Wind Workshop for State Lands

Tuesday, April 29 2003

Brian Parsons

Project Manager, Wind Applications

National Wind Technology Center

brian_parsons@nrel.gov

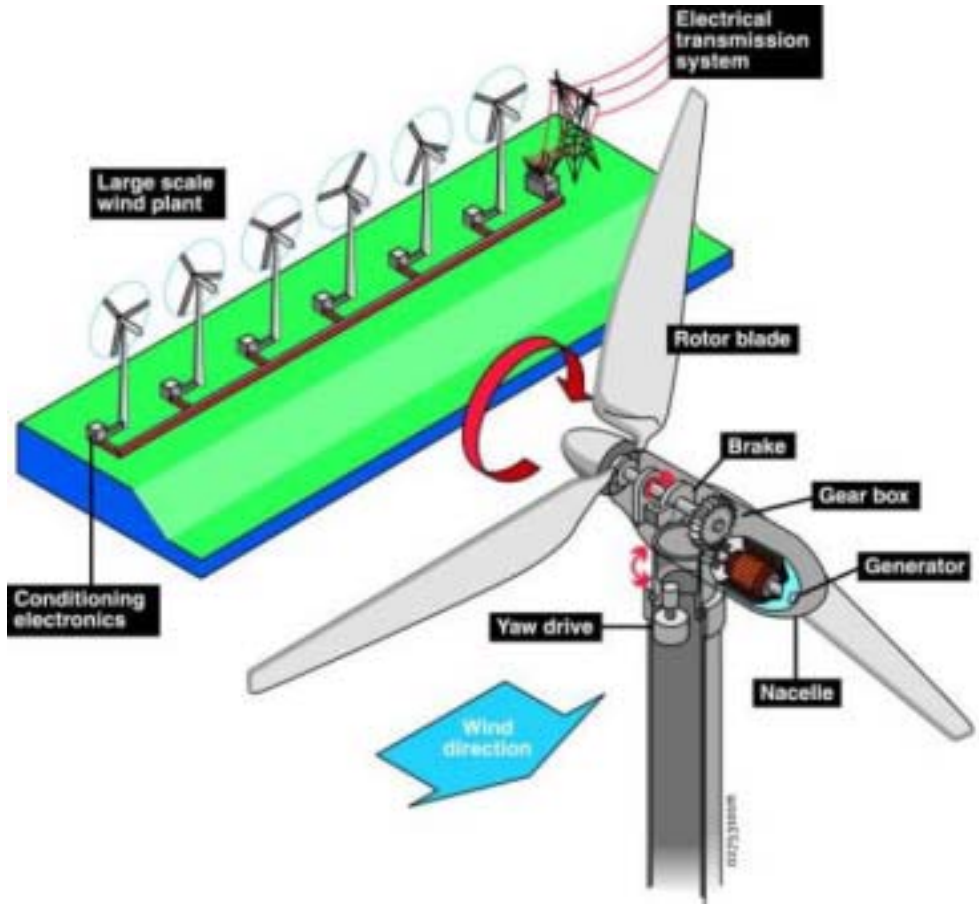
303 384-6958

NREL

National Renewable Energy Laboratory

Wind Energy Technology

At it's simplest, the wind turns the turbine's blades, which spin a shaft connected to a generator that makes electricity. Large turbines can be grouped together to form a wind power plant, which feeds power to the electrical transmission system.



Sizes and Applications

Small (≤10 kW)

- Homes (Grid connected)
- Farms
- Remote Applications

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

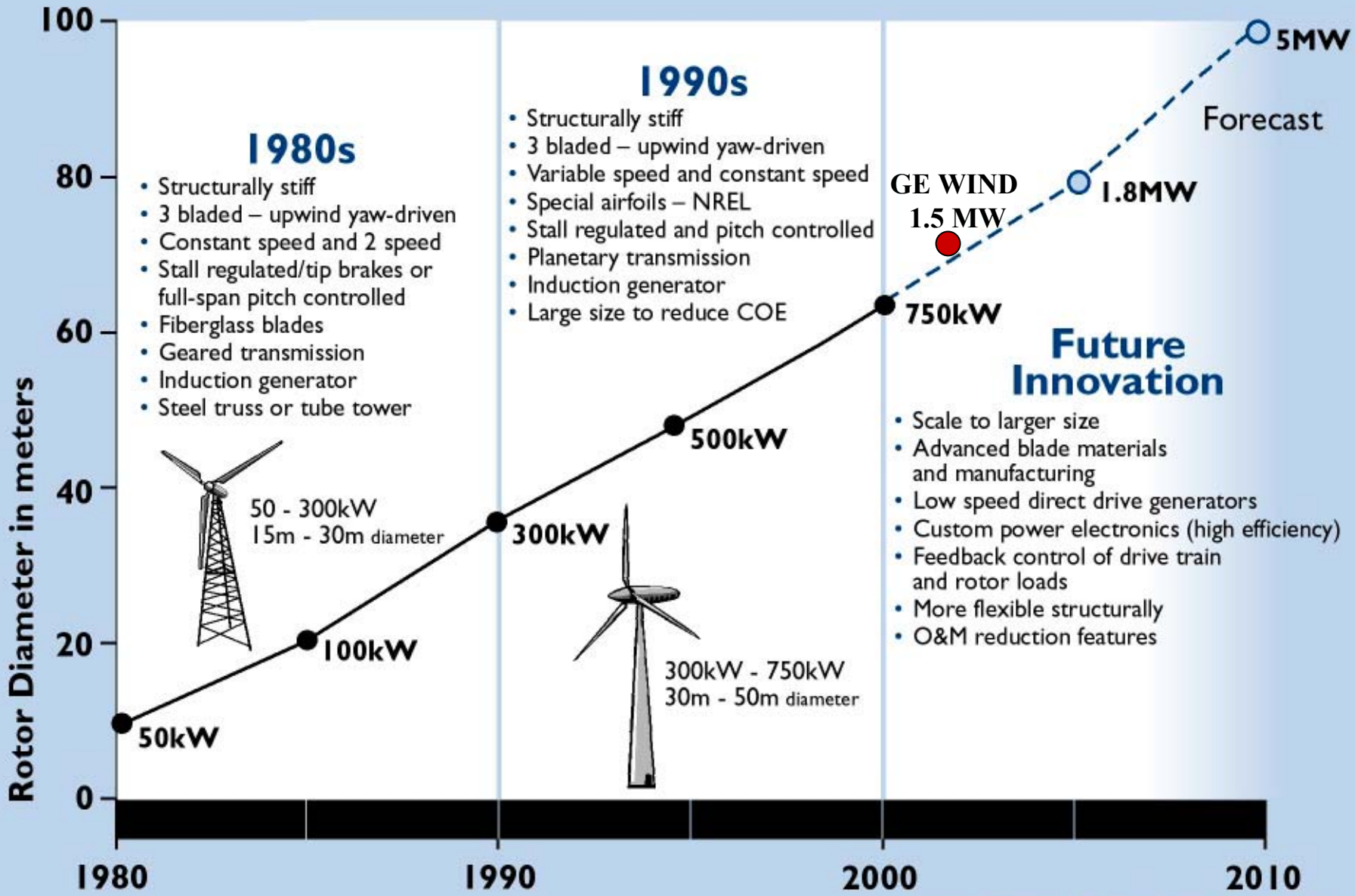
Intermediate (10-500 kW)

- Village Power
- Hybrid Systems
- Distributed Power

Large (500 kW – 6 MW)

- Central Station Wind Farms
- Distributed Power
- Offshore Wind Generation Stations

The Evolution of Commercial U.S. Wind Technology

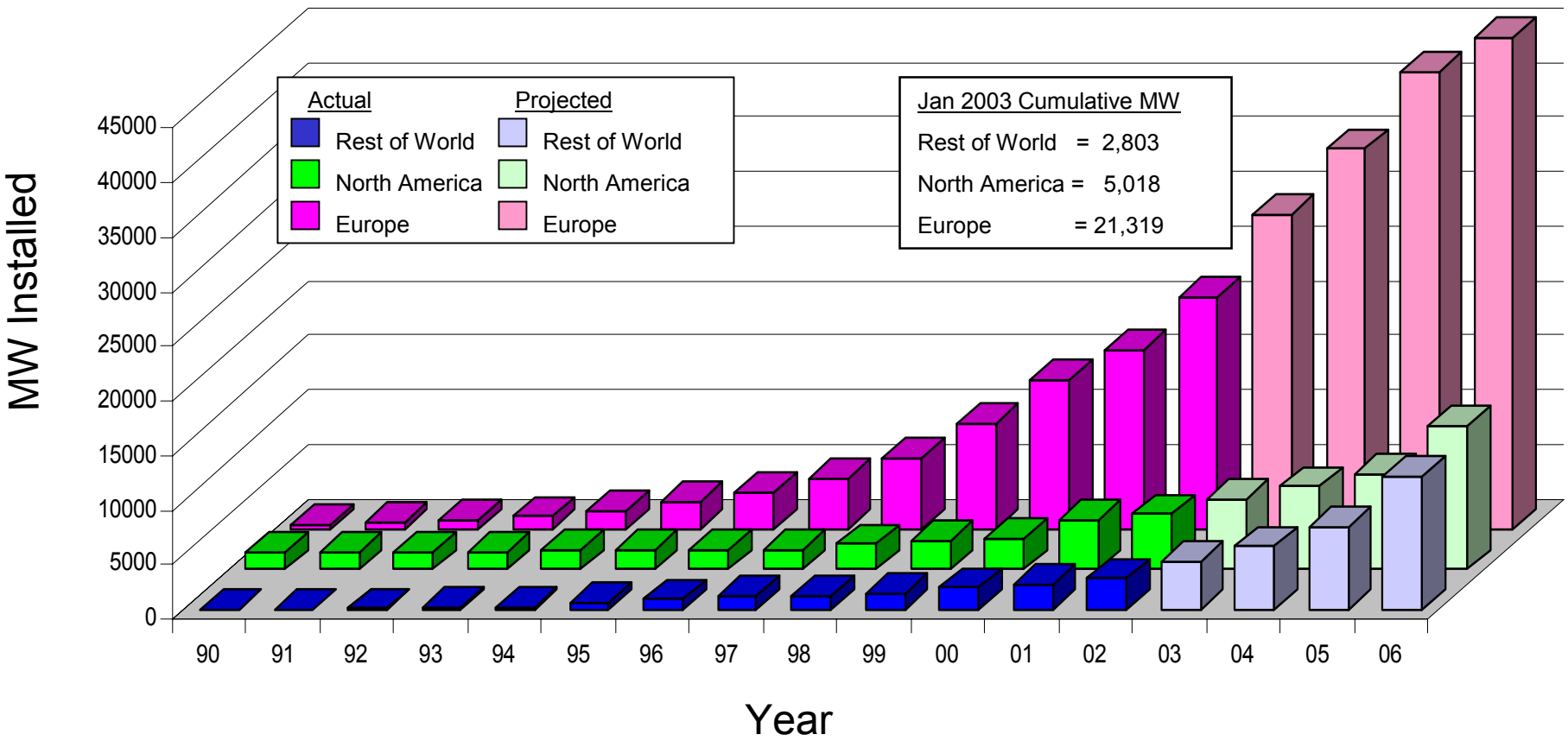


Source: Thresher & Dodge, Wind Energy Journal 1998

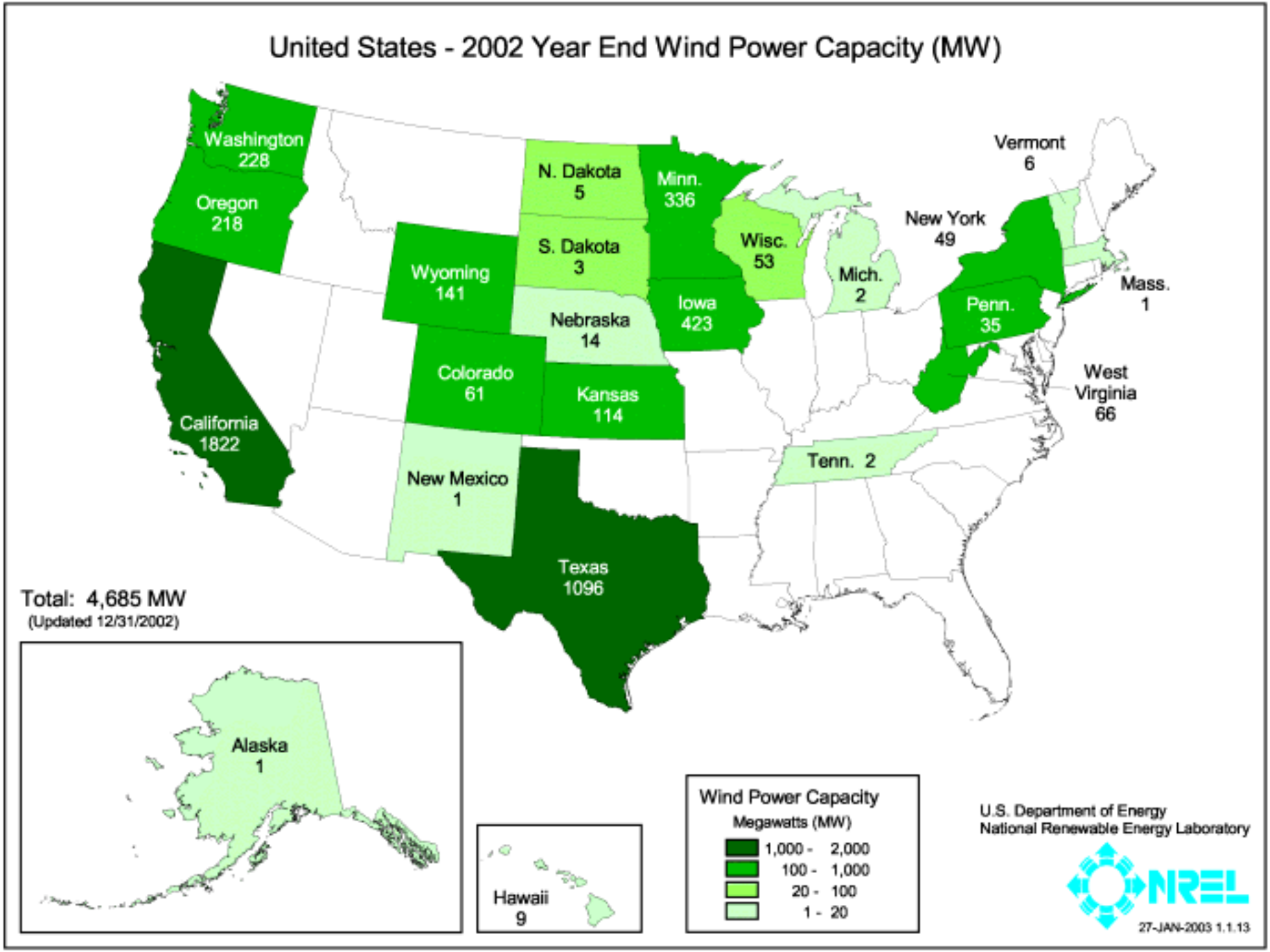
Maturing Wind Technology

- 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

Growth of Wind Energy Capacity Worldwide



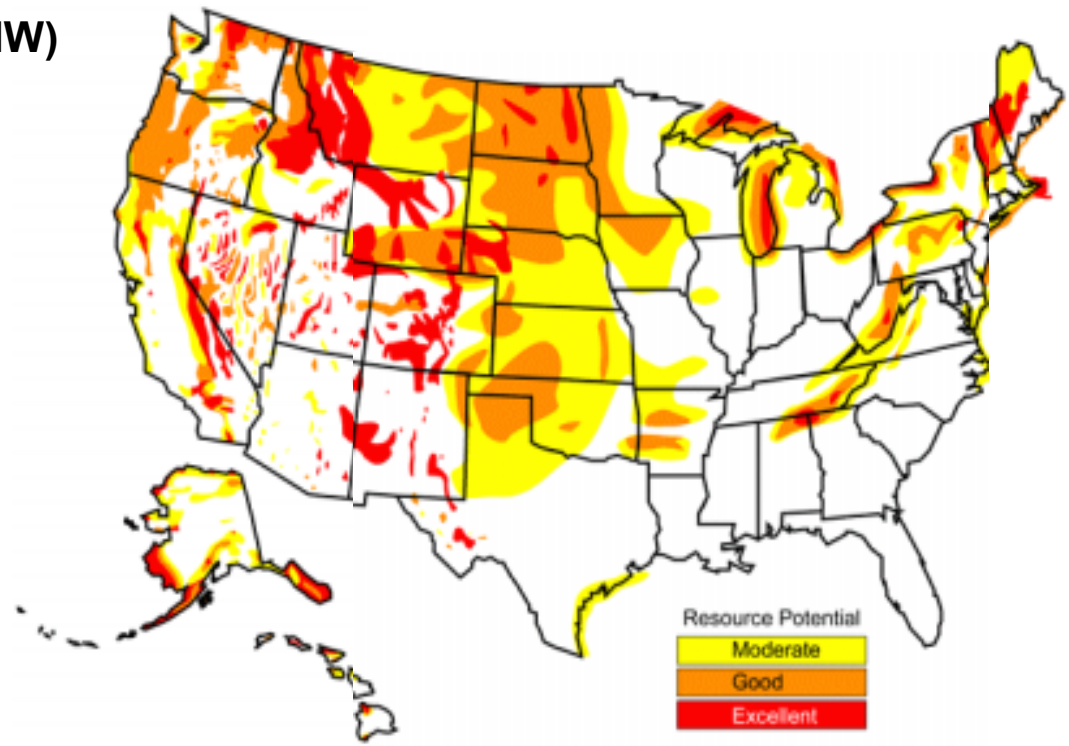
Sources: BTM Consult Aps, March 2001
Windpower Monthly, January 2003


United States - 2002 Year End Wind Power Capacity (MW)
Washington 228
Oregon 218
California 1822
Wyoming 141
N. Dakota 5
S. Dakota 3
Nebraska 14
Colorado 61
Kansas 114
New Mexico 1
Texas 1096
Minn. 336
Iowa 423
Wisc. 53
Mich. 2
Vermont 6
New York 49
Penn. 35
Mass. 1
West Virginia 66
Tenn. 2
Total: 4,685 MW
(Updated 12/31/2002)
Alaska 1
Hawaii 9
Wind Power Capacity
Megawatts (MW)
1,000 - 2,000
100 - 1,000
20 - 100
1 - 20
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
27-JAN-2003 1.1.13

U.S. Wind Energy Potential

Rank	State	Installed Capacity (MW)
1	North Dakota	1
2	Texas	1096
3	Kansas	114
4	South Dakota	4
5	Montana	0
6	Nebraska	15
7	Wyoming	141
8	Oklahoma	0
9	Minnesota	323
10	Iowa	425
11	Colorado	61
12	New Mexico	2
13	Idaho	0
14	Michigan	2
15	New York	48
16	Illinois	1
17	California	1859
	Other	575
	Total	4667

Expected by end of 2002

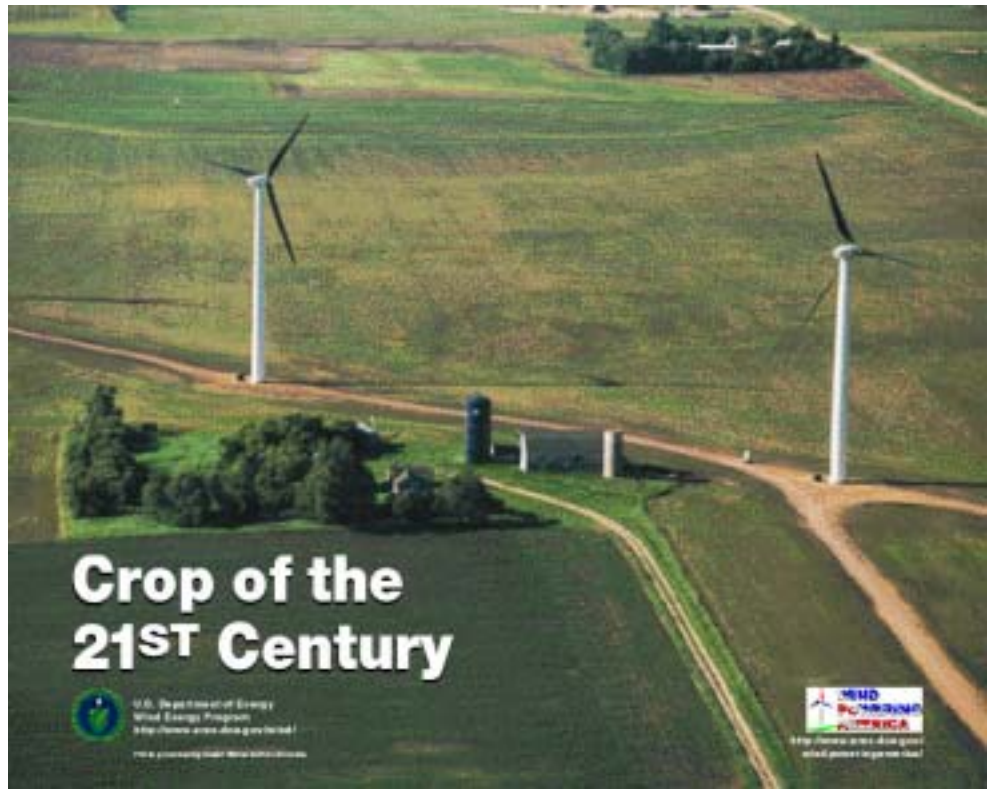


World Class Wind Potential

Germany's Potential: 100 GW
North Dakota's Potential: 250 GW

Drivers for Wind Power

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



Cost of Energy Trend

1979: 40 cents/kWh

2000:
4 - 6 cents/kWh

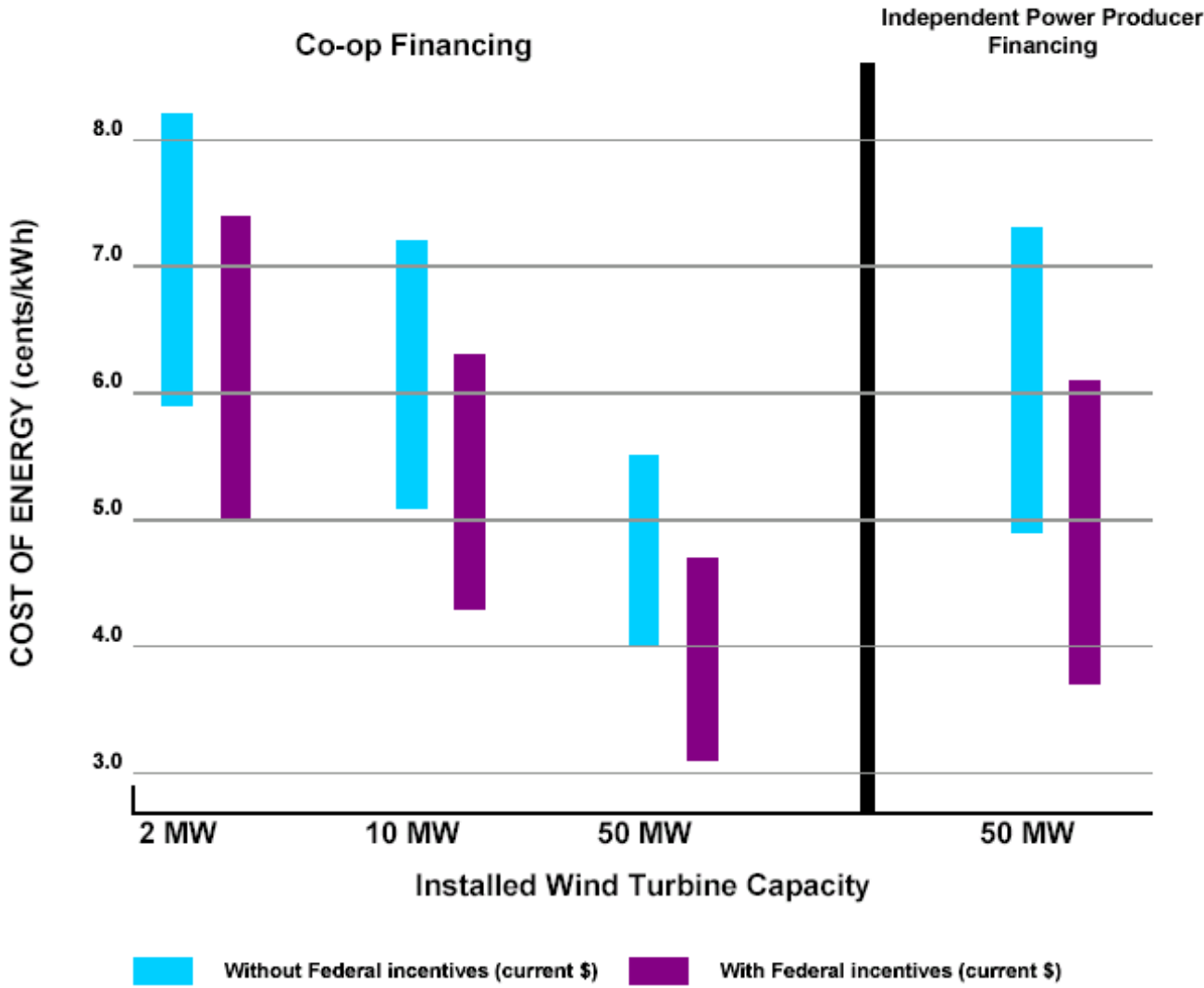
- Increased Turbine Size
- R&D Advances
- Manufacturing Improvements

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

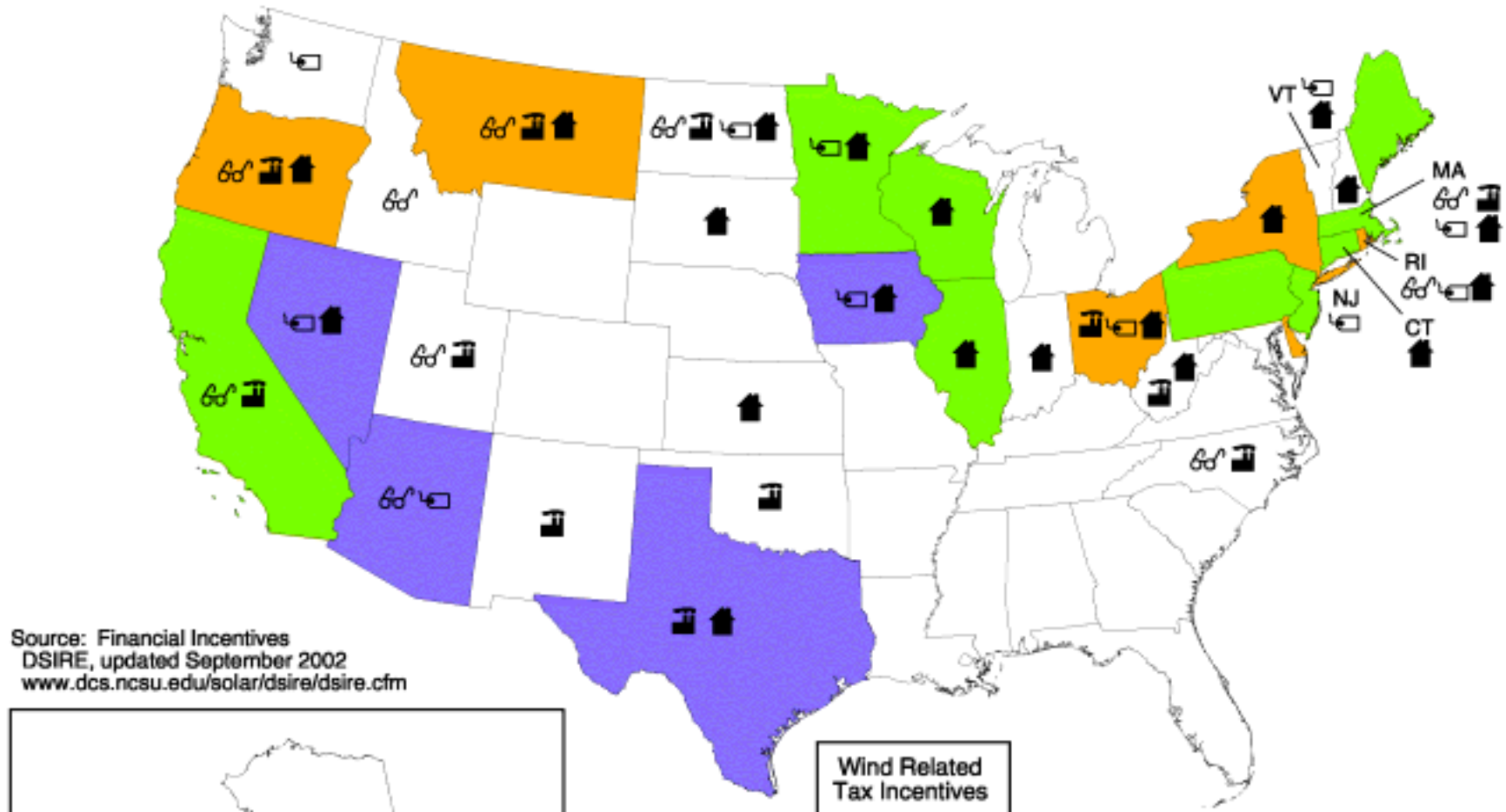
2004:
3 – 4.5 cents/kWh

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



United States - States with Renewable Energy Policies



Source: Financial Incentives
DSIRE, updated September 2002
www.dcs.ncsu.edu/solar/dsire/dsire.cfm

Wind Related Tax Incentives
- Personal I.T.
- Corporate
- Sales
- Property

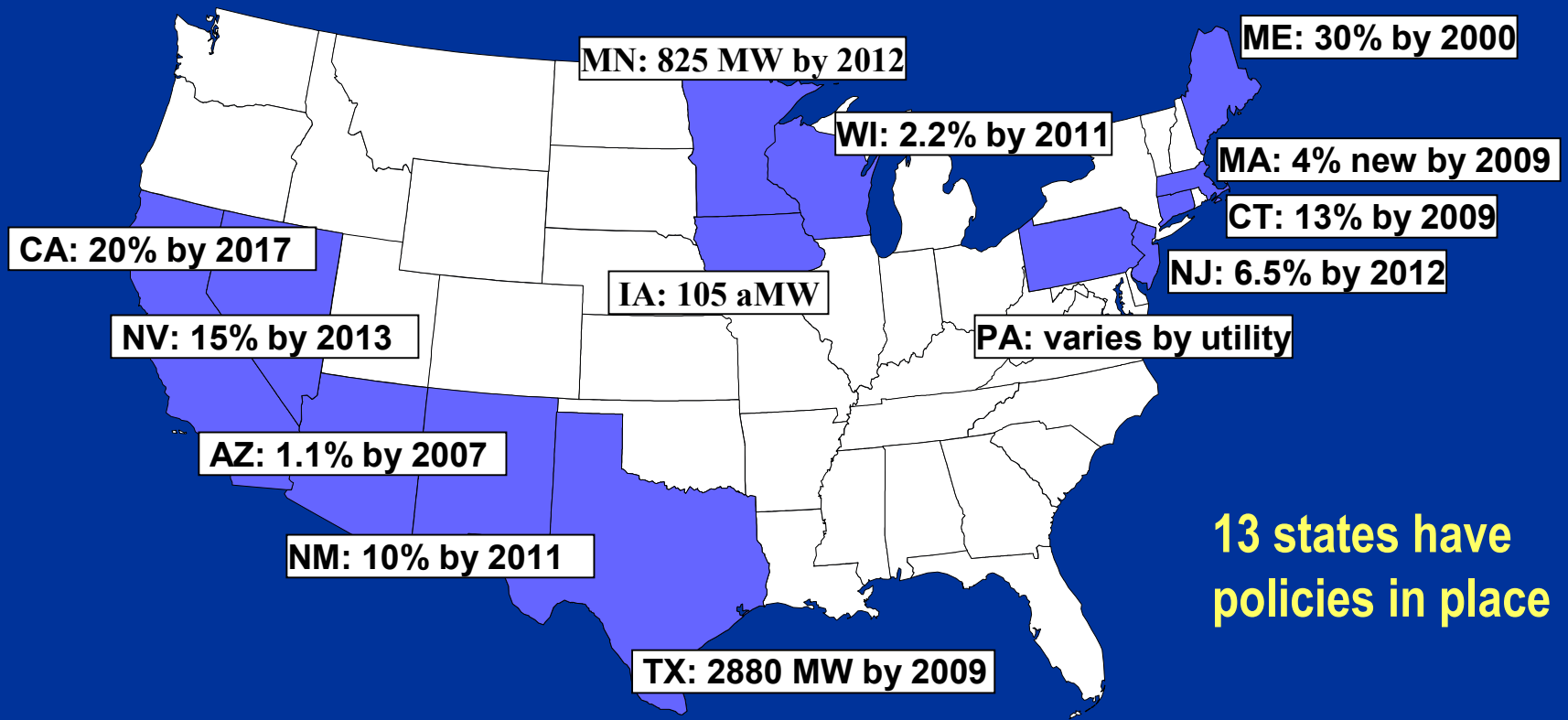
- System Benefit Charges
- Renewable Portfolio Standard
- Both SBC and RPS

U.S. Department of Energy
National Renewable Energy Laboratory

NREL

16-OCT-2002 1.1.16

Renewables Purchase Obligations

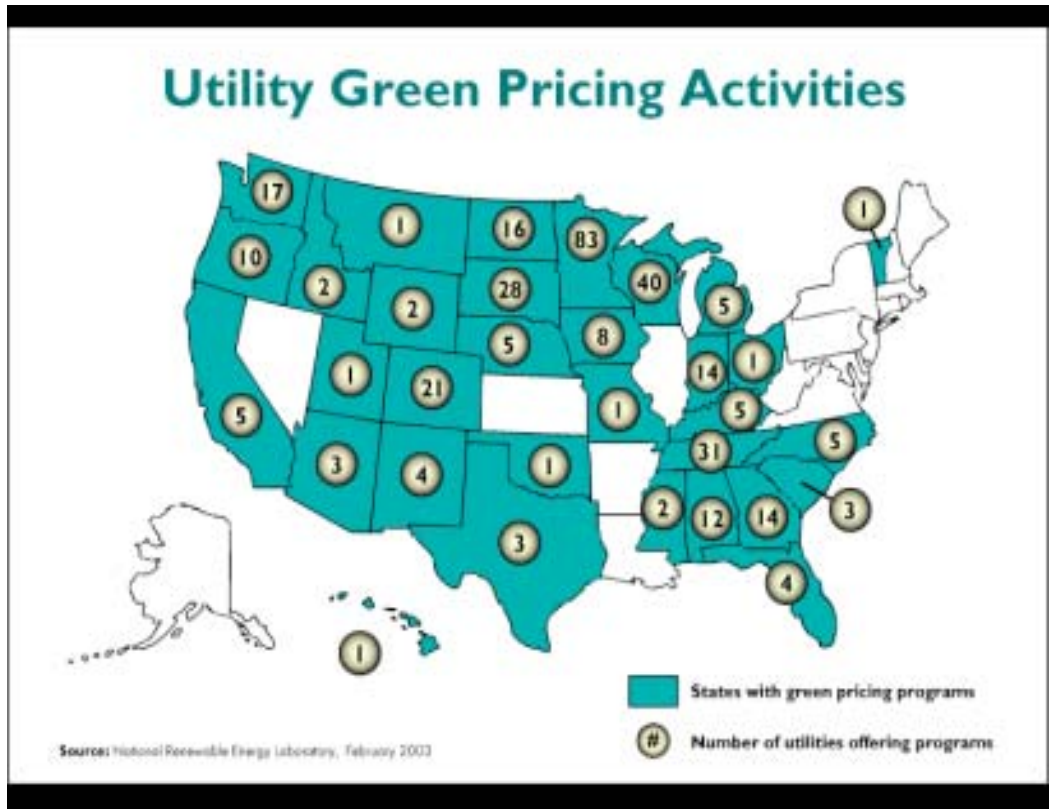


13 states have policies in place

Sources: Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory

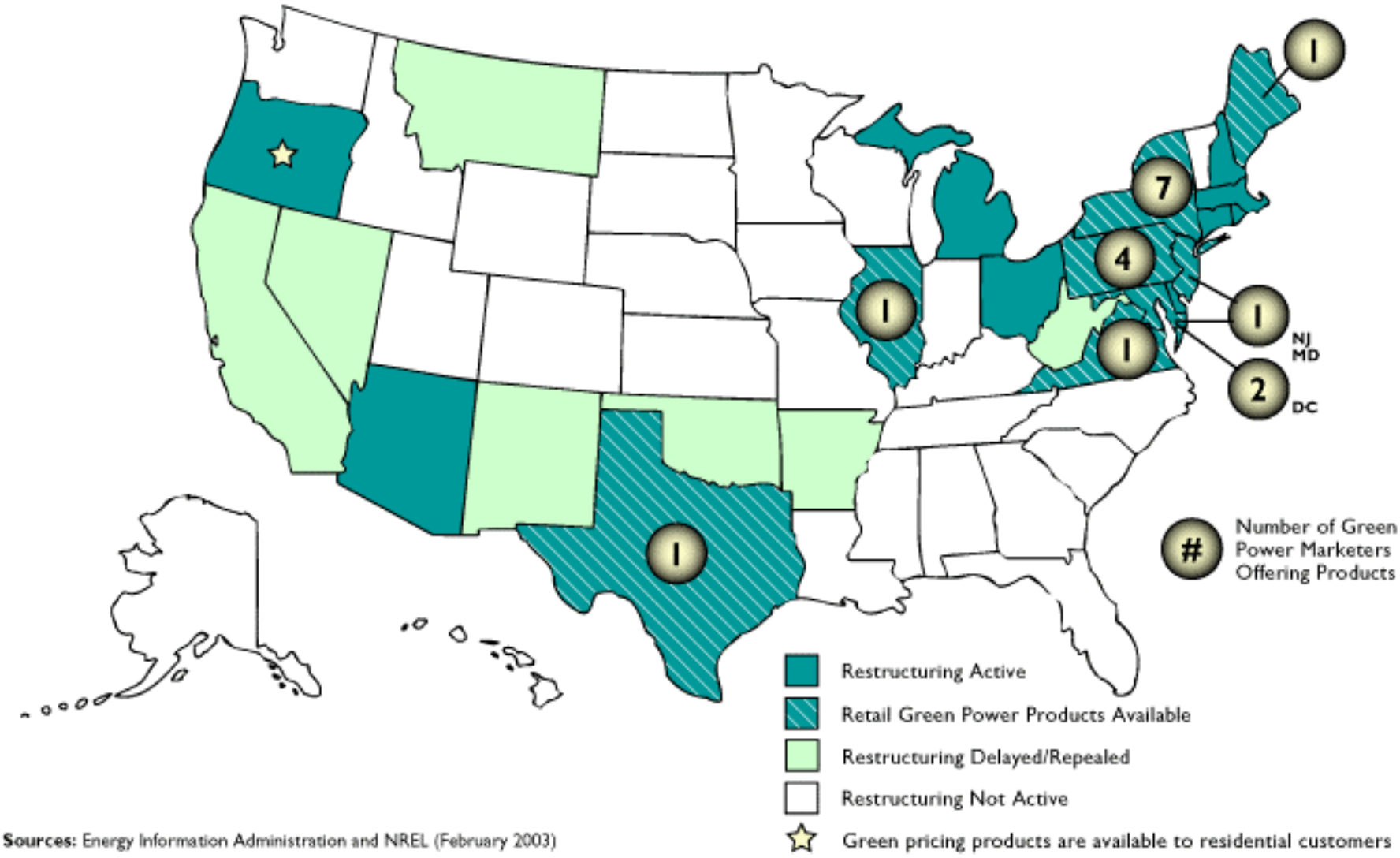
Green Power & Customer Choice

- 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

Green Power Marketing Activity in Competitive Electricity Markets



Sources: Energy Information Administration and NREL (February 2003)

Recent Developments

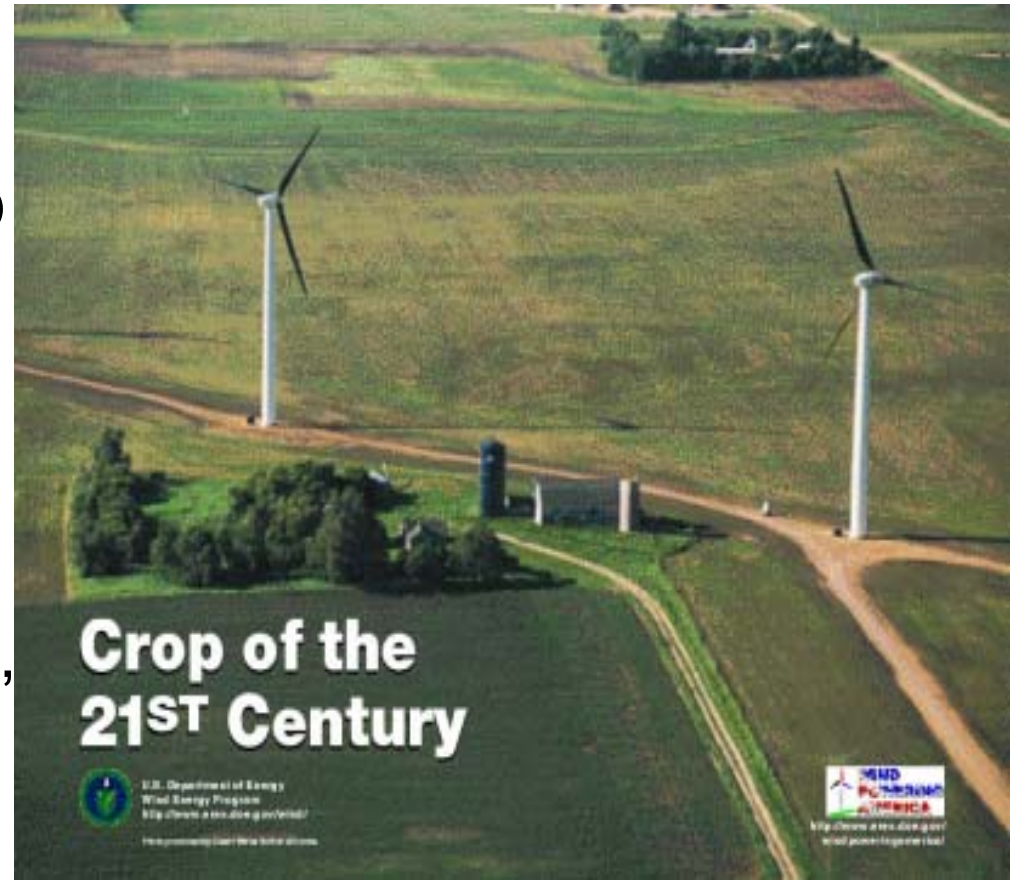
- The wind industry is delivering < 3 cent/ kWh, including PTC for large projects
- Many large projects completed last 2 years
  - 300 MW Stateline (WA/OR)
  - 109 MW Utilicorp (KS)
  - 4>100 MW in West Texas
- Gas price increases and the power crisis
  - CO: 162 MW of wind wins all-source bid on economics alone
  - “wind is the lowest cost resource”
  - serious consideration of GW (BPA, Austin, Pacificorp)
- Energy security and diversity issues
- Transmission and grid impacts to the forefront
- Serious consideration of off-shore wind for New England and Mid-Atlantic markets
- Farm Bill provisions passed

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 $500k -$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)

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

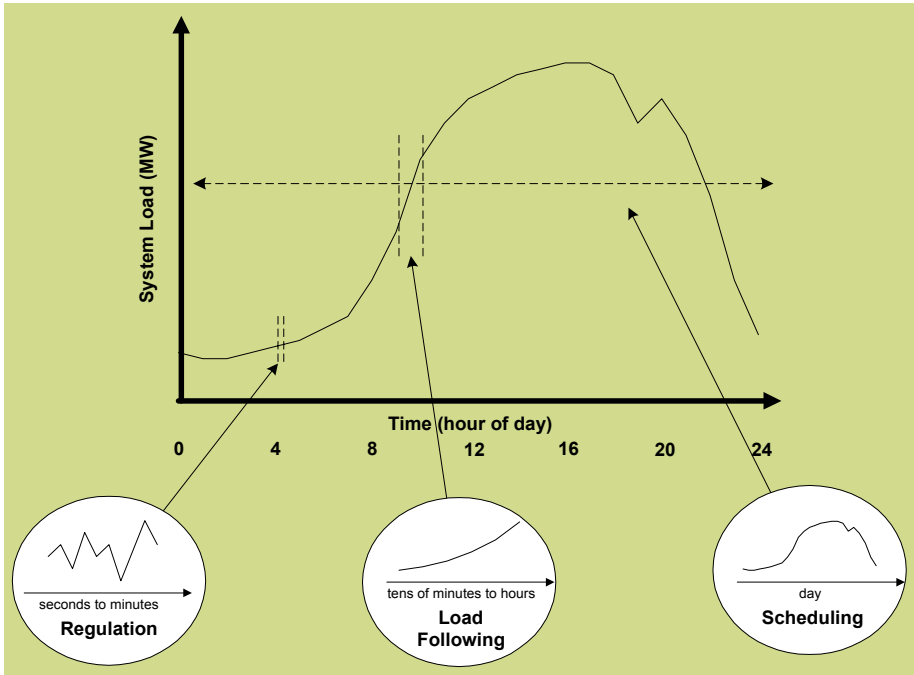


Wind Power's Natural Characteristics

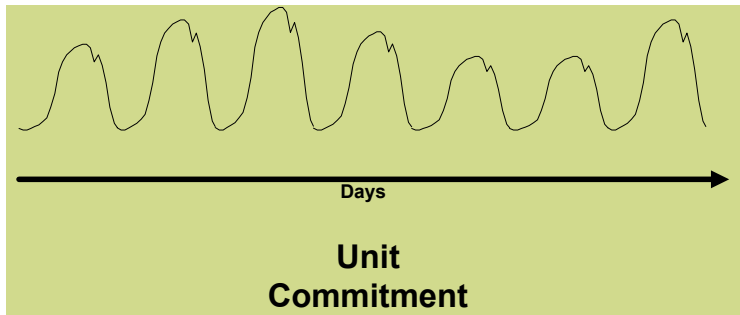
- ***Remote:*** Wind resources often distant from major markets
- ***Variable:*** Plant output varies with variations in the wind
- ***New:*** Operators more comfortable with established power technologies with known characteristics

Key Issue: How do you fairly account for wind's natural characteristics?

Power-System Operation Impacts



- Regulation -- seconds to a few minutes -- similar to variations in customer demand (loads)
- Load-following -- tens of minutes to a few hours -- usage follows predictable patterns, wind less so
- Scheduling and commitment of generating units -- one to several days -- wind impacts unclear



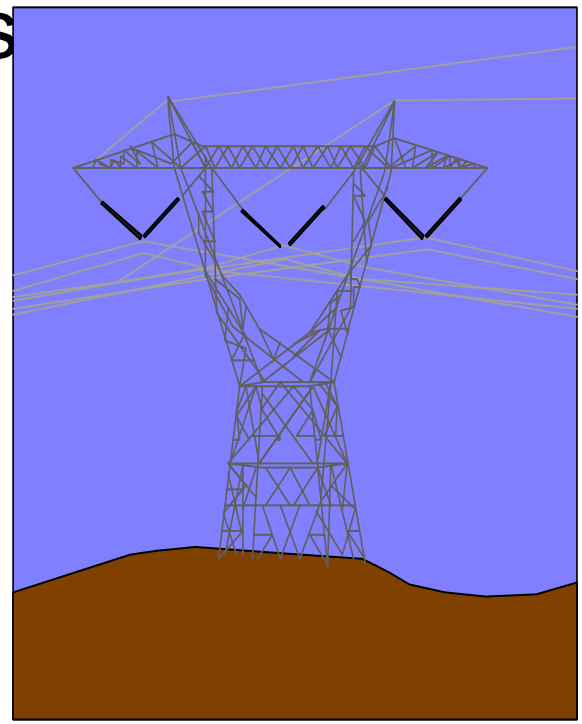
Wind controlled by nature, not power-plant operators!

Several Studies Have Begun To Quantify Wind's Impact On Ancillary Service Costs

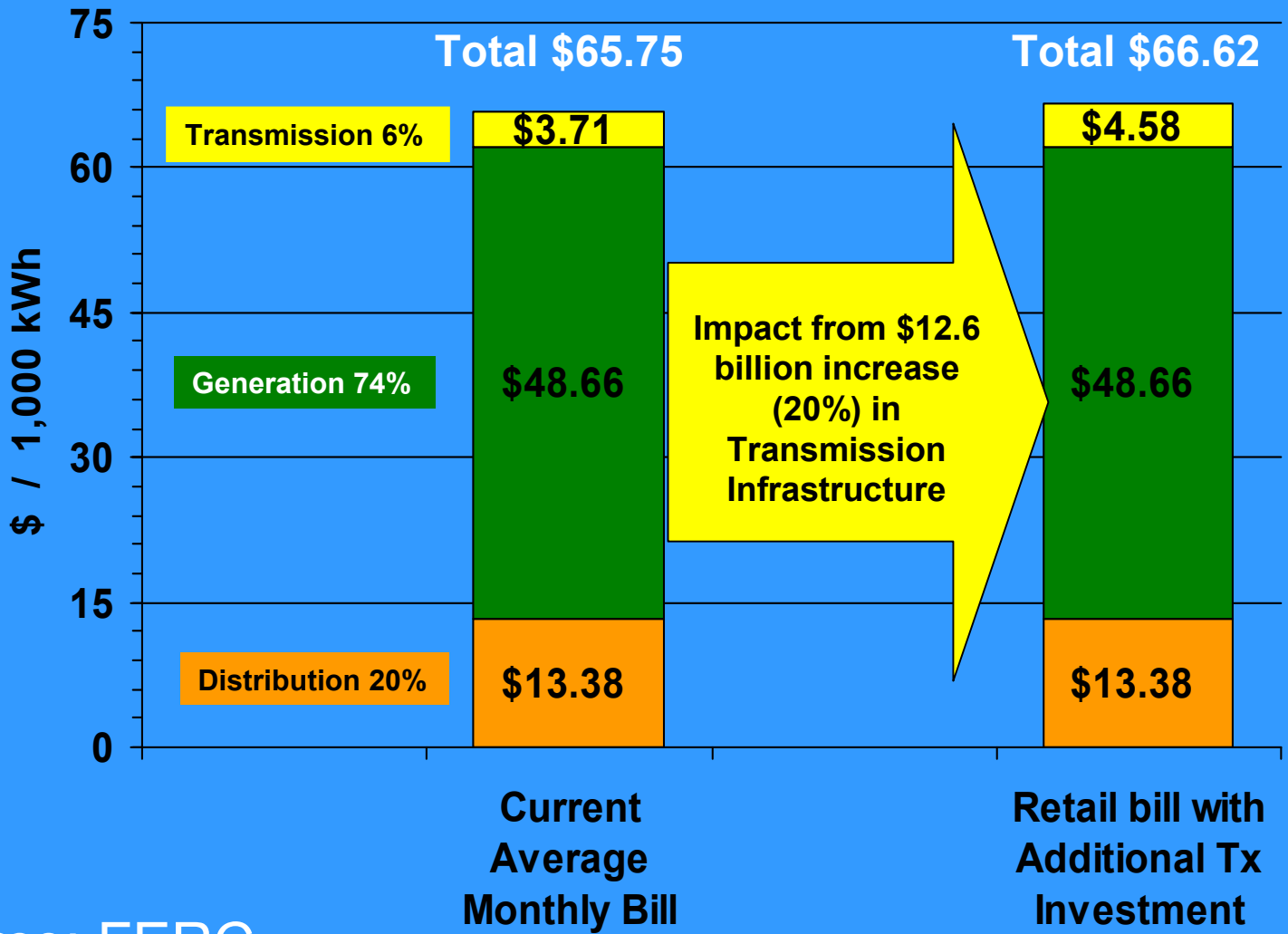
- Hirst/PJM – scaling did not account for geographic diversity
  - $0.70-2.80/MWh for imbalance payments, reduced with improved scheduling
  - $0.05-0.30/MWh for regulation, load paid $0.60/MWh
- Xcel/UWIG/Electrotek – large imbalance penalties assumed
  - 5% increased regulation with 3-4% penetration
  - $1.85/MWh for regulation, imbalance and forecasting
- PacifiCorp – preliminary findings
  - $5-6/MWh with 20% penetration
  - split between imbalance costs and reserve costs
- Nordel – very large penetration simulated, up to 21GW & 63%
  - No added regulation burden in aggregated Northern Europe
  - No impact on contingency reserves
  - 3-8% load following burden (study did not consider geographic diversity or aggregation with system)

Transmission is Most Critical Long-term Issue Facing Wind

- Current transmission system is increasingly stressed: new wires needed
- Transmission Policy
  - Tariffs and Operational Rules: difficult for non-dispatchable generators
  - Rules are evolving through FERC and RTO processes



LARGE TRANSMISSION INVESTMENTS HAVE VERY SMALL RETAIL BILL IMPACTS



Source: FERC

Emerging Opportunities

- Wind/Hydro operational synergies
- Transmission reform
  - Interconnection queue and wind generator modeling
  - FERC Standard Market Design and MISO rules
  - Infrastructure expansion (partnering with other resources)
  - Interruptible Firm service

Resources: On The Web

- AWEA Web site: http://www.awea.org
- NWTC Web site: http://www.nrel.gov/wind
- National Wind Coordinating Committee: http://www.nationalwind.org
- Utility Wind Interest Group site: http://www.uwig.org
- WPA Web site:

  http://www. Windpoweringamerica.gov
- Homepower Web Site: http://www.homepower.com
- Windustry Project: http://www.windustry.com
- Best Links: www.me3.org

Carpe Ventem