Navajo Wind Energy Feasibility Study on the Navajo Nation

Navajo Tribal Utility Authority

Office of Energy Efficiency and Renewable Energy

TRIBAL ENERGY PROGRAM

2007 Program Review Meeting

Denver, Colorado

November 06, 2007
Navajo Tribal Utility Authority was created as a tribal department under the Resources Division of the Navajo Tribe by resolution of the Tribal Council on January 22.

NTUA office was established in Shiprock with 15 employees: the City of Farmington offered assistance in setting up the operations.

Phillip W. (Vance) Vanderhoff, a non-Navajo, was named NTUA’s first General Manager.

My Hope is to provide a light in every Hogan!

1960

Phillip W. (Vance) Vanderhoff

An Enterprise of the Navajo Nation
Navajo Nation Council created NTUA in 1959 to provide modern utility services to the Navajo people.

NTUA operates under a Plan of Operation as a non-profit Tribal Enterprise charged with providing utility services at a reasonable rates to the public.

NTUA is governed by a Management Board of (7) members, to direct the operation of the Authority.

The Board is appointed and confirmed by the Government Services Committee.

The Board was granted certain powers thru Section 7 of Title 21 of the Navajo Nation Code.
Navajo Tribal Utility Authority

Mission

Provide electric, natural gas, water, wastewater treatment, photovoltaic and related services at competitive rates while contributing to the economy of the Navajo Nation, consistent with the improvement of the health and welfare of the residents of the Navajo Nation and the employment of the Navajo people.

Navajo Tribal Utility Authority
Post Office Box # 170
Fort Defiance, Arizona  86504-0170
Navajo Tribal Utility Authority

NTUA provides and operates Electric, Natural Gas, Water, Wastewater and Solar PV services on the Navajo Nation in Arizona, New Mexico, and Utah.

- Operates five District offices and four sub-offices.
- 38,156 electric customers
- 34,942 water customers
- 12,616 wastewater customers
- 7,225 gas customers
- 311 photovoltaic accounts
- NTUA purchases electric power and energy at wholesale from several sources.
- NTUA does not generate any electric power for its use.
Navajo Niyol (Wind) Project- Funded by Department of Energy

- NTUA and Navajo Wind Project Team will evaluate six sites.
- Wind Study will monitor and analyze tribal land within the States of Arizona and New Mexico.
- Wind Project Team will coordinate all activities in reviewing and evaluating these proposed sites.
- NTUA primary objective is to evaluate the wind energy potential.
- Determine if there are sufficient wind energy resources to generate electric power.
<table>
<thead>
<tr>
<th>Project Title</th>
<th>A Feasibility Study to Evaluate Wind Energy Potential on the Navajo Nation</th>
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<tbody>
<tr>
<td>Grant period</td>
<td>Sept. 01, 2005 to December 31, 2007</td>
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<tr>
<td>Grant Award Number</td>
<td>DE-FG36-05GO15180_A000</td>
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<tr>
<td>Partners</td>
<td>NTUA personnel involved in this grant are: Bernice Tsosie, Right of Way Agent, Pamela Myron, Electric Engineering Secretary, Wally Chief, Acting Manager, Larry Ahasteen, Project Manager, Navajo Wind Team: Dr. Tom Acker, NAU Project Advisor, Annie Frazier, Dine CARE, Advisor, Larry Flower, NREL, Advisor, Sandra Begay Campbell, Advisor, John Gaglioti, NAU Student,</td>
</tr>
<tr>
<td>Technical Contact</td>
<td>Larry Ahasteen, Project Manager, Post Office Box 170, Fort Defiance, Arizona 86515, Telephone Number (928) 729-6263</td>
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<td>Total Award</td>
<td>$ 200,000.00 (DOE)- $ 35,212.00 (NTUA)</td>
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<td>Task</td>
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<tr>
<td>Task 1</td>
<td>Project coordination and leadership</td>
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<tr>
<td>Task 2</td>
<td>Hardware purchase</td>
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<td>Task 3</td>
<td>Site specific renewable resource assessment</td>
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<td>Task 4</td>
<td>Land ownership analysis</td>
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<td>Task 6</td>
<td>Transmission and inter-connection considerations</td>
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<td>Task 7</td>
<td>Technology analysis</td>
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<td>Task 10</td>
<td>Benefit assessment</td>
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<td>Task 11</td>
<td>Preliminary system design</td>
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<td>Task 12</td>
<td>Training and other tribal professional development</td>
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<td>Task 13</td>
<td>Long-term operating and maintenance planning</td>
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<td>Task 14</td>
<td>Project planning for implementing a sustainable</td>
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<td>Task 15</td>
<td>Investigate financing options</td>
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<td>Task 16</td>
<td>Plan for a Tribal Council Resolution</td>
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<tr>
<td>Task 17</td>
<td>Write comprehensive business plan</td>
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</table>
To make electricity available to all the homes within the Nation, wind energy development will play a key role in this objective; and,

To open the range of economic development activities that provide long, challenging and prosperous careers for young Navajos.

To utilizing existing Tribal organization, Enterprise and Manpower on the Navajo Nation to develop this feasibility study.
NTUA in partnership with NAU will determine most feasible sites on the Navajo reservation.

NTUA will assign staffs to survey and map out the most feasible area and route to extend transmission line to a sub-station.

NTUA and NAU will monitor the sites for twelve months period and develop a comprehensive site studies of the sites.

A meteorologist will be consulted to assist the team in choosing proper site, review and analysis data.
Project Coordination and Leadership

Aubrey Cliffs

- Request for a Building Permit to install 2nd Met tower at Aubrey Cliffs to Coconino County Planning and Zoning Dept.

- Arizona Game & Fish Department and NAU’s Environmental Monitoring and Assessment (EMA) have agreed to develop avian studies protocol.

- Arizona Game & Fish Department and NAU have agreed to perform a study to determine the effects of meteorological towers on avian mortality

- NAU has secured an exemption from the Arizona Registrar of Contractors that required a licensed contractor to install meteorological towers in Coconino County.
Hardware Purchase

NTUA selected and purchase wind assessment equipments from NRG.
Assisted NAU in evaluating Wind resource assessment software (WindPRO 2.5)

Site Specific Renewable Resource Assessment

Wind data are currently collected and analyzed at two sites: Grey Mountain and Aubrey Cliffs with Northern Arizona University (NAU)
NTUA has collected data at 4 other wind sites
NTUA selected a Navajo Wind Project Team, which will consist of representatives from various organization to assist in the wind energy assessment, and develop a technical feasibility study of the wind energy resources on the Navajo Nation.

- NTUA selected 10 individual from various organization.
- NWT met every quarterly and annually to review the progress of the Project.
- 2005 Wind (Niyol) Scheduled a Kickoff meeting held in Window Rock, Arizona
Navajo Wind Project - Project Team

Organization

- Dine’ Care
- Navajo Businesses
- Crownpoint Technology Institute
- Northern Arizona University
- Dine Power Authority
- Sandia National Lab.
- National Renewable Energy Lab.
- Navajo Tribal Utility Authority
- Navajo Nation Government
- ICOUP

Navajo Wind Project Team
1. PROGRAM OVERVIEW

NTUA plans consist of the following:

- Expedite the development of wind energy sites
- Implementation of sites plan
- Engineering detail design of a wind farm for the Nation
Navajo Nation Council directed to all Tribal Programs and Enterprise to develop, research, and seek new plans to generate outside revenue for the Nation.
NN Council approved a resolution for NTUA to build electric generating facilities to services its load and not depend on offreservation electric generating facilities.
NTUA is proposing to conduct a 24 months comprehensive wind energy resources evaluation an development of a wind farm feasibility study.
5. The Navajo Nation and NTUA has the experience in carrying out this feasibility project.
Grey Mountain, one of the best wind power sites in Arizona, is within the Southeast corner of the Navajo Nation, about 50 miles North of Flagstaff, AZ.

In addition to a large area of Class 3 sites, Gray Mountain has the potential for around 430 MW of wind power in Class 4 sites and 210 MW in Class 5 sites, according to a wind map generated by TrueWind Solutions.

Gray Mountain is very close to multiple major transmission lines and a large substation, called the Moecopi Substation.
Aubrey Cliffs could be the best wind power sites in Arizona, it is on a Navajo Fee Simple and Arizona State Land (Check board land). It is managed by the Navajo Nation Department of Natural Resources and is also called the Big Boquillas Ranch. It is about 13 miles Northwest of Seligman, Arizona. Aubrey Cliff has the potential for around 300 MW of wind power in Class 4 sites according to a wind map generated by TrueWind Solutions. Aubrey Cliffs is very close to major 230 KV transmission lines (6 miles est.)
Canyon Diablo wind site has a moderate wind power sites in Northern Arizona, it is on Navajo Trust Land between the Navajo community chapter of Luepp and the ghost town of Two Guns, Arizona. Canyon Diablo has the potential for less than 200 MW of wind power in Class 3 sites according to a wind map generated by TrueWind Solutions. Canyon Diablo is very close to major 115 KV transmission lines (8 miles est.) to the north near the Luepp natural gas compressor station. Further study will be required at this proposed site- No Met Tower was installed- The proposed Sunshine Wind Farm was sited on the south end of this Wind Project.
Aubrey Cliff Wind Site
First Wind Site - Met Tower permit was approved by State Land Office. All required approval were completed.

Five new wind sites - All sites were approved by the Coconino Planning Commission.

Northern Arizona University will conduct land clearance to these sites.

Navajo Nation - Resources Committee will make the final determination of which developer they will work with.

Big Boguillas ranch is owned by the Navajo Nation - Land is a Fee Land / State Land-checker board.
Aubrey Cliff Wind Site – Sodar Analysis

Surface wind flow test around the Aubrey Cliff area where NTUA wind anemometer and SODAR assessment are currently being tested by Northern Arizona University.
NTUA Met tower Installation
/Aubrey Cliffs/
Gray Mountain Wind Site

Gray Mountain Windy Land
Average Annual Wind Resource 230 ft (70m) with Land Exclusions and Transmission

Legend
- Major Roads
- Transmission Lines
- Land Excluded 100%
- Woodlands - Excluded 50%
  Does not include Pinyon-Juniper Woodland

Created by: Grant Brumme
Date of Creation: 9/7/2005
For more information contact:
Dr. Tom Acker
Tom.Acker@nau.edu

Projection:
UTM, Zone 12, WGS84
Spatial Resolution of Wind Resource Data: 200m

Wind Power Classification

<table>
<thead>
<tr>
<th>Wind Power Class</th>
<th>Wind Power Density (W/m²)</th>
<th>Wind Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>0 - 200</td>
<td>0.0 - 12.3</td>
</tr>
<tr>
<td>Marginal</td>
<td>200 - 300</td>
<td>12.3 - 14.1</td>
</tr>
<tr>
<td>Fair</td>
<td>300 - 400</td>
<td>14.1 - 15.7</td>
</tr>
<tr>
<td>Good</td>
<td>400 - 500</td>
<td>15.7 - 16.8</td>
</tr>
<tr>
<td>Excellent</td>
<td>500 - 600</td>
<td>16.8 - 17.9</td>
</tr>
<tr>
<td>Outstanding</td>
<td>600 - 800</td>
<td>17.5 - 18.7</td>
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<tr>
<td>Supert</td>
<td>&gt; 800</td>
<td>&gt; 18.7</td>
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</table>
Prevailing Wind

GRAY MOUNTAIN WIND SITE

Navajo Tribal Utility Authority
Navajo Wind Project

Monthly mean values of wind speed in m/s

<table>
<thead>
<tr>
<th>Month</th>
<th>2005 mean</th>
<th>2006 mean</th>
<th>mean of months</th>
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<tr>
<td>Jan</td>
<td>5.5</td>
<td>5.6</td>
<td>5.6</td>
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<tr>
<td>Feb</td>
<td>5.4</td>
<td>5.4</td>
<td>5.4</td>
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<tr>
<td>Mar</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
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<tr>
<td>Apr</td>
<td>0.7</td>
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<tr>
<td>May</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
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<tr>
<td>Jun</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
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<tr>
<td>Jul</td>
<td>5.2</td>
<td>5.2</td>
<td>5.2</td>
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<tr>
<td>Aug</td>
<td>5.2</td>
<td>5.2</td>
<td>5.2</td>
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<tr>
<td>Sep</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Oct</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Nov</td>
<td>4.9</td>
<td>4.9</td>
<td>4.9</td>
</tr>
<tr>
<td>Dec</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
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</table>

mean, all data: 4.5
mean of months: 5.3

50 meter

20 meter
Second Wind Site- Met Tower permit installed.

Second Wind Site- All clearance were completed. Grazing permit tee signed consent forms.

- Avian and Bat Study ongoing with Northern Arizona University
- International Piping Products negotiated with Cameron Chapter to conduct feasibility study.
- Cameron Chapter supported thru a chapter resolution for IPP to study and develop the Wind Farm at Grey Mountain.
- Cameron Chapter supporting resolution was approved-Met Tower Installed-Collecting Wind Data-NTUA
**Engineering Survey**

- Legal survey by a license surveyor was completed
- Site review for Met Towers completed
- Legal description of the area
- Approval was given to IPP under a conditional Use Permit by Navajo Business Regulatory Office

**Environmental Assessment**

- Survey for cultural inventory was completed for permit
- Biologist surveyed completed for Biological assessment for revocable permit.
- Site specific protocol and survey design for avian and bat species at Grey Mountain wind sites is on going.
NTUA Met Tower Installation – Grey Mountain
Navajo Nation Wind Development Process

- Site Selection
- Land Agreements
- Wind Assessment
- Environmental review
- Economic Modeling
- Interconnection Studies
- Permitting
- Sales Agreements
- Financing
- Turbine Procurement
- Construction contracts
- Operation and Maintenance

Navajo Tribal Utility Authority
### Study of Potential Mohave Alternative/Complementary Generation Resources

#### Table: Wind Class at 80 m

<table>
<thead>
<tr>
<th>Site</th>
<th>Gray Mountain</th>
<th>Aubrey Cliffs</th>
<th>Clear Creek</th>
<th>Sunshine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Class at 80 m</td>
<td>4 to 7</td>
<td>4 to 5</td>
<td>3+ to 4</td>
<td>3</td>
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<tr>
<td>MW</td>
<td>450</td>
<td>100</td>
<td>75</td>
<td>60</td>
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</table>

#### Figure 4.2 — Gray Mountain Site Wind Resource Map

- Gray Mountain Site
- Mooorki Substation
- 500 KV Transmission
- 345 KV Transmission
- 69 KV Transmission

#### Figure 4.4 — Aubrey Cliffs Site Wind Resource Map

- Aubrey Cliffs Site
- 500 KV Transmission
- 230 KV Transmission
- Schigmian
- Route 66 Highway

Report Prepared for Southern California Edison
4.1.5.1 Gray Mountain

The Gray Mountain site has between 23,000 and 34,000 acres (35.9 to 53.1 sq. mi.) on which to site wind turbines. Assuming an average of eight turbines per section of land, the number of turbines that could be sited (assuming 1.65 MW turbines) would be 287 turbines, with the potential to site as many as 425 wind turbines. Building 450 MW at this site would equate to 272 turbines using 1.65 MW turbines. If larger turbines are used, somewhat fewer turbines can provide the same number of megawatts.

All of the land at the Gray Mountain site is on the Navajo Reservation and is the jurisdiction of the Cameron Chapter. The elevation at this site is about 6,400 feet above sea level and overlooks the Moenkopi Substation about 10 miles away.

4.1.5.2 Aubrey Cliffs

The Aubrey Cliffs site is an elevated ridgeline or cliff running about 10 miles in length and overlooking Aubrey Valley. This site is very similar in its appearance to many sites developed around McCamey, Texas, along high mesas and ridgelines. The elevation at this site is about 6,300 feet above sea level. If the site is limited to one or two rows of turbines sited along the length of the ridge, this site would consist of about 5,200 acres (8.1 sq. mi.). Assuming a spacing of 750 feet between turbines, about 56 turbines and 92 MW can be sited per row along the ridgeline. It is important to note that the land ownership at this site is a checkerboard of State Trust land and Navajo fee land. Therefore, both the Arizona State Land Department and the Navajo Nation would need to participate to allow this project to proceed as envisioned.
PLANS for 2007

TASKS

- Tribal Load Assessment - Export Market
  - Transmission – Interconnection Study
  - Technology Analysis
  - Economic benefits analysis for the Navajo Nation
  - Site Assessment, Protocols, and Surveys for Avian and Bat Species at Wind Research and development at Grey Mountain and Aubrey Cliff
  - Preliminary system design
  - Long term O&M planning
  - Investigate Financing Options - Navajo Nation
  - Resolution to Navajo Nation Council and Oversight Committee
  - Comprehensive business plan
Key Issues

1. Land clearance-
2. Tribal- Federal (BIA) Bureaucracy
3. Legal Issues
4. Approval from grazing permit tee
5. Chapter approval
6. Tribal approval- SAS process - Resource Committee
7. Tax issues
8. Environmental Group
9. Avian and Bat Issues
10. Fees
11. Rights of Ways
12. Appraisal of Land
13. Restitution-compensations
14. County Zoning Issues
15. Private Developers-Consultants