

Tribal Renewable Energy Integration: An Analysis of Current Tribal Infrastructure

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The main objective of this paper is to provide a comprehensive analysis and guide to integrating renewable energy into current tribal infrastructure. The analysis portion of the paper outlines scenarios, case studies, and field visits to examine and develop scenarios of how tribes have implemented renewable energy into their infrastructure, while examining the historical resource development of Native American tribes. Reference to various tools, programs, websites, and other resources will be provided to give tribes an incremental approach to integrating renewable energy onto tribal lands. The paper can assist tribes, who have interest or want an introduction to renewable energy the resources, to begin their quest to understand, develop, and eventually implement renewable energy on tribal lands.

Historical Renewable Energy Perspective

Renewable energy is a natural source of energy that is abundant and or regenerative. There are many different types of renewable energy such as solar, wind, biomass, geothermal, and hydro electric. These alternative forms of energy account for the production of roughly six percent of the energy consumed within the United States.² These energy production methods range from residential photovoltaic (PV) systems to

¹ Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Corporation, for the United States Department of Energy's National Nuclear Security Administration under DE-AC04-94AL85000.

² Energy Information Administration: http://www.eia.doe.gov/emeu/aer/pecss_diagram.html

utility scale wind turbines. Through the use of off-grid and on-grid systems, energy sustainability can slowly be achieved within the United States and particularly on tribal lands. Off-grid refers to not being connected to the electrical grid; on-grid refers to being connected to the electrical grid. Throughout much of the United States, there has been an insurgence in renewable energy systems, yet the United States' dependence on fossil fuels has also grown significantly. These issues along with many others should be of a particular concern to Native American tribes because they could capitalize on the renewable energy industry's growth potential and the foreseen benefits. Most Native American tribes are still addressing unmet needs in their development and planning stages of housing, health care, education, and businesses.

The development of tribal lands has lagged far behind non-tribal lands. This underdevelopment is illustrated through the 2000 Department of Energy (DOE) Energy Information Administration's (EIA) report on renewable energy and energy consumption on tribal lands.³ In the report, it states that there were 14.2 percent of Native American households on reservation lands that had no access to electricity, while the United States as a whole only 1.4 percent does not have access to electricity. Native American households with electricity generally pay higher percentages of their income for electricity than other U.S. households. These two startling facts are very disturbing because access to electricity can be within a few miles of their homes or just passing overhead through a high voltage line. In some cases, tribal nations such as the Navajo Nation have transmission and generation facilities on their lands, yet they still suffer from the highest number of Native American households without electricity. With over 34,000

³ April 2000 Energy Consumption and Renewable Energy Development Potential on Indian Lands. U.S. Department of Energy Energy Information Administration.

homes without access to electricity on Navajo lands and thousands of other reservations on millions of acres suffering from the same problem, there have been few answers to their rural electrification problem.

There have been several programs and legislative bills established to help reduce the number of Native American households without electricity and as a result invigorated interest in renewable energy sources on tribal lands. With the development of multiple programs and funds allocated in different federal programs, many tribes throughout the United States have been able to establish renewable energy on their lands. With tribal lands in the millions of acres and recent research unveiling that most of these lands are prime locations for wind, solar, biomass, geothermal, and various other renewable energy resources, it has helped tribes seek to diversify their revenue bases along with providing reliable energy for their members.

Currently, there are over 55.7 million acres of tribal trust land within the United States.⁴ Throughout those acres of land, there are over 500 different tribal nations involved in some sort of economic, service, or educational development on their lands. However, these developments do vary widely in size, purpose, and location. They can range from health clinics, cultural centers, and schools to manufacturing plants and casinos. This uneven distribution of development leads to many challenges with addressing the appropriate renewable energy system for a particular tribe. In the Harvard Publication entitled, *Native American at the New Millennium*, it is stated that “Native businesses (both on and off-reservation) grew at a rate of 93% between 1987 and 1992 as

⁴ 2006 Program Overview of the Division of Energy and Mineral Development., U.S. Department of Interior

compared to 26% of all U.S. businesses in the same period.”⁵ The development of revenue base and services within a tribal community is essential to the long term sustainability of current services and programs. The rapid growth that was experienced during that five year period was mainly due to increased financial resources available to some tribes in the form of gaming revenue.⁶

Even though the financial revenue increased significantly for some tribes across the nations, there are only 198 out of the 559 federally recognized tribes with gambling facilities. This leaves over fifty percent of all federally recognized tribes without gaming operations or large

revenue bases. Some of the factors that have stopped tribes from pursuing gaming endeavors ranged from cultural and tribal values

to lack of business markets.

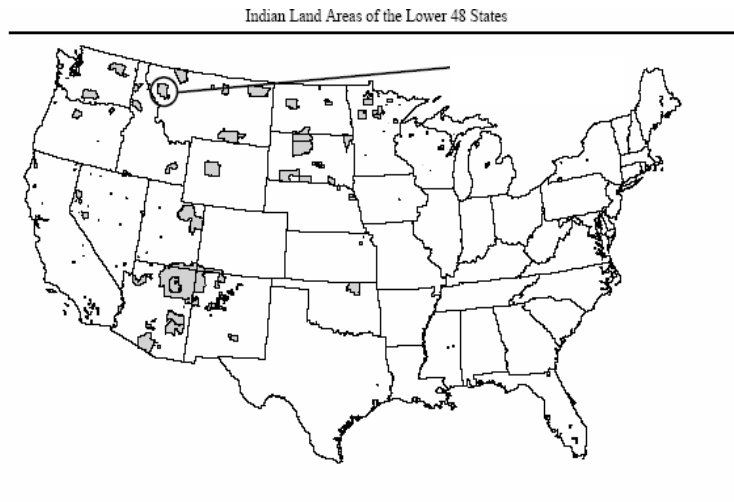


Figure 1: Tribal lands
Source: Bureau of Indian Affairs

With the development of renewable energy, alternative revenue generation is possible. This new type of development along with the fact that Native Americans on reservations suffering from the highest poverty rates in the United States (reaching as high as fifty-one percent) has generated interest in finding alternative ways to provide

⁵ The Harvard Project on American Indian Economic Development: Native American at New Millennium. Pg. 106. Available: http://www.ksg.harvard.edu/hpaied/res_main.htm

⁶ National Bureau of Economic Research :The Social and Economic Impact of Native American Casinos Available: <http://www.nber.org/papers/w9198.pdf>

services to tribal members and economic reliable revenue bases.⁷ Even though, economic development has steadily been increasing from a wide range of businesses the main increase in revenue bases has been from gaming. With increased gaming competition from other tribes and private gaming operations along with increased risks of over saturating the gaming market many tribes need to seek other forms of revenue to satisfy their revenue needs. With many tribes having vast land resources and excellent locations for renewable energy, it is almost an ideal match with the current needs of some tribes and the United States' goal of becoming energy independent.

Even though casino profits continue to grow, other forms of revenue like renewable energy should be considered to diversify their income. Most tribes across the United States have some form of housing, health, welfare, and administrative programs, which all could benefit from renewable energy systems. The development of this infrastructure has been a result of Native American tribes being recognized as sovereign nations and laws being passed to reaffirm their rights. These laws gave Native American tribes the power to dictate how they wanted to develop their lands and what services they wanted to provide their tribal citizens. Through the use of renewable energy, tribes have developed not only needed resources, but secured their energy as a sovereignty nation.

Since the establishment of the Indian Re-organization Act in 1934, Indian Self-Determination and Education Assistance Act in 1974, and the Tribal Self-Governance Program tribes have been given multiple tools that gave them the ability to create their own laws and regulations.⁸ Through these laws and programs, many tribes throughout the United States began to allot ancestral land that had been guaranteed in treaties and

⁷ The Harvard Project on American Indian Economic Development: Native American at New Millennium. Pg. 106. Available: http://www.ksg.harvard.edu/hpaied/res_main.htm

⁸ Department of Interior: 1996 BIA Accountability Report. Available: http://www.doi.gov/pfm/acct96/ind_bia.html

with this action, they gained the ability to create their future. One of the beneficial results of their independence was improved business development and the overall welfare of tribal nations.

The Navajo Nation, which today is the largest U.S. tribe, was one of the first tribes to undergo such a dramatic economic change due to its natural resources. Through several key decisions, the Navajo Nation established a tribal utility to increase electrification of homes across the Navajo Nation. The Navajo Nation's use of the land ranged from traditional sheep herding to uranium, coal, and oil mining. The Navajo Nation laid the foundation for other tribal nations to become utility providers and establish tribal governments. With the Navajo Nation developing its natural resources, it had many benefits of using its finite natural resources, but also many negative consequences that have greatly impacted their way of life. As a result of the environmental impacts, tribal members' remote locations, and revenue diversification the Navajo took the lead in establishing a renewable energy program that provides off-grid electricity to its members on the reservation. Navajo is also in the process of developing several renewable energy systems to sell clean and reliable electricity.⁹ As a result, the Navajo Nation is diversifying its energy resources and creating a sustainable energy and revenue source. Through the help of Tribal Renewable Energy Program (TEP) and other affiliates of the Navajo, they have been researching the possible development of an 80 Megawatt wind farm on their reservation.¹⁰ The Navajo have been developing their lands and providing energy to their members and the United States for several decades. The Navajo's existing energy infrastructure and the natural resources enables the

⁹ Navajo Tribal Utility Authority. Available: www.ntua.com

¹⁰ Andrew D. Mills. Wind Energy in Indian Country: Turning to Wind for the Seventh Generation.

establishment of renewable energy on their lands and is important to the success of establishing renewable energy.

Many tribal nations throughout the U.S. are assessing and developing their natural resources. The tribes that decided that they wanted to look into their renewable energy resources had many programs available to them to support their efforts. The Tribal Energy Program (TEP), which was established as part of the DOE programs, provided many tribal nations with grants to assess their wind, hydro, solar, or biomass resources. The TEP continues to provide technical advice and support for tribes that receive these grants to assist in accurately assess their resources and develop successful energy systems.¹¹

With energy becoming a global problem and basic affordable energy services still not being provided to many tribal members; many tribes are taking it upon themselves to look into renewable energy to provide electricity and revenue for their tribe. There has been an insurgence of interest in renewable energy being established on tribal lands. Many tribes, especially those who do not have the gaming resources are developing different methods of generating revenue and one of these ways includes the establishment of renewable power.

With energy prices steadily increasing over the last few decades and the public becoming conscious of environmental problems, the interest and use of renewable energy has also steadily increased. Renewable energy has the potential and has been providing the United States and world with energy resources for several decades. Even though renewable energy dates back to the use of wind mills, it has been the U.S. dependence of foreign oil along with environmental consequences that have opened the world's eyes on

¹¹ Tribal Renewable Energy Website: <http://www.eere.energy.gov/tribalenergy/>

the effects of fossil fuels. Along with many other circumstances make the use of renewable energy on tribal lands, an ideal way of providing revenue for tribes while helping the nation become less dependent on foreign sources of energy.

Analysis of Tribal Infrastructure and Guide to Renewable Energy

Energy and Infrastructure are the most significant issues in developing and sustaining economic growth on tribal lands. In some circumstances, available water can be an issue. One of the major problems among Native American reservations is the lack of infrastructure and or energy resources. Throughout the United States, there have been many successful tribal nations, which have built or were connected to essential energy, communication, health, education, and business infrastructure that allowed them to sustain successful operations. One of the main influences on the development of the tribal nations was their access to electrical power. Tribal Nations such as the Kaw, Hopi, Navajo, Northern Cheyenne Tribe, or Pueblo of Laguna (just to name a few) have all demonstrated interest in developing or established renewable energy systems on their lands to provide electricity to their people. All of which have received Tribal Energy Program funding to assess or develop their energy sources on their lands. The tribes that assessed these systems can see the true potential of renewable energy and the impact of preserving their pristine land.

The motives of these tribes vary, ranging from providing residential size photovoltaic systems to individual customers to installing utility scale wind turbines to exporting electricity. Their reasons were different, but their main objective is to provide sustainable, affordable, and reliable energy to benefit their members. The ability to provide essential necessities such as electricity on tribal lands greatly increases the tribes'

potential for business development and further economic growth.¹² In most tribal situations, their members may already be connected to a reliable energy grid and have no need to generate electricity. However, there are many benefits of renewable energy that could be used to improve the environment, decrease dependence on fossil fuels, increase reliability, reduce their energy bills and potentially attract more businesses on tribal land. Through owning the energy that is being generated, tribes can financially benefit from this resource by selling the electricity to develop their economies.

There are many different reasons to establish renewable energy on tribal lands. If a tribe was considering a renewable energy system, they should focus on what they want to accomplish by integrating renewable energy into their current gaming, health care, housing, or business establishments. They should also determine the electricity demand that they want to meet, scale of the project, and financial resource available to that particular project. A case study on the Native Village of Venetie Tribal Government, which was awarded a DOE Tribal Energy Program grant to assess and possibly established renewable energy in their native village, which completely relied on diesel fuel for its energy. The reasons to integrate renewable energy can be to diversify, mitigate environmental problems, cut energy costs, and develop a reliable source of energy. The Alaskan Natives had very few alternatives to their energy supply and as a result opted to look into renewable energy.¹³ In this particular case, the purpose of the project was clear. In other situations, it might not be as obvious such as business opportunities, reduce utility bills, and or cultural beliefs.

¹² The Harvard Project on American Indian Economic Development: Native American at New Millennium. Pg. 106. Available: http://www.ksg.harvard.edu/hpaied/res_main.htm

¹³ 2006 North American Energy and Mineral Institute Solar Technology Workshop

Another important aspect of assessing the potential of a renewable energy system is to assess the natural resources availability in the desired area. It is essential that a tribe understand their resources before anything is invested into the development of a renewable energy system. Depending on the resource available in the area there are different research tools available to begin assessing these resources. Renewable energy resources available on tribal lands are solar, wind, geothermal, hydro, and biomass. Solar, wind, and biomass maps (figures 2, 3, and 4) show a general overview of the potential wind, solar, or biomass resources available in a particular part of the country.

These sources differ greatly which can limit the amount of energy produced in a particular area. The amount of research needed also depends on the scale and the investment in the system.

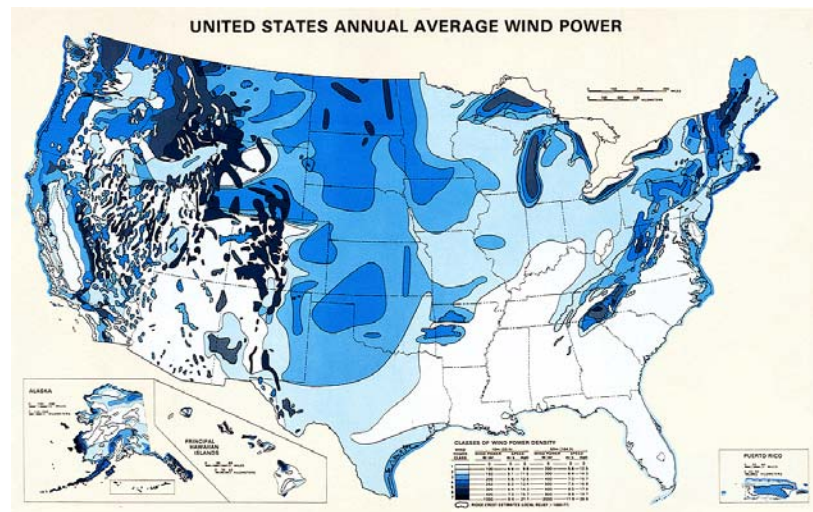


Figure 2: Map of Average Winds Speeds in the United States. Source: <http://www.nrel.gov/gis/maps.html>

If a tribe has determined that they wanted to establish a utility scale renewable energy system, then extensive research is needed to determine the true potential of the development. Some of the initial resources that can be used are wind, solar, biomass, hydro, and geothermal maps created by the National Renewable Energy Laboratory as

seen in Figures 2, 3, and 4.¹ These maps along with other resources will help determine what might be an available resource on tribal lands.

Discussions with professionals from

national laboratories, government agencies,

and tribal programs would help in finding the appropriate resource to pursue. Other helpful resources include local weather maps, personal weather accounts, and historical weather information.¹⁴ These are the preliminary steps to characterize the appropriate renewable energy in a particular area. These initial steps are simplified to install small systems. If a utility scale system is being considered, there are several other steps that must be accomplished.

After the preliminary work has been completed in finding the most feasible renewable energy resource then further tools can be used to assess these resources. One of the first tools to use is to measure or quantify the resource with real time data provided. An example of a measuring device for wind systems is an anemometer. This device is used to collect real time data on the wind speeds (at a specific height) within a proposed area and this can be used to further help determine or characterize the wind resource.¹¹

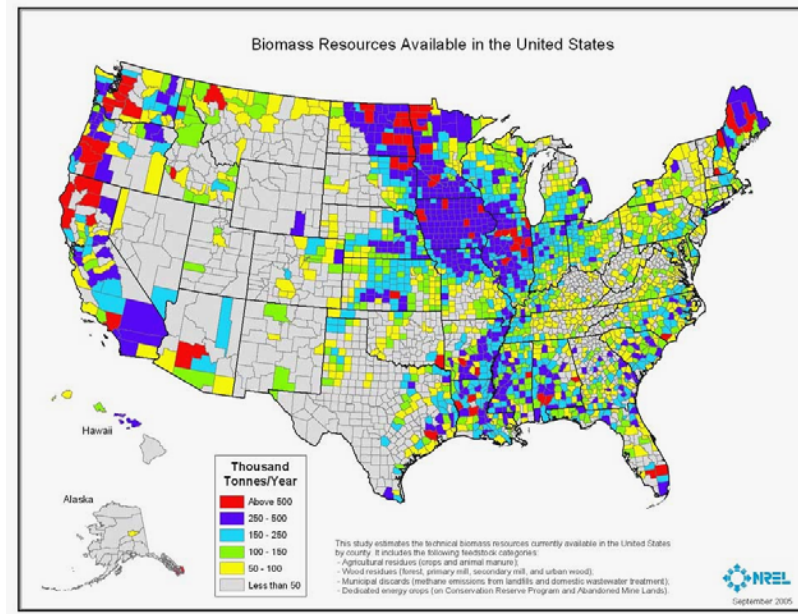


Figure 3: Map of Biomass Resources in the United States. Source: <http://www.nrel.gov/gis/maps.html>

¹⁴ Crownpoint Institute for Technology: Wind-Electrical System Design & Installation Workshop

There are also other tools that can help estimate the generation potential. Software programs like HOMERⁱⁱ and RETScreen Internationalⁱⁱⁱ can help design, setup different renewable energy systems and determine their production capability on historical, geographical, and observed data. Both programs allow for a theoretical approach to calculating

the generating capacity of a potential system.

These programs estimate energy savings, energy output, risk assessment, and other valuable information about different types of renewable energy

systems.¹⁵ Using this

software as a developmental tool to understand a renewable energy resource can enhance the understanding of a particular project and potentially the success. Even though these programs are helpful in getting a realistic view of renewable energy systems there are also draw backs that could prevent using the programs to their full capacity. Even though these programs are very helpful it might be in a user's best interest to be trained on these programs or work through online tutorials. Both of these programs require some knowledge of electrical, renewable energy systems, and costs of components. These programs overall are helpful and provide another tool that can be used.

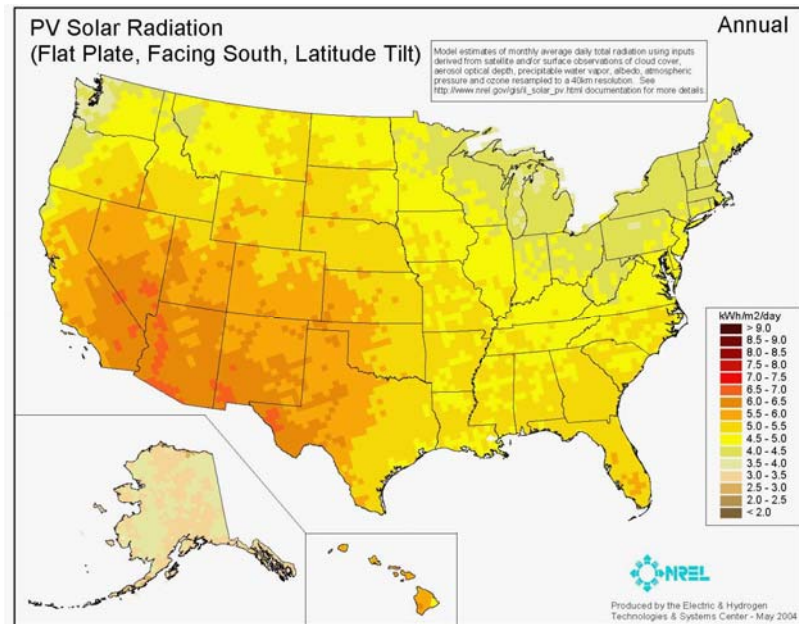


Figure 4: Map of Average Solar Radiation in the United States. Source: <http://www.nrel.gov/gis/maps.html>

¹⁵ Natural Resources Canada. RETScreen International. Available: <http://www.retscreen.net/ang/centre.php>

There can be several different ways to integrate renewable energy. An example of possible integration is in existing facilities such as housing, health clinics, administration buildings, and businesses. The renewable energy system could either supplement or provide all the energy for a facility. Energy efficiency could greatly reduce the total energy consumption. These types of improvements can complement a renewable energy system.

There are two key considerations to the implementation of renewable energy: energy conservation and planning. Energy conservation is a necessary and straightforward first step. Another step is to reduce energy use through design of facilities that use natural light and shading as well as other passive heating and cooling features. Energy efficient designed buildings help to reduce long term costs and increases energy savings. These actions are simple but widely overlooked solutions to decrease the cost of an electrical generating system and further make the RE system more effective. With much of the energy in the homes is used for lighting, heating, and cooling, there are simple ways a house could be designed to reduce the cost of these major home energy consumers.¹⁰ Even though the changes maybe are small, it could greatly reduce the energy consumption of the building and the overall costs of energy.

One of the main challenges the United States and tribal nations face is a profuse use of non-renewable energy sources at an ever increasing rate. A significant amount of energy consumption could be reduced if energy efficiency, conservative energy use, and construction design were further developed to take advantage of renewable energy. For example, many architectural and landscaping techniques can be implemented into residential, commercial, and industrial building to make the building energy efficient.

There are several ways in which this could be accomplished whether it is through the use of skylights, solar water heaters, or photovoltaic panels to offset energy consumption during peak hours.¹⁰

There are also cultural aspects of energy installation on tribal lands that could affect the development on their lands. During a field visit to the Hopi village, it was noted that some villages did not allow electrical power due to cultural beliefs and this prevents the wide-spread use of electricity in certain villages. Hotevilla is a very conservative Hopi village due to the residents' cultural traditions and as a result, there are numbers of households without electricity. Even though standard electrical lines were not allowed due to its potential to disrupt sacred areas, the use of photovoltaic systems was first accepted. Because of the remote location, the financial and cultural costs of providing electricity from the grid, solar power was seen as a viable alternative to providing electricity to the people in the village. Field visits to several Hopi villages were observed to have electricity from photovoltaic systems and the electrical grid. The example of the Hopi Tribe is intriguing is because they used met their needs of electricity and cultural values through the use of renewable energy systems. These types of applications not only improve the lives of the people in the village, but it preserves their unique culture.

Throughout the United States, there is not uniform infrastructure on tribal lands. The wide differentiation of the tribal infrastructure correlates to their energy development and revenue. The need to pursue renewable energy development can range widely from tribe to tribe depending on their needs and resources available. Even though energy needs change, renewable energy systems have many applications. Renewable energy

may be a feasible investment for a particular tribe, but the initial costs can outweigh the environmental, economical, and health benefits produced by a renewable energy system.

V. Conclusions

Tribes' reliable natural resources are their renewable energy sources. It does not make sense rely on a non-renewable energy source that will eventually diminish.

Whether this is tomorrow or in the future, there is a finite resource which will eventually be gone. As a result, everything that is dependent on this resource will have to use other resources. With humans' current symbiotic relationship with the earth, there has been repercussion associated with discover and plunder methods used to supply the world's global demand for energy. Even though the world potentially could have an energy crisis, there are tribes in the United States that have dealt with these inconveniences by developing advanced solutions to their once unique problems. These problems that the people of the Navajo, Hopi, and countless other tribal nations have faced and continue to face have provided a basis for learning how to live within our energy consumption needs and increase the use of renewable energy systems. It is possible that if more tribes continue to develop their lands or even design energy efficient buildings they could greatly reduce their energy consumption, while helping the nation to progress in its quest to become energy independent. Tribal nations will benefit greatly from renewable energy and the United States will also benefit greatly. As a result through the support of different government and tribal organizations, the use of renewable energy can continue to grow and help meet the tribe's and United States' goal of energy sovereignty.

My Experience

Through out my internship I gained a multitude of knowledge from field visits, hands-on experience, and working with professionals. This internship has allowed me to understand the unique electrification needs on Native American tribal lands and how to generate new creative ways of potentially satisfying these needs. These needs ranged from rural electrification to developing cultural sensitive solutions to cultural values. This varied perspective on the development of renewable energy on tribal lands was of particular interest to me and as a result was very informative. It also allowed me to understand the various programs that were providing services and funding to tribes to help them develop renewable energy systems and improve energy efficiency. The internship allowed me to attend conferences and workshops focused on solar, wind, and entrepreneurship. These conferences were very informative and allowed me to understand the inner workings of renewable energy. One specific workshop gave me a profound understanding of wind energy and what it takes to implement it on the home and utility scales. This workshop was also particularly interesting to me because it taught basic electrical wiring theory and installation of home scale wind systems. This workshop gave me hands-on experience with the actual construction of small wind turbines and installation of the entire wind system. This helped me understand the preparation involved in installing small wind systems and their benefits.

After attending the various workshops and conferences I was able to go into the field and see actual photovoltaic and wind systems. I was able to see the educational, social, and economic impact this technology had on the people who were using the system. Through talking with various professionals in renewable energy, I was amazed

at how essential renewable energy was on tribal lands, particularly in the Midwest of the United States. I was also able to have an understanding of the history and applications of renewable energy on tribal lands. The applications of renewable energy on tribal lands have been replacing less reliable and more expensive diesel generators for important infrastructure for communications, businesses, and educational facilities.

The overall internship experience went far beyond my expectations because of the inclusive, hands-on, and professional nature that I was able to experience. This internship was truly a great experience that allowed me to gain some of the same experiences that a Study Abroad would have given me, while providing me with the internship experience. Understand different culture beliefs and experiencing interactions with many different people from all backgrounds was also a huge benefit to me and I will continue to consider all aspects when solving a problem. This internship was one that I will never forget from the pristine landscape to the lives the renewable systems impacted; this has been an educational and memorable experience that will help guide me through my future endeavors.

ⁱ Available: <http://www.nrel.gov/gis/maps.html>

ⁱⁱ Available: <http://www.nrel.gov/homer/>

ⁱⁱⁱ Available: <http://www.retscreen.net/ang/home.php>