

Wind Energy Update and the 20% Wind Scenario



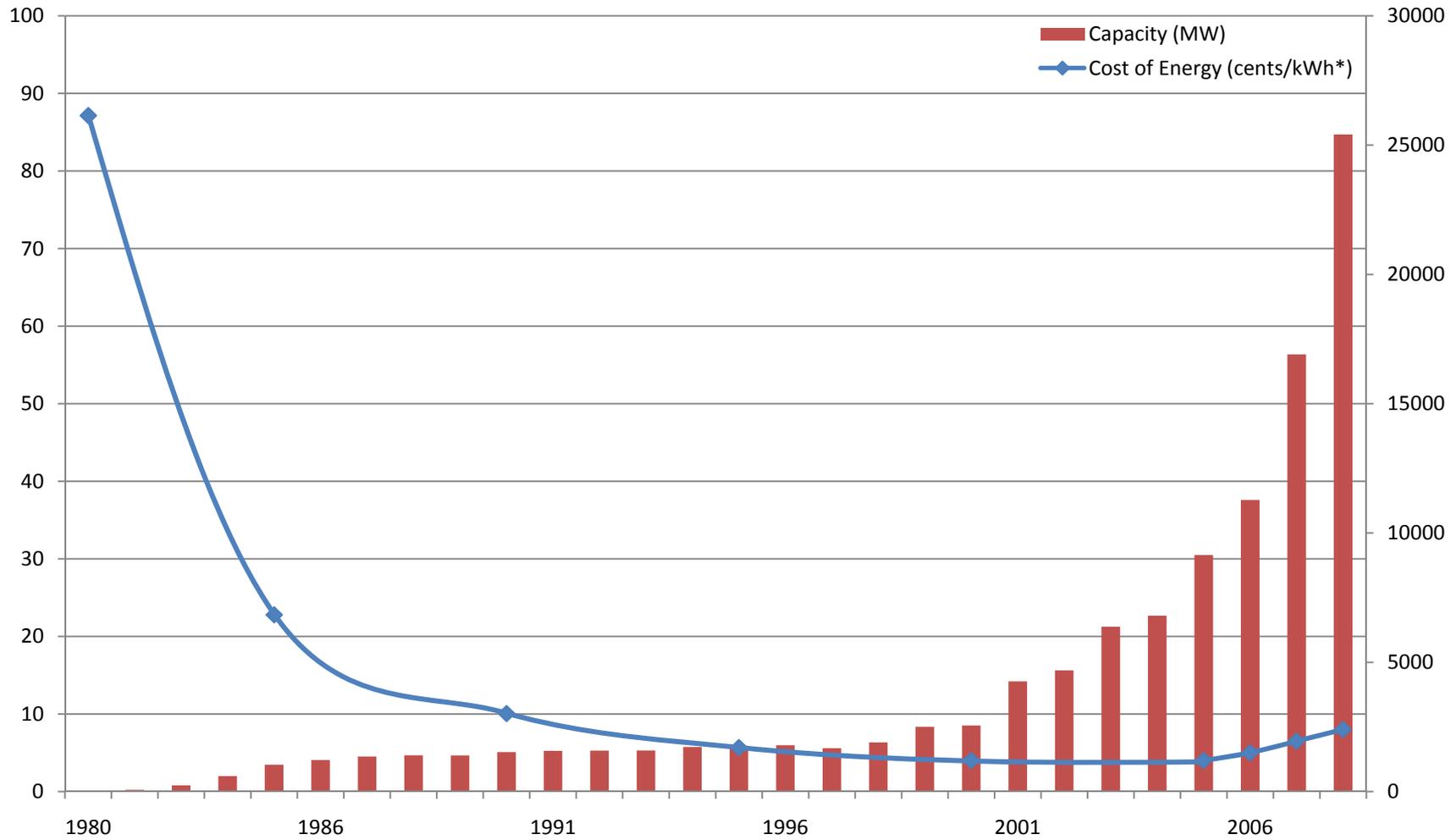
Larry Flowers

National Renewable Energy Laboratory

March 2009

Capacity & Cost Trends

Cost of Energy and Cumulative Domestic Capacity

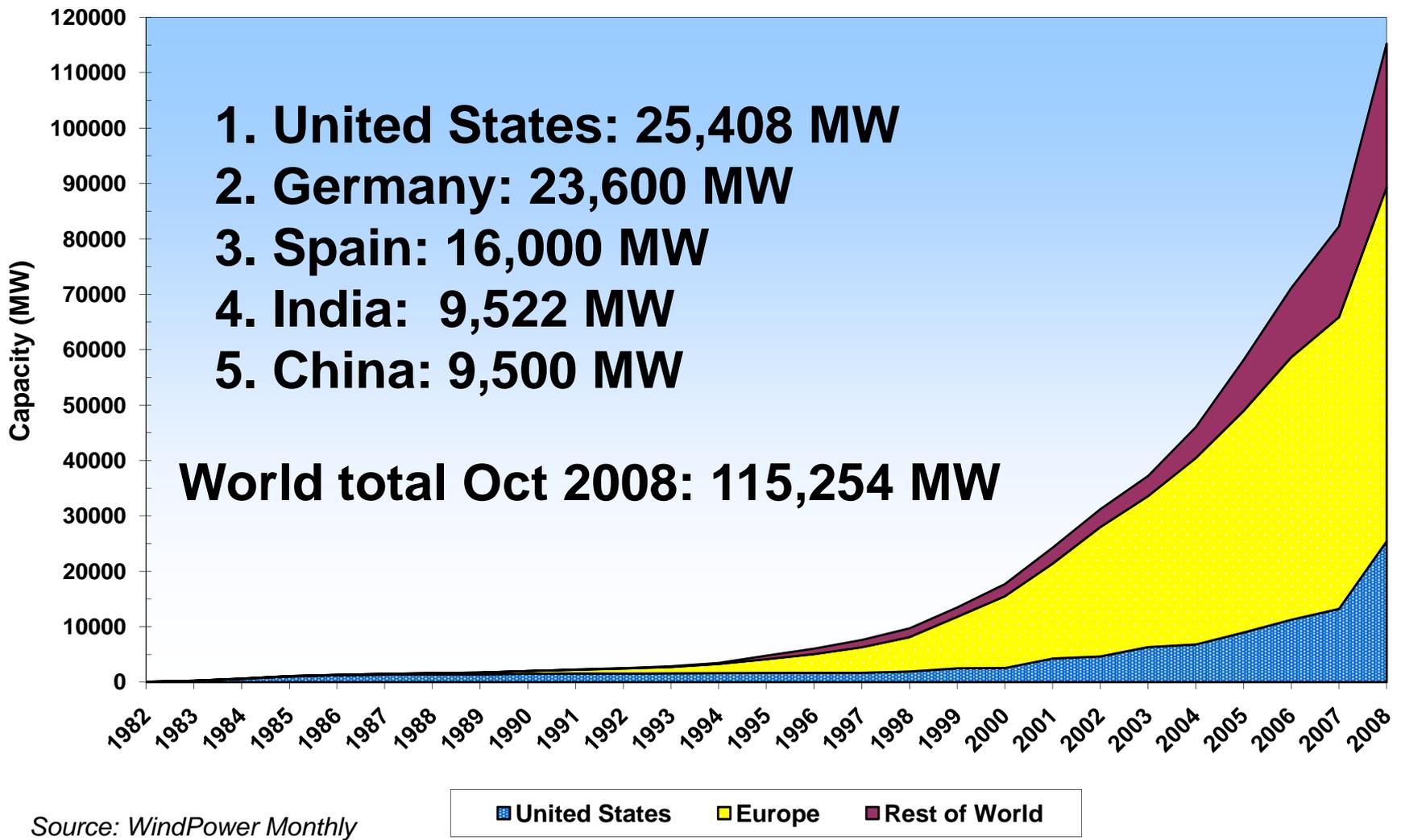


*Year 2000 dollars

Increased Turbine Size - R&D Advances - Manufacturing Improvements

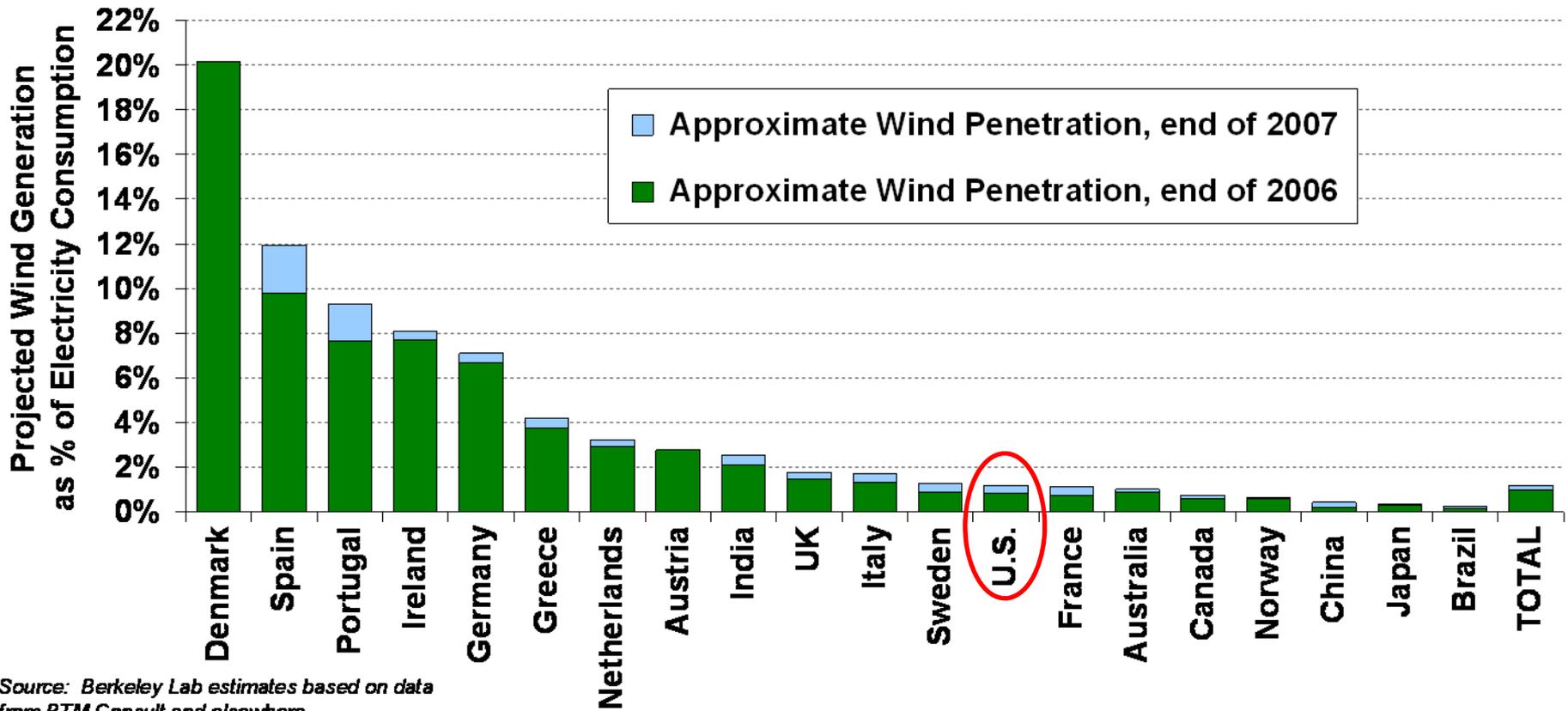
People Want Renewable Energy!

Total Installed Wind Capacity



Source: WindPower Monthly

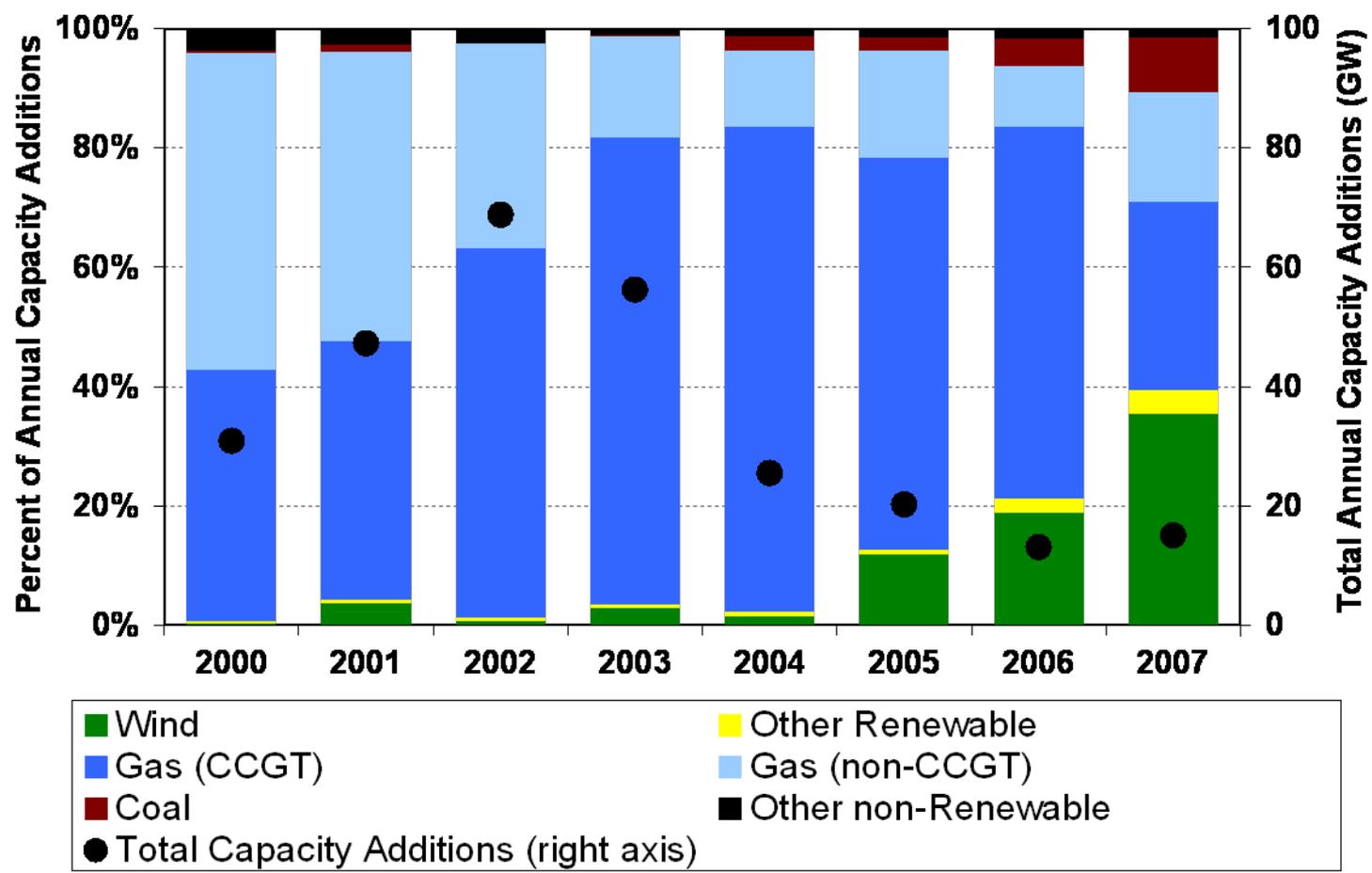
U.S Lagging Other Countries in Wind As a Percentage of Electricity Consumption



Source: Berkeley Lab estimates based on data from BTM Consult and elsewhere

Note: Figure only includes the 20 countries with the most installed wind capacity at the end of 2007

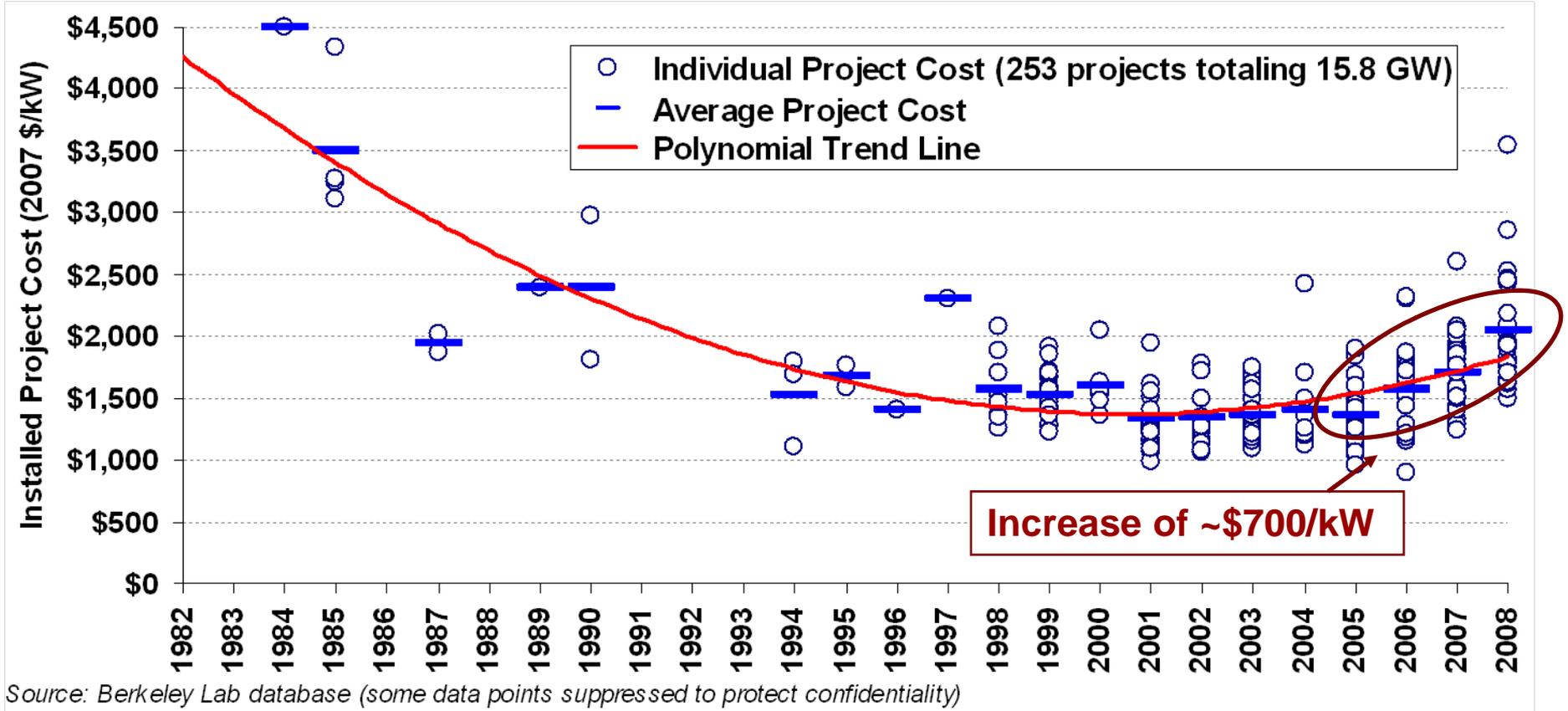
Wind Power Contributed 35% of All New Generating Capacity in the US in 2007



- Wind was the 2nd-largest resource added for the 3rd-straight year
- Up from 19% in 2006, 12% in 2005, and <4% in 2000-2004

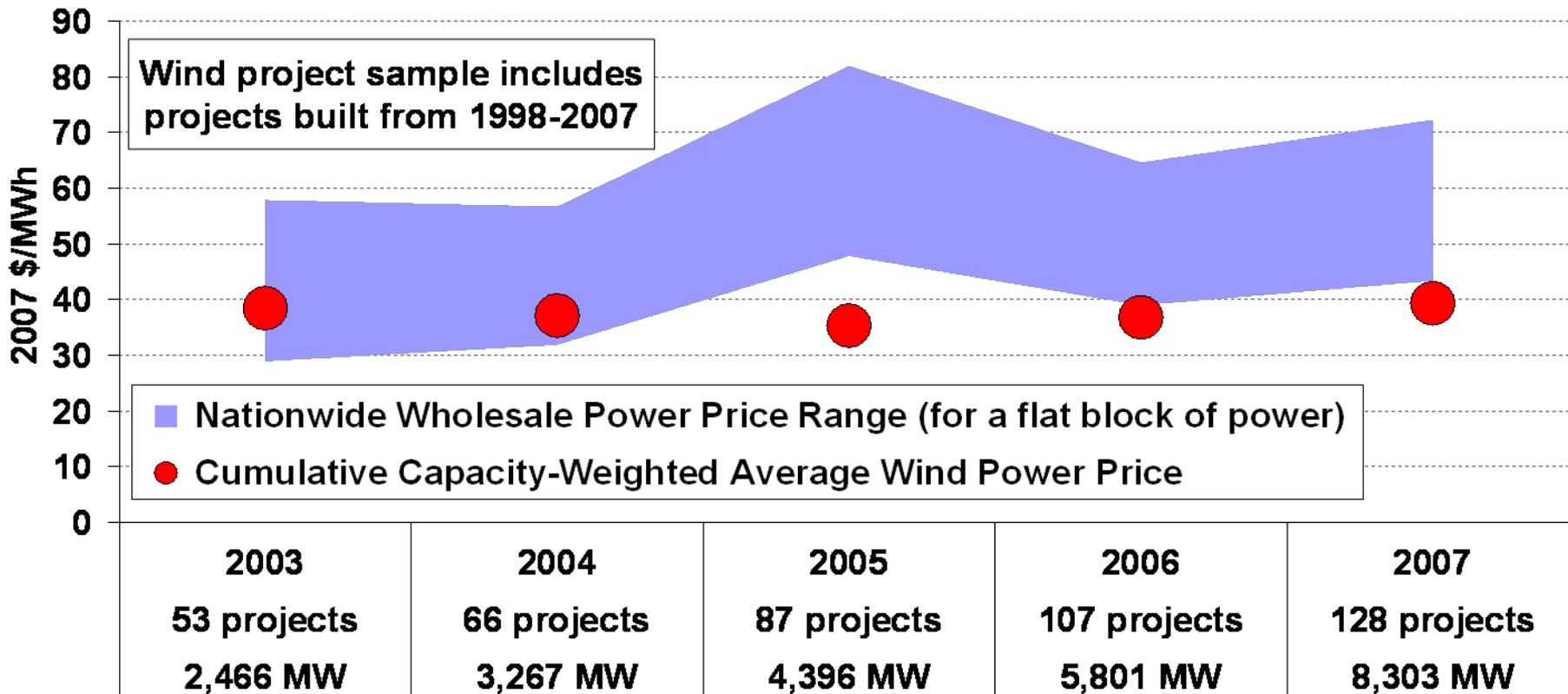
Source: EIA, Ventyx, AWEA, IREC, Berkeley Lab

Installed Project Costs Are On the Rise, After a Long Period of Decline



Note: Includes 227 projects built from 1983-2007, totaling ~13 GW (77% of capacity at end of 2007); additional ~2.8 GW of projects proposed for installation in 2008

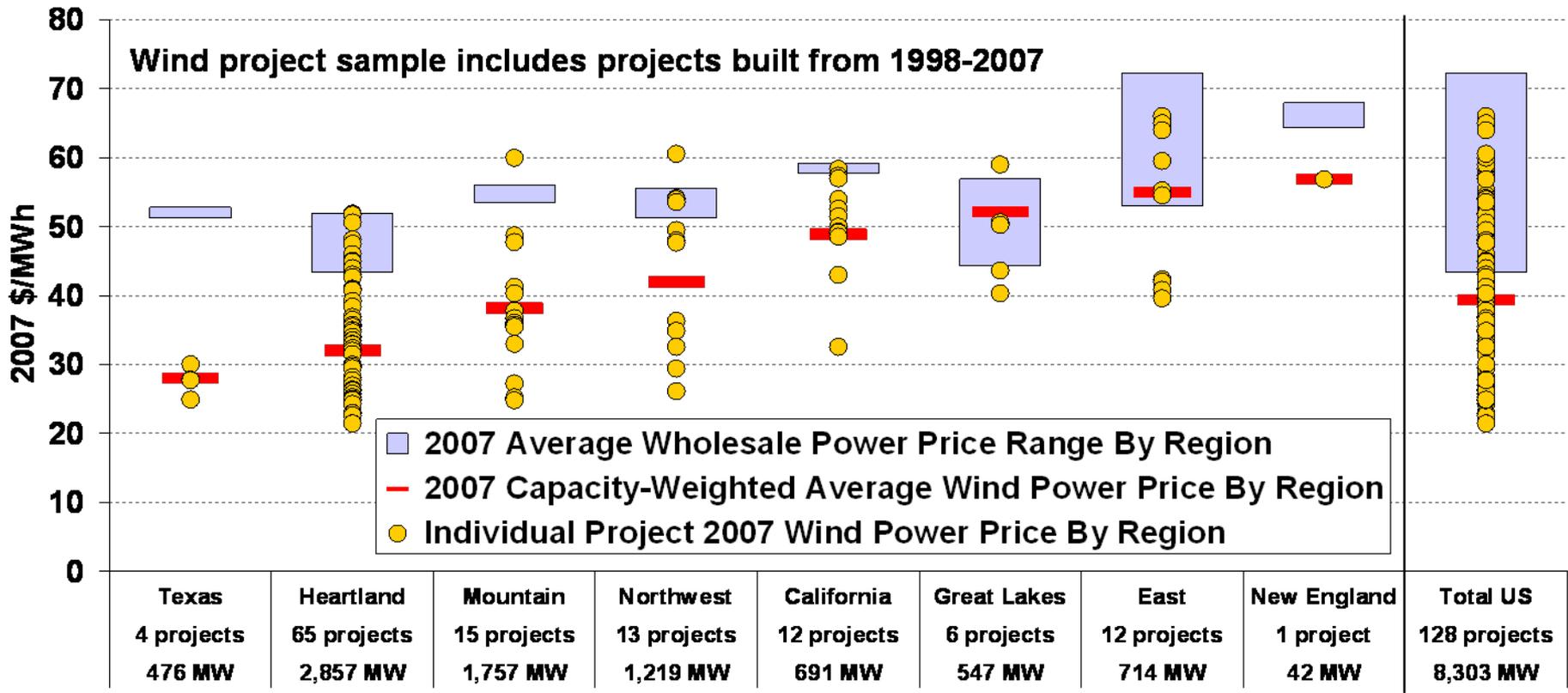
Wind Has Been Competitive with Wholesale Power Prices in Recent Years



Source: FERC 2006 and 2004 "State of the Market" reports, Berkeley Lab database, Ventyx

- Wholesale price range reflects flat block of power across 23 pricing nodes (see previous map)
- Wind prices are capacity-weighted averages from cumulative project sample

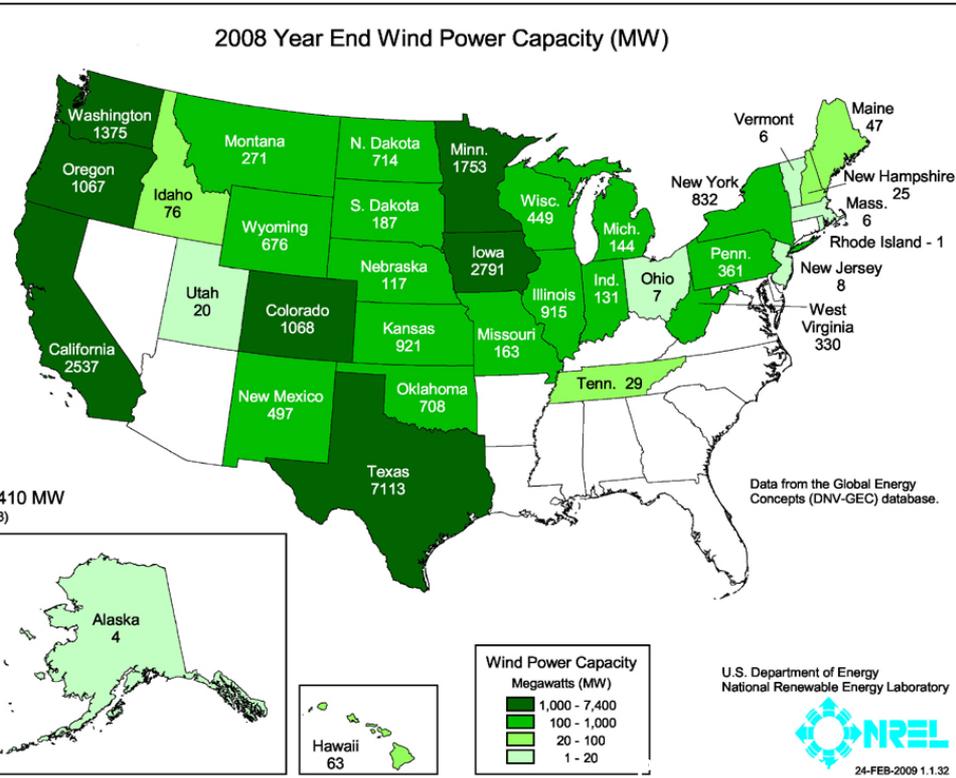
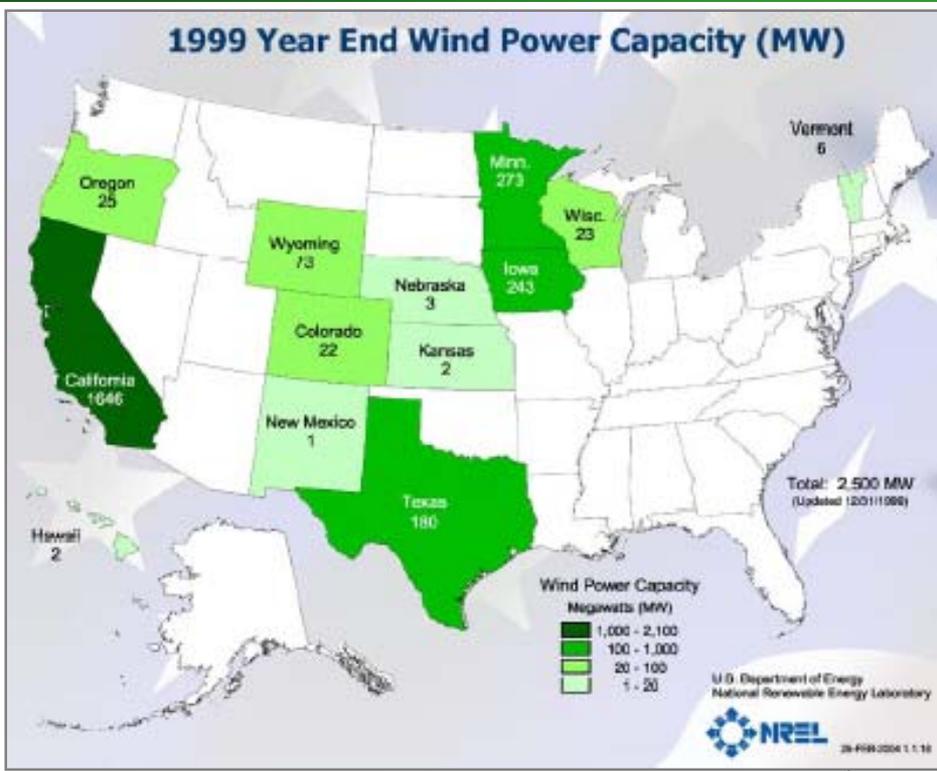
Wind Built After 1997 Was Competitive with Wholesale Prices in Most Regions in 2007



Source: Berkeley Lab database, Vertyx

Note: Even within a region there are a range of wholesale power prices because multiple wholesale price hubs exist in each area (see earlier map)

Installed Wind Capacities (‘99 – ‘08)

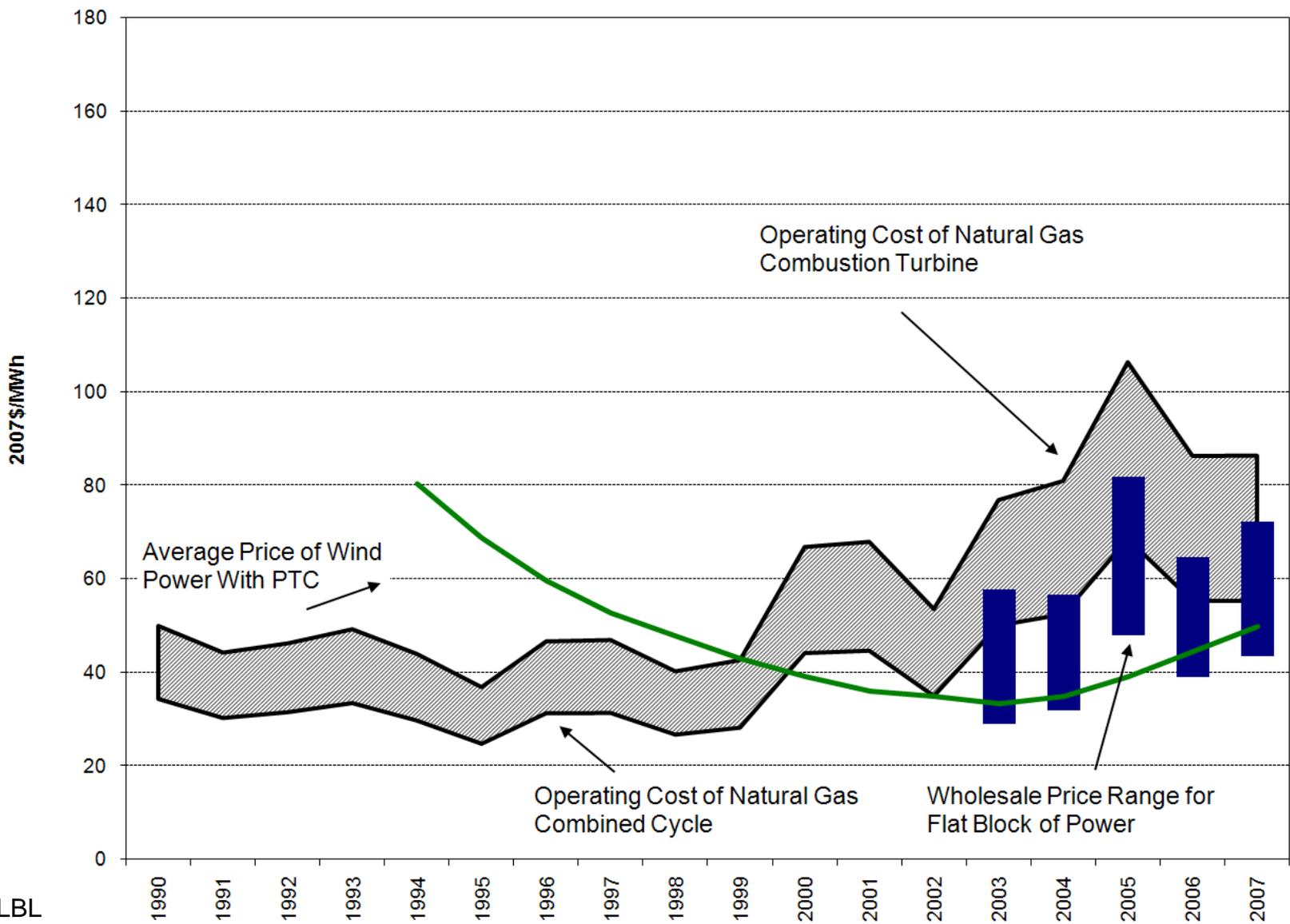


Drivers for Wind Power

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

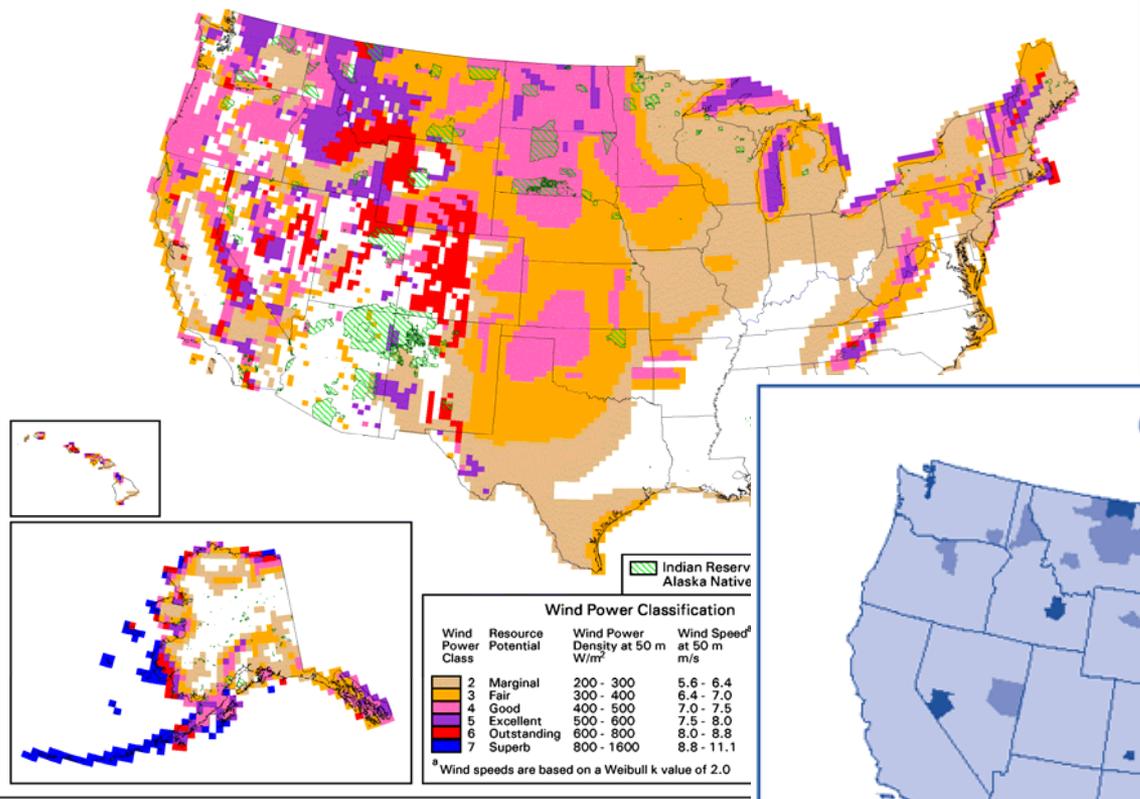


Comparative Generation Costs

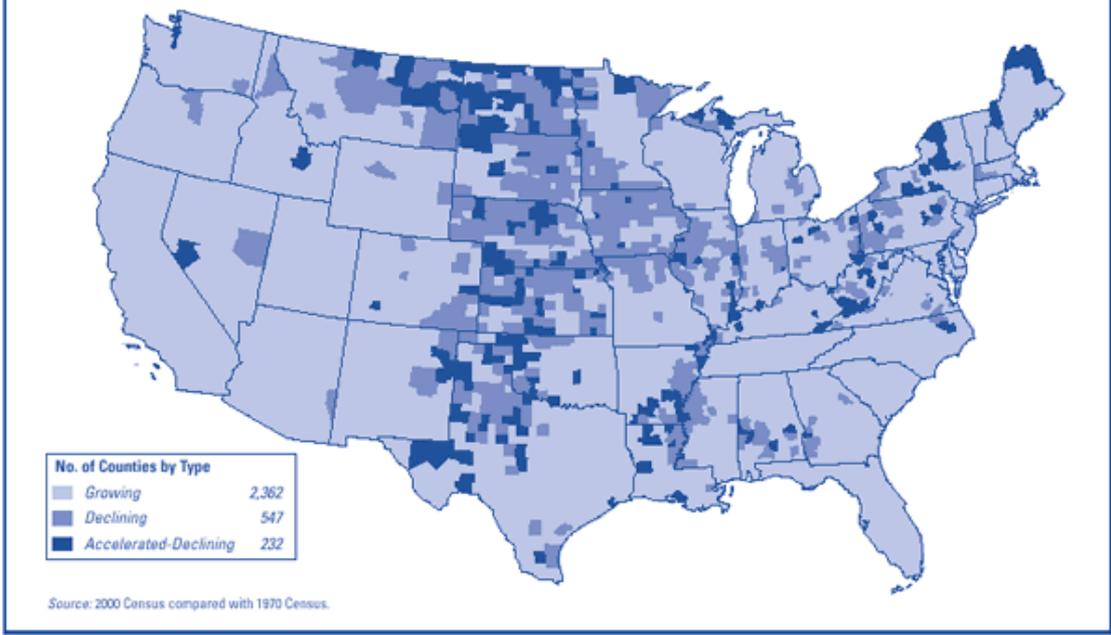


Windy Rural Areas Need Economic Development

United States - Wind Resource Map



Geographic Distribution of Depopulation



Colorado – Economic Impacts

from 1000 MW of new wind development

Wind energy's economic "ripple effect"

Direct Impacts

Payments to Landowners:

- \$2.5 Million/yr

Local Property Tax Revenue:

- \$4.6 Million/yr

Construction Phase:

- 912 new jobs
- \$133.6 M to local economies

Operational Phase:

- 181 new long-term jobs
- \$19.3 M/yr to local economies



Indirect & Induced Impacts

Construction Phase:

- 807 new jobs
- \$92.7 M to local economies

Operational Phase:

- 129 local jobs
- \$15.6 M/yr to local economies

Totals (construction + 20yrs)

Total economic benefit = \$924.3 million

New local jobs during construction = 1,719

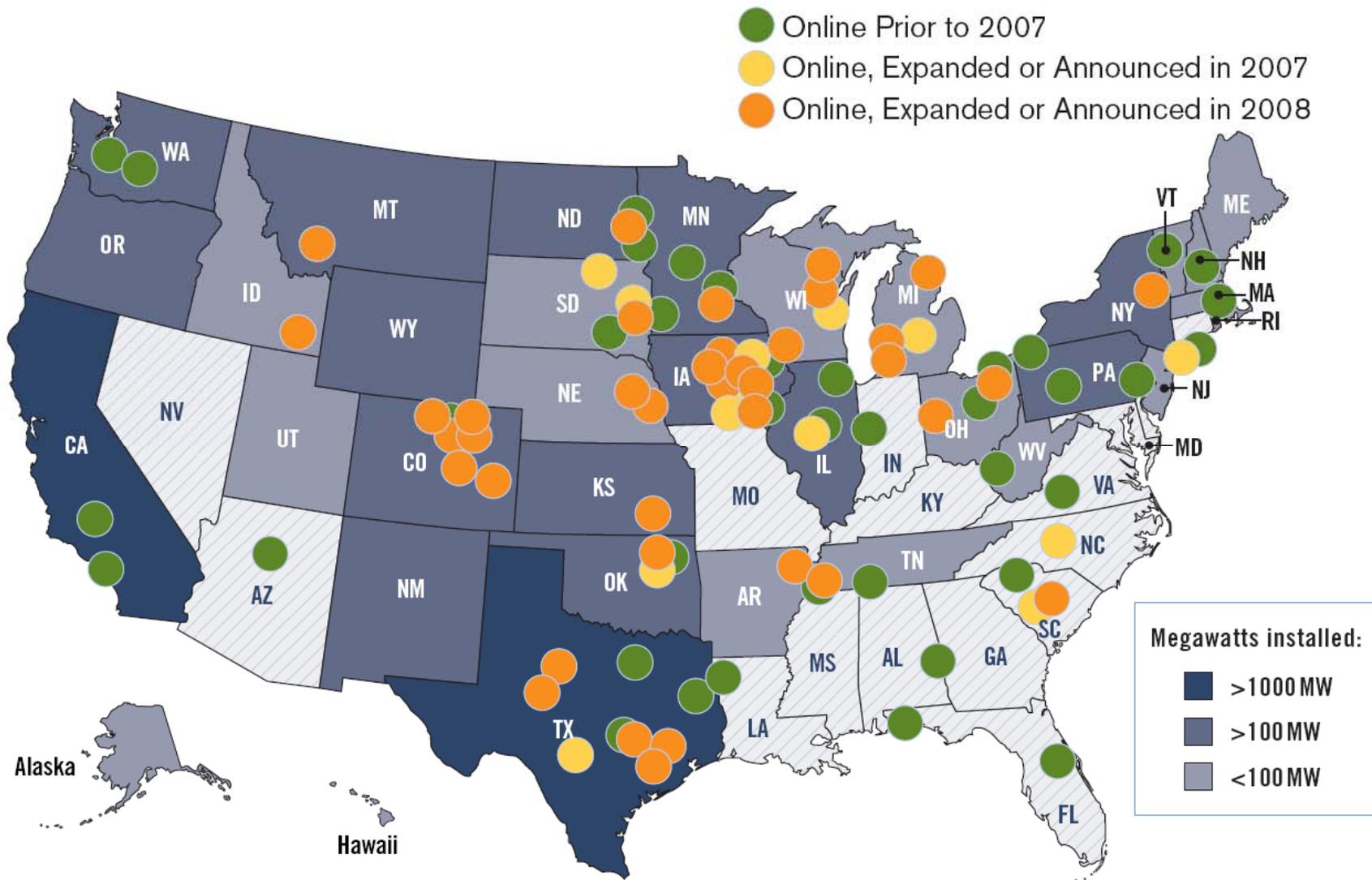
New local long-term jobs = 310

Peetz Table Wind Energy Center, CO

- 400.5 MW (1.5-MW turbines)
- Landowner payments: \$2 million/year, \$65 million over 30-year period
- 300 – 350 workers during peak construction (80% local)
- **16 – 18 O&M positions**
- Total annual tax payments: \$2.3 million/year (10% of total county budget); \$70 million over 30 years
- Located near Peetz, CO
- Owned by FPL Energy
- Constructed in 2007



Soaring Demand Spurs Expansion of U.S. Wind Turbine Manufacturing



Environmental Benefits

- No SO_x or NO_x
- No particulates
- No mercury
- No CO₂
- No water



Key Issues for Wind Power



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



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

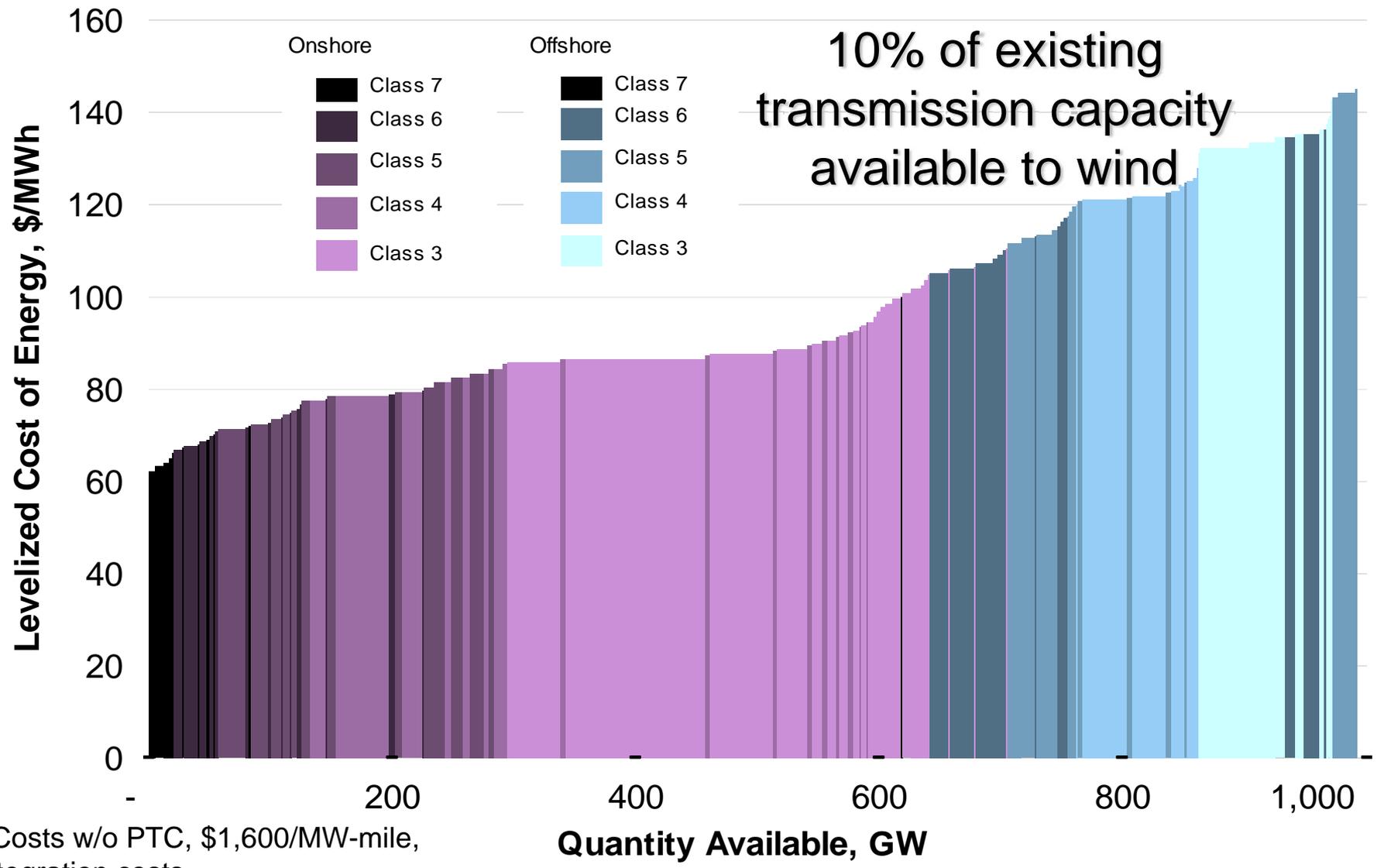


20% Wind Energy by 2030

**Increasing Wind Energy's Contribution to
U.S. Electricity Supply**

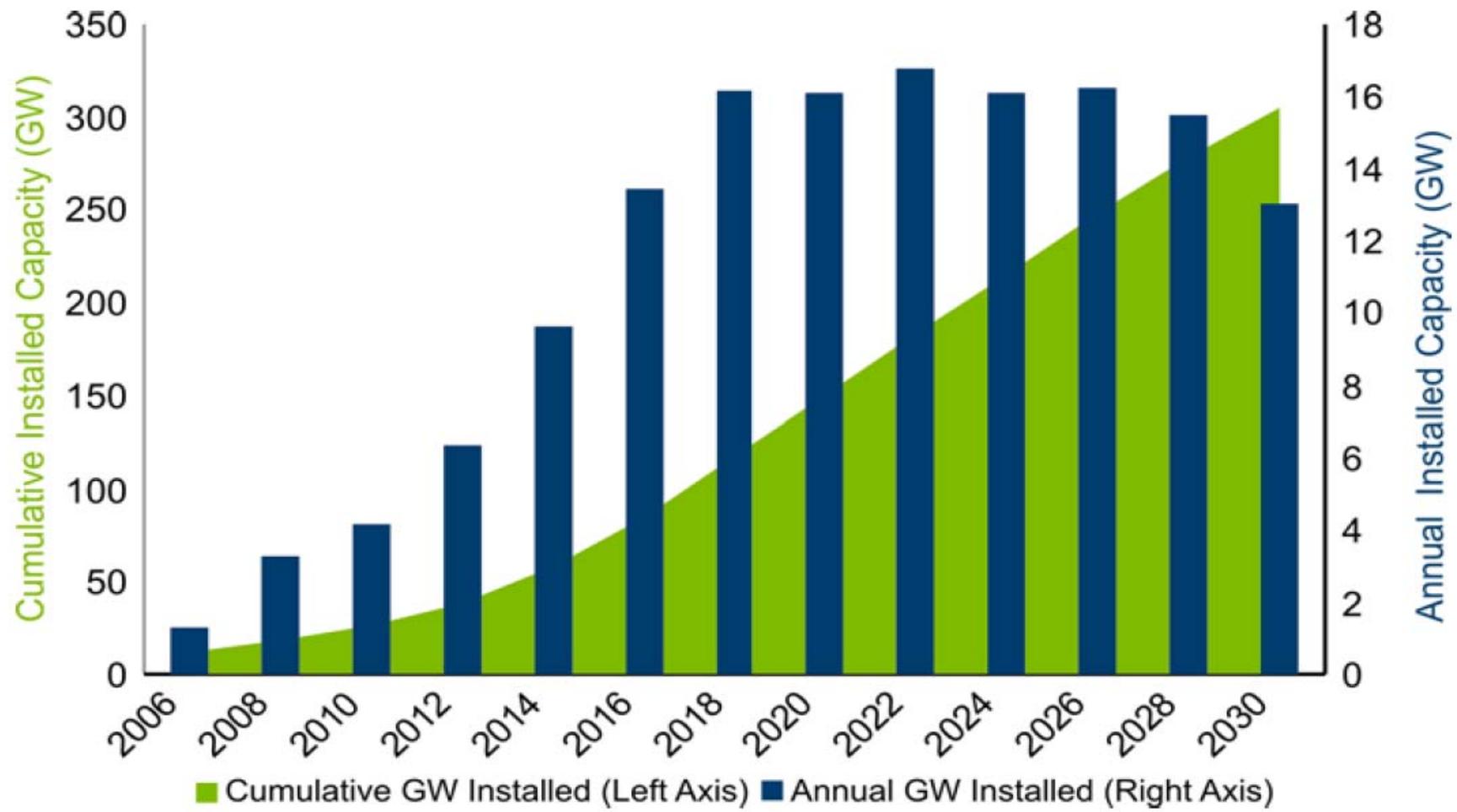
“The future ain’t
what it used to be.”
- Yogi Berra

Supply Curve for Wind Energy: Energy and Transmission Costs

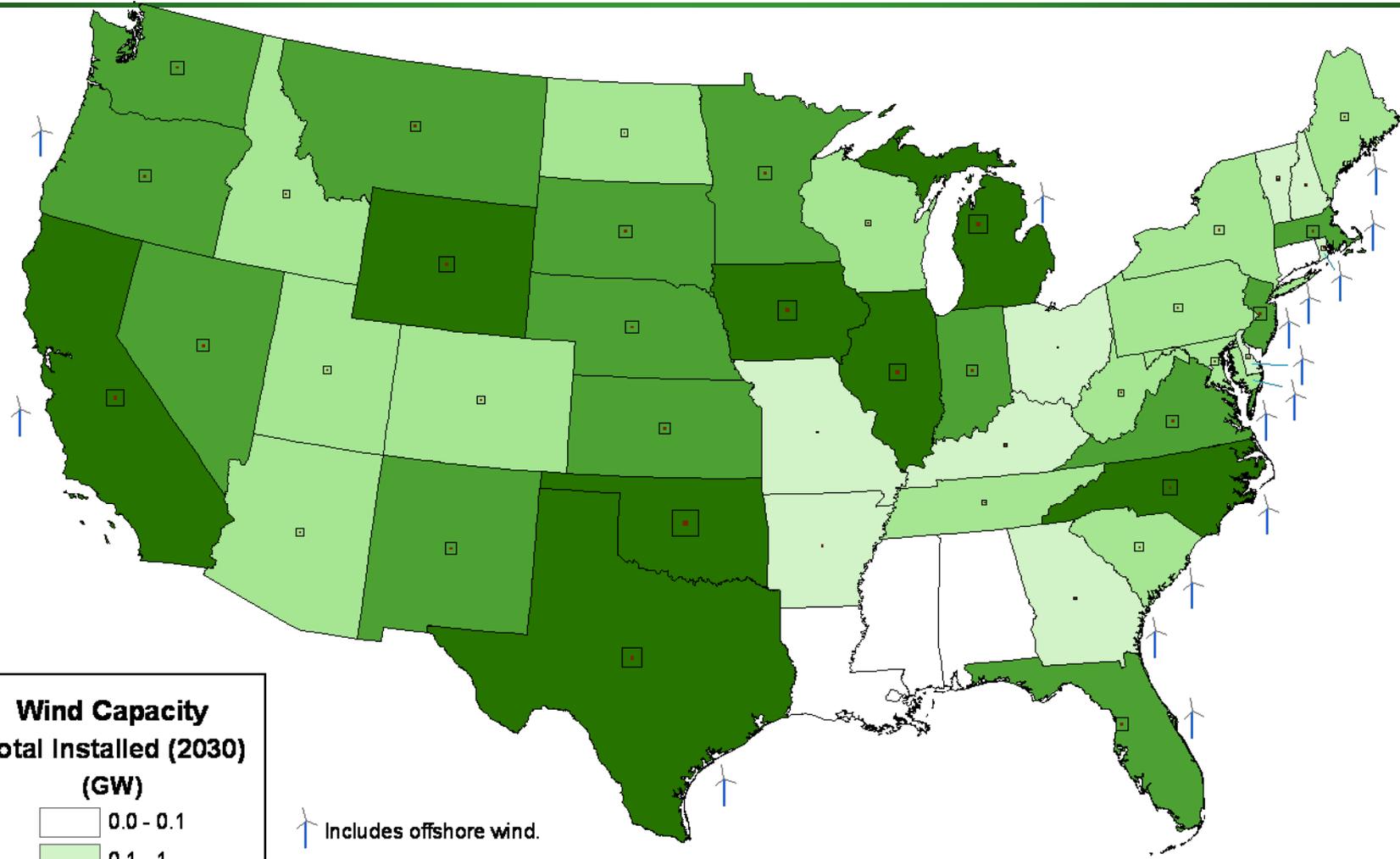


What does 20% Wind look like?

Figure 1-4. Annual and cumulative wind installations by 2030



Substantial Wind Development by 2030



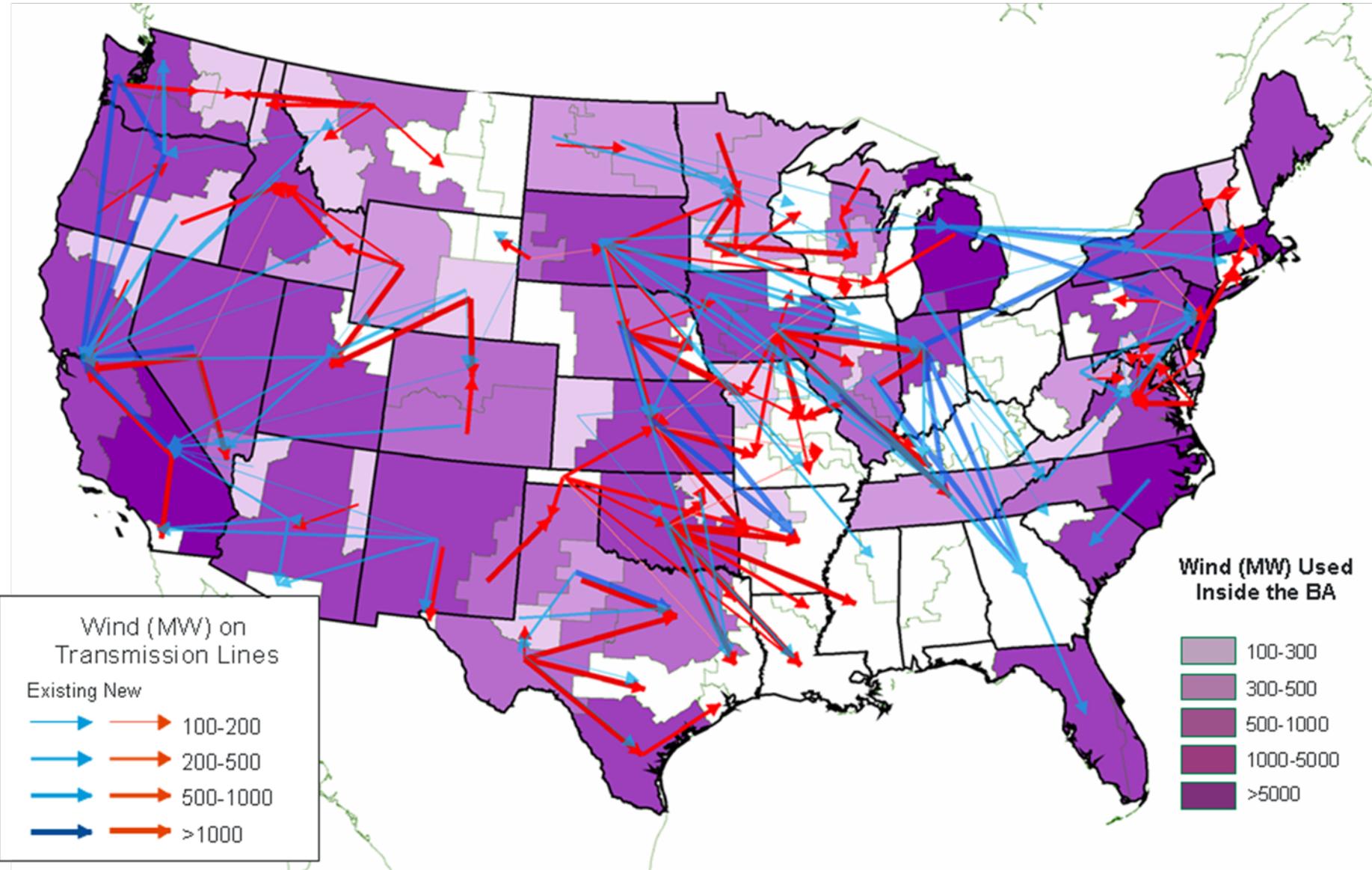
Wind Capacity
Total Installed (2030)
(GW)

	0.0 - 0.1
	0.1 - 1
	1 - 5
	5 - 10
	> 10

Includes offshore wind.

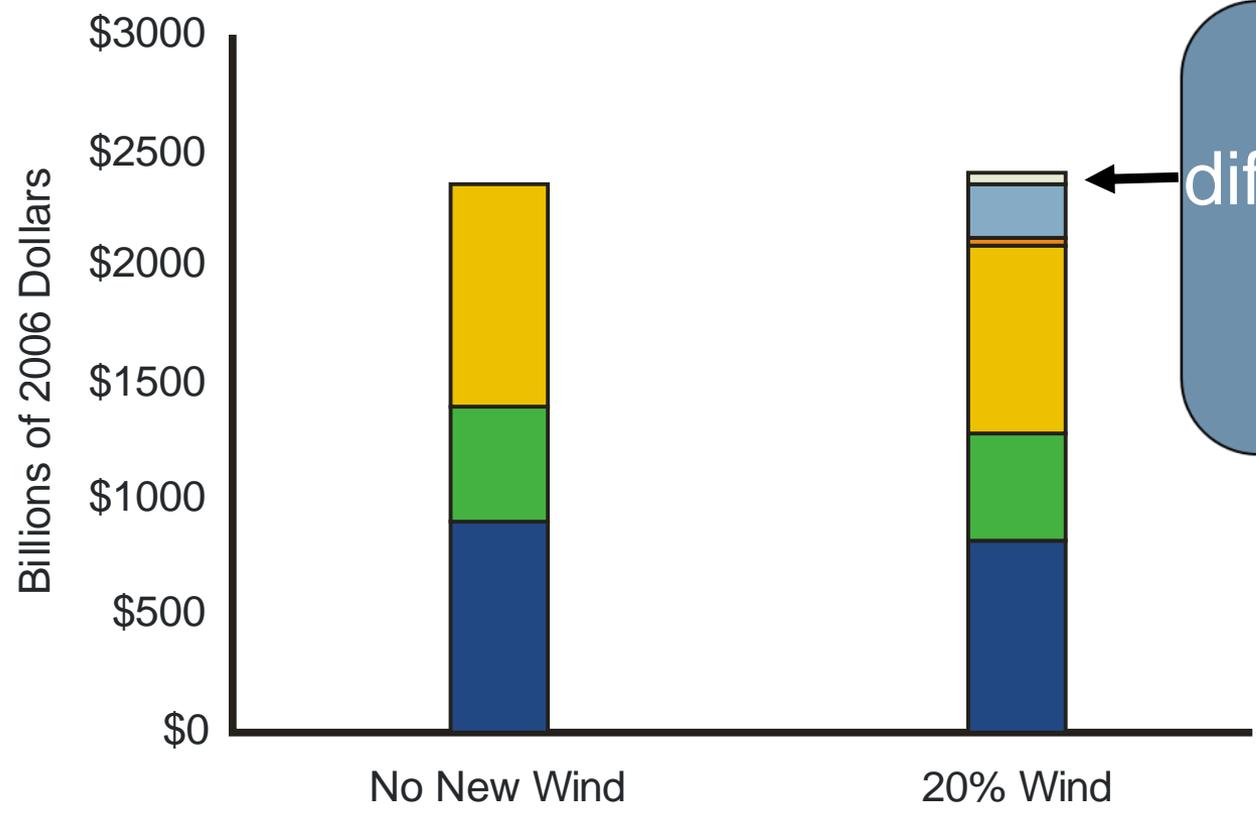
The black open square in the center of a state represents the land area needed for a single wind farm to produce the projected installed capacity in that state. The brown square represents the actual land area that would be dedicated to the wind turbines (2% of the black open square).

Need for New Transmission: Existing and New in 2030



Economic Costs of 20% Wind Scenario

Incremental investment cost of 20% Wind Scenario

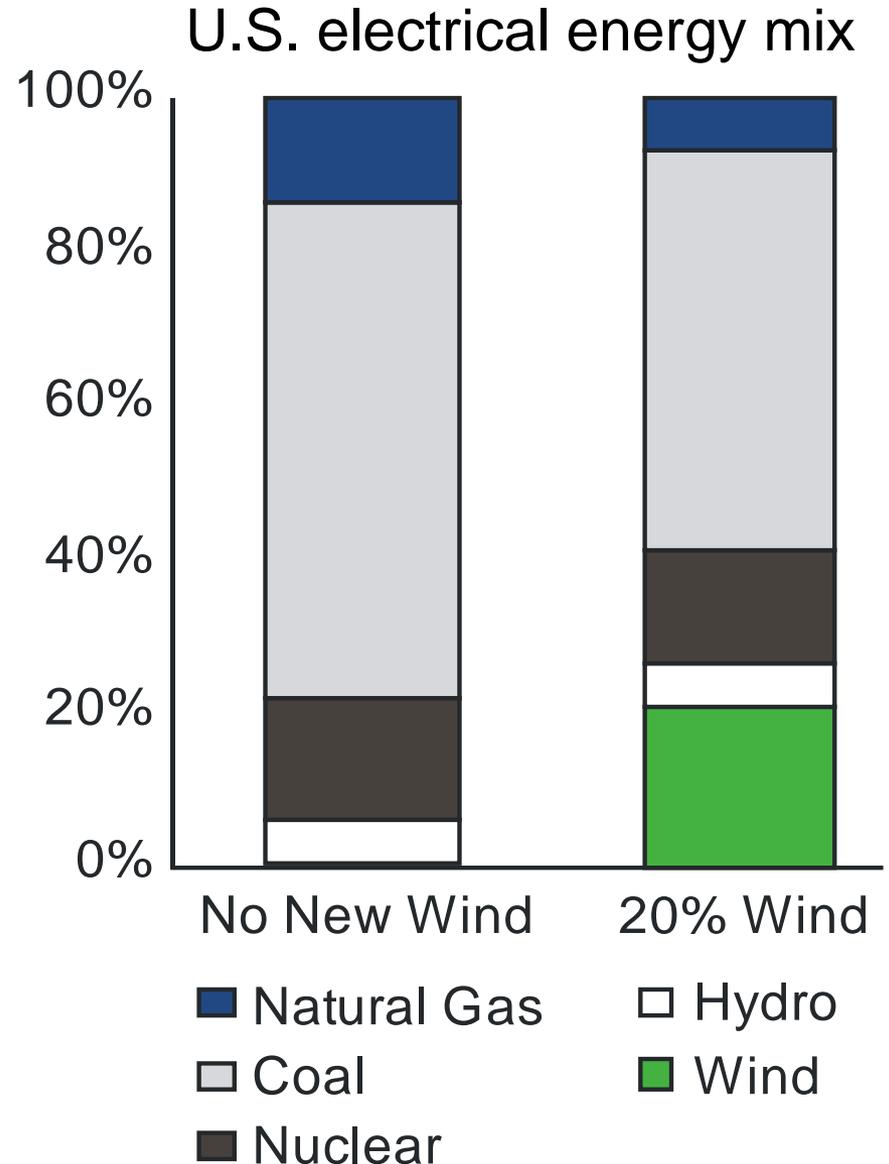


2% investment difference between 20% Wind and No New Wind

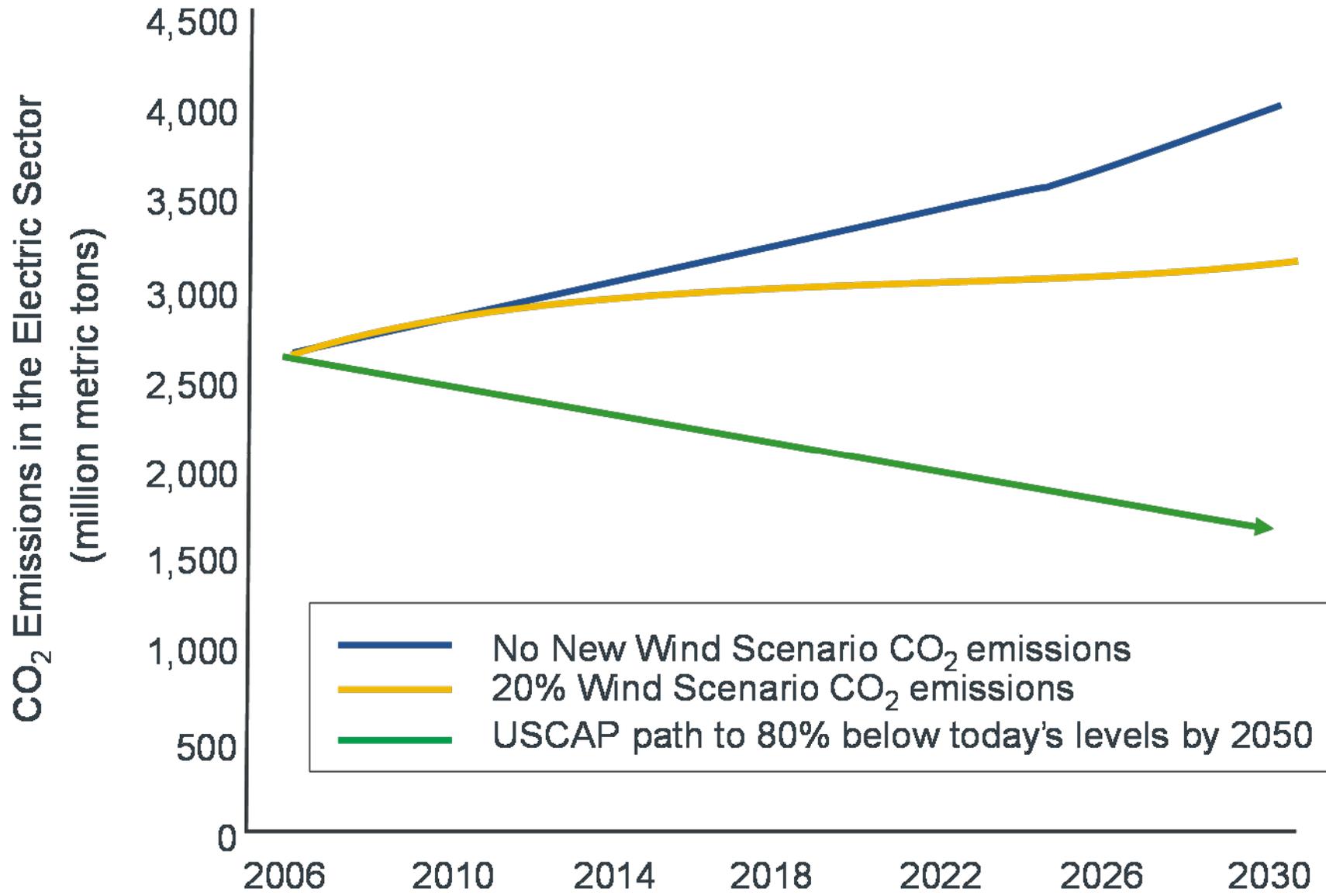
- Wind O&M Costs
- Wind Capital Costs
- Transmission Costs
- Fuel Costs
- Conventional O&M Costs
- Conventional Capital Costs

20% Wind Scenario Impact on Generation Mix in 2030

- Reduces electric utility natural gas consumption by 50%
- Reduces total natural gas consumption by 11%
- Natural gas consumer benefits: \$86-214 billion*
- Reduces electric utility coal consumption by 18%
- Avoids construction of 80 GW of new coal power plants



CO2 Emissions from the Electricity Sector



Cumulative impacts from 2007-2030

From the 20% Scenario- 300 GW new Onshore and Offshore development

Wind energy's economic "ripple effect"

Direct Impacts

Payments to Landowners:

- \$782 M

Local Property Tax Revenue:

- \$1,877 M

Construction Phase:

- 1.75 M FTE jobs
- \$ 293 B to the US economy

Operations:

- 1.16 M FTE jobs
- \$122 B to the US economy



Indirect & Induced Impacts

Construction Phase:

- 4.46 M FTE jobs
- \$651 B to the US economy

Operations:

- 2.15 M FTE jobs
- \$293 B to the US economy

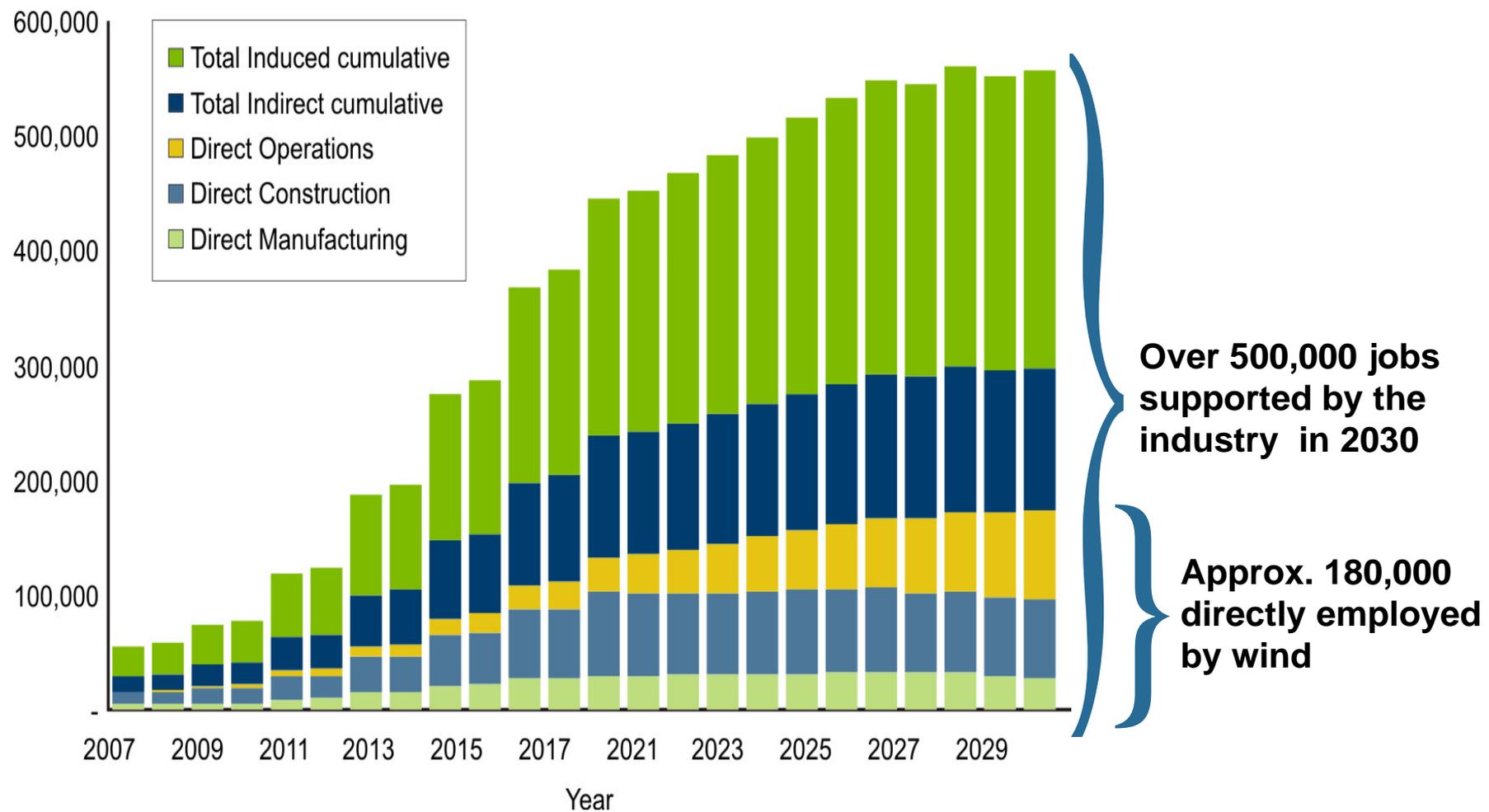
Totals (construction + 20yrs)

- Total economic benefit = \$1,359 billion
- New jobs during construction = 6.2 M FTE jobs
- New operations jobs = 3.3 M FTE jobs

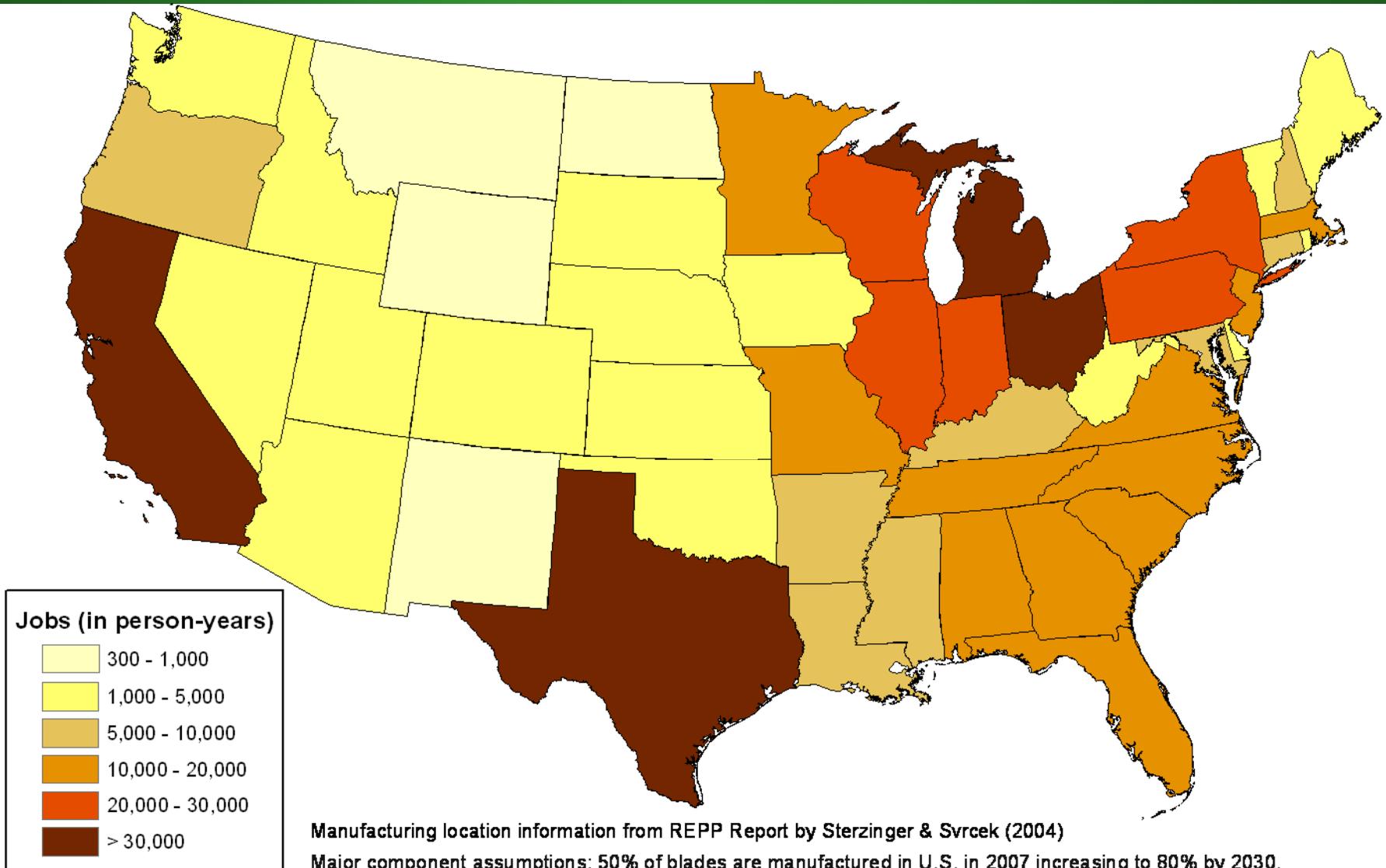
All monetary values are in 2006 dollars.
Construction Phase = 1-2 years

Jobs Supported by the 20% Scenario

Over 500,000 jobs would be supported between 2007 and 2030



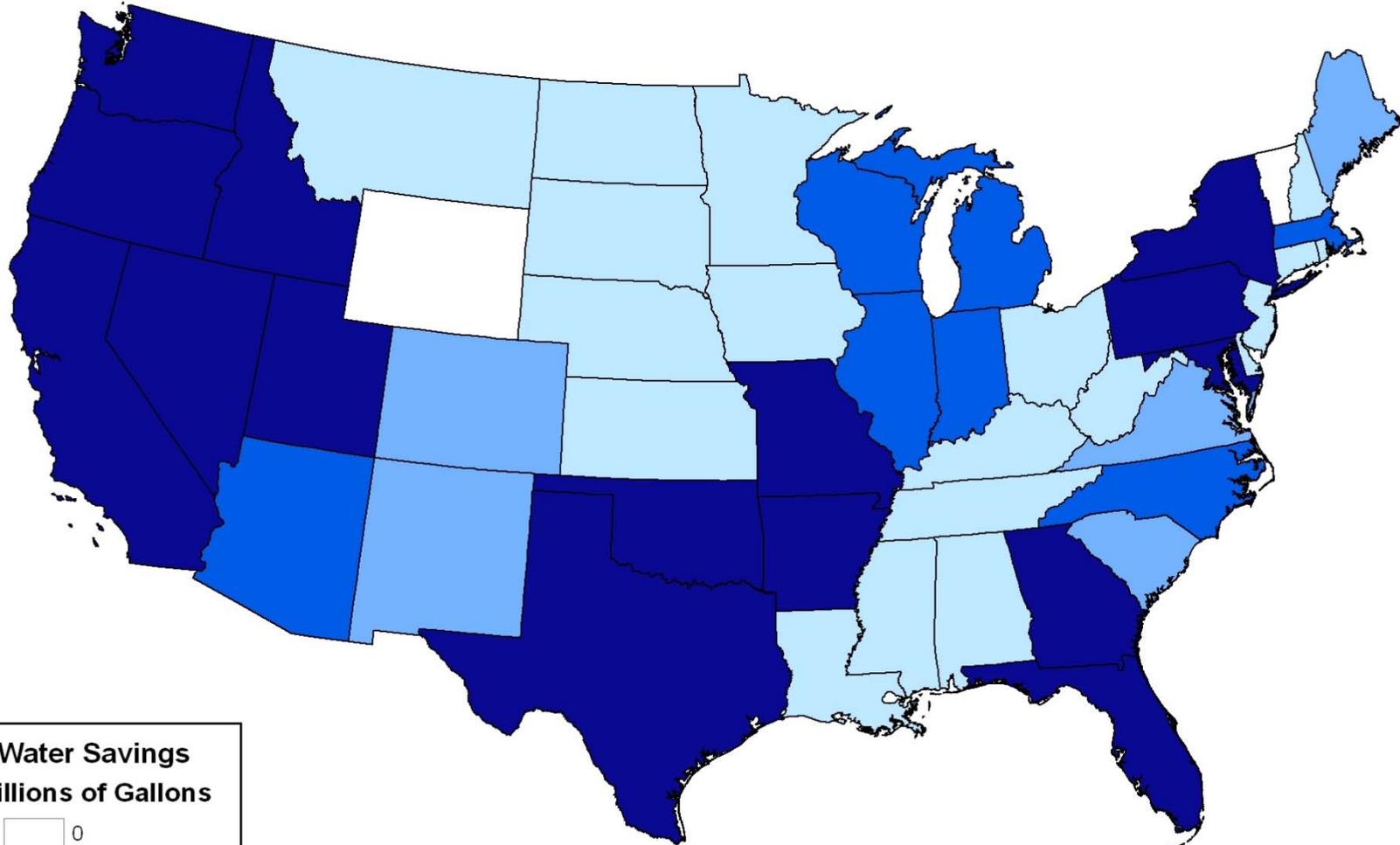
Manufacturing Jobs Supported by State



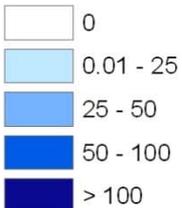
Manufacturing location information from REPP Report by Sterzinger & Svrcek (2004)

Major component assumptions: 50% of blades are manufactured in U.S. in 2007 increasing to 80% by 2030, 26% of towers are from the U.S. in 2007 increasing to 50% by 2030 and 20% of turbines are made in the U.S. increasing to 42% by 2030.

Cumulative Water Savings from 20% Scenario



Water Savings
Billions of Gallons



*Reduces water consumption of 4 trillion gallons through 2030
(represents a reduction in electric sector water consumption by
17% in 2030)*

Results: **Costs** & **Benefits**

Incremental direct cost to society	\$43 billion
Reductions in emissions of greenhouse gasses and other atmospheric pollutants	825 M tons (2030) \$98 billion
Reductions in water consumption	8% total electric 17% in 2030
Jobs created and other economic benefits	140,000 direct \$450 billion total
Reductions in natural gas use and price pressure	11% \$150 billion
Net Benefits: \$205B + Water savings	

Carpe Ventem

