

2006
Tribal Energy Review
Denver, Colorado
United States Department
of
Energy

October 25, 2006

Presented by:
Larry Ahasteen, Renewable Energy Specialist

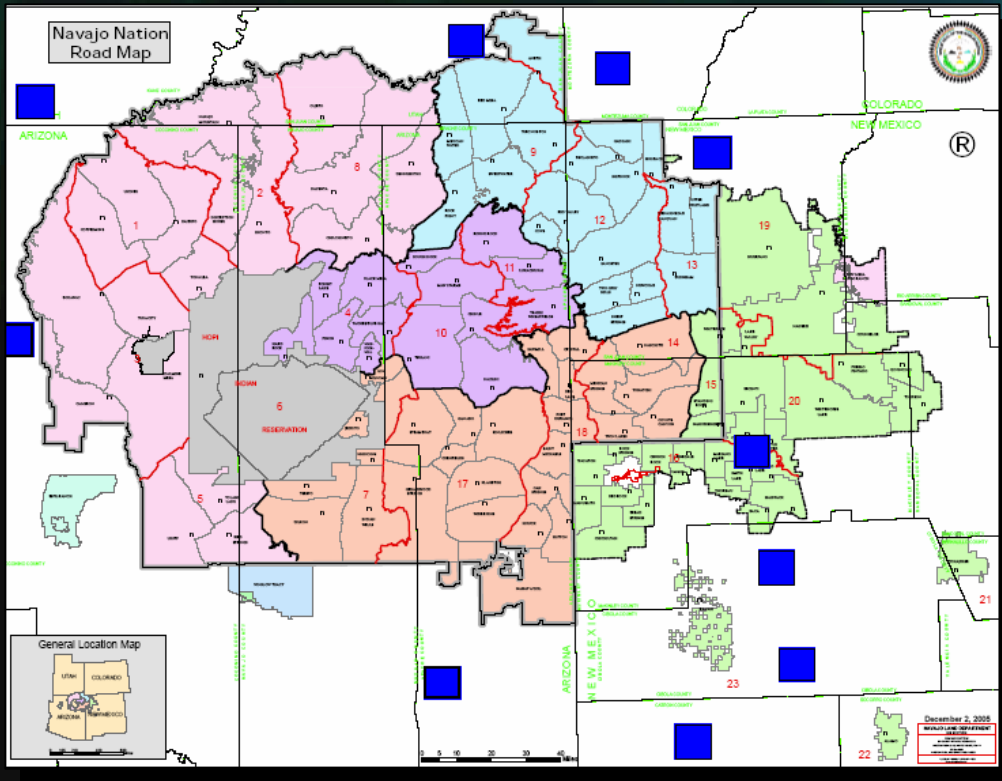
Navajo Niyol (Wind) Project

DE-FG36-05GO15180-A000

NAVAJO TRIBAL UTILITY AUTHORITY



- **Project Overview**
- **Project Location**
- **Project Participants**
- **Objectives**
- **On-going projects**
- **Project Status**
 - **Accomplishments**
 - **Technical or Management Issues**
 - **Activities Yet to Be Completed**
- **Future Plans**



Navajo Nation

The Navajo Nation is the home of the largest Indian tribe, and sprawls across northeast Arizona, New Mexico and Utah. It has an area of over 27,000 square miles and is situated on the southwestern Colorado Plateau. Very often, the size of the Navajo Nation is compared to that of the state of West Virginia.

NAVAJO TRIBAL UTILITY AUTHORITY

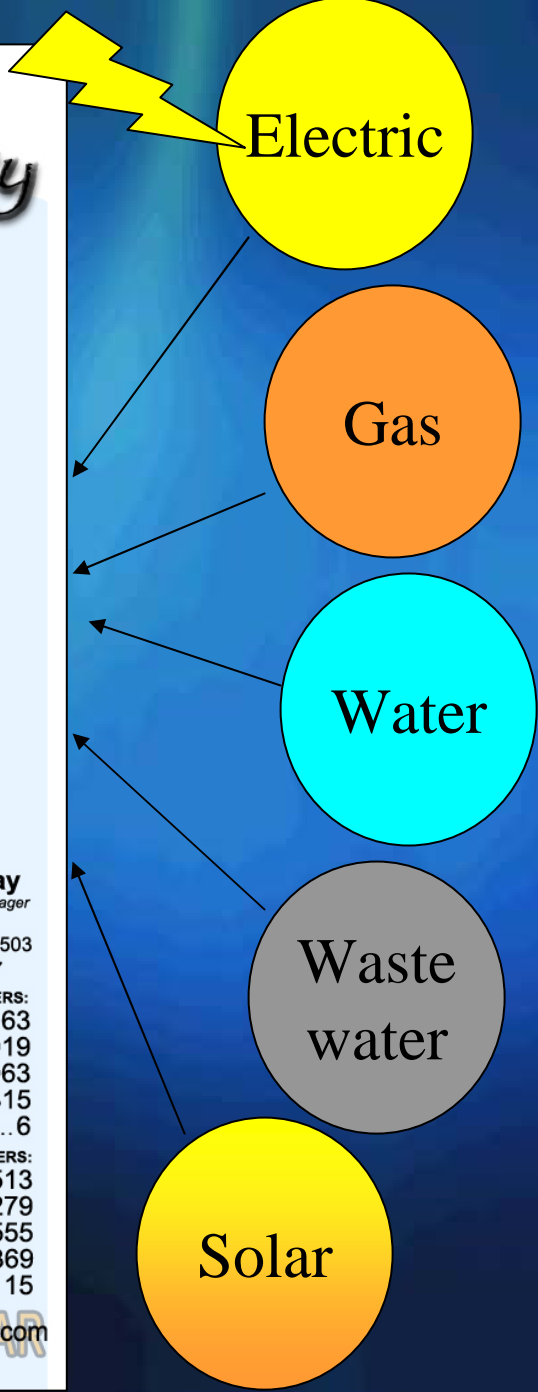


The Navajo Tribal Utility Authority is a non-profit enterprise established by the Navajo Nation Council to provide multi-utility services to the Navajo Nation and the Navajo People. Since 1959, NTUA has supplied electricity, water, natural gas, wastewater treatment, and photovoltaic (solar power) services to residents throughout the Navajo Nation which land base spreads across northeastern Arizona, northwestern New Mexico, and southeastern Utah

NAVAJO TRIBAL UTILITY AUTHORITY

Navajo Tribal Utility Authority

An Enterprise of the Navajo Nation



Dale Luna
 Kayenta District Manager
 PO Box 37
 Kayenta, AZ 86033
 1-928-697-3574

KAYENTA CUSTOMERS:
 Electric 4,087
 Water 2,366
 WW 1,029
 Solar 109

TUBA CITY CUSTOMERS:
 Electric 2,084
 Gas 2,942
 Water 3,409
 WW 2,070
 Solar 52



Justin Paul, Jr.
 Dilkon District Manager
 HC63 Box D
 Winslow, AZ 86047
 1-928-657-3258

DILKON CUSTOMERS:
 Electric 3,919
 Gas 738
 Water 2,303
 WW 855
 Solar 55

CHINLE CUSTOMERS:
 Electric 10,164
 Gas 1,716
 Water 5,998
 WW 2,027
 Solar 60



Daniel Wauneka
 Chinle District Manager
 PO Box 549
 Chinle, AZ 86503
 1-928-674-5670

SHIPROCK CUSTOMERS:
 Electric 7,748
 Gas 1,762
 Water 7,556
 WW 2,461
 Solar 17



Eugene John
 Shiprock District Manager
 PO Box 1749
 Shiprock, NM 87420
 1-505-368-4634

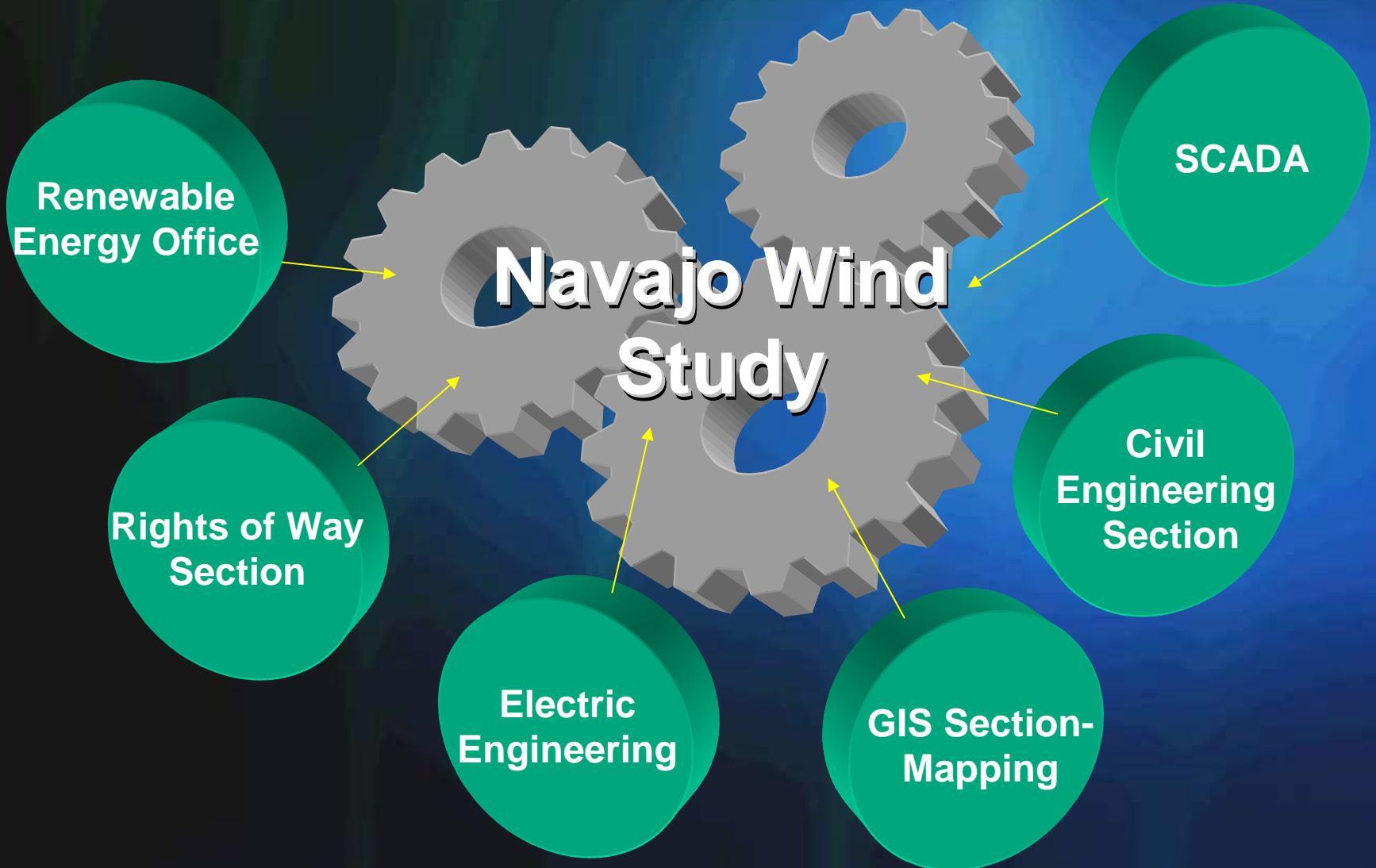
FT DEFIANCE CUSTOMERS:
 Electric 9,163
 Gas 2,919
 Water 7,063
 WW 3,315
 Solar 6

CROWNPOINT CUSTOMERS:
 Electric 513
 Gas 279
 Water 4,555
 WW 1,369
 Solar 15



Kenneth Begay
 Fort Defiance District Manager
 PO Box 587
 Fort Defiance, AZ 86503
 1-928-729-5727

NTUA Engineering and Technical Section



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



- NTUA and Navajo Wind Project Team will evaluate six sites with a meteorologist.
- Study will monitor and analyze proposed 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.

Navajo Wind Project- Project Participants

Dine' Care

**Navajo
Businesses**

**Crownpoint
Technology
Institute**

**National
Renewable
Energy Lab.**

**Northern Arizona
University**

**Sandia National
Lab.**



**Navajo Wind Project
Team**

**Dine Power
Authority**

**Navajo Tribal
Utility Authority**

**Navajo Nation
Government**

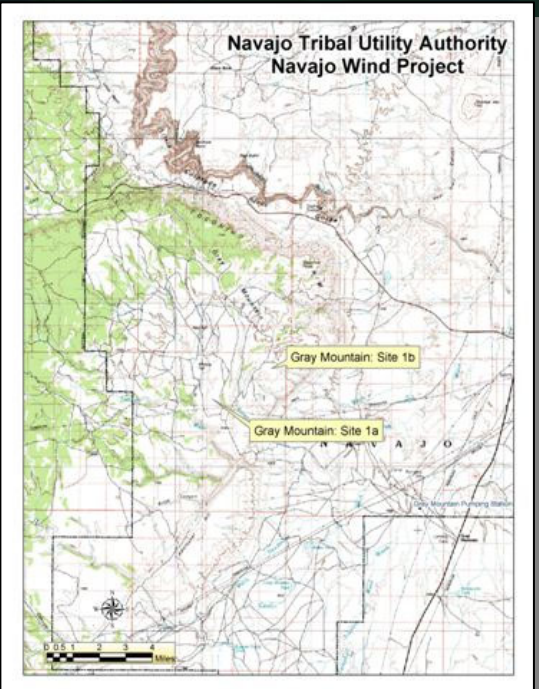
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PROGRAM OVERVIEW

1.

The Authority 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 TRIBAL UTILITY AUTHORITY

2.

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

Navajo Tribal Utility Authority

Navajo Engineering Construction Authority

Dine Power Authority

Navajo Nation Government

NAVAJO TRIBAL UTILITY AUTHORITY

3.



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

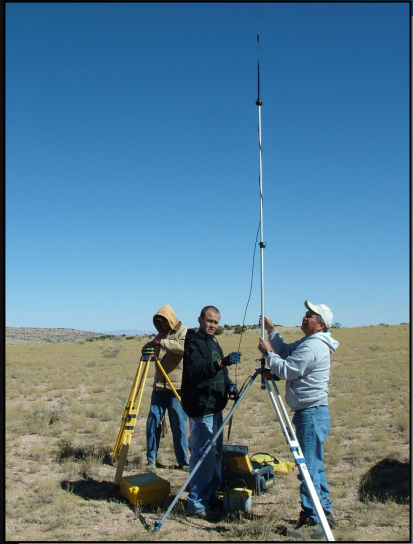


NAVAJO TRIBAL UTILITY AUTHORITY

4.



NTUA is proposing to conduct a 24 months comprehensive wind energy resources evaluation and 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.

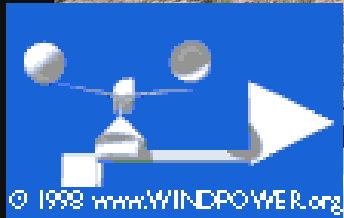


NAVAJO TRIBAL UTILITY AUTHORITY



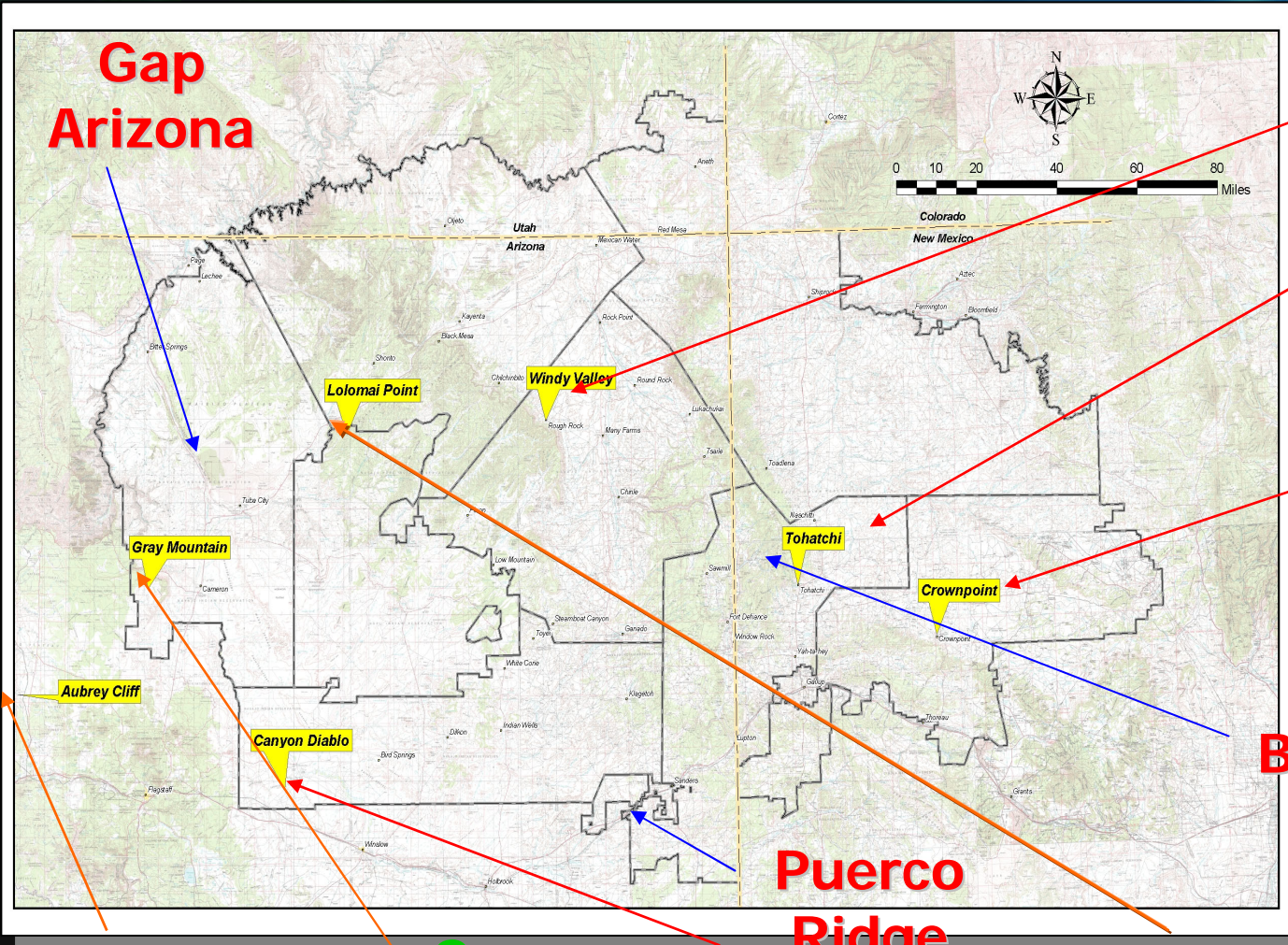
The Navajo Nation seeks three primary objectives:

- 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.



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

Niyol (Wind) Development Navajo Nation Process



**Gap
Arizona**

**Windy
Valley**

Tohatchi

Crownpoint

**Deezi
Bluff New
Mexico**

**Puerco
Ridge**

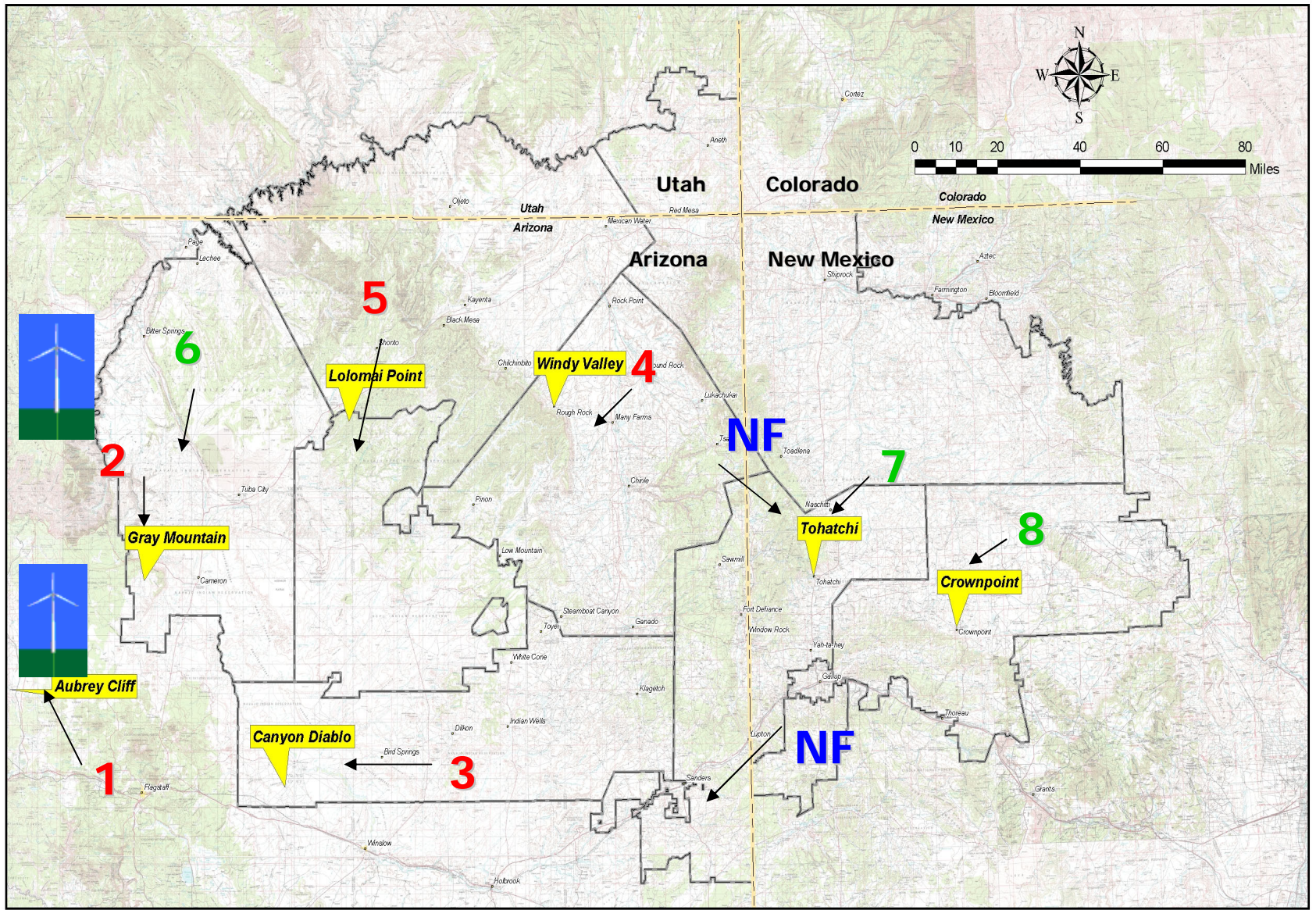
Abrey Cliff

**Gray
Mountain**

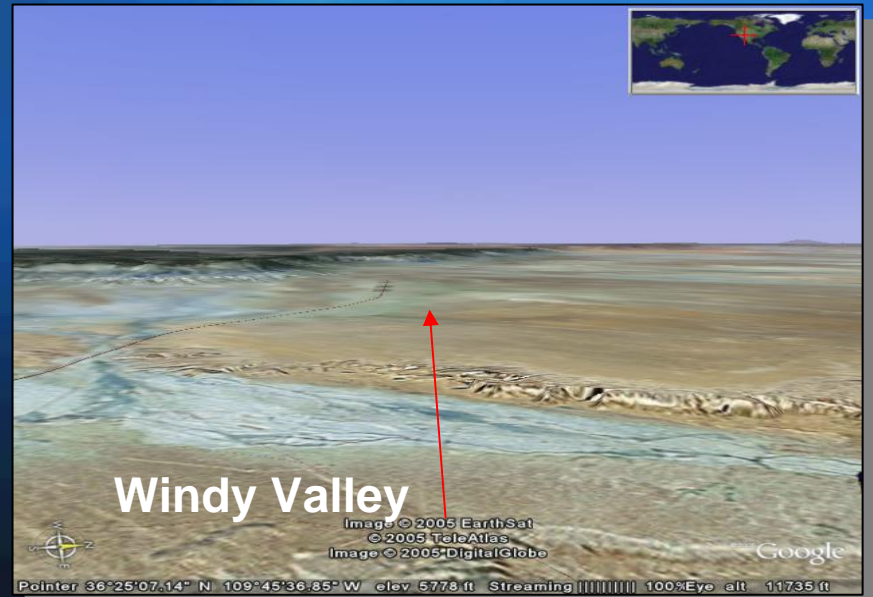
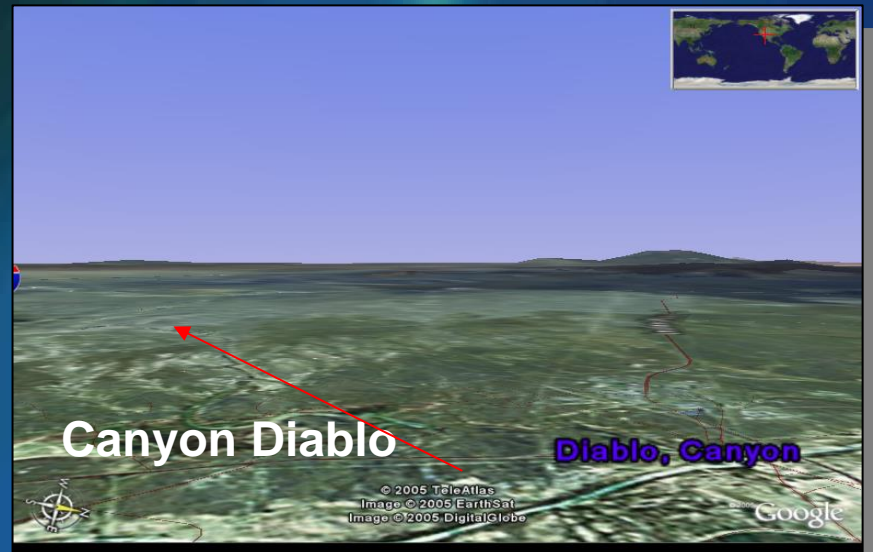
**Canyon
Diablo**

**Lolomai
Point**

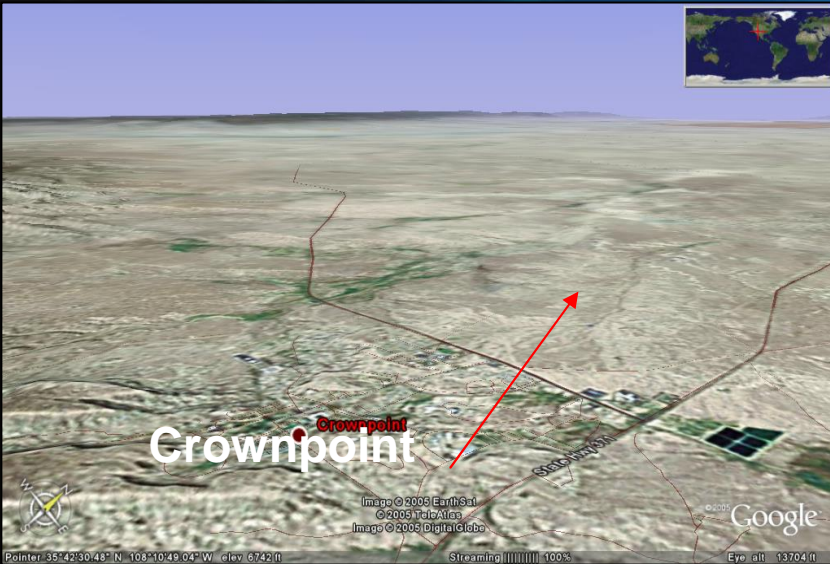
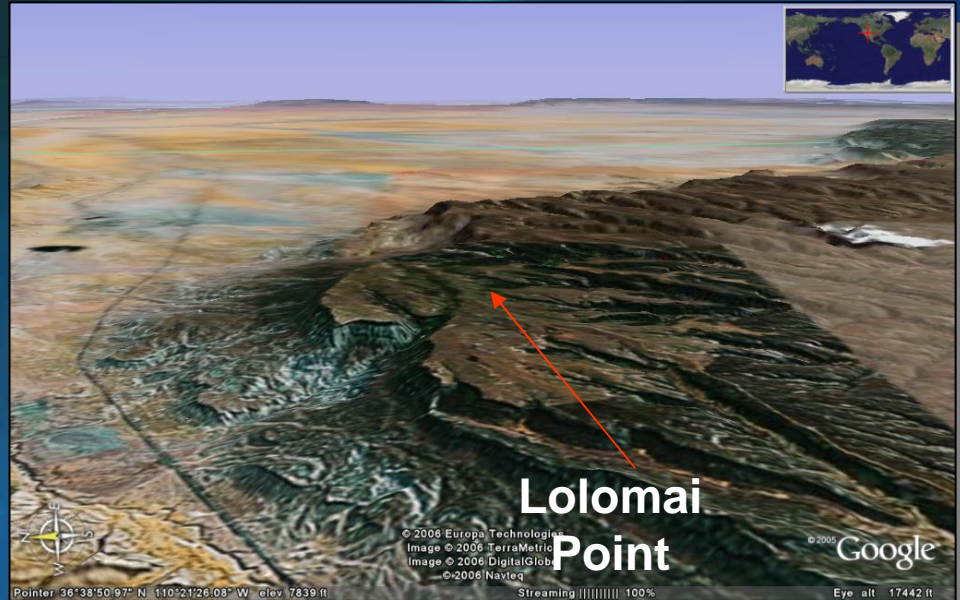
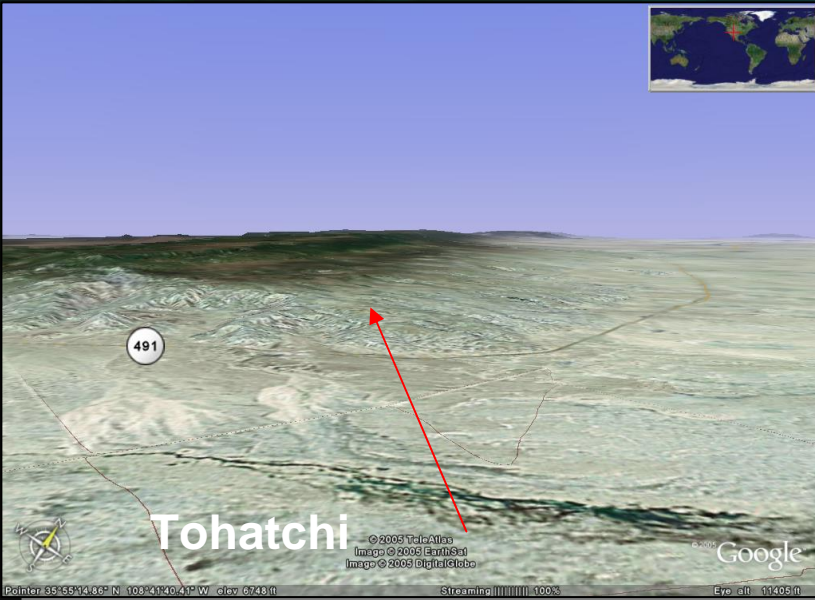
Wind Sites- Navajo Nation



Ranking Wind Sites- Navajo Nation



Wind Sites- Navajo Nation



Wind Sites- Navajo Nation

Gray Mountain Wind Sites



- ❖ Second Wind Site- Met Tower permit needs approval from grazing permit tee.
- ❖ Second Wind Site- All clearance were completed ready to be send to tribe land office for approval.
- ❖ Develop new site plans – roads archeological survey- Avian Study
- ❖ Dine Power Authority is exploring to develop this area with-Citizen Energy consultant, Mass.
- ❖ Cameron Chapter supporting resolution was approved-Met Tower Installed-Collecting Wind Data-NTUA





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

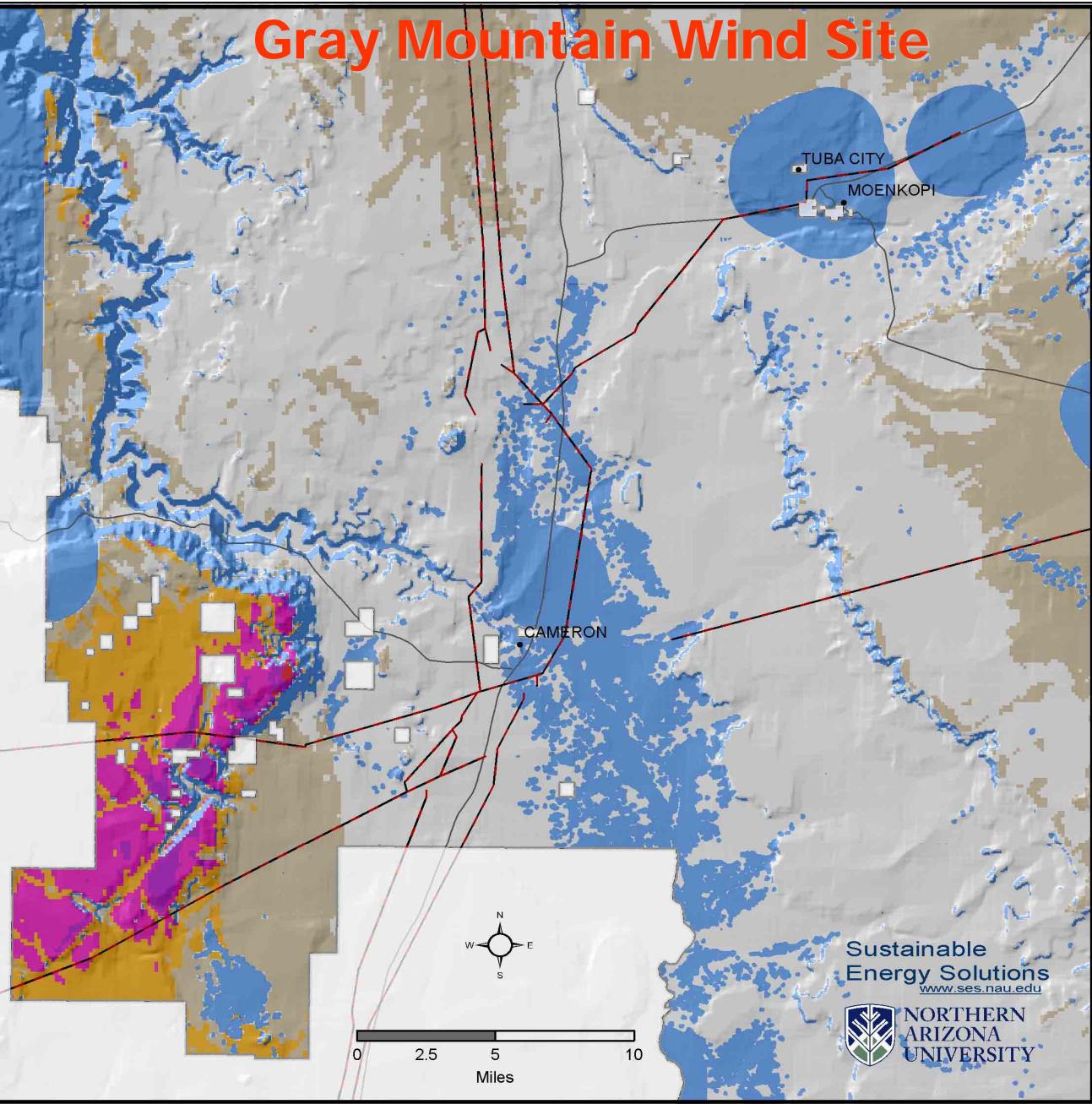
-  Major Roads
-  Transmission Lines
-  Land Excluded 100%
-  Woodlands - Excluded 50%
Does not include Pinyon-Juniper Woodland

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

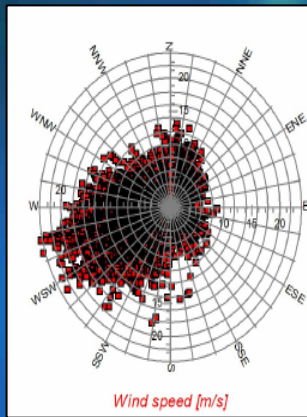
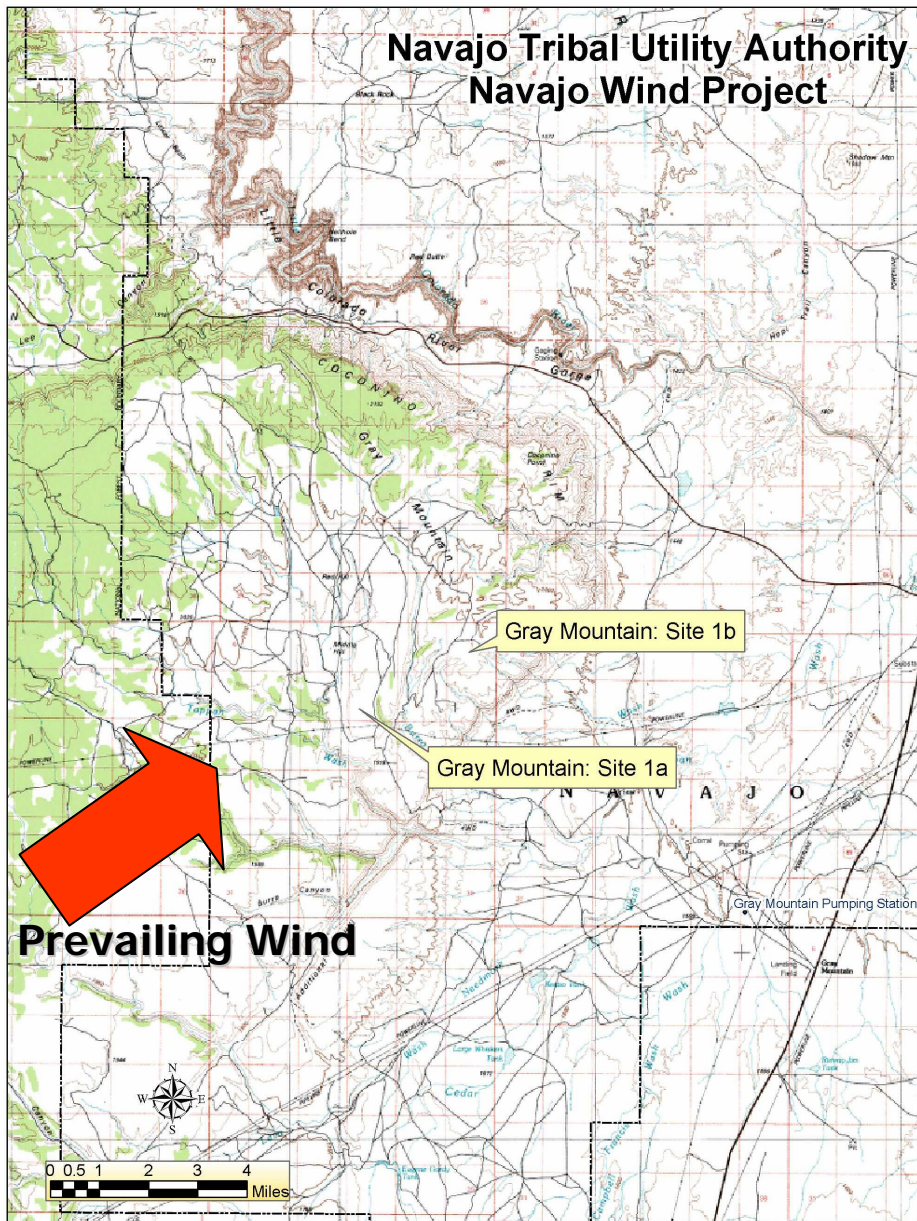
Wind Power Class	Wind Power Density (W/m ²)	Wind Speed (mph)	
	1 Poor	0 - 200	0.0 - 12.3
	2 Marginal	200 - 300	12.3 - 14.1
	3 Fair	300 - 400	14.1 - 15.7
	4 Good	400 - 500	15.7 - 16.8
	5 Excellent	500 - 600	16.8 - 17.9
	6 Outstanding	600 - 800	17.9 - 19.7
	7 Superb	> 800	> 19.7



Sustainable Energy Solutions
www.ses.nau.edu



Navajo Tribal Utility Authority Navajo Wind Project



Monthly mean values of wind speed in m/s

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	5.8	5.8	5.8	5.8
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

Wind speed [m/s]

WindPRO version 2.4.0.67 Dec 2004

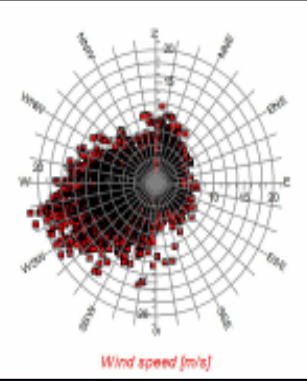
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 Example: Data from Files)
 C:\NRI\GIS\arcdata\06061\total.bl
 C:\NRI\GIS\arcdata\06062\total.bl

Project: 05/17/2006 5:12 PM / 1
 User: Northern Arizona University
 15800 S. McCormick Circle, P.O. Box 15800
 US-FLAGSTAFF, AZ 86011
 +1 (928) 623-6363

Created: 05/17/2006 5:12 PM

Meteo data report, height: 30.0 m

Name of meteo object: Gray Mt. 30m Tower



Monthly mean values of wind speed in m/s

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		4.6

Wind speed [m/s]

WindPRO version 2.4.0.67 Dec 2004

File: AZstate
 Example: Data from Files)
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 C:\NRI\GIS\arcdata\06062\total.bl

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 15800 S. McCormick Circle, P.O. Box 15800
 US-FLAGSTAFF, AZ 86011
 +1 (928) 623-6363

Created: 05/17/2006 5:14 PM

Meteo data report, height: 10.0 m

Name of meteo object: Gray Mt. 30m Tower

GRAY MOUNTAIN WIND SITE

Gray Mountain Wind Site –Second Tower



Environmental Assessment

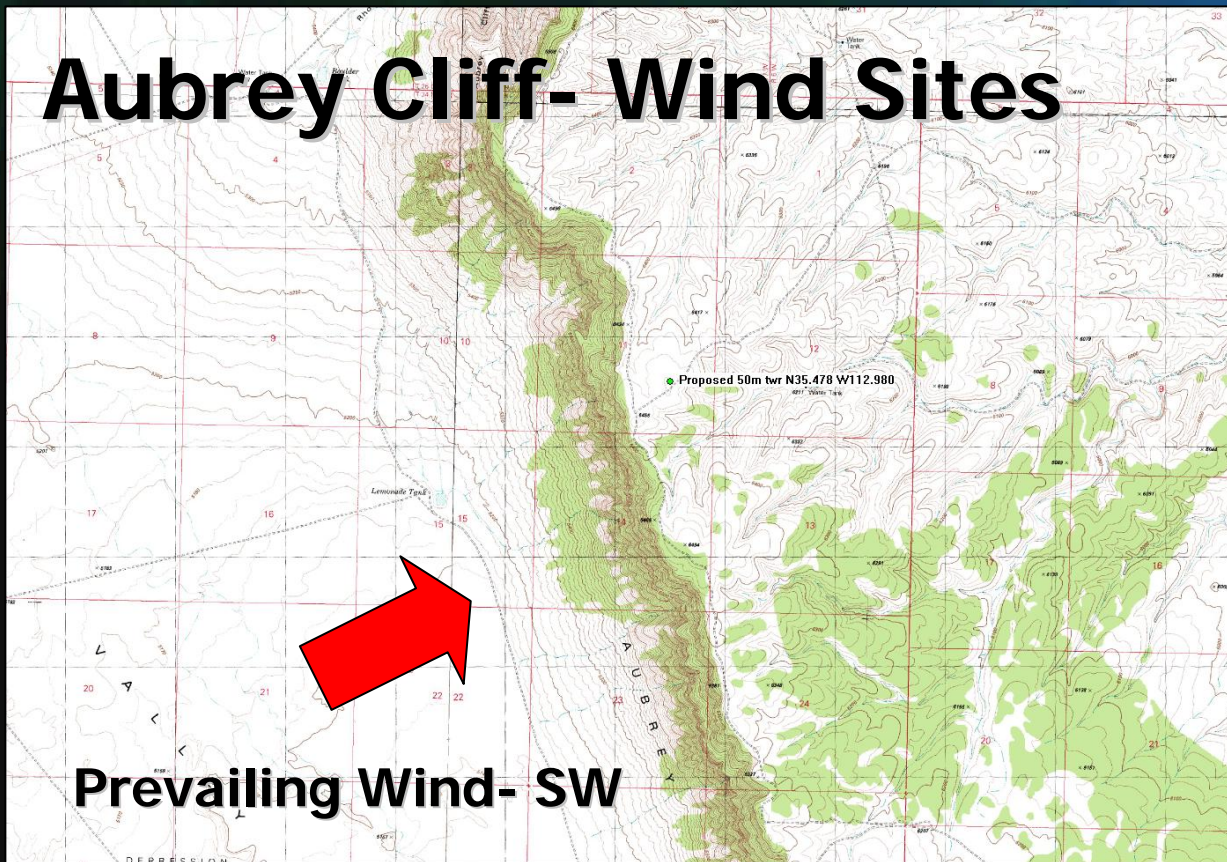
- Survey for cultural inventory was completed for revocable permit
- Biologist surveyed completed for Biological assessment
- Avian studies will be contracted (RFP) in January 2007

Gray Mountain Wind Site –Second Tower



- Legal survey was completed
- Site review for Met Towers completed
- License surveyor completed the surveying for location of permit area
- Legal Description of the area
- Ready for approval by Resource Committee

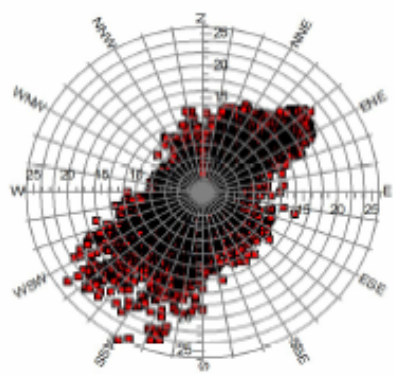
Aubrey Cliff- Wind Sites



Project: AZState
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Meteo data report, height: 30.0 m
 Name of meteo object: Aubrey Cliffs 30m Tower

PrintedPage: 04/04/2006 5:06 PM / 1
 Licensed user: Northern Arizona University
 15600 S. McConnell Circle, P.O. Box 15600
 US-FLAGSTAFF, AZ 86011
 +1 (928) 523-8363
 Calculated: 04/04/2006 5:05 PM



Monthly mean values of wind speed in m/s

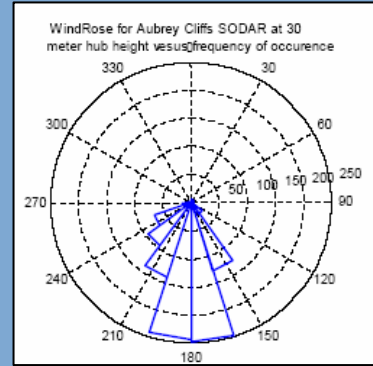
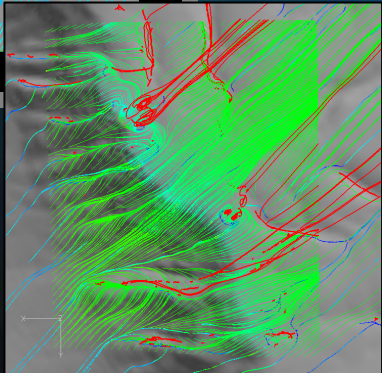
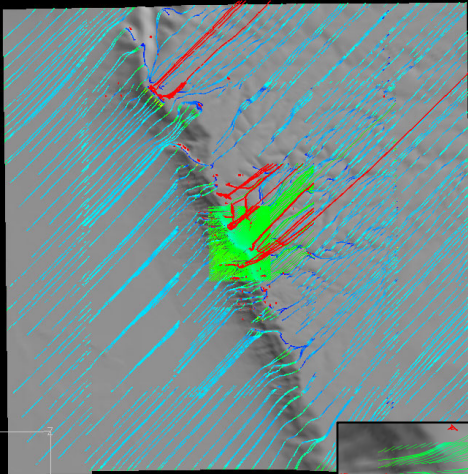
Month	2005	2006	mean	mean of months
Jan		8.0	8.0	8.0
Feb		8.0	8.0	8.0
Mar		7.4	7.4	7.4
Apr		6.2	6.2	6.2
May				
Jun	7.8		7.8	7.8
Jul	5.1		5.1	5.1
Aug	4.2		4.2	4.2
Sep	6.7		6.7	6.7
Oct	7.6		7.6	7.6
Nov	7.4		7.4	7.4
Dec	6.9		6.9	6.9
mean, all data	6.4	7.7	6.8	
mean of months	6.5	7.4		6.9

Aubrey Cliff- Wind Sites



- ❖ First Wind Site- Met Tower permit was approved by State Land Office- All required approval was completed
- ❖ Five new wind site- All sites are currently in the approval stage.
- ❖ Northern Arizona University will conduct land clearance to these sites.
- ❖ Navajo Tribal Utility Authority-GM Office is exploring to develop this area with Foresight Wind as a Consultant- NTUA Board approval pending
- ❖ 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



Project Location

The monitoring site was located at Deeza Bluff at an elevation of 8970 feet

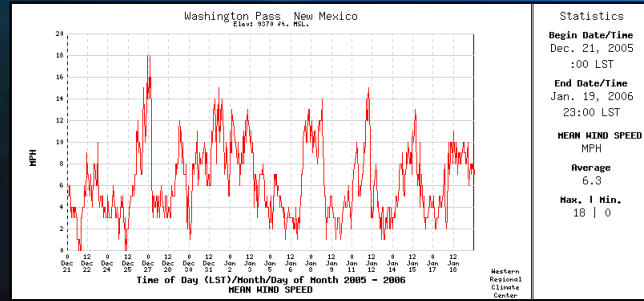
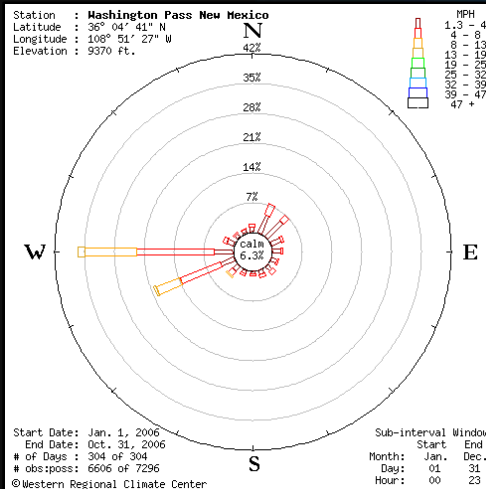
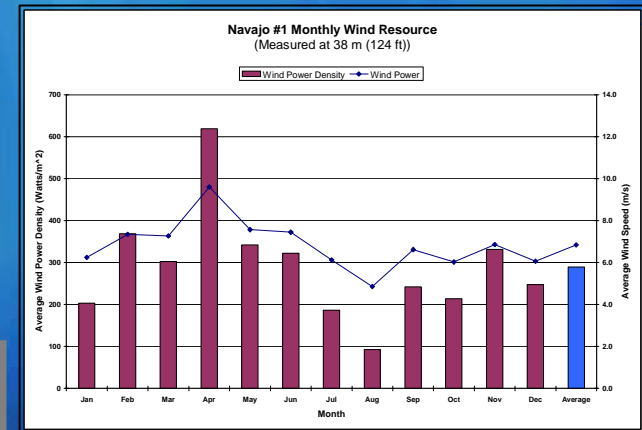
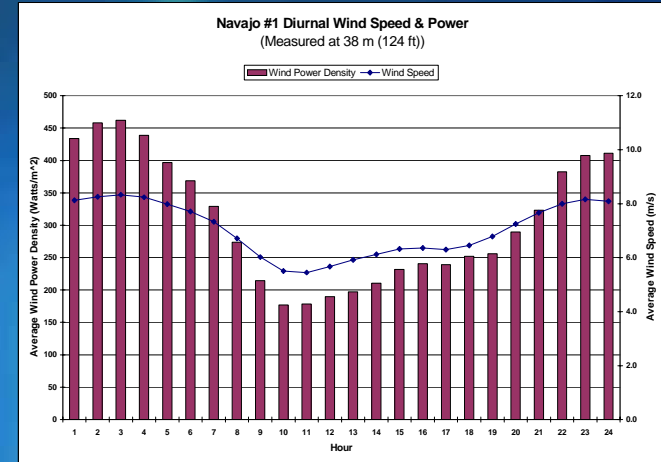
Project Instrumentation

The instrumentation consisted of an NRG Wind Explorer system including cup anemometer, wind vane and data logger. The instruments were mounted at a height of 124 feet on an existing communications tower. The data consists of 10-minute average wind speed, wind speed standard deviation and wind direction.

Results

Summary

Annual Average Wind Speed & Power Density:	6.8 m/s (15.2 mph) / 289 watts/m ²
Month with best wind resource:	April
Average wind speed and power density for best month:	9.6 m/s (21.3 mph) / 619 watts/m ²
Month with worst wind resource:	August
Average wind speed and power density for worst month:	4.9 m/s (10.9 mph) / 93 watts/m ²
Adjusted Annual Average Wind Speed & Power Density	6.5 m/s (14.4 mph) / 250 watts/m ²



Deezi Bluff, New Mexico

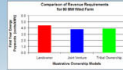
Introduction:

NTUA received a Department of Energy grant for a detailed wind farm feasibility study in June 2005. Sites on Navajo may be viable for hundreds of utility scale wind turbines.

Such wind farms will bring skilled jobs for Navajo workers, additional tax revenue to the Navajo government, and can build capacity for numerous Navajo businesses.

Gray Mountain:

Many sites around Navajo may be suitable for wind farms, but the best site is on Gray Mountain. The estimated potential is around 430 MW. On-site monitoring will help verify this estimate.



Various ownership and incentive options exist so that the Navajo Nation can adapt a wind project to its priorities and preferences. Many are financially viable:

- Landowner** - Outside company develops and owns wind farm
- Joint Venture** - Navajo company partners with outside developer, eventually owning part of wind farm
- Tribal Owner** - Navajo Nation issues bonds to finance project without outside partner

Benefits to Navajo Nation:

Tax Revenues - Wind farms will pay a possessory interest tax and the business activity tax during its operation, amounting to approximately \$0.7 - 1.0 million dollars per year in additional taxes.

Jobs - The various boxes explain the tasks involved in building a wind farm. Navajo workers and businesses routinely carry out tasks similar to those needed for wind farms. An 80 MW wind farm would create 60-110 temporary construction jobs and 11-16 full time operations jobs.

Future Opportunities - The skills learned in building one wind farm can be used and improved to establish a sustainable economy all over the West.

Conclusions:

Building a wind farm on Navajo land can bring many benefits to the Navajo economy without disrupting the land around the wind farm. The benefits range from new jobs to increased tax revenues. Federal incentives and regional demand for renewable energy make wind energy projects financially viable. Based on the preferences of the Navajo Nation, the wind farm can be owned by an outside company or even the Tribal government itself. Many questions remain as to the feasibility of a wind farm on the Navajo Nation, but the prospects are promising.

Multiple Land Use

While wind farms cover a large area, the majority of the land remains suitable for other uses, especially agriculture. Only the access roads and turbine bases will reduce the land available for grazing livestock.



Excavation and Foundations

Concrete for the large foundations can be supplied by Navajo concrete suppliers. One supplier has more than thirty years experience building feed-mix plants for large construction jobs.



Concrete aggregate, but not cement, is available within the Navajo Nation. Many businesses own the equipment used in excavation.



Acknowledgements:

Larry Prosser of Northern Tribal Utility Authority provided valuable guidance for this study. Researchers at Northern Arizona University provided copyright, support, and feedback. Andrew Mills is supported by a National Science Foundation Fellowship for Studies at UC Berkeley.

Steel Erection of Turbine Towers

NECA and other Navajo businesses install water towers around the Navajo Nation. The skills used in erecting water towers are similar to the steel erection skills needed to install the tower sections that support wind turbines.



Electrical Collection System

Transformers are connected at each turbine to a substation with underground cables.



NTUA routinely installs and maintains transformers and substations.

Roads, Site Prep, Utility Shed

Dirt roads, able to support a very large crane along with semi-trucks, will need to be built from the highway to each turbine. A utility shed is built to monitor the performance of the wind farm along with housing workers and equipment for routine maintenance.



Economic Impacts of a Navajo Wind Farm:
Summary of work during Summer 2005 with the Sustainable Energy Solutions group at Northern Arizona University

WINDPOWER®
CONFERENCE & EXHIBITION
JUNE 4-7 2006
PITTSBURGH, PA
The David L. Lawrence Convention Center



Over 5000 attendees and over 290 exhibitors participated



Wind Energy in Indian Country: Turning to Wind for the Seventh Generation- Andrew Mill

FUTURE PLANS



TASKS TO START IN 2007

- Tribal Load Assessment- Export Market
- Transmission –Interconnection Study
- Technology Analysis
- Economic Analysis- NAU
- Environmental Assessment- Avian Study
- Preliminary system design
- Long term O&M planning
- Investigate Financing Options- Navajo Nation
- Resolution to Navajo Nation Council and Oversight Committee
- Comprehensive business plan



VISION: Provide Clean Affordable Energy for the NAVAJO PEOPLE



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