

**Oklahoma**  
*oeupi* | **Wind**  
**Power**  
**Initiative**

**Dr. Scott Greene**

**Director**

**Oklahoma Wind Power  
Initiative**

**University of Oklahoma**



# Outline

- Oklahoma Wind Power Initiative (OWPI) Overview
- Wind Basics
- Community Wind Options
- Native American Experiences & Opportunities
- Native American Funding & Additional Resources
- U.S. & Oklahoma Wind Energy
- Barriers to Wind Development

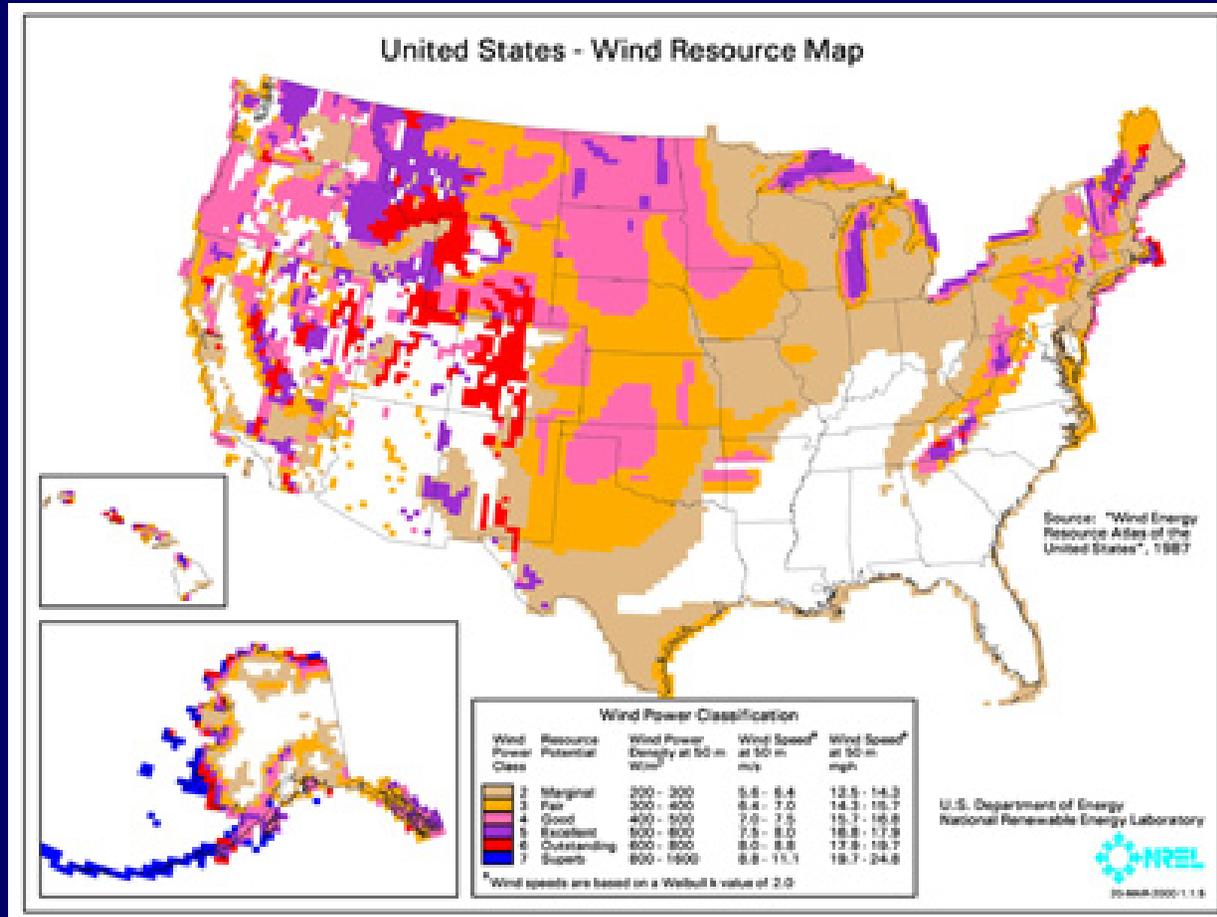
# What is OWPI?

- A collaborative project between OU and OSU investigating and promoting wind power in Oklahoma
- Provide resource and economic information to landowners, state officials and policy makers, investors, and other stakeholders

# What do we do?

- **Resource Assessment**
  - Wind resource maps
  - Data collection at tall tower sites
- **Policy Studies**
  - Track Oklahoma and other state policies
- **Outreach**
  - Educational programs
  - Community meetings
  - Bi-monthly newsletter – The Oklahoma WinCharger
- **Promote & Attract:**
  - Research opportunities
  - Economic development

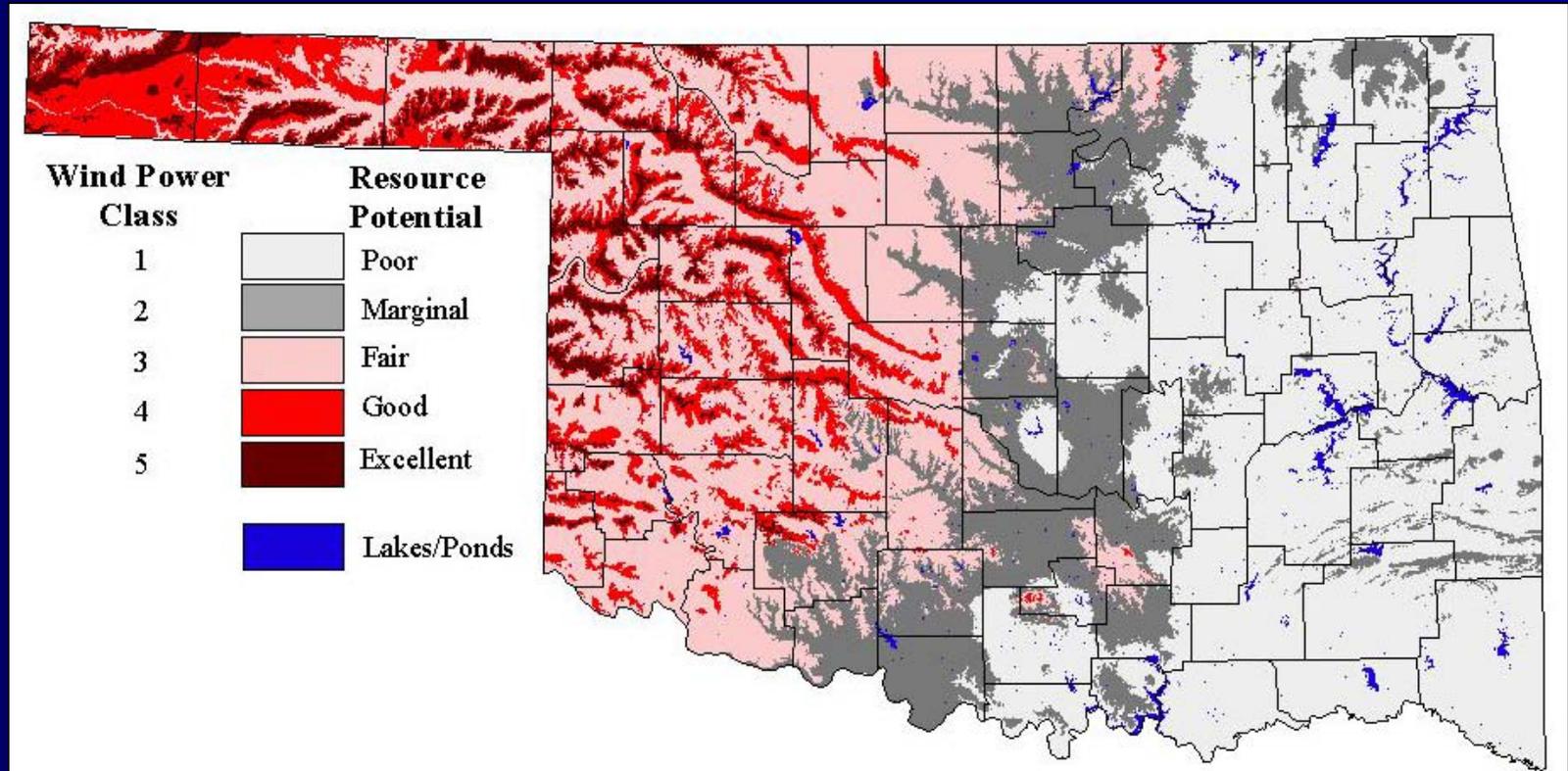
# PREVIOUS ESTIMATES



USDOE, 1987

1/3° longitude by 1/4° latitude

# Wind Resource Map

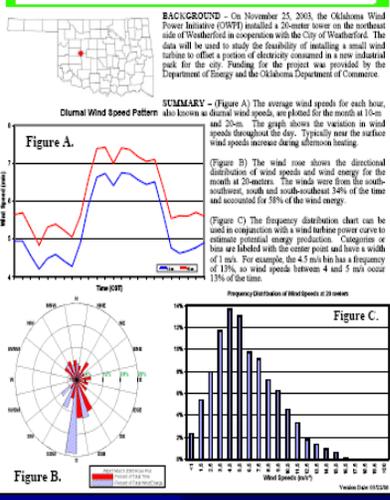


# Other OWPI Products...

### March 2006 Wind Summary Weatherford Tower Sensors at 10 and 20 m



Height	Average Wind Speed	Wind Power Density
10 m (33 ft)	5.39 m/s (11.8 mph)	177 W/m <sup>2</sup>
20 m (66 ft)	6.09 m/s (13.6 mph)	251 W/m <sup>2</sup>



September 19, 2007

Oklahoma Wind Power Initiative - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.ocgi.okstate.edu/owpi/

Google

M Gmail - Inbox Getting Started Latest Headlines



**OWPI**

**ORDERS OUTSTANDING**

**WIND WORKING GROUP OF 2007**

**BY WIND POWERING AMERICA**

---

**HOME**

**MENU**

- ▶ About OWPI
- ▶ Oklahoma Wind Information
- ▶ Wind Climatology Reports
- ▶ OWPI Tall Tower Data
- ▶ Educational Outreach
- ▶ OWPI Newsletter
- ▶ National Wind Information
- ▶ Events
- ▶ Related Links
- ▶ Solar Information
- ▶ Biofuel Information
- ▶ Contact Us



The Oklahoma Wind Power Initiative (OWPI) investigates and promotes wind energy resources in our state. We provide resources and economic information to policy makers, land owners, potential wind energy investors, and citizens of Oklahoma; we also help wind power stakeholders network through outreach activities.

**Interactive Maps**



Wind Resource Map

**Latest OWPI News...**

- ▶ Emerging Energy Technology Survey - Oklahoma State Agency Interests. [\[more...\]](#)
- ▶ OWPI Receives Outstanding Wind Working Group of the Year Award! [\[more...\]](#)
- ▶ Economic Impact of Wind Farm Development in Oklahoma. [\[more...\]](#)
- ▶ Oklahoma OWPI Wind Resource Map Featured in Wind Today's Second Quarter Magazine. [\[more...\]](#)
- ▶ Oklahoma Community Wind Guidebook now available! [\[more...\]](#)

**ASSOCIATED ORGANIZATIONS**



Renewable Energy for Oklahoma Tribes

### Oklahoma Wind Power Initiative Wind Turbine Facts

OR - 1.5 MW small turbine - The most common turbine in Oklahoma

Nacelle	Hub
Weight: 115,000 lbs. (57.5 tons)	Weight: 22,000 lbs. (11 tons)
Hub Height: 80 m (262 ft)	Hub Height: 80 m (262 ft)

Tower	Blades
Consists of 3 sections: Base - 87,000 lbs. (43.5 tons) Middle - 55,000 lbs. (27.5 tons) Top - 45,000 lbs. (22.5 tons)	Length: 37 m (121 ft) Weight: 12,000 lbs. (6 tons) Composed of lamina-aid fiberglass
Total Weight: 187,000 lbs. (93.5 tons)	Feathering: changing the angle of the turbine blades so that they do not turn in high wind speeds (> 45 mph)
Tower Height: 80 m (262 ft)	
Base Diameter: 14 ft (4 m)	
Top Diameter: 7.5 ft (2 m)	



**Key Facts:**

- ▶ About two wind turbines can fit on one acre of land, depending on the size of the turbine.
- ▶ At the maximum speed of 20 revolutions per minute, the tips of the blades are moving at 180 miles per hour.
- ▶ One 1.5 MW turbine can power 300 Oklahoma homes.
- ▶ Wind turbines are tested to withstand wind speeds of over 150 mph.
- ▶ The tower sections are made of 2 inch thick steel.

**Key Facts:**

- ▶ For more information, contact The Oklahoma Wind Power Initiative at (405) 325-5873 or <http://www.okstate.edu/owpi>

## The Oklahoma WinCharger

Oklahoma Wind Power Initiative

OWPI: A collaborative project between the University of Oklahoma and Oklahoma State University that investigates and promotes wind energy resources in our state.

July/August 2007 Vol. 7 # 4

**In This Issue...**

- OWPI News & Events ... 2
- Policy ... 3
- Wind ... 5
- Solar ... 8
- Biofuels ... 10
- Renewable News ... 11
- Calendar of Events ... 12

**Staff:**

Editor & Designer: Dr. Larry Flowers, OWPI-OSU  
 Production Editor: Dr. Betty Rife, OWPI-OSU

**Copy Editor:** Miss Elicia, OWPI-OSU

**Contributors:** Steve Rader, Geography Department, OWPI-OSU  
 Matt McInnis, School of Public Policy Program, OWPI-OSU



Pictured left to right: Clayton Robinson, Stephanie Buway, Rep. James Covey, & Larry Flowers.

# Wind Energy Basics

September 19, 2007

Renewable Energy for Oklahoma Tribes

# Sizes & Applications



## Small ( $\leq 10$ kW)

- Homes
- Farms
- Remote application



## Intermediate (10-660 kW)

- Village power
- Hybrid systems
- Distributed power

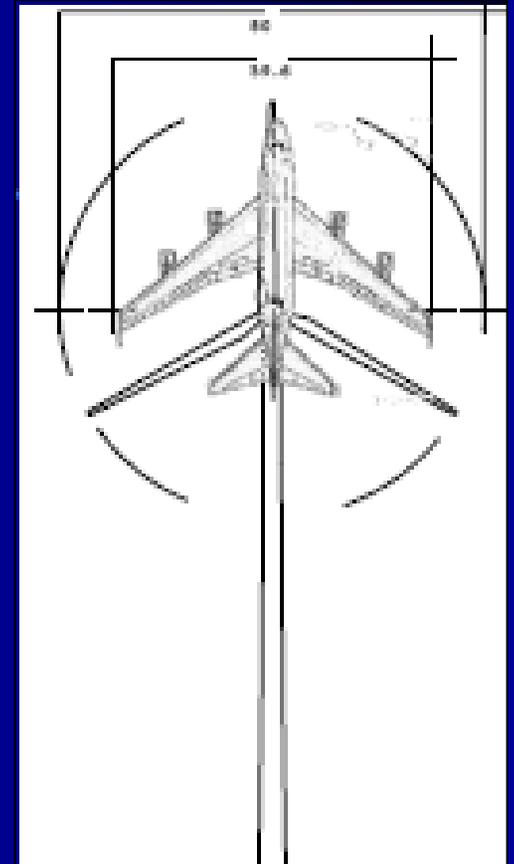


## Large (1 MW - 3+MW)

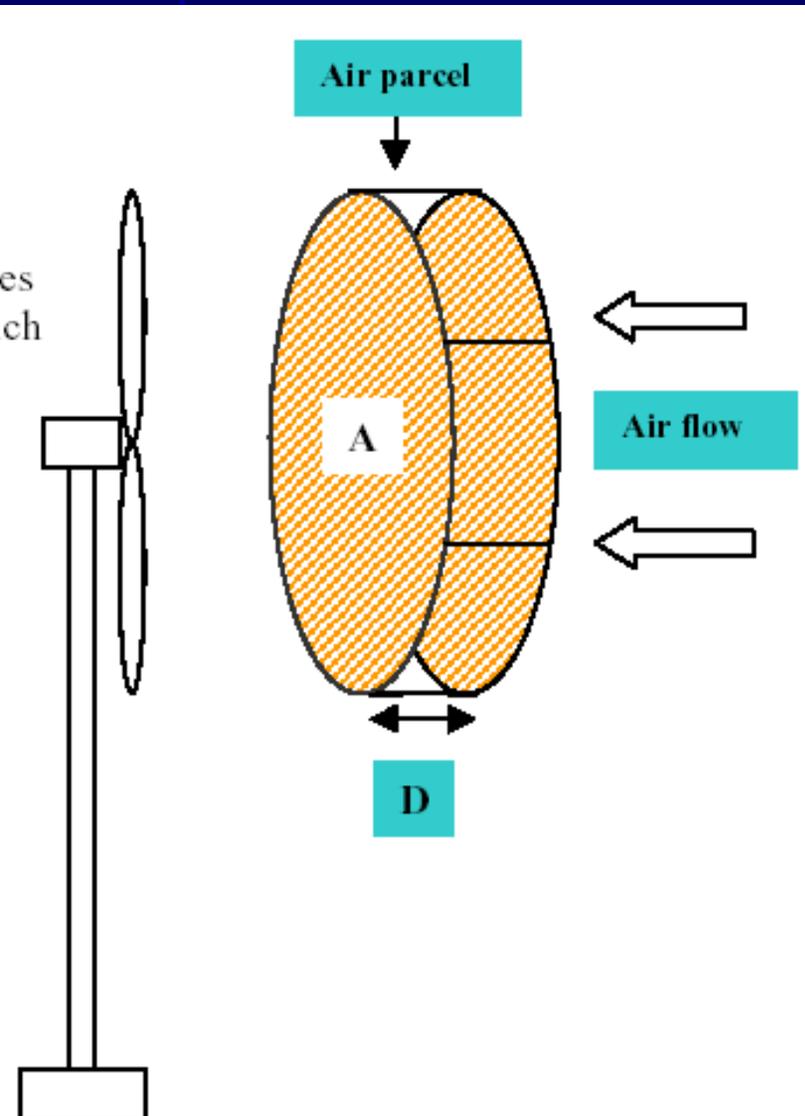
- Central station wind farms
- Distributed Power
- Community wind

# How big are we talking?

This picture shows a Vestas V-80 2.0-MW wind turbine superimposed on a Boeing 747 JUMBO JET



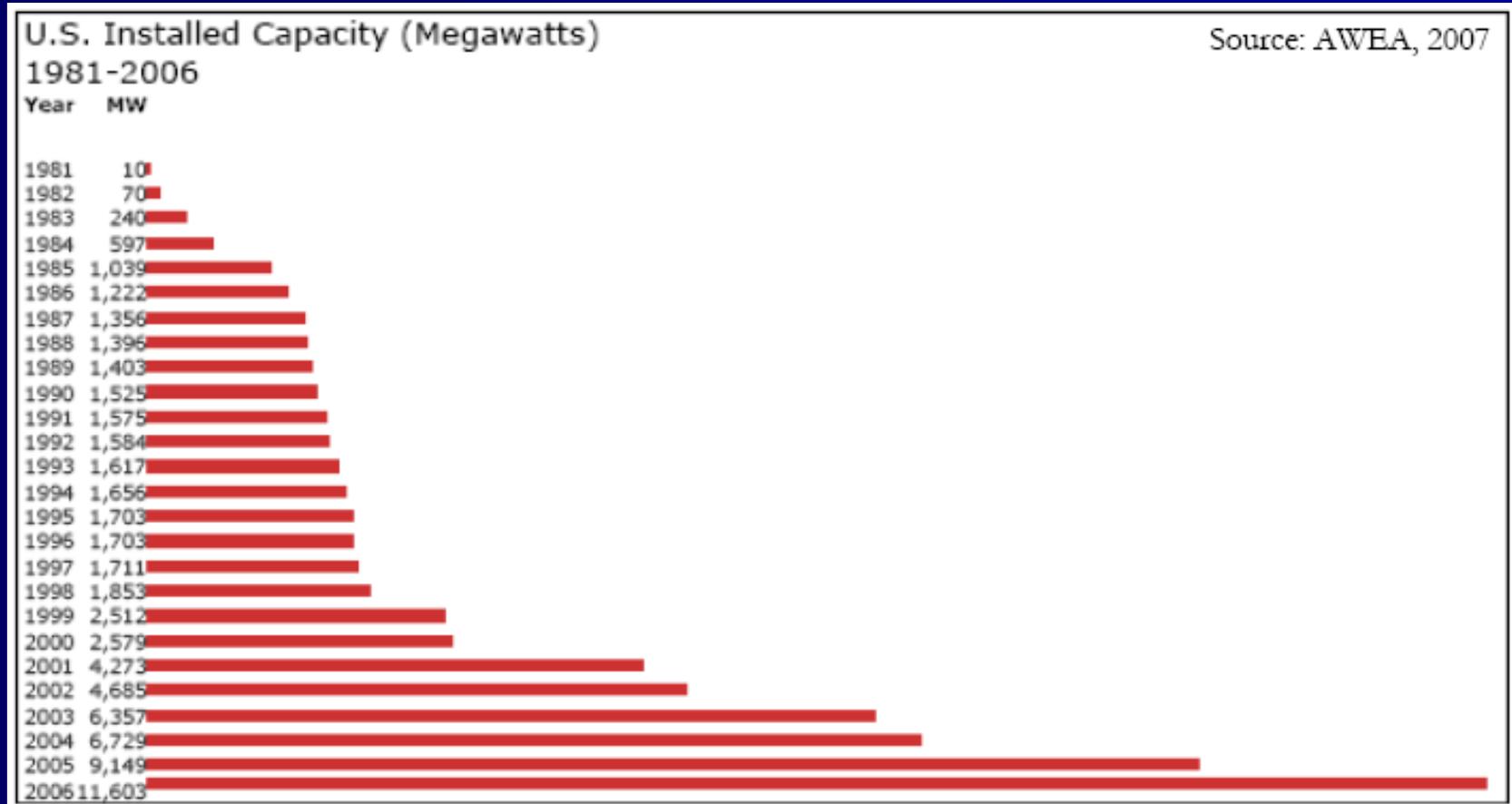
# Wind Power Density



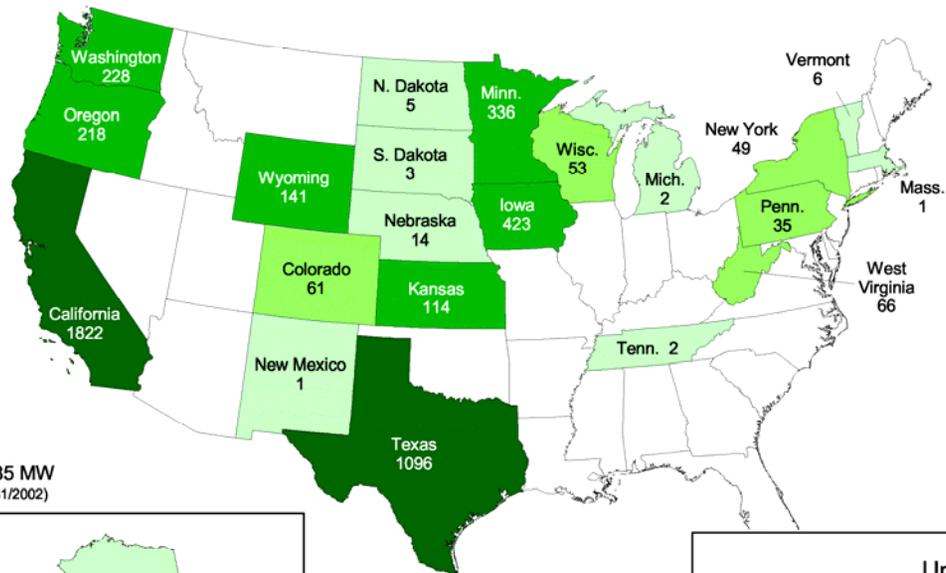
## Important Point!

Power is proportional to **CUBE** of  
wind speed

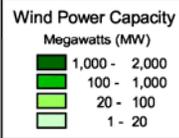
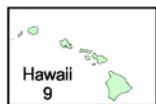
# Installed U.S. Wind Trends



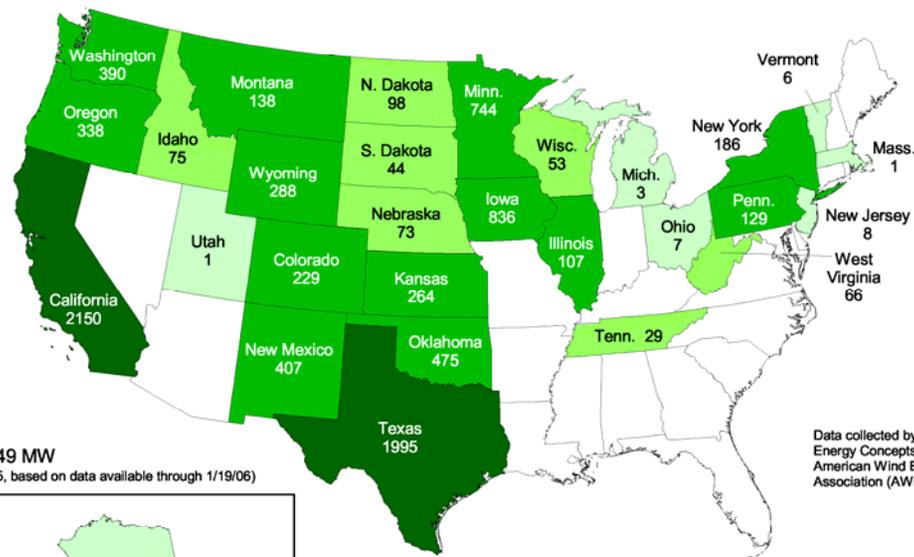
### United States - 2002 Year End Wind Power Capacity (MW)



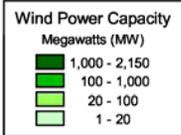
Total: 4,685 MW  
(Updated 12/31/2002)



### United States - 2005 Year End Wind Power Capacity (MW)



Total: 9,149 MW  
(As of 12/31/05, based on data available through 1/19/06)



Data collected by Global Energy Concepts and the American Wind Energy Association (AWEA).

September 19, 2007

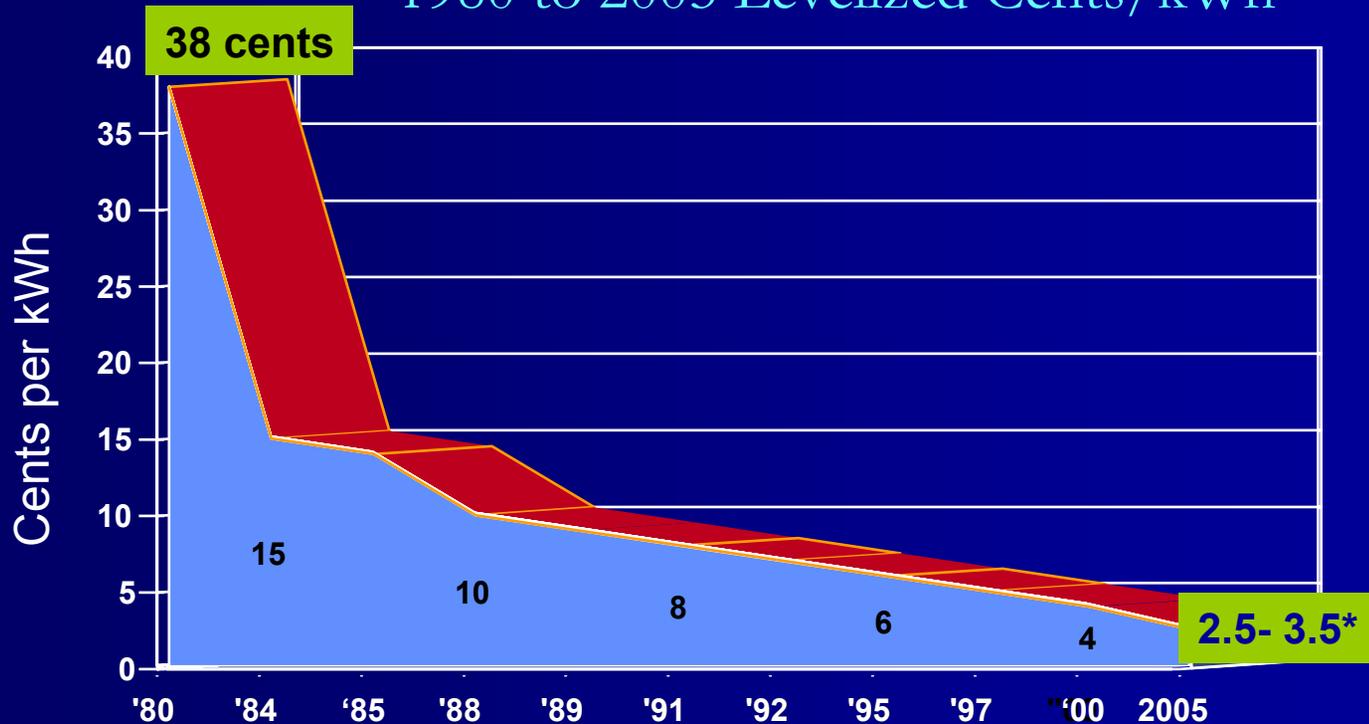
Re

U.S. Department of Energy  
National Renewable Energy Laboratory



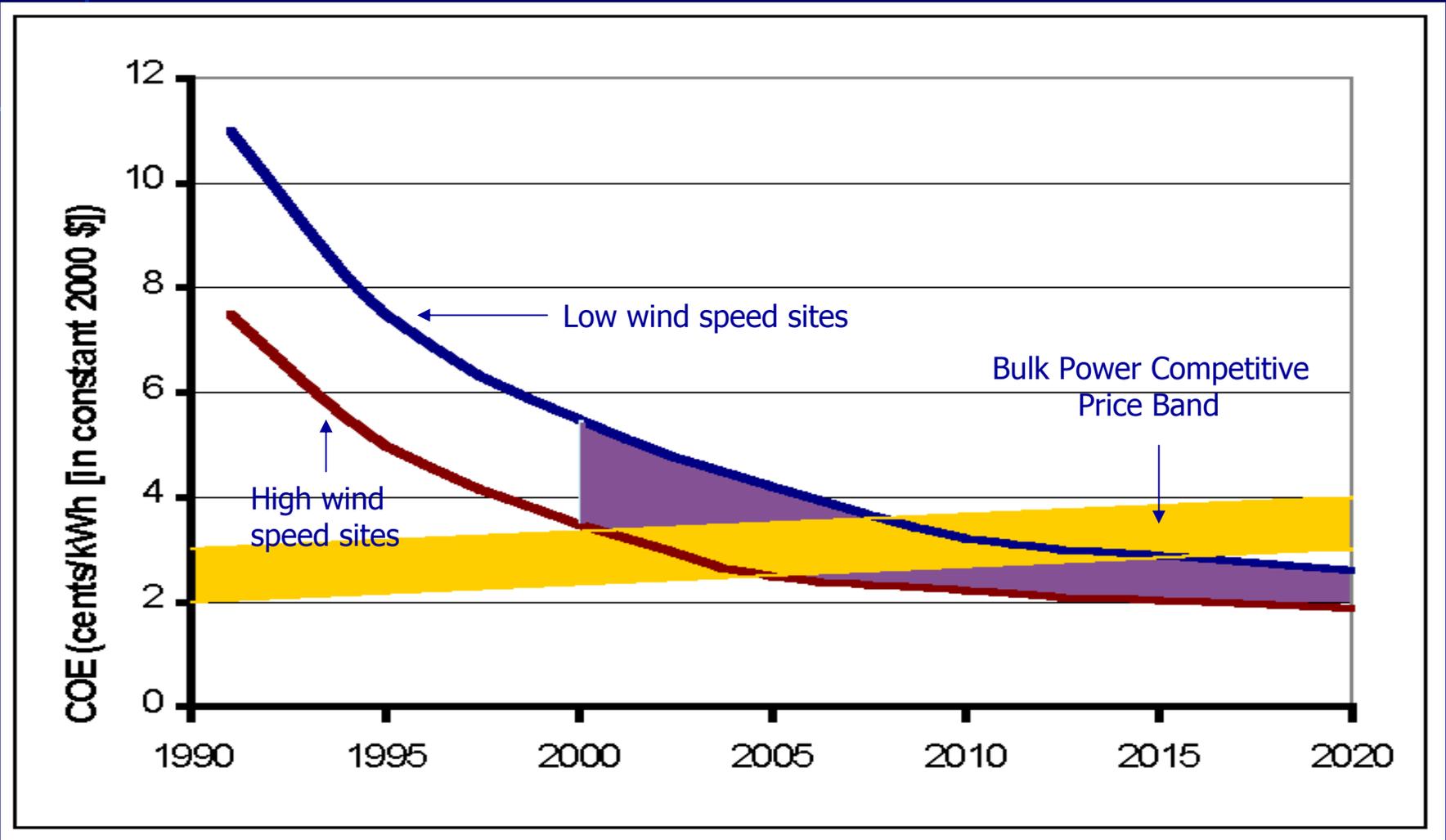
# Wind Economics

Cost of Wind-Generated Electricity  
1980 to 2005 Levelized Cents/kWh



\* Assumptions: Levelized cost at excellent wind sites, large project size, not including PTC (post 1994)

# Cost of Wind Energy



# Wind Economics (¢/kWh)

- **Coal:** 1.5 to 3.5
- **Gas:** 3.6 to 5.4 (depending on gas prices)
- **Wind:** 2.1 to 4.0 (with PTC)
- **Nuclear:** 11.1 to 14.5

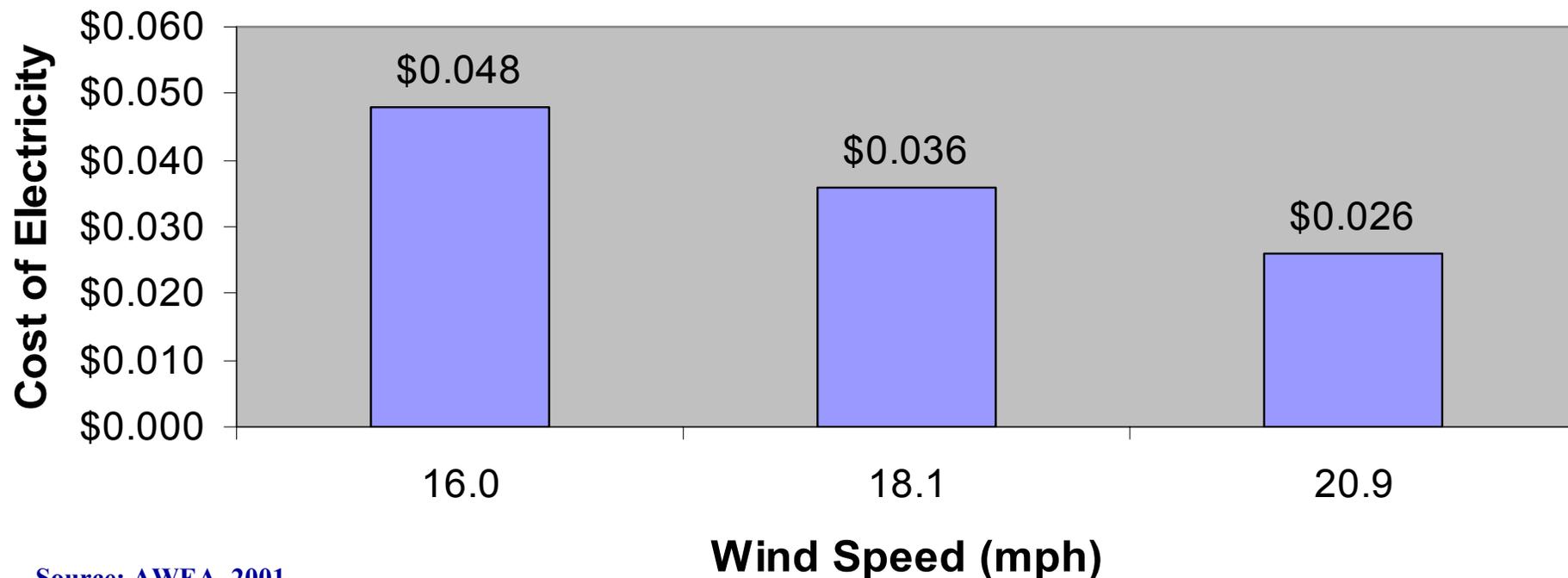
# Determining Factors of Cost

- Wind resource
- Financing and ownership structure
- Taxes and policy incentives
- Plant size: equipment, installation and O&M economies of scale
- Turbine size, model, and tower height
- Green field or site expansion
- What is included: land, transmission, ancillary services



# Wind Speed Matters

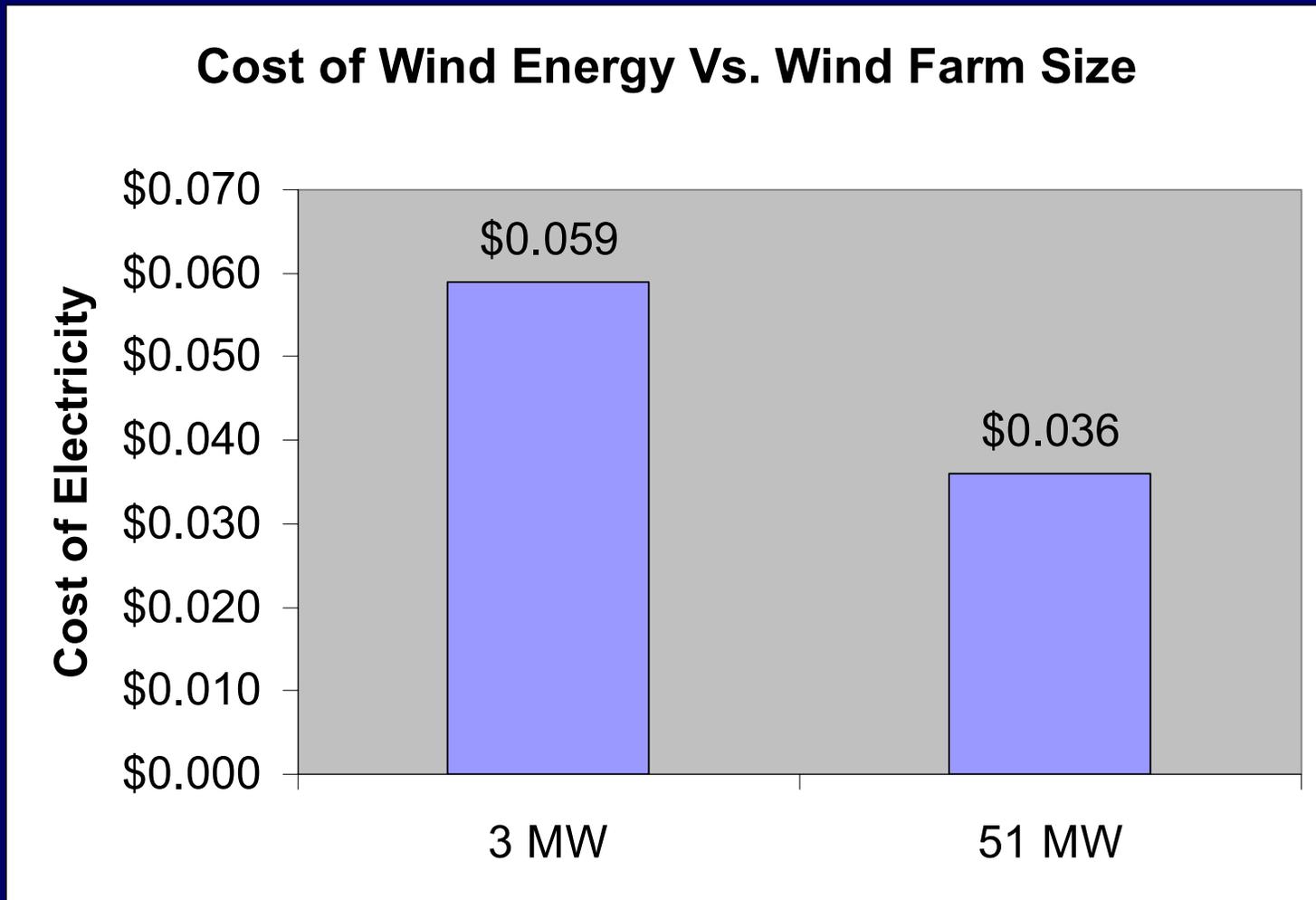
## Cost of Wind Energy Versus Wind Speed



Source: AWEA, 2001

**\* Assuming the same size project, the better the wind resource, the lower the cost.**

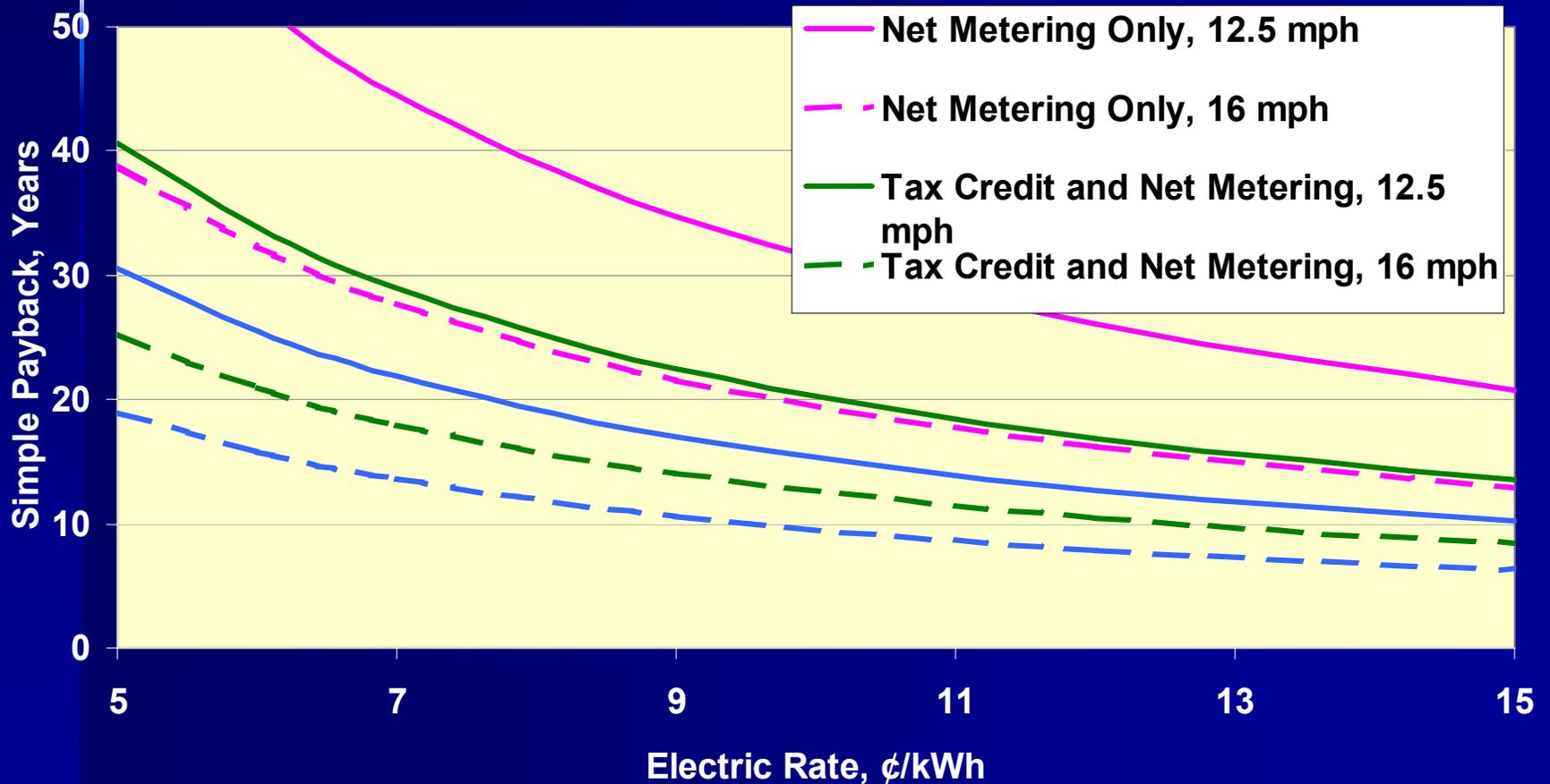
# Size of the Project Matters



**\* Assuming the same average wind speed, a large wind farm is more economical than a small one.**

# Small Wind Economics

Simple Payback  
Bergey Excel, 100 ft Tower



# Community Wind Options

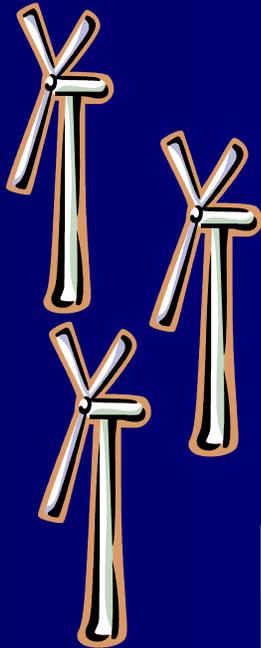
September 19, 2007

Renewable Energy for Oklahoma Tribes

# What is Community Wind?

- Small wind projects <20 MW
- Local ownership
- Development where large projects may not be feasible
- Examples: Rosebud Sioux; Spirit Lake School; Mackinaw City

# Wind Project Development Process

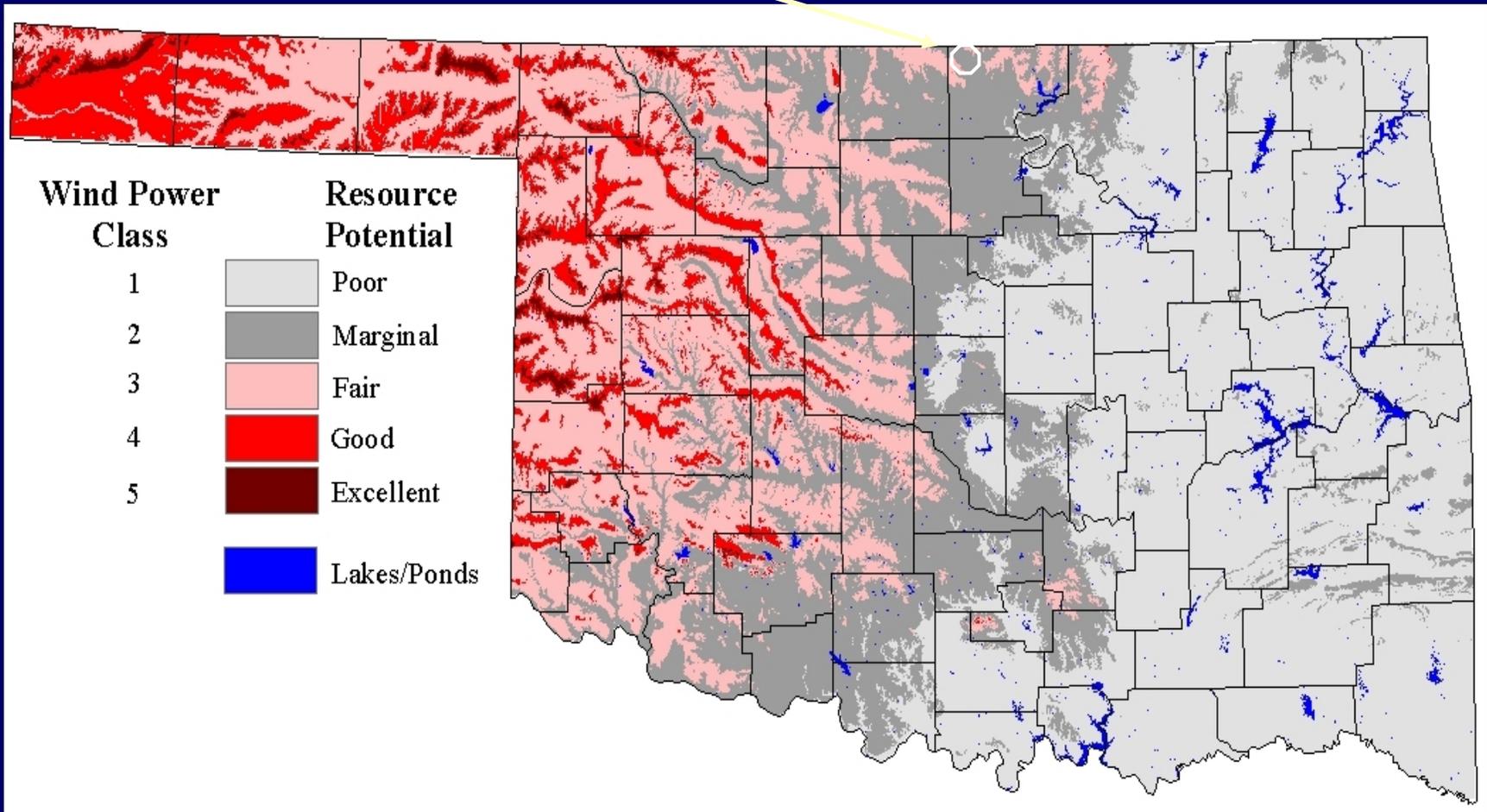


# Community Wind: Step 1

## 1. Wind Resource Assessment

- OWPI's Anemometer Loan Program
- Native American Anemometer Loan Program

# Approximate Location of Kaw Tower (center of circle)



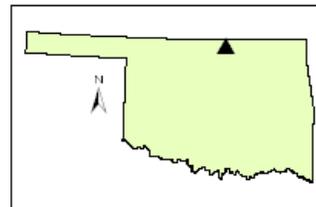
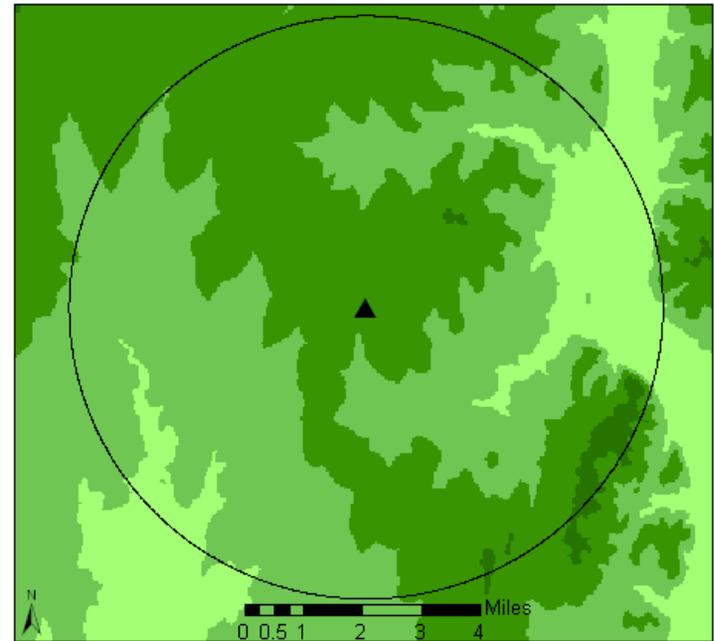
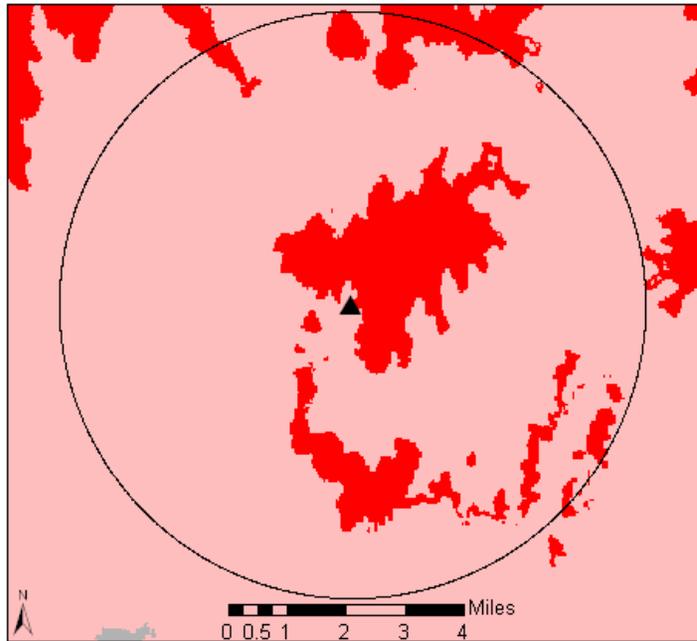
## Action Shots:

**Right: Assembling the  
Gin Pole**

**Bottom: Begin raising  
the tower into place**

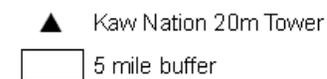
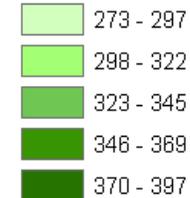


# Kaw Nation 20m Tower: Wind Resource & Elevation



## Elevation (m)

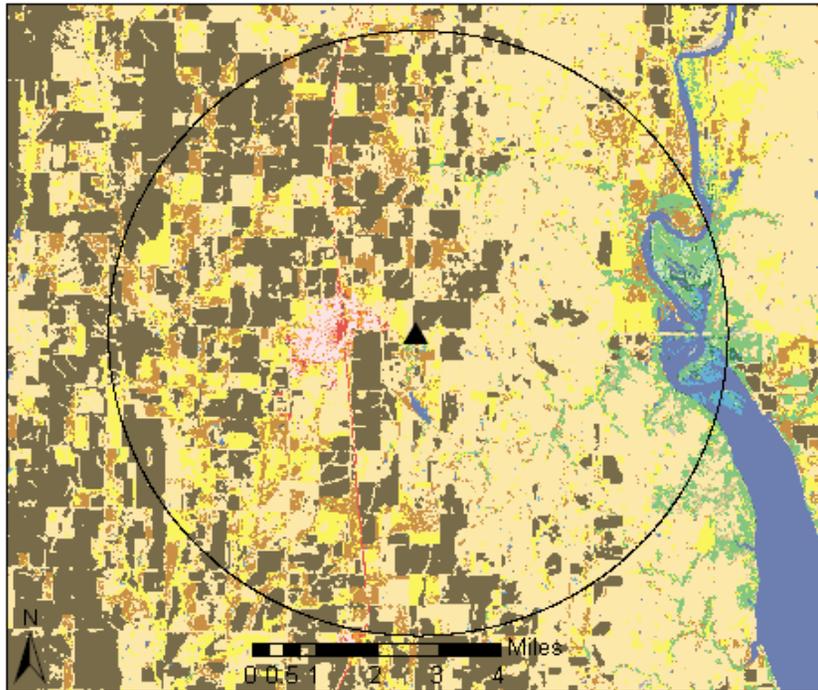
### Value



Version Date:  
January 25, 2006  
[www.ocgi.okstate.edu/owpi](http://www.ocgi.okstate.edu/owpi)

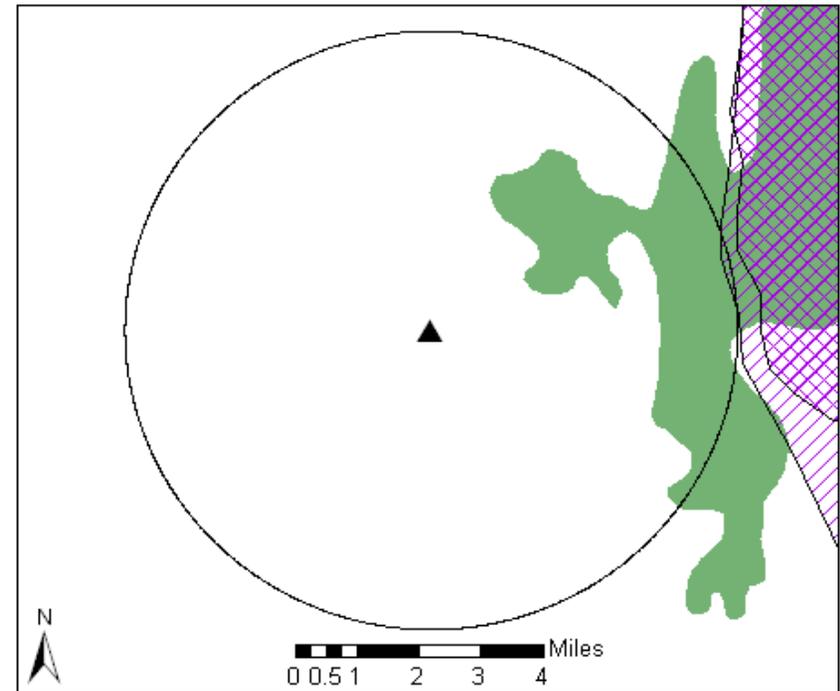


# Kaw Nation 20m Tower: Land Use/Land Cover & Protected Wildlife Regions



- ▲ Kaw Nation 20m Tower
- 5 mile buffer

\*For the Land Use/Land Cover legend, please see attached chart.



- ▨ Greater Prairie Chicken (present)
- ▨ Greater Prairie Chicken (early 20th century)
- The Nature Conservancy's Areas of Conservation Significance
- ▲ Kaw Nation 20m Tower
- 5 mile buffer



Version Date:  
January 25, 2006  
[www.ocgi.okstate.edu/owpi](http://www.ocgi.okstate.edu/owpi)

# Sample wind analysis

## Iowa Tribe 20-m Tower Winter 2001 - 2002 Wind Summary



<u>Month</u>	<u>Average Wind Speed</u>	<u>Wind Power Density</u>	<u>%Intervals Used</u>
December '01	4.95 m/s (11.1 mph)	138 W/m <sup>2</sup>	100%
January '02	5.16 m/s (11.6 mph)	129 W/m <sup>2</sup>	93%
February '02	5.48 m/s (12.3 mph)	188 W/m <sup>2</sup>	96%

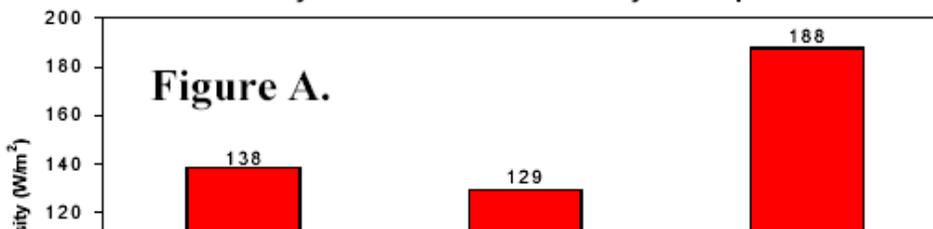


**BACKGROUND** - On June 4, 2001, the Iowa tribe installed a 20-meter tilt-up wind resource tower near the town of Perkins, Oklahoma. The tower and instrumentation were obtained from the U.S. DOE's National Renewable Energy Laboratory (NREL) as part of their Native American wind instrument loan program.

**SUMMARY** - (Figure A.) The average wind power density (WPD) is plotted for each month in the season. WPD is used to gauge the amount of energy in the wind, and its computation is independent of turbine type.

(Figure B.) The wind rose shows the directional distribution of wind speeds and wind energy. For the winter of 2001 - 2002, the winds were from the south-southeast, south, and south-southwest, approximately

Monthly Wind Power Density Comparison



# Community Wind: Steps 1-3

## 1. Wind Resource Assessment

- OWPI's Anemometer Loan Program
- Native American Anemometer Loan Program

## 2. Communication with Utilities

- Long process but very important
- Power purchase agreement negotiations

## 3. Financing Options

- Various loan and grant programs (discussed later)

# Community Wind: Steps 4-6

## 4. Legal Counsel

- Permits, PPAs, Business Structures

## 5. Turbine Procurement

- Size? Quantity?

## 6. Business Structure

- LLCs, Co-ops, “Flip” structures

# Community Wind: Steps 7-8

## 7. Insurance

- Property liability, construction, operation & maintenance

## 8. Construction

- Final stages!

# Native American Experiences & Opportunities

September 19, 2007

Renewable Energy for Oklahoma Tribes

# Fort Peck Tribes – Assiniboine & Sioux; Poplar, MT

- Power is provided by two 50kW turbines
- Average annual savings ~ \$30,000
- 10 years of planning
  - 12 months of wind data
- DOE grant = \$350,000

# Pueblo of Laguna Tribe - Albuquerque, NM

- Laguna Majors Ranch – Youth Development Ranch
- DOE grant = \$220,820
- Off-grid 8.1 kW wind/photovoltaic hybrid system
  - Used to provide electricity for water pumping, lighting, communication, and general use

# Campo Band of Kumeyaay Indians – San Diego County

- 50 MW project (25 2 MW Gamesa turbines)
- Muht Hei, Inc. – economic development for the Kumeyaay Tribe
- \$51 million from GE Energy Financial Services
- Assistance from Babcock & Brown – global investment and advisory firm

# Campo Band of Kumeyaay Indians – San Diego County

- Profits for the Campo Tribe -
  - Land lease agreements (\$16,000/turbine)
  - Royalties from electricity sales
  - Upfront payment of \$200,000

# DoE Assisted Projects in Oklahoma

- **Citizen Potawatomi**
  - Development of strategic energy plan
- **Cherokee Nation**
  - Feasibility study
- **Kaw Nation**
  - Feasibility study for commercial wind
- **Fort Sill Apache**
  - Energy assessment
- **Pawnee**
  - Feasibility and planning for energy future

# OWPI Native American Anemometers

- Citizen Potawatomi Nation
- Eastern Shawnee Tribe
- Iowa Nation
- Caddo Nation
- Otoe-Missouri Tribe
- Kaw Nation

# Funding & Other Resources for Native American Tribes

September 19, 2007

Renewable Energy for Oklahoma Tribes

# Funding Options

- **U.S. Department Of Energy**

- *Tribal Energy Program*

<http://www.eere.energy.gov/tribalenergy/>

- Provides grants for tribal renewable energy and energy efficiency projects as well as for capacity building.

- **Small Business Administration**

- *Office of Native American Affairs*

<http://www.sba.gov/aboutsba/sbaprograms/naa/index.html>

# Funding Options con't

- **U.S. EPA**

- *American Indian Tribal Portal*

<http://www.epa.gov/tribalportal>

- **State Incentives**

- *Database of State Incentive for Renewable Energy*

<http://www.dsireusa.org>

# Funding Options con't

- **USDA** – <http://www.rurdev.usda.gov/>
  - Renewable Energy grants & loan guarantees
  - Value Added Producer Grants
  - Rural Business Opportunity Grants
  - Intermediate Relending Program
  - Rural Business Grants
- U.S. Department of Interior
- U.S. Department of Commerce

# Additional Resources

- Bureau of Indian Affairs
  - Technical assistance and guidance
  - EMDP – Scott Haase (Friday)
- Intertribal Council on Utility Policy (ICOUP)
  - Policy analysis and recommendations

# Resources con't

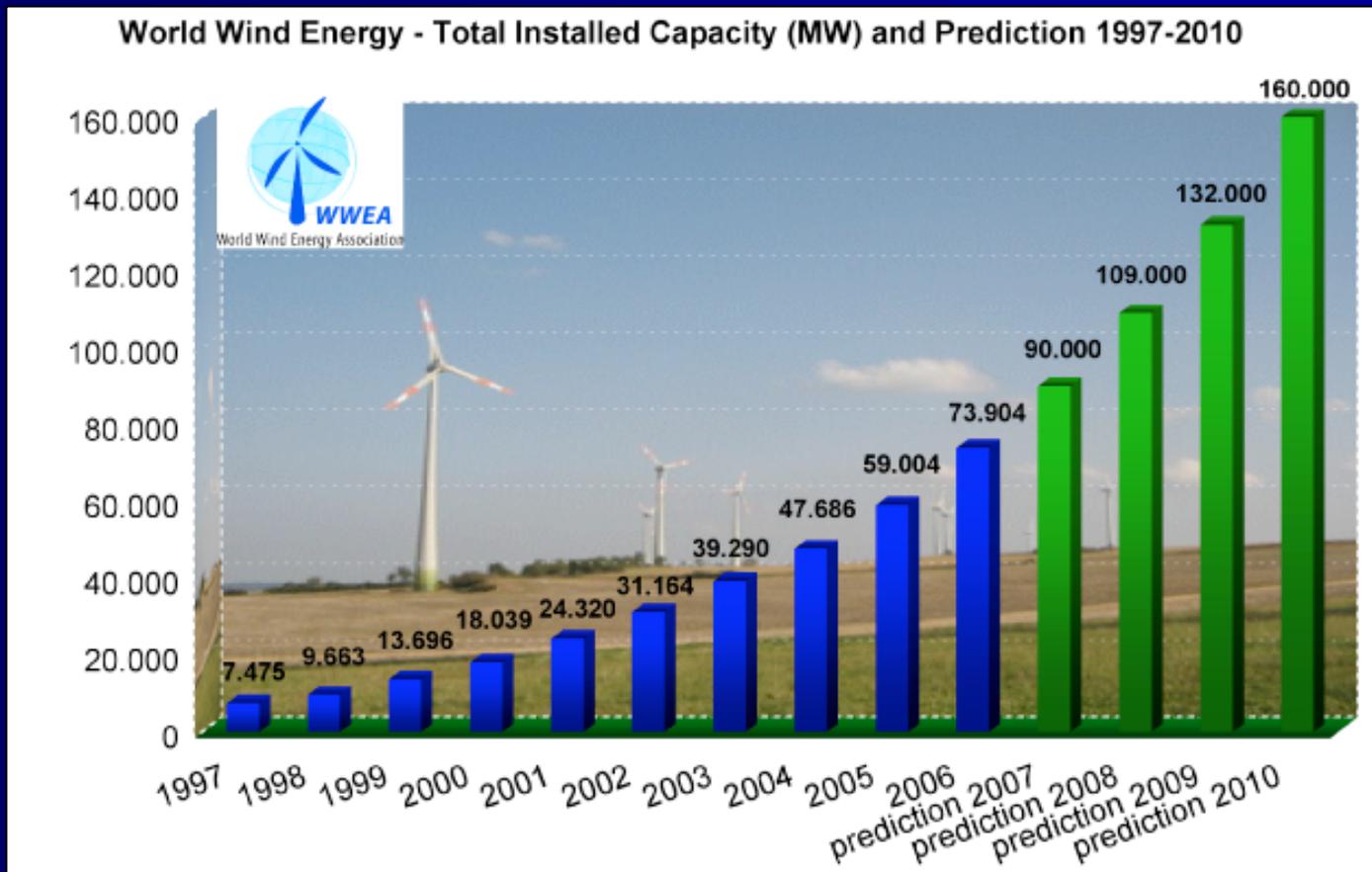
- NREL / DOE / Tribal Energy Program
  - Clearinghouse for Native American information
- Wind Energy Applications Training Symposium (WEATS)
  - Hands-on workshop, meet with tribal members, networking opportunity

# U.S. & Global Wind Power

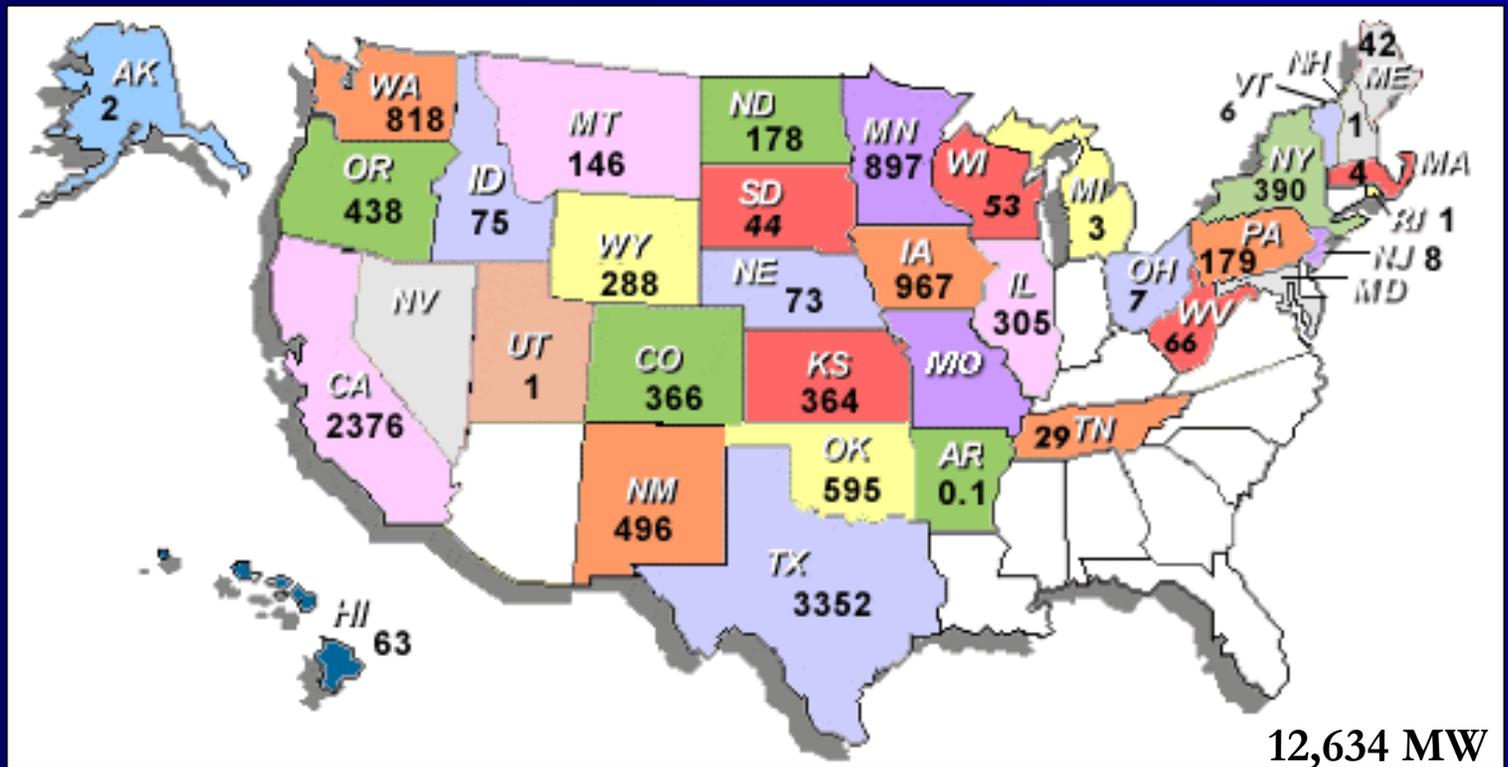
September 19, 2007

Renewable Energy for Oklahoma Tribes

# Global Wind Power Trends



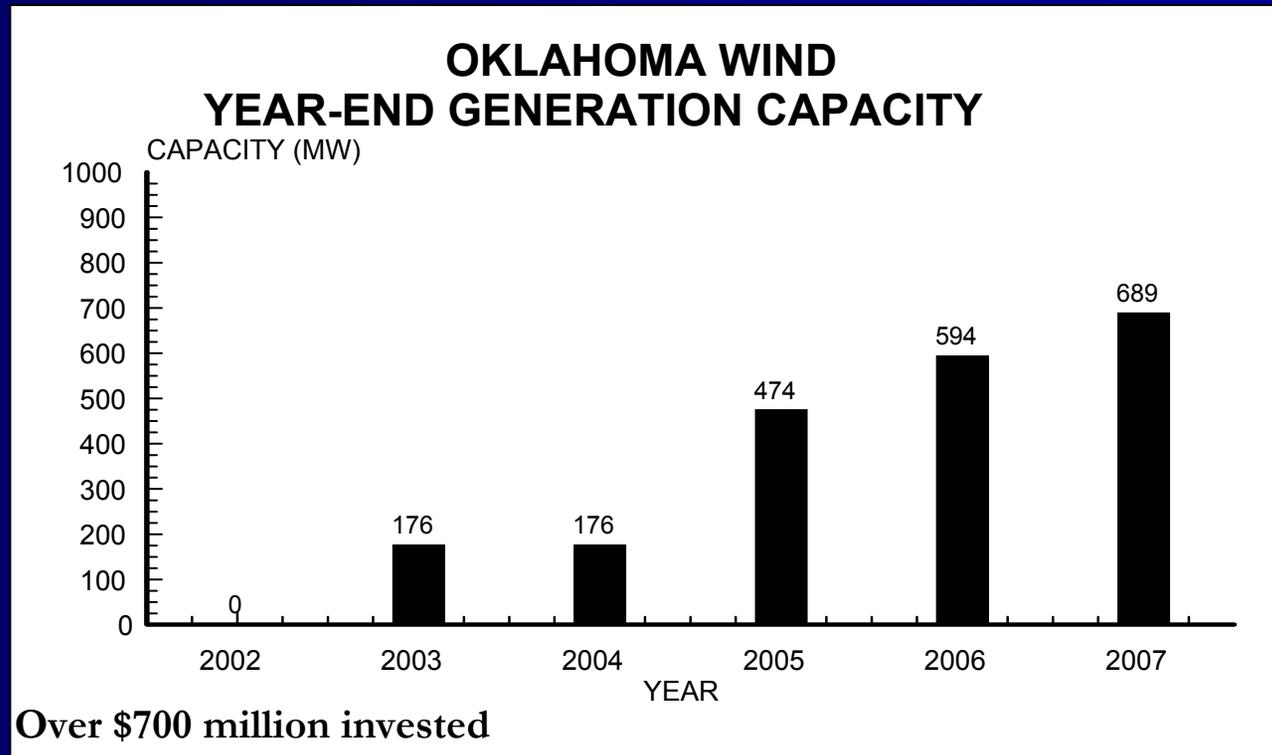
# U.S. Installed Wind Power



Source: AWEA – June 30, 2007



# Oklahoma Installed Wind Energy



**New installations of 1000+ MW by 2015**

# Blue Canyon Wind Farm (Horizon Wind)

- Total: 225 MW
- 45 – 1.65MW NEG-Micon turbines
- 84 – 1.8MW Vestas turbines
- ~ 22,500 homes – WFECC
- ~ 27,000 homes – PSO
- 8 Full-time employees
- ~ 100 temporary construction jobs
- Landowners receive base payments plus a percentage of energy produced
- Estimated that over \$4 million will be paid in property taxes in years 6-20 of the project





# Oklahoma Wind Energy Center (Florida Power & Light)

- Total: 102 MW
  - ~ 30,000 homes
  - OG&E and OMPA
- 68 – GE 1.5MW turbines
- 8 Full-time employees in 2004
  - Est. payroll in 2004: \$300,000
- ~ 150 temporary construction jobs
- Lease payments to landowners
  - Estimated to total of \$280,000 in 2004





September 19, 2007

Renewable Energy for Oklahoma Tribes

# Weatherford Wind Energy Center (Florida Power & Light)

- Total: 147 MW
- Phase I: 106.5 MW
- Phase II: 40.5 MW
  - ~ 44,000 homes
  - Public Service Company of Oklahoma
- 98 GE 1.5 MW turbines
- \$150,000 payment in lieu of taxes to Weatherford School District for 5 years





Renewable Energy for Oklahoma Tribes

# Centennial Wind Farm (OG&E)

- Total: 120 MW
- 80 GE 1.5 MW turbines
- ~36,000 homes
- Owned and operated by OG&E



Photo Courtesy of OG&E

# Sleeping Bear

- Total: 94.5 MW
- ~28,000 homes
- Electricity to be purchased by Public Service Company of Oklahoma (PSO)
- Developed by Chermac Energy, owned by Edison Mission Group
- Completion date: August 2007

# Barriers to Wind Development

September 19, 2007

Renewable Energy for Oklahoma Tribes

# Barriers

- *Avian Issues?*
- *Noise?*
- *Visual Impact?*
- *Transmission?*
- *Intermittency?*

# Birds...



- Altamont Pass
- Other collisions & fatalities
  - Homes, skyscrapers, cars, cats

# Noise...

Bedroom at night:

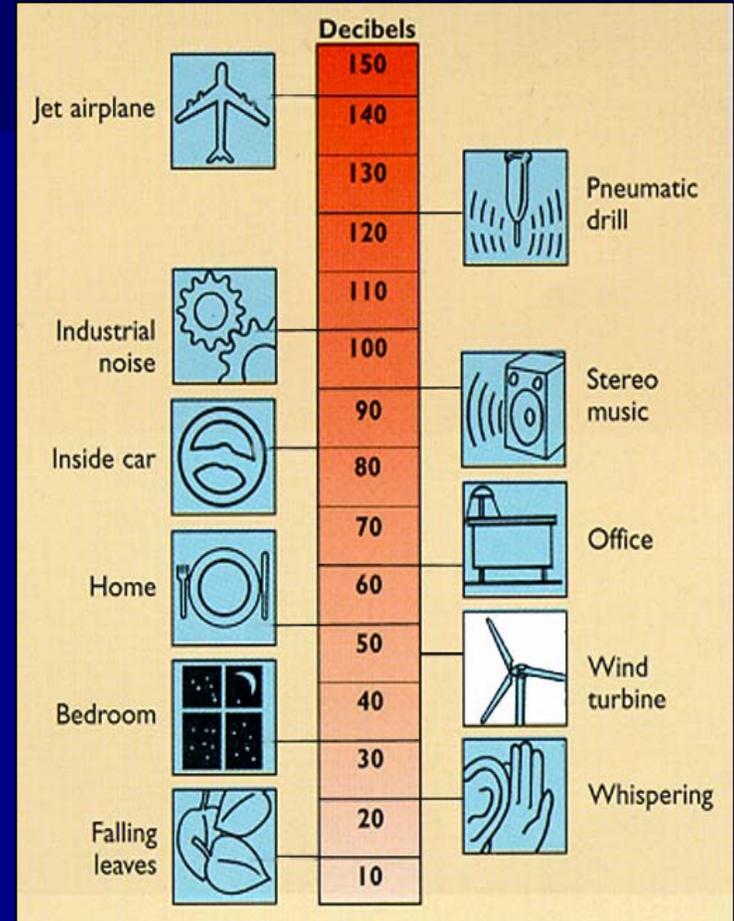
*30 decibels*

Wind turbine:

*45 decibels*

Noise at home:

*50 decibels*



# Transmission

Oklahoma Wind Resource Map - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www2.ocgi.okstate.edu/website/owpi2/viewer.htm

Gmail - Inbox Getting Started Latest Headlines

## owpi OKLAHOMA WIND RESOURCE MAP

**Layer / Legend**

**Layers**

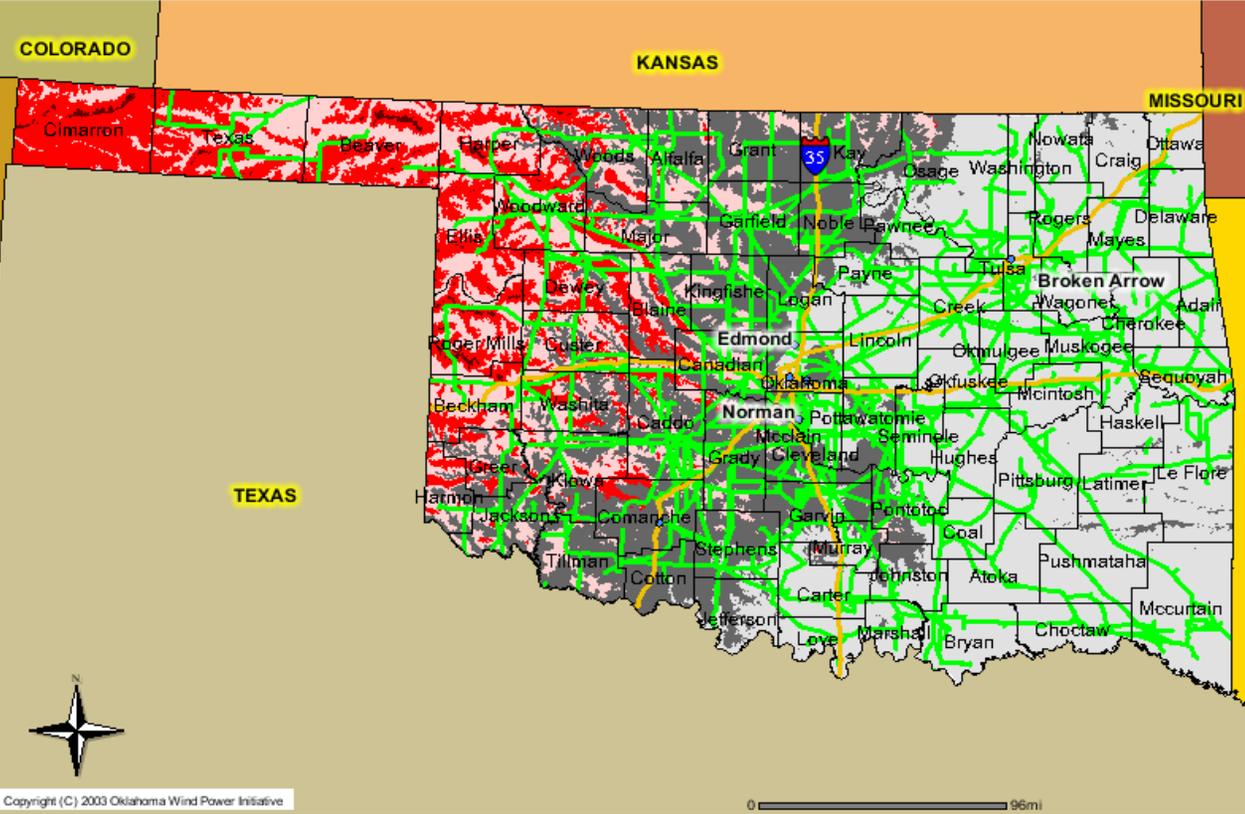
Visible Active

- Transmission Lines (see Help)
- Wind Resource at 164 ft - Model 1
- Wind Resource at 164 ft - Model 2

 **OSU**

[Help](#) [Email](#) [Print Map](#)

**Topographic Map**



Copyright (C) 2003 Oklahoma Wind Power Initiative

0 96mi

**Zoom In**

# Other Barriers...

- Visual Impact
- Intermittency
  - Wind is not 100% of the electricity portfolio

# Summary -- Why Wind?

- Opportunities for Energy Security and Independence
- Reduce Vulnerability to volatile utility prices
- Improved environmental stewardship through reduction of air pollution from fossil fuel electricity sources
- Resources, funds, and support exist to:



*Carpe Ventum!*

# For more information...



Scott Greene

100 E. Boyd Street, SEC Room 410

Norman, OK 73019

(405) 325-8870

[jgreene@ou.edu](mailto:jgreene@ou.edu)

[www.ocgi.okstate.edu/owpi](http://www.ocgi.okstate.edu/owpi)