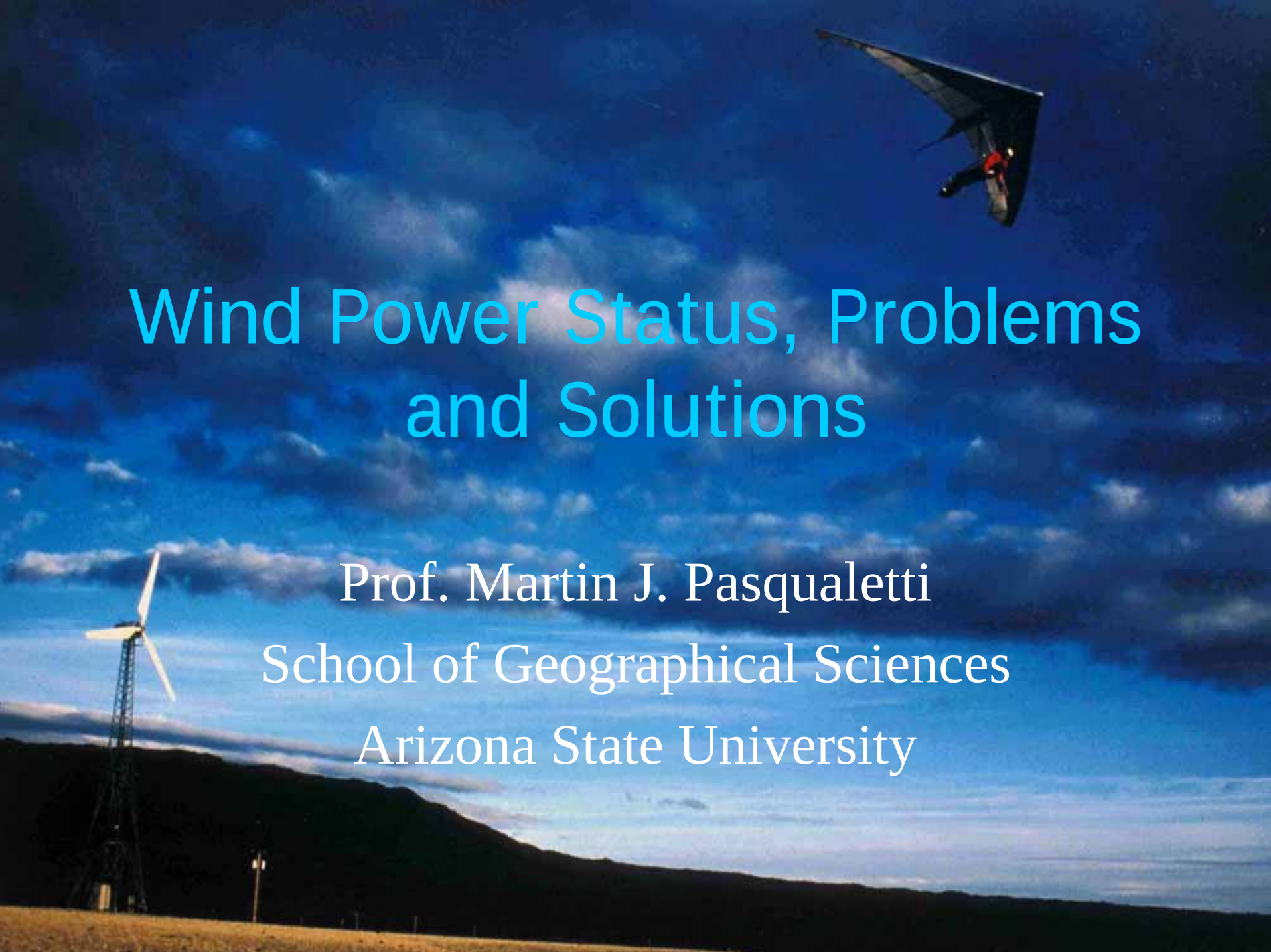


Wind Power Status, Problems and Solutions

Prof. Martin J. Pasqualetti
School of Geographical Sciences
Arizona State University

Humanity's Top 10 Problems for the Next 50 Years

1. Energy
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism and War
7. Disease
8. Education
9. Democracy
10. Population

Source: Nobel laureate, Richard Smalley

Wind Power is One Part of the Energy Supply Answer

Environmental Benefits

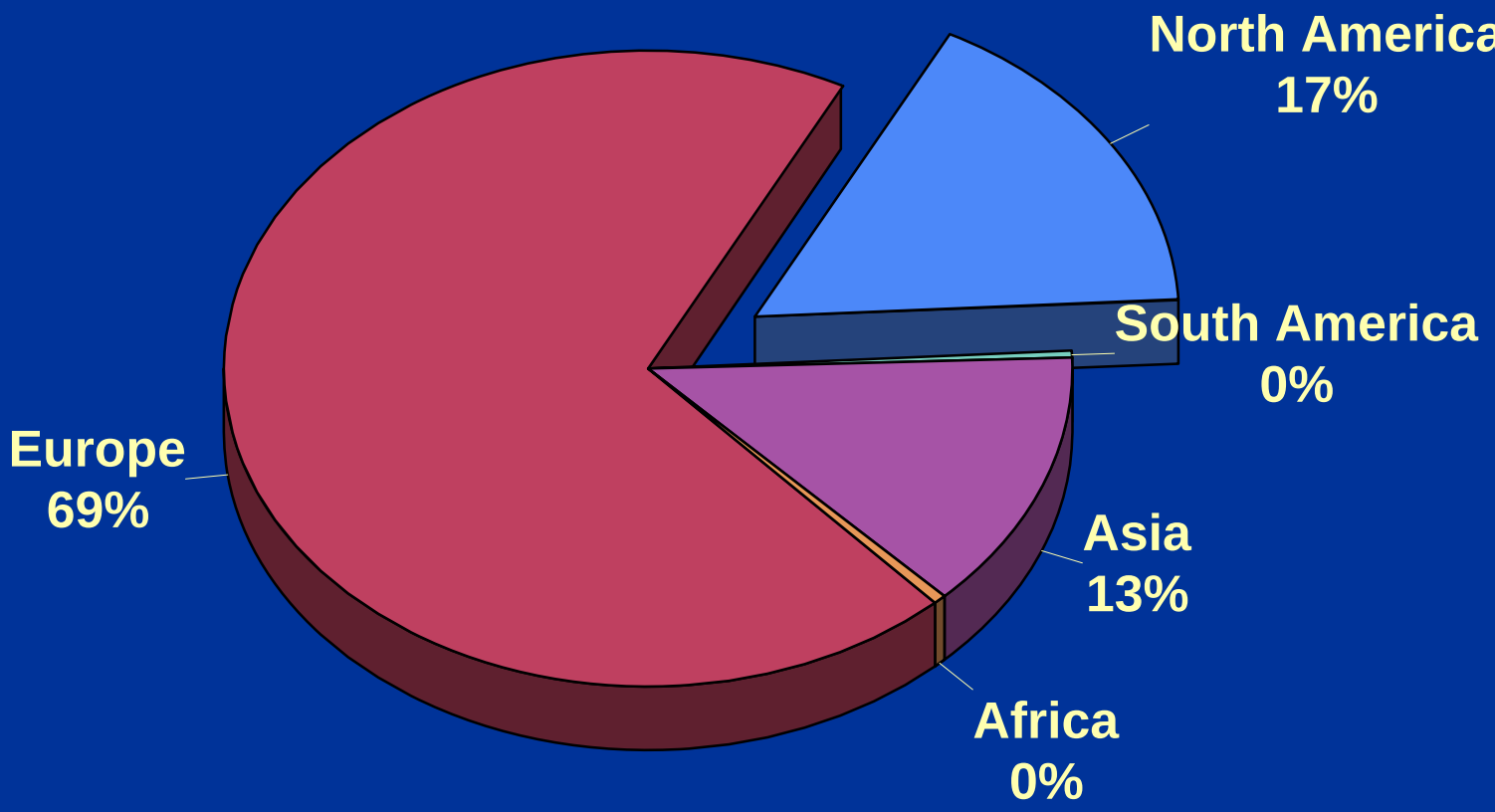
- No SOx or NOx
- No particulates
- No mercury
- No CO2
- No water required
- No waste
- Reversible

Three Themes

- Status
- Problems
- Solutions

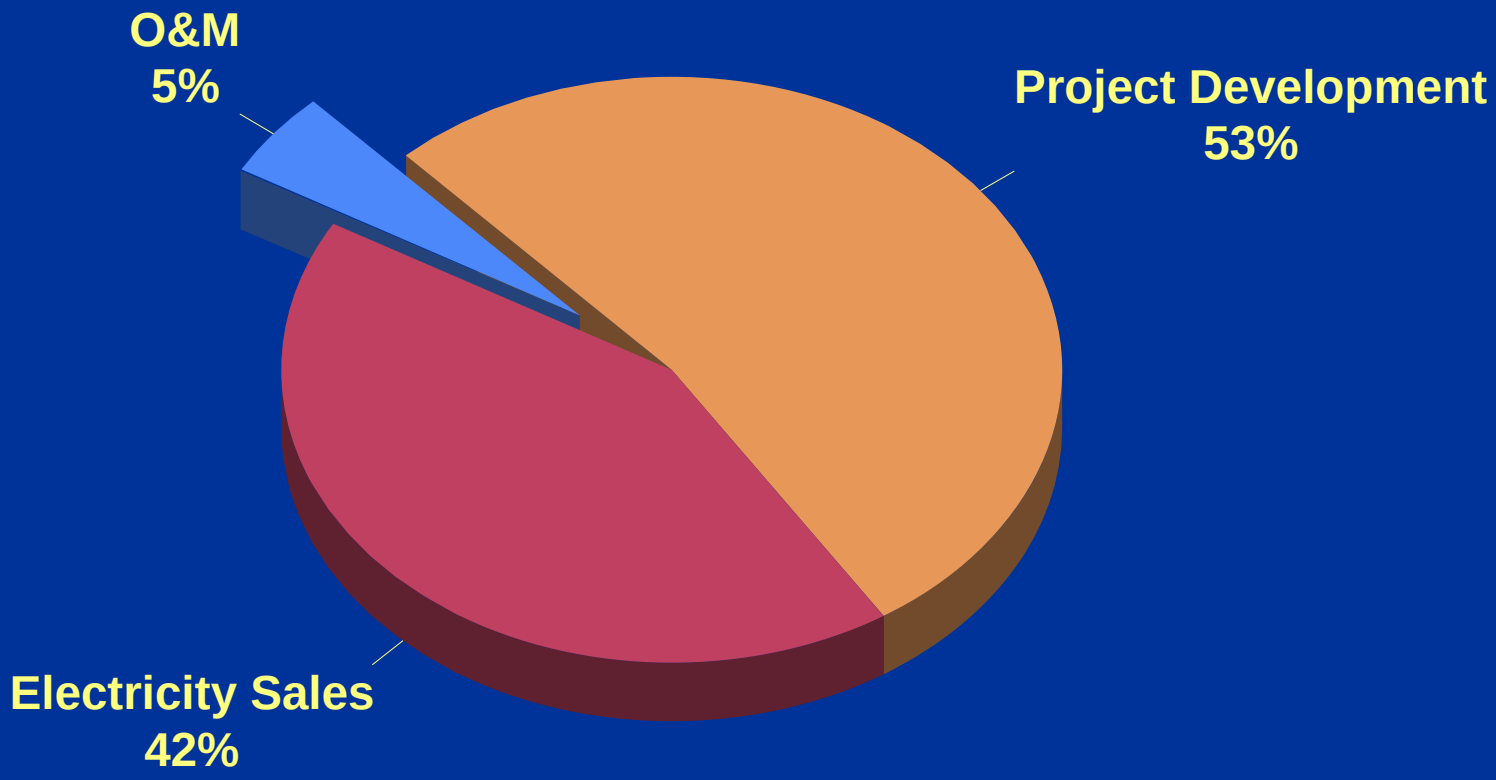
#1 - Wind Power Status

World Wind Capacity 2005
~58,000 MW



Source: Paul Gipe Associates

Wind Energy is a Real Business
US$22 Billion in 2005



Source: Paul Gipe Associates

American Wind Energy Association

What is Wind's Market Potential?

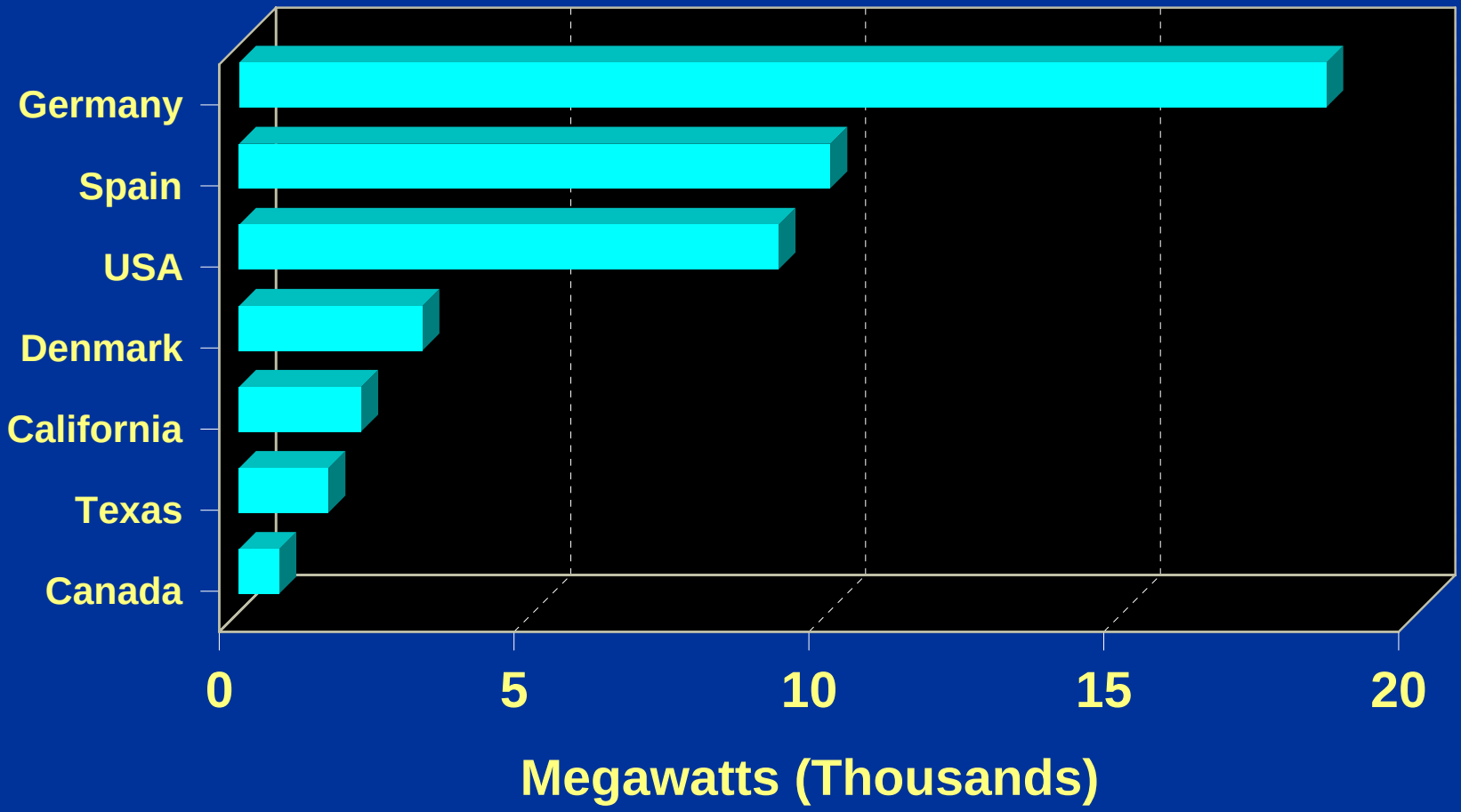
- At least 20,000 MW total installed by 2010 in U.S.
- 6% of electricity supply by 2020

→ = 100,000 MW of wind power installed by 2020

= a $100 billion market!

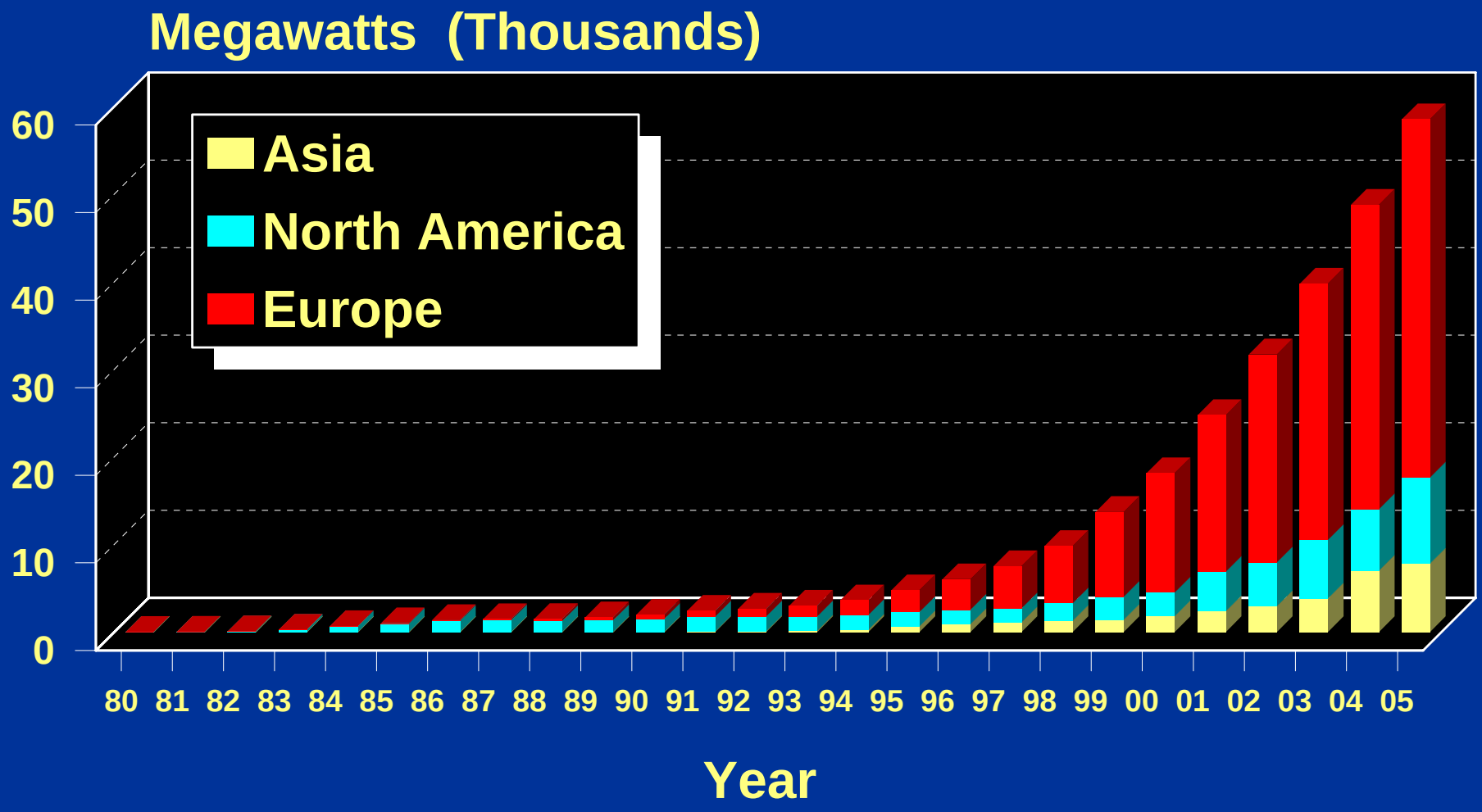
Randy Swisher, AWEA Annual Meeting, Chicago 2005.

Installed Wind Capacity 2005
Where Canada & US Stands



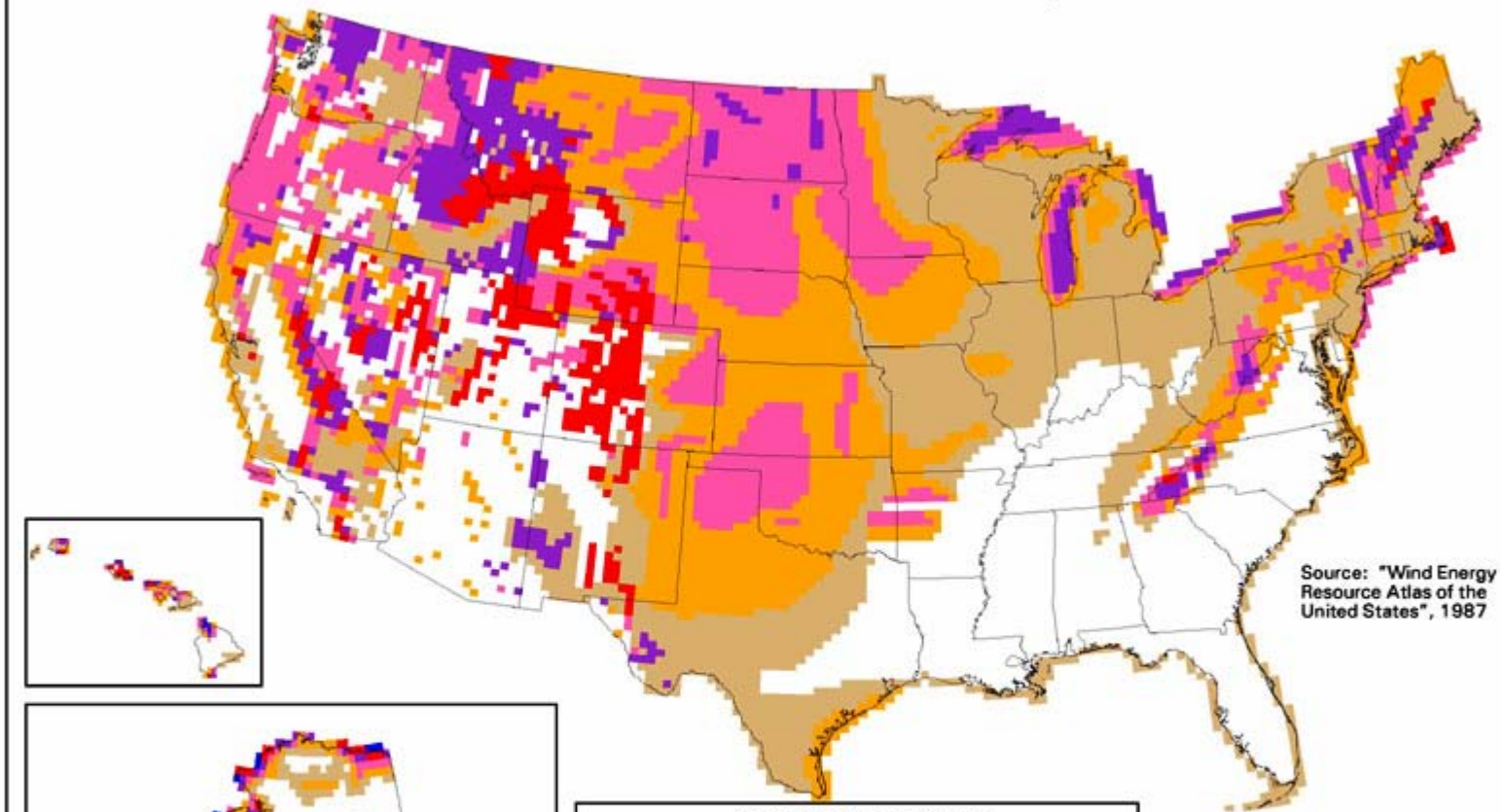
Source: Paul Gipe Associates

World Wind Generating Capacity



Source: Paul Gipe Associates

United States - Wind Resource Map



Source: "Wind Energy Resource Atlas of the United States", 1987

Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

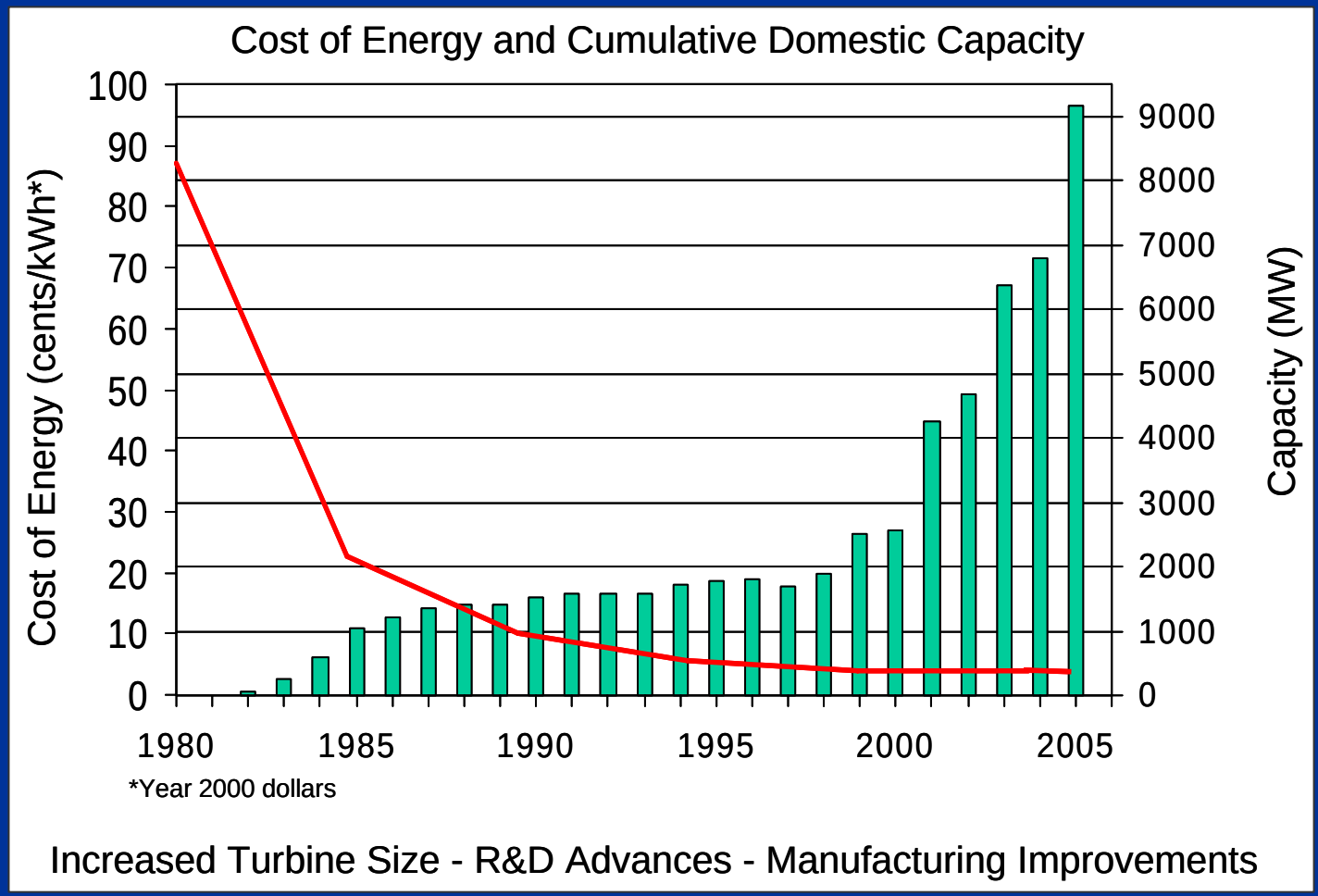
[a] Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

20-MAR-2000 1.1.5

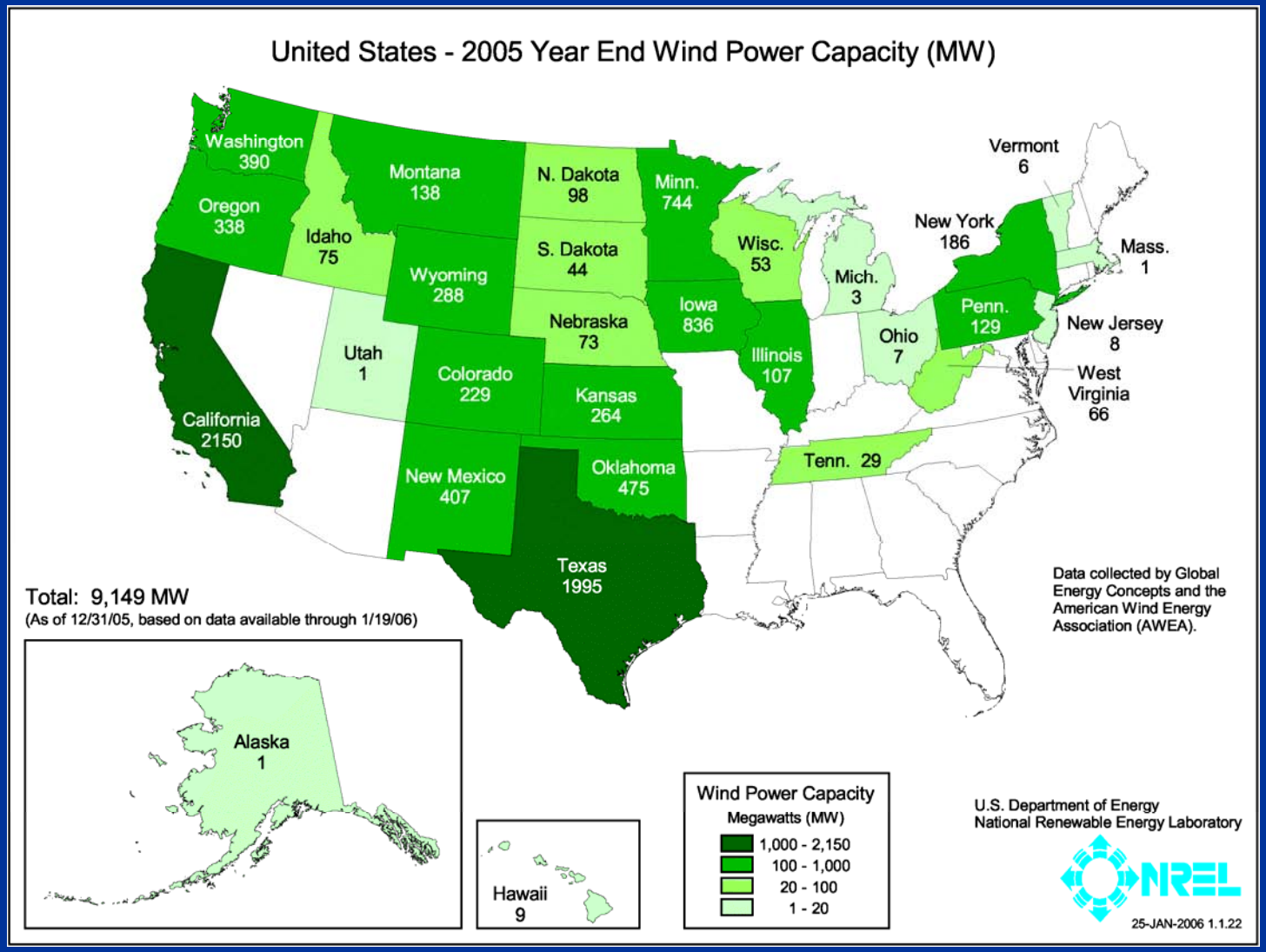
Capacity & Cost Trends in the U.S.



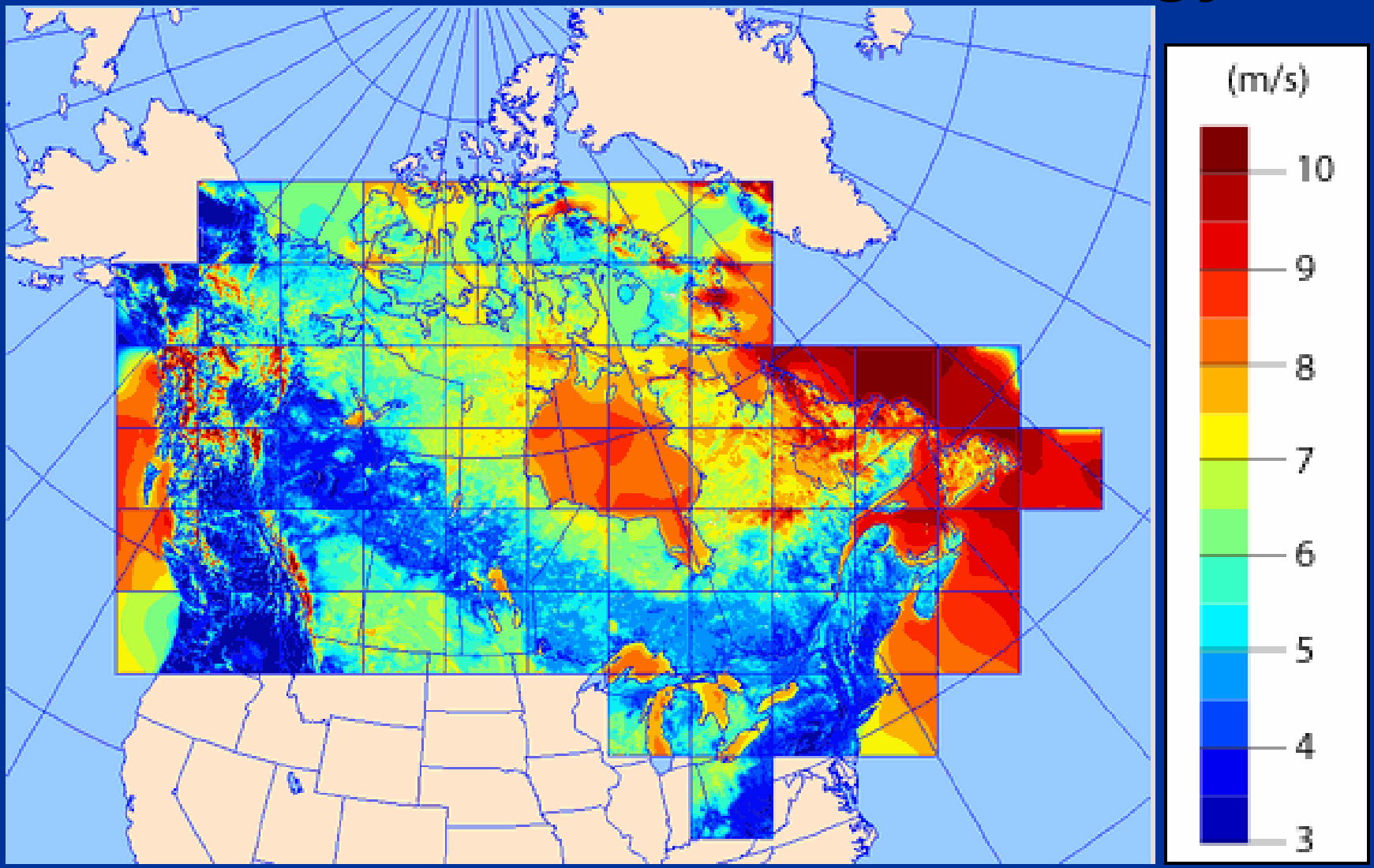
Source: NREL

Installed Capacity – US

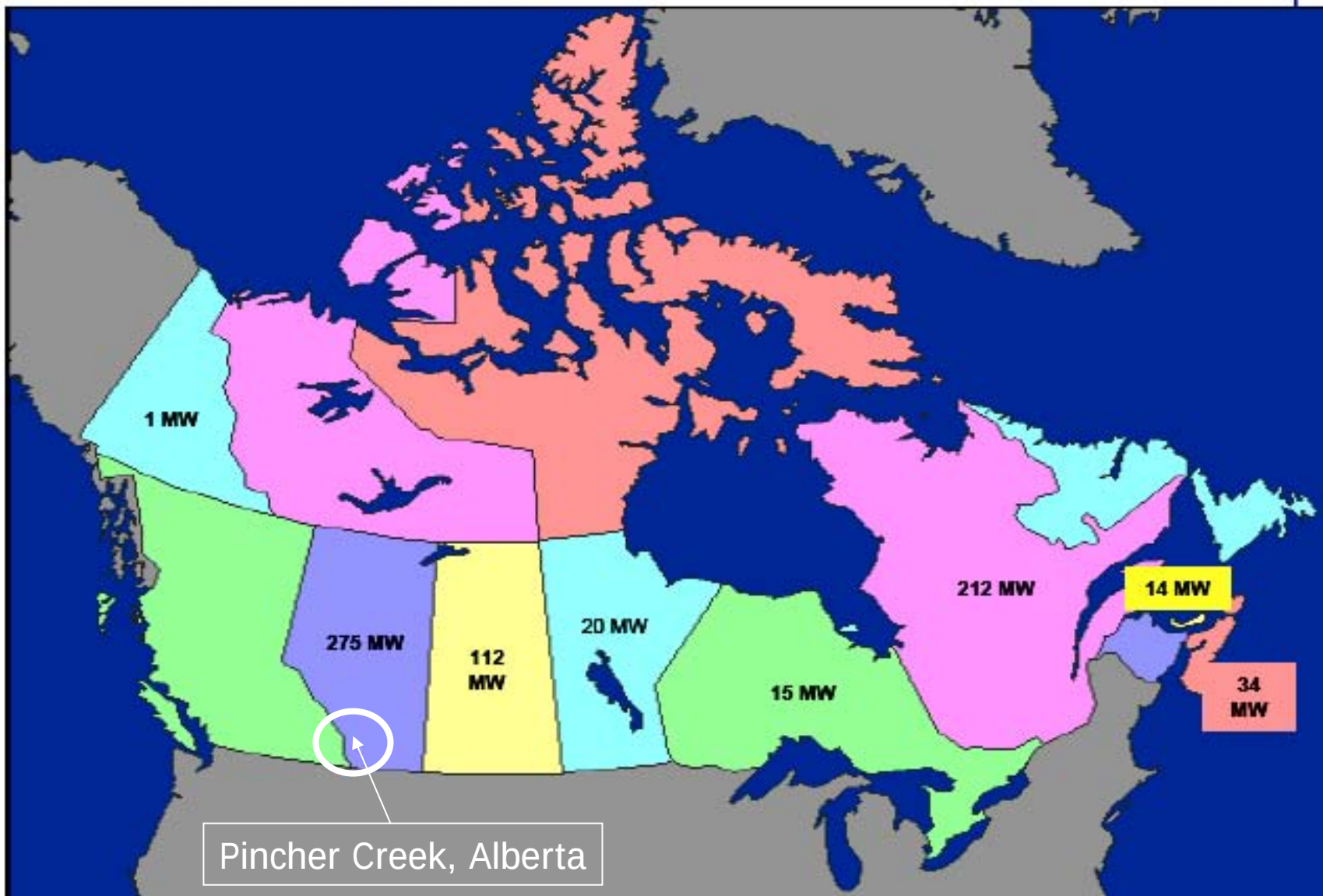
12/31/05 – 9,149 MW



Canada Mean Wind Energy



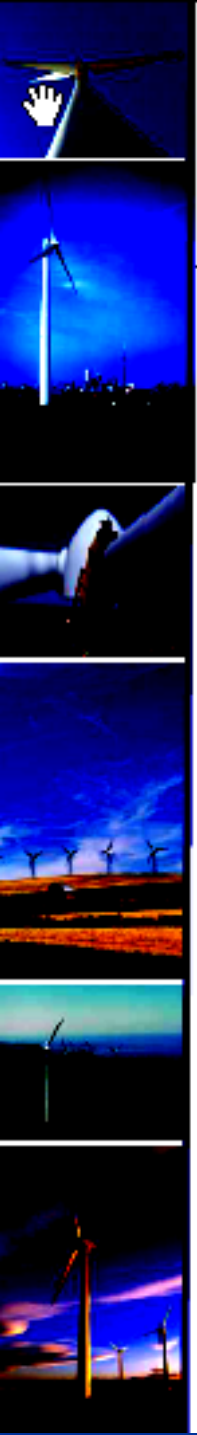
January 2006: 683 MW Installed Capacity in Canada

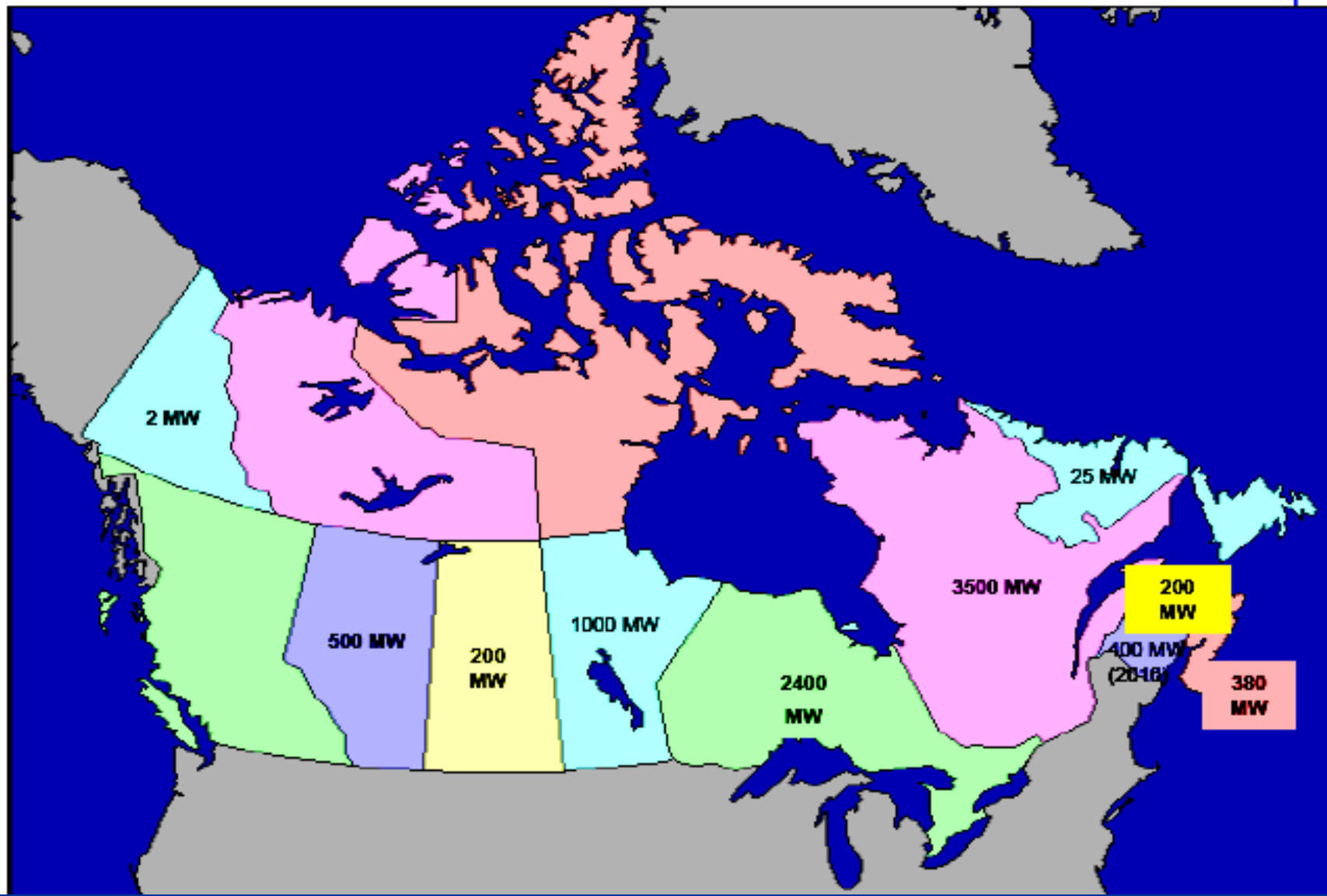


Pincher Creek Wind Development
Alberta, Canada

~ 200 MWe June 2006

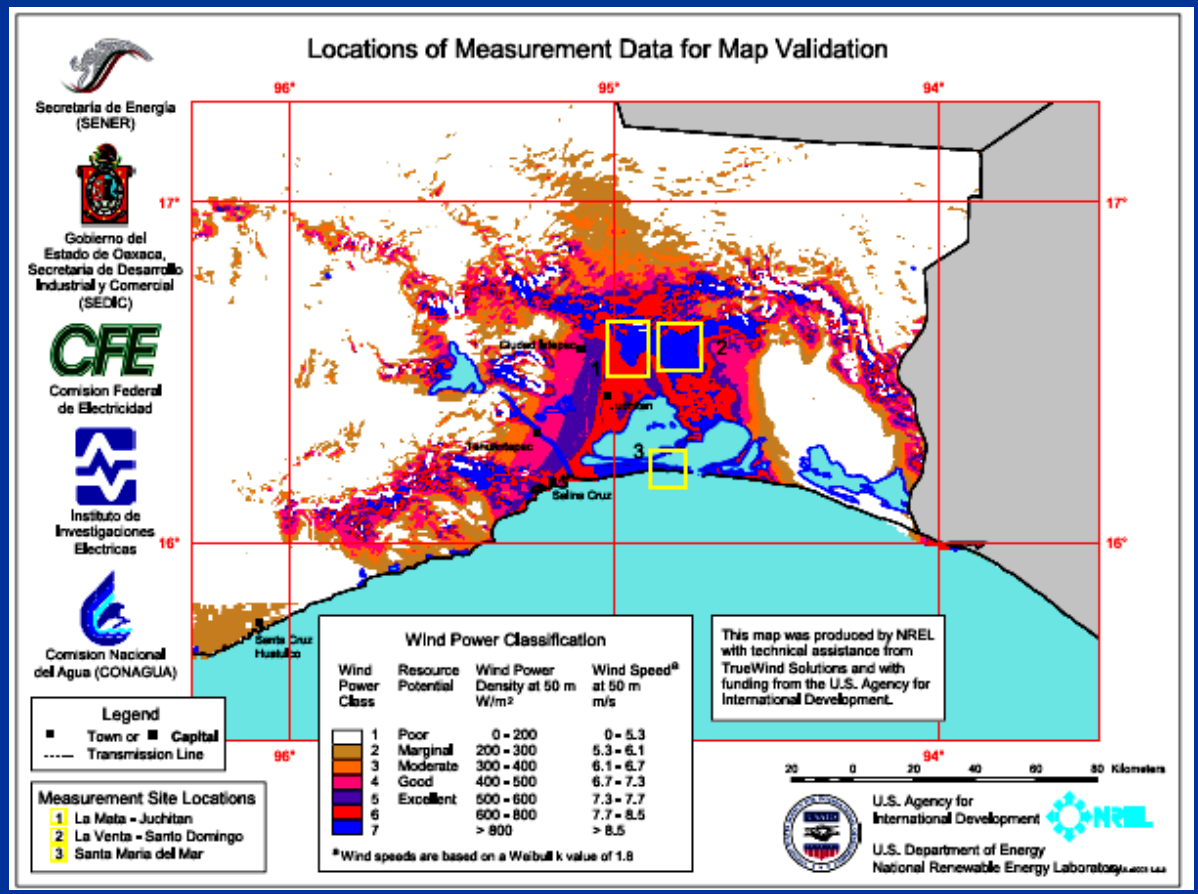
Implementing Current Provincial Targets: 8,500+ MW by 2015





Wind Energy Resource of Oaxaca

Isthmus of Tehuantepec



Source: D. Elliott, M. Schwartz, G. Scott, S. Haymes, D. Heimiller, R. George, *Wind Energy Resource Atlas of Oaxaca*, August 2003

Photo: Mathew Taylor

Class 3 – Class 7 = >44,000 MW potential in Oaxaca*

* Assumptions: installed capacity per sq km = 5 MW; total land area = 91,500 sq km.

#2 – Problems

Visual Aesthetics

You can do many things to make wind turbines less objectionable, but you cannot make them invisible.

- Highlands County, Virginia
- Cape Cod, Massachusetts
- Palm Springs, California

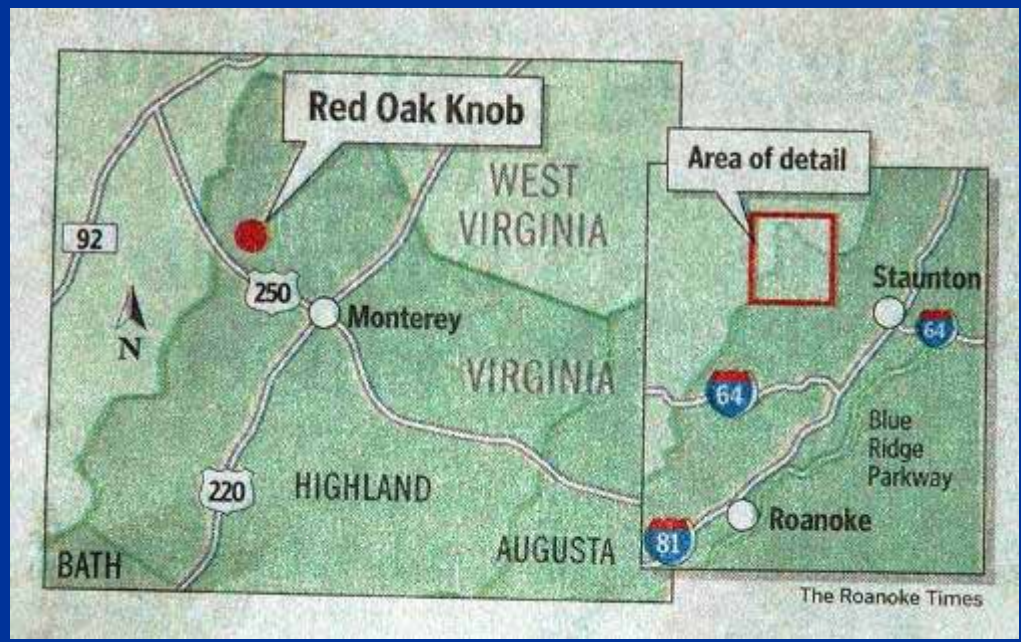
Opposition in Highland County, VA

THE ROANOKE TIMES

Highlands torn by

winds of change

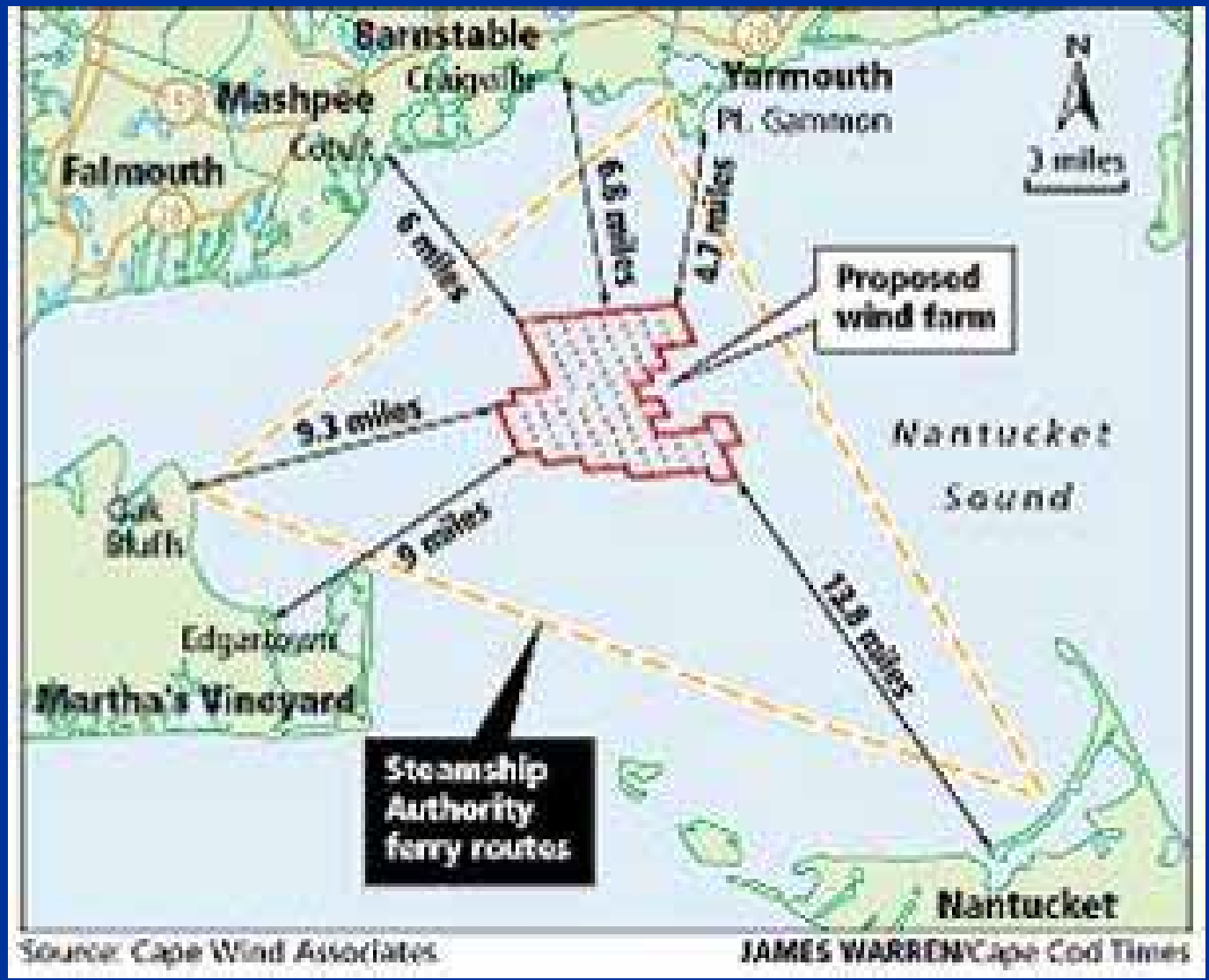
A proposal to build wind turbines in Highland County has polarized the rural community's residents.



Simulation

Red Oak Knob, Virginia – June 2005

Cape Wind Project



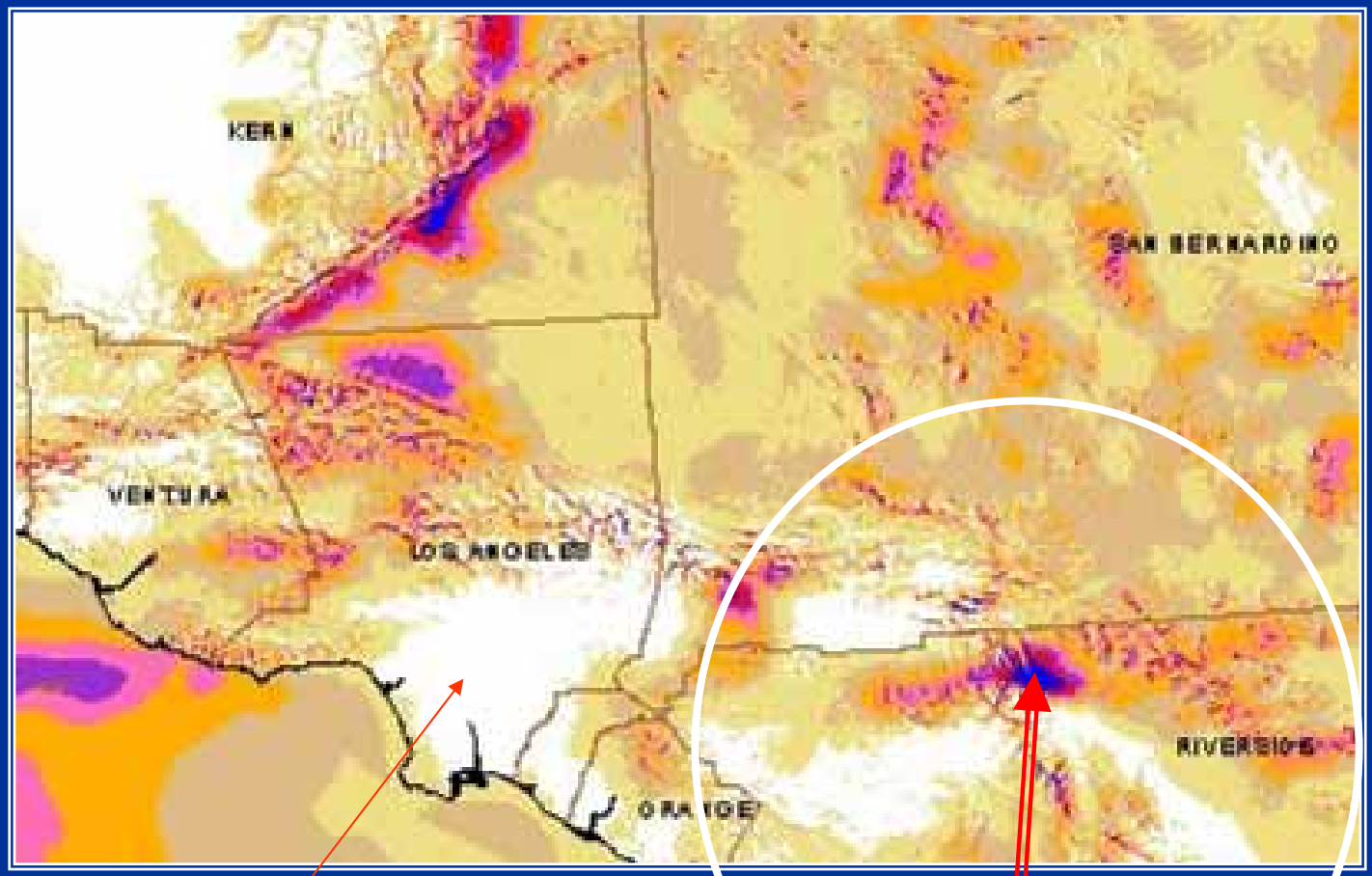
- 24 sq miles
- 130 turbines
- Max height: >400 ft

Opposition at Cape Cod (Nantucket Sound)

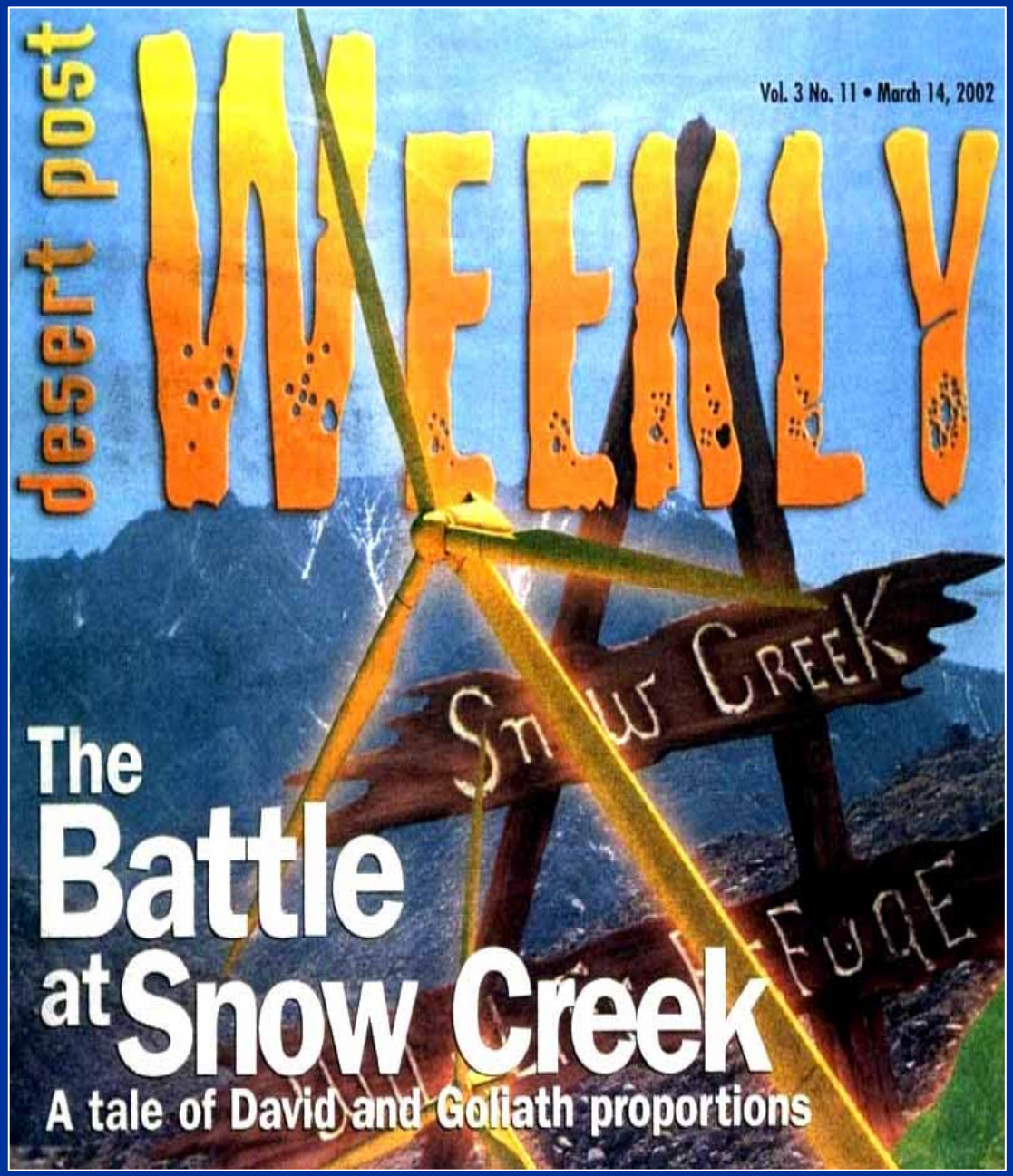
Cape Wind Opponent with Visual Simulation

Cape Wind Visualization

Palm Springs, California



Palm Springs
Wind Developments



Opposition at Palm Springs

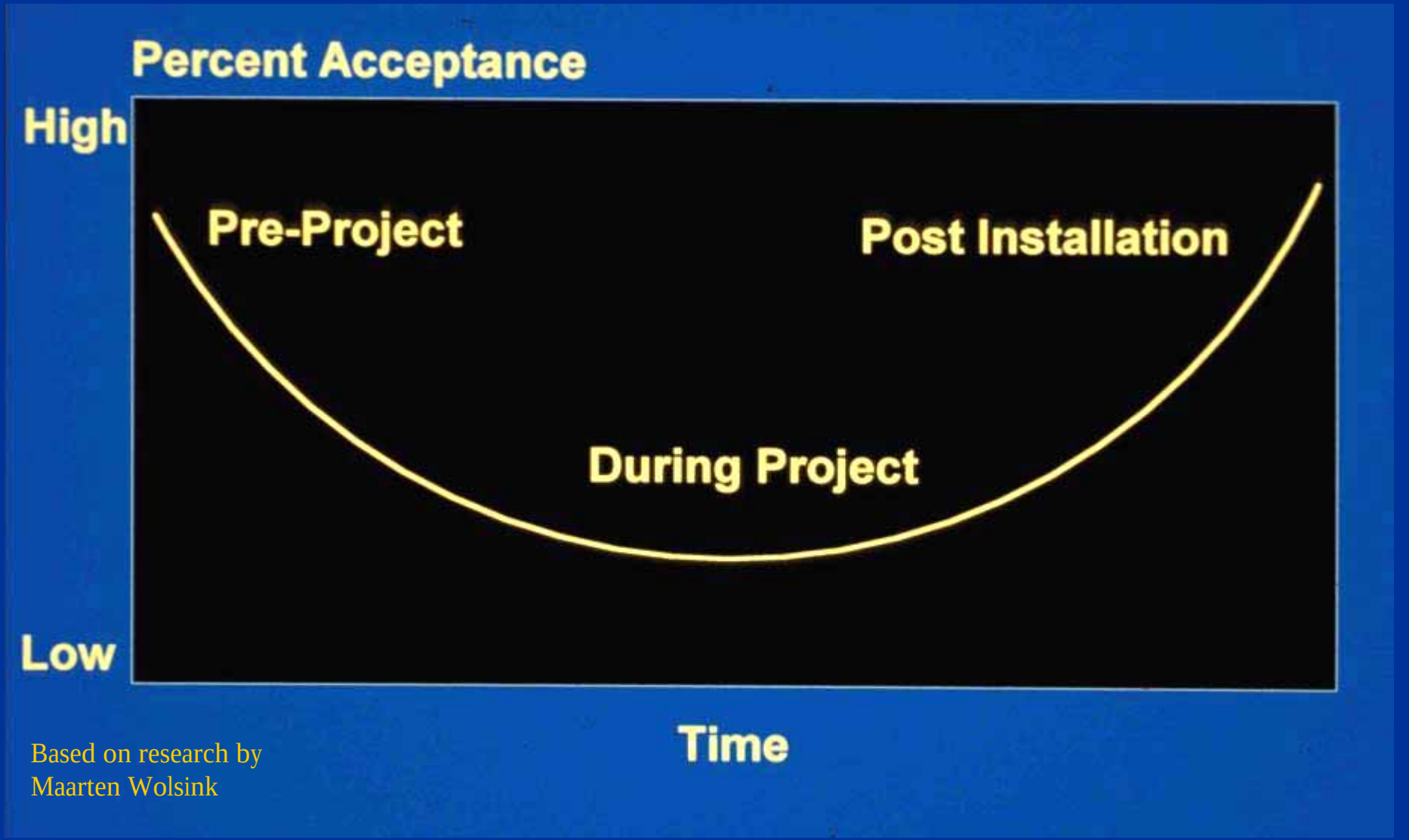
Visual Impacts – Palm Springs

Impacts Upon Isolated Homes – Palm Springs

Growing Acceptance

Wind Farm Tours

Sequence of Acceptance



Based on research by
Maarten Wolsink

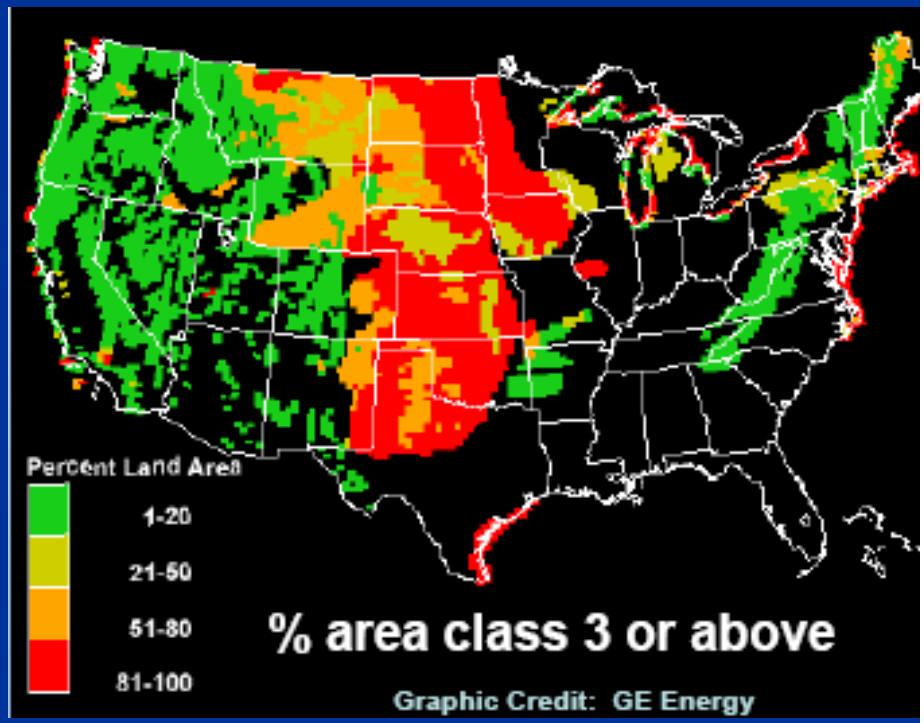
P.S.
That's not wind.
We're blowing you a kiss.
Love, Palm Springs
FAIRWAY

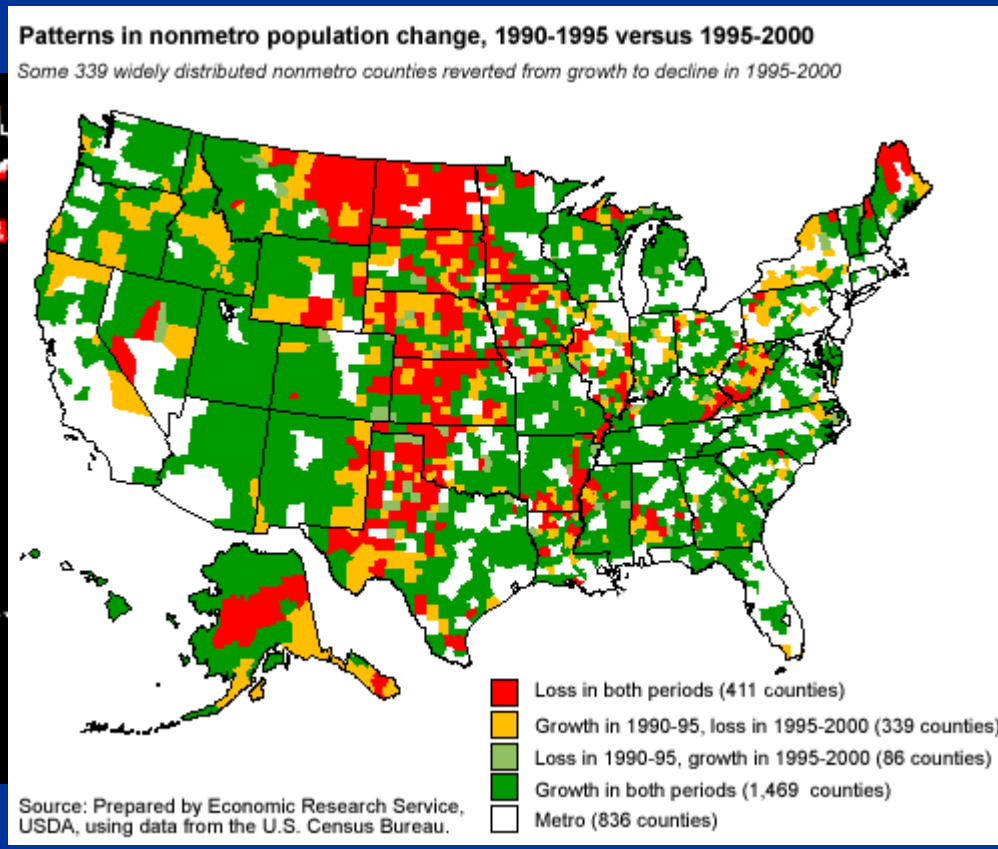
#3 - Solutions

1. Move from NIMBY → PIMBY
2. Recognize the “Morality” of Wind Energy Landscapes
3. Develop Compatibility Rankings

(PIMBY) Please In My BackYard

Windy Rural Areas Need Economic Development





Saving the Family Farm
Dixon, Illinois

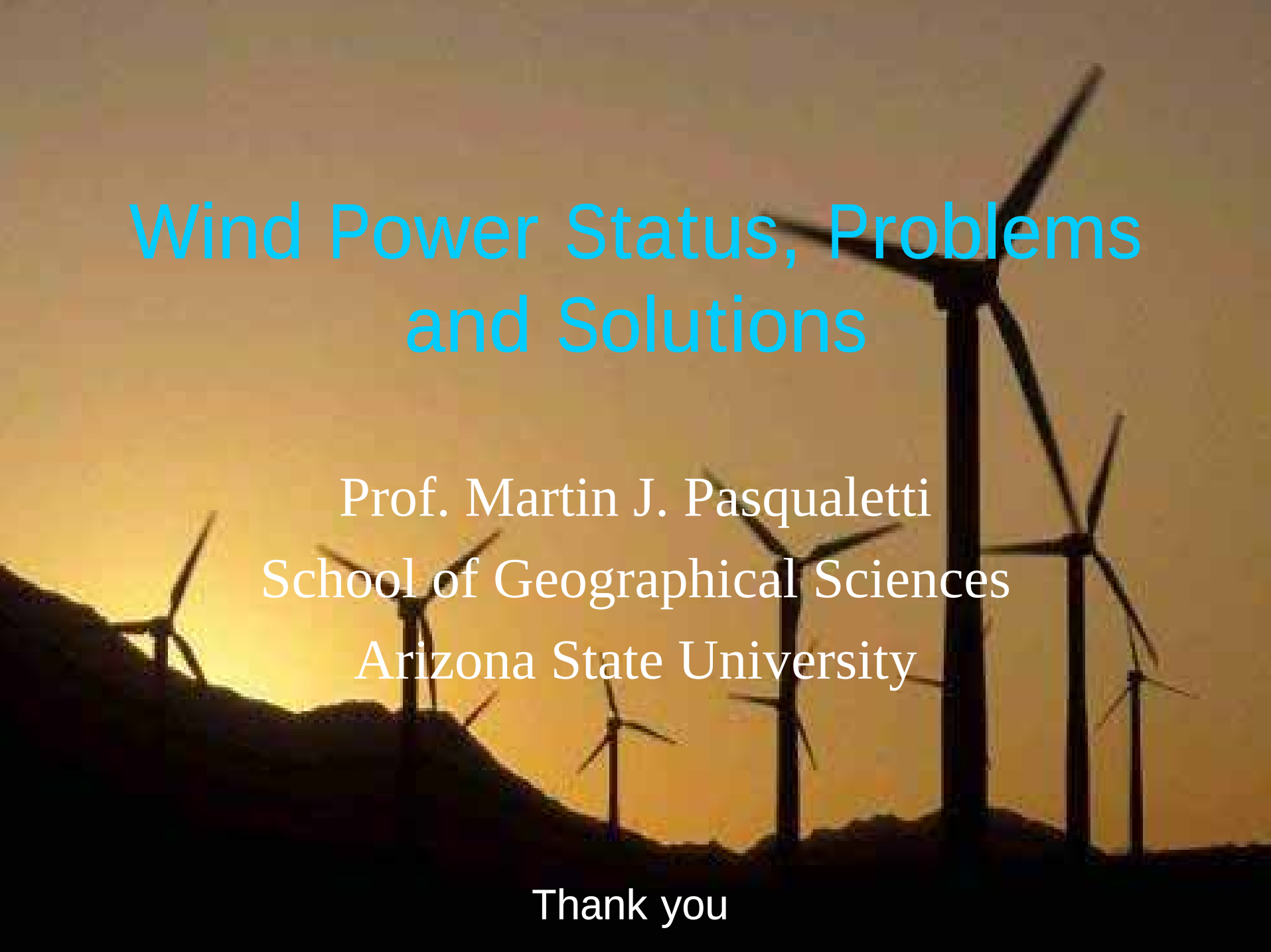
Revenues to farmers are $3-5,000 per turbine per year

2. The Morality of Wind Energy Landscapes

Wind Power Promotes Awareness of Energy Supplies

3. Develop Compatibility Rankings

- Rank #1 properties would be those where it is not only suitable but overtly requested for wind development, such as farms in Iowa or Kansas
- Rank #2 properties would likely be acceptable, such as in southeastern Washington
- Rank #3 properties might be acceptable in certain circumstances, such as near Palm Springs
- Rank #4 properties would be completely off-limits, for example, on the top of Mt. Rushmore



Wind Power Status, Problems and Solutions

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School of Geographical Sciences

Arizona State University

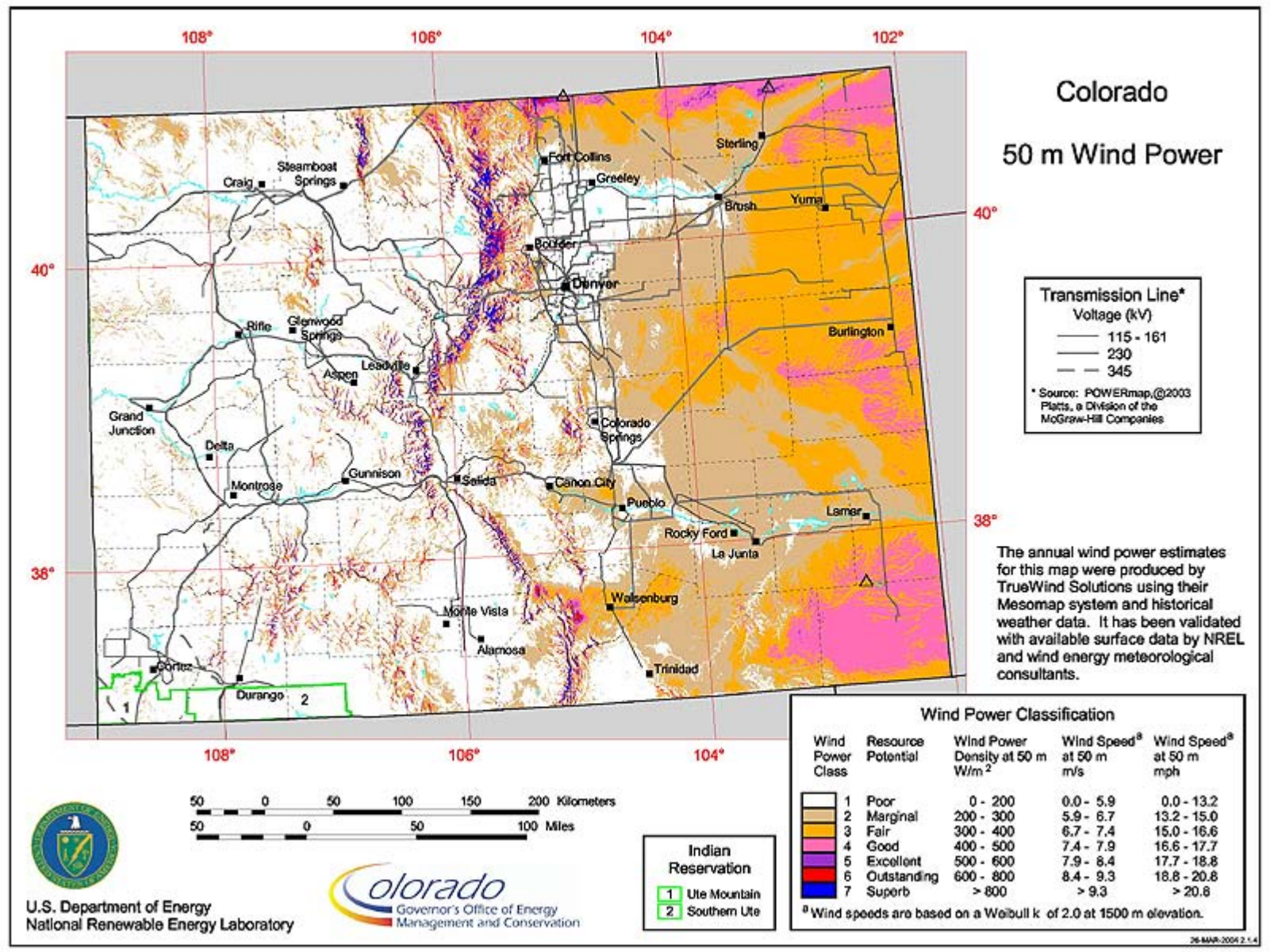
Thank you

Case Study: Prowers County, Colorado

- 162-MW Colorado Green Wind Farm (108 turbines)
- $200M+ investment
- 400 construction workers
- 14-20 full-time jobs
- Land lease payments $3000-$6000 per turbine
- **Prowers County 2002 assessed value $94M; 2004 assessed value +33% (+$32M)**
- **Local district will receive 12 mil tax reduction**
- Piggyback model

"Converting the wind into a much-needed commodity while providing good jobs, the Colorado Green Wind Farm is a boost to our local economy and tax base."

John Stulp, county commissioner, Prowers County, Colorado


Colorado
50 m Wind Power
108°
106°
104°
102°
40°
38°
Sterling
Fort Collins
Greeley
Craig
Steamboat Springs
Brush
Yuma
Boulder
Denver
Burlington
Rifle
Glenwood Springs
Leadville
Aspen
Grand Junction
Delta
Colorado Springs
Gunnison
Montrose
Salida
Canon City
Pueblo
Lamar
Rocky Ford
La Junta
Walsenburg
Monte Vista
Alamosa
Cortez
Durango
Trinidad
1
2
Transmission Line*
Voltage (kV)
115 - 161
230
345
* Source: POWERmap,@2003 Platts, a Division of the McGraw-Hill Companies
The annual wind power estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
Wind Power Classification
Wind Power Class | Resource Potential | Wind Power Density at 50 m W/m² | Wind Speed[a] at 50 m m/s | Wind Speed[a] at 50 m mph
1 Poor 0 - 200 0.0 - 5.9 0.0 - 13.2
2 Marginal 200 - 300 5.9 - 6.7 13.2 - 15.0
3 Fair 300 - 400 6.7 - 7.4 15.0 - 16.6
4 Good 400 - 500 7.4 - 7.9 16.6 - 17.7
5 Excellent 500 - 600 7.9 - 8.4 17.7 - 18.8
6 Outstanding 600 - 800 8.4 - 9.3 18.8 - 20.8
7 Superb > 800 > 9.3 > 20.8
[a] Wind speeds are based on a Weibull k of 2.0 at 1500 m elevation.
50 0 50 100 150 200 Kilometers
50 0 50 100 Miles
Indian Reservation
1 Ute Mountain
2 Southern Ute
U.S. Department of Energy
National Renewable Energy Laboratory
Colorado
Governor's Office of Energy Management and Conservation
26-MAR-2004 2.1.4

Benefits of Wind Power
Lamar, CO

Summary of Wind's Benefit to Prowers County

- $764,000/year: new county revenues
- $917,000/year: School General Fund
- $203,000/year: School Bond Fund
- $189,000/year: Prowers Medical Center
- 29% Increase in County Tax Base
- Tremendous Support from Community

Courtesy: Craig Cox