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Wind & Hydropower Technologies Program

# Tracking the Evolution of the U.S. Wind Power Market: 2008 Wind Technologies Market Report

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Lawrence Berkeley National Laboratory

**DOE/NREL Wind Powering America Webinar**

July 30, 2009



# 2008 Wind Technologies Market Report: Third Issue in Annual Series

- Goal is to publish annual, publicly available report summarizing key trends in the U.S. wind market, building from AWEA's data collection efforts
- Current report focuses on 2008; scope primarily includes utility-scale wind applications; data sources are numerous and diverse
- Contributions from LBNL, NREL, DOE, AWEA, and Exeter Associates; funding from the U.S. DOE's Wind & Hydropower Technologies Program



# Report Contents

- Wind installation trends
- Wind industry trends
- Price, cost and performance trends
  - Power sales prices
  - Installed wind project costs
  - Wind turbine transaction prices
  - Wind project performance
  - O&M cost trends
- Policy and market drivers
- Future outlook

**This presentation covers all topics, except transmission, integration, and O&M costs**





# Basic Themes of This Presentation, and the 2008 Report

- U.S. wind industry is growing and maturing at a rapid pace, effectively preparing itself for further growth
- Wind has been competitive in wholesale power markets in recent years, due to:
  - installed cost reductions (historically)
  - performance improvements
  - rising wholesale power prices
- Recent escalation in wind project costs and wind prices, and corresponding drop in wholesale market prices, puts more dramatic increases in sector growth at some risk



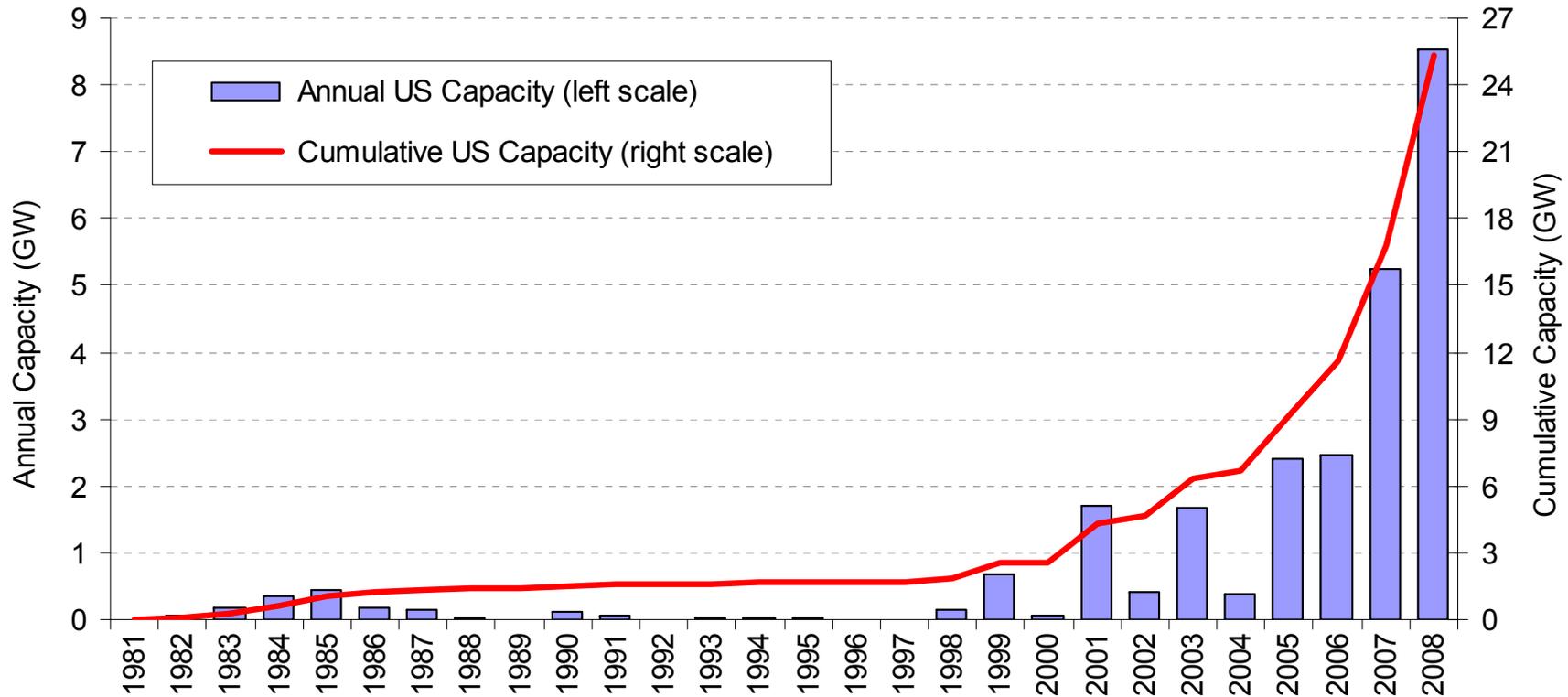
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# Installation Trends



# Four Years of Strong Growth: U.S. Wind Power Capacity Up >50% in 2008

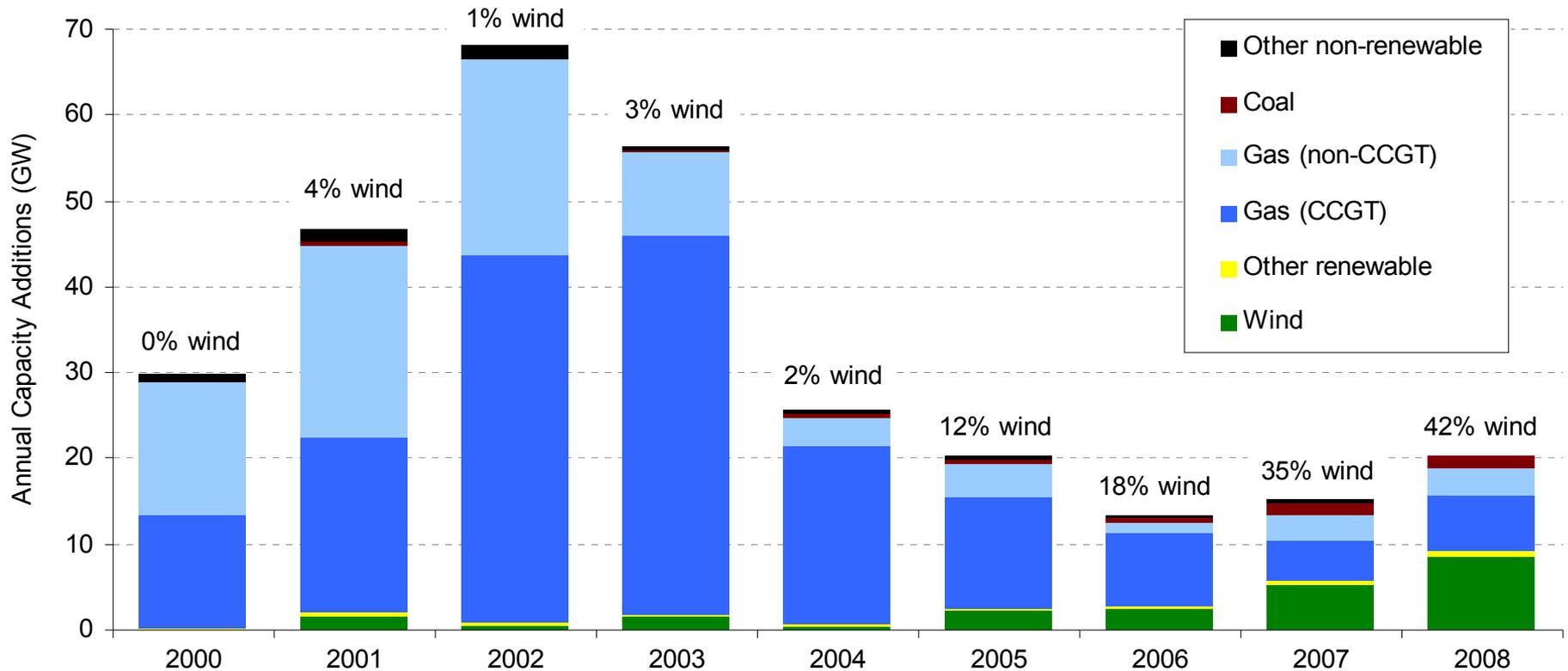


## Record year for new U.S. wind capacity:

- 8,558 MW of wind added in 2008, bringing total to 25,369 MW
- Roughly \$16.4 billion in 2008 project investment



# Wind Is a Major Source of New Generation Capacity Additions: Wind Contributed 42% of New Additions in the US in 2008



- Wind was the 2<sup>nd</sup>-largest resource added for the 4<sup>th</sup>-straight year



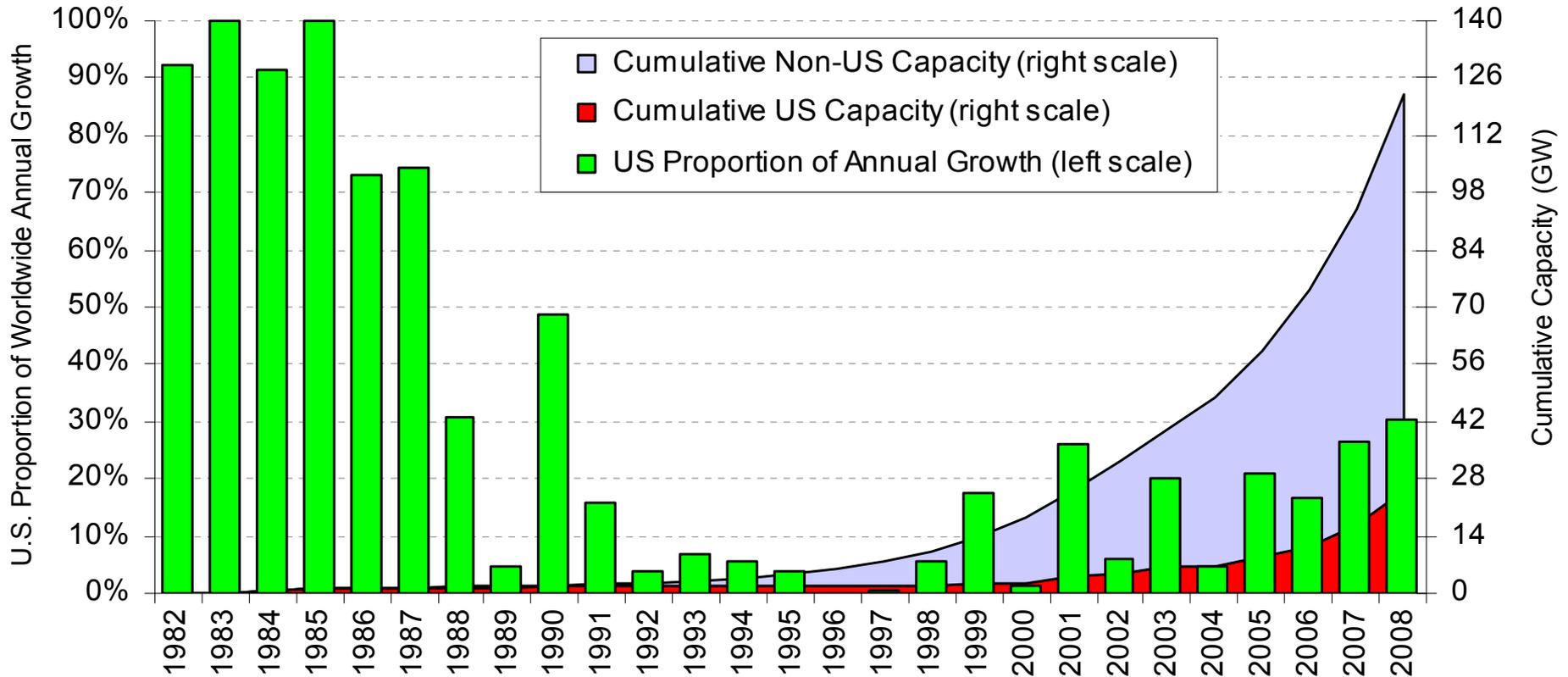
# The U.S. Led the World in Annual Capacity Growth and Cumulative Wind Capacity

Annual Capacity (2008, MW)		Cumulative Capacity (end of 2008, MW)	
<b>U.S.</b>	<b>8,558</b>	<b>U.S.</b>	<b>25,369</b>
China	6,246	Germany	23,933
India	1,810	Spain	16,453
Spain	1,739	China	12,121
Germany	1,665	India	9,655
France	1,200	Italy	3,731
Italy	1,010	France	3,671
U.K.	869	U.K.	3,263
Portugal	679	Denmark	3,159
Australia	615	Portugal	2,829
<i>Rest of World</i>	3,999	<i>Rest of World</i>	18,106
<b>TOTAL</b>	<b>28,390</b>	<b>TOTAL</b>	<b>122,290</b>

Source: BTM Consult; AWEA for U.S. capacity

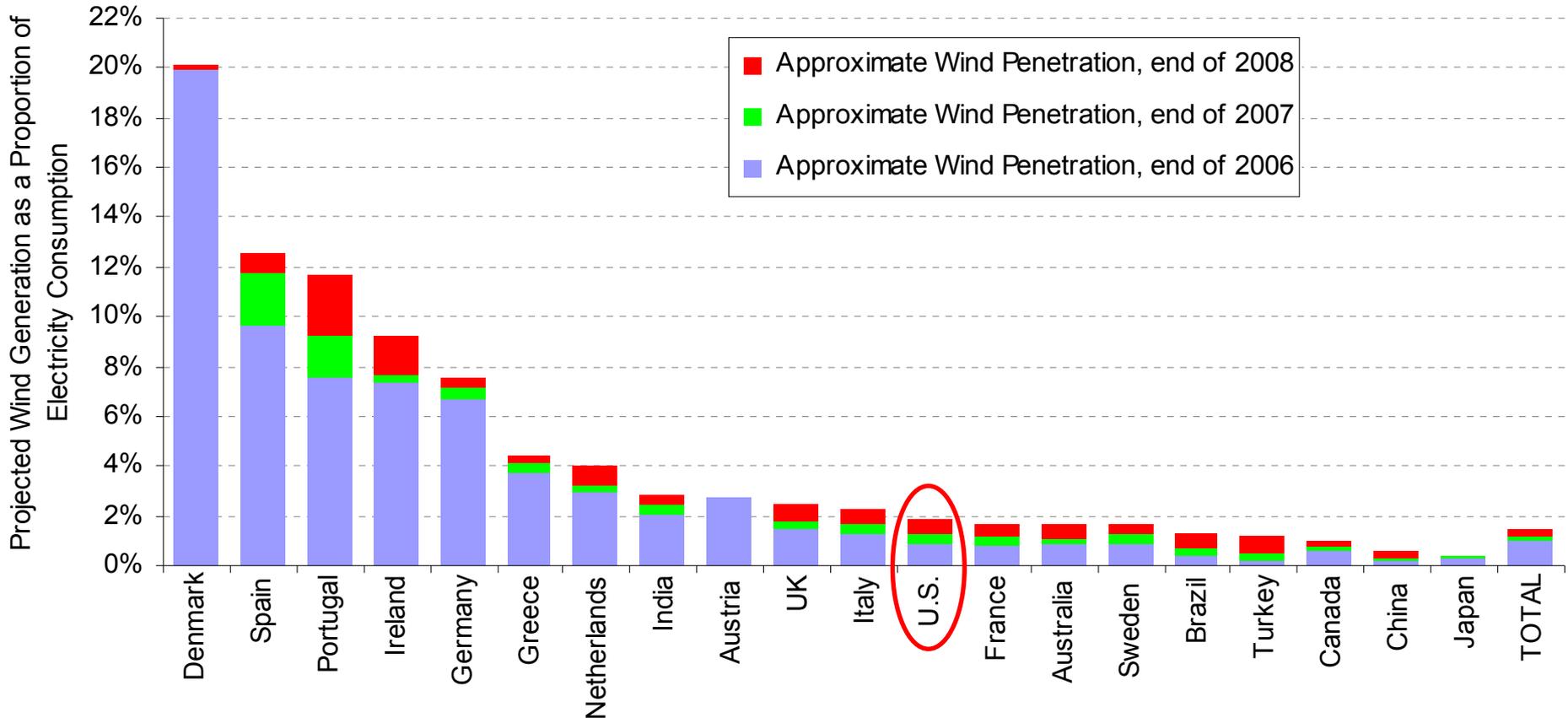


# U.S. Share of Global Wind Capacity: 30% of 2008 Additions, 21% of Cumulative





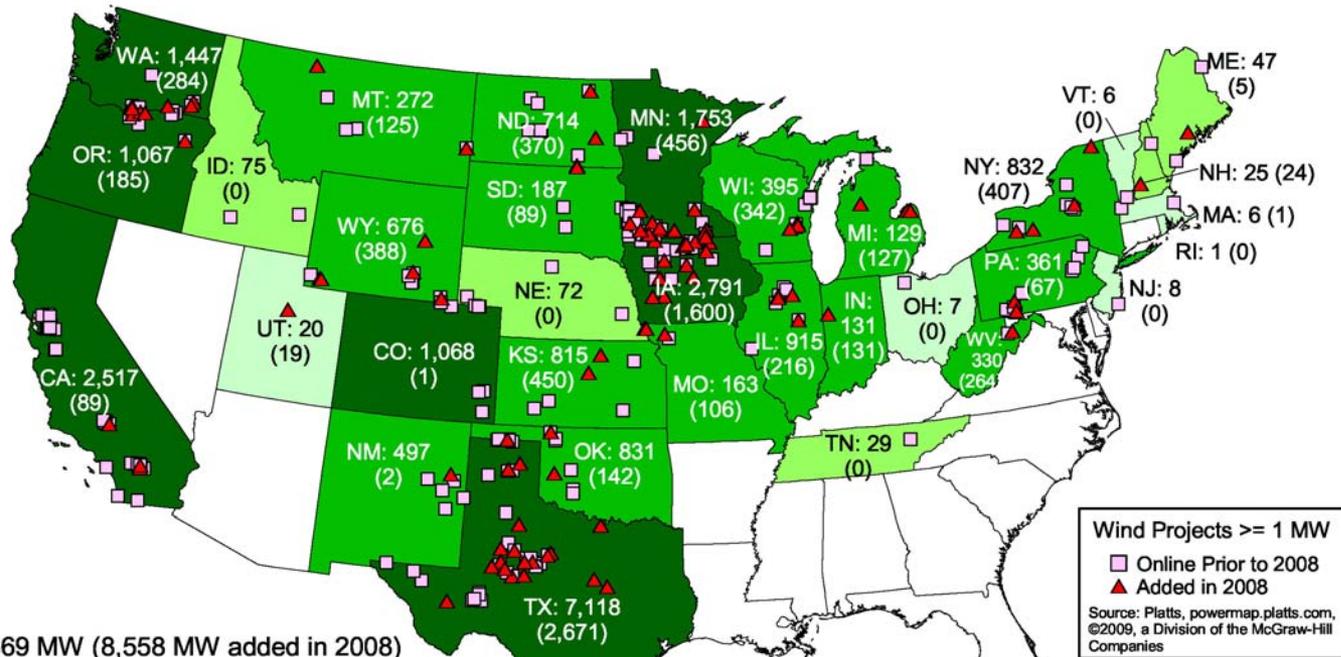
# U.S Lagging Other Countries in Wind As a Percentage of Electricity Consumption



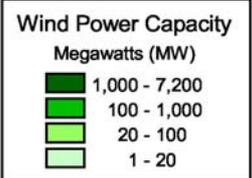
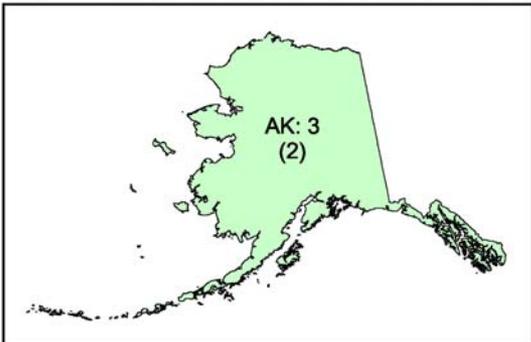
Note: Figure only includes the 20 countries with the most installed wind capacity at the end of 2008



# Geographic Spread of Wind Projects in the United States Is Reasonably Broad



Installed capacity data are from the AWEA project database. Locations are based on matching the database with Platts POWERmap data, the physical description in the database, and other available data sources.





# Texas Easily Led Other States in Both Annual and Cumulative Capacity

Annual Capacity (2008, MW)		Cumulative Capacity (end of 2008, MW)		Estimated Percentage of In-State Generation	
Texas	2,671	Texas	7,118	Iowa	13.3%
Iowa	1,600	Iowa	2,791	Minnesota	10.4%
Minnesota	456	California	2,517	South Dakota	8.8%
Kansas	450	Minnesota	1,753	North Dakota	7.1%
New York	407	Washington	1,447	Kansas	6.7%
Wyoming	388	Colorado	1,068	Colorado	6.6%
North Dakota	370	Oregon	1,067	Oregon	5.4%
Wisconsin	342	Illinois	915	Texas	5.3%
Washington	284	New York	832	New Mexico	4.5%
West Virginia	264	Oklahoma	831	Wyoming	4.1%
Illinois	216	Kansas	815	Washington	3.9%
Oregon	185	North Dakota	714	Oklahoma	3.7%
Oklahoma	142	Wyoming	676	Montana	3.4%
Indiana	131	New Mexico	497	California	3.1%
Michigan	127	Wisconsin	395	Hawaii	2.2%
Montana	125	Pennsylvania	361	Idaho	1.6%
Missouri	106	West Virginia	330	New York	1.4%
South Dakota	89	Montana	272	Illinois	1.4%
California	89	South Dakota	187	Wisconsin	1.3%
Pennsylvania	67	Missouri	163	West Virginia	0.9%
Rest of U.S.	52	Rest of U.S.	622	Rest of U.S.	0.2%
<b>TOTAL</b>	<b>8,558</b>	<b>TOTAL</b>	<b>25,369</b>	<b>TOTAL</b>	<b>1.8%</b>

- 13 states had >500 MW of wind capacity at the end of 2008 (7 had >1000 MW, 3 had >2500 MW)
- 2 states (IA and MN) have in-state wind generation that exceeds 10% of total in-state generation (6 other states exceed 5%)

Source: AWEA project database, EIA, Berkeley Lab estimates



# Wind Now >20% of Some Utilities' Sales

Total Wind Capacity (end of 2008, MW)	
Xcel Energy	2,906
MidAmerican Energy	2,363
Southern California Edison	1,137
Pacific Gas & Electric	981
Luminant	913
City Public Service of San Antonio	502
American Electric Power	468
Alliant Energy	446
Austin Energy	439
Puget Sound Energy	435
Exelon Energy	351
Great River Energy	319
Empire District Electric Company	255
First Energy	244
San Diego Gas & Electric	239
Portland General Electric	225
Public Service New Mexico	204
MSR Public Power Agency	200
Reliant Energy	199
Minnkota Power Cooperative	193

Estimated Percentage of Retail Sales (for utilities with > 100 MW of wind)	
Minnkota Power Cooperative	22.6%
Empire District Electric Company	20.7%
Otter Tail Power	14.9%
Southern Minn. Muni. Power Authority	13.0%
Austin Energy	11.7%
Xcel Energy	10.7%
MSR Public Power Agency	9.3%
Great River Energy	9.1%
City Public Service of San Antonio	8.2%
MidAmerican Energy	8.1%
Public Service New Mexico	6.2%
Luminant	5.6%
Alliant Energy	5.4%
Puget Sound Energy	5.3%
Seattle City Light	5.3%
Northwestern Energy	5.0%
Minnesota Power	4.6%
Aquila	3.9%
Portland General Electric	3.3%
Southern California Edison	3.1%

*See full report for the many assumptions used to generate the data in this table*

Source: AWEA, EIA, Berkeley Lab estimates



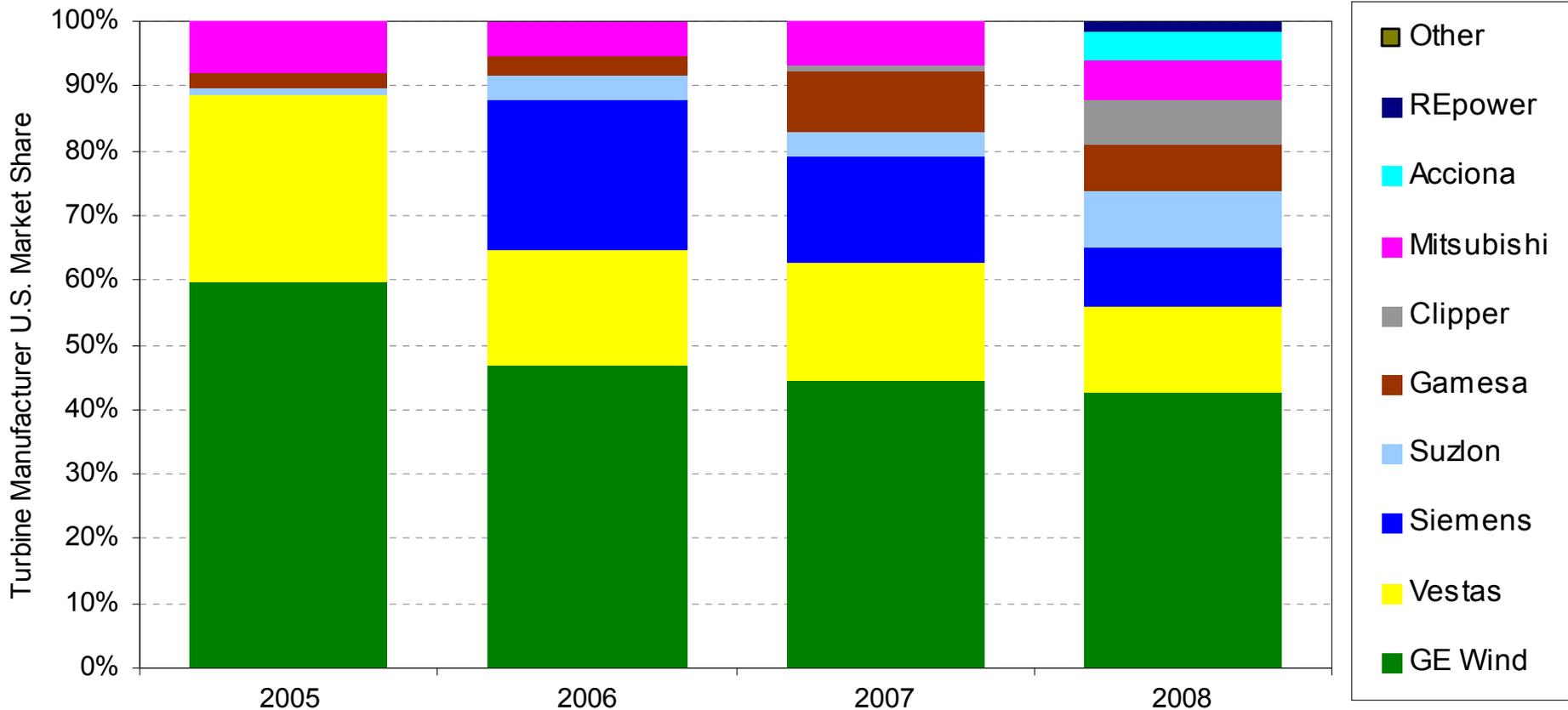
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# Industry Trends



# GE Remained the Top Turbine Vendor in the U.S. Market, But a Growing Number of Other Manufacturers are Capturing Market Share





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

- AWEA estimates that roughly 8,400 new domestic manufacturing jobs were added in the U.S. wind sector in 2008 (total U.S. wind employment growth in 2008 = 35,000)
- The # of utility-scale turbine vendors assembling nacelles in the U.S. rose from just one in 2004 (GE) to five in 2008 (GE, Gamesa, Clipper, Acciona, CTC/DeWind)

*Note: Map is not intended to be exhaustive*

### New Facilities Opened in 2008

1. Evonik (composites), Mobile, AL, +26 jobs
2. LM Glasfiber (blades), Little Rock, AR, +1,000 jobs within 5 years
3. Vestas (blades), Windsor, CO, +650 jobs
4. Acciona (turbines), West Branch, IA, +110 jobs
5. TPI Composites (blades), Newton, IA, +140 jobs
6. ATI Casting Services (casting and foundry), Alpena, MI, +20 jobs
7. Katana Summit (towers), Columbus, NE
8. GE (parts fulfillment center), Schenectady, NY
9. Molded Fiberglass (blades), Aberdeen, SD, +up to 750 jobs
10. GE (parts operation center), Memphis, TN
11. Wausaukee Composites (housings), Cuba City, WI, +61 jobs

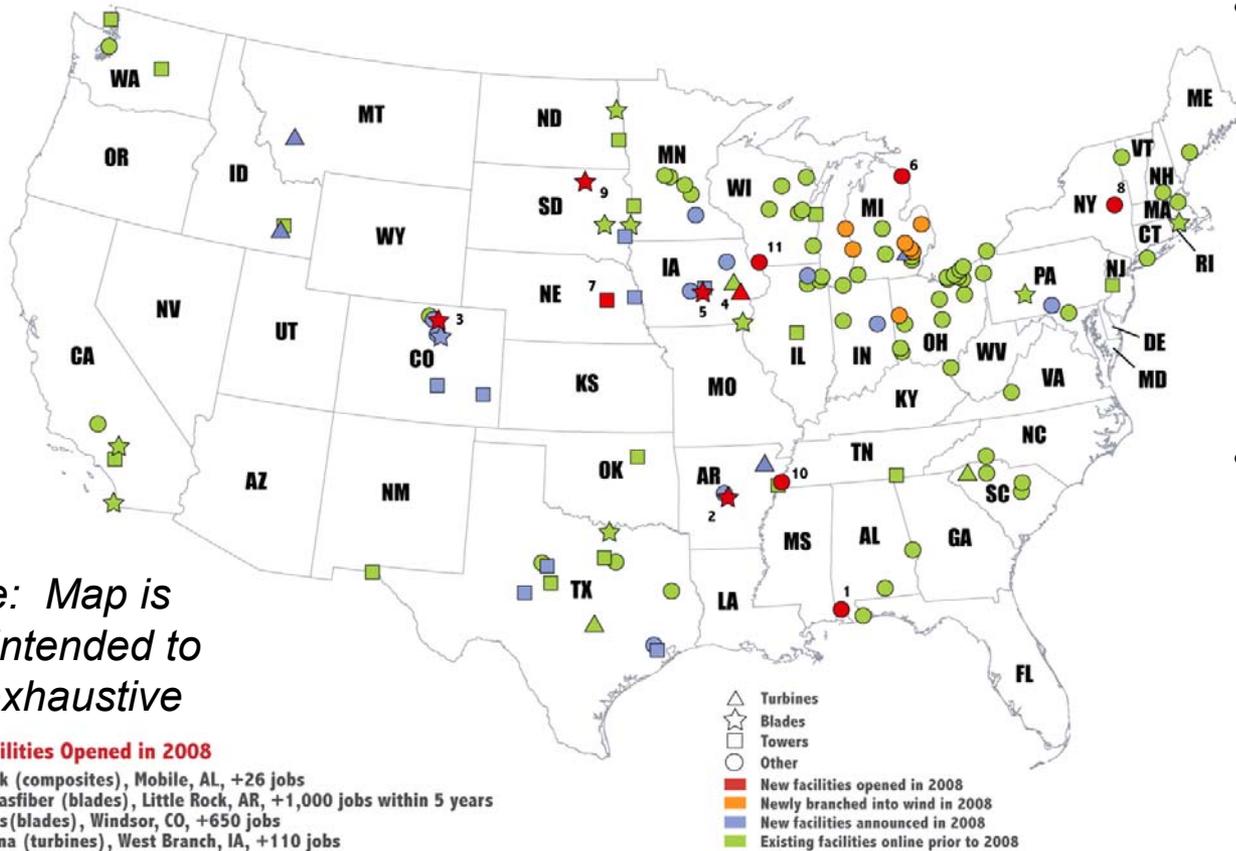


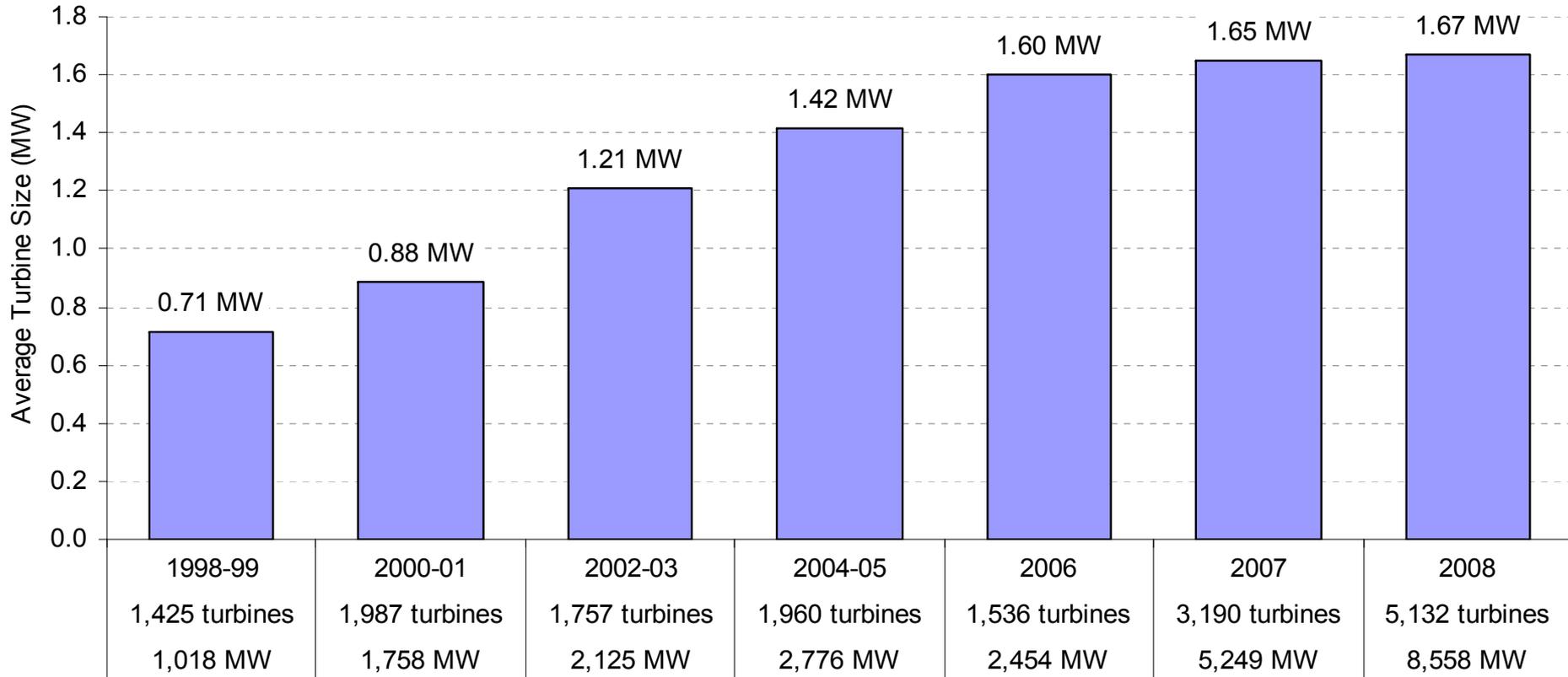
Figure includes wind turbine and component manufacturing facilities, as well as other supply chain facilities, but excludes corporate headquarters and service-oriented facilities. The facilities shown here are not intended to be exhaustive. Those facilities designated as "Turbines" may include turbine assembly and/or turbine component manufacturing, in some cases also including towers and blades.



This map was created by  
 The National Renewable Energy Laboratory  
 for the U.S. Department of Energy  
 May 18, 2009



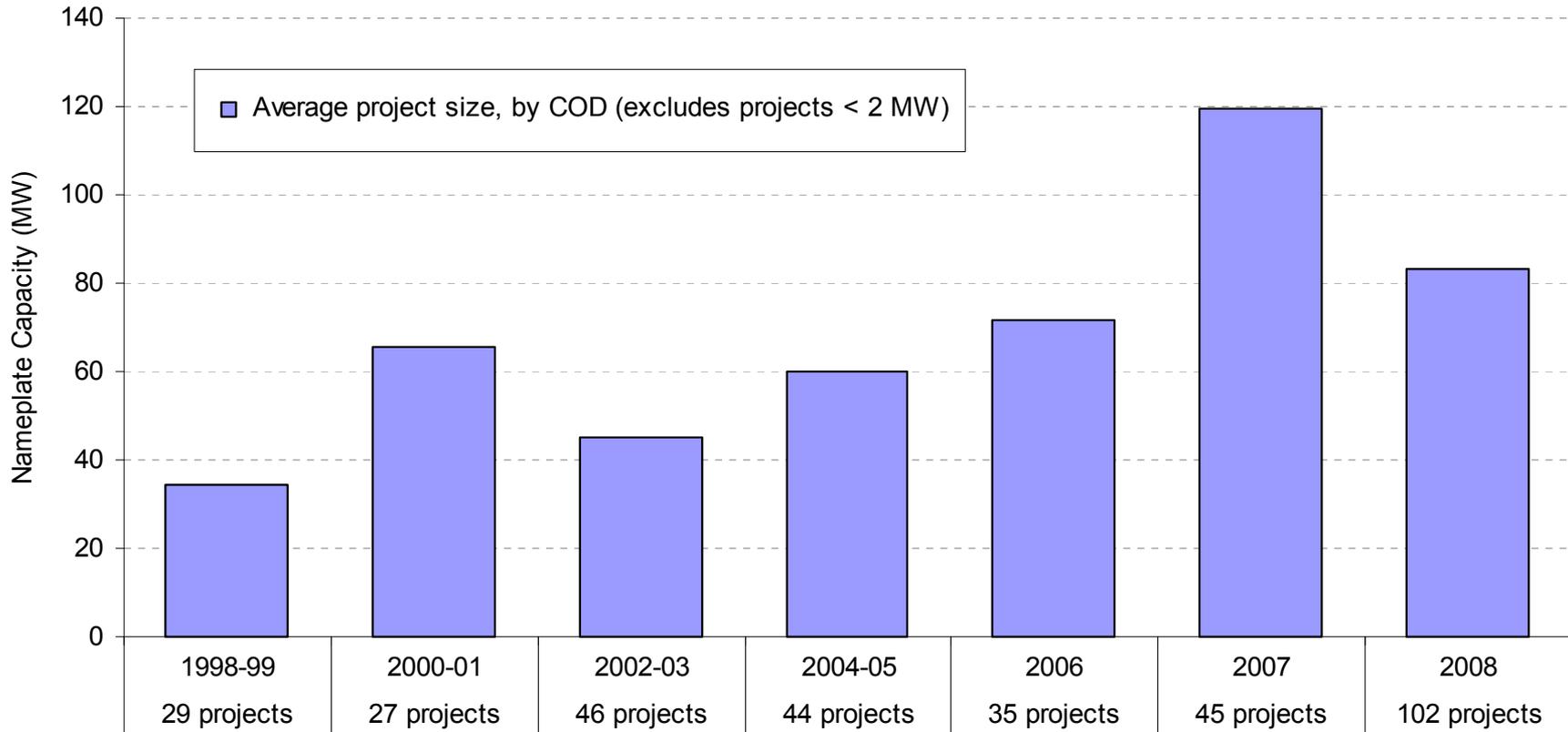
# Average Turbine Size Inched Higher in 2008



~20% of turbines installed in 2008 were larger than 2.0 MW, up from ~16% in 2006 and 2007, and just 0.1% in 2004-2005



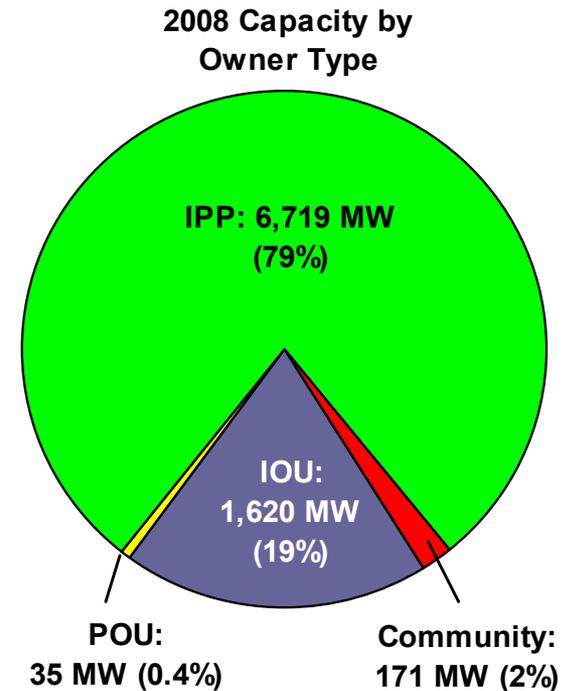
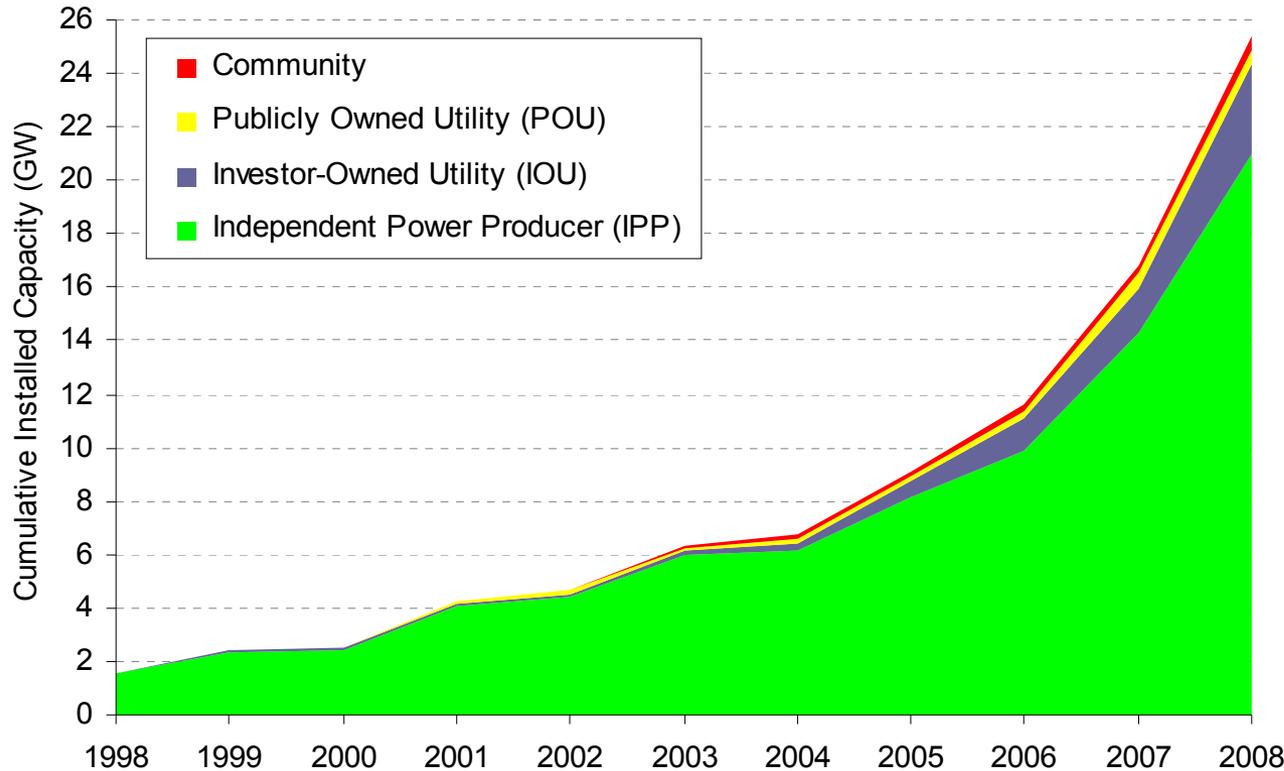
# Average Project Size Declined in 2008, Bucking Longer-Term Trend



Despite retreat in 2008, the average 2008 project size was still larger than in any other period (other than 2007)



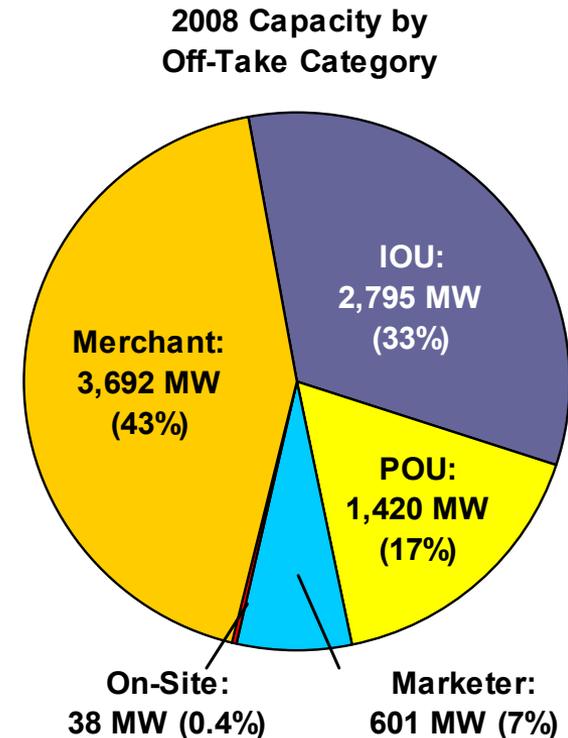
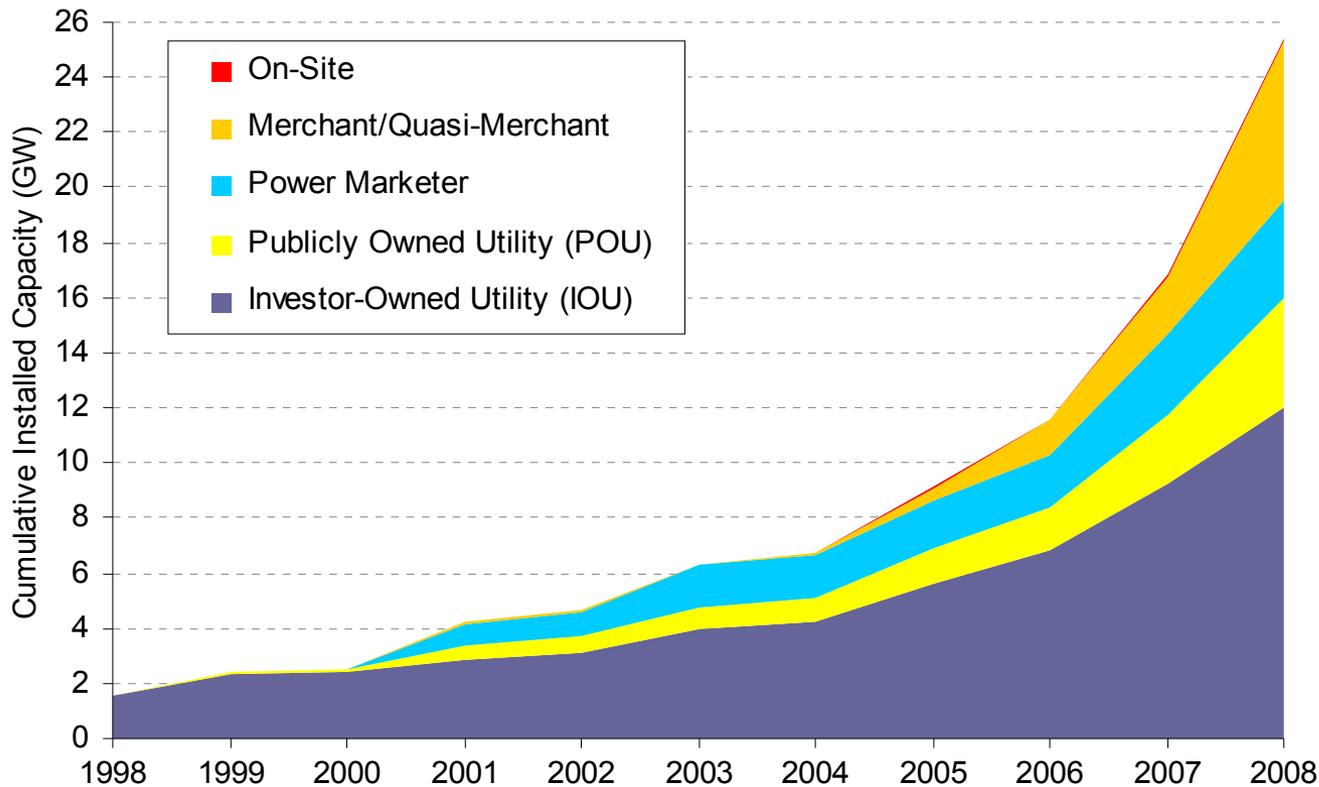
# IPP Ownership Remained Dominant, But Utility Ownership Continued to Gain



- Utility ownership (IOU) gained some ground in 2008
- Community wind market share stagnant since 2004



# Contracted Sales to Utilities Remained the Most Common Off-Take Arrangement



But “merchant” plants were very popular in 2008 (unlikely to be as popular in 2009, due to credit freeze and lower wholesale power prices)

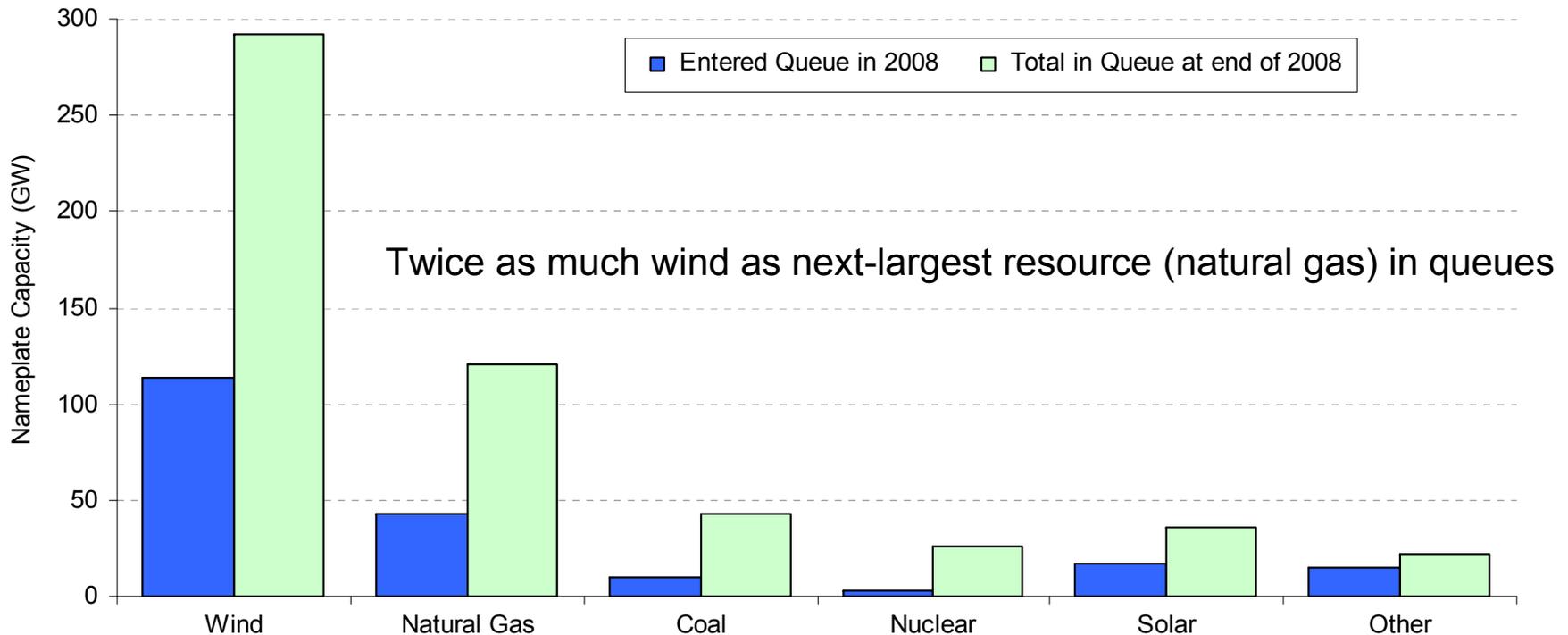


# Policy Is Now More Favorable to Wind Than At Any Other Time in the Past Decade

- ARRA 2009 established a number of federal policies to support wind
- Federal PTC currently in place through 2012 (longest extension in history)
- Wind projects can elect a 30% ITC or a 30% cash grant in lieu of the PTC
- Subsidized financing double-dipping penalty removed for ITC / cash grant
- New allocations of Clean Renewable Energy Bonds
- Expansion and enhancement of Federal loan guarantee program
- Increased R&D funding
- Four new state RPS policies (MI, MO, OH, KS), and many revisions to existing state RPS policies (total is now 29 states plus Washington, D.C.)
- State renewable funds, tax incentives, utility planning, green power, and growing interest in carbon regulation all also played a role in 2008
- Efforts to pass an RPS and carbon regulation at the Federal level continue



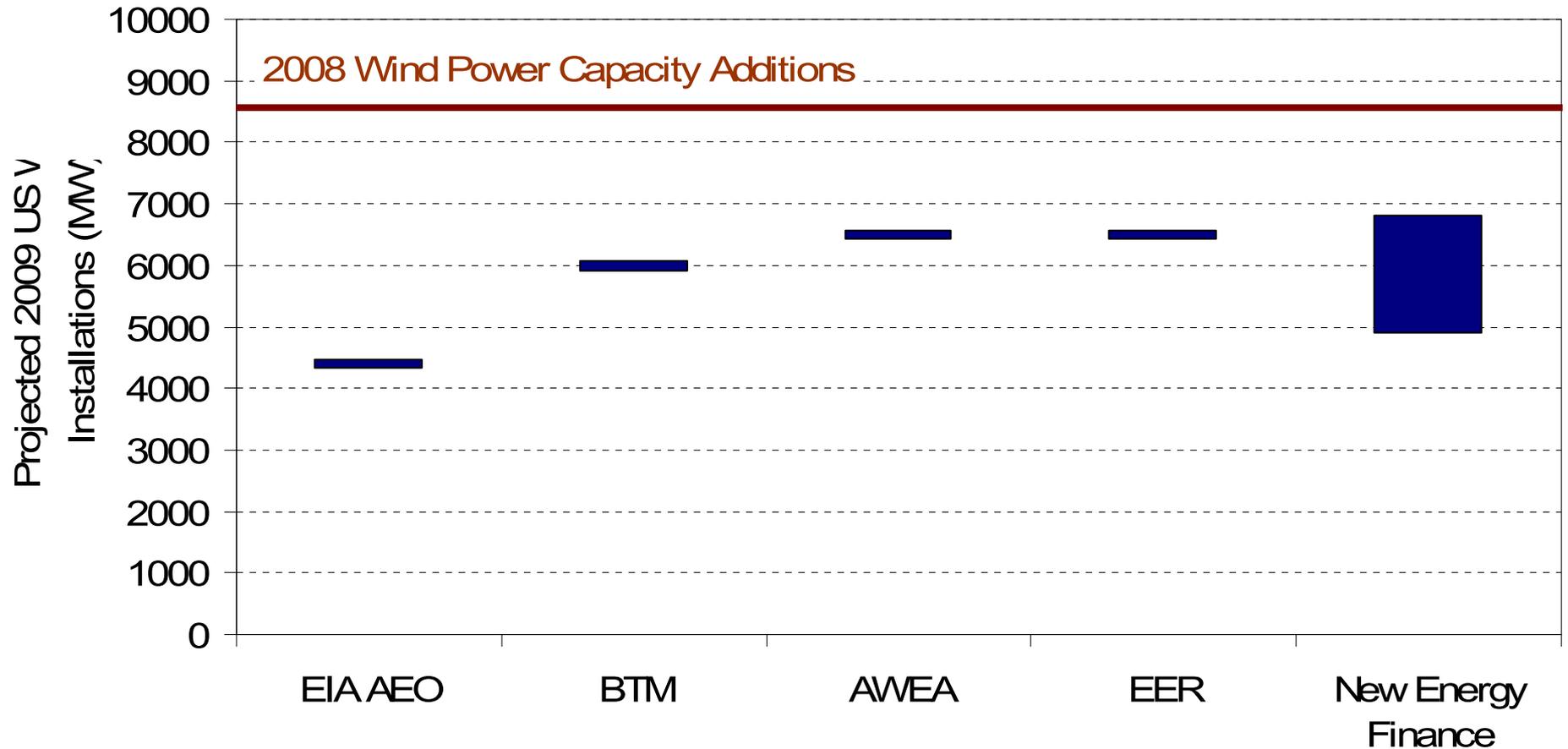
# Nearly 300 GW of Wind in Transmission Interconnection Queues



- MISO (64 GW), ERCOT (52 GW), SPP (48), and PJM (43 GW) account for >70% of total wind in queues
- ***Not all of this capacity will be built....***



# But 2009 Is Expected To Be a Slow(er) Year for the US Wind Sector





# Headwinds Challenge Further Expansion...

**Investment  
climate**



**EESA 2008; ARRA 2009**

**Transmission  
investment**



**New federal policies under  
consideration; state efforts  
underway**

**Comparative  
economics**



**Federal RPS? Federal  
climate legislation? State  
policies?**



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# Price, Cost, and Performance Trends



# Wind Power Price, Cost, and Performance Trends

## Project-Level Power Sales Prices

- Sample of 145 projects built from 1998-2008, 9.8 GW
- Prices reflect bundled price of electricity and RECs as sold by the project owner under a PPA; dataset excludes merchant plants and projects that sell RECs separately

## Project-Level Performance/Capacity Factor

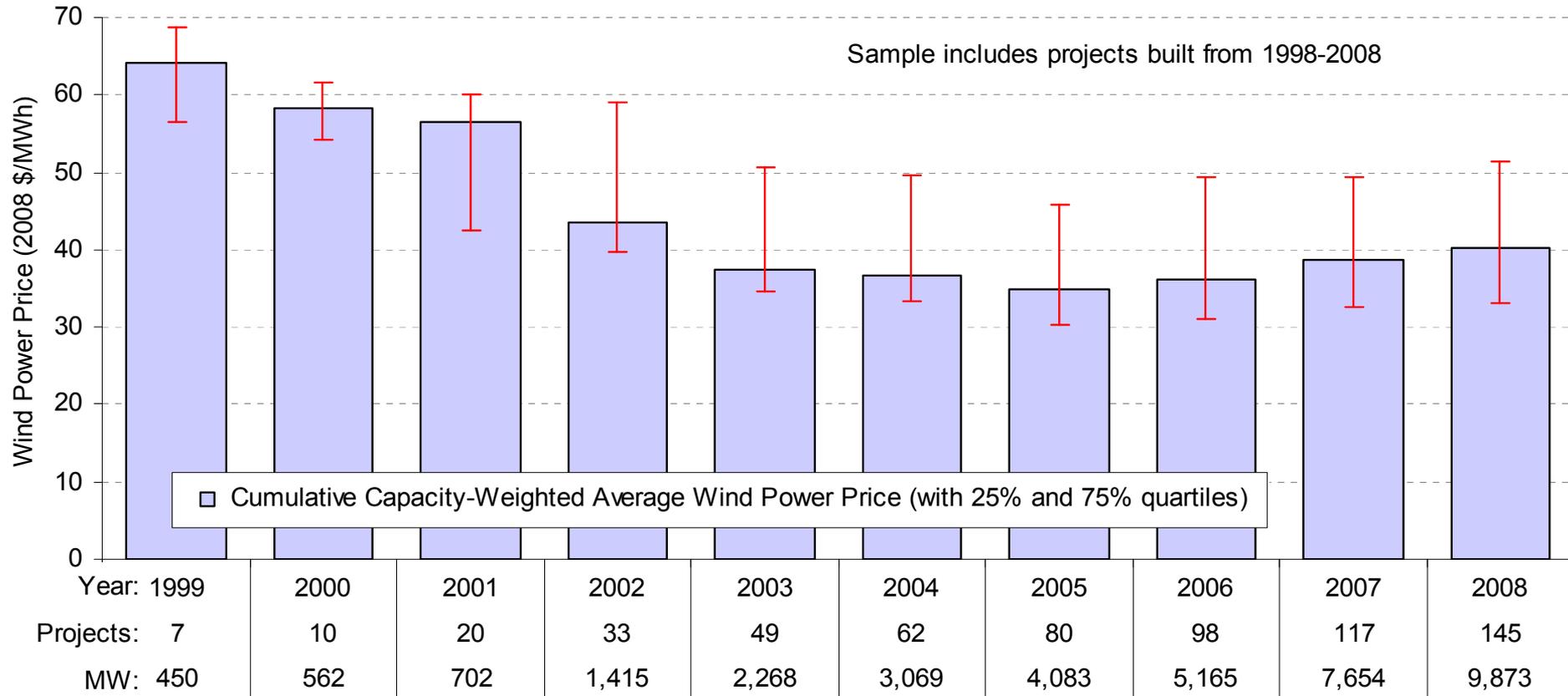
- Sample of 180 projects built from 1983-2007, 14.2 GW

## Project-Level and Turbine-Level Capital Costs

- Project sample: 283 projects built from 1983-2008, 18.6 GW
- Turbine sample: 59 transactions from 1997-2008, 21.1 GW



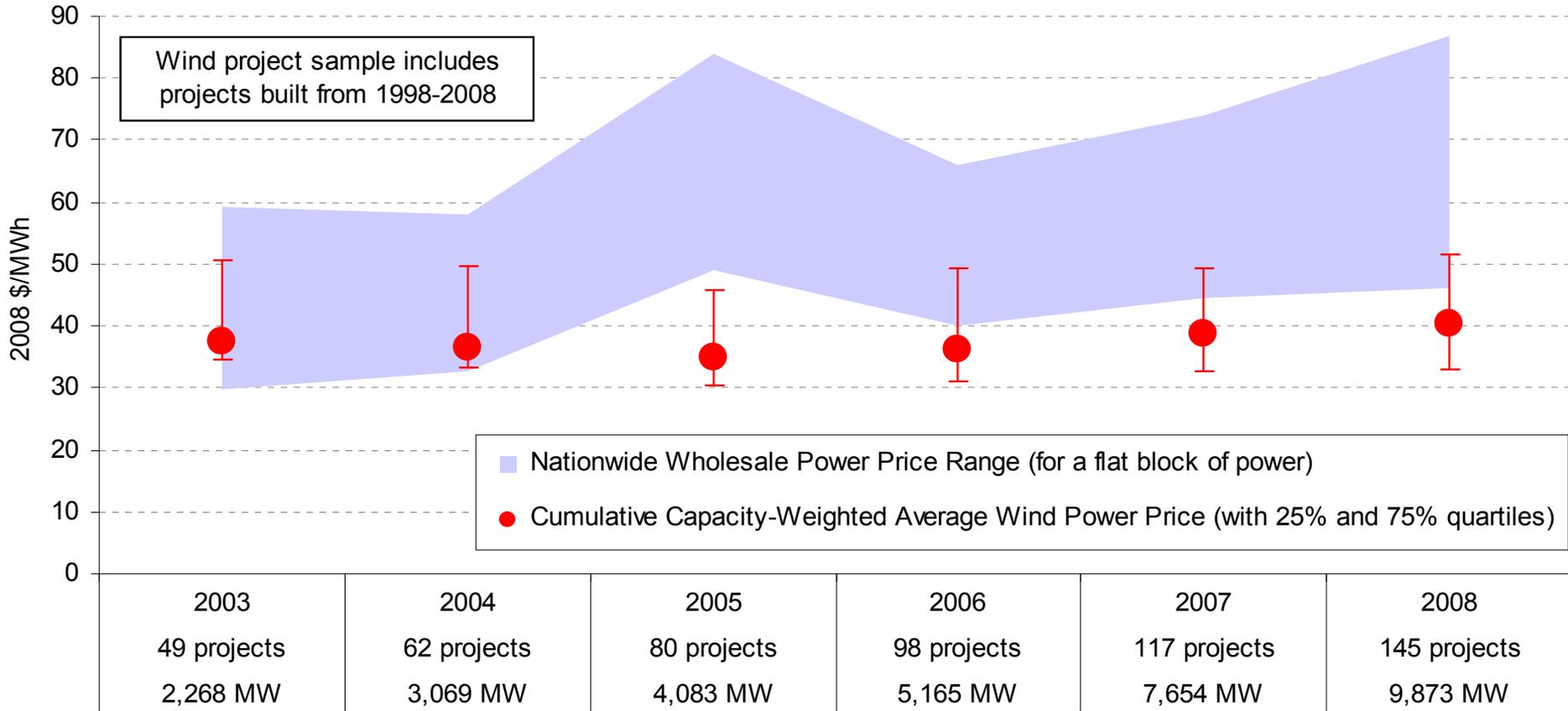
# Cumulative Average Sales Price for Sample of Projects Built After 1997 Remains Low



Small increases since 2005 are due to rising prices from newly built projects, but cumulative nature of graphic mutes degree of price increase



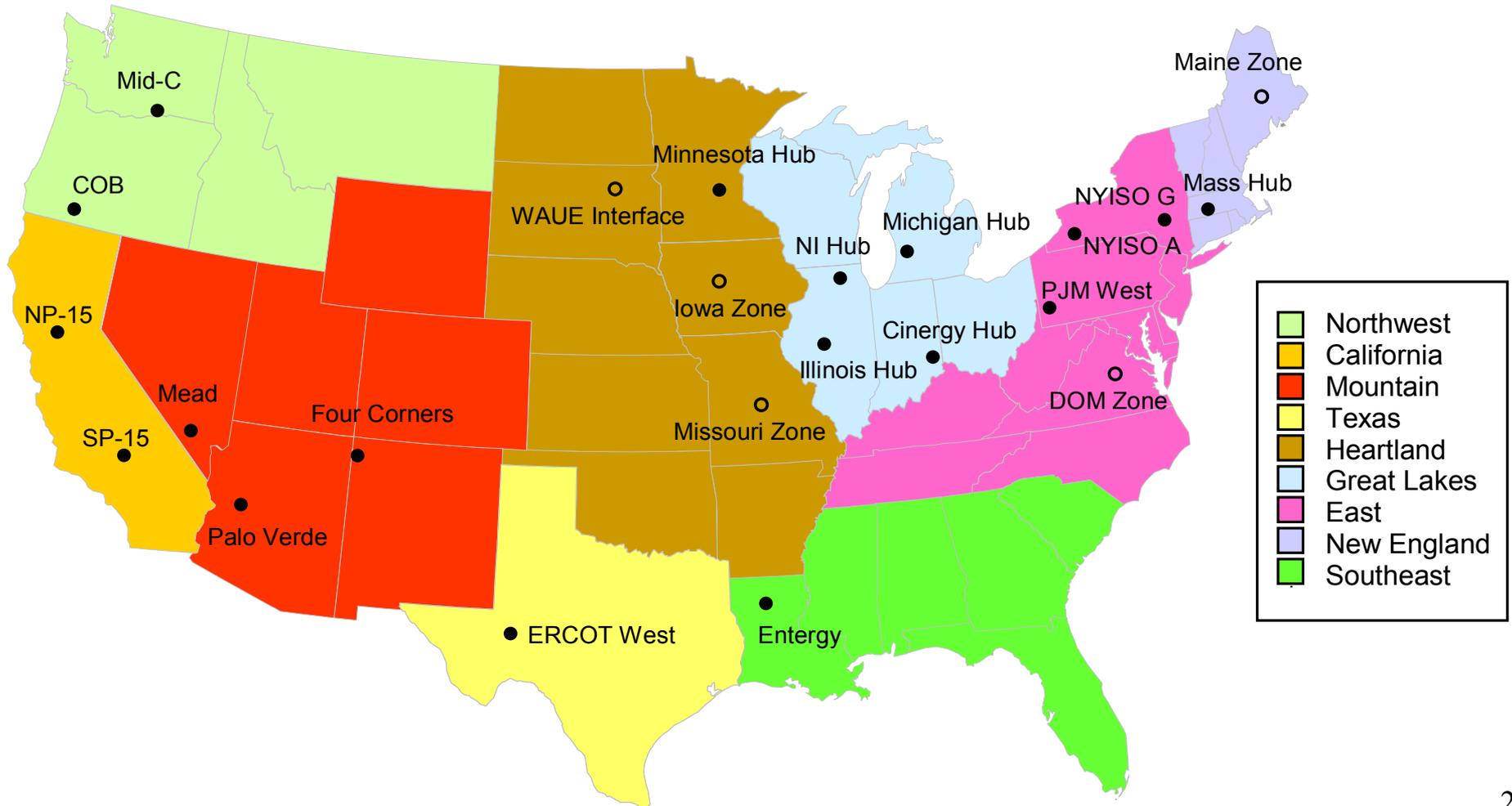
# Wind Has Been Competitive with Wholesale Power Prices in Recent Years



- Wholesale price range reflects flat block of power across 23 pricing nodes
- Wind power prices include sample of projects built from 1998-2008

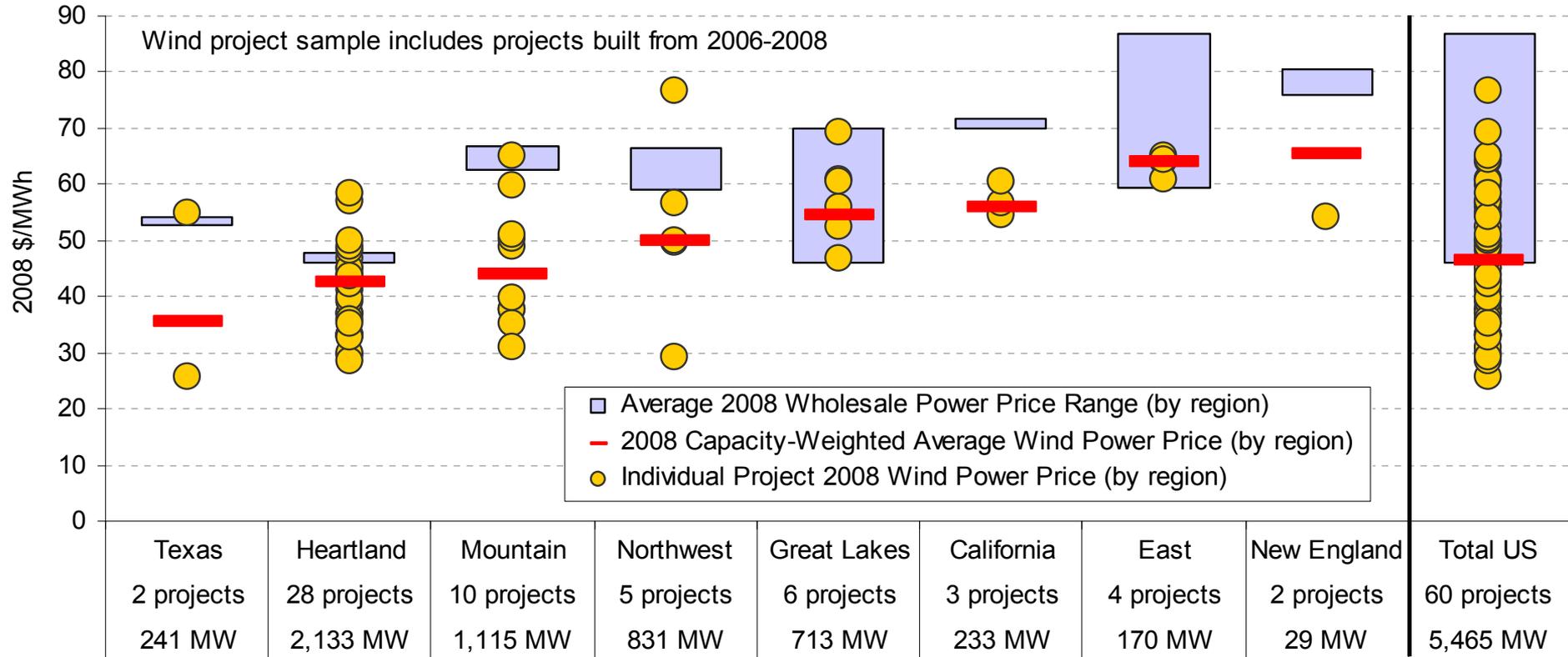


# Regions and Wholesale Price Hubs Used in Analysis





# Even Among More-Recent Projects, Wind Was Competitive in Most Regions in 2008



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

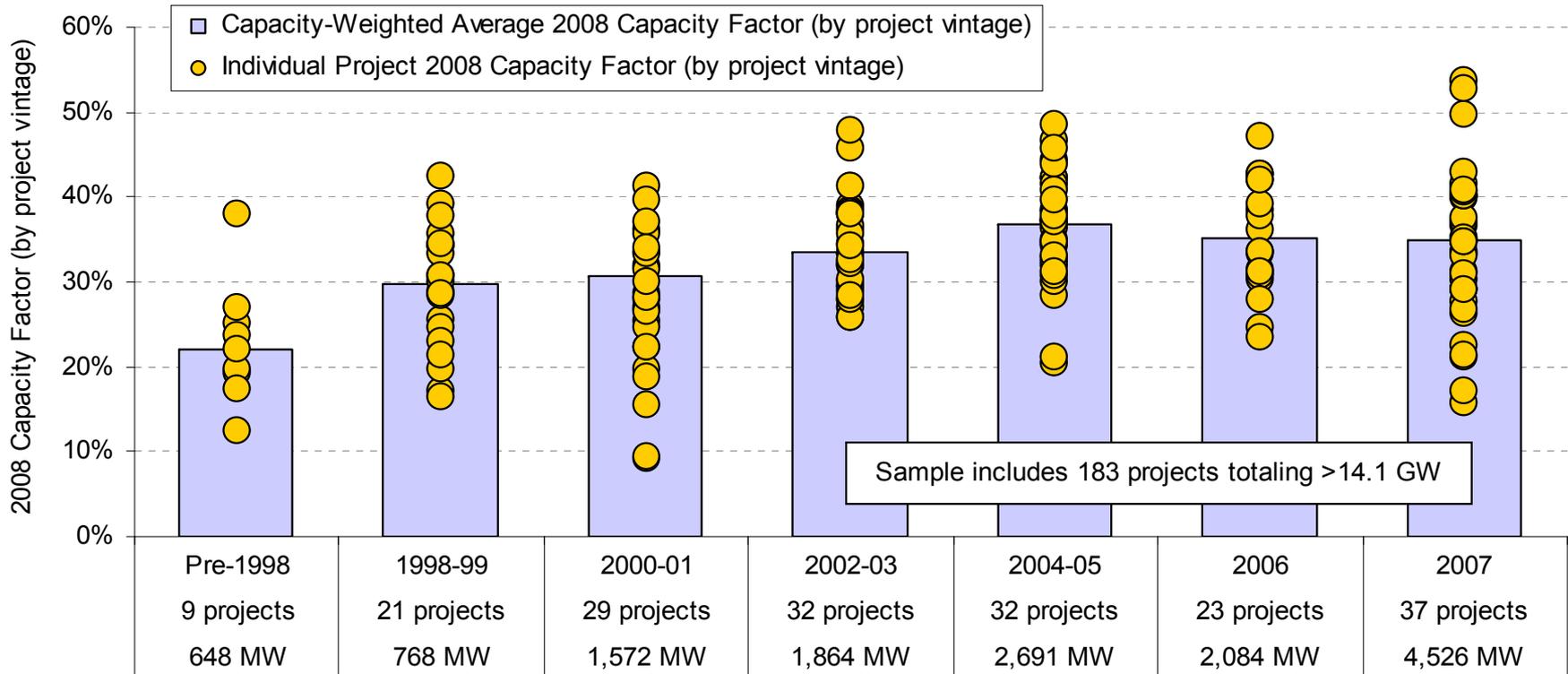


# Trends To Be Somewhat Concerned With...

- Project performance improvements leveling off
- Project and turbine costs have risen
- Wholesale power prices have plummeted



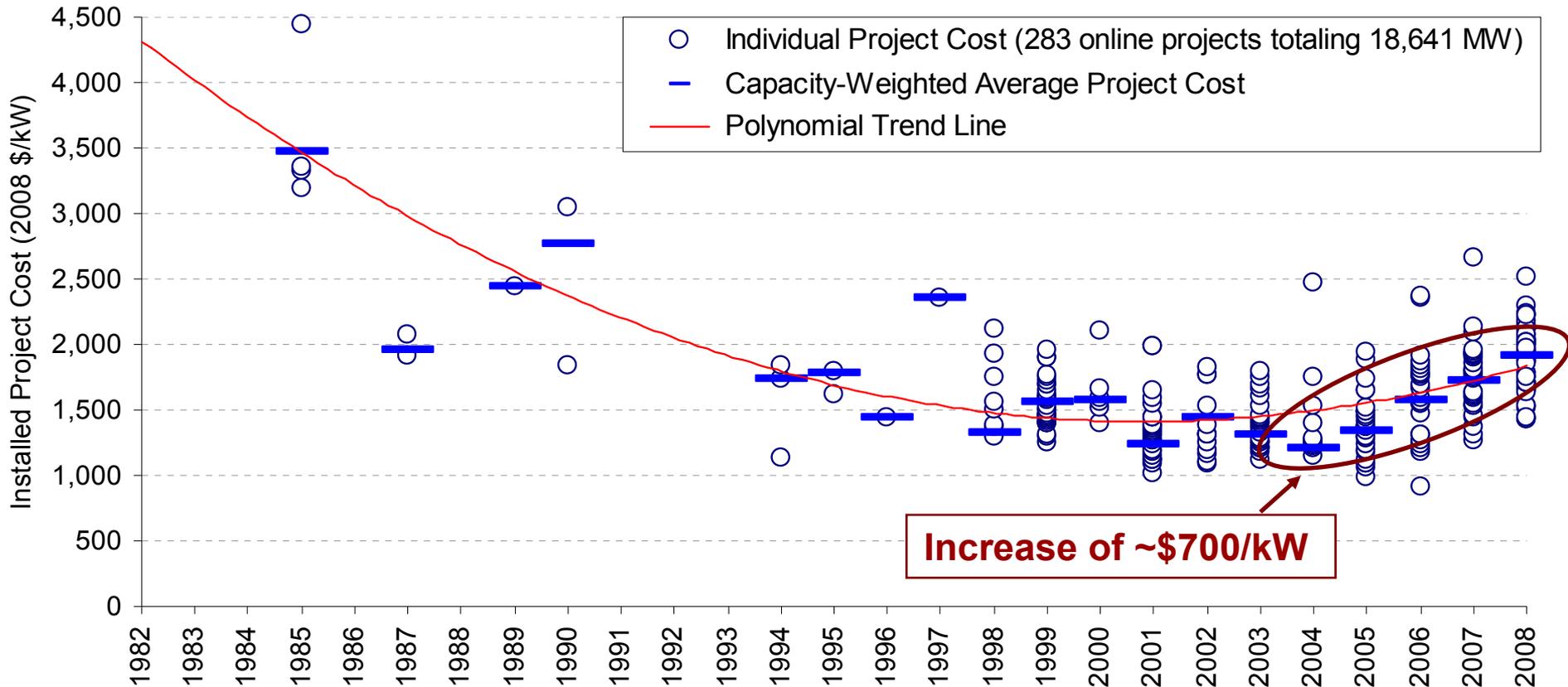
# Average Wind Project Performance Has Improved Over Time, But Leveled Off in Recent Years



Of the projects installed prior to 2004, 5.5% had capacity factors in excess of 40%; of the projects installed from 2004-2007, 26.1% had capacity factors in excess of 40%



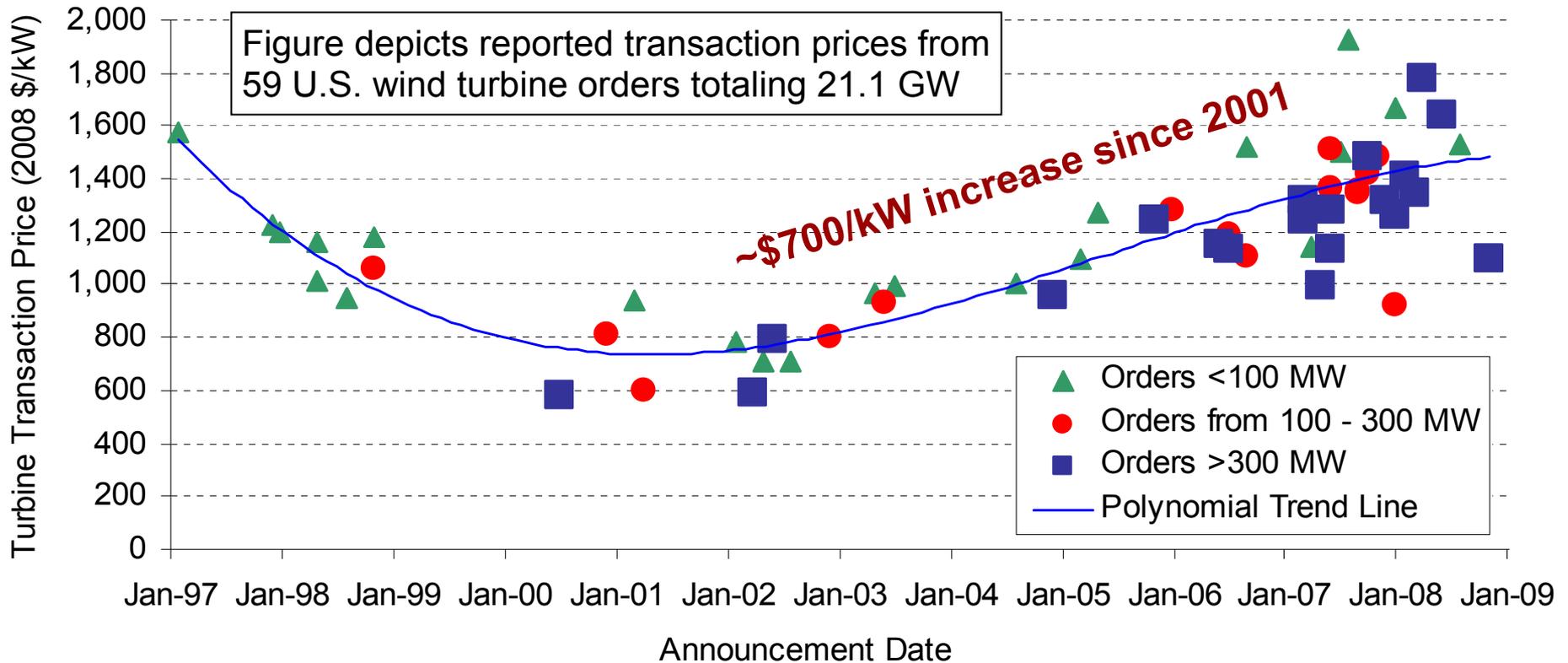
# Installed Project Costs Rose Substantially, After a Long Period of Decline



Sample of 3,600 MW of projects proposed for construction in 2009 (not shown in graphic) are ~\$205/kW higher still (averaging ~\$2,120/kW)



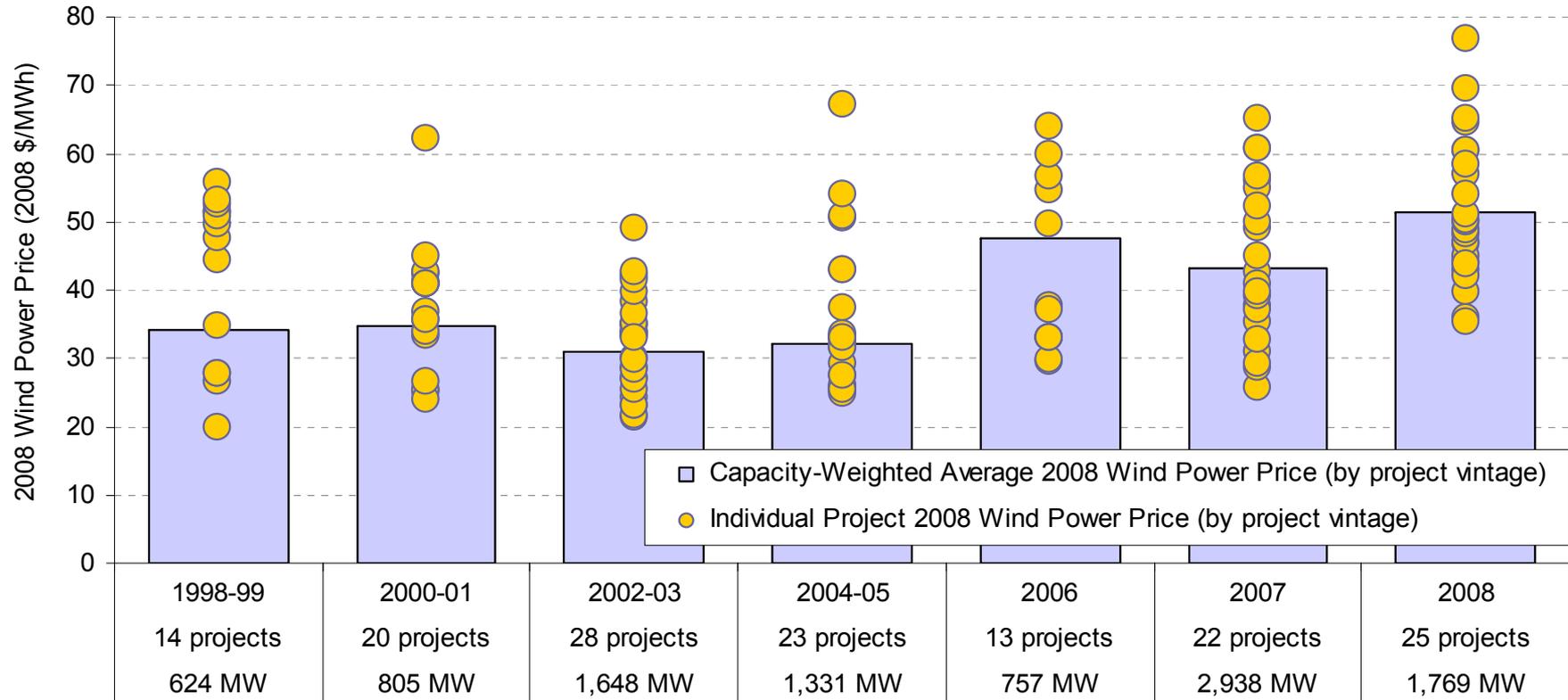
# Wind Turbine Prices Are Softening, But Remain High By Historical Standards



Though not shown in above graphic, spot turbine prices have softened as a result of the global recession and reversals in cost drivers, with 5-25% overall turbine price reductions seen through mid-2009



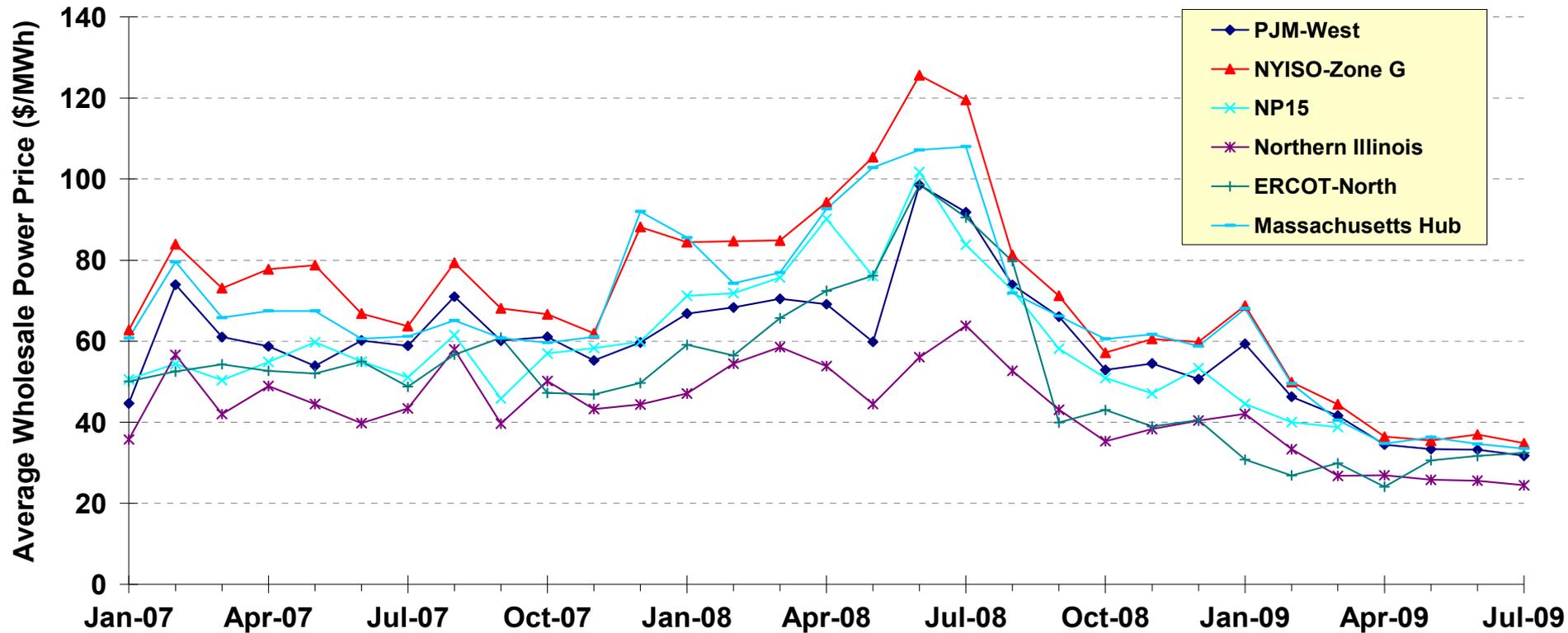
# As a Result of Foregoing Trends, Binning by COD Date Shows that Prices Have Increased Substantially Since 2002-2003...



- Graphic shows prices in 2008 from projects built from 1998-2008
- Projects built in 2008 are ~\$15-20/MWh higher, on average, than those built in 02-03

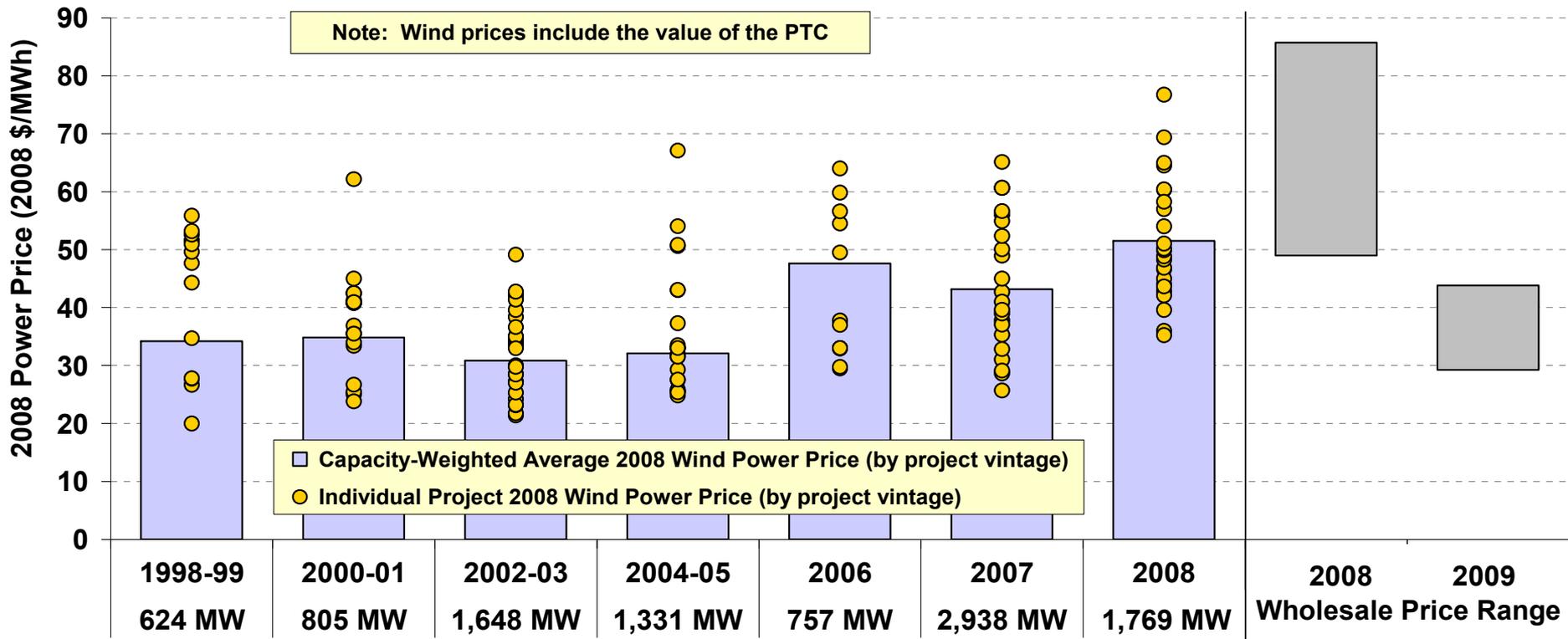


# ...While Wholesale Prices Have Recently Plummeted (with Natural Gas Prices)





# Result: The Near-Term Economics of Wind Has Become Somewhat Less Attractive





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# Future Outlook



# Forecasts Predict Slow 2009, with Resurgence in 2010

- 2009 likely to be a slow year, due to impact of global recession; predictions in table below range from 4,400 MW to 6,800 MW
- Forecasts show a market resurgence in 2010, however, and continuing at least through 2012, as the policies established in ARRA 2009 come into full swing, and as financing constraints are relieved

Source	2009	2010	2011	2012	Cumulative Additions 2009-2012
EIA	4,400	10,400	11,900	13,700	40,400
BTM	6,000	8,500	10,000	13,000	37,500
EER	6,500	9,000	11,000	10,000	36,500
NEF	4,900 – 6,800	na	na	na	na
AWEA	~ 6,500	na	na	na	na



# Uncertainties in Market Growth in Near-Term Reflect Balance Among Countering Trends

## Stronger Growth

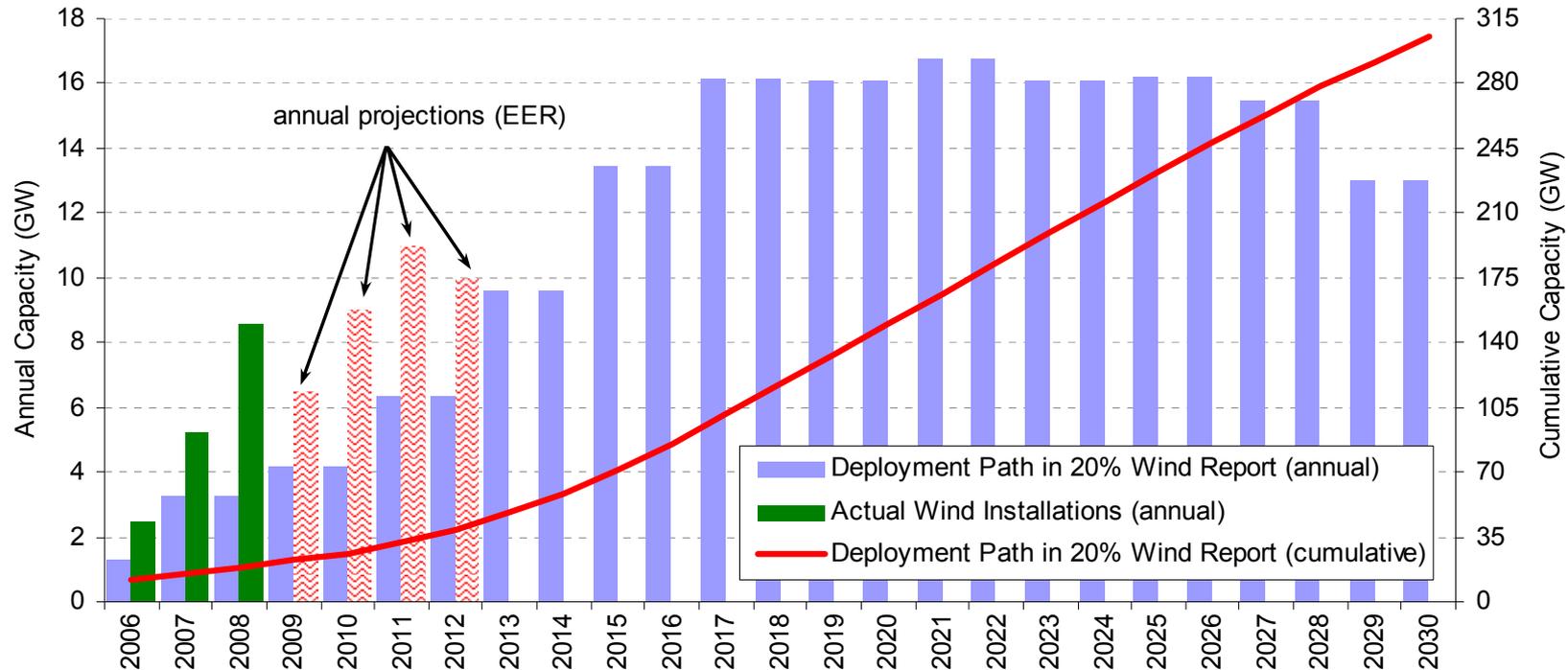
- Stronger federal and state policy support than at any point in last decade
- Expectations for further federal policy support through RPS, climate policy, and/or transmission policy
- Dropping wind turbine prices may improve comparative economics of wind, over time

## Weaker Growth

- Duration of financial crisis uncertain, and degree to which ARRA will alleviate impacts on wind unclear
- Natural gas and wholesale power prices and price expectations have plummeted
- Inadequate transmission infrastructure beginning to constrain new builds
- Increased competition from other renewable energy sources, in some regions



# U.S. Remains on Early Track To Meet 20% of Nation's Electricity with Wind by 2030



But ramping up to ~16 GW/year and maintaining that pace for a decade is an enormous challenge, requiring proactive policy, substantial transmission expansion, mitigation of output variability, and eased siting and permitting processes



# For More Information...

See full report for additional findings, a discussion of the sources of data used, etc.

- <http://www1.eere.energy.gov/windandhydro/>

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