

Wind Energy: Technology, Markets, Economics and Stakeholders

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



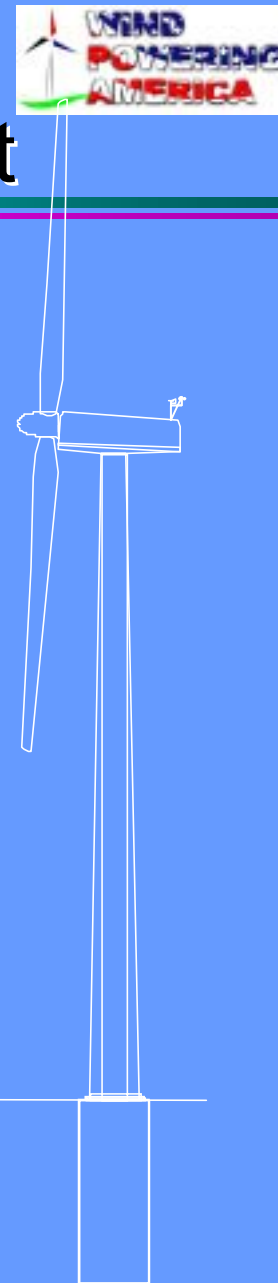
Large (250 kW - 2+MW)

- Central Station Wind Farms
- Distributed Power

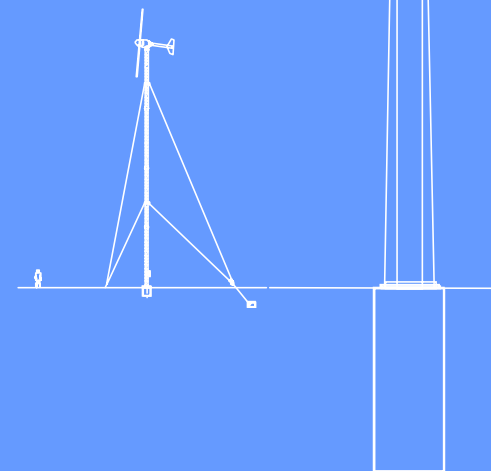
Small Wind Turbines are Different

- Large Turbines (600-1800 kW)
 - Installed in Windfarms, 10 - 100 MW
 - Provide Low Cost Power to the Grid
 - < \$1,000/kW
 - Require 6 m/s (13 mph) Average Wind Speeds
- Small Turbines (0.3-50 kW)
 - Installed Off-Grid or at On-Grid Facilities
 - \$2,000-6,000/kW
 - Designed for Reliability / Low Maintenance
 - Require 4 m/s (9 mph) Average

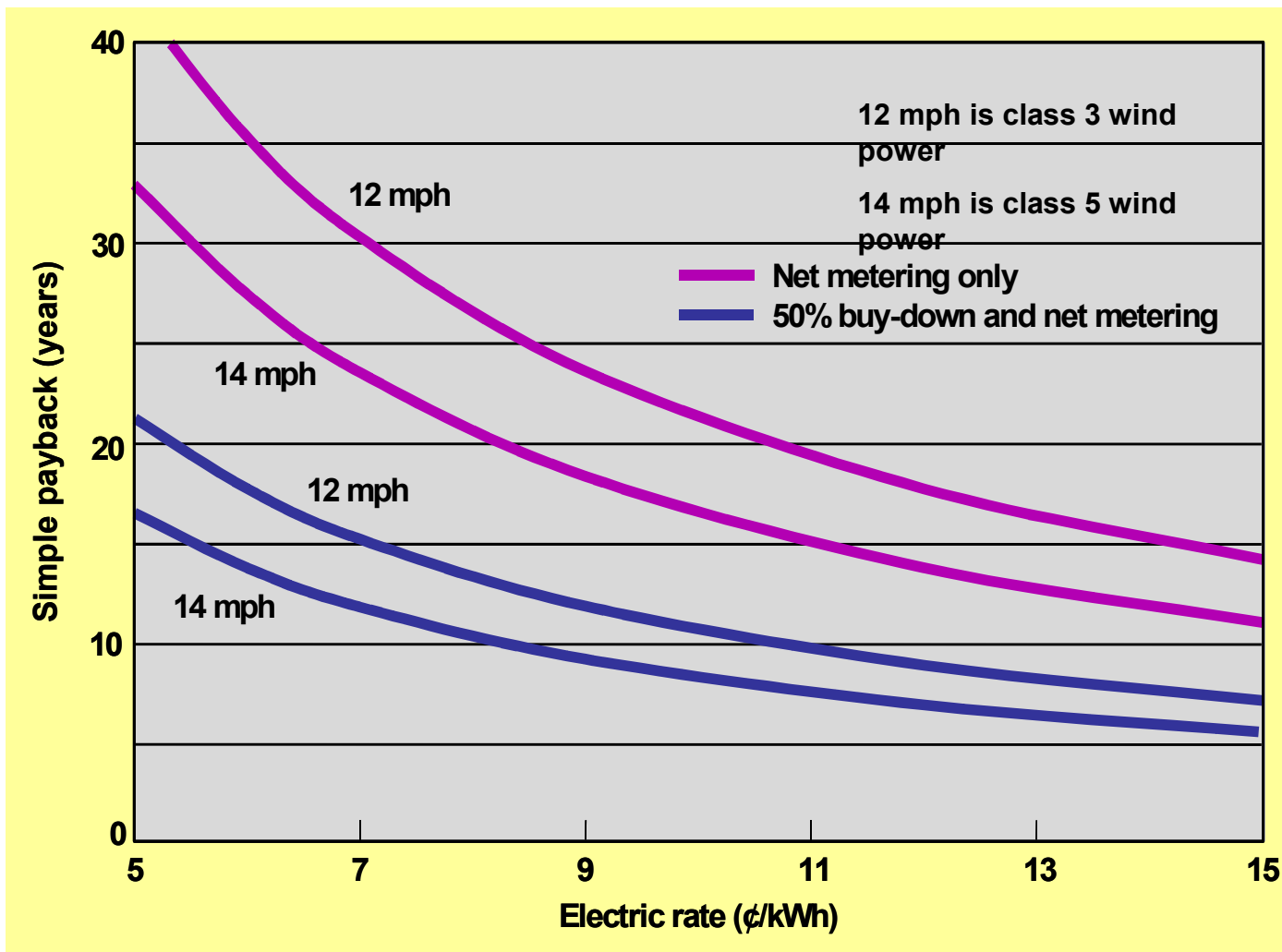
1,500 kW
Wind
Turbine



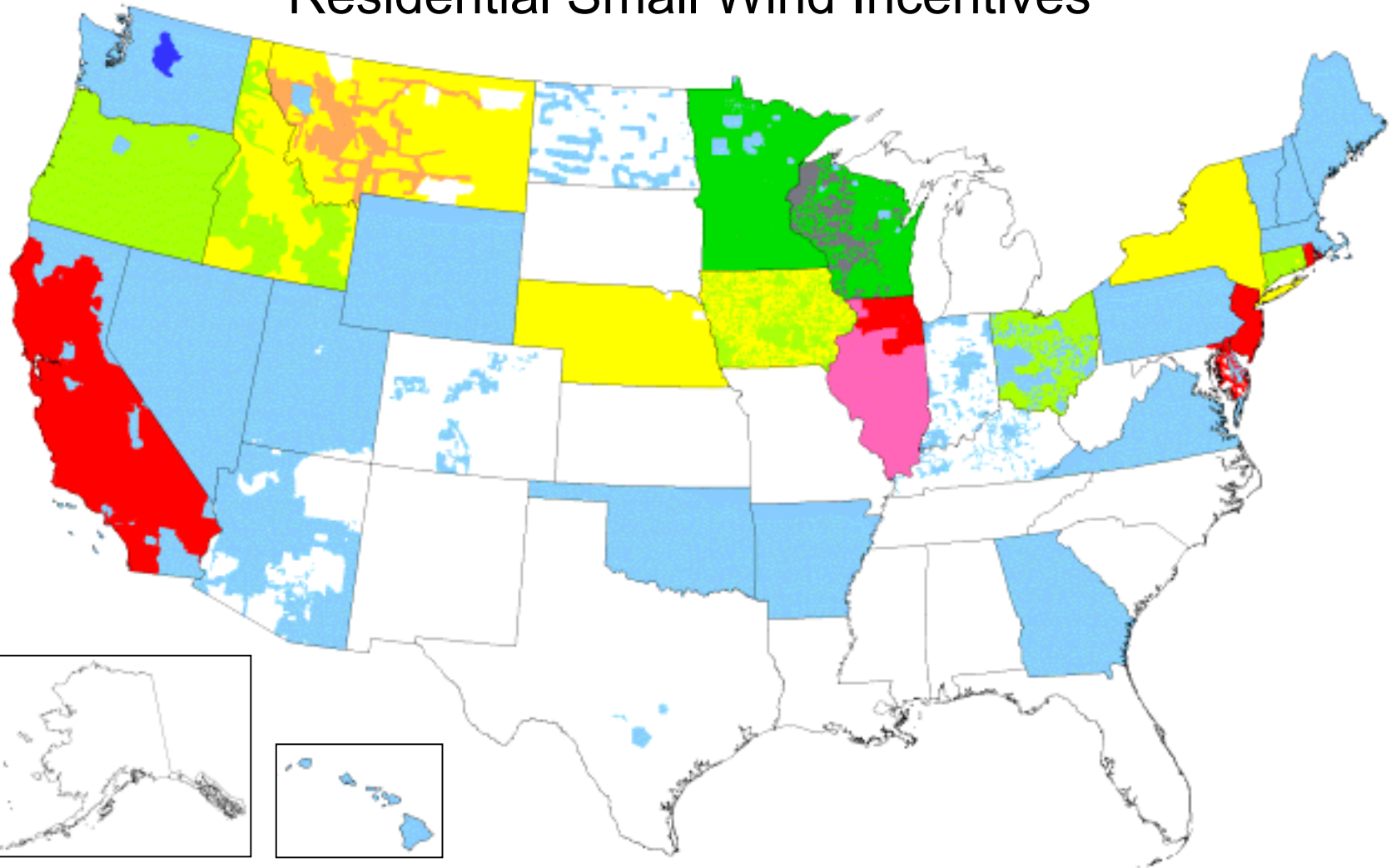
10 kW
Wind
Turbine



Incentives Make Small Wind Systems More Economical



Residential Small Wind Incentives



 Buydown
  Net Metering
  Loans
  Productivity Incentives
  Loans & Prod. Incentives*

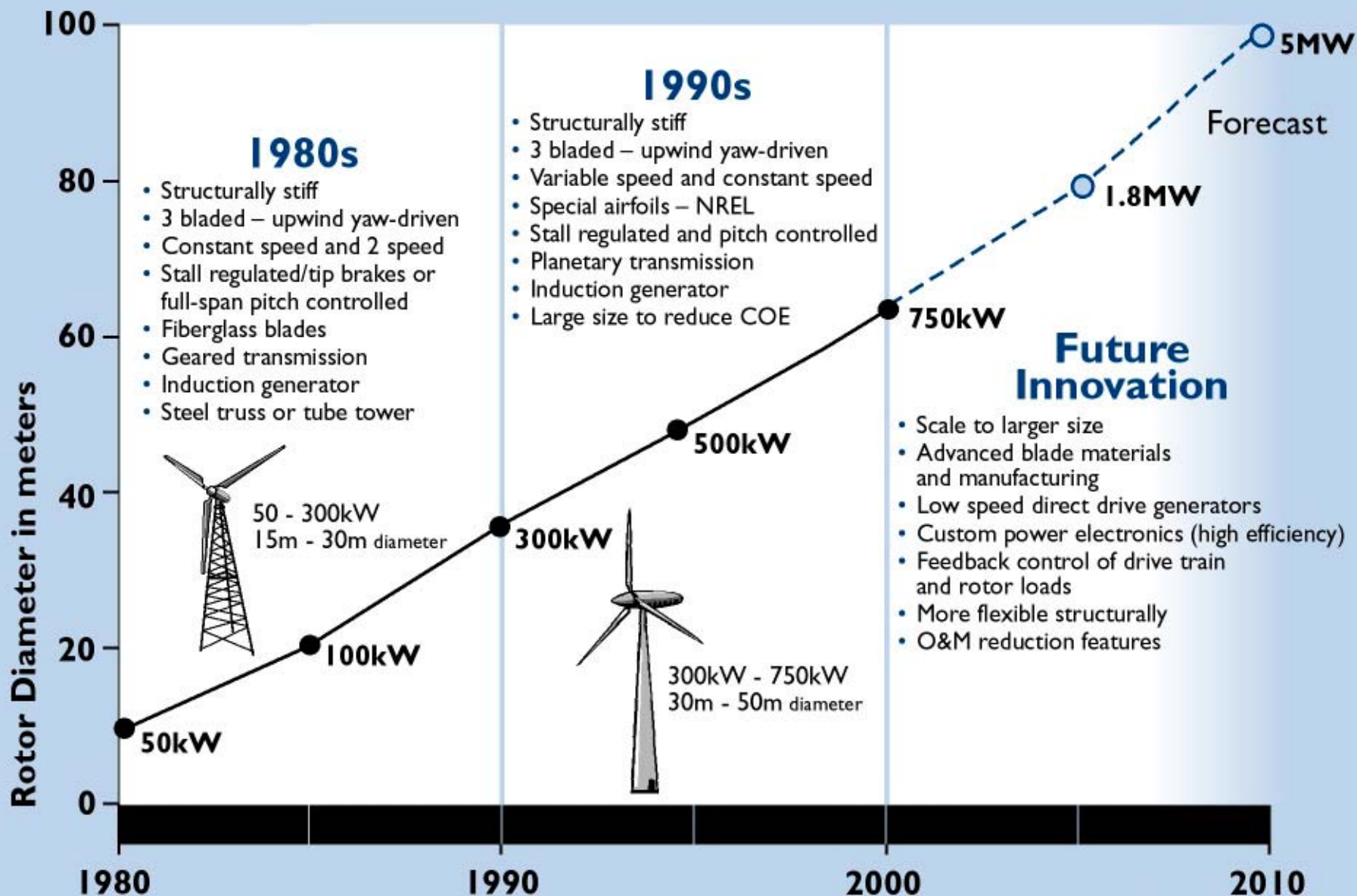
 Buydown & Net Metering
  Buydown & Loans
  Net Metering & Loans
  Net Metering & Prod. Incentives

*In Minnesota, loans apply only to farmers.

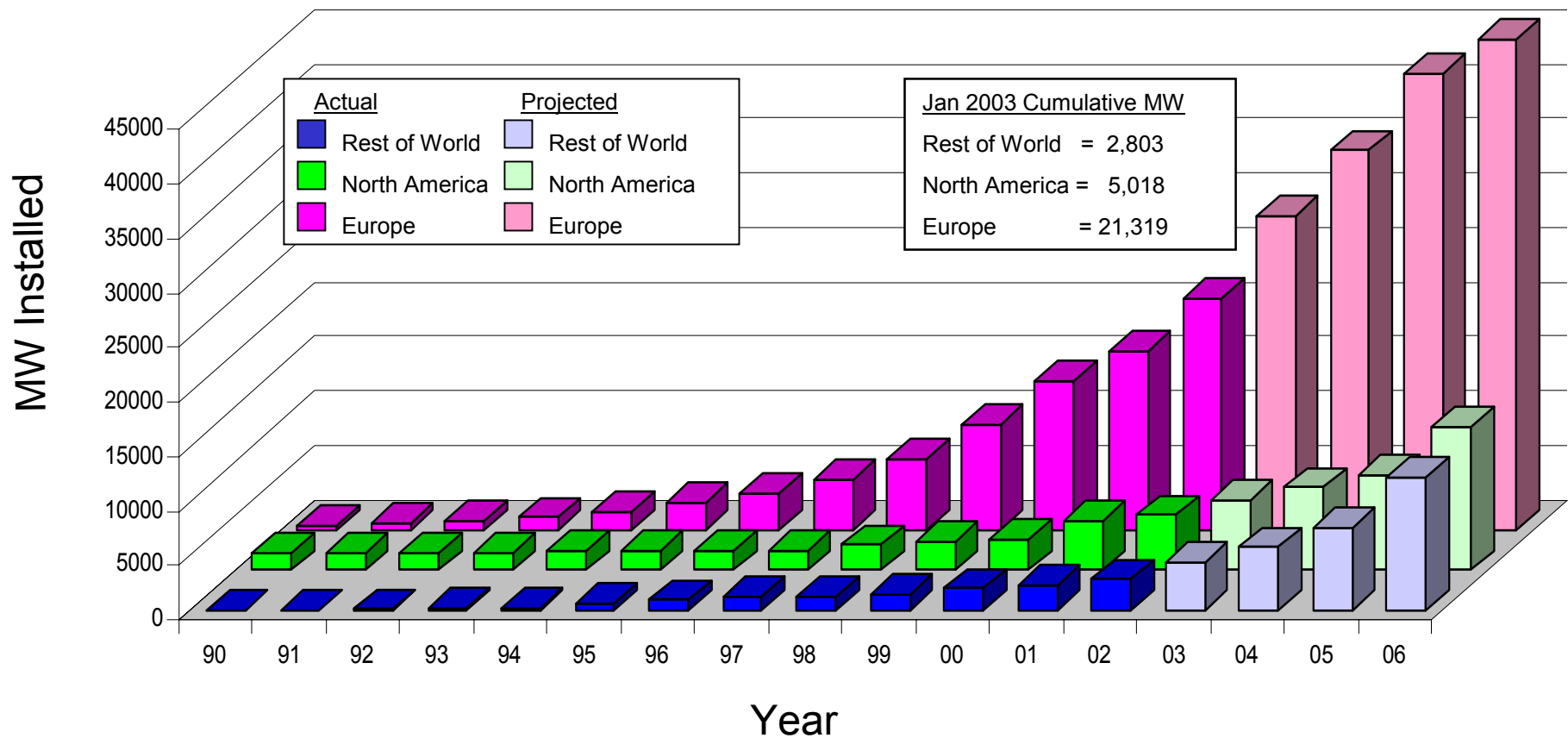
Mar. 7, 2003



THE EVOLUTION OF COMMERCIAL U.S. WIND TECHNOLOGY

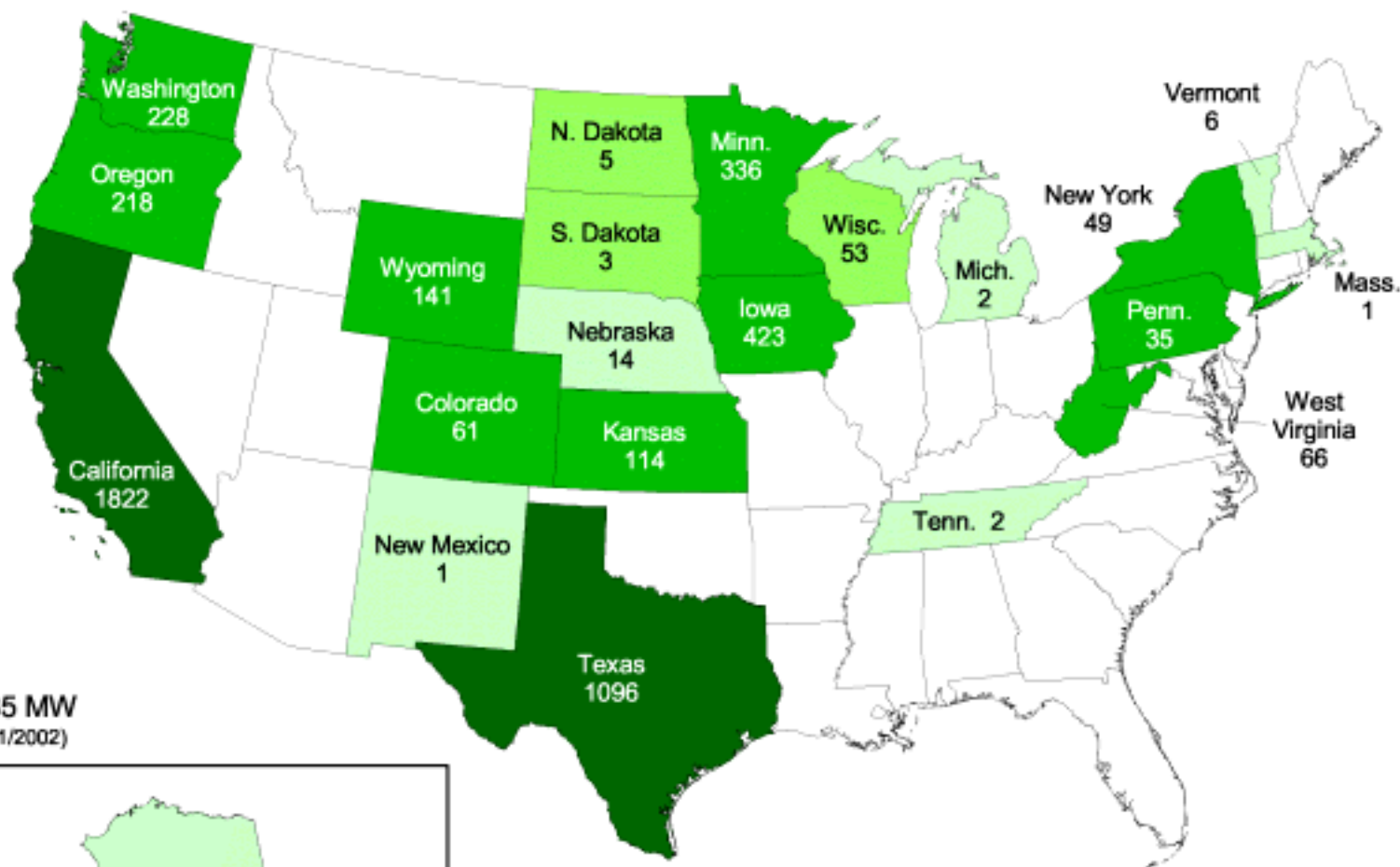


Growth of Wind Energy Capacity Worldwide



Sources: BTM Consult Aps, March 2001
Windpower Monthly, January 2003

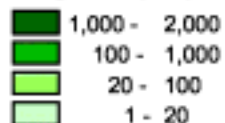
United States - 2002 Year End Wind Power Capacity (MW)



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



Wind Power Capacity
Megawatts (MW)



U.S. Department of Energy
National Renewable Energy Laboratory



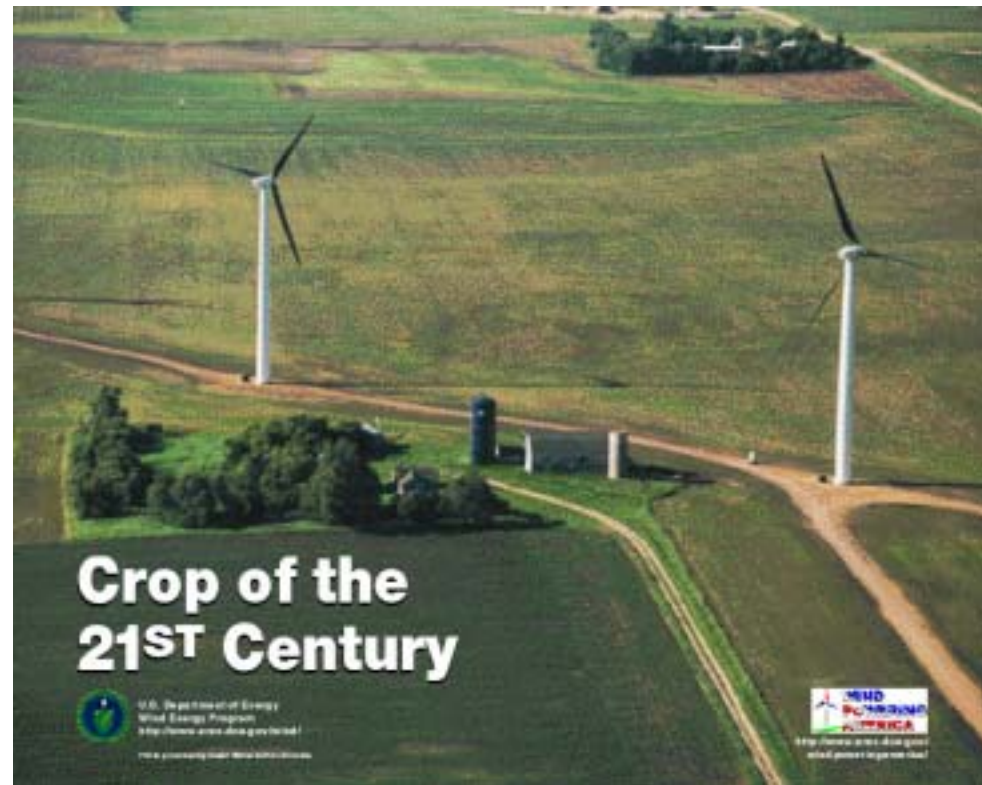
Maturing Wind Technology



- 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
- 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

Drivers for Wind Power

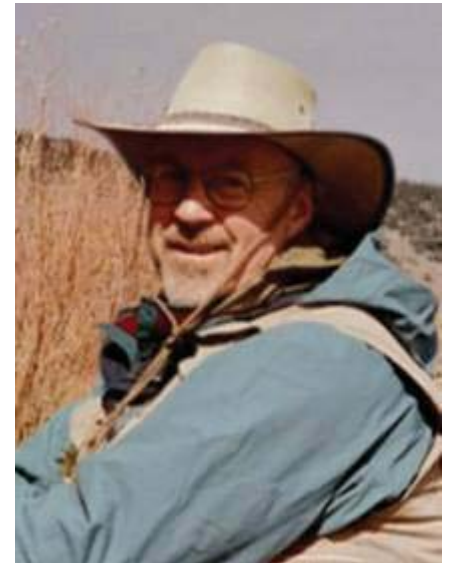
- Declining Wind Costs
- Fuel Price Uncertainty
- Federal and State Policies
- Economic Development
- Green Power
- Energy Security





“You don’t have to be a utility commissioner to see that we need better regulatory policies to achieve the diversity, economic development, and environmental benefits of wind power.”

Bob Anderson, Montana Public Service Commission, Helena, Montana



Wind Economics - Determining Factors

- 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



Cost of Energy Trend

1979: 40 cents/kWh

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

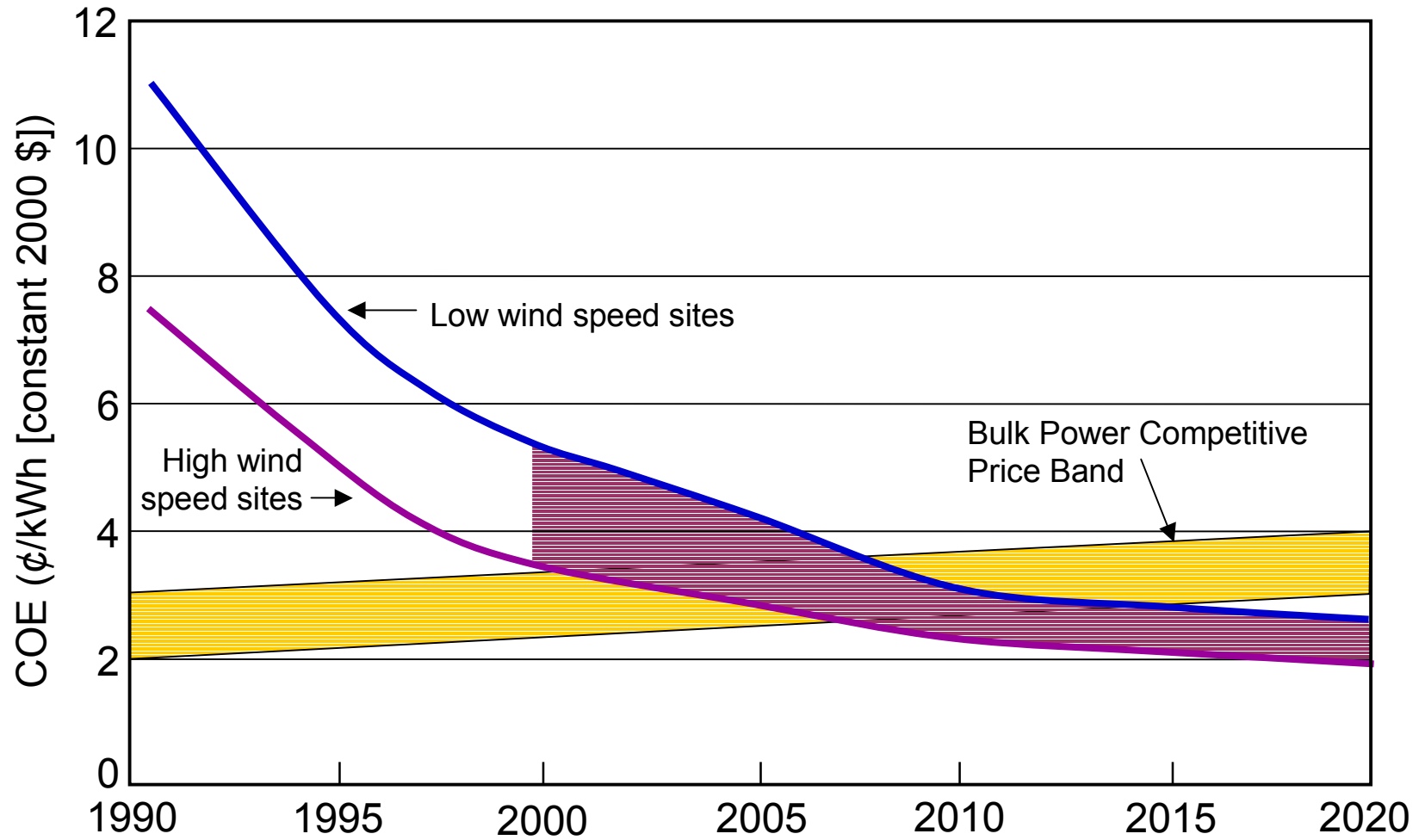


NSP 107 MW Lake Benton wind farm
4 cents/kWh (unsubsidized)

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

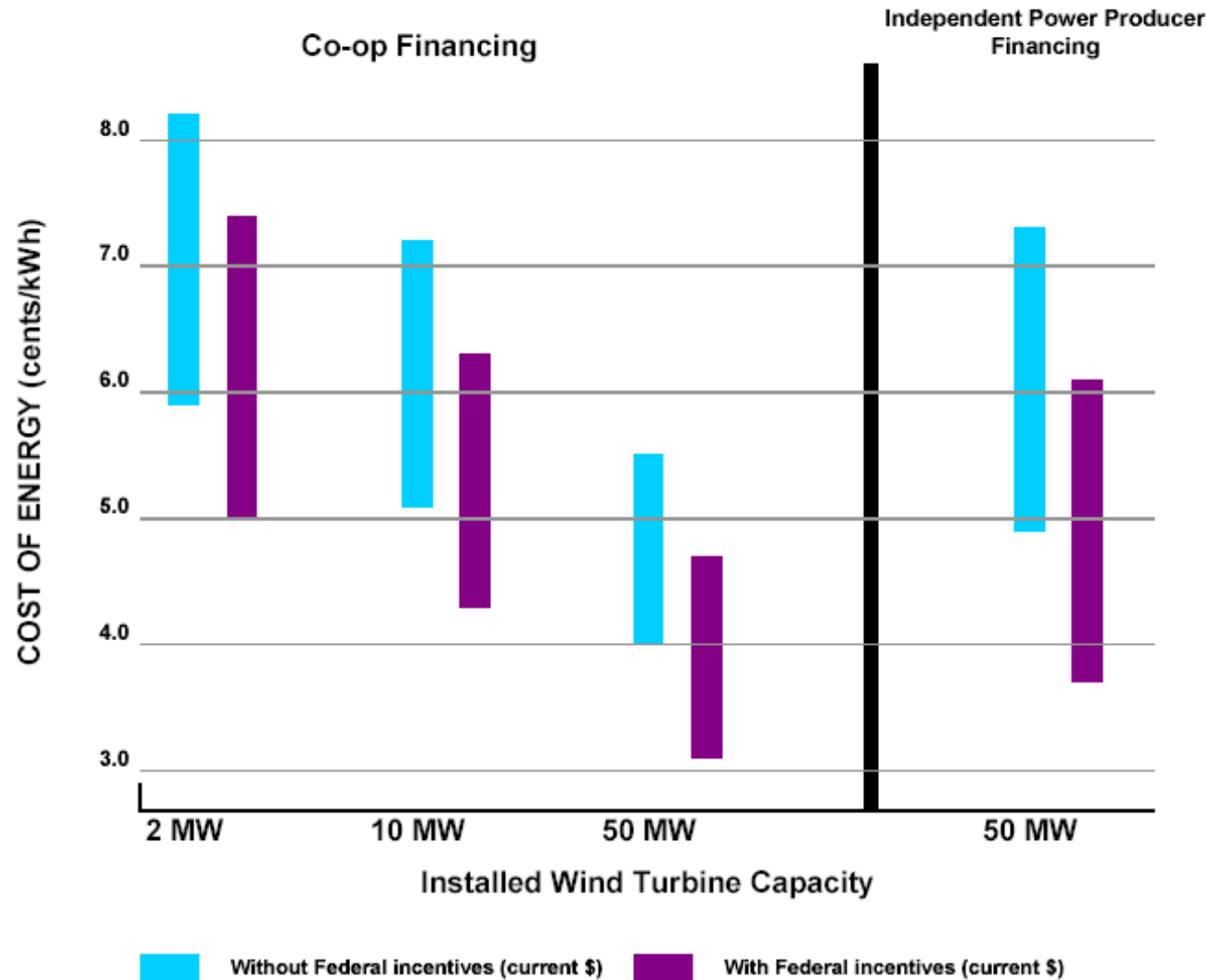
**2004:
3 – 4.5 cents/kWh**

Wind Cost of Energy



COOP vs. IPP Financing

- Larger plants are significantly less expensive per kWh
- Public power can own/ install smaller plants at comparable cost to large IPP projects
- Aggregation of demand reduces costs

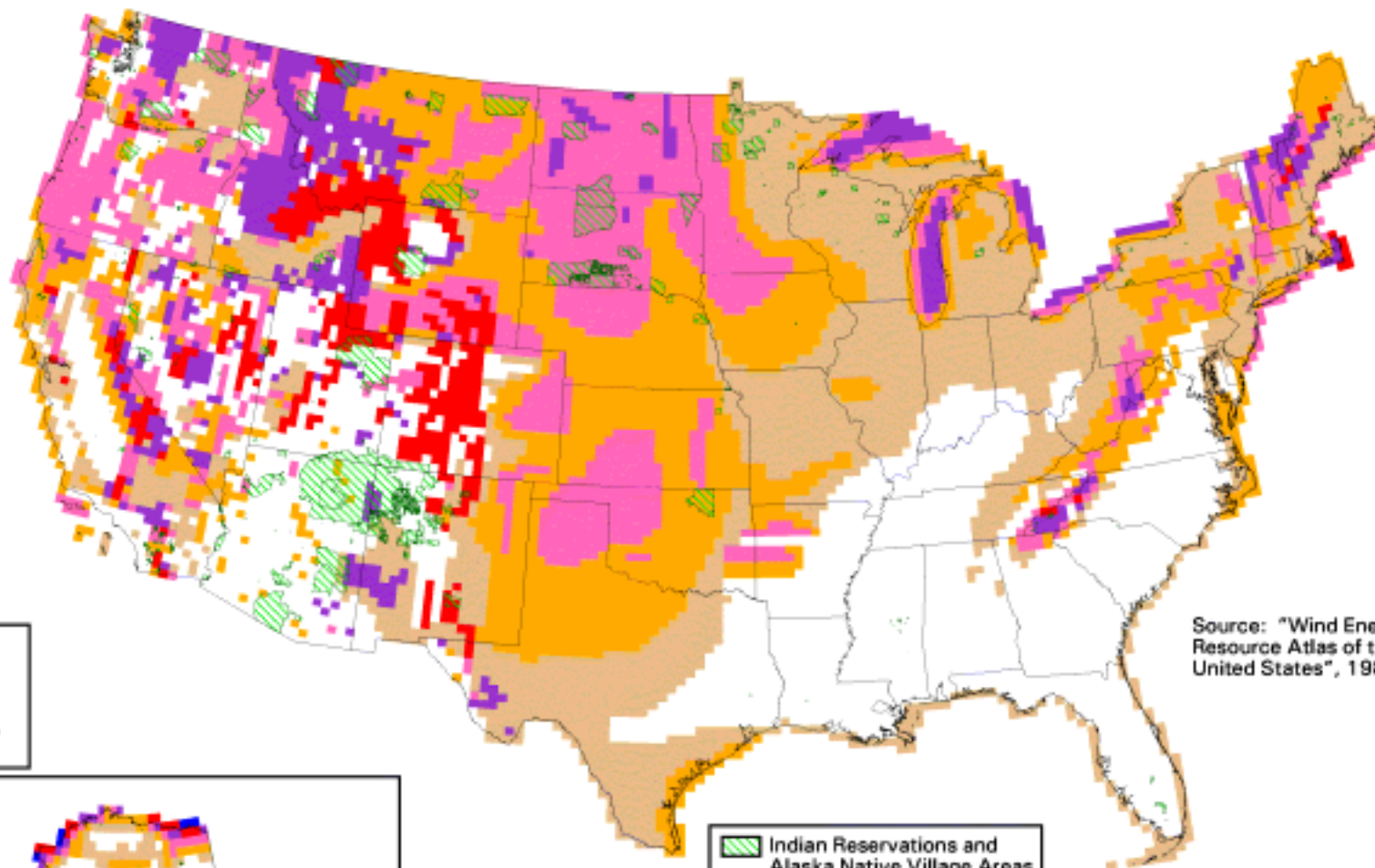




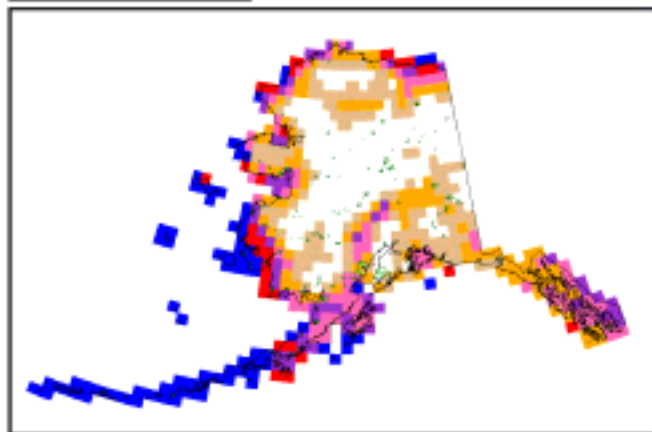
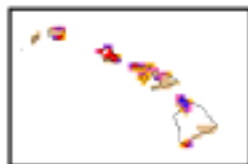
“Wind energy adds diversity to our generation fleet and provides a hedge against fossil fuel price increases. In addition, the development of renewable energy resources is widely supported by the public and our customers.”

Rick Walker, director, Renewable Energy Business Development, AEP Energy Services, Inc., Dallas, TX

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

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Recent Developments

- The wind industry is delivering ~3 cent/kWh contracts, including PTC for large projects
- Several large projects under development
 - 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



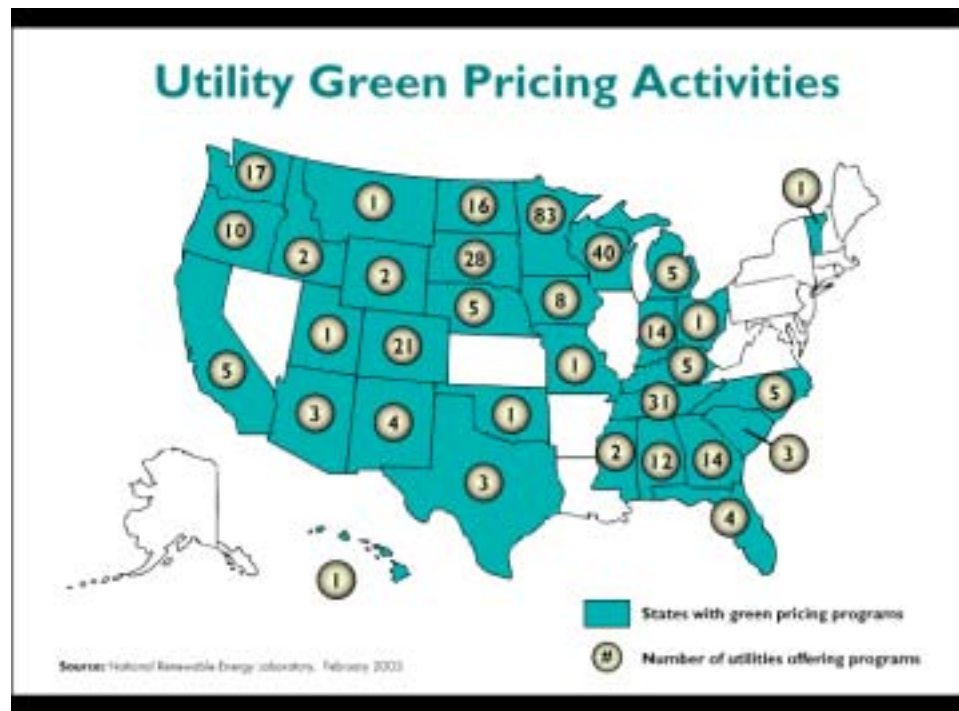
Wind Farm Development: Driving Factors

- Wind Resource
- Proximity to Transmission Lines/Substations with excess capacity
- State Policy Provisions
 - property/sales tax,
 - permitting and review,
 - subsidies and incentives
 - renewable power purchase mandates
- Utility green power programs and customer demand
- Federal Policy
 - renewal of production tax credit
 - potential purchase mandates



Green Power & Customer Choice

- More than 90 utilities in 30 states are offering green pricing programs where customers pay a premium to cover extra cost of renewable energy.
- Many utilities are offering green products to meet customer demand and diversify supply portfolio



Map from DOE's Green Power site at www.eren.doe.gov/greenpower

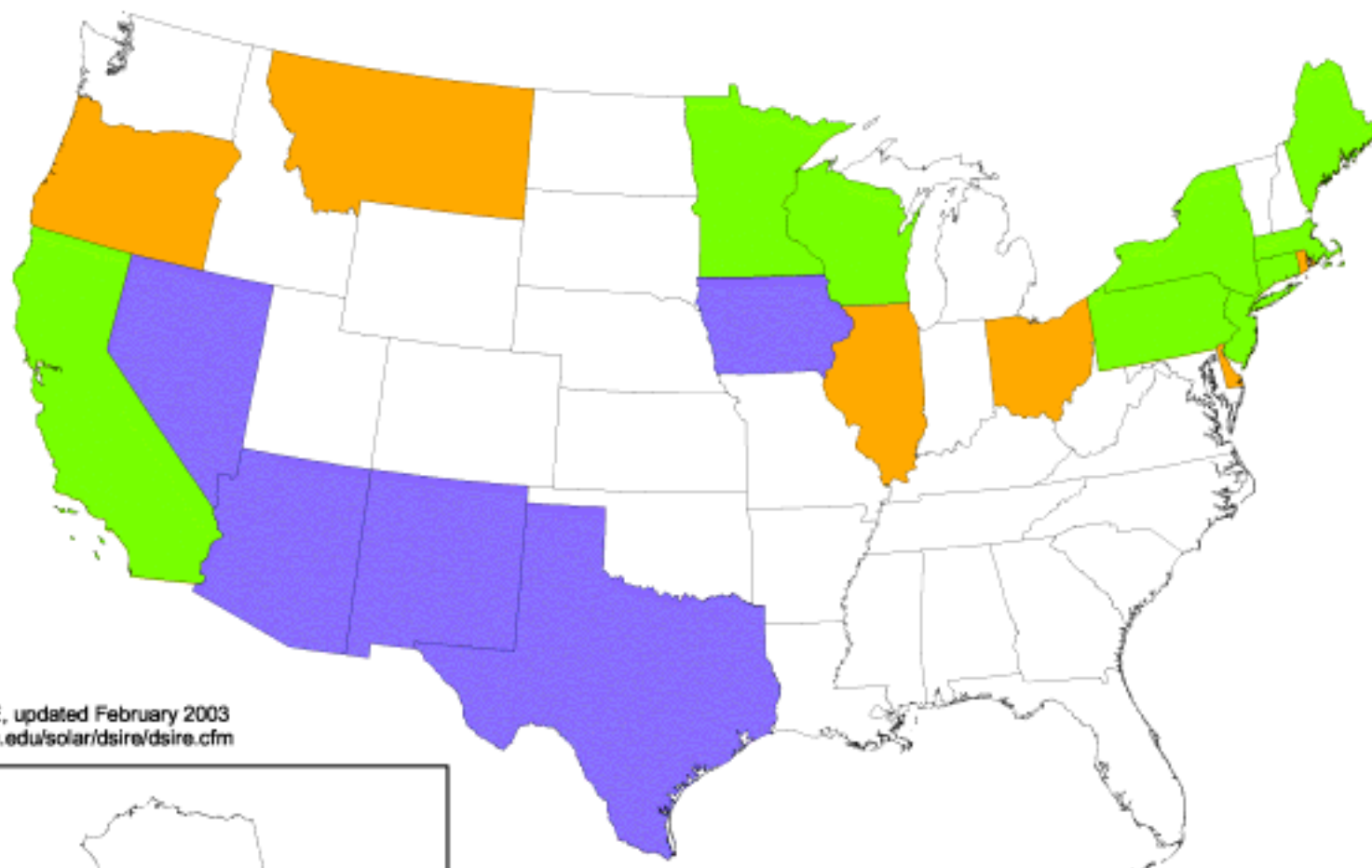


“Our customers wanted this wind program and it was our job to deliver it. It has turned out to be a huge source of community pride. The turbines are a visible landmark showing the Moorhead Community’s commitment to a better world for our children.”

Christopher Reed, Moorhead Public Service, Moorhead, Minnesota



United States - States with Renewable Energy Policies



Source: DSIRE, updated February 2003
www.dcs.ncsu.edu/solar/dsire/dsire.cfm



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

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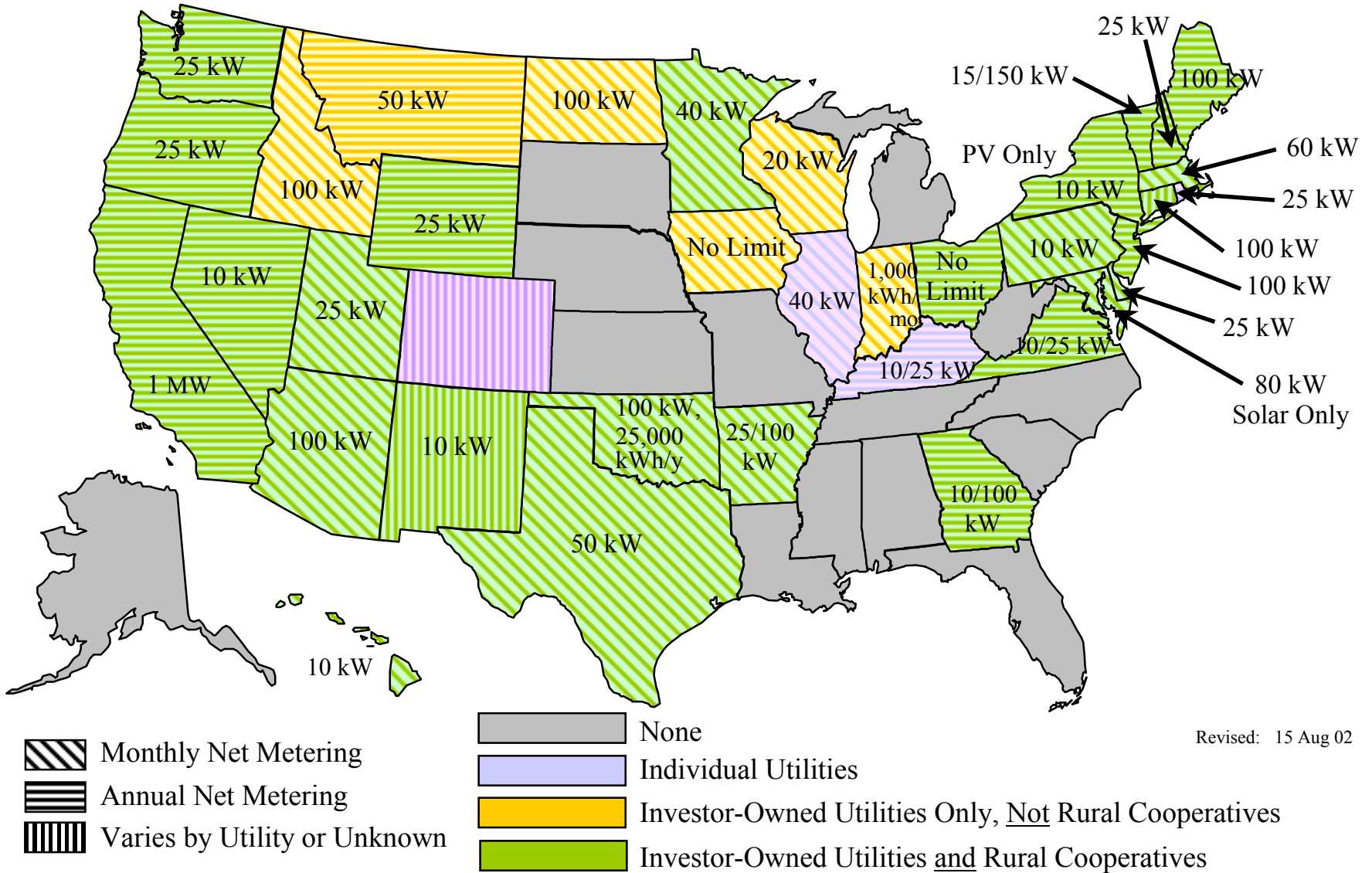


"The wind offers energy independence for many Kansas residents. Federal, state, and local governments should work together to provide access to affordable energy choices."

State Representative Tom Sloan, Lawrence, Kansas



Net Metering By State



Revised: 15 Aug 02



“It seems only natural for rural utilities to do everything they can to advance both farm-based renewable energy development and rural economic development in a cost-effective way. In my opinion, wind energy is the next great chapter in the rural electrification story.”

Aaron Jones, Washington Rural Electric Cooperative Association; Olympia, WA

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)



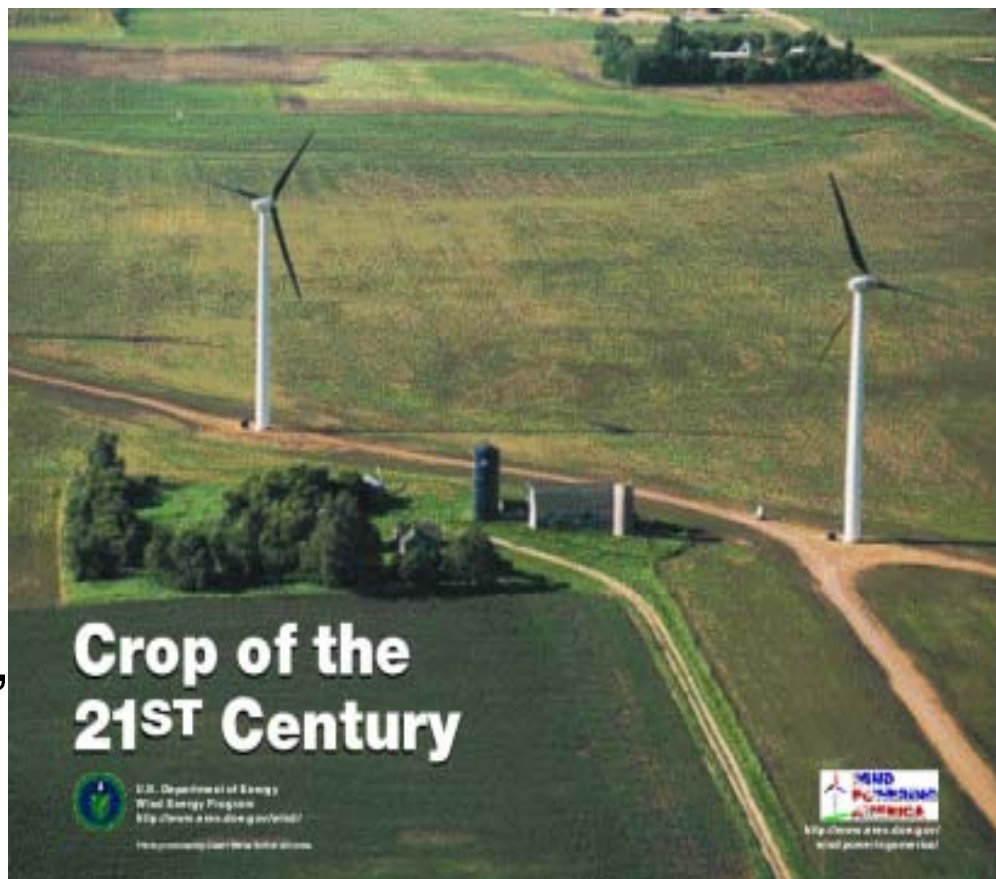


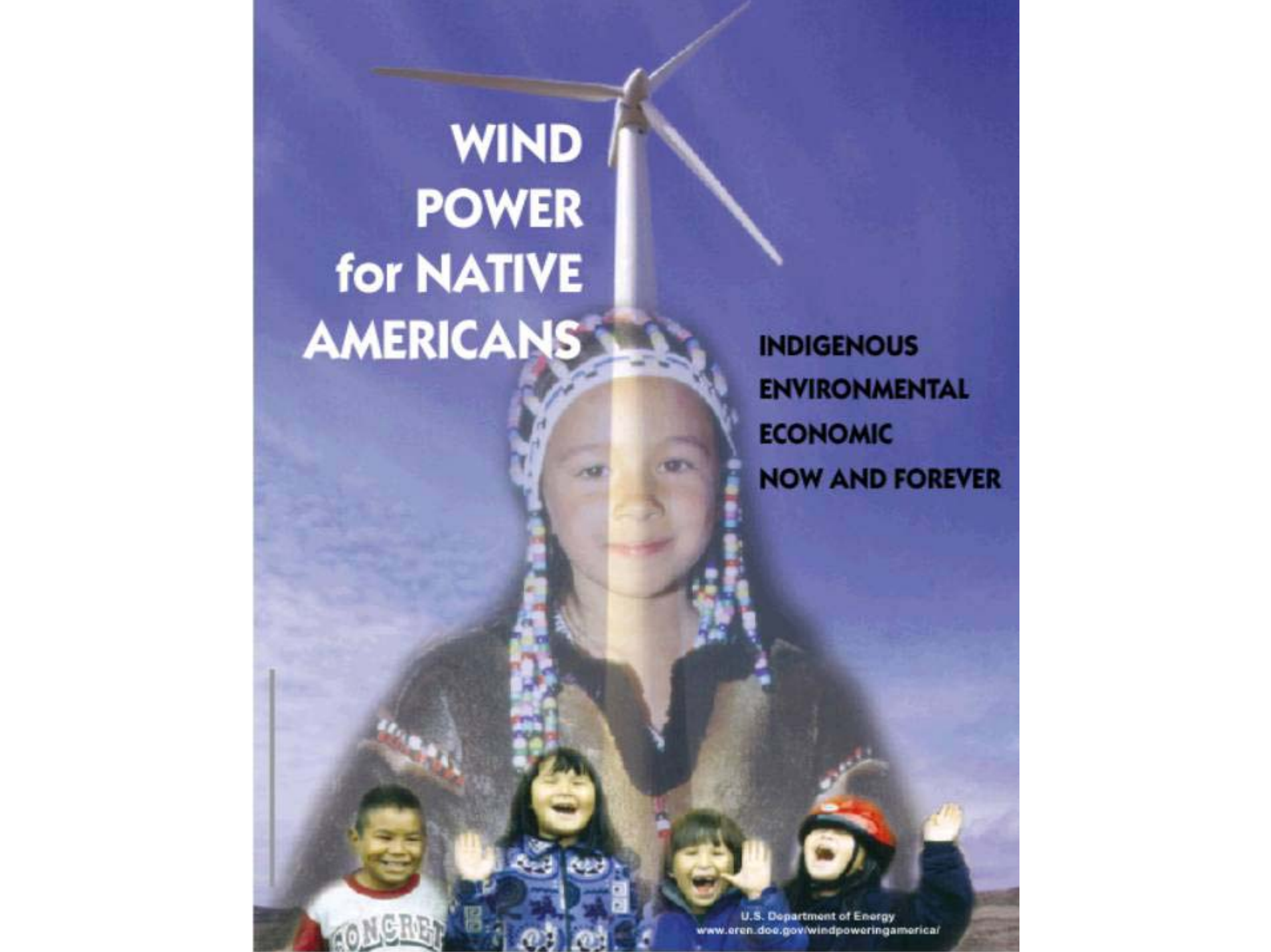
“Wind is a homegrown energy that we can harvest right along side our corn or soybeans or other crops. We can use the energy in our local communities or we can export it to other markets. We need to look carefully at wind energy as a source of economic growth for our region”

David Benson, Farmer and County Commissioner, Nobles County, Minnesota

Key Issues for Wind Power

- Restructuring and Policy Uncertainty
- Transmission: access, RTO formation and rules, new lines
- Operational impacts: intermittency, ancillary services, allocation of costs
- Siting and Permitting: avian, noise, visual, federal land
- Accounting for non-monetary value: green power, no fuel price risk, reduced emissions





WIND POWER for NATIVE AMERICANS

**INDIGENOUS
ENVIRONMENTAL
ECONOMIC
NOW AND FOREVER**



“In evaluating the potential of wind energy generation, Native Americans realize that wind power is not only consistent with our cultural values and spiritual beliefs, but can also be a means of achieving Native sustainable homeland economies.”

Ronald Neiss, Rosebud Utility Commission President, Rosebud Sioux Reservation, South Dakota



Carpe Ventem
www.windpoweringamerica.gov