either crystalline silicon or thin-film semiconductor material. Silicon cells are more efficient at converting sunlight to electricity, but generally have higher manufacturing costs. Thin-film materials typically have lower efficiencies, but can be simpler and less costly to manufacture" (SEIA 2012). Commercially available solar panels generally have an efficiency of 15%, but higher-end panels get up to 21% (Florida Solar Energy Center 2007). Additionally, solar power is measured in insolation, the average number of kilowatt-hours per square meter per day. This measurement takes into account the earth's tilt, cloud cover, and the fact that the sun will not provide energy at night (SEIA 2012).

Appendix B - Survey

(Verbal consent) "Are you willing to participate in a survey about your experience in the park for our undergraduate thesis? We are not affiliated with The National Park Service in any way and your responses will be held in confidence."

1) Is this your first visit to the Grand Canyon? Yes/No

2) Overall, how enjoyable has your visit to the Grand Canyon been? Please rank your experience on a 1-5 scale, with 1 being unenjoyable, 5 being extremely enjoyable

3) During your visit, was it important to you to be in an area where human influence was not noticeable? Please rank your experience on a 1-5 scale, with 1 being not important, 5 being extremely important

4) During your visit, was there anything that detracted from your nature experience?

5) Are you aware that the Grand Canyon is trying to be a leader in sustainable practices? (Y/N)

6) Did you notice the solar panels around the visitors center? (Y/N)

7) Overall, do you have a favorable or unfavorable impression of the appearance of solar panels? favorable/unfavorable/neutral

8) On a scale from 1-5, how attractive are the free-standing solar panels? 1 being unattractive, 5 being attractive. [point to the free standing ones for clarity] [**Can you elaborate on your answer?]**

9) On a scale from 1-5, how attractive are the rooftop solar panels? 1 being unattractive, 5 being attractive. [point to the rooftop panels for clarity][**Can you elaborate on your answer?]**

10) On a scale from 1-5, how did seeing the solar panels affect your experience in the park? 1 being negatively affected my experience, 5 being positively affected my experience

11) Can you elaborate on your answer? [what contributed to this perception?]

12) Have you taken any photos of the solar panels? Yes/No

13) What were your reasons for taking or not taking photos of the panels?

14) Have the solar panels affected the way you think about what the Grand Canyon and the National Park Service represent? Yes/No/Maybe

15) After seeing the solar panels, will you think differently about renewable energy practices? Yes/No/Maybe

16) How would your opinion about the look of these solar panels change if you were seeing them somewhere other than in a national park? More favorable, less favorable, neutral

17) What contributes to your opinion?

We just have a few quick questions for statistical purposes:
[**Gender]:**
What year were you born?
Zip code:
Length of stay (hours, if less than 1 day or nights):
Are you spending the night inside or outside the park? Inside/Outside

In what type of lodging did you and your group spend the night(s)? :
__ Lodge, Motel, Cabin, Rented Condo/Home or Bed & Breakfast
__ RV/Trailer Camping
__ Tent Camping in Developed Campground
__Back Country Camping
__ Personal Residence
other: _____

What was the main reason you visited the park:
__sightseeing
__ day-hiking
__backpacking
__mule-rides
__cultural history
__natural history
__tour guide service
__helicopter rides
__photography/painting
other: _____

18) After talking about solar panels with us, will you think differently about solar panels and/or renewable energy in the future? Yes/No/Maybe

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