



Navajo Tribal Utility Authority

Navajo Wind Energy Feasibility Study on the Navajo Nation

Presented By: Larry Ahasteen
Renewable Energy Specialist

Office of Energy Efficiency and
Renewable Energy

TRIBAL ENERGY PROGRAM
2007 Program Review Meeting

Denver, Colorado
November 06, 2007

Utah

110- Community Chapters



Arizona

New Mexico



Navajo Nation



**My Hope is to provide a light
in every Hogan !**

1960

Phillip W. (Vance) Vanderhoff

An Enterprise of the Navajo Nation

1959-

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.

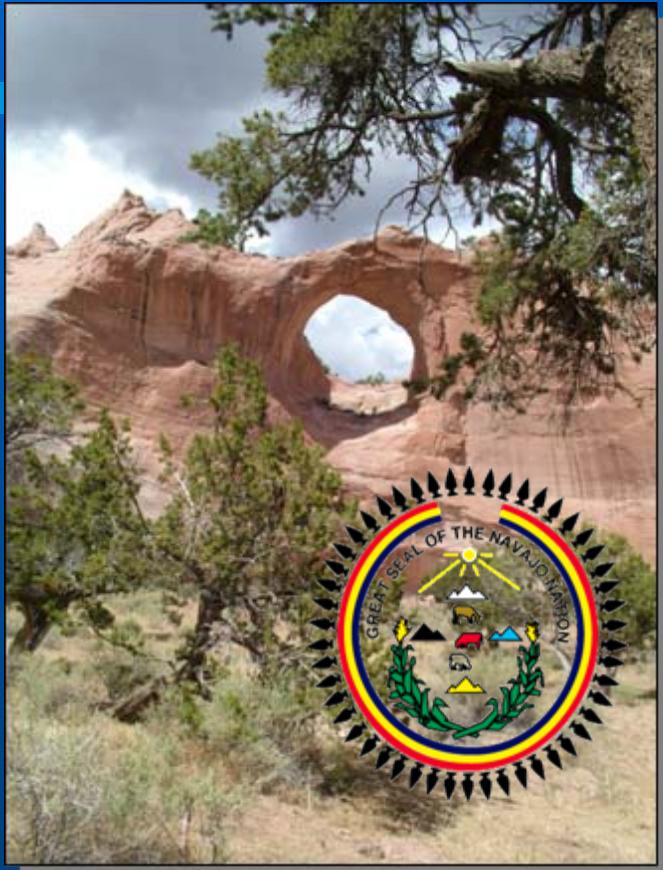
Phillip W. (Vance) Vanderhoff, a non-Navajo, was named NTUA's first General Manager

NAVAJO TRIBAL UTILITY AUTHORITY- HISTORY SUMMARY



- 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
Enterprise of the Navajo Nation

Navajo Tribal Utility Authority

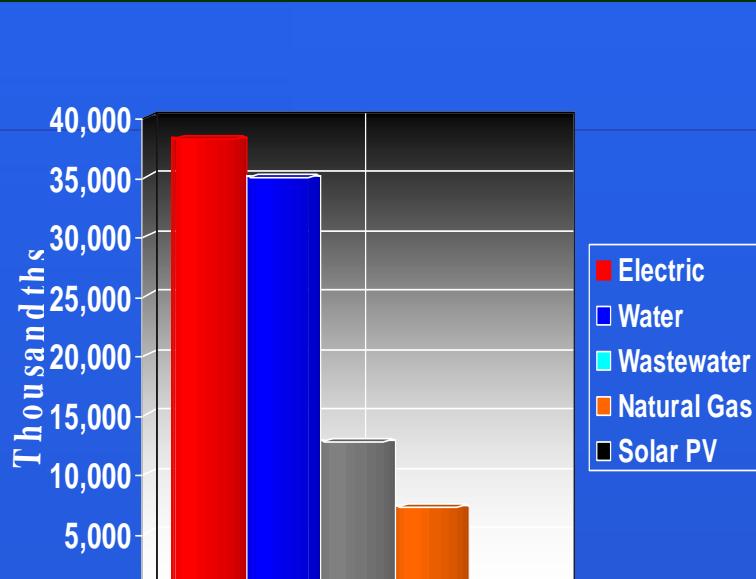
Post Office Box # 170

Fort Defiance, Arizona 86504-0170

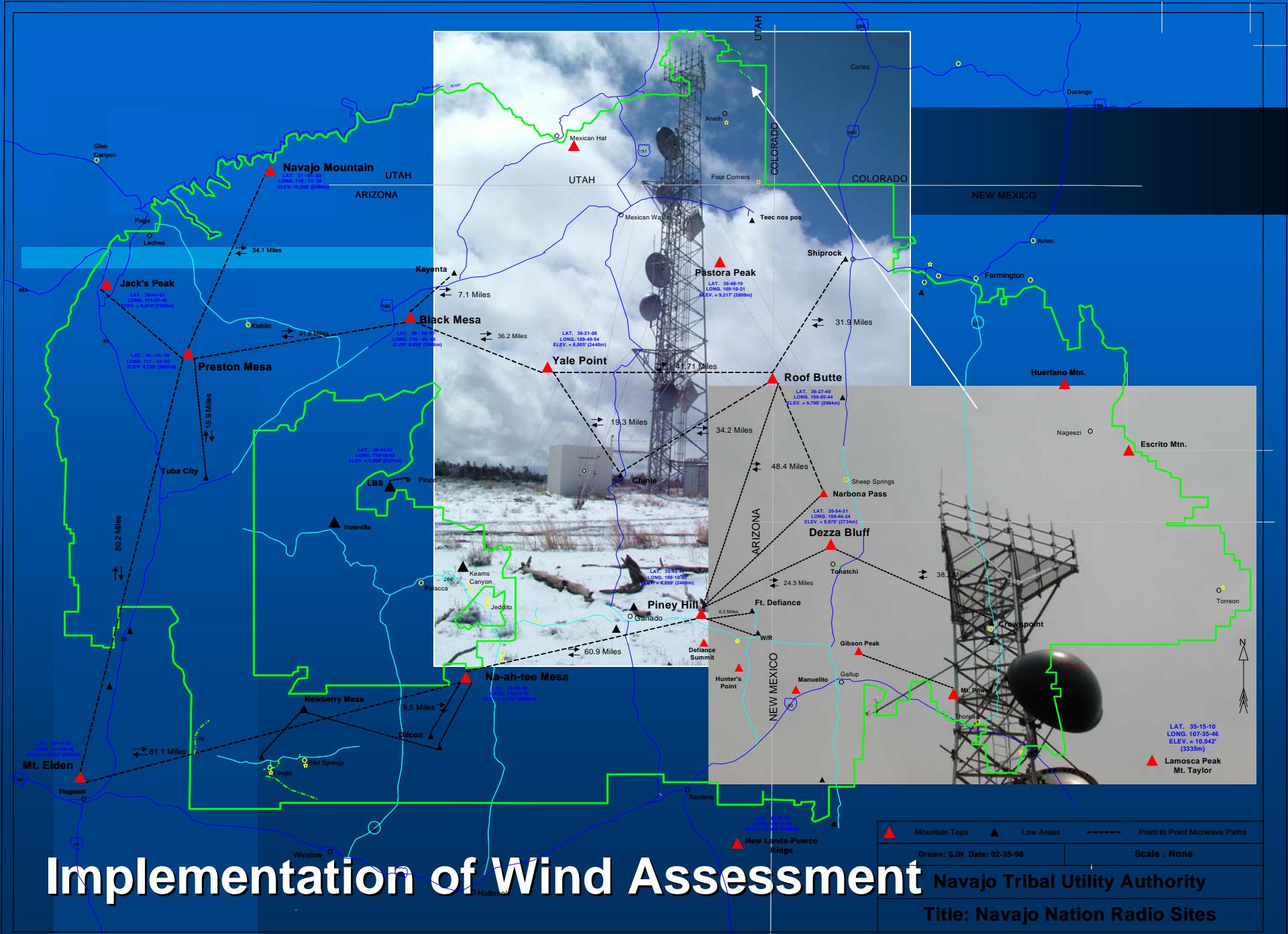


Navajo Tribal Utility Authority

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.

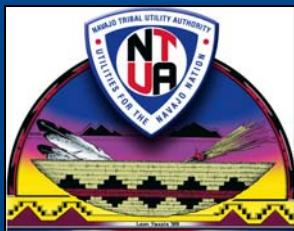


Navajo Niyol (Wind) Project- Funded by Department of Energy



- 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.

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



Project Title :

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

Grant period:

Sept. 01, 2005 to December 31, 2007

Grant Award Number

DE-FG36-05GO15180_A000

Partners:

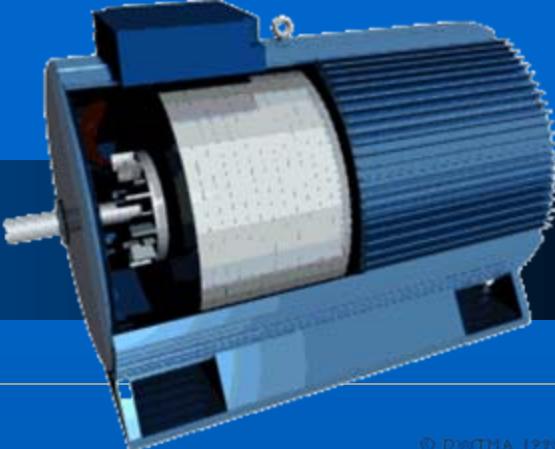
NTUA personnel involved in this grant are: Bernice Tsosie, Right of Way Agent, Pamela Myron, Electric Engineering Secretary, Wally Chief, Acting Manager, Larry Ahasteen, Project Manager, Navajo Wind Team: Dr. Tom Acker, NAU Project Advisor, Annie Frazier, Dine CARE, Advisor, Larry Flower, NREL, Advisor, Sandra Begay Campbell, Advisor, John Gaglioti, NAU Student,

Technical Contact:

**Larry Ahasteen, Project Manager,
Post Office Box 170,
Fort Defiance, Arizona 86515,**

**Telephone Number (928) 729-6263
\$ 200,000.00 (DOE)- \$ 35,212.00 (NTUA)**

Total Award :



Milestone Activities

© DWYTHA 1998

Tasks	Activities	Start Date	Completion Date
Task 1	Project coordination and leadership	9/1/05	8/31/07
Task 2	Hardware purchase	12/5/05	2/7/06
Task 3	Site specific renewable resource assessment	9/1/05	8/24/07
Task 4	Land ownership analysis	9/1/05	2/24/06
Task 5	Tribal load assessment and export markets	9/1/05	2/8/06
Task 6	Transmission and inter-connection considerations	10/3/05	4/23/07
Task 7	Technology analysis	3/1/06	6/30/06
Task 8	Economic analysis	1/30/06	8/17/07
Task 9	Environmental assessment	2/1/06	7/31/07
Task 10	Benefit assessment	2/1/06	6/29/07
Task 11	Preliminary system design	12/5/05	6/1/07
Task 12	Training and other tribal professional development	1/23/06	7/31/07
Task 13	Long-term operating and maintenance planning	2/26/07	5/31/07
Task 14	Project planning for implementing a sustainable	3/1/06	6/15/07
Task 15	Investigate financing options	5/2/06	6/15/07
Task 16	Plan for a Tribal Council Resolution	11/1/05	6/29/07
Task 17	Write comprehensive business plan	1/30/06	8/20/07

OBJECTIVES



- 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.

Navajo Tribal Utility Authority



Project Narrative



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



Navajo Niyol (Wind) Team

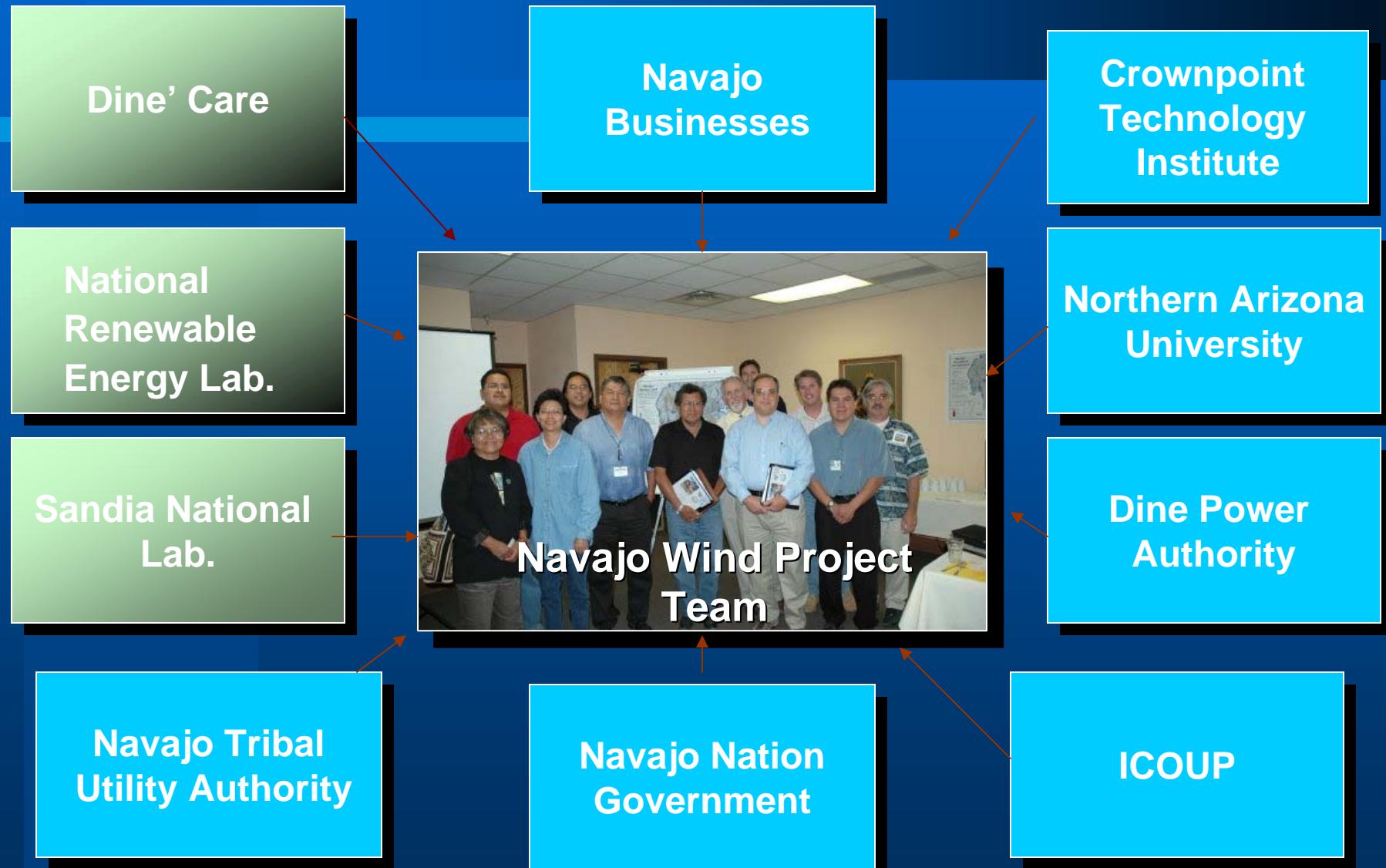


NTUA selected a Navajo Wind Project Team, which will consist of representatives from various organization to assist in the wind energy assessment, and develop a technical feasibility study of the wind energy resources on the Navajo Nation.



- ✓ 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



Navajo Windy Land

Average Annual Wind Resource 164 ft (50m) with Land Exclusions and Transmission

Navajo Reservation Boundary

- Navajo

- Navajo

- Navajo

Gap
Arizona

Legend

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

Created by: Grant
Data of Creation: 12/2012

Abrey Cliff

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

Gray
Mountain

Lolomai
Point

Windy Valley

Tohatchi

Crownpoint

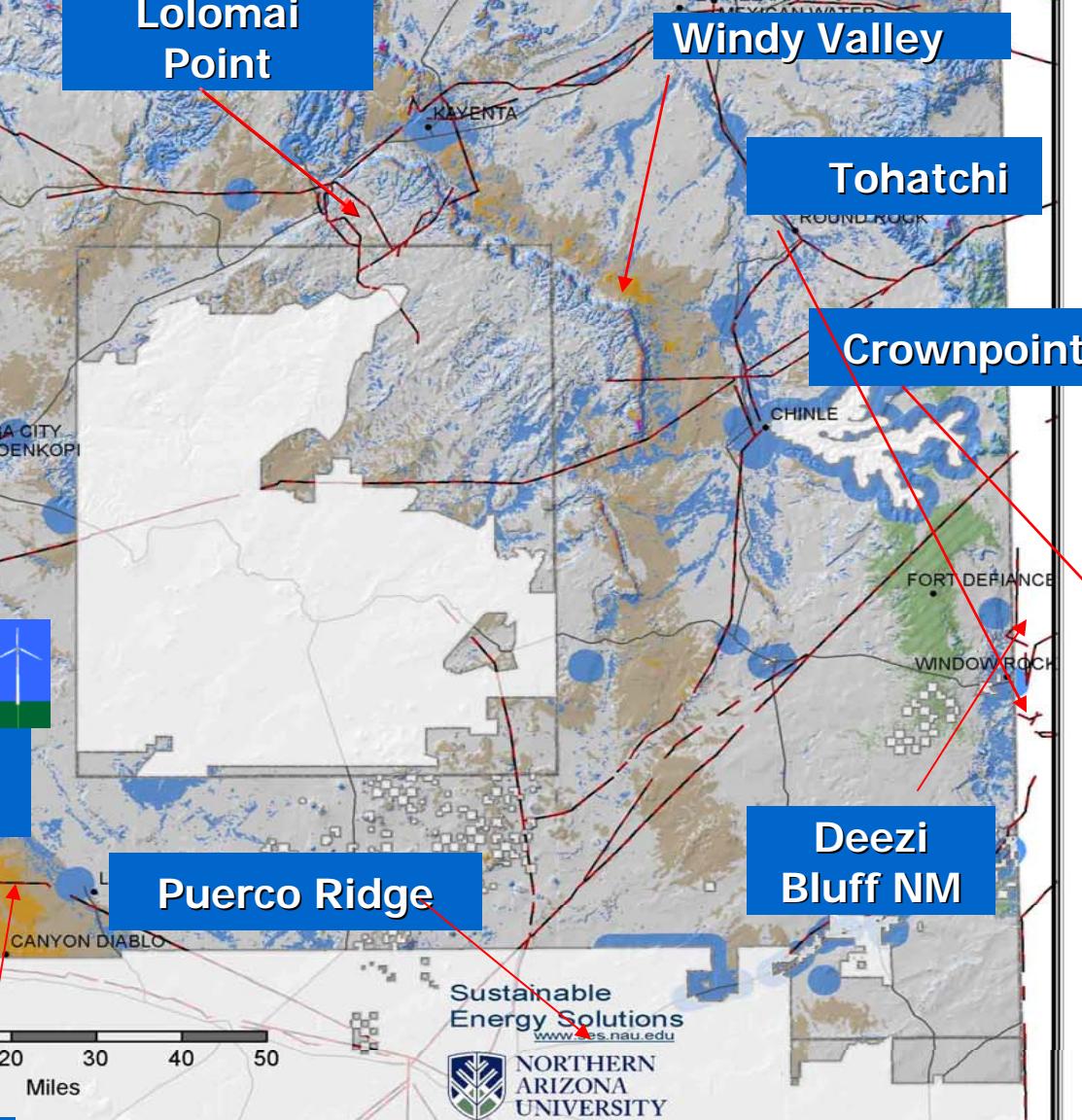
Wind Power Classification

Wind Power Class	Wind Power Density (W/m^2)	Wind Speed (mph)
1 Poor	0 - 200	0.0 - 12.3
2 Marginal	200 - 300	12.3 - 14.1
3 Fair	300 - 400	14.1 - 15.7
4 Good	400 - 500	15.7 - 16.8
5 Excellent	500 - 600	16.8 - 17.9
6 Outstanding	600 - 800	17.9 - 19.7
7 Superb	> 800	> 19.7

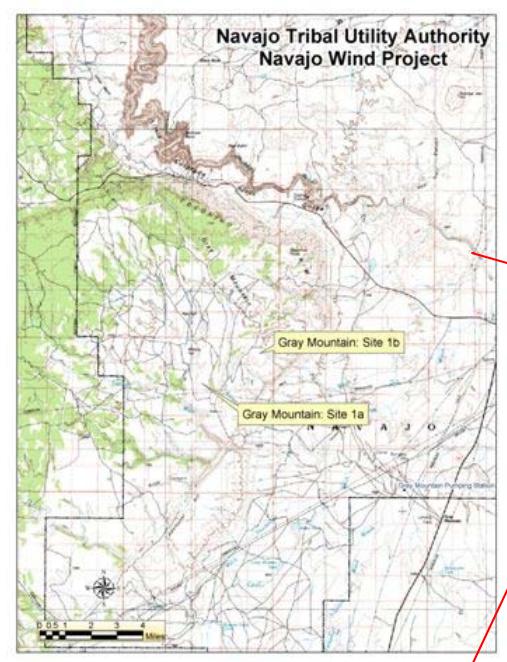
Canyon Diablo

Wind Sites- Navajo Nation

Sustainable
Energy Solutions
www.es.nau.edu
NORTHERN
ARIZONA
UNIVERSITY



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





2.

**Navajo
Tribal
Utility
Authority**

**Navajo
Engineering
Construction
Authority**

Navajo Nation Council directed to all Tribal Programs and Enterprise to develop ,research ,and seek new plans to generate outside revenue for the Nation

**Dine
Power
Authority**

**Navajo
Nation
Government**

Navajo Tribal Utility Authority



3.



NN Council approved a resolution for NTUA to build electric generating facilities to service its load and not depend on off-reservation electric generating facilities



Navajo Tribal Utility Authority





4.

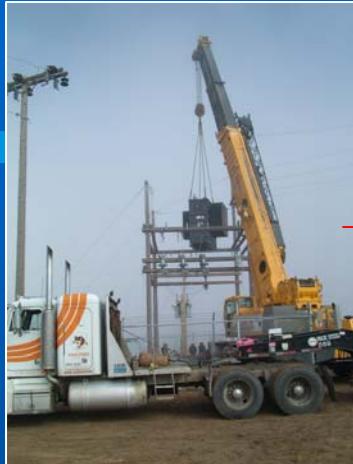
**NTUA is proposing to
conduct a 24 months
comprehensive wind energy
resources evaluation an
development of a wind farm
feasibility study**

Navajo Tribal Utility Authority



5.

The Navajo Nation and NTUA
has the experience in
carrying out this feasibility
project.

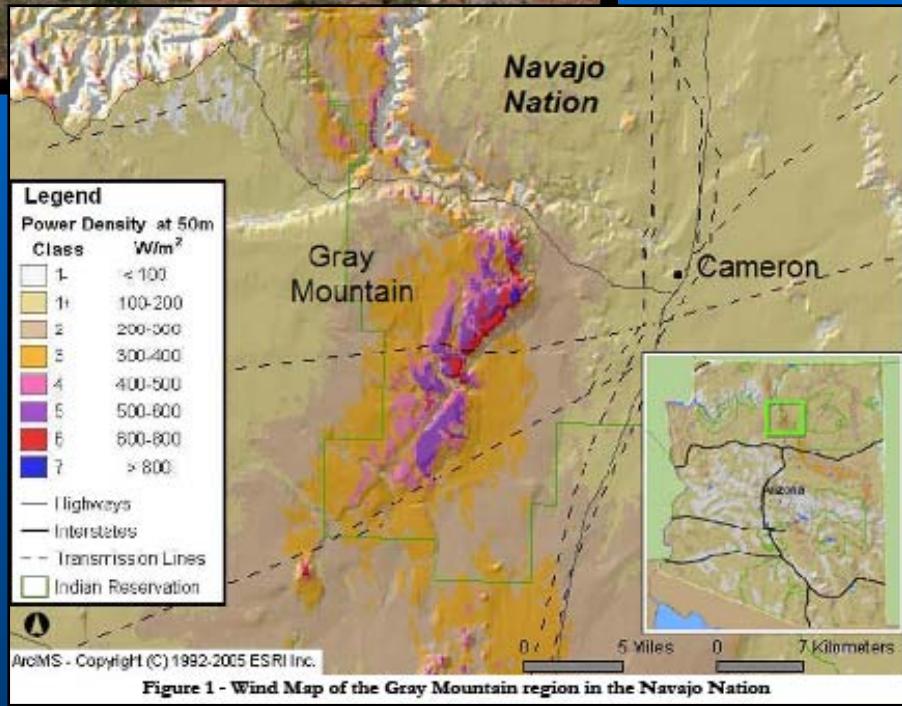


Navajo Tribal Utility Authority





Grey Mountain – Wind Study

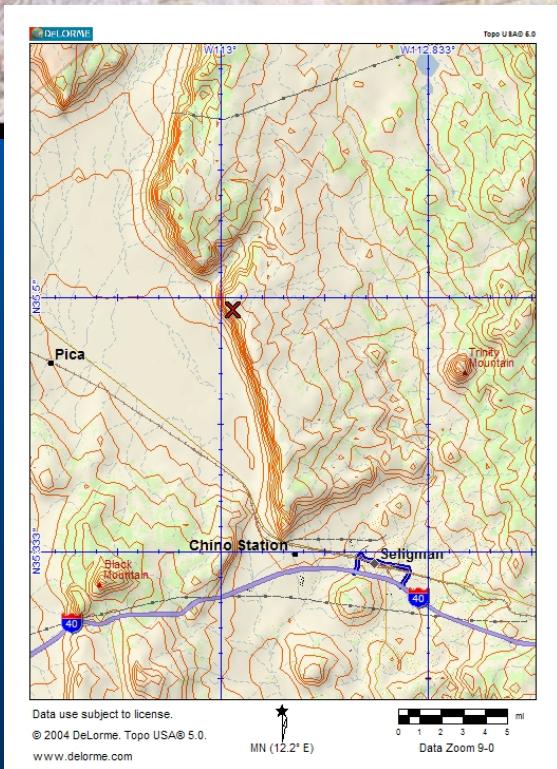


Grey Mountain, one of the best wind power sites in Arizona, is within the Southeast corner of the Navajo Nation, about 50 miles North of Flagstaff, AZ.

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- Wind Study



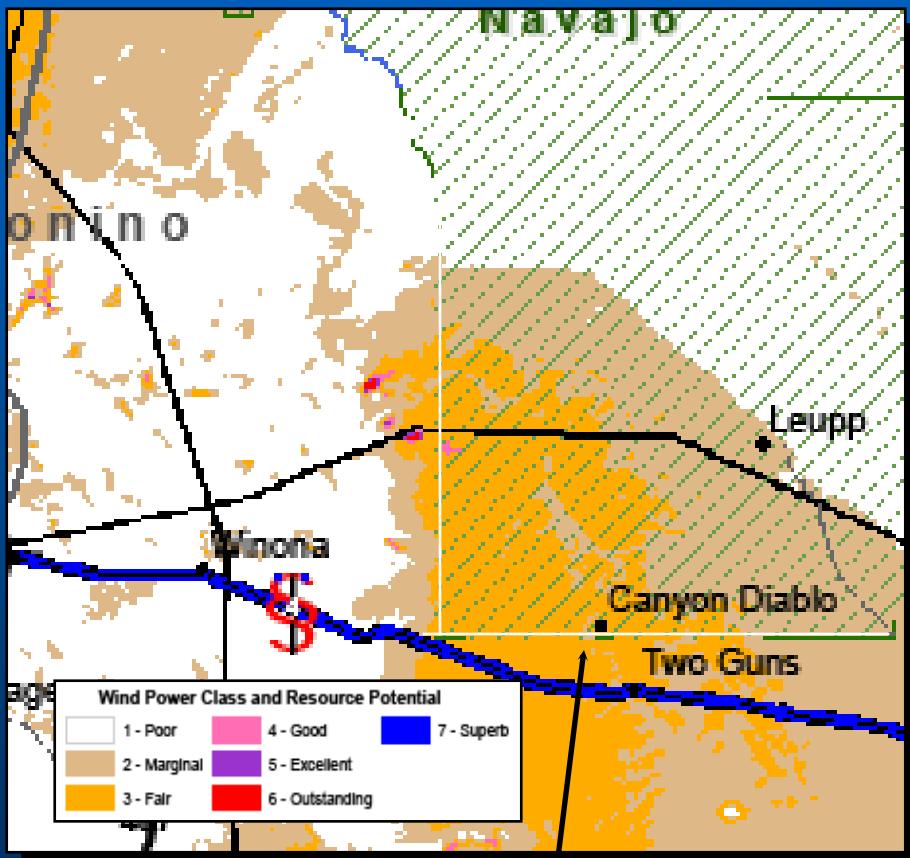
Aubrey Cliffs could be the best wind power sites in Arizona, it is on a Navajo Fee Simple and Arizona State Land (Check board land). It is managed by the Navajo Nation Department of Natural Resources and is also called the Big Boquillas Ranch. It is about 13 miles Northwest of Seligman, Arizona.

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 Study



Sunshine Wind Farm

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.

113°06'00" W

113°04'00" W

TOPO! map printed on 11/06/06 from "Aubrey Cliffs 110406.tpo" and "Untitled.tpg"

113°02'00" W

113°00'00" W

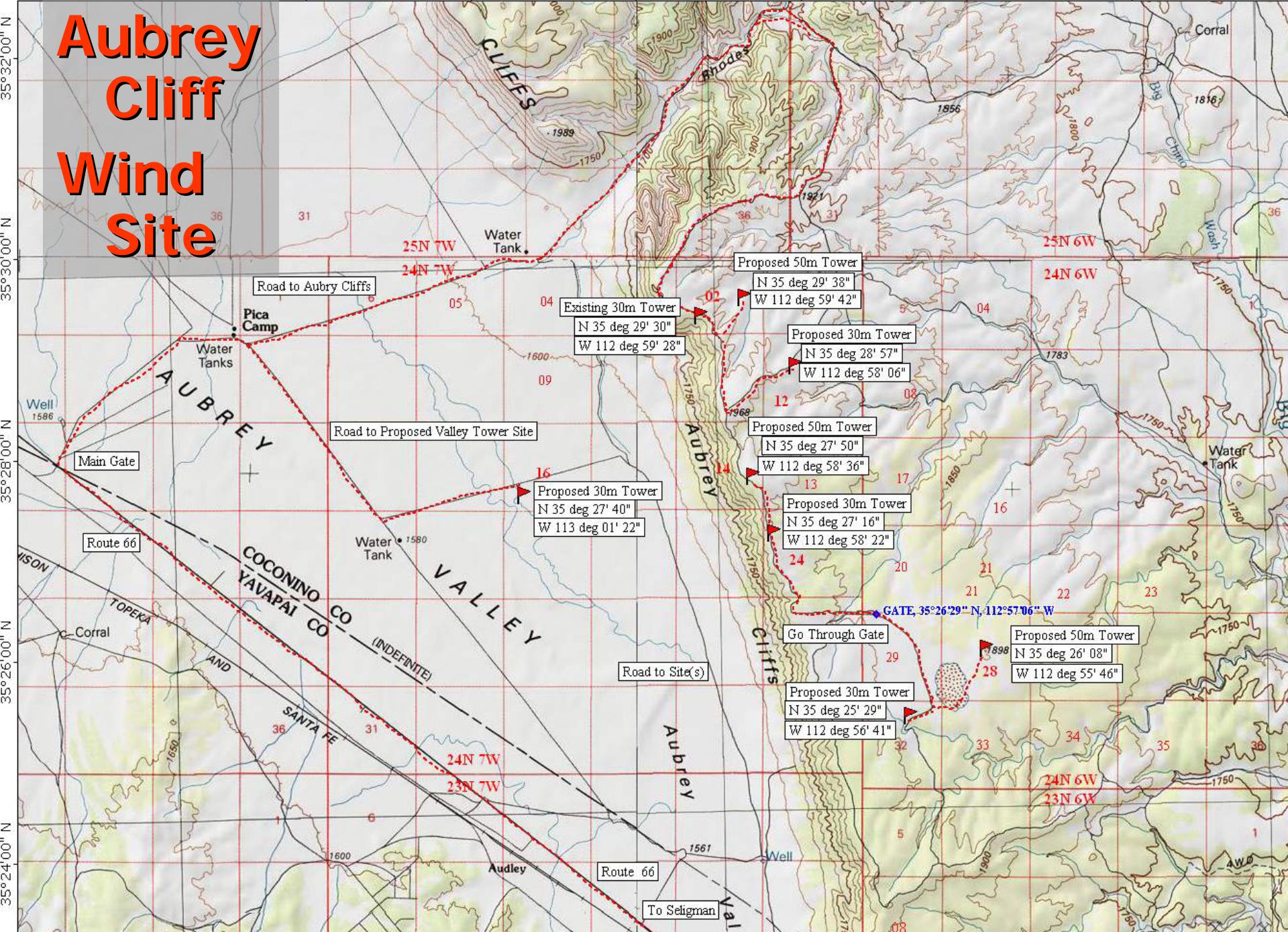
112°58'00" W

112°56'00" W

112°54'00" W

NAD27 113

Aubrey Cliff Wind Site



Aubrey Cliff- Wind Sites



First Wind Site- Met Tower permit was approved by State Land Office- All required approval were completed

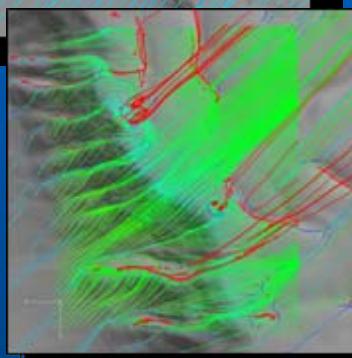
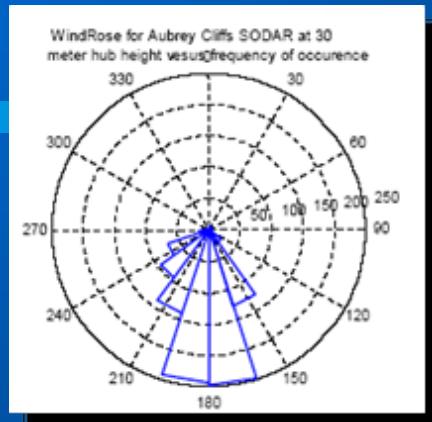
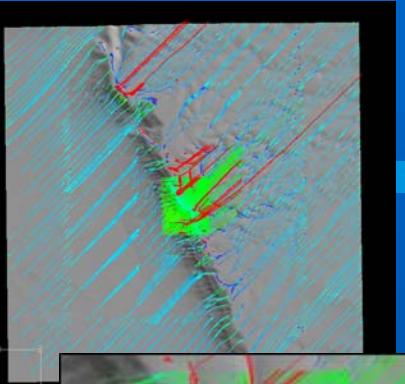
Five new wind site- All sites were approved by the Coconino Planning Commission

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 Bogillas 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



Navajo Tribal Utility Authority



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

Navajo Reservation Boundary
within Arizona includes:
-Navajo National Monuments
-Navajo Trust Land
-Navajo-Hopi Joint Use Areas.

Legend

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

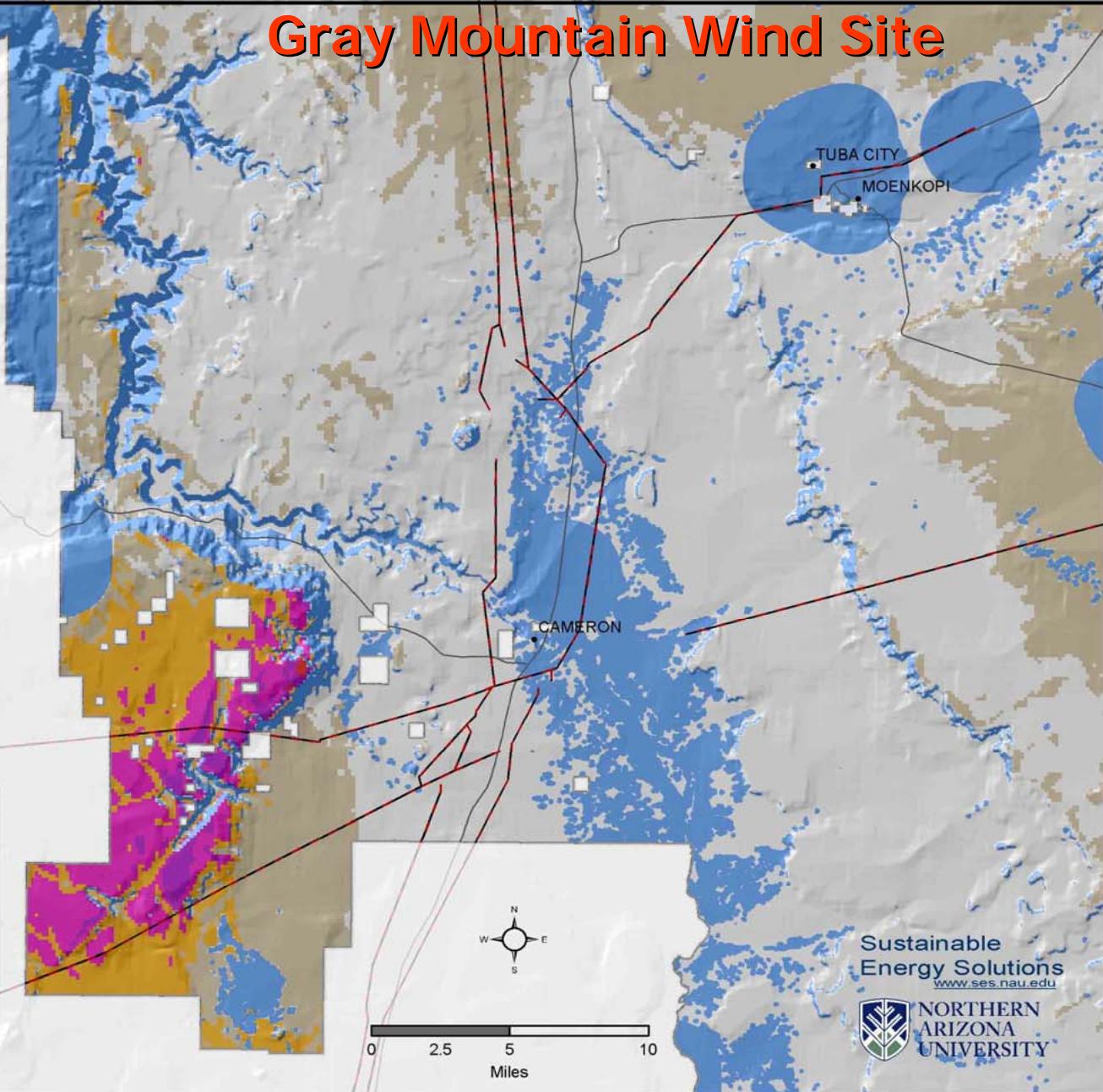
Created by: Grant Brummels
Date of Creation: 9/7/2005
For more information contact:
Dr. Tom Acker

Tom.Acker@nau.edu

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

Wind Power Classification

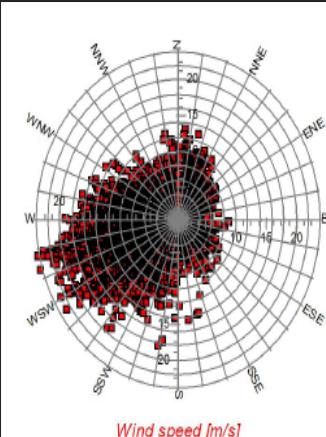
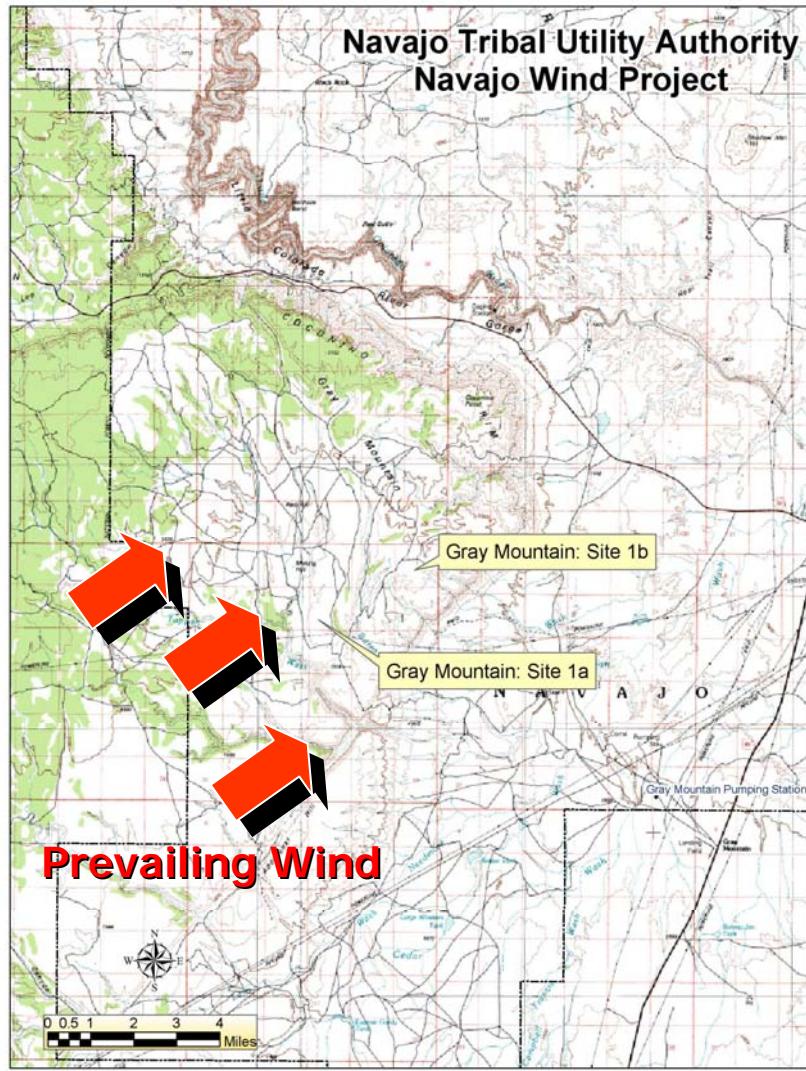
Wind Power Class	Wind Power Density (W/m^2)	Wind Speed (mph)
1 Poor	0 - 200	0.0 - 12.3
2 Marginal	200 - 300	12.3 - 14.1
3 Fair	300 - 400	14.1 - 15.7
4 Good	400 - 500	15.7 - 16.8
5 Excellent	500 - 600	16.8 - 17.9
6 Outstanding	600 - 800	17.9 - 19.7
7 Superb	> 800	> 19.7



Sustainable
Energy Solutions
www.ses.nau.edu

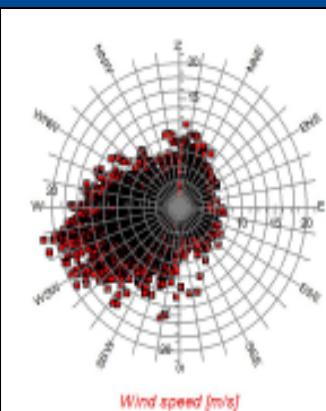
 NORTHERN
ARIZONA
UNIVERSITY

GRAY MOUNTAIN WIND SITE



Month	2005	2006	mean	mean of months
Jan	5.5	5.5	5.5	5.5
Feb	5.4	5.4	5.4	5.4
Mar	6.5	6.5	6.5	6.5
Apr	6.7	6.7	6.7	6.7
May				
Jun	5.6	5.6	5.6	5.6
Jul	5.2	5.2	5.2	5.2
Aug	3.8	3.8	3.8	3.8
Sep	5.0	5.0	5.0	5.0
Oct	4.9	4.9	4.9	4.9
Nov	4.9	4.9	4.9	4.9
Dec	5.0	5.0	5.0	5.0
mean, all data	4.9	6.0	5.3	
mean of months	4.9	6.0	5.3	5.3

50 meter



Month	2005	2006	mean	mean of months
Jan	4.7	4.7	4.7	4.7
Feb	4.7	4.7	4.7	4.7
Mar	5.5	5.5	5.5	5.5
Apr	5.8	5.8	5.8	5.8
May				
Jun	4.9	4.9	4.9	4.9
Jul	4.6	4.6	4.6	4.6
Aug	3.3	3.3	3.3	3.3
Sep	4.2	4.2	4.2	4.2
Oct	4.0	4.0	4.0	4.0
Nov	4.2	4.2	4.2	4.2
Dec	4.3	4.3	4.3	4.3
mean, all data	4.2	5.2	4.5	
mean of months	4.2	5.2	4.5	4.6

20 meter

Gray Mountain Wind Sites



- **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**

Gray Mountain Wind Site – Second Tower



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



NTUA Met Tower Installation – Grey Mountain



Navajo Nation Wind Development Process

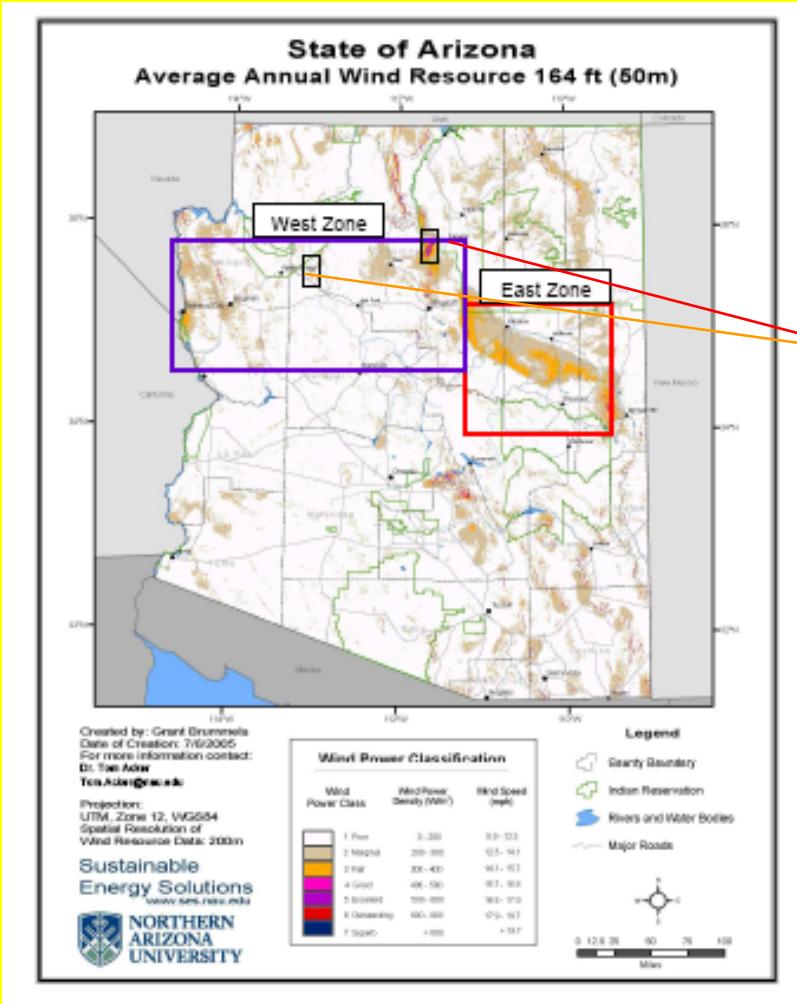


- ❖ Site Selection
- ❖ Land Agreements
- ❖ Wind Assessment
- ❖ Environmental review
- ❖ Economic Modeling
- ❖ Interconnection Studies
- ❖ Permitting
- ❖ Sales Agreements
- ❖ Financing
- ❖ Turbine Procurement
- ❖ Construction contracts
- ❖ Operation and Maintenance

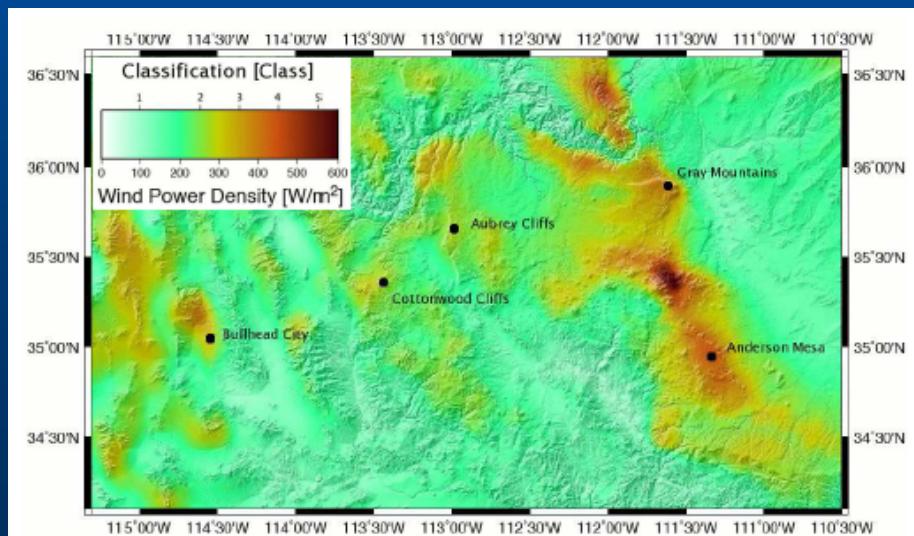
Navajo Tribal Utility Authority



Arizona Public Service Wind Integration Cost Impact Study



Modeling Zone	Wind Energy Site \ Diversity	MW of Installed Capacity				
		1% Med	4% High	4% Med	4% Low	10% Med
West / APA	Bullhead City	78				
	Cottonwood Cliffs	36				
	Aubrey Cliffs	36	72	144		324
	Gray Mountain	72	36	180	288	324
	Anderson	72	144	180		324
East / APSCo	Young	36				288
	Pinedale	36				
	Hay Hollow	36				
	Greer	72				
	Springerville	36				
		Total	108	510	468	468
						1260



Study of Potential Mohave Alternative/Complementary Generation Resources



Synapse
Energy Economics, Inc.

Sargent & Lundy LLC
Global Energy Consulting

Site	Gray Mountain	Aubrey Cliffs	Clear Creek	Sunshine
Wind Class at 80 m	4 to 7	4 to 5	3+ to 4	3
MW	450	100	75	60

Figure 4-2 — Gray Mountain Site Wind Resource Map

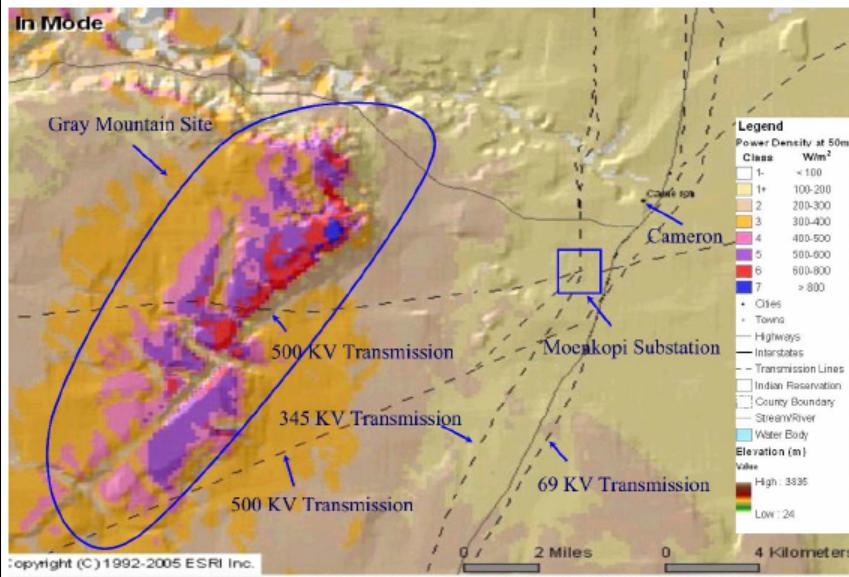
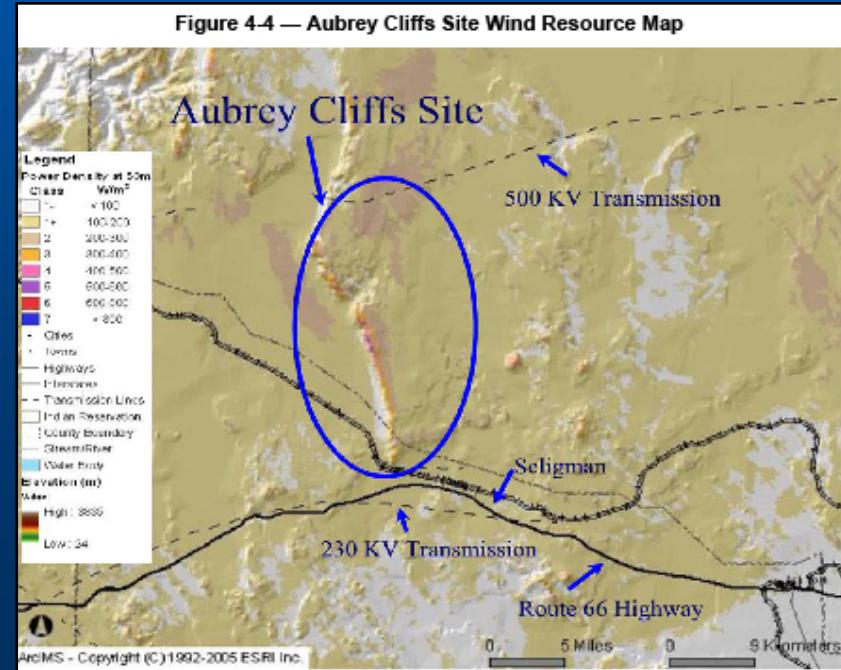


Figure 4-4 — Aubrey Cliffs Site Wind Resource Map



Report Prepared for
Southern California Edison

Study of Potential Mohave Alternative/Complementary Generation Resources



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 in 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

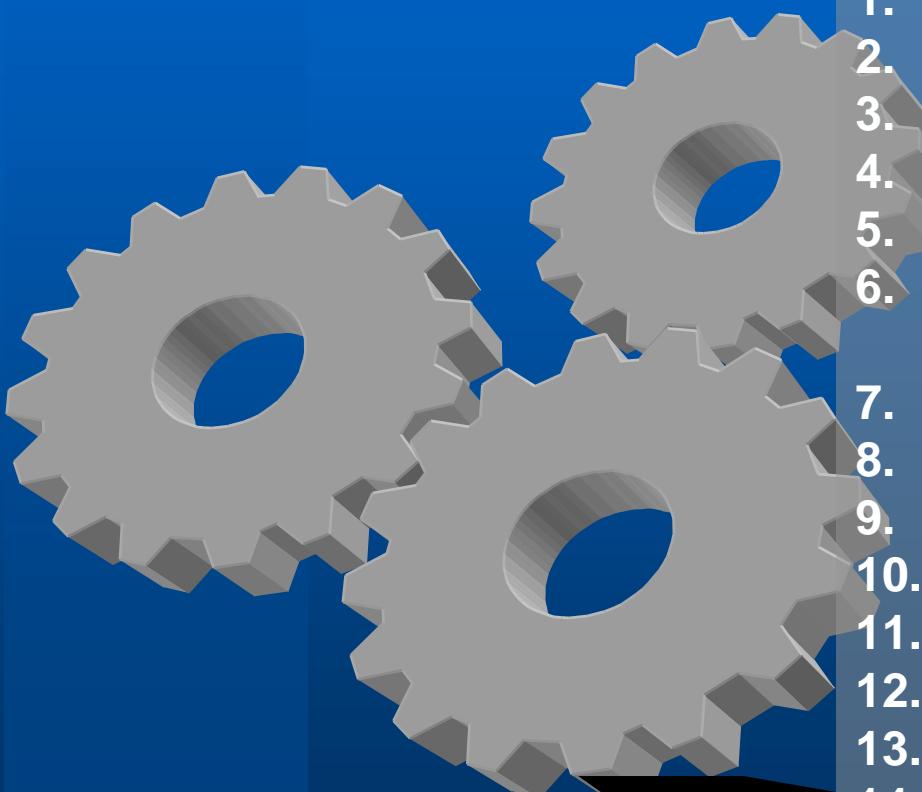
TASKS

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 a 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 permittee**
 - 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**

