

ANNOUNCEMENT

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B. Recipient/Contractor

Navajo Tribal Utility Authority, Fort Defiance, AZ

C. STI Product Title

A Feasibility Study to Evaluate Wind Energy Potential on the Navajo Nation

D. Author(s)

Terry Battiest
terryb@ntua.com
 E-mail Address(es):

E. STI Product Issue Date/Date of Publication

11/30/2012 (mm/dd/yyyy)

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Terry Battiest, Renewable Engineer, NTUA
 Name and/or Position
terryb@ntua.com 928/729-6263
 E-mail Phone
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**A FEASIBILITY STUDY TO EVALUATE WIND ENERGY
POTENTIAL ON THE NAVAJO NATION**

FINAL REPORT

DOE Award DE-FG36-05CH15180



Award Recipient:

**Walter W. Haase, P.E.
Principal Investigator
Navajo Tribal Utility Authority
Post Office Box 170
Fort Defiance, AZ 86504
928-729-5721 (Main)
928-729-2135 (Fax)
Website : www.ntua.com**

CONSORTIUM TEAM MEMBERS

Dr. Tom Acker and Steve Atkins
Sustainable Energy Solutions
Northern Arizona University

Karan English and Janet C. Lynn
Ecological Monitoring & Assessment Program
Northern Arizona University

Pat Ponce
Arizona Wind Working Group
Northern Arizona University

Anna Marie Frazier
Diné CARE

Larry Flowers
Wind Powering America
DOE National Renewable Energy Laboratories

Sandra Begay-Campbell
Tribal Energy Program
Sandia National Laboratories

Navajo Tribal Utility Authority (NTUA):

Niecy Tsosie and Carole Tom
Right-of-Way Agents

Terry W. Battiest
Renewable Engineer

Srinivasa Venigalla
Supervisor, Electrical Engineering Planning Department

Lester Lee, Supervisor
Supervisor, Electrical Engineering

Wally Chief
Manager, Engineering & Technical Services Division

Walter W. Haase
General Manager

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I. Executive Summary

The project, *A Feasibility Study to Evaluate Wind Energy Potential on the Navajo Nation*, is funded under a solicitation issued by the U.S. Department of Energy Tribal Energy Program. Funding provided by the grant allowed the Navajo Nation to measure wind potential at two sites, one located within the boundaries of the Navajo Nation and the other off-reservation during the project period (September 5, 2005 - September 30, 2009). The recipient for the grant award is the Navajo Tribal Utility Authority (NTUA).

The grant allowed the Navajo Nation and NTUA manage the wind feasibility from initial site selection through the decision-making process to commit to a site for wind generation development. The grant activities help to develop human capacity at NTUA and help NTUA to engage in renewable energy generation activities, including not only wind but also solar and biomass. The final report also includes information about development activities regarding the sited included in the grant-funded feasibility study.

II. Project Overview

Under this grant opportunity, the grant 1) funded a one-year wind resource assessment for each site; 2) funded a preliminary bat and avian study for each sites; and 3) fostered the development of the Navajo Wind Working Group. The award allowed the NTUA to build up human capacity for both wind feasibility and knowledge of energy generaton, resulting in its participation in the development of a formal wind generation project.

The final report for this grant award includes 1) a description of activities performed; 2) an overview of the wind feasibility studies outcomes, 3) a discussion the impact of the findings of the study, and 4) provides a status update wind development initiatives on the Navajo Nation as a result of this grant.

III. Project Objective

The objective of the project is to evaluate the wind energy potential for utility-scale power generation at two sites on Navajo tribal lands

IV. Description of Activities Performed

The Navajo Nation

The Navajo Nation, or *Diné Bi keyah* (which translates as ‘Land of the People’ in the Navajo language), is located on the Colorado Plateau in northeastern Arizona, northwestern New Mexico and the extreme southeastern corner of Utah. *Diné Bi keyah* covers over 27,000 square miles, an area that is comparable in size to the state of West Virginia. The Navajo reservation possesses vast natural resources—both renewable and non-renewable—including surface and groundwater; range lands; forests; irrigated farmlands; lakes; fish and wildlife; and an abundant supply of coal, oil and natural gas. It also has substantial wind and solar resources.

Diné Bi keyah is home to over 200,000 Navajo tribal members, a number that is projected to grow to an estimated 250,000 by the year 2020. Historically, Navajo people have a native economy based upon sheep herding and grazing. These traditional practices live on, due in large part to the resiliency of the elderly.

Navajo Tribal Utility Authority

The Navajo Tribal Utility Authority (NTUA) is a multi-utility provider established in 1959 to provide essential services for the people and entities of the Navajo Nation. The current offerings include the following utility services: 1) electricity, 2) water, 3) waste water, 4) natural gas, and 5) photovoltaic program for off-grid residential customers. In 2009-10, the NTUA expanded its portfolio by adding telecommunication, wireless services and energy generation. The NTUA is a wholly-owned enterprise of the Navajo Nation.

The NTUA became involved with renewable energy in the 1980’s with a pilot project to deploy photovoltaic (PV) modules on the Navajo Nation. Solar power on remote well systems soon became commonplace in the core business model at NTUA. In the 1990’s NTUA made its first customer offering with the deployment of 240W PV systems to provide off-grid lighting for homes. This marked the establishment of the Solar Program, which was expanded with 680W PV systems by the end of the decade; these systems allowed customers to have home power, albeit limited, beyond basic lighting. Since 2002, NTUA has provided three generations of PV systems which include small

wind turbines for supplemental power to the systems. In 2009, the program made a commitment to energy generation and the Solar Program evolved into the Renewable Energy Program.

The electricity services staff is trained to support PV power in the field throughout the Authority's seven districts. These personnel have developed their interest and a growing commitment to renewable energy initiatives within the organization. The opportunity to erect anemometer towers for the grant was embraced as a learning opportunity by NTUA personnel and allowed NTUA to develop these resources and skills in-house for future self-funded activities. The NTUA also reached out to the resources available through the Northern Arizona University, which provided technical assistance throughout the project and performed the preliminary bat and avian assessments for the project.

Project Plan

The Navajo Tribal Utility Authority proposed to the DOE Tribal Energy Program a project to evaluate the wind energy resource and to assess the potential for electricity generation on the Navajo Nation. To accomplish this objective, NTUA proposed a project plan to conduct comprehensive wind feasibility studies at six locations, including one located off of the Nation. A total of seventeen (17) tasks were proposed to meet these objective:

1. Select site for wind assessment by installation of anemometer towers and meteorological studies
2. Establish land ownership analysis and permitting
3. Conduct electric load assessments and export-marketing analysis
4. Negotiate agreements with transmission provider
5. Analyze wind turbine technology (wind turbine, blades, and tower cost/power curve), construction and financing
6. Conduct an economic analysis, including a search for credits and a wind output analysis
7. Provide benefits and impacts for environmental assessment, biological assessment, avian studies, and cultural inventory (permits from Navajo nation government/BIA cultural office)
8. Provide benefit assessment regarding employment, culture, society, etc.

9. Conduct a preliminary system design
10. Plan for training and other tribal professional development
11. Provide a cost analysis for long-term operation and maintenance
12. Plan for the implementation of a sustainable renewable energy development project
13. Investigate financing options, power purchase agreements, sales agreements, etc.
14. Plan for tribal approval process
15. Write a comprehensive business plan
16. Meet with tribal leaders to plan project coordination and leadership
17. Plan to purchase hardware and software

Project Sites

The Navajo Nation renewable energy profile includes several areas with substantial wind resources, several forested areas providing a limited biomass resource and a very significant solar resource. The Nation's wind resource is primarily located within Arizona and includes the state's most prominent wind resource at Gray Mountain, within the boundaries of the Cameron and Gray Mountain Chapters (units of local government). The second significant site for this project, a formation known as the Aubrey Cliffs, is located near Seligman, Arizona, off of the Navajo Nation on Boquillas Ranch.

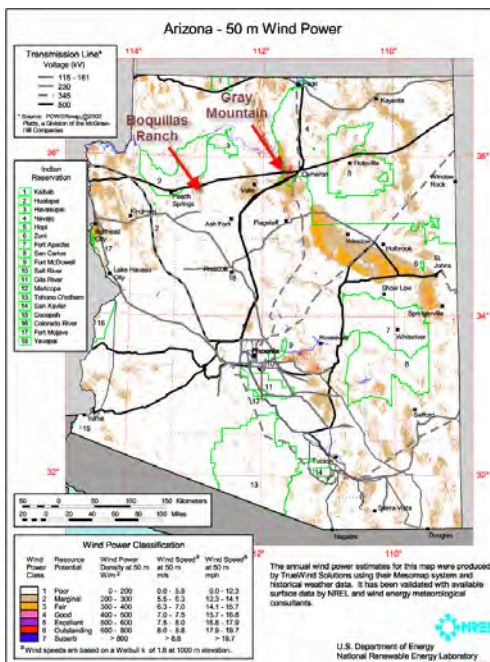


FIGURE 1 50m Wind Power Map (by NREL) – with locations of Gray Mountain, Aubrey Cliffs

In 2005, at the time of the funding opportunity announcement for this grant, the NTUA had started its initial efforts to quantify and understand the wind resources available on the Navajo Nation. Driven by the high level of interest generated among the wind industry's leaders about Navajo's wind potential, NTUA was on a path of development of human capacity in renewable energy generation at NTUA. An initial listing of prospective sites was developed and included 18 potential sites. This list was eventually pared down to six sites for inclusion in the grant application. The six sites include the following:

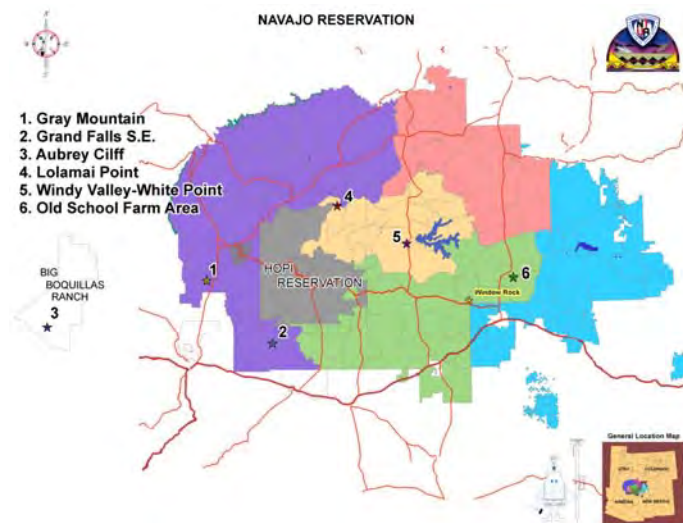


FIGURE 2 Initial six sites of Wind Feasibility Study by NTUA

After submitting the grant application, NTUA determined that only two of the sites warranted feasibility activities: 1) Gray Mountain and 2) Aubrey Cliffs.

IV. Description of Activities Performed

DOE funding for the wind feasibility project came at a time when the wind industry was beginning to mature and wind plants (farms) were being installed on a widespread basis. Lay people were beginning to become familiar with wind resource maps and many prospectors were pursuing opportunities in the most promising wind areas. The Navajo Nation is home to what is perhaps the most significant wind resource area in Arizona along its western fringe at Gray Mountain. These prospectors were approaching local residents and communities, the Navajo Nation central government, and the Navajo

Nation's energy enterprises, including NTUA, in hopes of developing wind generation projects.

The funding opportunity enabled the Navajo Nation and NTUA the opportunity to investigate and participate in prospecting activities of its wind resources—an opportunity which likely would not have occurred without the Tribal Energy Program. NTUA identified regional resources, especially the Northern Arizona University, to aid in the development of feasibility planning and implementation of the project.

The NTUA has successfully partnered with Northern Arizona University for technical assistance throughout the project, including project siting, assistance with permitting, met tower erection, data collection, management and analysis, and development of a preliminary bat and avian assessment. The partnership also allowed NTUA to assist with the erection of Northern Arizona University-owned anemometers at both NTUA wind sites. NTUA and NAU are also participants in the Arizona Wind Working Group, a statewide collaboration of public and private entities interested in the propagation of wind generation development.

Gray Mountain

Gray Mountain has been described as the most significant wind resource area in the American Southwest. It may be characterized as a high mesa of over 500,000 acres rather than a traditional mountain formation, sitting along the western boundary of the Navajo Nation at the Little Colorado River and serving as the eastern gateway into the Grand Canyon National Park. It is contained within the Gray Mountain and Cameron Chapter, the units of local government on the Navajo Nation. It is wholly located on Navajo Nation trust lands. Wind maps for the region indicate a substantial area of Gray Mountain possesses Class 4-6 wind (good to outstanding) with small pockets of Class 7 wind, which is considered 'superb'. Access to transmission is extremely favorable at Gray Mountain as it is located near a major confluence of transmission facilities. The successful development of the Gray Mountain site is a goal of both the local Chapters and the Navajo Nation central government.

Land use on the Navajo Nation follows a complicated process which includes approval of land use by the local chapter, adherence to the BIA right-of-way process, approval of the Navajo Nation and final approval by the BIA. This complicated process to obtain site control exhausted a year and a half of the two year project period, requiring an extension of the project end date.

The 50m meteorological (met) tower with anemometers was installed at Gray Mountain on September 21, 2007. The commitment to collect one year's worth of data was satisfied on September 21, 2008. The Gray Mountain met tower has been continuously operational since its installation, barring the several outage periods due to lightning strikes.

The scope of the original award was overly ambitious and many of the tasks are not reasonable for a feasibility study activity. The cause, at least in part, is due to the fact that neither the Navajo Nation nor NTUA had prior experience in wind prospecting activities or wind generation development. The following provides a comparison of project accomplishments to tasks identified in the project proposal:

1. Select site for wind assessment by installation of anemometer towers and meteorological studies: *NTUA engaged resources at Northern Arizona University to assist with the site selection for the met tower at Gray Mountain. Northern Arizona University's Sustainable Energy Solutions group was already engaged in a state-wide initiative to identify and place met towers at the state's most promising wind resource sites.*
2. Establish land ownership analysis and permitting: *NTUA engaged with the local community located within the Gray Mountain and Cameron Chapters to request support through Chapter resolutions for land use to install and maintain met towers at Gray Mountain. Upon securing support from the local community, NTUA engaged in the lengthy process to complete required studies (e.g. biological assessments, cultural assessments) required to attain the required land use permit.*
3. Conduct electric load assessments and export-marketing analysis: *Electric load assessments and marketing analysis were activities which were not sufficiently funded by the project and were excluded as tasks within the project.*
4. Negotiate agreements with transmission provider. *A transmission study was not appropriate for inclusion in a feasibility study project; neither was it sufficiently funded by the project and was, therefore, excluded from the project.*
5. Analyze wind turbine technology (wind turbine, blades, and tower cost/power curve), construction and financing. *Technology analysis and selection is pre-mature in a feasibility study project and was excluded from the project.*
6. Conduct an economic analysis, including a search for credits and a wind output analysis. *NTUA engaged in learning about project funding models through the Navajo Wind Working Group and the larger Arizona Wind Working Group. However,*

an economic analysis is not an appropriate activity in a feasibility study and was excluded from the project.

7. Provide benefits and impacts for environmental assessment, biological assessment, avian studies, and cultural inventory (permits from Navajo nation government/BIA cultural office). *Cultural inventories, environmental assessments and biological surveys were included at the start of the project to obtain right-of-way for the installation of the anemometer towers. These initial findings help identify further studies which may be required if a site is selected for development. A preliminary bat and avian assessment was also funded by the grant. The Executive Summary of this assessment is included in Appendix A.*
8. Provide benefit assessment regarding employment, culture, society, etc. *NTUA, as the recipient of the grant, seeks to achieve two objectives per the NTUA Plan of Operation:*
 - *To create employment for the Navajo people*
 - *To improve the quality of life for the Navajo people**A wind generation project supports these objections through job creation and expansion of services for our customers.*
9. Conduct a preliminary system design. *A formal system design is not reasonable for inclusion in a feasibility study project and was excluded from the project.*
10. Plan for training and other tribal professional development. *NTUA has engaged in training and learning activities via its participation in the Navajo and Arizona Wind Working Groups. Implementation of the feasibility study activities, including project management, tower installation, and DOE project reviews aided in the development of human capacity at NTUA.*
11. Provide a cost analysis for long-term operation and maintenance. *A cost analysis is premature for a feasibility study project and was excluded from the project.*
12. Plan for the implementation of a sustainable renewable energy development project. *The intent of Task 12—to plan for sustainability—is accomplished via project planning and analysis activities, such as technology selection, O&M strategy, risk mitigation and financial analysis for the project. NTUA did not have exposure to these concepts in 2005; this demonstrates the significance and benefit the grant program is toward building human capacity in tribal communities.*

13. Investigate financing options, power purchase agreements, sales agreements, etc. *An evaluation of finance options and power sales and purchase agreements is premature in a feasibility study project and were excluded from the project.*
14. Plan for tribal approval process. *The Navajo Nation has granted authority to NTUA, a wholly-owned enterprise, to conduct generation activities via the NTUA Plan of Operation.*
15. Write a comprehensive business plan. *Development of a comprehensive business plan is premature for a feasibility study project.*
16. Meet with tribal leaders to plan project coordination and leadership. *The grant allowed the Navajo Nation and NTUA to engage in discussions to familiarize and educate tribal leaders about renewable energy resources and the potential for energy generation. However, project coordination is premature for a feasibility study grant.*
17. Plan to purchase hardware and software. *Software for wind analysis was purchased using grant funds. Anemometer towers were also purchased using grant funds.*

The 17 tasks included in the original grant application are valid for the development of a renewable energy project. However, for a feasibility project, several tasks were misguided, requiring information this is only available in more developed projects. As an example, the appropriate wind turbine technology for a project is dependent upon the characteristics of the wind regime at a project site, such as the capacity factor, turbulence, and wind speed. For the Navajo project, the feasibility assessment of the wind resource was the first attempt to measure the wind resource at Gray Mountain and served to validate the need to install additional met towers to fully characterize the site. Data from multiple met towers is required understand the wind resource of larger project sites, such as the Gray Mountain site. Further, the cost for some studies, such as for interconnection and transmission, are beyond the funding available by the grant.

There is currently no project development activity at the Gray Mountain site. However, the Aubrey Cliffs site is under development—which provides an opportunity to contrast how beneficial a project task list can be when it is developed appropriately. In this case, tasks are more appropriate for project in the pre-development or development phase.

Aubrey Cliffs (Boquillas Ranch)

Aubrey Cliffs is a series of cliff escarpments located on the Boquillas Ranch, near the northwestern Arizona town of Seligman. (In the remainder of this report, the site shall be referred to as Boquillas Ranch or “Big Bo”, as it is commonly referenced today.) The Boquillas Ranch includes approximately 490,000 acres and is jointly operated by the Navajo Nation and the Arizona Department of Game and Fish. The Boquillas Ranch is a combination of privately owned land and state trust lands, located approximately 80 miles west of the Navajo Nation. While not as substantial as Gray Mountain, wind resource maps also show good to superb wind resources at Boquillas Ranch. Access to transmission is promising as transmission is available on both to the north and to the south of the proposed project location.

Land use is also different at Boquillas Ranch, as the Navajo Nation-owned property is in fee simple status. Thus, land use is determined by permitting under Coconino County. The 50m meteorological (met) tower with anemometers was installed at Boquillas Ranch on May 22, 2008. The commitment to collect one year’s worth of data was satisfied on May 22, 2009. The Boquillas Ranch met tower has been continuously operational since its installation.

Similar to Gray Mountain, the scope of the original award was overly ambitious and many of the original tasks were not appropriate under a feasibility study. However, the Boquillas Ranch site has been under development for wind generation since 2009 and many of the tasks are now being completed as the project moves closer to construction. The following includes activities beyond the project period to contrast a feasibility-only study with an on-going project that is in development. The following, as was shown for Gray Mountain, provides a comparison of project accomplishments to tasks identified in the project proposal:

1. Select site for wind assessment by installation of anemometer towers and meteorological studies: *NTUA engaged Northern Arizona University to assist with siting the location of one met tower at Boquillas Ranch. The met tower was installed on May 22, 2008.*

2. Establish land ownership analysis and permitting: *Boquillas Ranch is operated as a fish and wildlife recreation area by the State of Arizona and is jointly owned by the Navajo Nation and State of Arizona. The NTUA has secured a land lease and site control for the project site. This activity was not funded by the grant.*
3. Conduct electric load assessments and export-marketing analysis: *Upon obtaining site control for the project, NTUA and its development partner assessed transmission capacity and export-marketing activities. As a result of these activities, the project has moved forward with an executed power purchase agreement with a regional utility. This activity was not funded by the grant.*
4. Negotiate agreements with transmission provider. *A transmission study was completed and transmission path identified for the project. This activity was not funded by the grant.*
5. Analyze wind turbine technology (wind turbine, blades, and tower cost/power curve), construction and financing. *NTUA continues to evaluate turbine technology offerings and will select technology for the project prior to the start of construction. Project cost analysis, financing structure and construction cost assumptions are used to assure financial and economic feasibility. This activity was not funded by the grant.*
6. Conduct an economic analysis, including a search for credits and a wind output analysis. *Based upon wind data accumulated at multiple locations on Boquillas Ranch, it was determined that an 85MW is feasible at the project site. Financing relies upon available tax credits and other subsidies for financial feasibility of the project. This activity was not funded by the grant.*
7. Provide benefits and impacts for environmental assessment, biological assessment, avian studies, and cultural inventory (permits from Navajo nation government/BIA cultural office). *Cultural inventories, environmental assessments and biological surveys were included at the start of the project to obtain right-of-way for the installation of the anemometer towers. A preliminary bat and avian assessment were also funded by the grant. The Executive Summary of this assessment is included in Appendix B.*
8. Provide benefit assessment regarding employment, culture, society, etc. *The project benefits for the Big Bo Wind Project are unique as the project site is approximately 80 miles from the nearest point to the Navajo Nation. Primary benefits of the project include employment opportunities for Navajo citizens, development of an ownership*

- structure which allows the Navajo Nation to have a majority equity position in the project and the development of a utility-scale renewable energy generation project on Navajo Nation tribal lands. This activity was not funded by the grant.*
9. *Conduct a preliminary system design. A formal system design will be completed when final permitting and site control of state land is completed. This activity was not funded by the grant.*
 10. *Plan for training and other tribal professional development. The Navajo Nation and NTUA have greatly benefited from the opportunity afforded by the DOE funding, from local wind working groups, and collaboration with project development and project finance partners. To develop a pipeline for wind plant technicians, NTUA has engaged an educational partner to establish a training program which supports technical skills for renewable energy technologies, especially for wind and solar technologies. This activity was not funded by the grant.*
 11. *Provide a cost analysis for long-term operation and maintenance. NTUA has assumed historic O&M cost for the operation of the wind project. O&M costs assumptions are critical in the project cost analysis and power purchase agreement, as well as technology selection, management of the plant and risk mitigation and management for the project. This activity was not funded by the grant.*
 12. *Plan for the implementation of a sustainable renewable energy development project. The intent of Task 12—to plan for sustainability—was accomplished via project planning and analysis activities, such as technology selection, O&M strategy, risk mitigation and financial analysis for the project. This demonstrates a benefit of how the grant program helps to build human capacity in tribal communities. This activity was not funded by the grant.*
 13. *Investigate financing options, power purchase agreements, sales agreements, etc. The process of negotiating and securing a power purchase agreement is a multi-faceted and iterative—as well as meticulous—process which requires sound resource assessment data, knowledge of the energy market, reliable financial advice, and a myriad of other information to ensure feasibility of a project over its project life. This activity was not funded by the grant.*
 14. *Plan for tribal approval process. The Navajo Nation has granted authority to NTUA, a wholly-owned enterprise, to conduct generation activities via the NTUA Plan of Operation. This activity was not funded by the grant.*

15. Write a comprehensive business plan. *The development of a comprehensive business plan requires that a substantial amount of project details and assumptions are known about a project. Inclusion of a comprehensive business plan in a feasibility study project is premature.*
16. Meet with tribal leaders to plan project coordination and leadership. *The lease process included senior leadership from Economic Development, Natural Resources, Tax Commission, Department of Justice, Community Development, and Office of the Controller, as well as the Navajo Nation Council and President of the Navajo Nation. This activity was not funded by the grant.*
17. Plan to purchase hardware and software. *Software for wind analysis was purchased using grant funds. Anemometer towers were also purchased using grant funds.*

* * * * *

After the project was started, it became clear to NTUA personnel that many of the tasks were not attainable within a feasibility study project. NTUA contacted the Project Officer and negotiated a change in scope. The final approved project plan for the grant is located in Appendix C. Tasks removed from the scope of the award are grayed out in this table.

V. Conclusions and Recommendations

Activities funded by the grant included the following major activities:

- Development of the Navajo Wind Working Group
- Site selection for the installation of a 50m anemometer tower
- Permitting activities
- Procurement of anemometer tower
- Installation of anemometer tower
- Maintenance of the anemometer tower and data collection
- Analysis of the wind data

Overview of the Wind Feasibility Studies Outcomes

At the time when the project began, 50m met towers were the industry standard for collecting wind data for feasibility studies. There is no utility infrastructure at either the Gray Mountain or Boquillas Ranch met tower locations so data loggers are powered using batteries. (Neither was PCS service available at either location.) Data was collected and transferred manually for these met towers. The following provides a brief synopsis for each site.

GRAY MOUNTAIN: Summary data for the Gray Mountain met tower is shown in Figure 3. The Gray Mountain met tower was problematic in that lightning strikes frequently affected met towers in the area, including the NTUA tower.. In this case, three strikes seemed to directly impact data collection in 2009 and 2010. However, data was complete for year 1 of data collection, which satisfies the commitment for the grant. There is also discrepancy in the data during the final 6 months of data collected in 2010, which may be due to faulty or damaged equipment, such as a damaged anemometer. The data indicates that the wind resources are strongest during the spring season (March-May) in which winds are typically in the Class 6 range. The wind is typically comes in from the west-southwest and is strongest in late afternoon. The wind is at its lowest during the morning hours and during fall months. Accordingly, winds are considered to be marginal during the fall months.

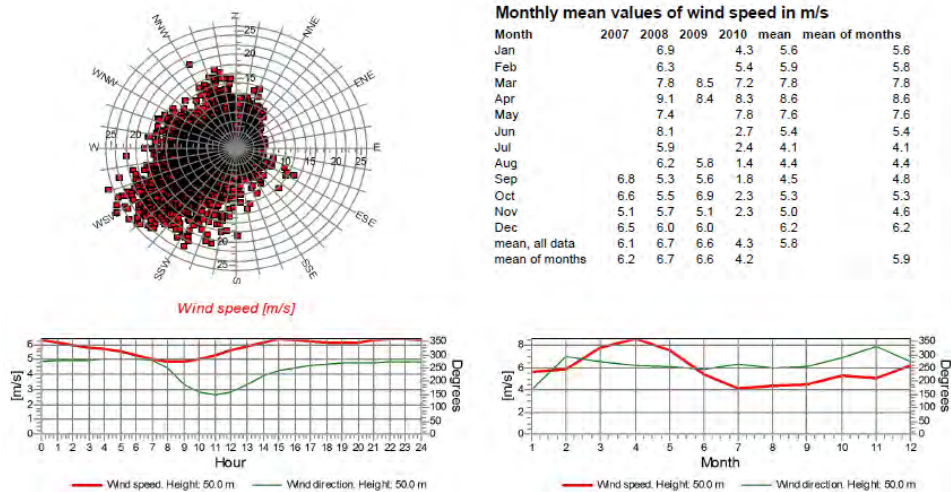


FIGURE 3 Met Tower Data Summary at Gray Mountain

(9/27/2007 – 11/11/2010)

Note that the quality of the wind resource at Gray Mountain cannot be ascertained from data collected at this met tower but is known from adjacent towers collecting wind data at Gray Mountain. However, data that is collected at this met tower helps to characterize the wind resource at this location on Gray Mountain and contributes to the wind regime for the entire site.

BOQUILLAS RANCH: Summary data for the Boquillas Ranch met tower is shown in Figure 4. Unlike the Gray Mountain met tower data, the data set is 100% complete over the reporting period of the report. Thus, the data is complete for year 1 of data collection, which satisfies the commitment for the grant. The data for Boquillas Ranch indicates that the wind resources are strongest during the spring season (April-June) in which winds are typically in the Class 6-7 range. The wind is primarily from the west-southwest and secondarily from the east-northeast direction. Like Gray Mountain, the wind is strongest in late afternoon. The wind is at its lowest during mid-morning hours and is considered low to marginal during late summer.

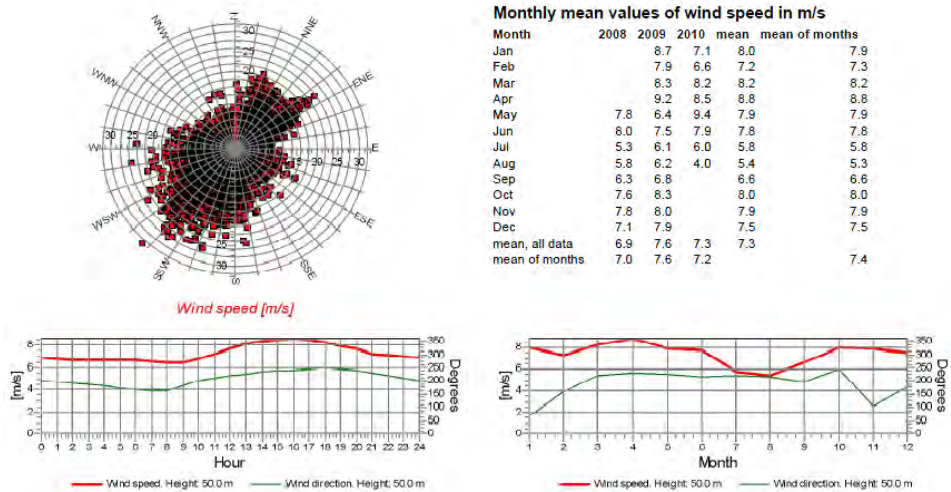


FIGURE 4 Met Tower Data Summary at Boquillas Ranch

(05/22/2008 – 08/28/2010)

Analysis of raw wind data was completed using WindPRO, which was purchased using grant funding.

Impact of Findings

The results of the wind analysis confirmed that wind resources at both Gray Mountain and Boquillas Ranch are viable for wind generation development. At Gray Mountain, development activities have largely stalled due to multiple parties getting engaged with the local community resulting in factionalism. Other approaches, such as to the central government or Navajo enterprises, add more complexity and challenges. To date, there is no substantial progress toward the development of a wind project at Gray Mountain.

At Boquillas Ranch, the findings of the feasibility study validated that further studies are warranted at the site. The challenges of developing at Boquillas Ranch are substantially less, because of its remote location and the normal use of the site. The promise of a wind farms has allowed NTUA to develop a project ownership model which gives that Navajo Nation majority ownership in a generation project.

Status of Wind Development Initiatives on the Navajo Nation

NTUA has taken the lead on development of the Boquillas Ranch site and has engaged development and financial partners to assist with the development of the project.

Additional towers were installed at the multiple locations to gain additional data about the wind resource on a proposed project footprint area. Collectively, this data provides a additional information about the wind resource and allowed NTUA to determine that Phase 1 of the project site will support an 85MW wind farm. The Boquillas Ranch Wind Project now has a PPA for an 85MW wind farm which will commence construction in the coming months. A second phase is also planned for the Boquillas Ranch project site.

VI. Lessons Learned

The grant award afforded the Navajo Nation and NTUA the opportunity to participate in the initial step—feasibility assessment—of the wind energy generation development process. Since 2005, the wind industry has experienced increasing awareness and exposure to the general public and is now considered to be a viable business opportunity for private citizens and governments. The NTUA has gleaned the following Lessons Learned from the experience of planning, implementing and evaluating the results of a feasibility initiative.

- There are a number of standard tools which are readily available to start wind prospecting: The national laboratories provide renewable energy resource maps which identify prospective resource locations. On-line tools (internet) are also easily accessible.
- NTUA's experience with wind prospecting has a learning curve, just as with any other endeavor. There are multiple resources that are available and willing to assist with disseminating information about generation development, including DOE, universities and colleges, industry partners, the national laboratories, utility partners, and wind industry organizations.
- Wind resource assessment is extremely site specific. Findings should not be generalized over large spatial regions. For project sites, like Gray Mountain or Boquillas Ranch, multiple met towers are required to understand the wind characteristics and flow.
- More data is good. In the case of the data presented above, three years and two years are presented for the Gray Mountain and Boquillas Ranch sites, respectively. Having multiple years of data in the Gray Mountain data set allows the characterization of wind when there is a collection failure, such as when a lightning strike affects a data logger.. It also reduces the impact of collecting data in a year which may be atypical for wind.
- Project may not always proceed as originally planned. Communication with the Project Office is mutually beneficial and can help to resolve misunderstanding and help to create expectations between both parties.

APPENDIX A

EXECUTIVE SUMMARY

FROM

**PRELIMINARY SITE EVALUATION, SURVEY PROTOCOL AND
STUDY DESIGN FOR AVIAN AND BAT SPECIES
AT THE GRAY MOUNTAIN WIND ENERGY SITE
NAVAJO NATION, ARIZONA**

EXECUTIVE SUMMARY

In northern Arizona and the southern Colorado Plateau, wind energy research is rapidly moving from anecdotal studies to a foundation for a new industrial sector. Due to the landscape and topography of Arizona, several wind development projects are proposed. One concern with the construction of wind energy sites is the potential effect on wildlife. In particular reports of negative impacts to birds and bats from wind energy development have raised concern. Anticipating, understanding and mitigating such effects are essential.

Data from anemometers at Gray Mountain, Arizona, suggest good potential for wind energy development. Gray Mountain provides habitat for migratory and resident bird species, including several raptor and passerine species of conservation concern. Historical records provide some insight; however, information on species richness and abundance, nesting, roosting, foraging locations, migratory pathways, and daily use patterns is limited for both birds and bats. Thus, the Ecological Monitoring & Assessment Program at Northern Arizona University completed a preliminary site evaluation for the proposed wind energy site at Gray Mountain.

The purpose of the preliminary site evaluation was to provide an early assessment of the potential impacts to birds and bats from the construction of a wind energy facility. The evaluation included a comprehensive literature review of avian and bat populations in relation to impacts from wind facilities. Resource managers and experts in the field were interviewed. A site visit to the project area provided additional information about the habitat and other site characteristics that may be pertinent to birds and bats.

Based on the site topography, habitat, and research from other developed wind energy sites, impacts on birds at the Gray Mountain project area are expected to be lower than average for western wind farms. Although the Gray Mountain project area provides ridgelines that may attract migratory and resident raptors, it is not expected to attract high concentrations of raptors. Overall, resident passerine use of the site is expected to be low and any impacts are predicted to be to common desert grassland and scrub species. Sixteen bat species, including two species of conservation concern and five migratory species, are known to occur or potentially occur within the proposed Gray Mountain project area. Understanding bat interactions and causes of mortality at wind energy facilities is complex and information limited. Due to this limited information on birds and bats within the project area, and the overall concern raised by reports of bat mortality and cumulative effects on bat populations across the United States, pre-construction surveys are recommended to further determine the potential risks that a wind energy facility may pose to birds and bats at Gray Mountain.

Using the available knowledge of the proposed project area, recommendations for a site - specific protocol and design were developed for conducting pre-construction avian and bat surveys. Prior to beginning surveys however, additional site specific information about turbine placement and the project area are required to provide a final study design and detailed survey protocol.

APPENDIX B

EXECUTIVE SUMMARY

FROM

**PRELIMINARY SITE EVALUATION
FOR AVIAN AND BAT SPECIES
AT THE AUBREY CLIFFS**

EXECUTIVE SUMMARY

In northern Arizona wind energy research is rapidly moving from anecdotal studies to a foundation for a new industrial sector. Due to the landscape and topography of Arizona, several wind energy development projects are proposed for the region. One concern with the construction of wind energy sites is the effect on wildlife. In particular, reports of negative impacts to birds and bats from wind energy development have raised concern. Anticipating and understanding such effects are essential. Data from anemometers at Aubrey Cliffs, Coconino County, Arizona, suggest high wind energy development potential. To provide an initial assessment of the potential site specific impacts to bird and bat species, the Ecological Monitoring & Assessment Program at Northern Arizona University completed a preliminary site evaluation for the proposed wind energy site at Aubrey Cliffs.

The purpose of the preliminary site evaluation was to provide an early assessment of the potential impacts to birds and bats from the construction of a wind energy facility. The evaluation included a comprehensive literature review of avian and bat populations in relation to impacts from wind facilities. Resource managers and experts in the field were interviewed to gather site specific information. A site visit to the project area provided additional information about the habitat and other site characteristics that may be pertinent to birds and bats.

Aubrey Cliffs and the adjacent Aubrey Valley have a high diversity and abundance of raptors and bats and may provide a significant corridor for fall migratory species. Strong updrafts created by the steep southwest and west facing cliffs provide ideal conditions for migratory species and daily movement corridors for resident and wintering birds. Raptors are attracted to the area year round, due to the abundance and concentration of mammalian prey within the Aubrey Valley below the cliffs. Based on this information, fatalities to resident and migratory raptor species at the Aubrey Cliffs project area are expected to be similar to or higher than those experienced by other wind energy facilities in the western U.S.. Additionally, short-term construction related disturbance impacts are possible. Overall, resident passerine use of the site is expected to be low and impacts to these species are predicted to be generally confined to common desert grassland and scrub species.

Eighteen bat species including 10 species of conservation concern and five migratory species are known to occur or may occur within the proposed Aubrey Cliffs project area (Table 3). Fourteen of these have been documented in Aubrey Valley and other portions of the project area during surveys in 2005 and 2006 conducted by the Arizona Game and Fish Department. Based on mortality patterns observed at other wind development sites, these species, especially the migratory tree bats, warrant particular attention when monitoring for future wind facilities. Understanding bat interactions and causes of mortality at wind facilities is complex and information limited.

Based on the current information of use and movement patterns for birds and bats within the project area, and the overall concern raised by reports of high bat mortality and their cumulative effects on bat populations across the United States, pre-construction surveys are recommended to further assess the potential impacts of a wind facility at Aubrey Cliffs.

APPENDIX C

PROJECT PLAN

FOR

**A FEASIBILITY STUDY TO EVALUATE WIND ENERGY
POTENTIAL ON THE NAVAJO NATION**

Feasibility Study to Evaluate Wind Energy Potential on the Navajo Nation
Grant No. DE-FG36-05GO15180
Schedule Status- Milestone Activities

ID	TASK NAME	START	FINISH	TASK ASSIGNED TO
1	Task 1 - Project coordination and leadership	09/01/2005	08/31/2009	NTUA, NAU
2	- Project Start	09/01/2005		NTUA
3	- Revise and update project Gantt chart	09/15/2005	08/31/2009	NTUA, NAU
4	- Schedule and visit PNM East New Mexico Wind Farm	10/21/2005	11/30/2005	NTUA
5	- Semi-annual meetings at Window Rock (on-going)	09/08/2005	08/31/2009	NTUA, NAU
11	- Semi-annual meetings in Flagstaff (on-going)	01/18/2006	08/31/2009	NTUA, NAU
15	- Project End		08/31/2009	NTUA
16	Task 2 - Hardware purchase	12/05/2005	02/07/2006	NTUA
17	- Purchase anemometry kits	12/05/2005	02/07/2006	NTUA
18	- Receive anemometry kits	02/07/2006	02/07/2006	NTUA
19	Task 3 - Site specific renewable resource assessment	09/01/2005	08/31/2009	NTUA
20	- Select site for anemometer kits	09/01/2005	09/16/2005	NTUA, NAU
21	- Obtain permission/permits to install anemometers	09/19/2005	07/14/2006	NTUA, NAU
22	- Permissions/permits received	06/30/2006	06/30/2006	NTUA, NAU
23	- Install anemometer kits	10/18/2007	05/23/2008	NTUA, NAU
24	- Begin recording data	10/18/2007	05/23/2008	NTUA, NAU
25	- Prepare 6 month report	10/18/2007	02/20/2009	NAU
26	- Report due on first 6 months of data analysis	06/30/2008	02/20/2009	NAU
27	- Prepare full year data analysis report	10/18/2007	06/30/2009	NAU
28	- Full year data analysis report	10/18/2007	08/31/2009	NAU
29	- Project end data analysis report (1+ year of data)	12/31/2008	08/31/2009	NAU
30	Task 4 - Land ownership analysis	09/01/2005	02/24/2006	NTUA
31	- Land ownership and access analysis for proposed sites	09/01/2005	02/24/2006	NTUA, NAU
32	Gray Mountain	09/01/2005	10/31/2005	NAU
33	Aubrey Cliffs	01/02/2006	01/27/2006	NAU
34	Leupp Area	02/01/2006	02/24/2006	NAU
35	Task 5 - Tribal load assessment and export markets	09/01/2005	02/08/2006	NTUA
36	- Navajo Loads Assessment	09/01/2005	11/03/2005	NTUA or RFP
37	- Export Market Analysis	11/04/2005	02/08/2006	NTUA or RFP
38	- Loads and export market report due	02/08/2006	02/08/2006	NTUA or RFP
39	Task 6 -Transmission and inter-connection considerations	10/03/2005	04/23/2007	NTUA
40	- Begin planning for transmission and interconnection studies	10/03/2005	02/28/2006	NTUA or RFP
41	- Request Feasibility Study	03/01/2006	03/31/2006	NTUA or RFP
42	- Transmission study (System Impact Study)	04/03/2006	04/28/2006	NTUA or RFP
43	- Inter-connection study (Facility Study)	05/01/2006	10/31/2006	NTUA or RFP
44	- Transmission & inter-connection report due	04/23/2007	04/23/2007	NTUA or RFP
45	Task 7 - Technology analysis	03/01/2006	06/30/2006	NTUA
46	- Technology analysis	03/01/2006	06/30/2006	RFP
47	- Technology analysis report due	06/30/2006	06/30/2006	RFP
48	Task 8 - Economic analysis	01/30/2006	08/17/2007	NTUA
49	- Set-up Economic Model for Wind Development Project(s)	01/30/2006	03/31/2006	RFP
50	- Contract with meteorologist: prediction of wind farm output	04/03/2006	05/01/2006	RFP
51	- Intermediate wind farm economic analysis	02/26/2007	03/30/2007	RFP
52	- Final wind farm economic analysis	07/02/2007	08/17/2007	RFP
53	- Economic analysis report due	08/17/2007	08/17/2007	RFP
54	Task 9 - Environmental assessment	02/01/2006	07/31/2007	NTUA, NAU
55	- Plan for Avian and NEPA analyses	02/01/2006	10/28/2007	NTUA, NAU
56	- Avian analysis	10/29/2007	05/30/2008	NAU
57	- NEPA	04/03/2006	07/31/2007	NAU
58	- Environmental assessment report due	07/31/2007	07/31/2007	NTUA
59	Task 10 - Benefit assessment	02/01/2006	06/29/2007	NTUA, Dine Care
60	- Benefits and Impacts assessment	02/01/2006	06/29/2007	NTUA, Tallman
61	- Benefits and Impacts report due	06/29/2007	06/29/2007	NTUA, Tallman
62	Task 11 - Preliminary system design	12/05/2005	06/01/2007	NTUA
63	- Initiate preliminary system design: export and NTUA load	01/02/2005	01/13/2006	RFP
64	- Community Input and Tribal Govt Input	01/09/2006	05/31/2007	RFP

ID	TASK NAME	START	FINISH	TASK ASSIGNED TO
65	- Preliminary system design	02/01/2006	02/28/2006	RFP
66	- Preliminary system design report due	02/28/2006	02/28/2006	RFP
67	- System design	02/26/2007	05/31/2007	RFP
68	- System design report due	06/01/2007	06/01/2007	RFP
69	Task 12 - Training and other tribal prof. development	01/23/2006	12/22/2010	NTUA, NAU
70	- Chapter & Community Outreach, Education, Input	01/23/2006	12/22/2010	NTUA, NAU
71	- Tribal Govt. Outreach, Education, Input	01/23/2006	12/22/2010	NTUA, NAU
72	Task 13 - Long-term operating and maintenance planning	02/26/2007	05/31/2007	NTUA
73	- O&M study	02/26/2007	05/31/2007	RFP
74	- O&M report due	05/31/2007	05/31/2007	RFP
75	Task 14 - Project planning for implementing a sustainable	03/01/2006	06/15/2007	NTUA
76	- Sustainability planning	03/01/2006	06/15/2007	NTUA
77	- Sustainability report due	06/15/2007	06/15/2007	Dine Care, RFP
78	Task 15 - Investigate financing options	05/02/2006	06/15/2007	NTUA
79	- Plan for financing options	05/02/2006	01/31/2007	NTUA
80	- Financing analysis	02/01/2007	06/15/2007	NTUA
81	- Financing analysis report due	06/15/2007	06/15/2007	NTUA
82	Task 16 - Plan for a Tribal Council Resolution	11/01/2005	06/29/2007	NTUA
83	- Plan for chapter and Tribal Council Resolutions	11/01/2005	06/29/2007	NTUA
84	- Resolution plan	06/29/2007	06/29/2007	NTUA
85	Task 17 - Write comprehensive business plan	01/30/2006	08/20/2007	NTUA
86	- Plan comprehensive business plan; form templates	01/30/2006	03/31/2006	RFP or NAU
87	- Write business plan report	06/18/2007	08/17/2007	RFP or NAU
88	- Business plan	08/20/2007	08/20/2007	RFP or NAU

APPENDIX D

PHOTOGRAPHS OF GRAY MOUNTAIN

Photographs of Project - Gray Mountain



APPENDIX E

PHOTOGRAPHS OF BOQUILLAS RANCH

Photographs of Project - Boquillas Ranch

