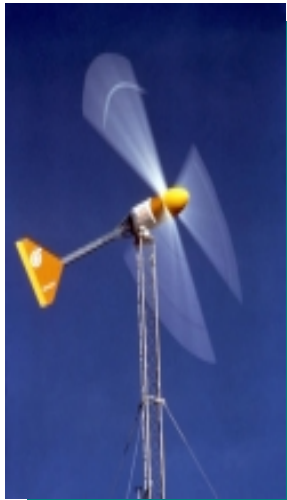


Wind Power Update

Larry Flowers – NREL

Sizes and Applications



Small (≤ 10 kW)

- Homes
- Farms
- Remote Applications

(e.g. water pumping,
telecom sites,
icemaking)



Intermediate (10-250 kW)

- Village Power
- Hybrid Systems
- Distributed Power

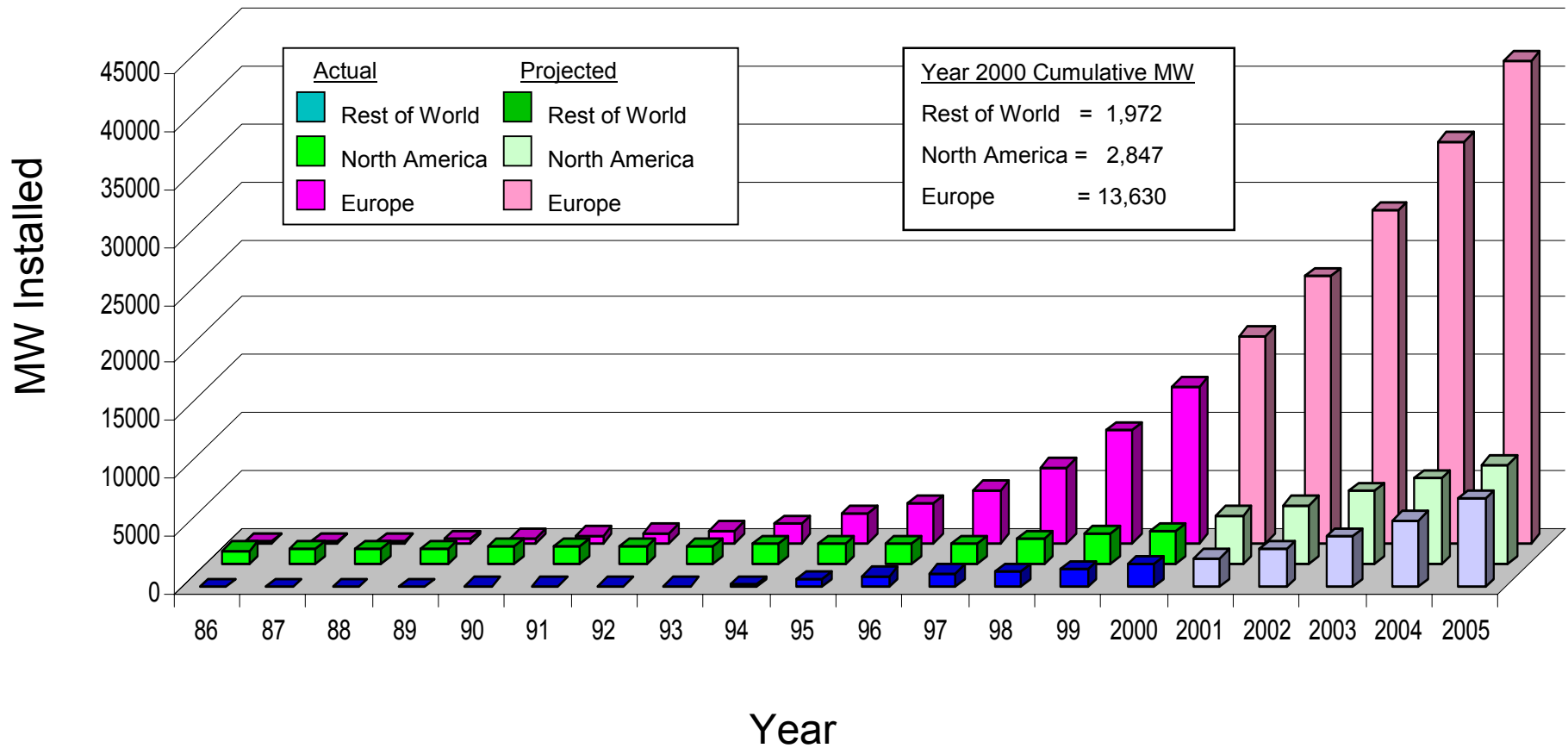


Large (250 kW - 2+MW)

- Central Station Wind Farms
- Distributed Power



Growth of Wind Energy Capacity Worldwide



Source: BTM Consult Aps - March 2001



International Market Trends

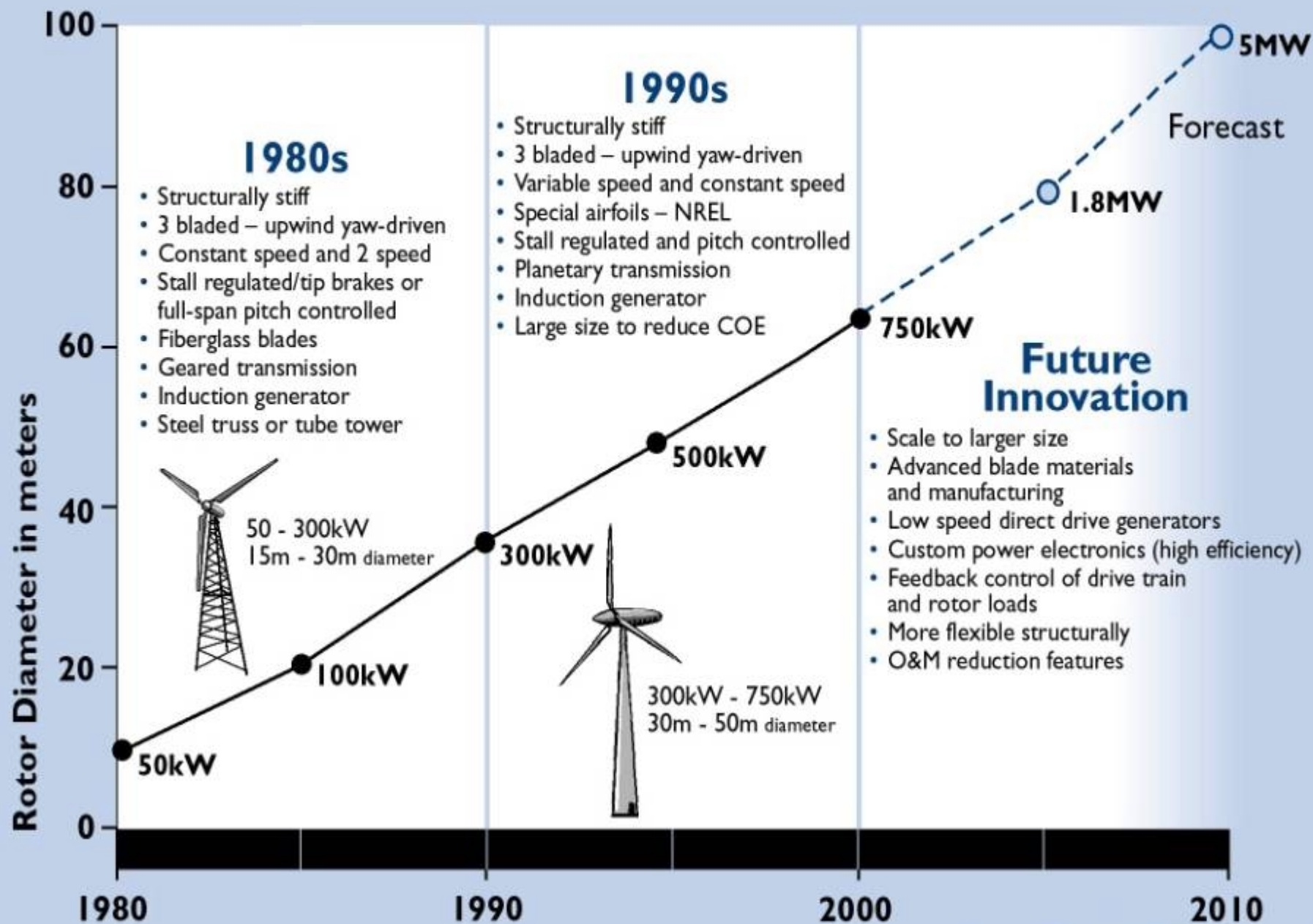


- \$5 billion/year in sales
- Fastest growing electric technology: 29% worldwide
- 45% world market from Danish companies
- European future in off-shore open installations
 - **86 MW in 2000**
 - **Growing to 2400 MW's in 2005***

**Source BTM Consult ApS - March 2001*



THE EVOLUTION OF COMMERCIAL U.S. WIND TECHNOLOGY



Cost of Energy Trend

1979: 40 cents/kWh

**2000:
4 - 6 cents/kWh**

- Increased Turbine Size
- R&D Advances
- Manufacturing Improvements



NSP 107 MW Lake Benton wind farm
4 cents/kWh (unsubsidized)

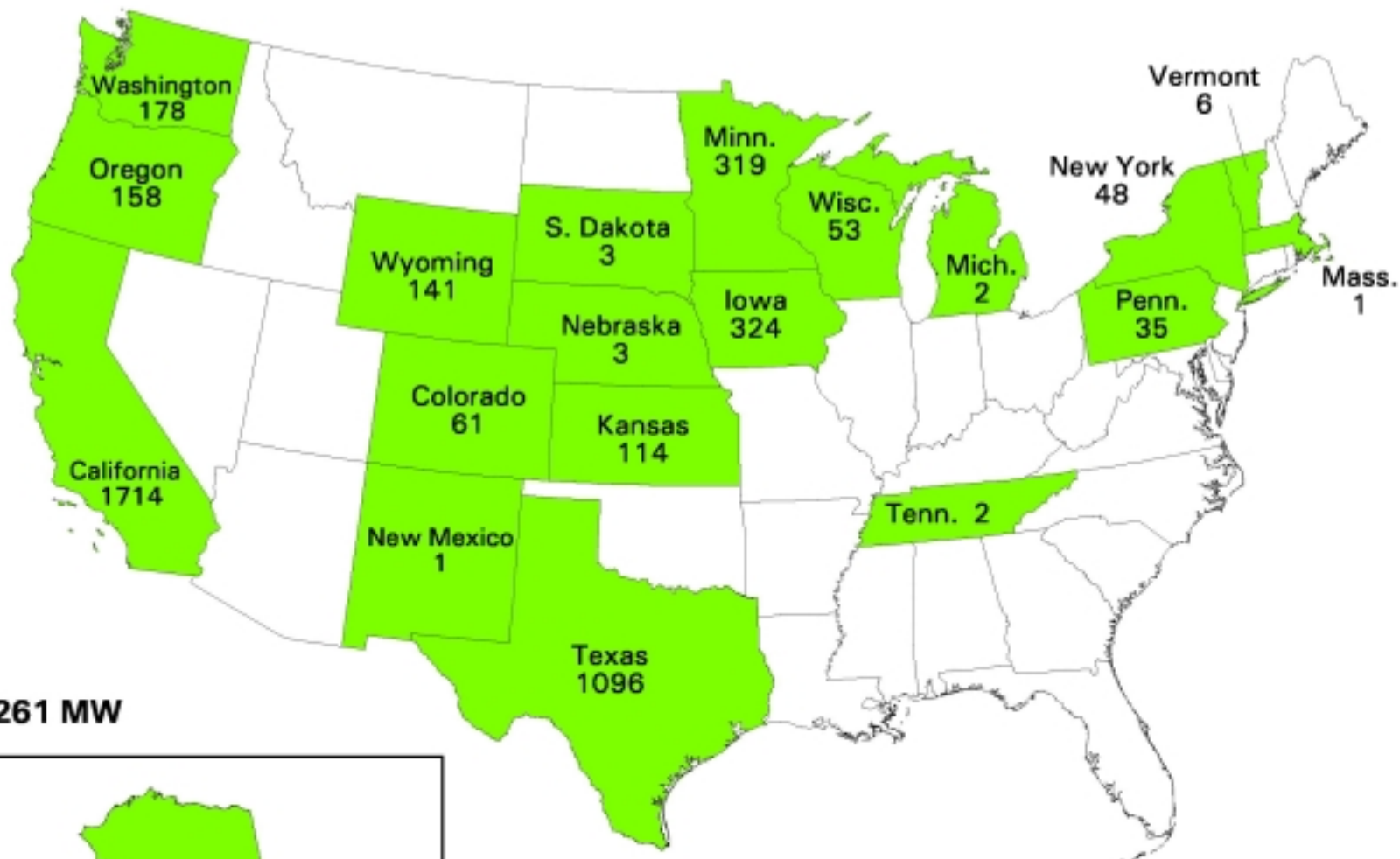
**2004:
3 - 5 cents/kWh**

A Maturing Wind Technology

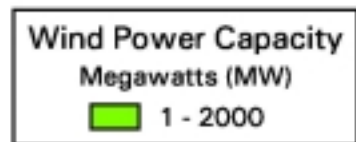


- Technology has matured over 25 years of learning experiences
- Availabilities reported of 98-99%
- Certification to international standards helps to avoid “show stoppers”
- Performance and cost have dramatically improved
 - hardware issues are being promptly addressed
- New hardware is being developed on multiple fronts:
 - higher productivity and lower costs
 - larger sized for both land and off-shore installations
 - tailored designs for high capacity factor, low wind speed and extreme weather conditions

United States - 2001 Wind Capacity (MW)



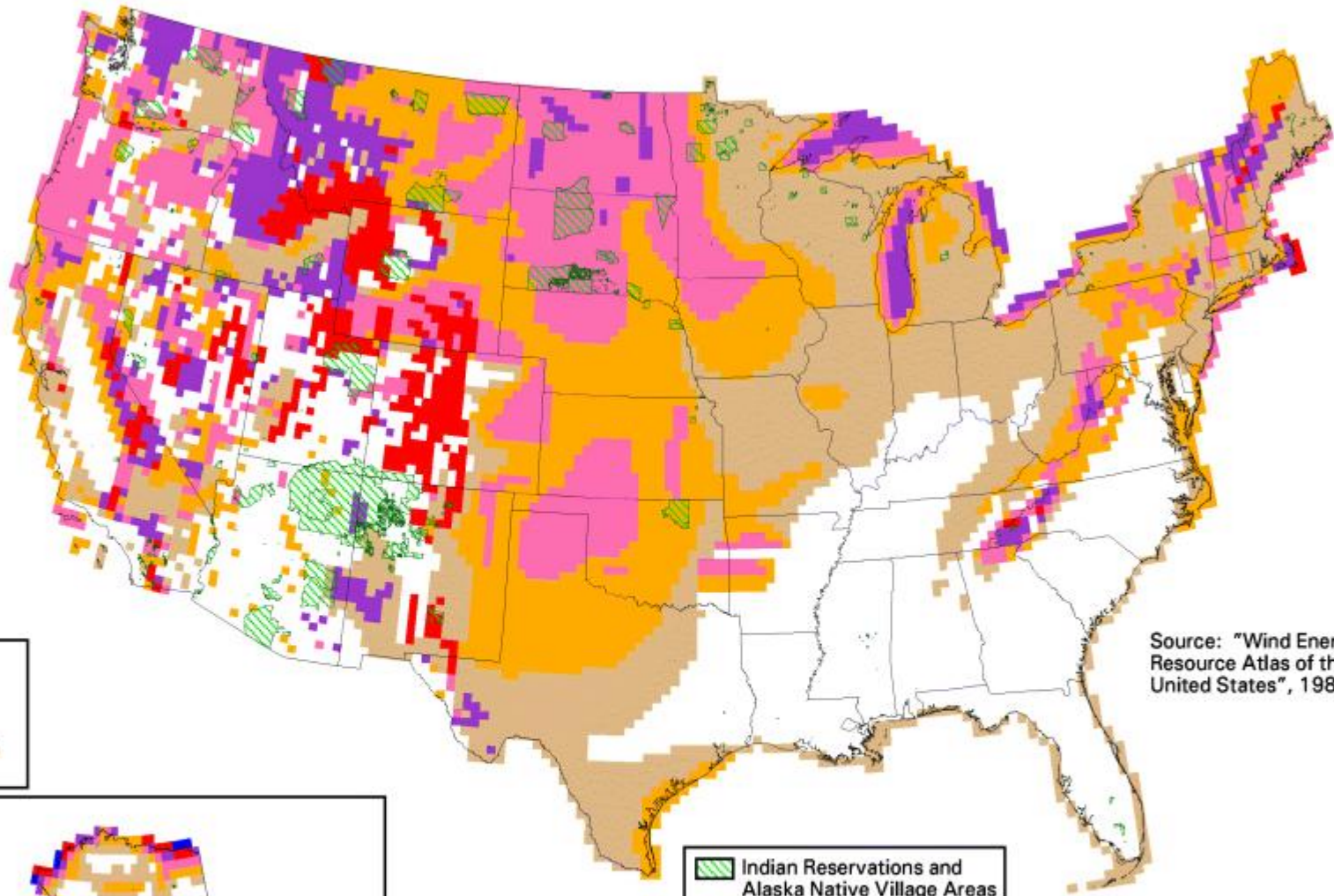
Total: 4,261 MW



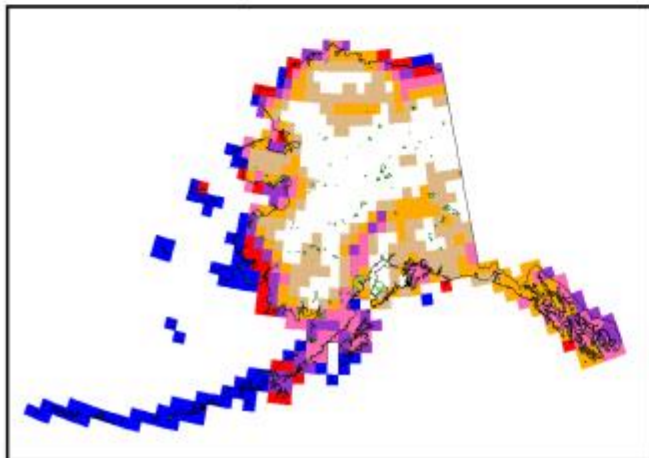
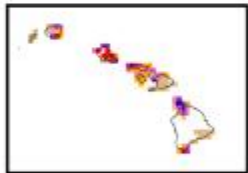
U.S. Department of Energy
National Renewable Energy Laboratory










United States - Wind Resource Map



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



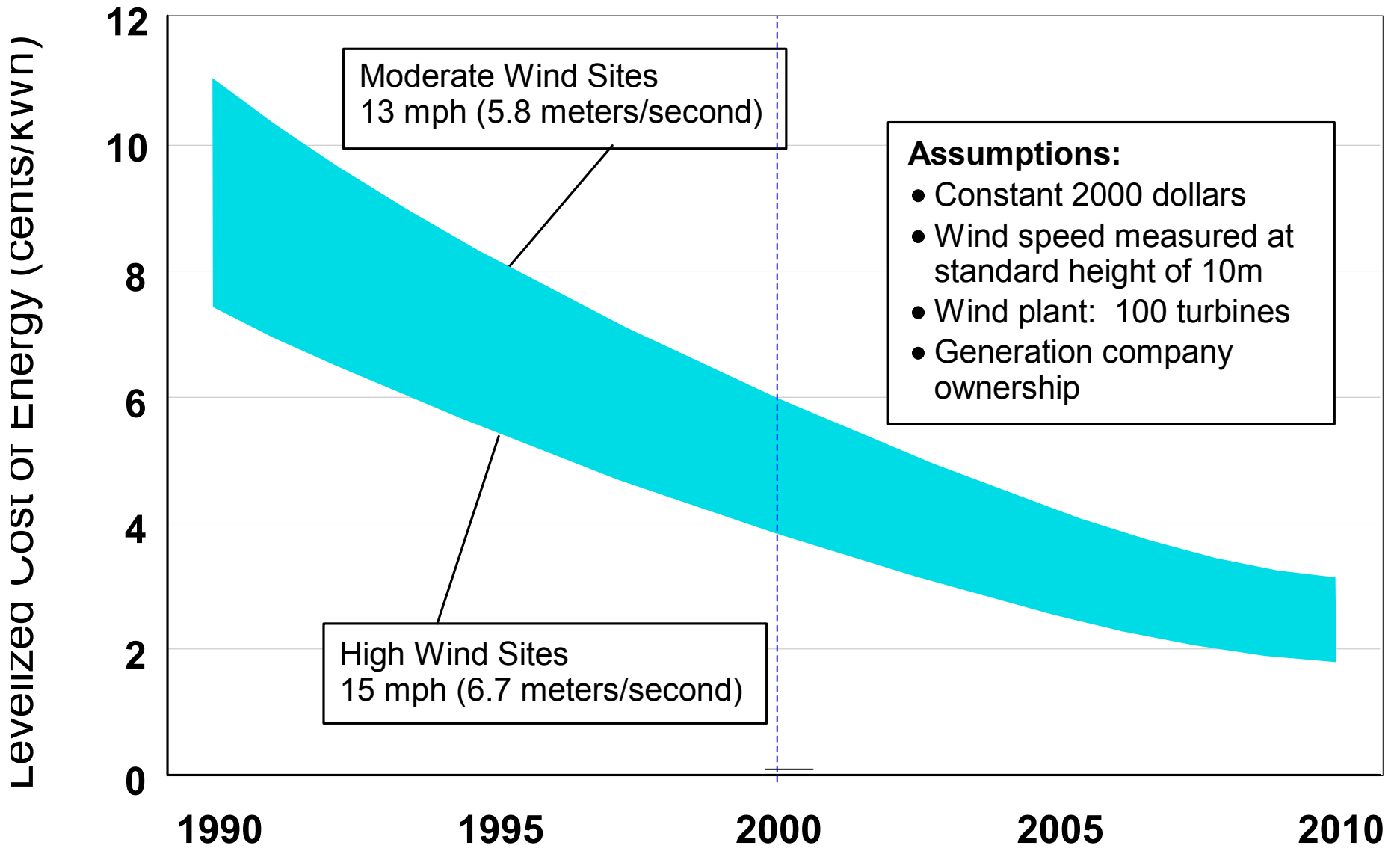
 Indian Reservations and Alaska Native Village Areas

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

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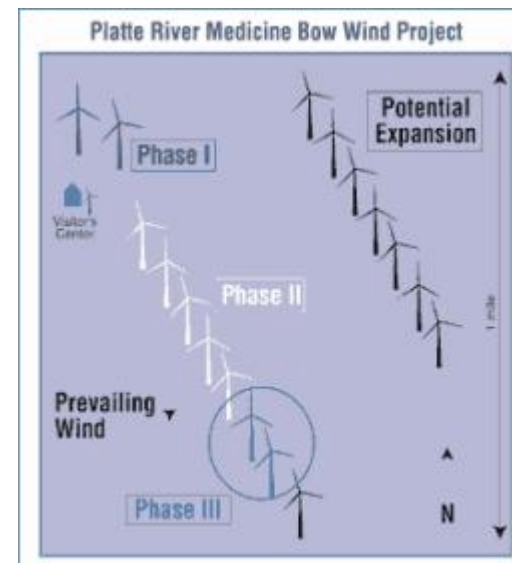
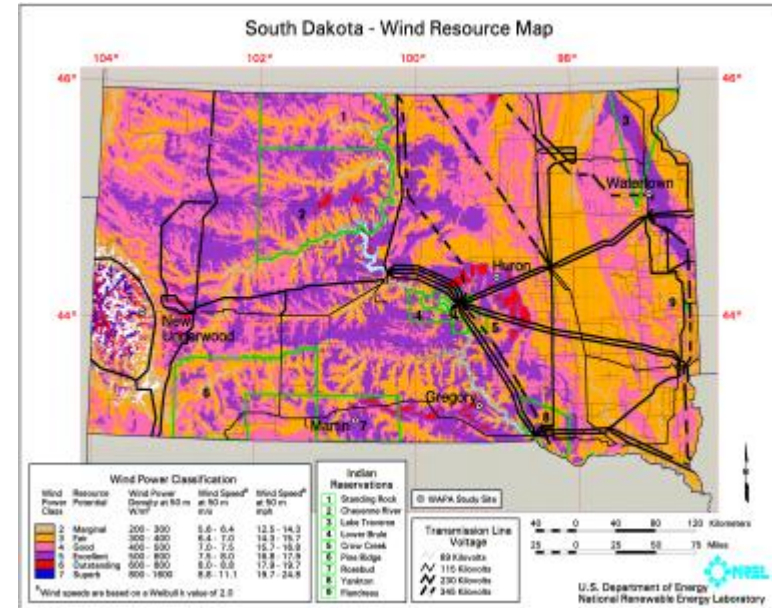




But... *It really depends*

Location, Location, Location

- Resource
 - 1 mph in average speed is ~ 0.5 cents/kWh
 - Raising tower from 50 to 100m increases kWh ~15% or more in class 4-5
 - Coincidence of wind with load increases value
- Permitting
 - private vs. public land
 - state and local regulations
- Existing site expansion
 - quick, low cost option
- What is included
 - transmission, land



Plant and Turbine Size

- Spread “nearly fixed” costs: permitting, crane, legal and other soft costs
- Volume discount from manufacturer
- Economies of scale may bring O&M to under 0.2 cents/kWh
- Next generation of 1.2-2.0 MW machines are 10-15% cheaper/kWh





Finances and Incentives

- Production Tax Credit
 - 1.7 cents/kWh (escalating) for 10 years equates to around 1.1 cents/kWh reduction in contract price
 - deadline pressure *increases* costs
- State and Local tax, etc. can be significant
 - +/- 0.5 cents/kWh impact
- Public Power (100% debt at tax free rates)
 - 60% of GenCo or IPP cents/kWh
- Renewable Energy Production Incentive
 - annual appropriations problem leads to little impact





Wind Energy Value



- Emissions free power beginning to have additional value
 - green markets
 - emissions credits
- Reliability/capacity value
- Fuel/Resource diversity and risk
- Intermittency
 - non-dispatchable (different types of kWh)
 - ancillary service costs ??



Recent Developments

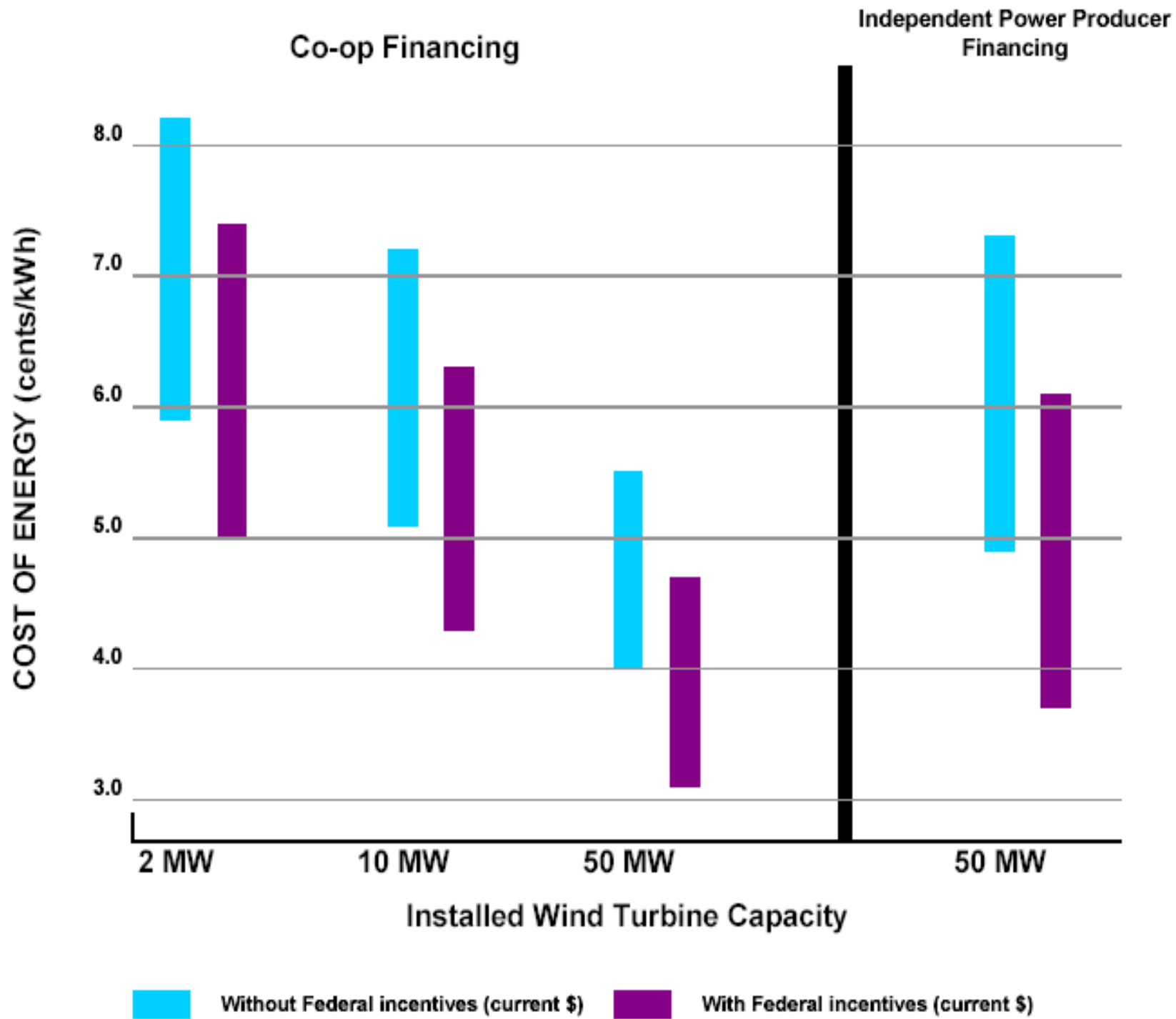
- The wind industry is delivering ~3 cent/kWh contracts, including PTC for large projects
- Several large projects under developments
 - 300 MW Stateline (WA/OR)
 - 109 MW Utilicorp (KS)
 - 4 >100 MW under development in West Texas
- Gas price increases and the power crisis
 - CO: 162 MW of wind wins all-source bid on economics alone
 - “wind is the lowest cost resource”
 - serious consideration of GW (BPA, Austin)
 - transmission and grid impacts to the forefront
- RUS loan to Basin Electric for Green Pricing program in S. Dakota
- NPPD RFP for 20 MW



Conclusions

- The wind industry is delivering ~ 3 cent/kWh contracts, including PTC for large projects
- This price will likely be higher for small projects in new locations
- Value side important: but cost dominates in domestic markets today







Economic Development Opportunities

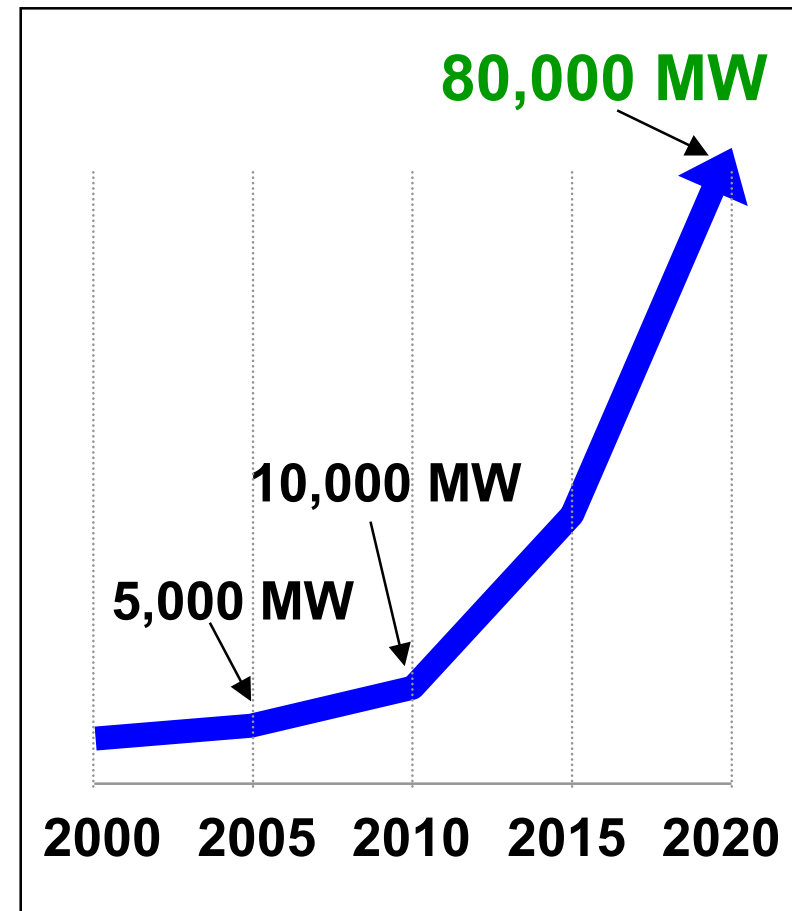
- Land Lease Payments: 2-3% of gross revenue
\$2500-4000/MW/year
- Local property tax revenue: 100 MW brings in on the order of \$1 million/yr
- 1-2 jobs/MW during construction
- 2-5 permanent O&M jobs per 50-100 MW,
- Local construction and service industry: concrete, towers usually done locally
- Investment as Equity Owners: production tax credit, accelerated depreciation
- Manufacturing and Assembly plants expanding in U.S. (Micon in IL, LM Glasfiber in ND)



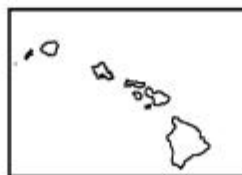
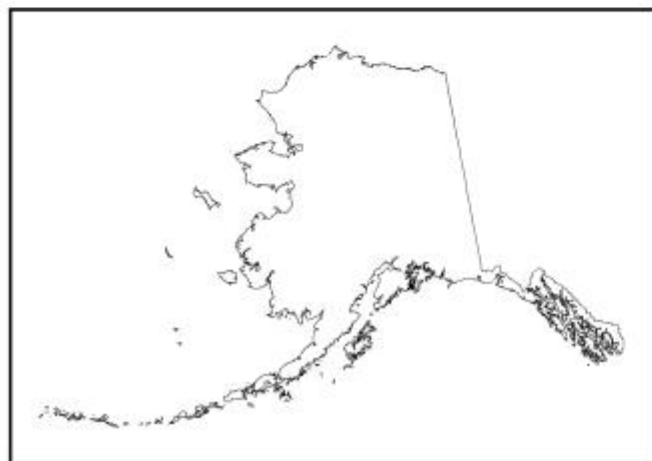
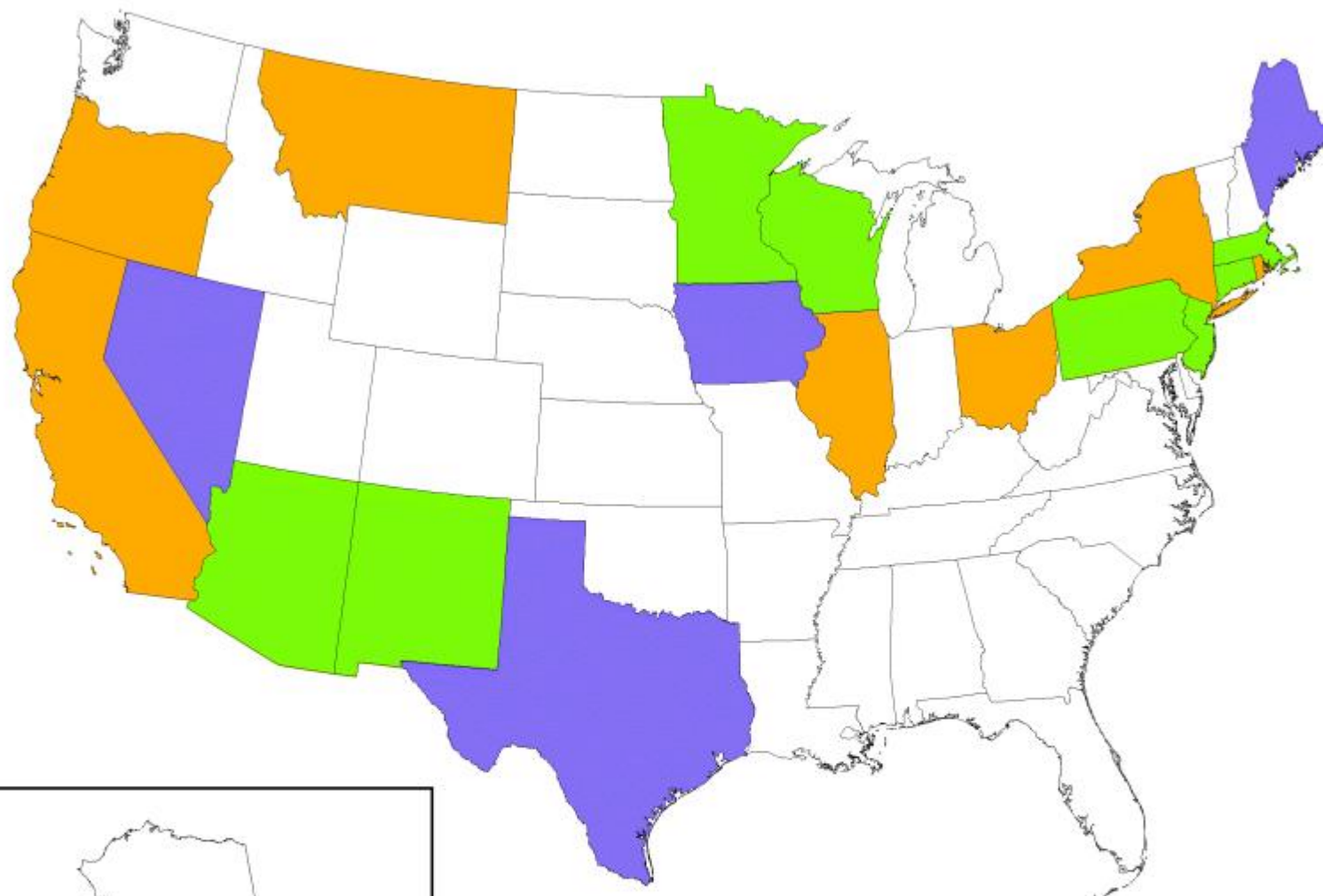





Goals

- Provide at least 5% of the nation's electricity with wind by 2020
 - Install more than 5000 MW by 2005
 - Have more than 10,000 MW on-line by 2010
- Double the number of states that have more than 20 MW of wind capacity to 16 by 2005, and triple the number to 24 by 2010
- Increase wind's contribution to federal electricity use to 5% by 2010
- Supplemental goals
 - Federal agencies-2.5% RE by 2005; 7 1/2% by 2010



United States - State with Renewable Energy Policies

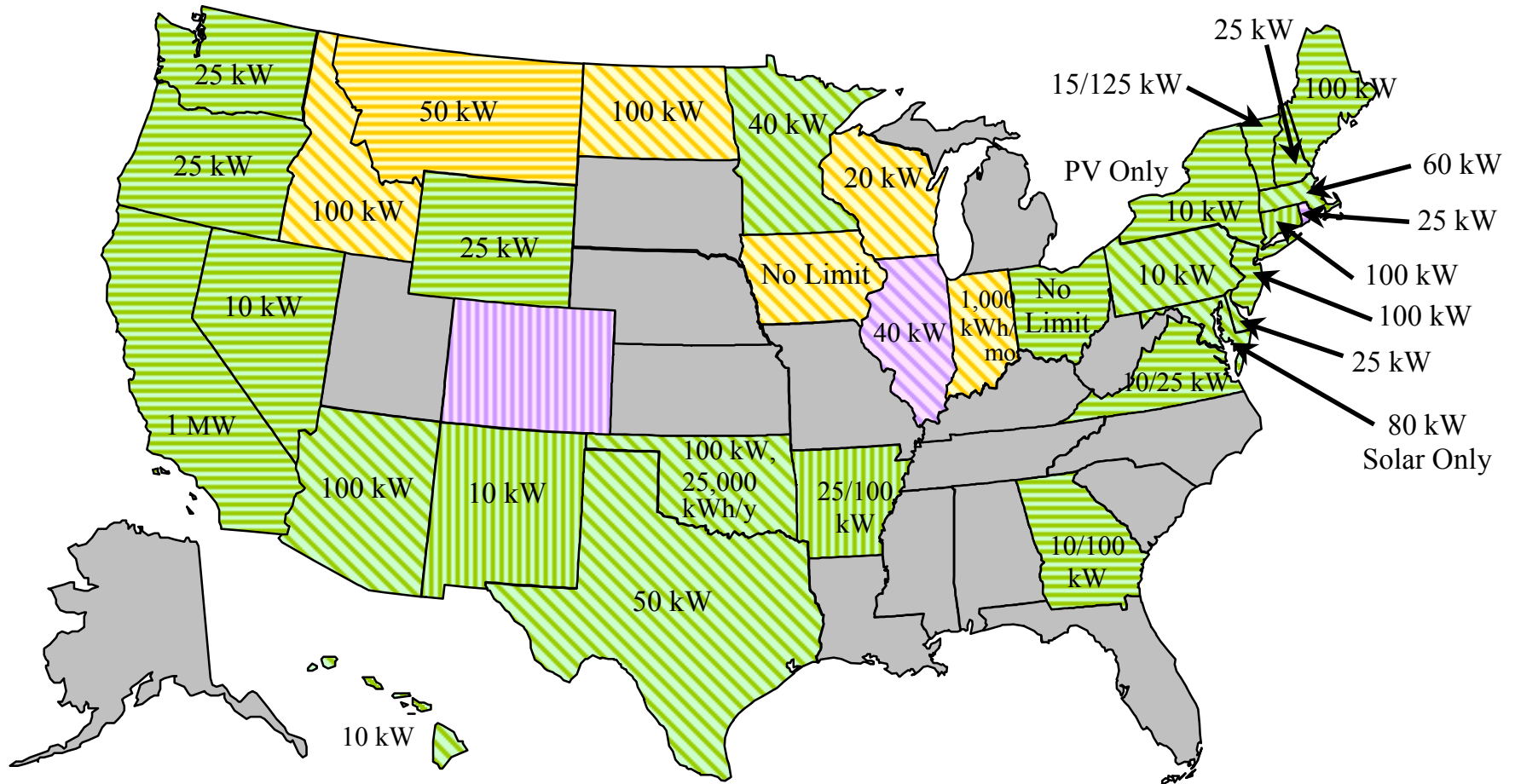








-  System Benefit Charges
-  Renewable Portfolio Standard
-  Both SBC and RPS

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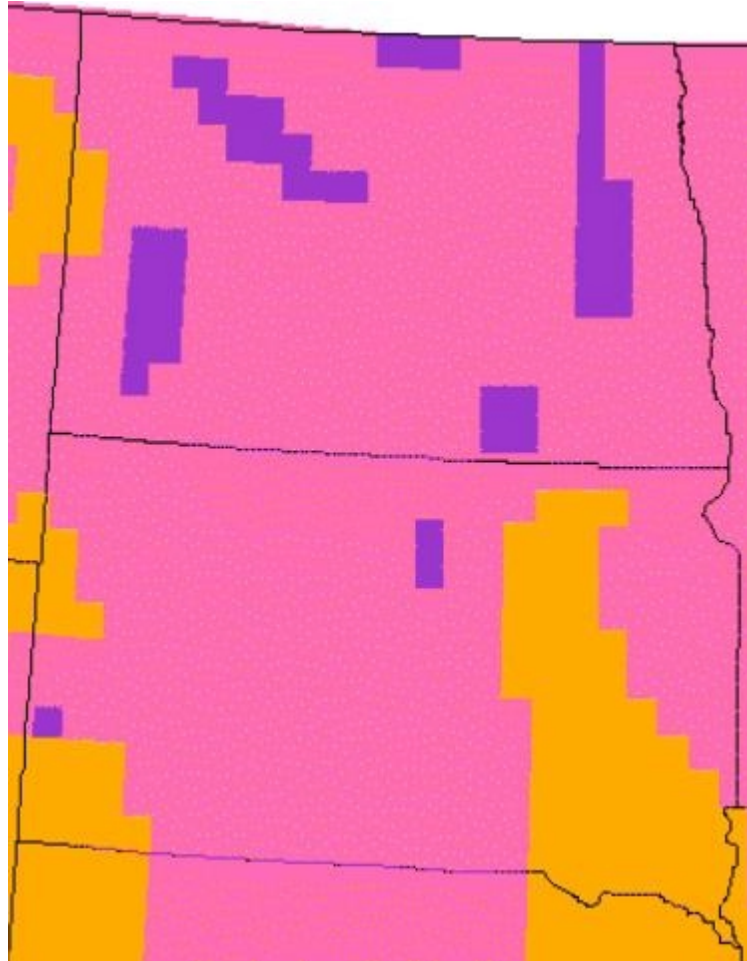
Net Metering By State



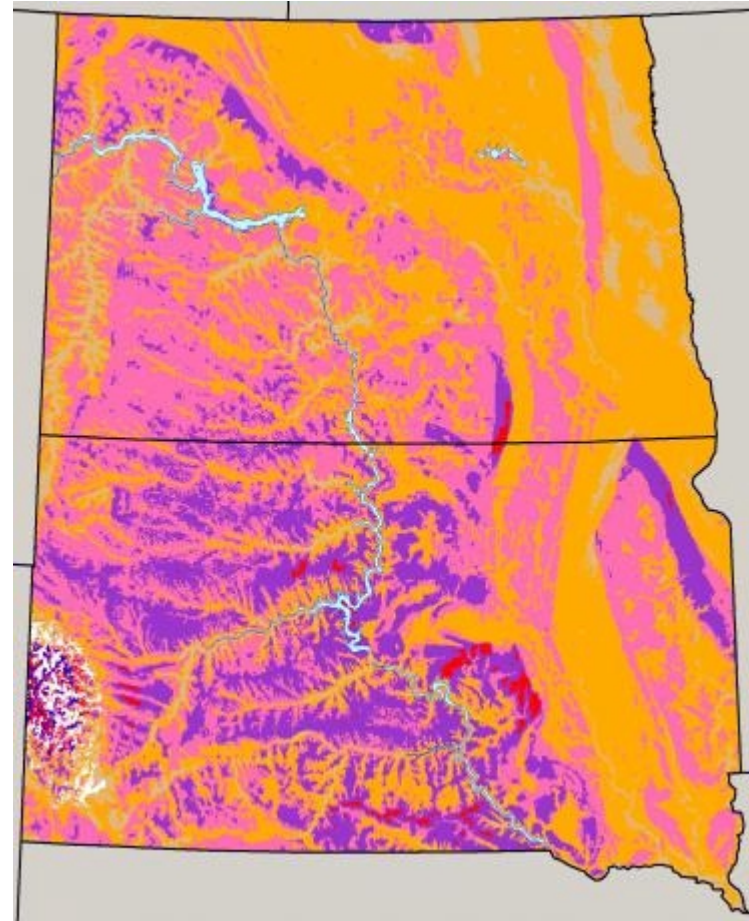
- | | |
|--|--|
|  Monthly Net Metering |  None |
|  Annual Net Metering |  Individual Utilities |
|  Varies by Utility or Unknown |  Investor-Owned Utilities Only, <u>Not</u> Rural Cooperatives |
| |  Investor-Owned Utilities <u>and</u> Rural Cooperatives |

Revised: 9 Jan 02

Comparison of Digital Wind Map from 1987 U.S. Wind Atlas and New (2000) High-Resolution (1-km²) Wind Map North and South Dakota



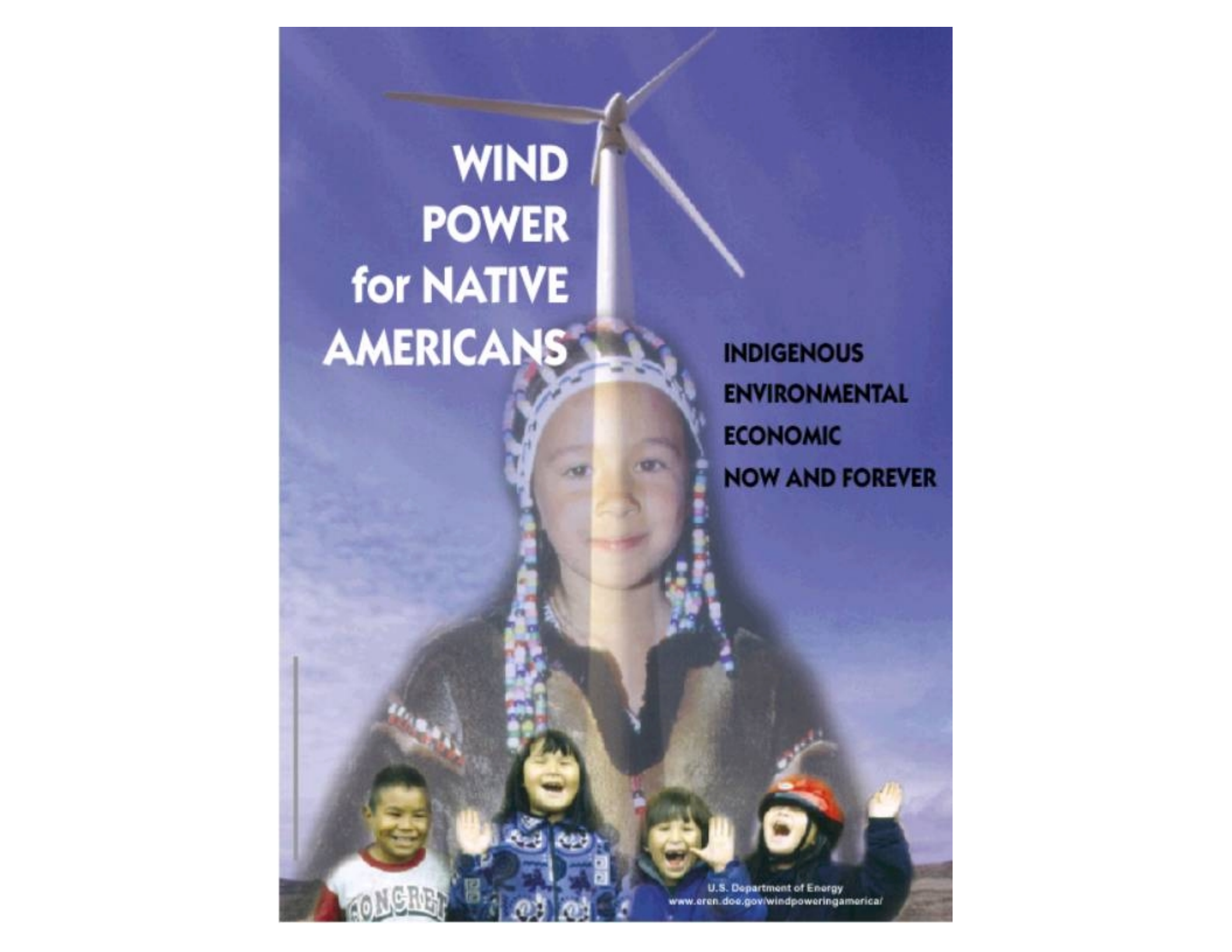
1987



2000

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^a Wind speeds are based on a Weibull k value of 2.0

A composite image featuring a wind turbine, a Native American woman in traditional dress, and four children in the foreground. The wind turbine is positioned at the top, with its blades extending across the top of the frame. The Native American woman is the central figure, wearing a traditional headdress with colorful beads and a dark, patterned garment. The four children are at the bottom, smiling and waving. The background is a clear blue sky.

**WIND
POWER
for NATIVE
AMERICANS**

**INDIGENOUS
ENVIRONMENTAL
ECONOMIC
NOW AND FOREVER**



WIND POWERING AMERICA

Wind Powering America

Wind Powering America

Regional Activities

Native Americans

Public Power



Wind Powering America is a commitment to dramatically increase the use of wind energy in the United States. This initiative will establish new sources of income for American farmers, Native Americans, and other rural landowners, and meet the growing demand for clean sources of electricity.

Through Wind Powering America, the United States will achieve targeted regional economic development, protect the local environment, reduce air pollution, lessen the risks of global climate change, and increase energy security.



Learn about Wind Powering America events happening in your area by visiting the [regional activities page](#) and [calendar](#).

What is Wind Power?
Where is Wind Power?
How do I get Wind Power?

WPA Highlights
[Native American Workshop](#)
[Oklahoma Workshop](#)

Business Information
[Department of Energy](#)
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Wind Turbine Photos

Send your comments to the [Wind Powering America Webmaster](#).