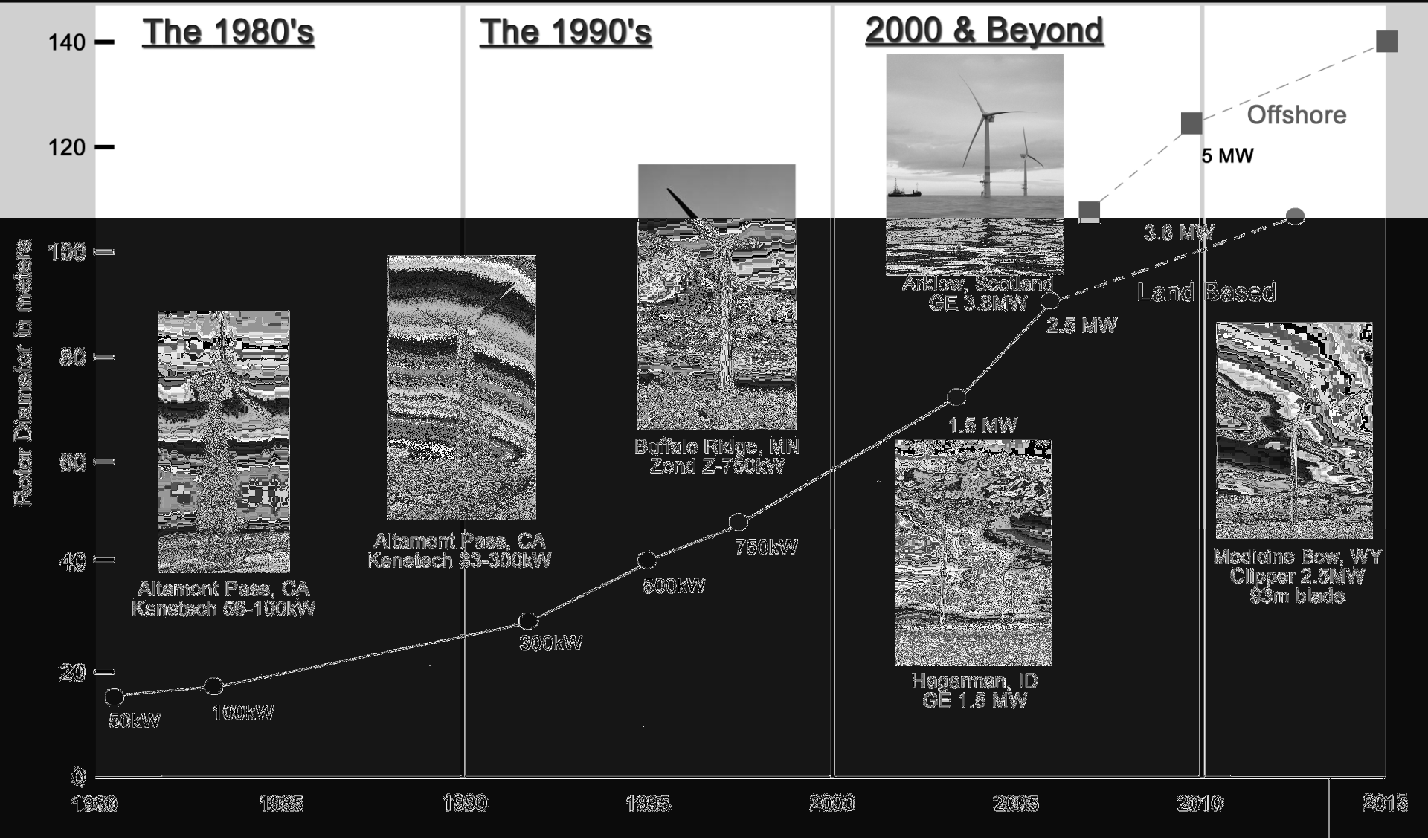
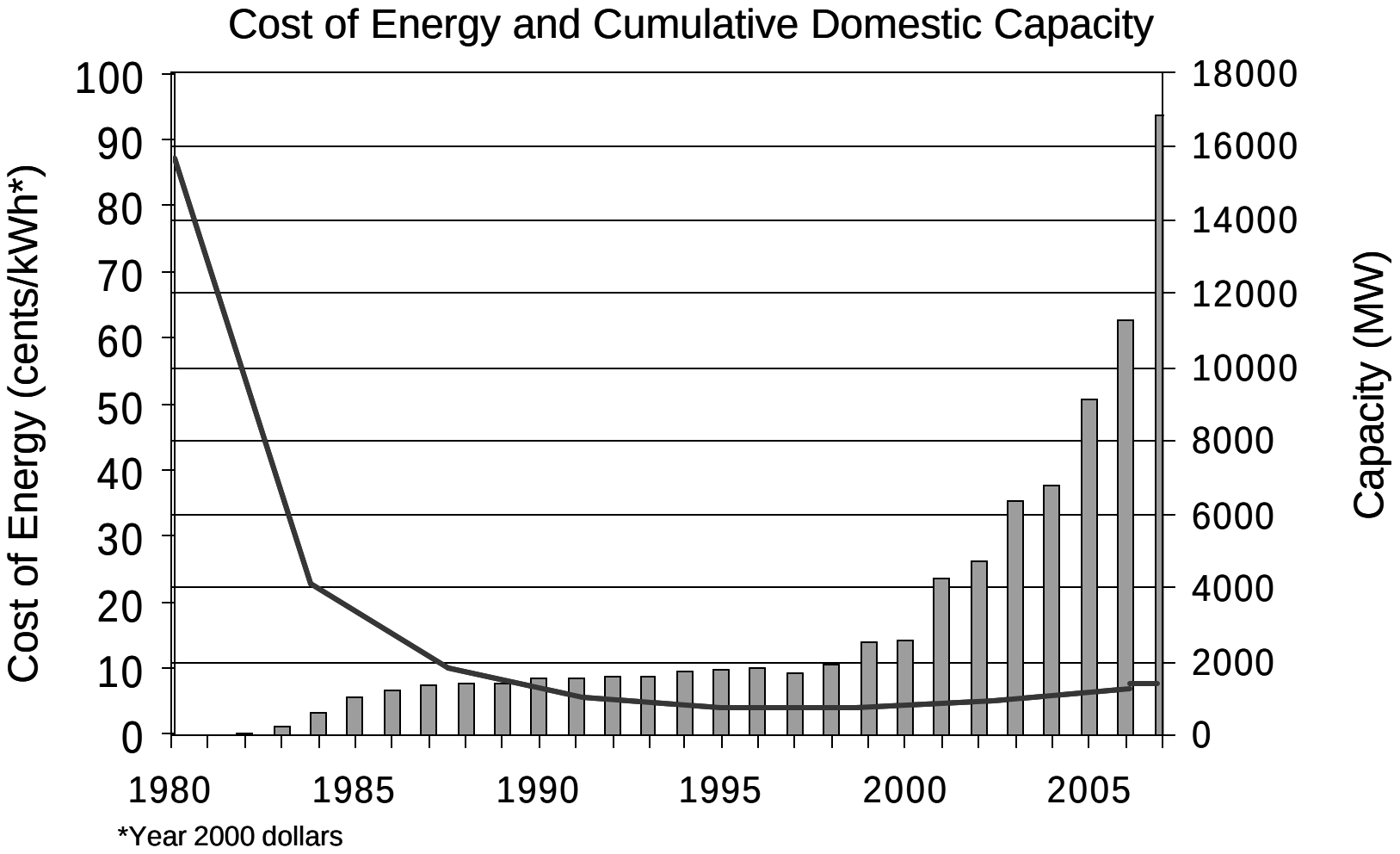
Wind Energy Update

RMLUI 2008 Land Use Conference
Ron Lehr, Presenter
Presentation by Larry Flowers
National Renewable Energy Laboratory

Evolution of U.S. Commercial Wind Technology



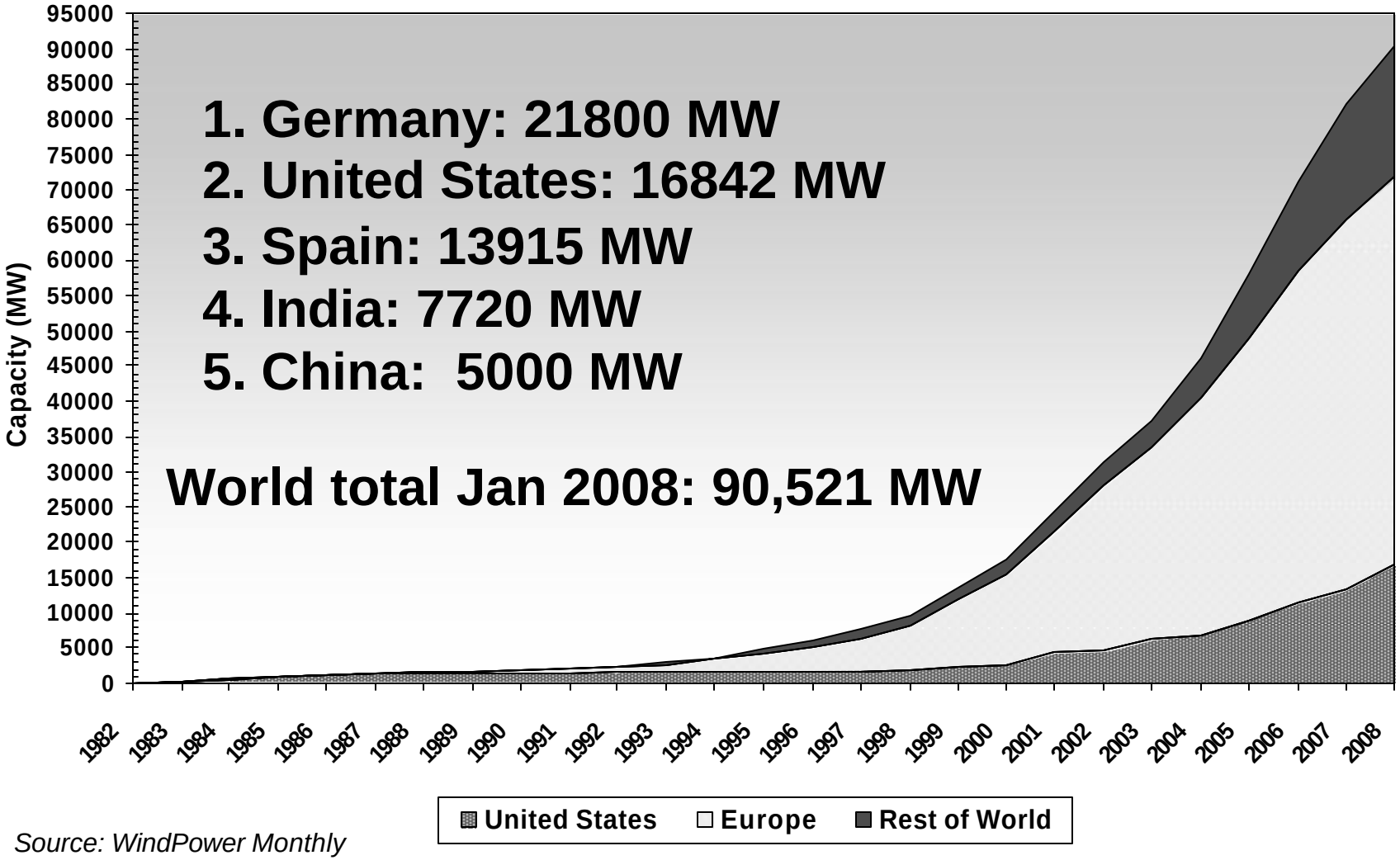
Capacity & Cost Trends



Increased Turbine Size - R&D Advances - Manufacturing Improvements

People Want Renewable Energy!

Total Installed Wind Capacity



Source: WindPower Monthly

U.S. Leads World in Annual Wind Capacity Additions; Second in Cumulative Capacity

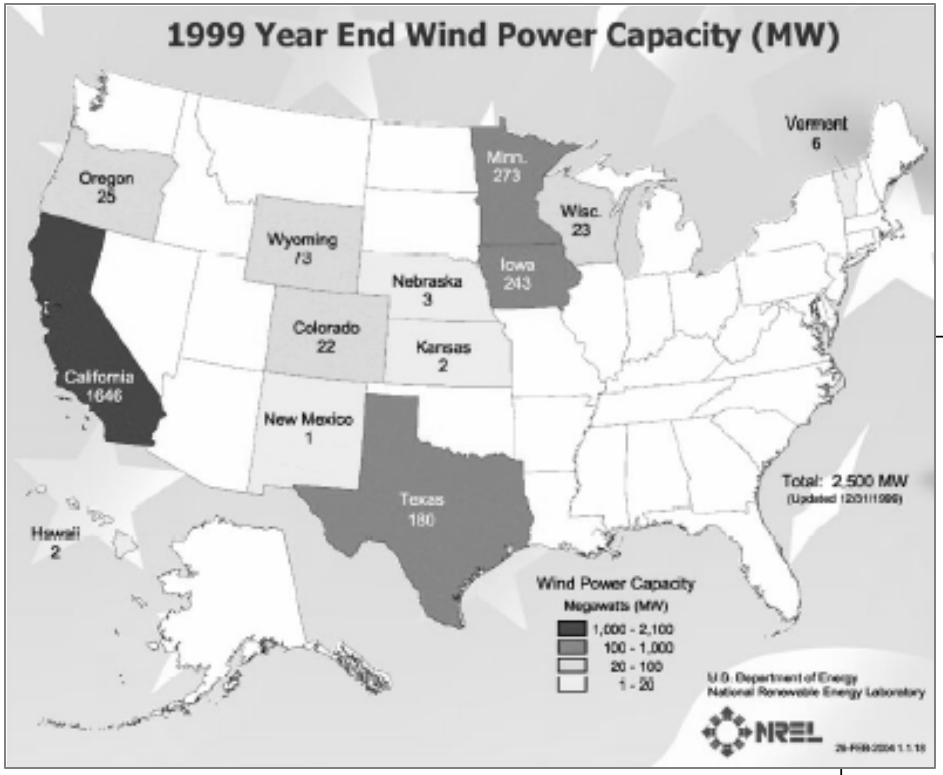
International Rankings of Wind Power Capacity

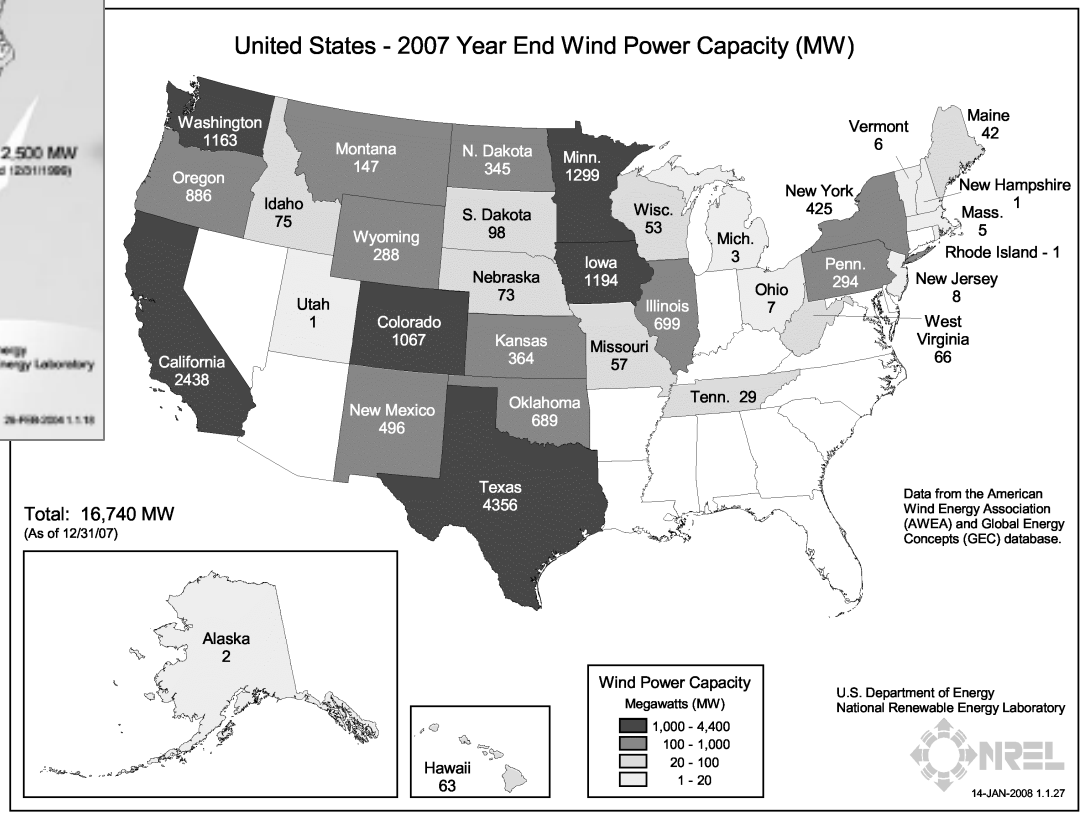
Cumulative Capacity (end of 2007, MW)	
Germany	21,800
United States	16,842
Spain	13,915
India	7,720
China	5,000
Denmark	3,132
France	2,624
Rest of World	19,488
Total	**90,521**

Incremental Capacity (2007, MW)	
United States	5,144
China	2,406
Spain	2,300
India	1,450
Germany	1,178
France	1,155
Portugal	494
Rest of World	5,248
Total	**19,375**

Data source: Windpower Monthly Windicator, January 2008

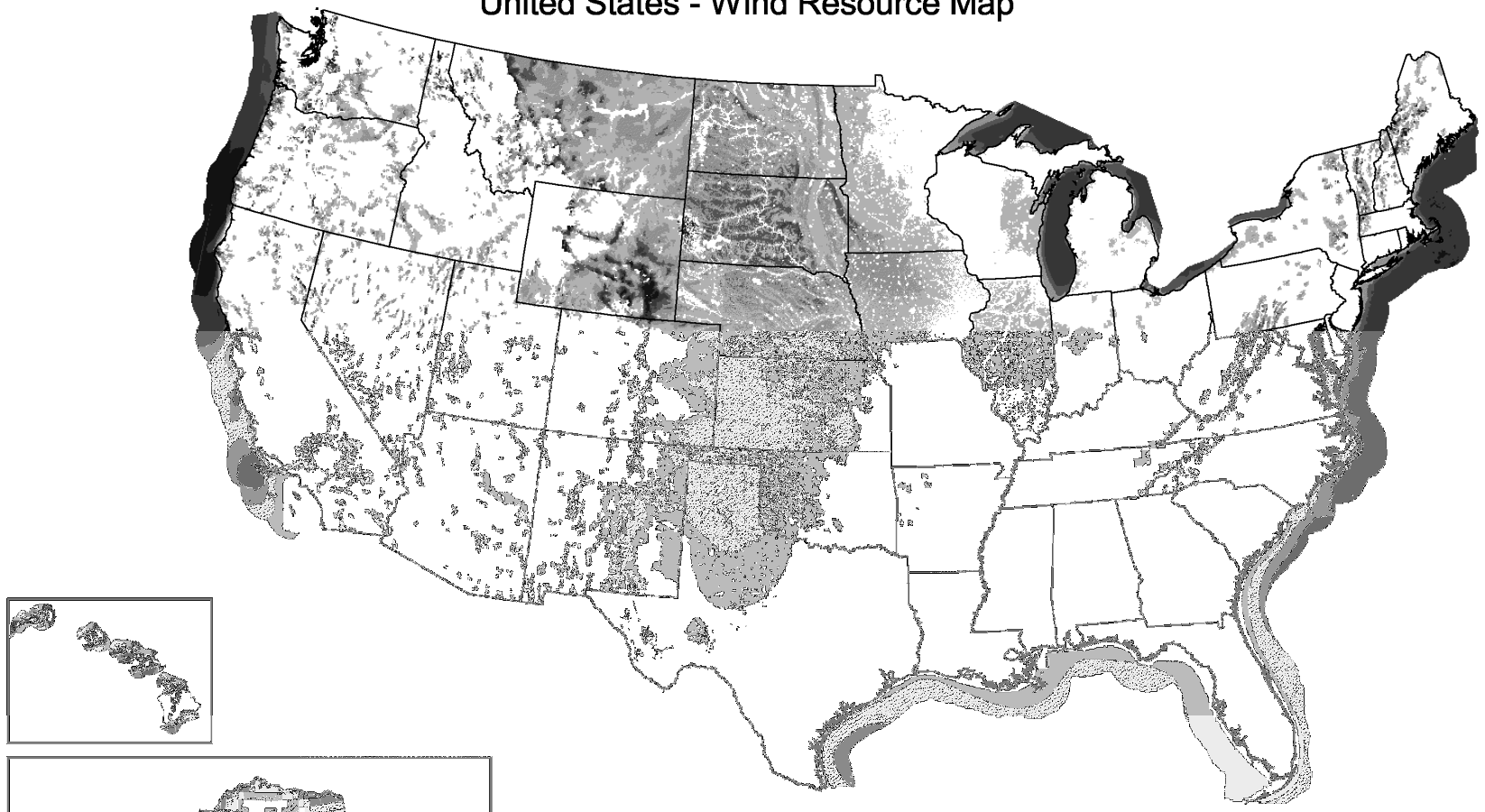
Installed Wind Capacities
(‘99 – Dec ’07*)

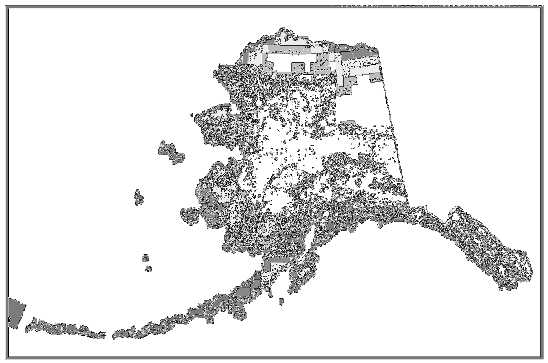




*Preliminary data

United States - Wind Resource Map





Wind Power Classification

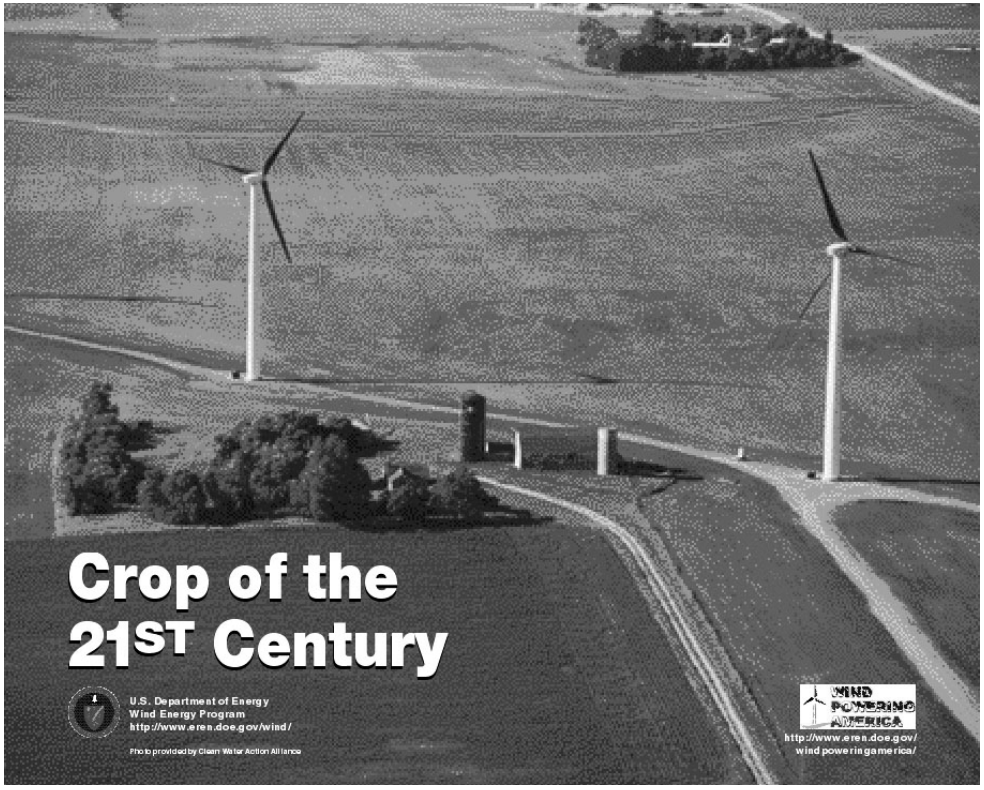
Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m²	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

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

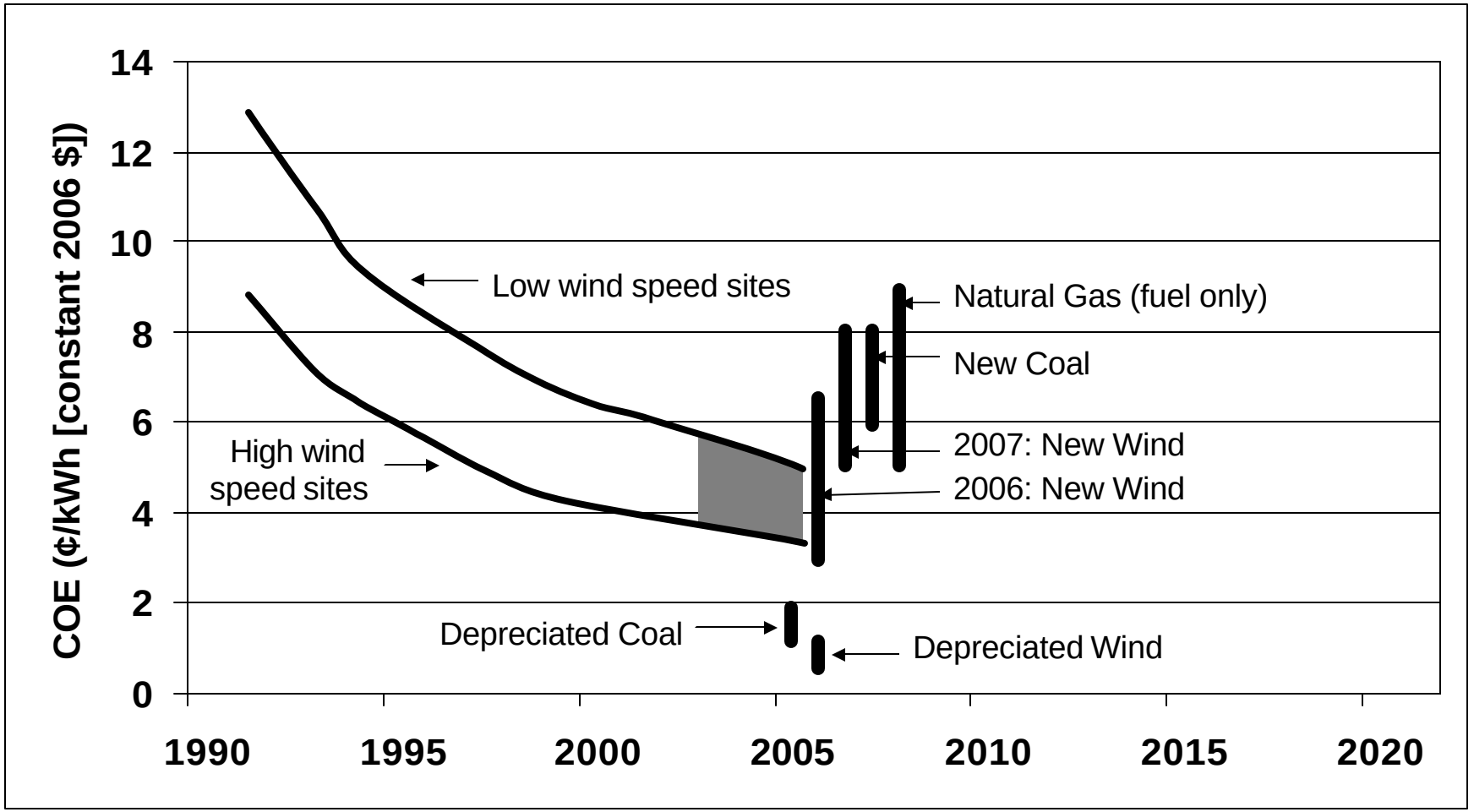
U.S. Department of Energy
National Renewable Energy Laboratory

Drivers for Wind Power

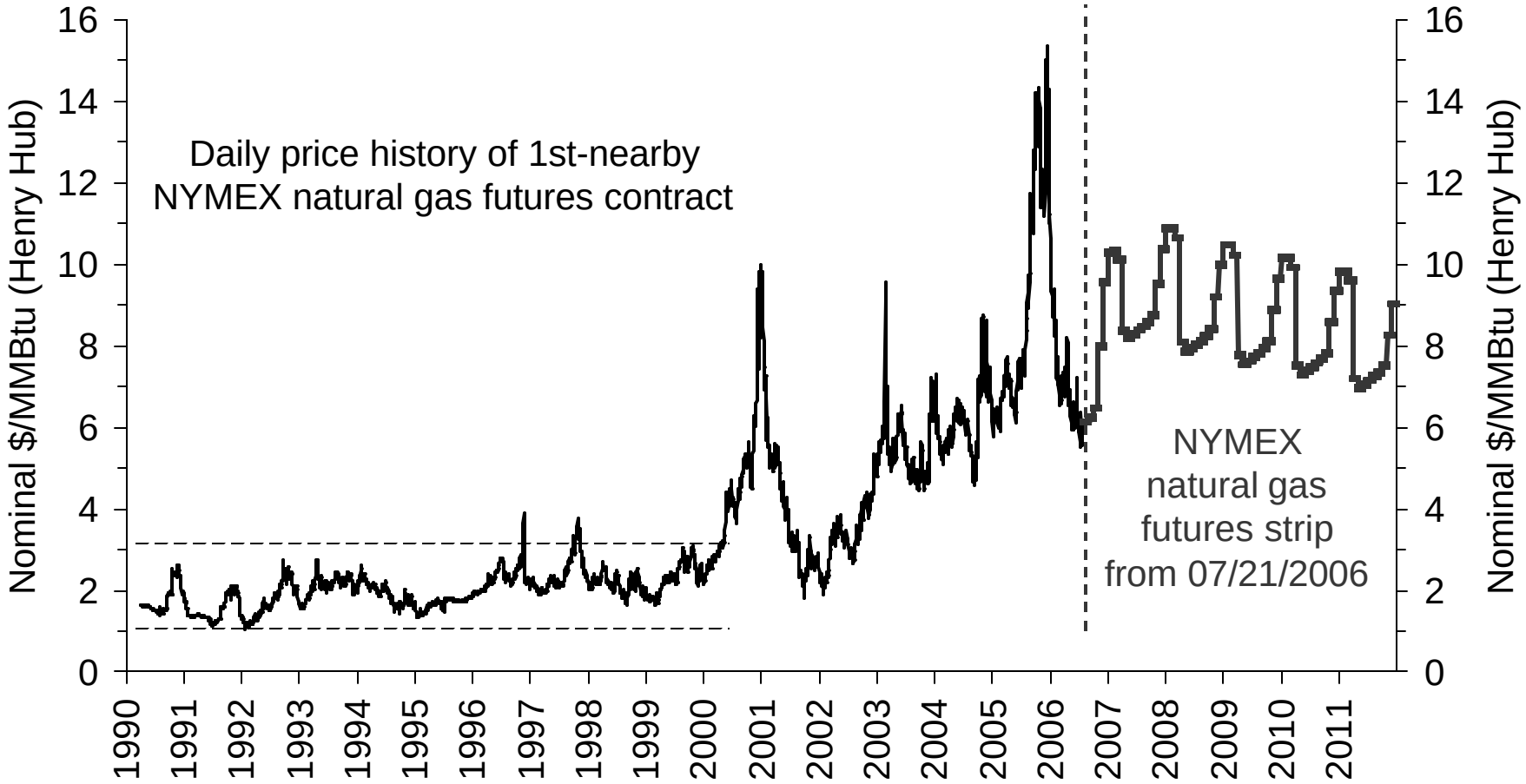
- Declining Wind Costs
- Fuel Price Uncertainty
- Federal and State Policies
- Economic Development
- Public Support
- Green Power
- Energy Security
- Carbon Risk



Wind Cost of Energy



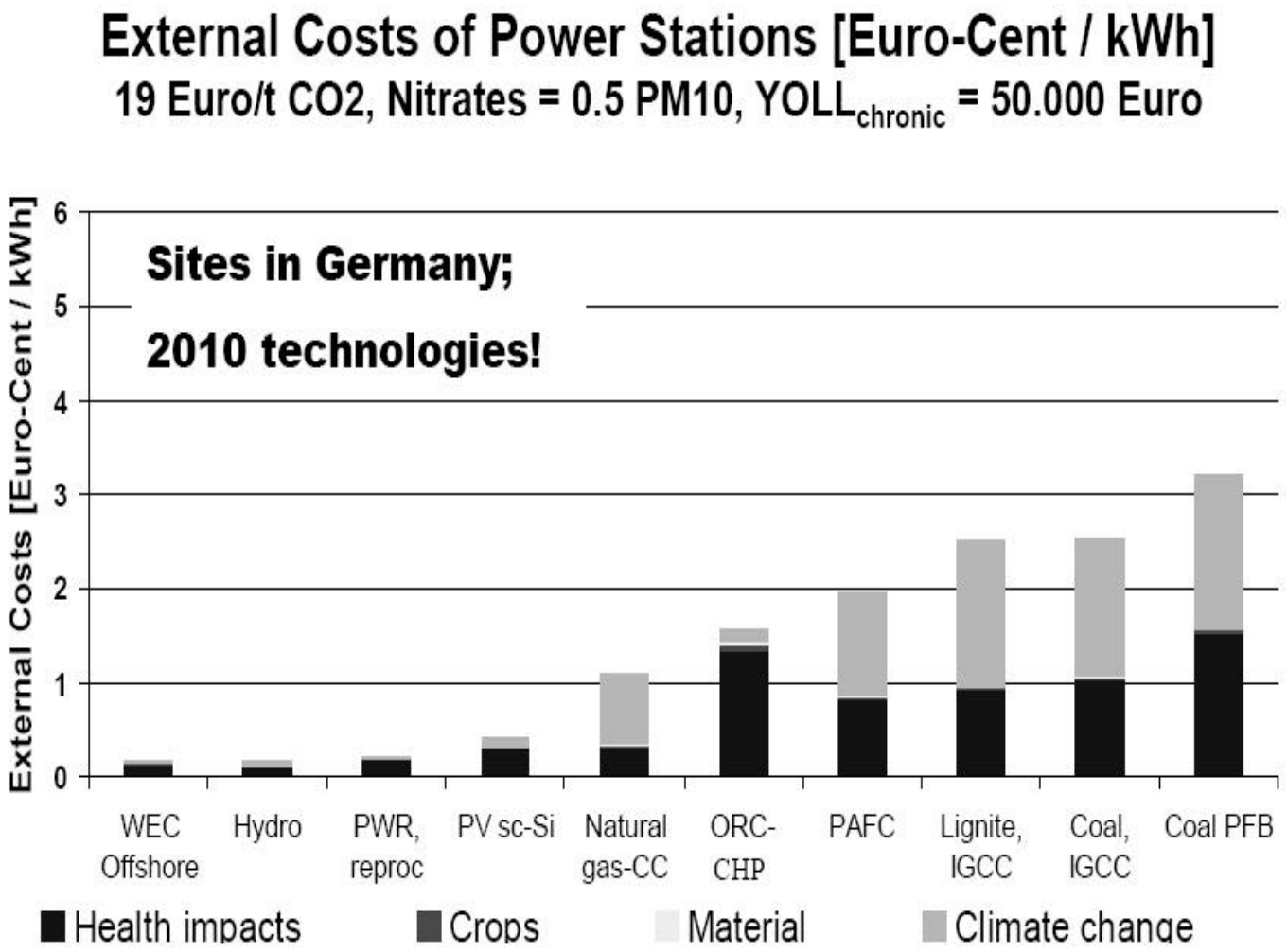
Natural Gas – Historic Prices



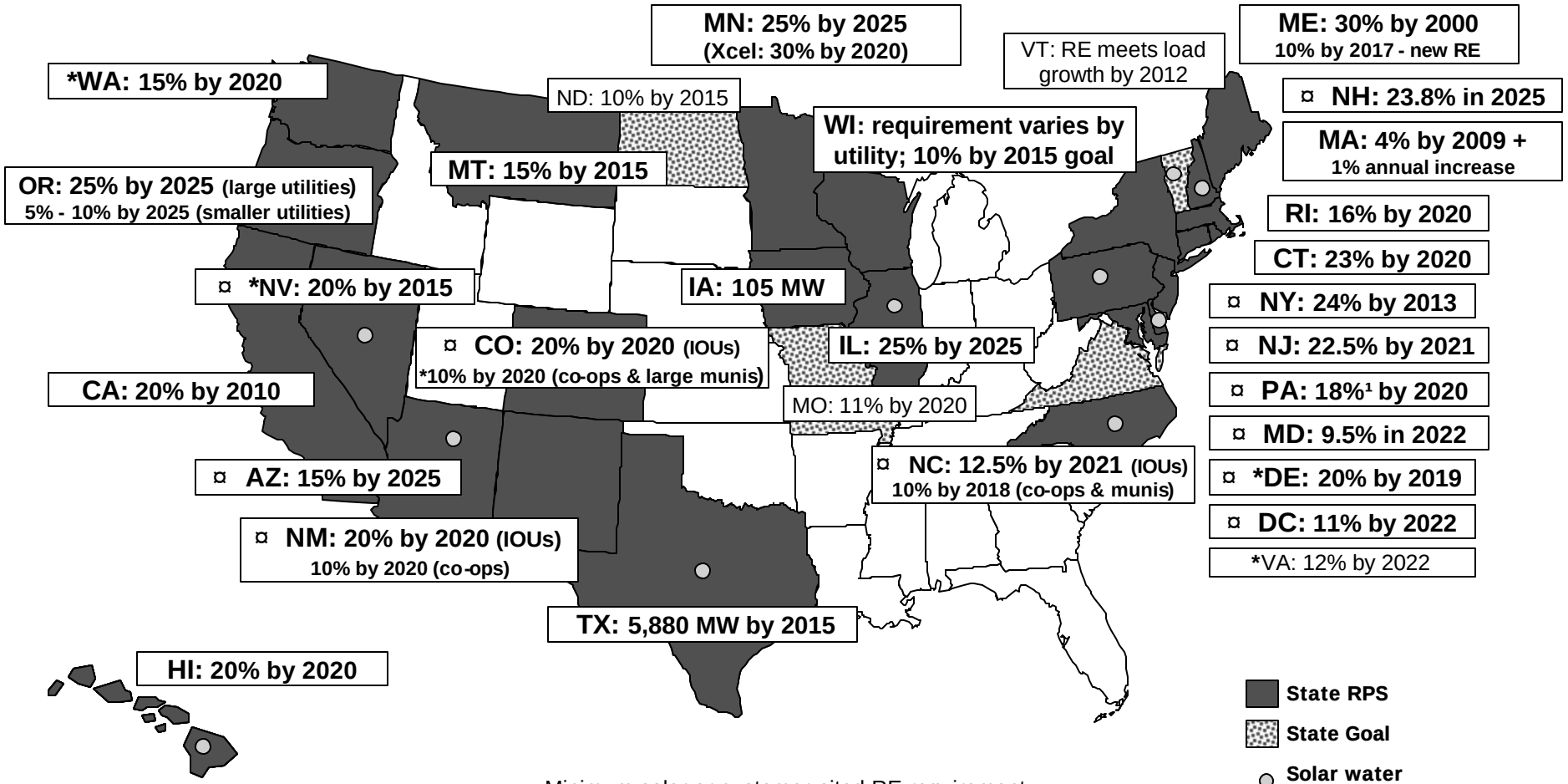
Source: LBNL

Major Market Distortion: External Costs of Fossil Fuels not Reflected in Pricing

(The PTCs are a bargain)



Renewables Portfolio Standards



¤ Minimum solar or customer-sited RE requirement
* Increased credit for solar or customer-sited RE
¹PA: 8% Tier I / 10% Tier II (includes non-renewables)

DSIRE: www.dsireusa.org

January 2008

Wind Energy Investors



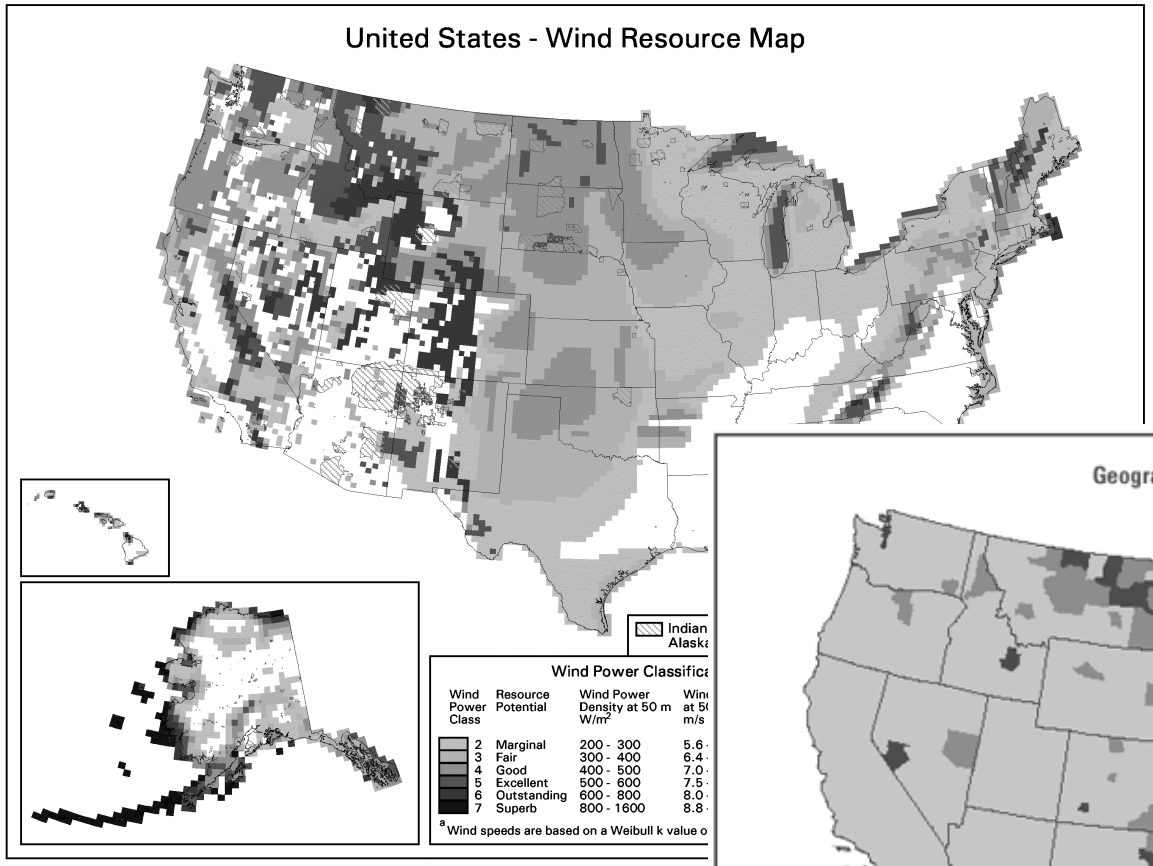
BP Solar

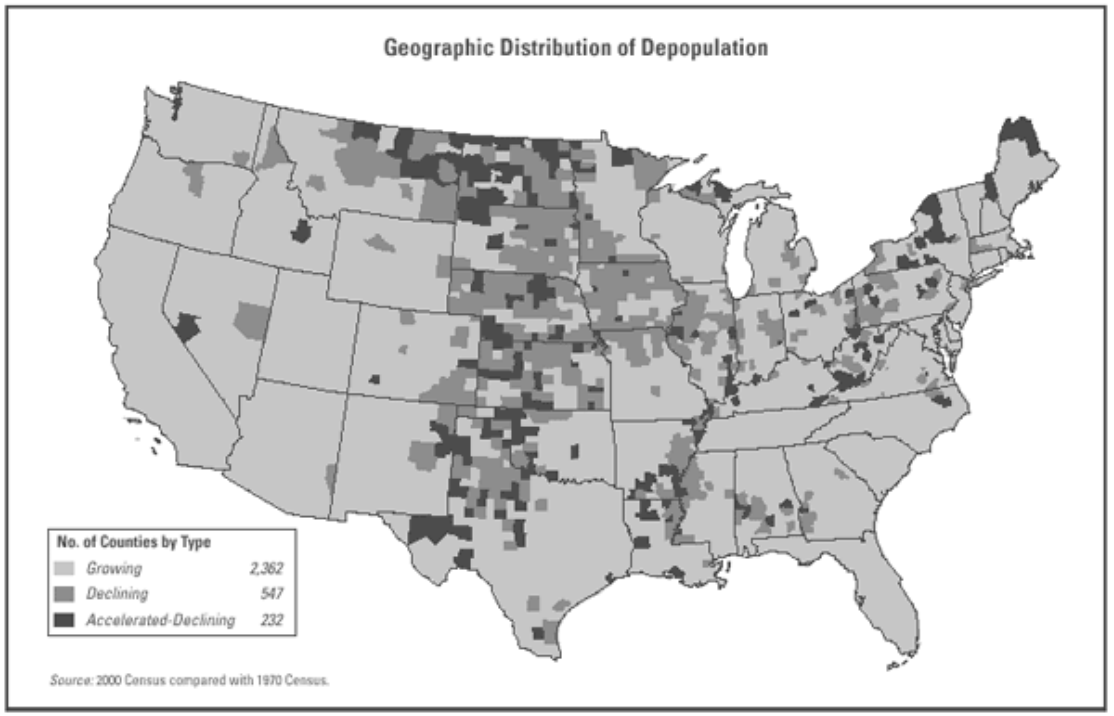
JOHN DEERE


Economic Development Impacts

- **Land Lease Payments**: 2-3% of gross revenue $2500-4000/MW/year
- **Local property tax** revenue: ranges widely - $300K-1700K/yr per 100MW
- 100-200 **jobs**/100MW during construction
- 6-10 permanent O&M **jobs** per 100 MW
- Local construction and service industry: concrete, towers usually done locally

Windy Rural Areas Need Economic Development





Case Study: Texas

Utilities and wind companies invested $1B in 2001 to build 912 MW of new wind power, resulting in:

- **2,500 quality jobs with a payroll of $75M**
- $13.3M in tax revenues for schools and counties
- $2.5M in 2002 royalty income to landowners
- Another 2,900 indirect jobs as a result of the multiplier effect
- $4.6M increase in Pecos County property tax revenue in 2002

Case Study: Minnesota

107-MW Minnesota wind project

- **$500,000/yr in lease payments to farmers**
- $611,000 in property taxes in 2000 = 13% of total county taxes
- 31 long-term local jobs and $909,000 in income from O&M (includes multiplier effect)

Case Study: Iowa

240-MW Iowa wind project

- $640,000/yr in lease payments to farmers ($2,000/turbine/yr)
- $2M/yr in property taxes
- $5.5M/yr in O&M income
- **40 long-term O&M jobs**
- **200 short-term construction jobs**
- Doesn't include multiplier effect

Case Study: New Mexico

- 204-MW wind project built in 2003 in DeBaca and Quay counties for PNM
- 150 construction jobs
- 12 permanent jobs and $550,000/yr in salaries for operation and maintenance
- $550,000/year in lease payments to landowners
- **$450,000/year in payments in lieu of taxes to county and school districts**
- Over $40M in economic benefits for area over 25 years

Photo: PNM

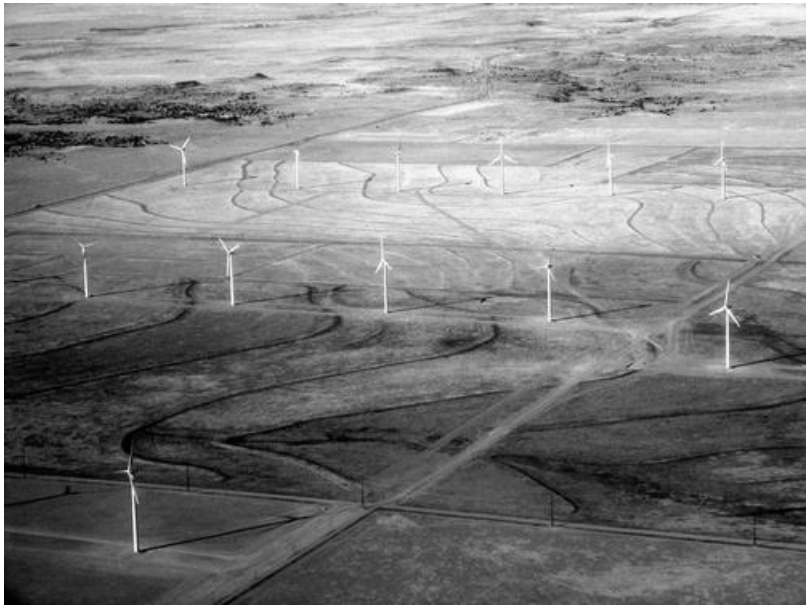
Source: PNM, New Mexico Wind Energy Center Quick Facts, 2003.

Case Study: Hyde County, South Dakota

40-MW wind project in South Dakota creates $400,000 - $450,000/yr for Hyde County, including:

- More than $100,000/yr in annual lease payments to farmers ($3,000 - $4,000/turbine/yr)
- $250,000/yr in property taxes (25% of Highmore's education budget)
- 75 -100 construction jobs for 6 months
- 5 permanent O&M jobs
- Sales taxes up more than 40%
- Doesn't include multiplier effect

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

Local Ownership Models

- Minnesota farmer cooperative (Minwind)
- FLIP structure
- Farmer-owned small wind
- Farmer-owned commercial-scale

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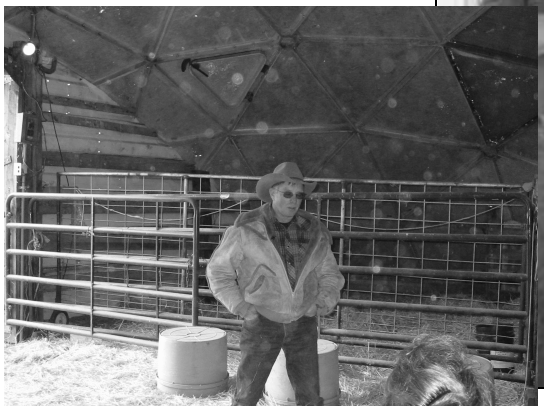
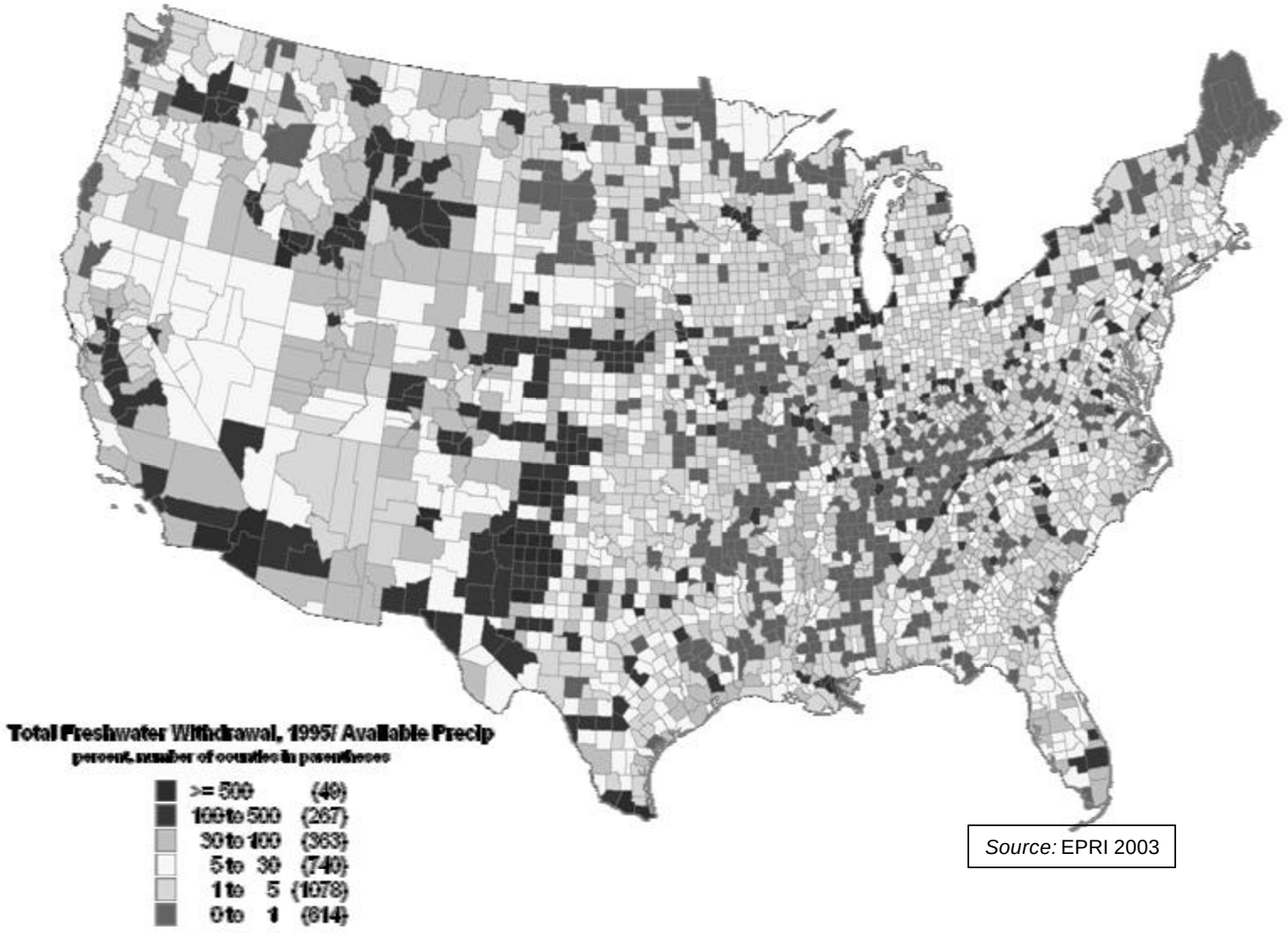


Environmental Benefits

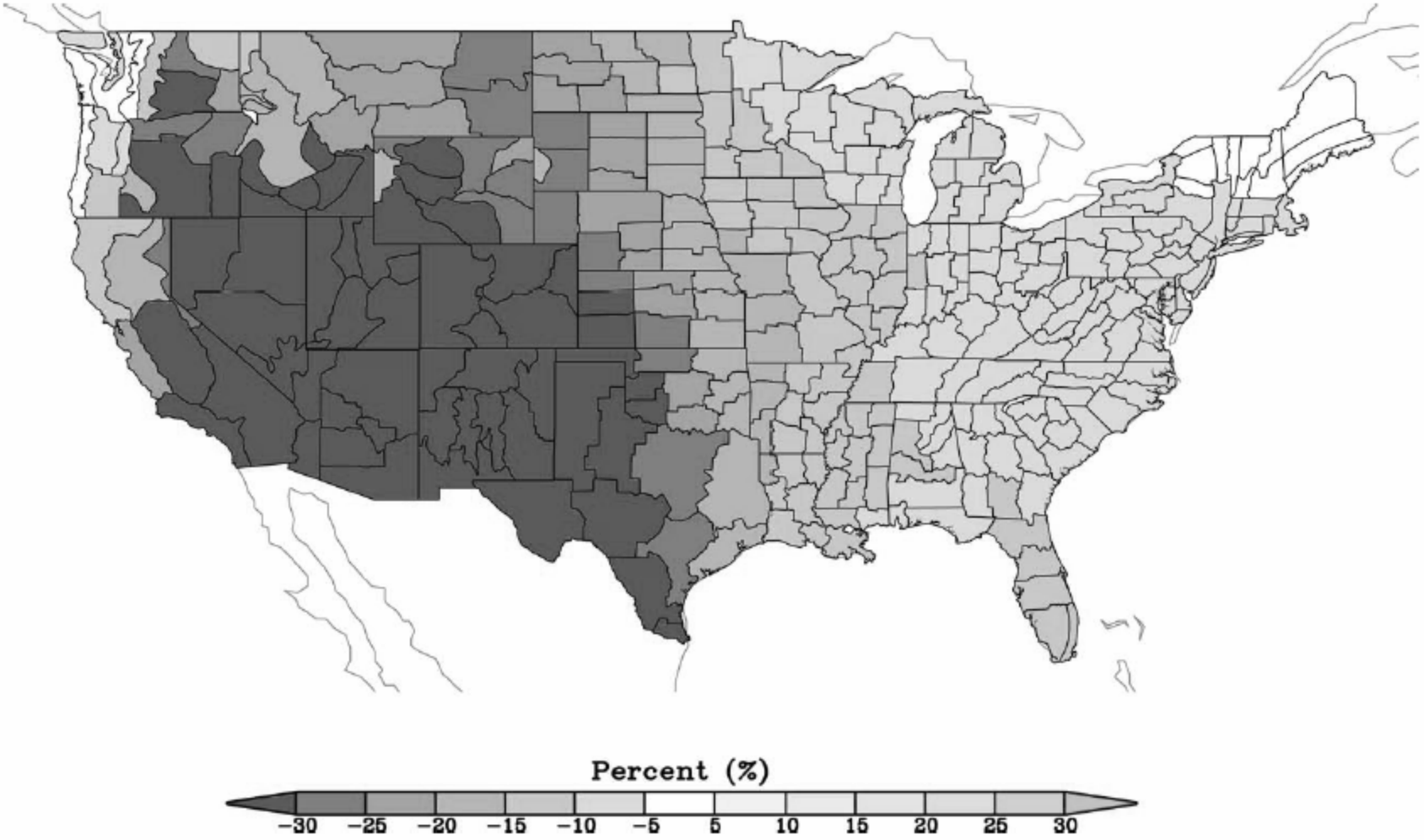
- No SOx or NOx
- No particulates
- No mercury
- No CO2
- No water

Sustainable Withdrawal Of Freshwater Is National Issue



Source: EPRI 2003

Change in Annual (PCPN-Potential Evapotranspiration) 2035-2060



Source: NOAA

Key Issues for Wind Power

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

Integrating Wind into Power Systems

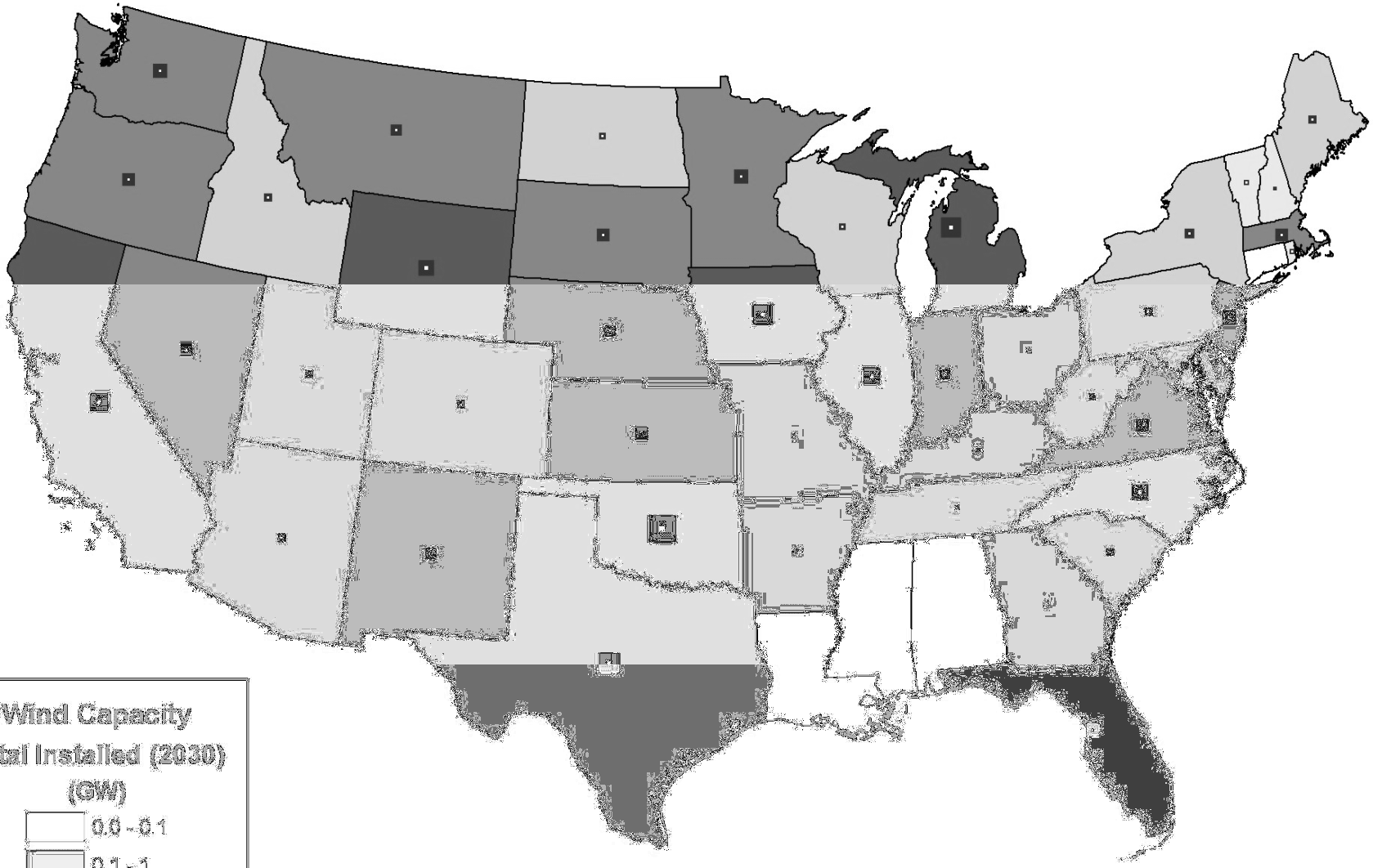
Table 6. Key Results from Major Wind Integration Studies Completed 2003-2006

Date	Study	Wind Capacity Penetration	Cost ($/MWh)				
			Regulation	Load Following	Unit Commitment	Gas Supply	TOTAL
2003	Xcel-UWIG	3.5%	0	0.41	1.44	na	1.85
2003	We Energies	4%	1.12	0.09	0.69	na	1.90
2003	We Energies	29%	1.02	0.15	1.75	na	2.92
2004	Xcel-MNDOC	15%	0.23	na	4.37	na	4.60
2005	PacifiCorp	20%	0	1.6	3	na	4.60
2006	CA RPS (multi-year)	4%	0.45*	trace	na	na	0.45
2006	Xcel-PSCo	10%	0.2	na	2.26	1.26	3.72
2006	Xcel-PSCo	15%	0.2	na	3.32	1.45	4.97
2006	MN-MISO 20%	31%	na	na	na	na	4.41**

** 3-year average* *** highest over 3-year evaluation period*

Source: National Renewable Energy Laboratory.

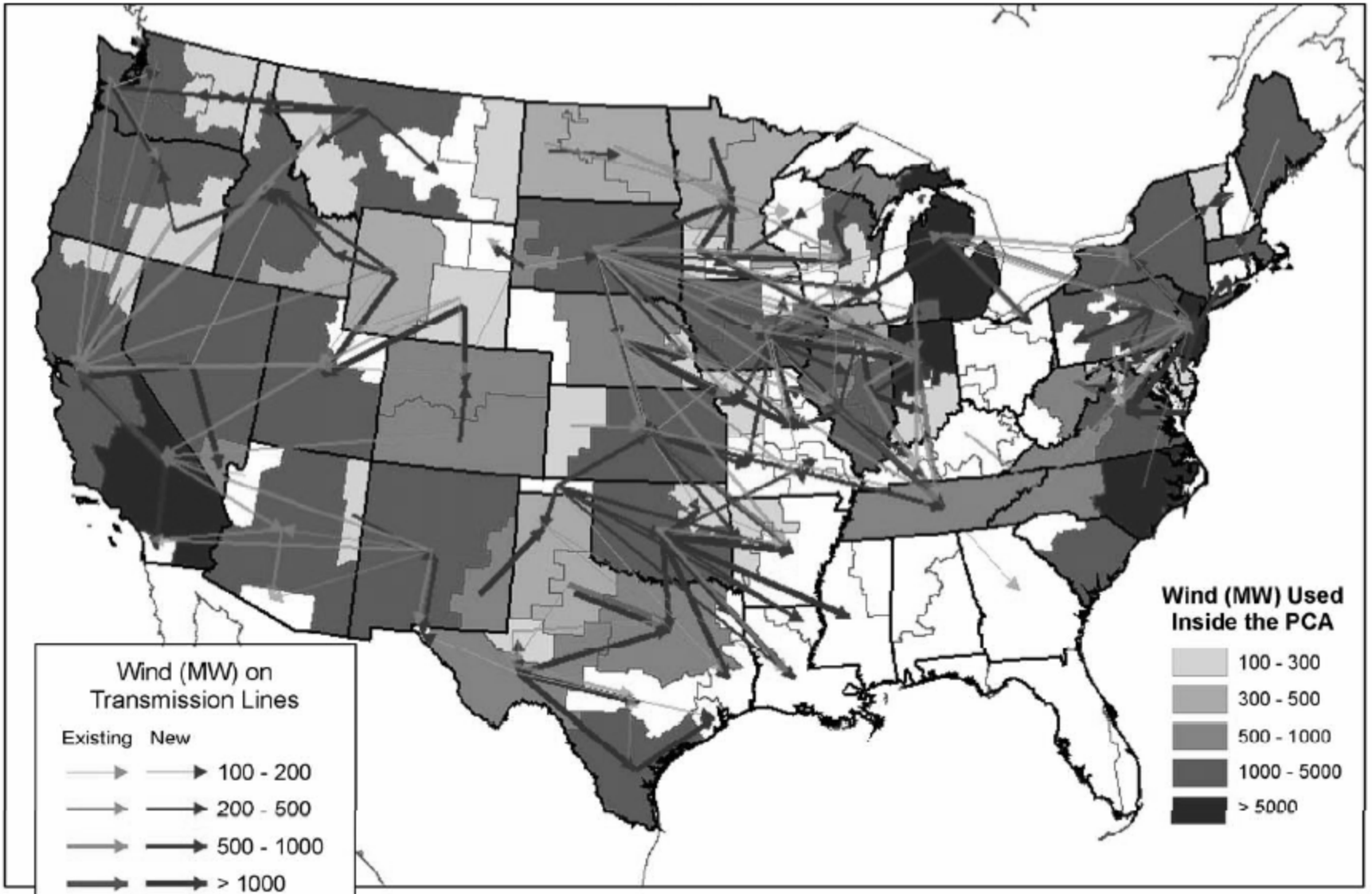
Installed Wind Nameplate Capacity by State (2030)



The black square in the center of a state represents the land area needed for a single wind farm to produce the projected installed capacity in that state. The white square represents the actual land area that would be dedicated to the wind turbines (2% of the black square).

2030 - Between PCA Transfers and In-PCA Use for Wind (All Classes)

Total Between PCA Transfer >= 100 MW (all power classes, onshore and offshore)
Arrows originate and terminate at the centroid of the PCA for visualization purposes; they do not represent physical locations of transmission lines.



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