U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

2009 Wind Technologies Market Report

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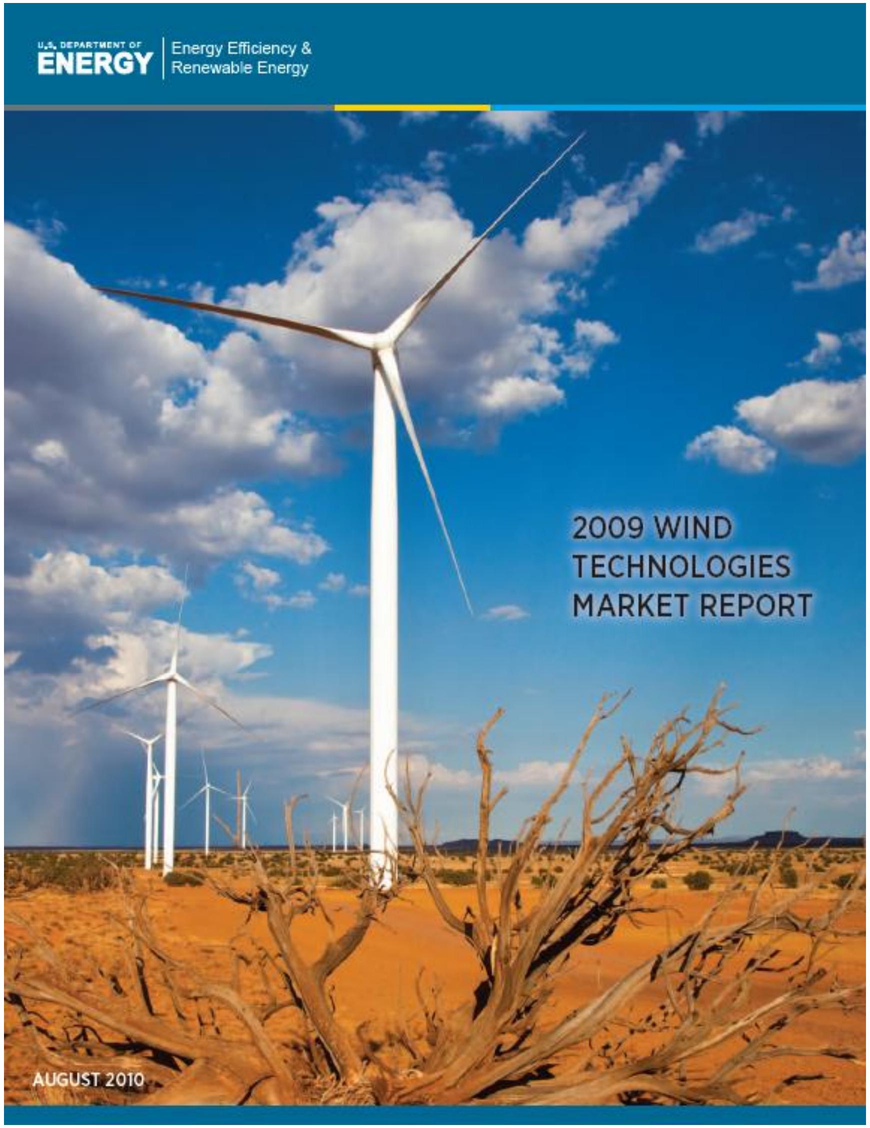
Report Summary

August 2010

Presentation Overview

- Introduction to 2009 edition of U.S. wind energy market report
- 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



2009 Wind Technologies Market Report

Purpose, Scope, and Data:

- With a focus on 2009, summarize trends in the U.S. wind power market, including information on wind installations, industry developments, power sales prices, project costs, performance, O&M costs, policy/market trends
- Scope primarily includes wind turbines and projects over 100 kW in size
- Data sources include AWEA, EIA, FERC, SEC, etc. *(see full report)*

Report Authors:

- Primary authors: Ryan Wiser and Mark Bolinger, Berkeley Lab
- Contributions from others at Berkeley Lab, Exeter Associates, NREL

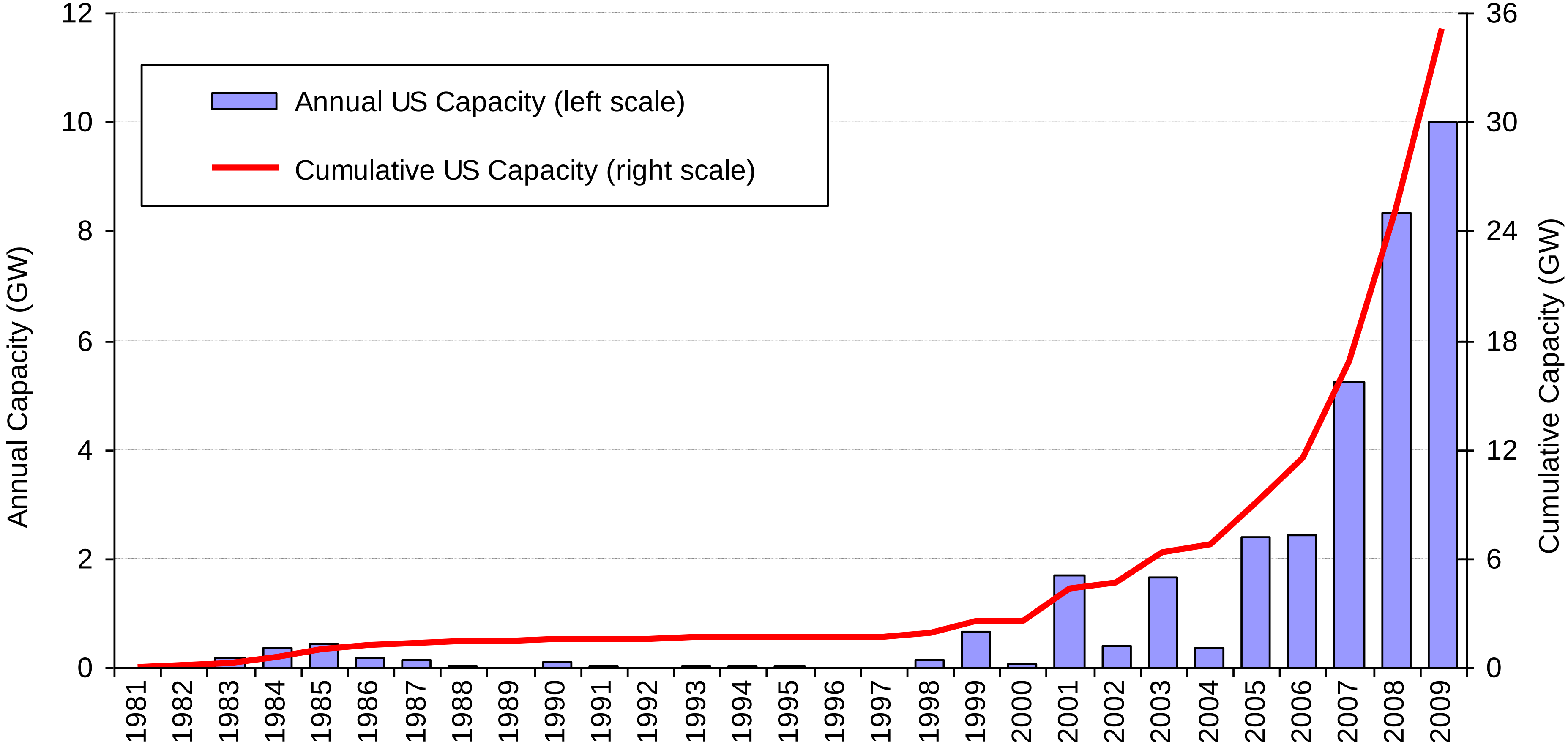
Available at: http://windandwater.energy.gov/

New to the 2009 Edition of the Report

- Turbine and component imports into the U.S., and import share
- Trends in hub height and rotor diameter of installed projects
- Expanded discussion of the offshore wind energy sector
- Data on wind power curtailment in Texas and the Midwest
- Impact of the *Recovery Act* on the U.S. wind power industry

Installation Trends

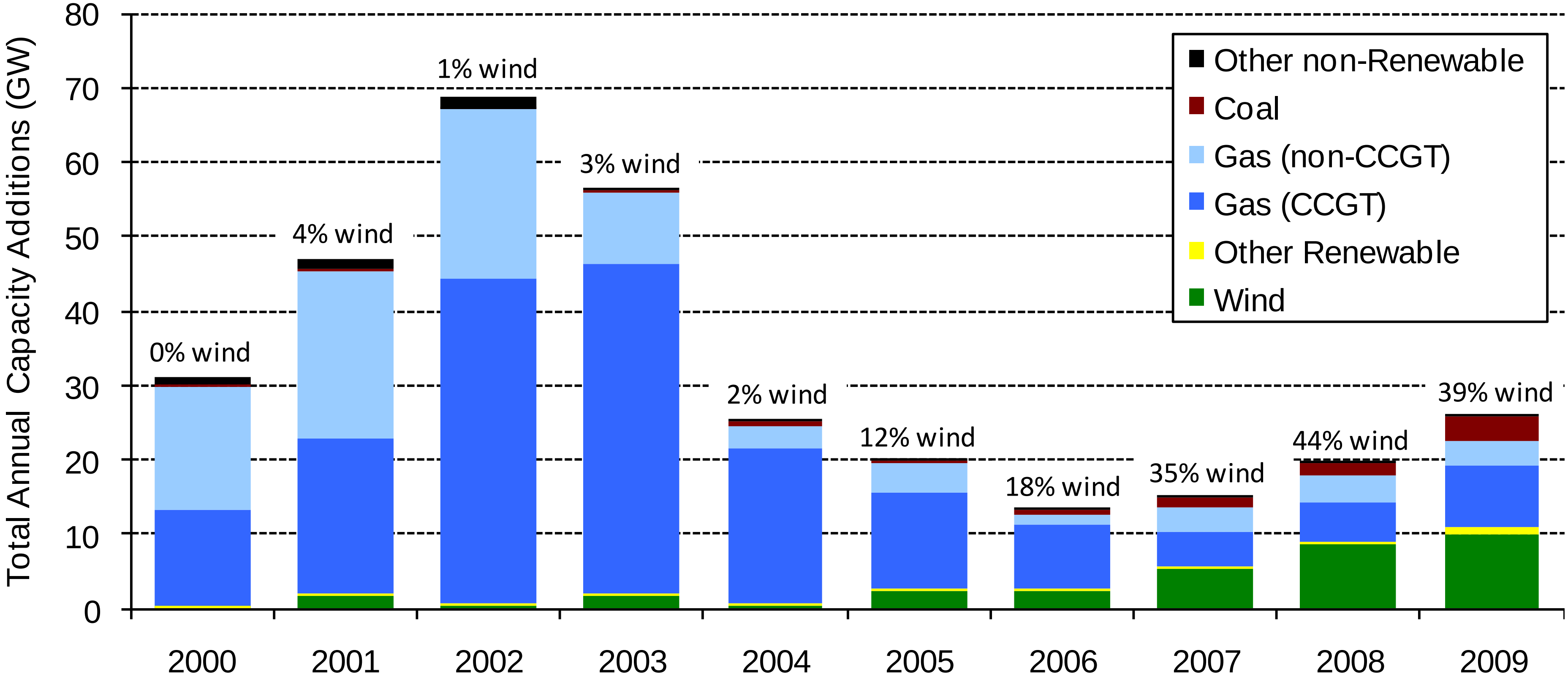
U.S. Wind Power Capacity Up >40% in 2009



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

- 10 GW of wind power added in 2009, bringing total to ~35 GW
- Nearly $21 billion in 2009 project investment

Wind Power Contributed 39% of All New Generating Capacity in the U.S. in 2009



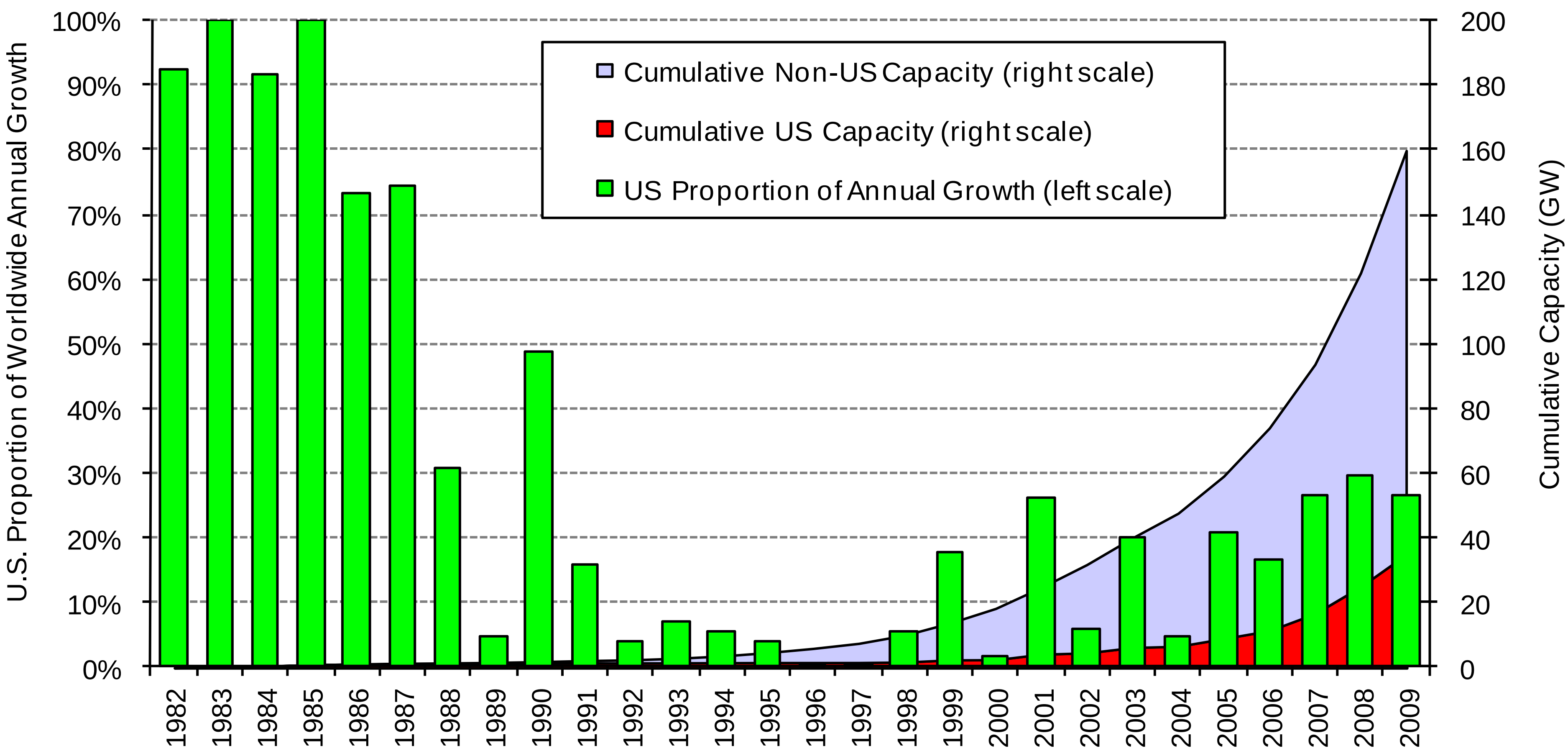
Wind was the 2nd-largest resource added for the 5th-straight year

U.S. Led World in Cumulative Capacity, But Fell to 2nd in Annual Capacity Growth

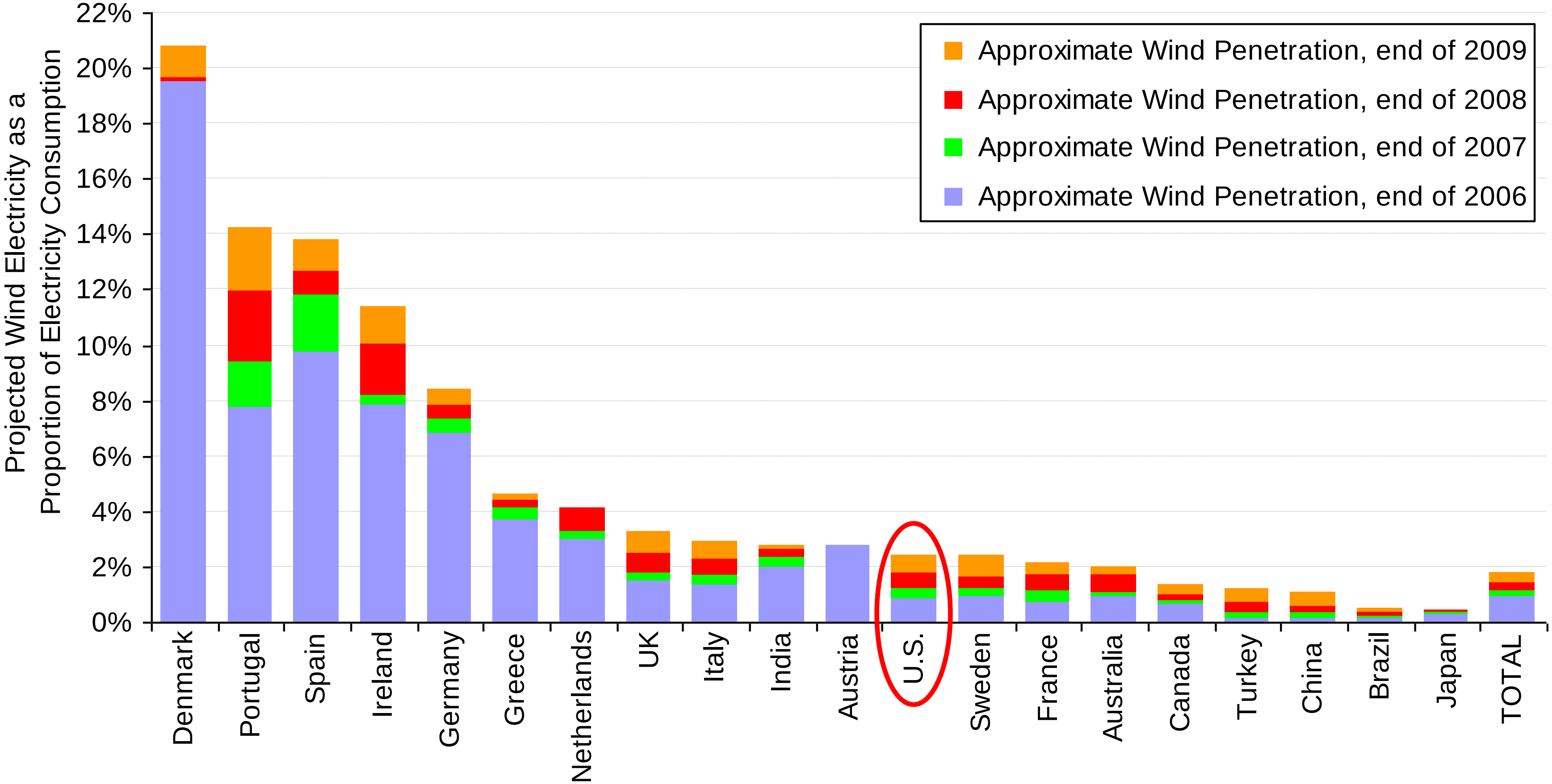
Annual Capacity (2009, MW)		Cumulative Capacity (end of 2009, MW)	
China	13,750	**U.S.**	**35,155**
U.S.	**9,994**	China	25,853
Spain	2,331	Germany	25,813
Germany	1,917	Spain	18,784
India	1,172	India	10,827
Italy	1,114	Italy	4,845
France	1,104	France	4,775
U.K.	1,077	U.K.	4,340
Canada	950	Portugal	3,474
Portugal	645	Denmark	3,408
Rest of World	4,121	*Rest of World*	22,806
TOTAL	**38,175**	**TOTAL**	**160,080**

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

U.S. Share of Global Wind Power Capacity: 26% of 2009 Additions, 22% of Cumulative

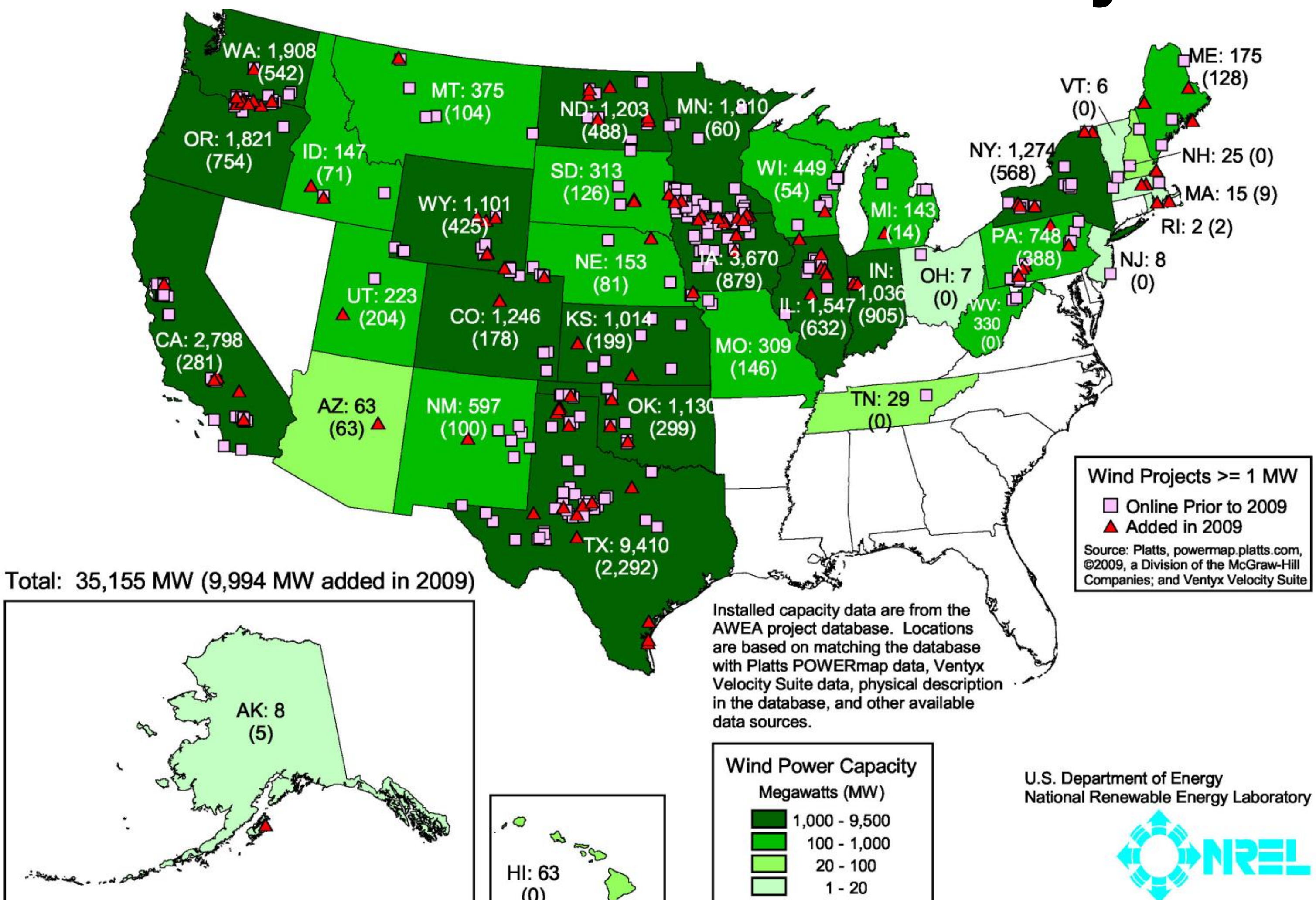


U.S Lagging Other Countries in Wind As a Percentage of Electricity Consumption



Note: Figure only includes the 20 countries with the most installed wind power capacity at the end of 2009

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



Texas Easily Led Other States in Both Annual and Cumulative Capacity

Annual Capacity (2009, MW)		Cumulative Capacity (end of 2009, MW)		Estimated Percentage of In-State Generation	
Texas	2,292	Texas	9,410	Iowa	19.7%
Indiana	905	Iowa	3,670	South Dakota	13.3%
Iowa	879	California	2,798	North Dakota	11.9%
Oregon	754	Washington	1,908	Minnesota	10.7%
Illinois	632	Oregon	1,821	Oregon	9.0%
New York	568	Minnesota	1,810	Colorado	7.7%
Washington	542	Illinois	1,547	Kansas	7.4%
North Dakota	488	New York	1,274	Texas	6.8%
Wyoming	425	Colorado	1,246	Wyoming	6.7%
Pennsylvania	388	North Dakota	1,203	Oklahoma	5.0%
Oklahoma	299	Oklahoma	1,130	Montana	4.9%
California	281	Wyoming	1,101	Washington	4.9%
Utah	204	Indiana	1,036	New Mexico	4.6%
Kansas	199	Kansas	1,014	California	3.4%
Colorado	178	Pennsylvania	748	Maine	3.1%
Missouri	146	New Mexico	597	Idaho	3.0%
Maine	128	Wisconsin	449	Indiana	2.7%
South Dakota	126	Montana	375	New York	2.2%
Montana	104	West Virginia	330	Hawaii	2.2%
New Mexico	100	South Dakota	313	Illinois	2.1%
Rest of U.S.	358	*Rest of U.S.*	1,376	*Rest of U.S.*	0.3%
TOTAL	**9,994**	**TOTAL**	**35,155**	**TOTAL**	**2.5%**

Source: AWEA project database, EIA, Berkeley Lab estimates

- 14 states had >1000 MW of wind capacity at the end of 2009 (3 had >2000 MW)
- 4 states have in-state wind generation that exceeds 10% of total in-state generation (10 states exceed 5%)

Wind Now >10% of Nine Utilities' Sales

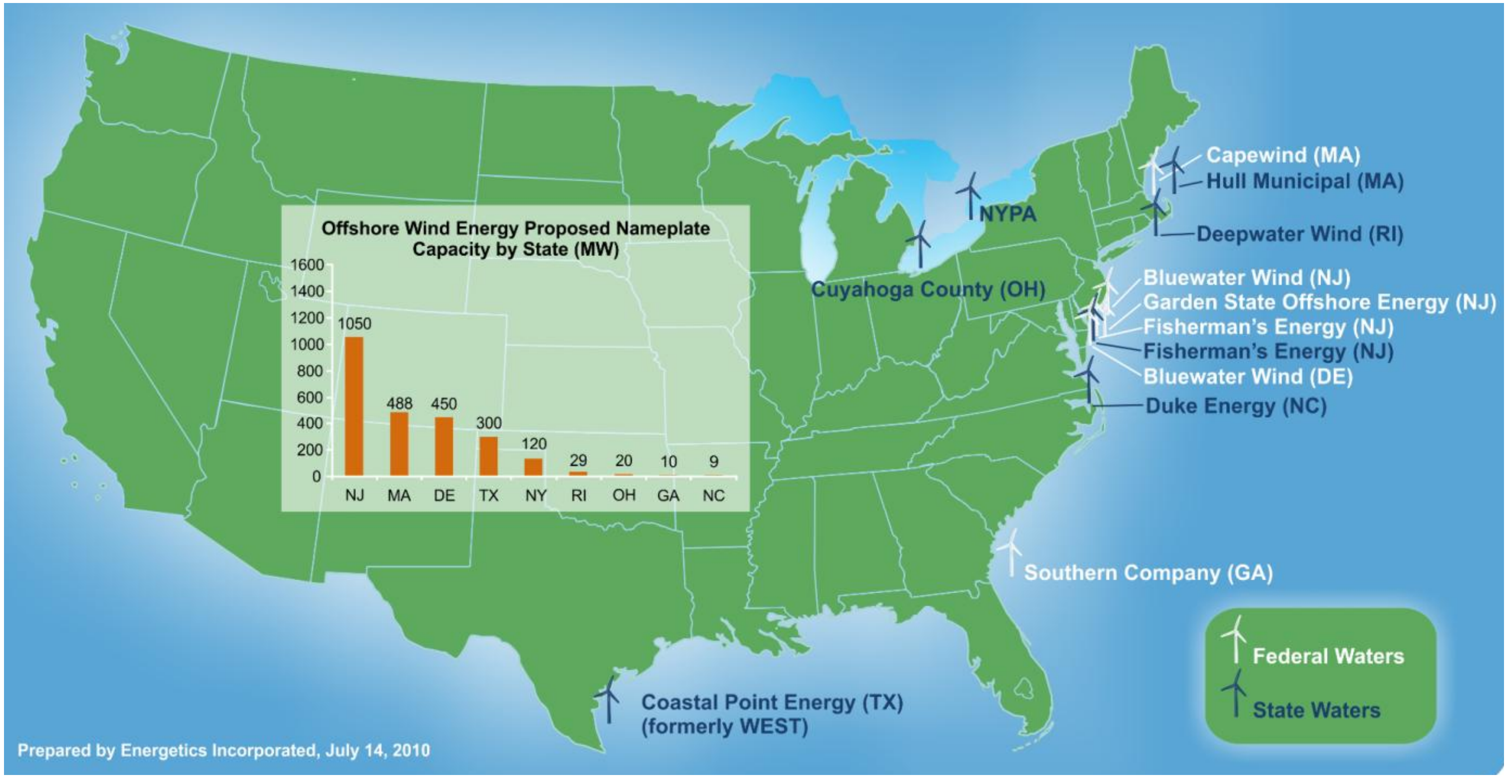
Total Wind Capacity (end of 2009, MW)	
Xcel Energy	3,176
MidAmerican Energy	2,923
Southern California Edison	1,772
American Electric Power	1,196
Pacific Gas & Electric	1,131
Luminant	913
Alliant Energy	645
City Public Service of San Antonio	579
Puget Sound Energy	479
Austin Energy	439
First Energy	376
Portland General Electric	375
Minnkota Power Cooperative	357
Basin Electric	352
SDG&E	342
Great River Energy	319
Westar	295
Oklahoma Gas & Electric	272
Empire District Electric Company	255
SCPPA (not including LADWP)	233

Estimated Percentage of Retail Sales (for utilities with > 100 MW of wind)	
Minnkota Power Cooperative	38.0%
Empire District Electric Company	18.1%
Turlock Irrigation District	18.0%
Otter Tail Power	14.0%
Sunflower Electric Power Corp.	13.2%
Xcel Energy	11.1%
Austin Energy	10.3%
Great River Energy	10.1%
Westar	10.1%
Western Farmers' Electric Cooperative	9.8%
MidAmerican Energy	9.6%
Snohomish PUD	8.5%
MSR Public Power Agency	8.4%
City Public Service of San Antonio	8.4%
Public Service New Mexico	6.8%
Cowlitz PUD	6.5%
WPPI Energy	6.4%
Alliant Energy	5.9%
Puget Sound Energy	5.4%
Northwestern Energy	5.3%

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

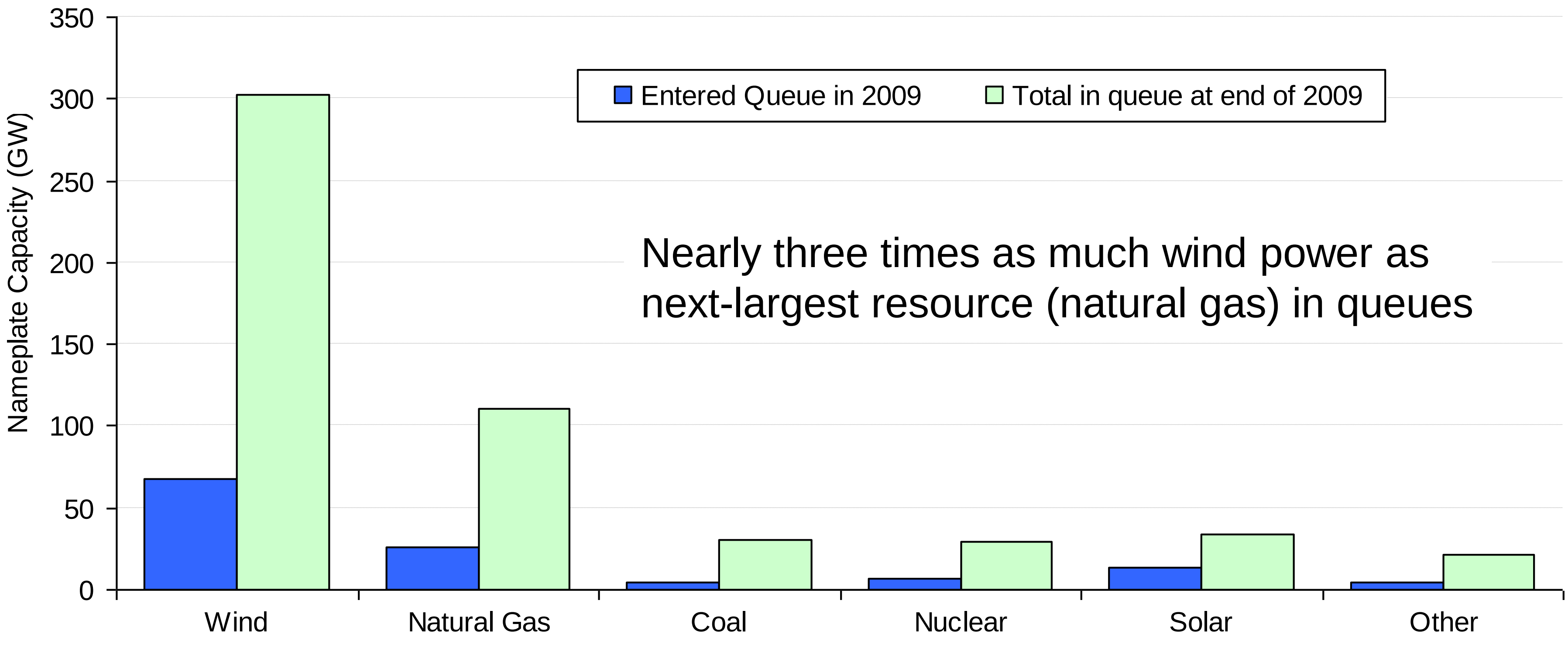
Source: AWEA, EIA, Berkeley Lab estimates

No Offshore Projects Have Been Built in the U.S., But 13 Projects Are At a More-Advanced Permitting/Development Stage



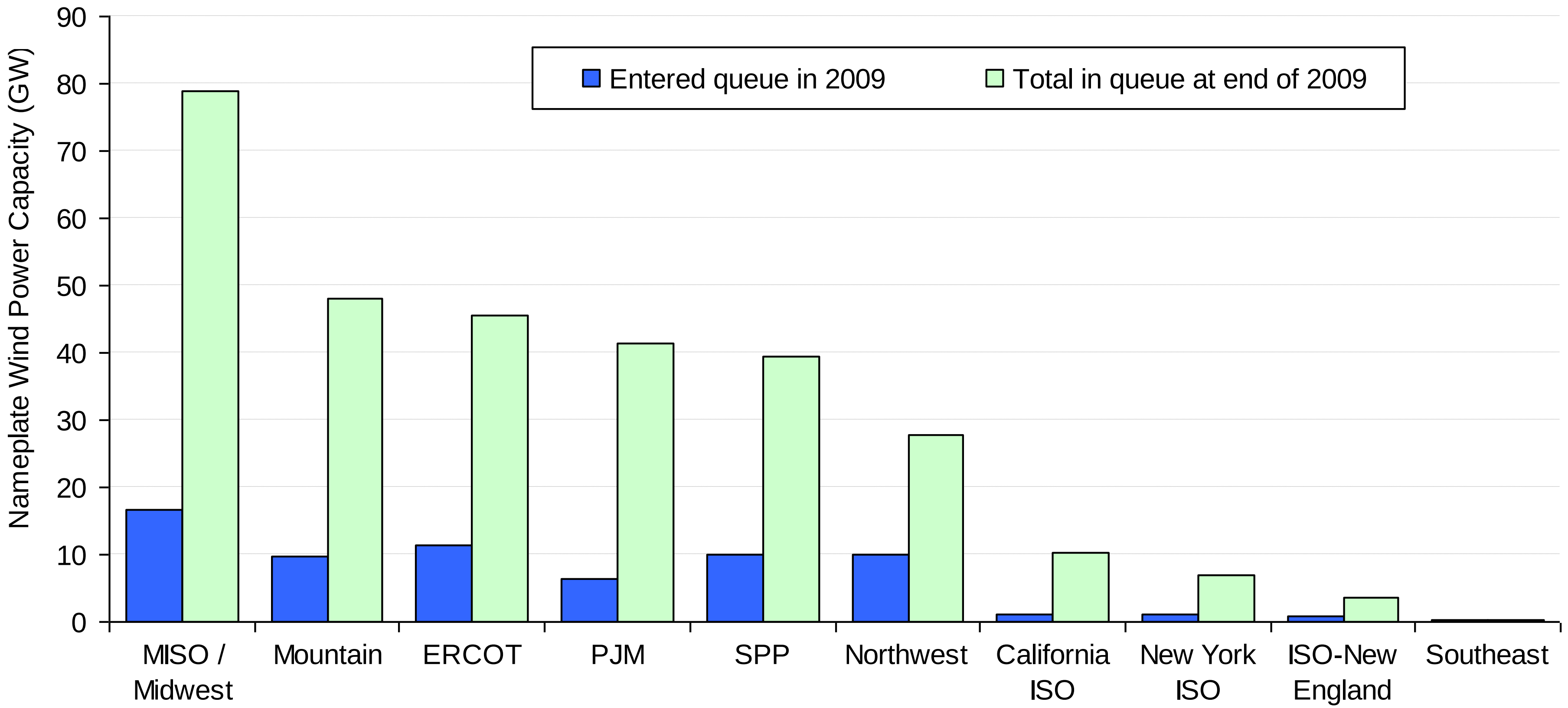
- Three projects have signed or proposed power purchase agreements
- Cape Wind granted approval by Department of Interior in April 2010

Roughly 300 GW of Wind Power Capacity in Transmission Interconnection Queues



Not all of this capacity will be built….

>90% Planned for Midwest, Mountain, ERCOT, PJM, SPP, and Northwest Regions



Not all of this capacity will be built….

Market for Small Wind Turbines Continued to Grow in 2009

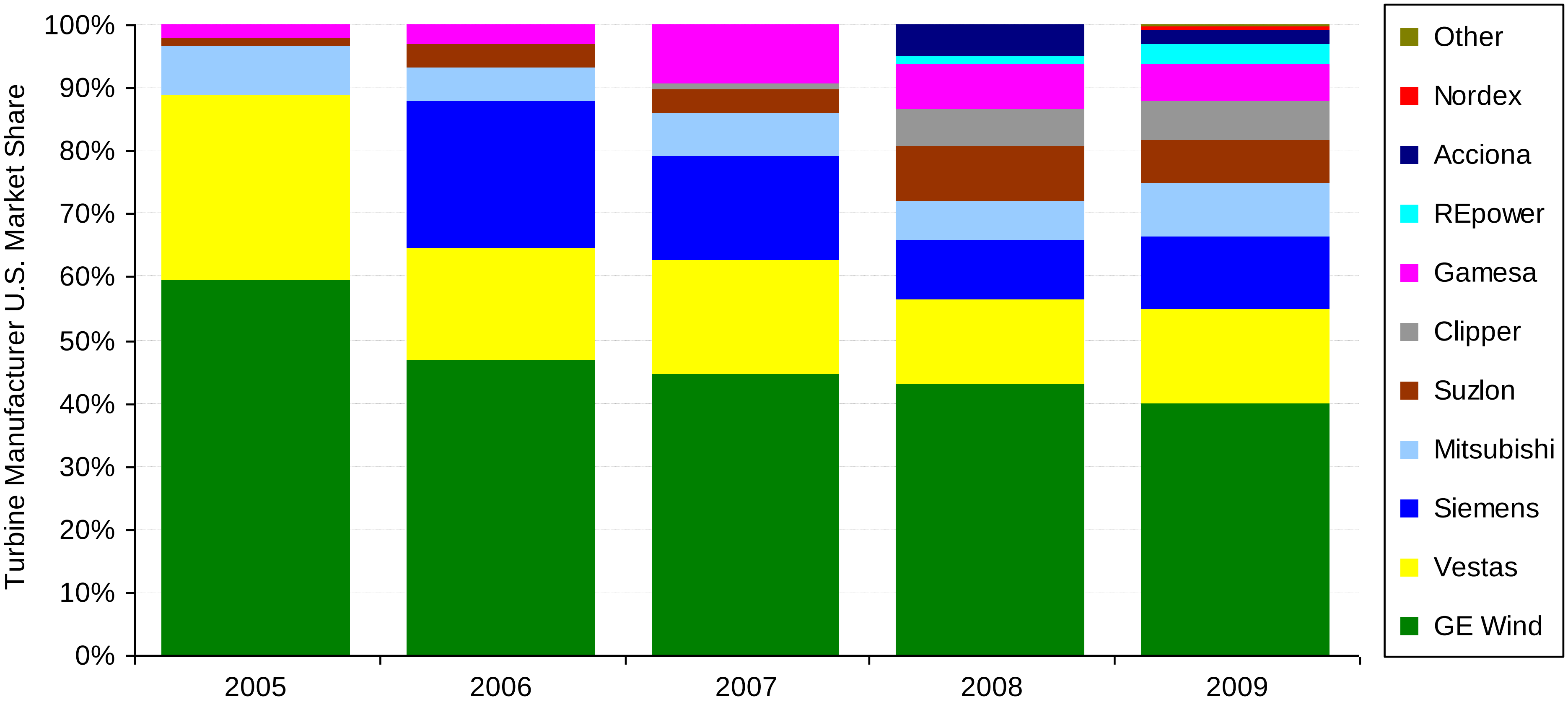
Year	Annual Sales of Small Wind Turbines into the United States		
	Number of Turbines	Capacity Additions	Sales Revenue
2005	4,324	3.3 MW	$10 million
2006	8,329	8.6 MW	$33 million
2007	9,092	9.7 MW	$42 million
2008	10,386	17.4 MW	$73 million
2009	9,800	20.3 MW	$82 million

Source: AWEA (2010b)

- Sales of small wind turbines (turbine size to 100 kW) in the U.S. equaled 20.3 MW in 2009, or $82 million
- Roughly 15% growth in annual sales (in capacity terms), relative to 2008, yielding cumulative capacity of roughly 100 MW

Industry Trends

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



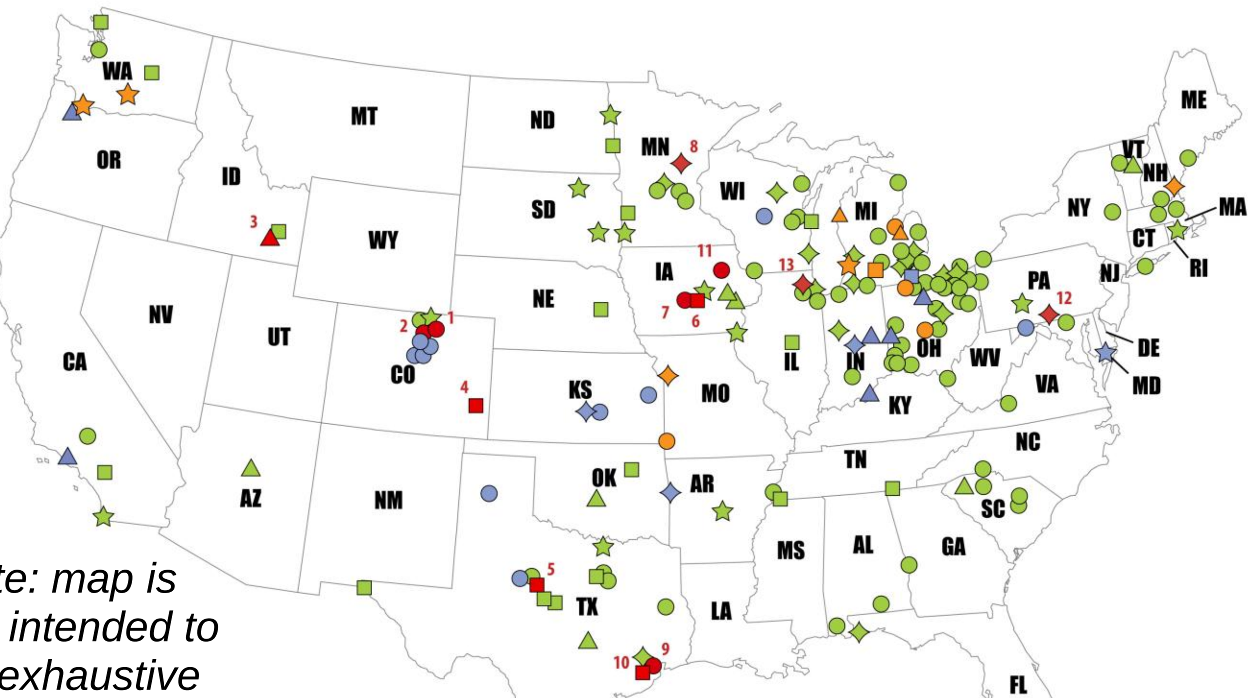
Most Wind Turbine Vendors Active in the U.S. Market Saw Growth in 2009

Manufacturer	Turbine Installations (MW)				
	2005	2006	2007	2008	2009
GE Wind	1,433	1,146	2,342	3,585	3,995
Vestas	700	439	948	1,120	1,490
Siemens	0	573	863	791	1,162
Mitsubishi	190	128	356	516	814
Suzlon	25	92	197	736	702
Clipper	3	0	48	470	605
Gamesa	50	74	494	616	600
REPower	0	0	0	94	330
Acciona	0	0	0	410	204
Nordex	0	0	3	0	63
Other	2	2	0	12	31
TOTAL	**2,402**	**2,454**	**5,249**	**8,350**	**9,994**

- Chinese and South Korean manufacturers seeking entry into U.S. market
- For first time in 2009, a turbine vendor from China (Goldwind) saw sales in the U.S.

U.S. Wind Turbine Manufacturing Strong, But With Slower Growth

- AWEA estimates that the wind power sector provided roughly 85,000 full-time jobs in the U.S. at the end of 2009 (18,500 of which were in manufacturing)
- 7 of the 10 wind turbine vendors with the largest share of the U.S. market in 2009 have one or more manufacturing facilities operating in the U.S., while 2 of the remaining 3 have announced specific plans to open facilities in the future



Note: map is not intended to be exhaustive

New Facilities Opened in 2009

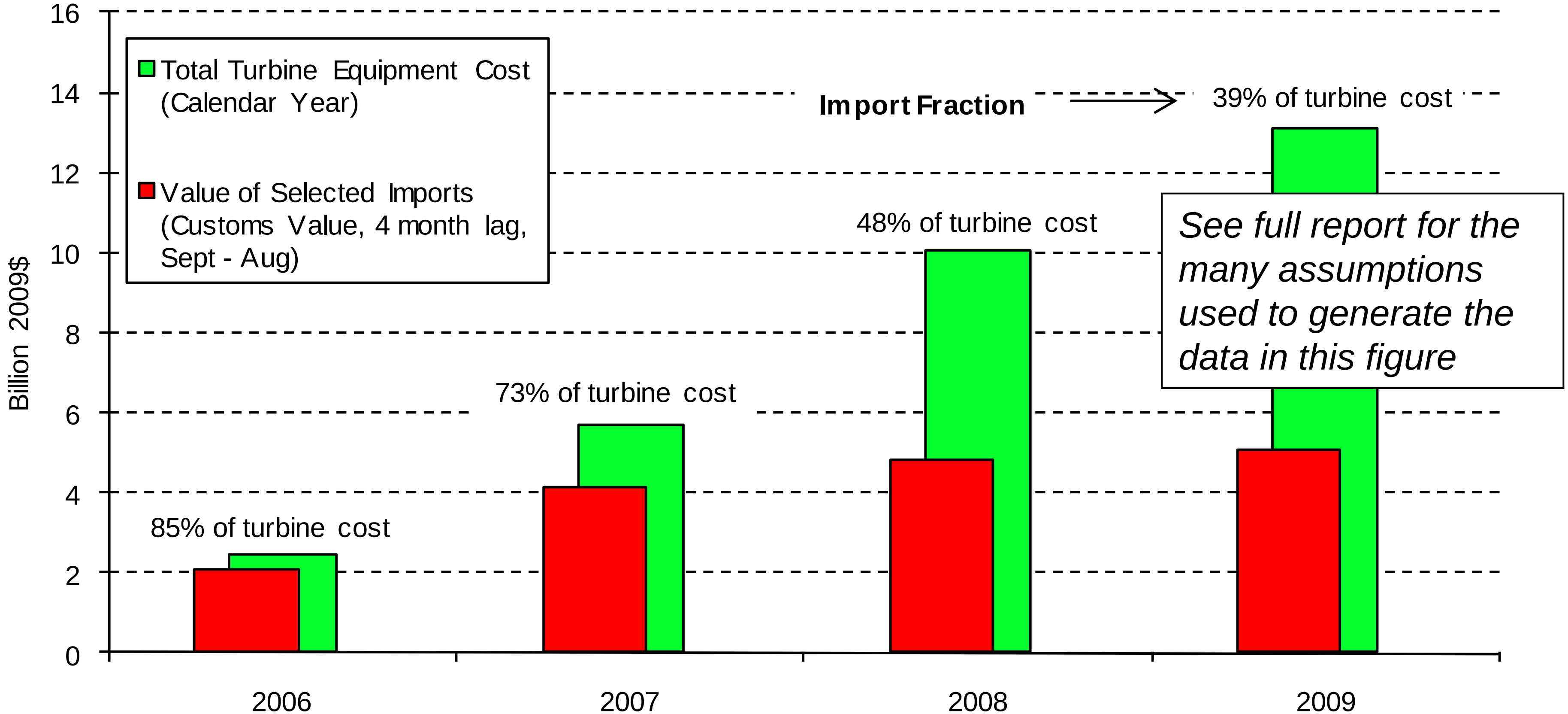
1. Hexcel (glass prepreg), Windsor, CO, +100 jobs
2. Creative Foam (composites), Longmont, CO, +150 jobs
3. Nordic Windpower (turbines), Pocatello, ID, +160 jobs
4. Dragon Wind (towers), Lamar, CO, +60-80 jobs
5. Tower Tech (towers), Abilene, TX, +150 jobs
6. Trinity Structural Towers (towers), Newton, IA, +140 jobs
7. Goian North America (elevation systems), Ankeny, IA, +12 jobs
8. Mille Lacs Band of Ojibwe (generators), Mille Lacs Reservation, MN, +7 jobs
9. RLTC Wind Towers (towers), MacGregor, TX, +75-250 jobs
10. RBC Bearings (bearings), Houston, TX, +35 jobs
11. Sector 5 Technologies (components), Oelwein, IA, +99 jobs
12. Vacon Inc (AC drives), Chambersburg, PA, +94 jobs
13. Winergy (gear drives), Elgin, IL, +300 jobs

Nacelles & Components
Turbines
Blades
Towers
Other
New facilities opened in 2009
Newly branched into wind in 2009
New facilities announced in 2009
Existing facilities online prior to 2009

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, nacelles and blades.

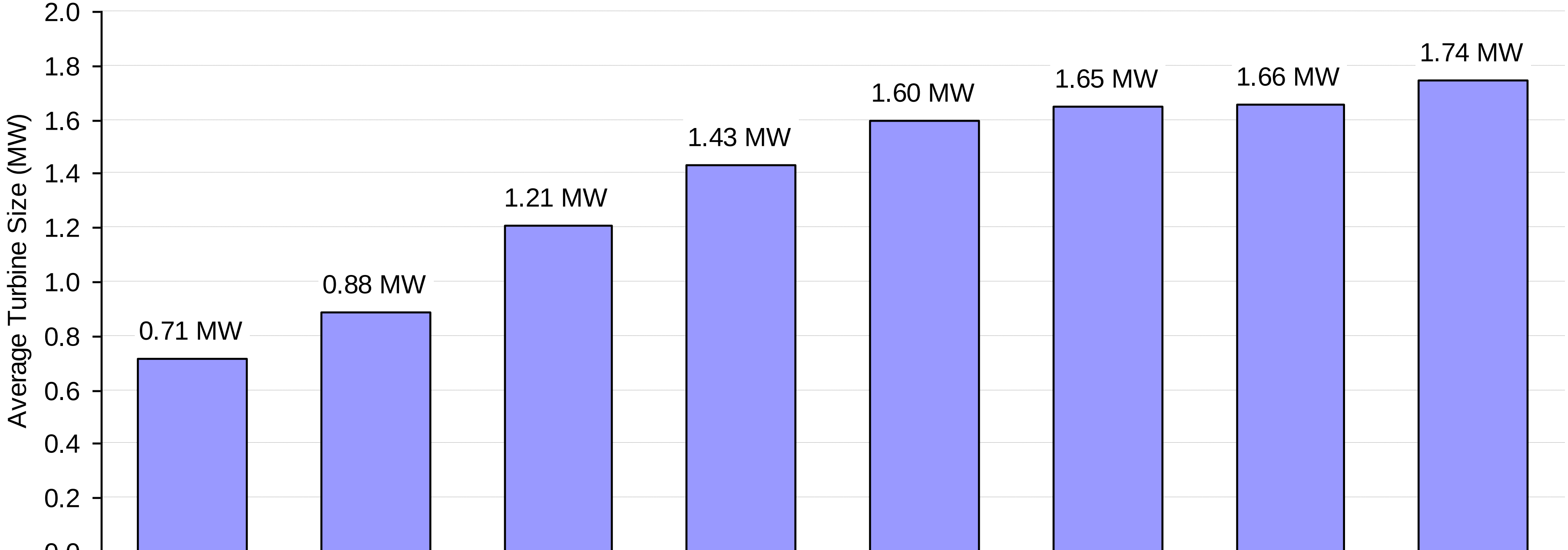
NREL
This map was created by The National Renewable Energy Laboratory for the U.S. Department of Energy. April 22, 2010

A Growing % of Equipment Used in U.S. Projects Has Been Sourced Domestically



- U.S. is largest importer of wind equipment; 7th largest exporter
- Wind power capacity growth has outpaced import growth

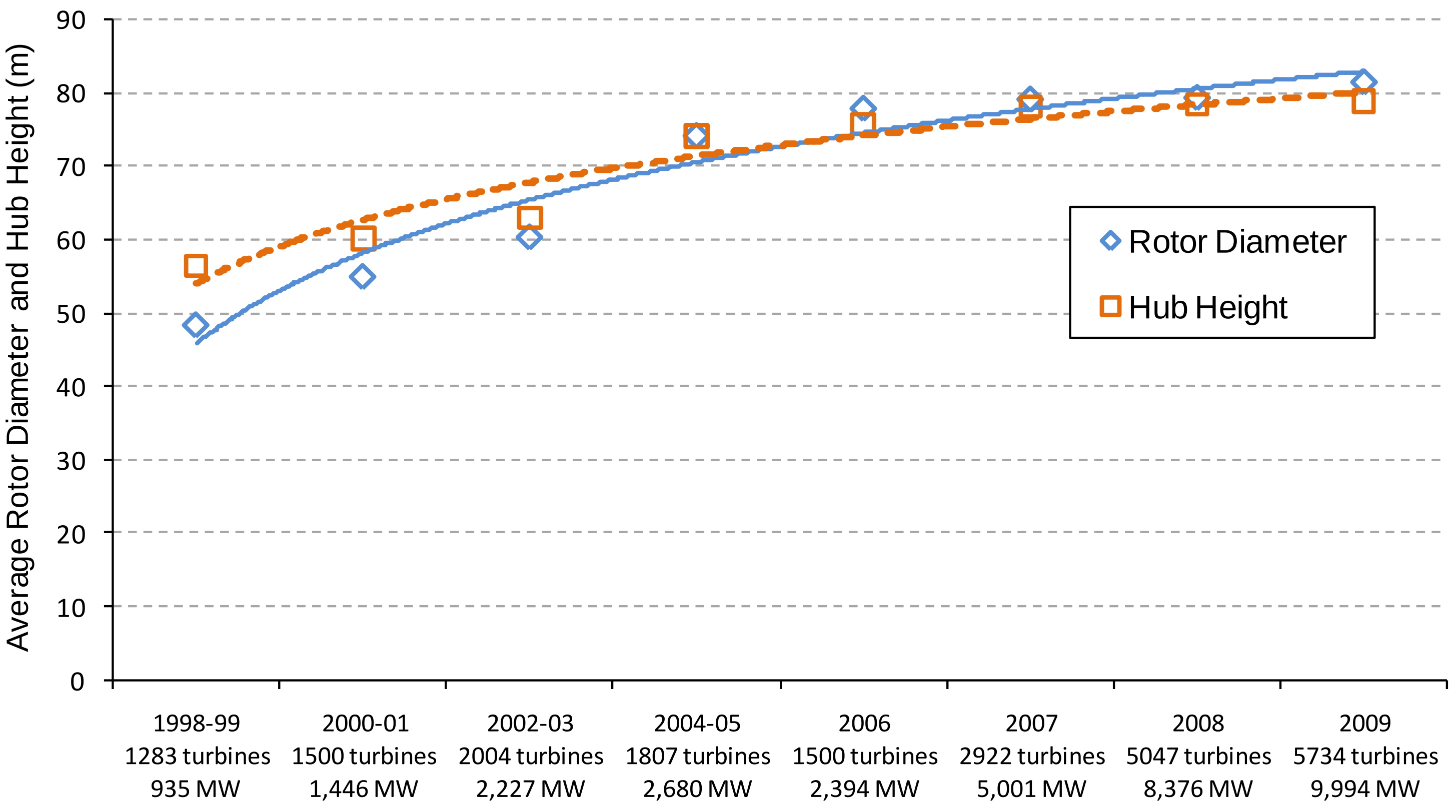
Average Turbine Size Higher in 2009



1998-99	2000-01	2002-03	2004-05	2006	2007	2008	2009
1,425 turbines	1,987 turbines	1,757 turbines	1,960 turbines	1,536 turbines	3,190 turbines	5,029 turbines	5,734 turbines
1,016 MW	1,758 MW	2,125 MW	2,803 MW	2,454 MW	5,249 MW	8,350 MW	9,994 MW

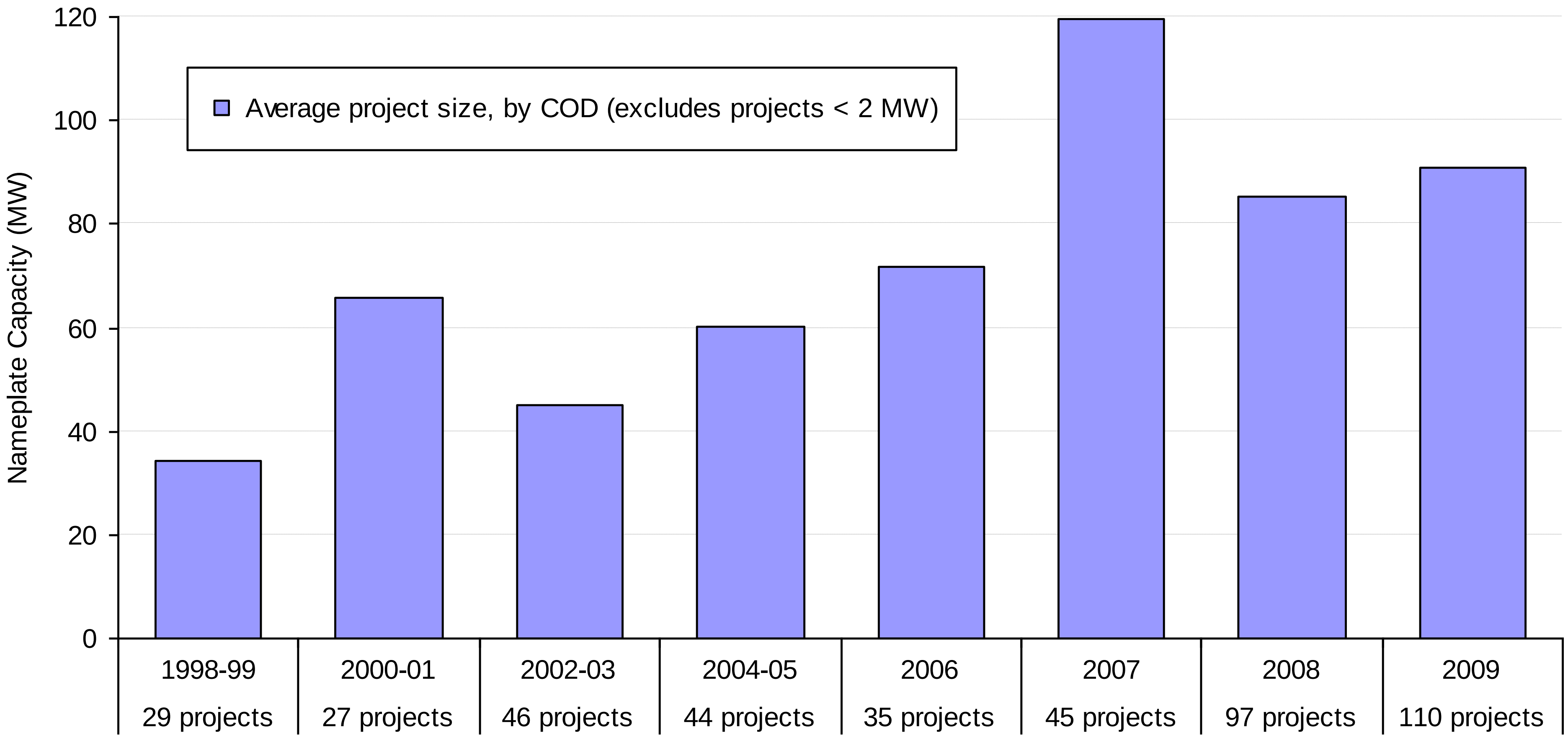
25% of turbines installed in 2009 were larger than 2.0 MW, up from 19% in 2008, 16% in 2006 & 2007, and just 0.1% in 2004-05

Average Hub Heights and Rotor Diameters Have Increased Over Time



On average, since 1998-99, hub heights are 22 meters (39%) higher and rotor diameters are 33 meters (69%) larger

Average Project Size Resumed Its Upward Trend in 2009



Developer Consolidation Continued in 2009

- But acquisitions and investments still below 2006-2007 pace:

  2009: 6 deals = 18 GW of wind development pipeline

  2008: 5 deals = 19 GW

  2007: 11 deals = 37 GW

  2006: 12 deals = 34 GW

  2005: 8 deals = 11 GW

  2002-04: 4 deals = 4 GW

- Slackening might reflect the financial crisis, and that many of the prime targets for investment and/or acquisition had already been acquired in previous years

Investor	Transaction Type	Developer	Announcement Date
EDF (SIIF Energies)	Acquisition	enXco	May-02
Gamesa	Investment	Navitas	Oct-02
AES	Investment	U.S. Wind Force	Sep-04
PPM (Scottish Power)	Acquisition	Atlantic Renewable Energy Corp.	Dec-04
AES	Acquisition	SeaWest	Jan-05
Goldman Sachs	Acquisition	Zilkha (Horizon)	Mar-05
JP Morgan Partners	Investment	Noble Power	Mar-05
Arclight Capital	Investment	CPV Wind	Jul-05
Diamond Castle	Acquisition	Catamount	Oct-05
Pacific Hydro	Investment	Western Wind Energy	Oct-05
EIF U.S. Power Fund II	Investment	Tierra Energy, LLC	Dec-05
Airtricity	Acquisition	Renewable Generation Inc.	Dec-05
Babcock & Brown	Acquisition	G3 Energy LLC	Jan-06
Iberdrola	Acquisition	Community Energy Inc.	Apr-06
Shaw/Madison Dearborn	Investment	UPC Wind	May-06
NRG	Acquisition	Padoma	Jun-06
CPV Wind	Acquisition	Disgen	Jul-06
BP	Investment	Clipper	Jul-06
BP	Acquisition	Greenlight	Aug-06
Babcock & Brown	Acquisition	Superior	Aug-06
Enel	Investment	TradeWind	Sep-06
Iberdrola	Acquisition	Midwest Renewable Energy Corp.	Oct-06
Iberdrola	Acquisition	PPM (Scottish Power)	Dec-06
BP	Acquisition	Orion Energy	Dec-06
Naturener	Acquisition	Great Plains Wind & Energy, LLC	Feb-07
HSH Nordbank	Investment	Ridgeline Energy	Feb-07
Energias de Portugal	Acquisition	Horizon	Mar-07
Iberdrola	Acquisition	CPV Wind	Apr-07
Duke Energy	Acquisition	Tierra Energy, LLC	May-07
Acciona	Acquisition	EcoEnergy, LLC	Jun-07
Babcock & Brown	Acquisition	Bluewater Wind	Sep-07
Good Energies	Investment	EverPower	Sep-07
E.ON AG	Acquisition	Airtricity North America	Oct-07
Wind Energy America	Acquisition	Boreal	Oct-07
Marubeni	Investment	Oak Creek Energy Systems	Dec-07
NTR	Investment	Wind Capital Group	Apr-08
Canadian Pension Plan	Investment	Noble Power	Apr-08
ArcLight and Terra-Gen	Acquisition	Allco Wind Energy	Jun-08
Duke Energy	Acquisition	Catamount	Jun-08
Veolia	Acquisition	Ridgeline Energy	Oct-08
Riverstone Holdings	Acquisition	Babcock & Brown	Jun-09
Terra Firma	Acquisition	Everpower Wind	Aug-09
APEX Wind Energy	Acquisition	BQ Energy, LLC	Jun-09
Global Infrastructure Partners	Investment	Terra-Gen Power Holdings	Nov-09
NRG Energy	Acquisition	Bluewater Wind	Nov-09
Enel	Investment	Geronimo Wind	Nov-09

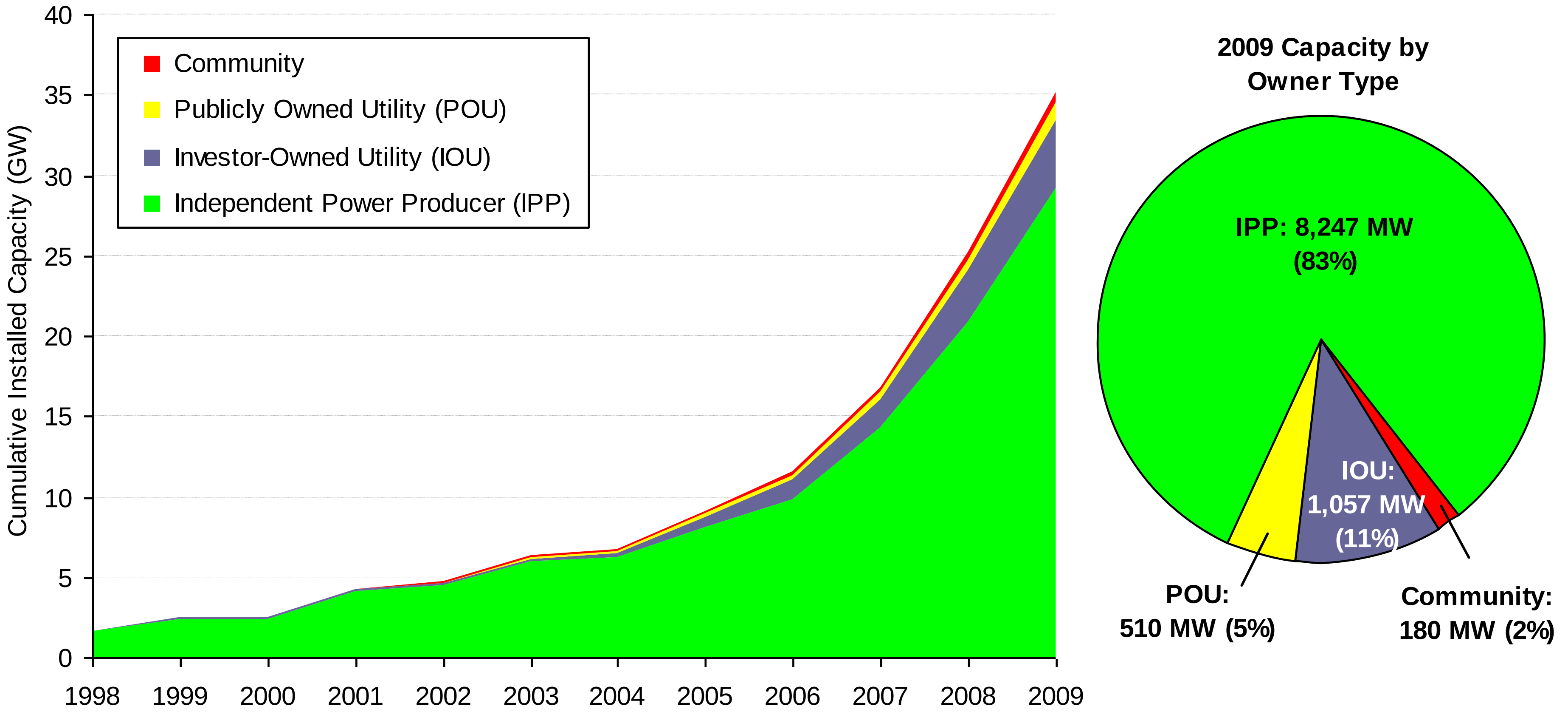
* Select list of announced transactions; excludes joint development activity

Source: Berkeley Lab

Treasury Cash Grant Expanded Financing Options, Buoyed the Wind Sector

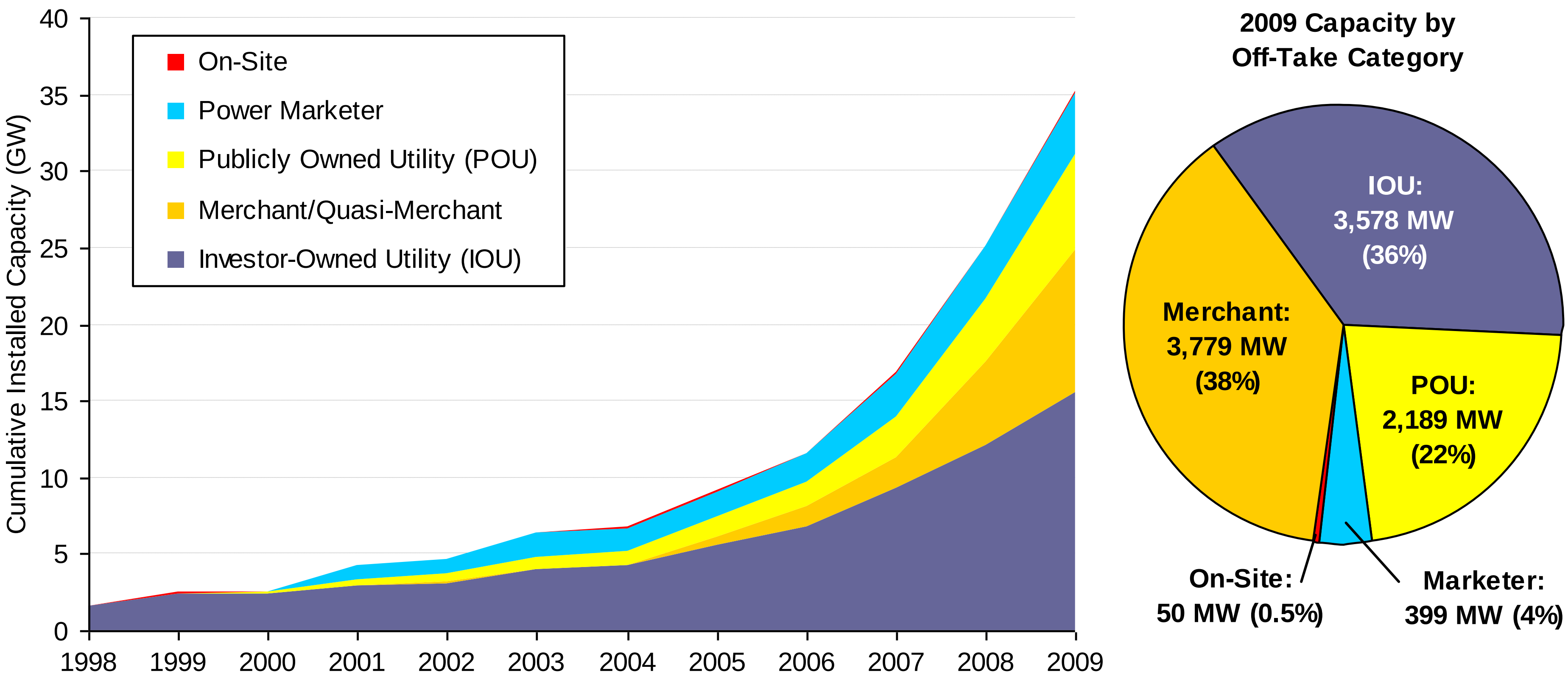
- Section 1603 of Recovery Act allows choice of a cash grant in lieu of the PTC or ITC
  - Reduces dependence on tax equity investors
  - Enables greater use of project-level term debt instead of tax equity
- 6400 MW (>64%) of wind power capacity built in 2009 used grant
  - As much as 2400 MW may not have been built in 2009 absent the grant
  - Only about 7 of >60 projects that chose grant used third-party tax equity
- Efforts to extend the grant program focus on continued shortage of tax equity in the market
- Lenders (both banks and insurance companies) now back in the market, and with improving terms
- Relatively weak demand for federal loan guarantees

IPP Project Ownership Remained Dominant



- Utility ownership held steady in 2009
- Community wind market share stagnant since 2004

Contracted Sales to Utilities Remained the Most Common Sales Arrangement



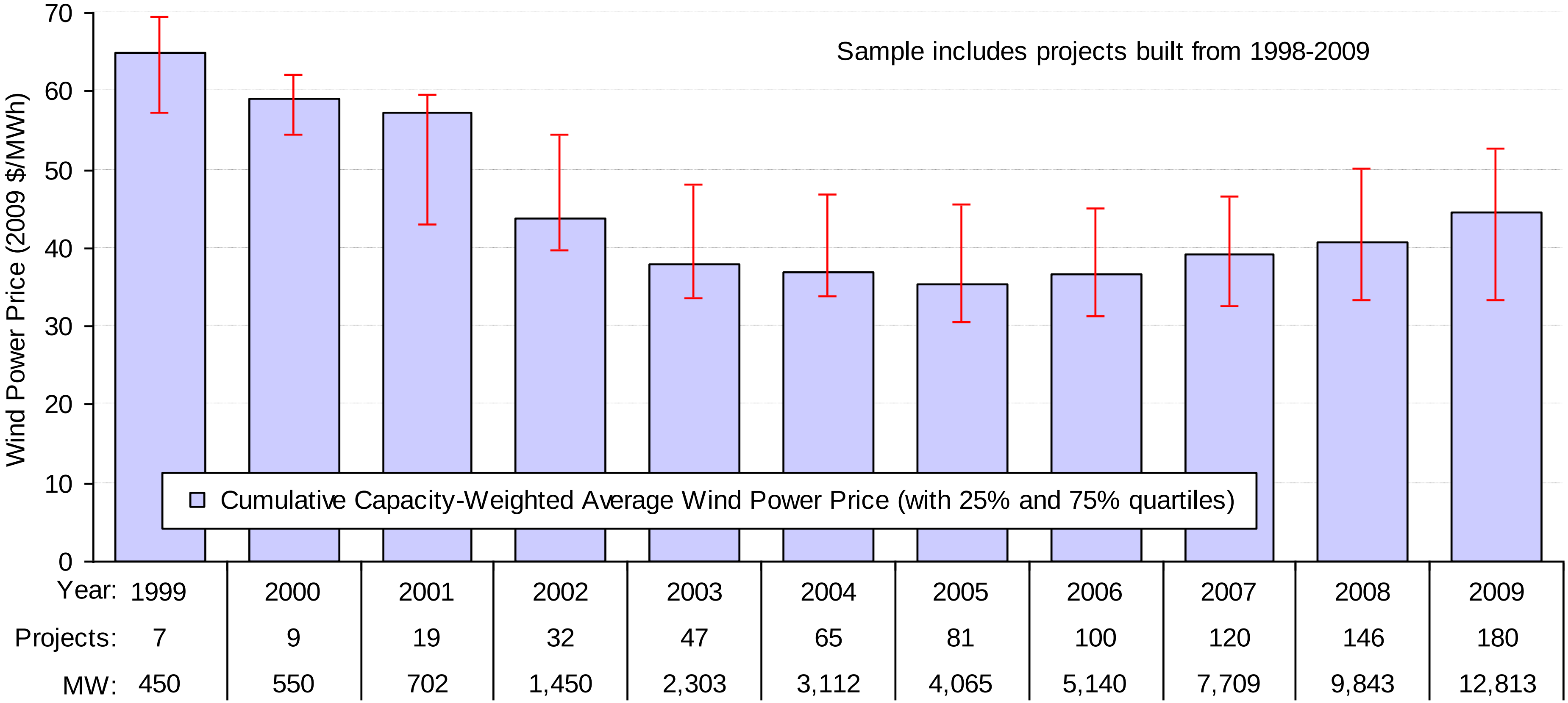
But “merchant” plants were surprisingly (due to tight credit and sharply lower wholesale power prices) popular in 2009

Price, Cost, and Performance Trends

Upward Pressure on Wind Power Prices Continued in 2009

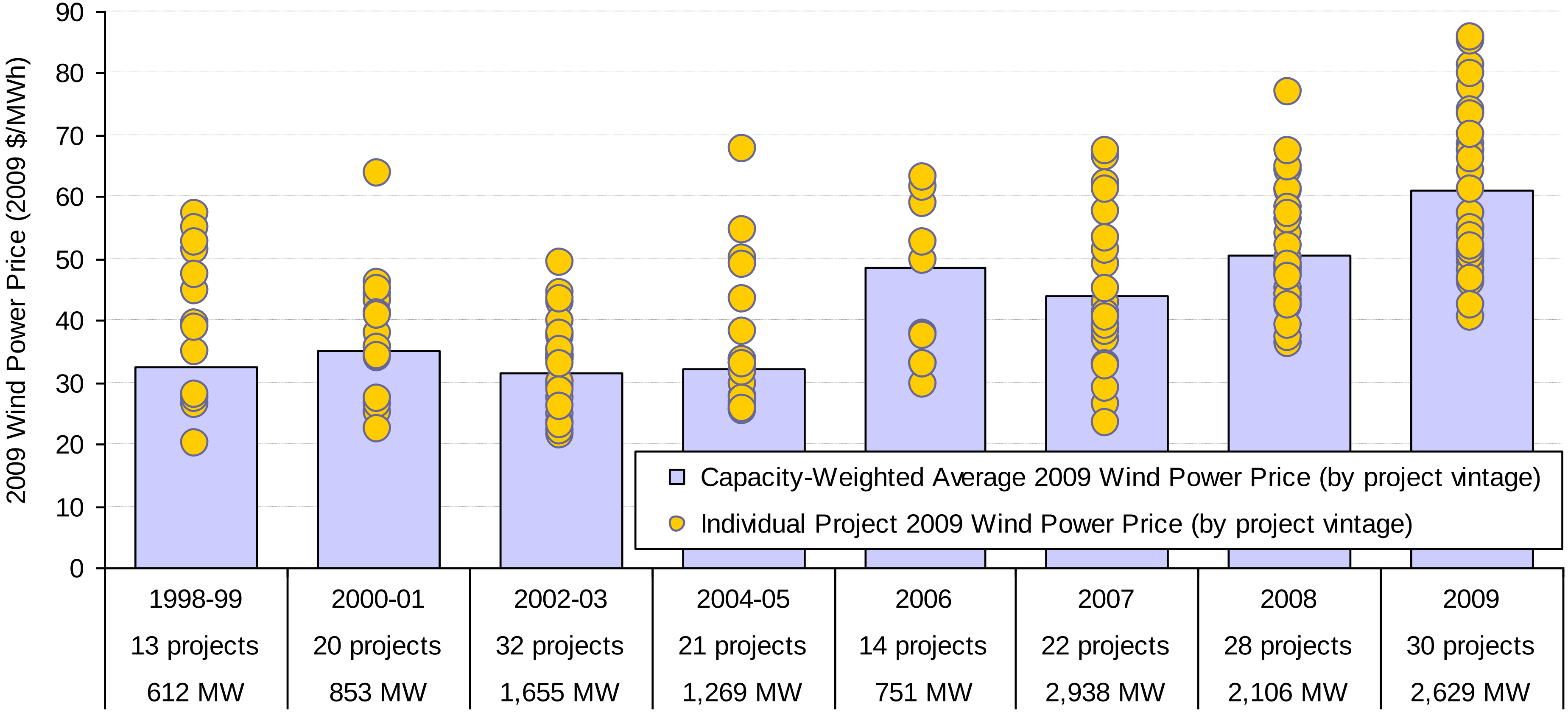
- Berkeley Lab maintains a database of wind power sales prices; next few slides present data from that database
- Sample includes 180 projects built from 1998-2009, totaling 12,813 MW (38% of all wind capacity added in that period)
- Prices reflect the bundled price of electricity and RECs as sold by the project owner under a power purchase agreement
  - Dataset excludes merchant plants and projects that sell renewable energy certificates (RECs) separately
  - Prices reflect receipt of state and federal incentives (e.g., the PTC or Treasury grant); as a result, prices <u>do not</u> reflect wind energy generation costs -- prices would be higher were state/federal incentives not available

Cumulative Average Sales Price for Sample of Projects Built After 1997 Low But Rising



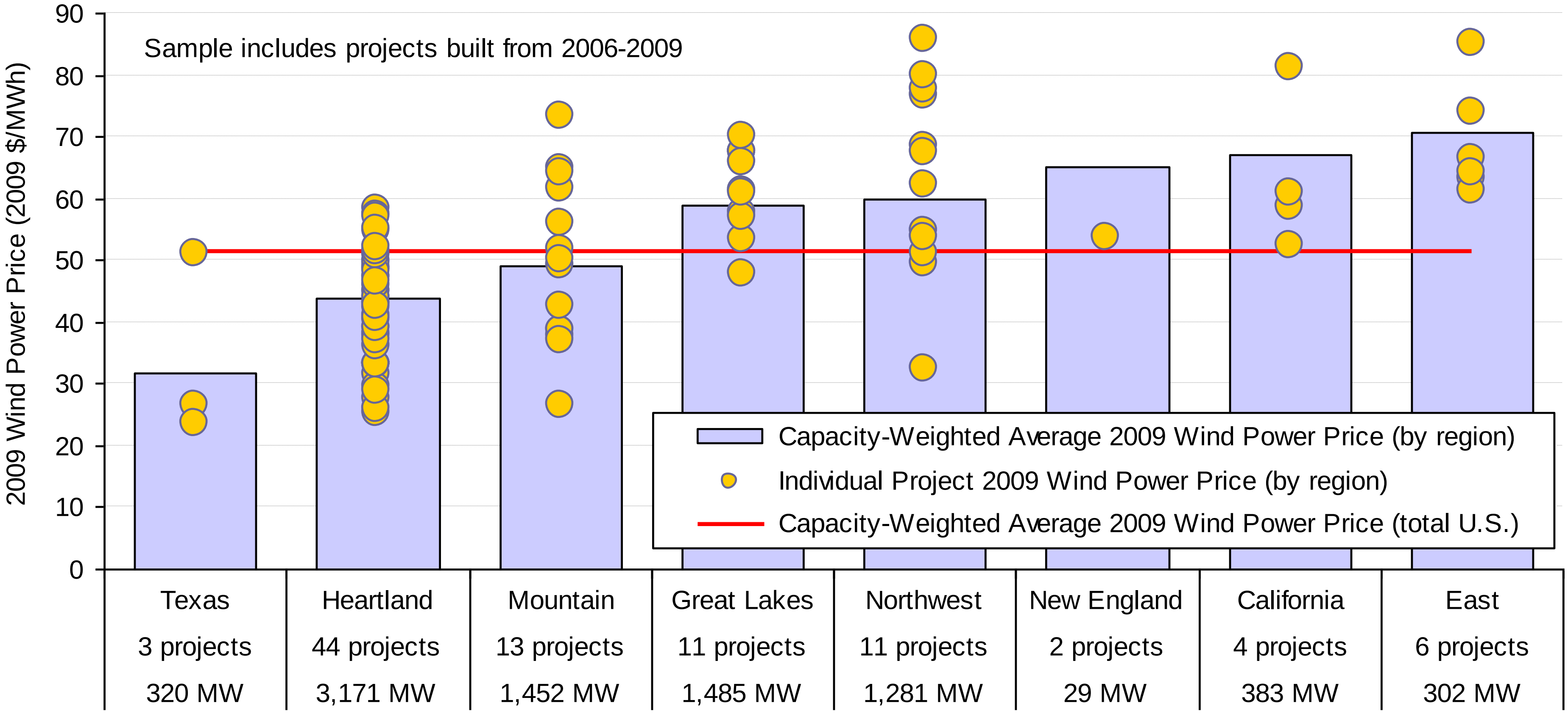
Increase in prices since 2005 due to rising prices from newly built projects, but cumulative nature of graphic mutes degree of apparent price increase

Binning by Commercial Operation Date Shows that Prices Have Increased Recently



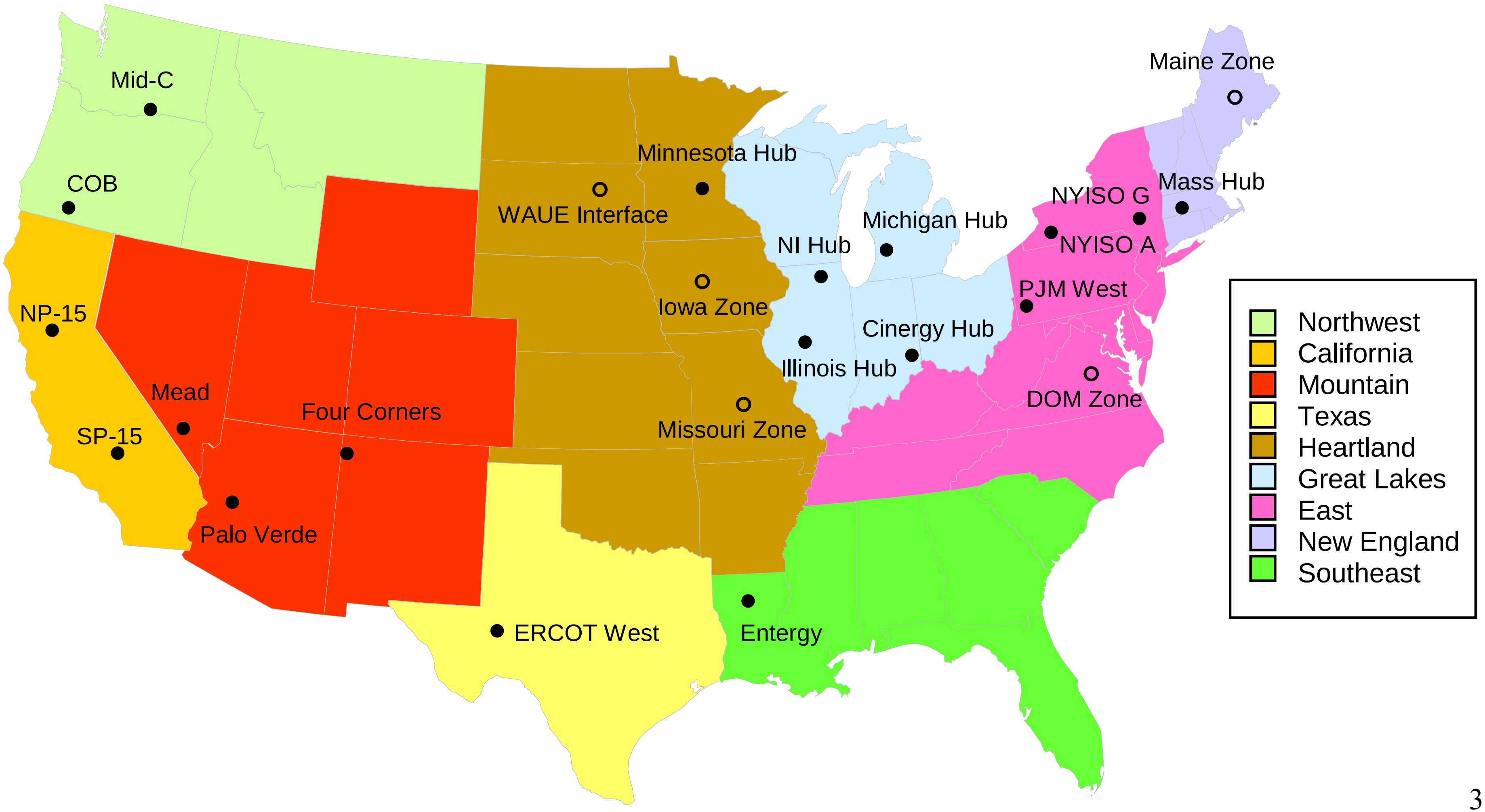
Graphic shows prices in 2009 from projects built from 1998-2009

Regional Differences Explain Some of the Underlying Variability in Wind Sales Prices

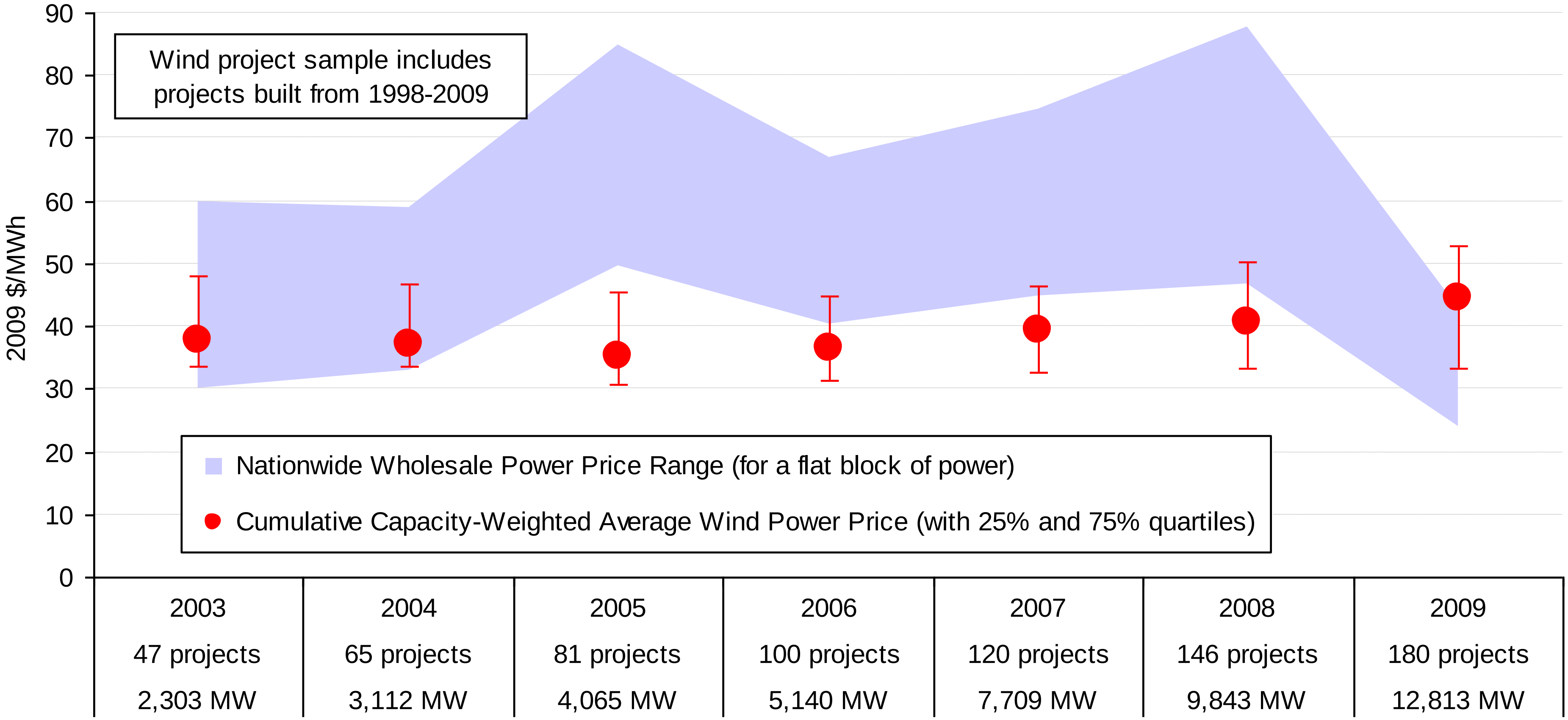


Texas and the Heartland are lower-price regions, while the East and California are higher-price (note: sample size is problematic in many regions)

Regions and Wholesale Price Hubs Used in Analysis

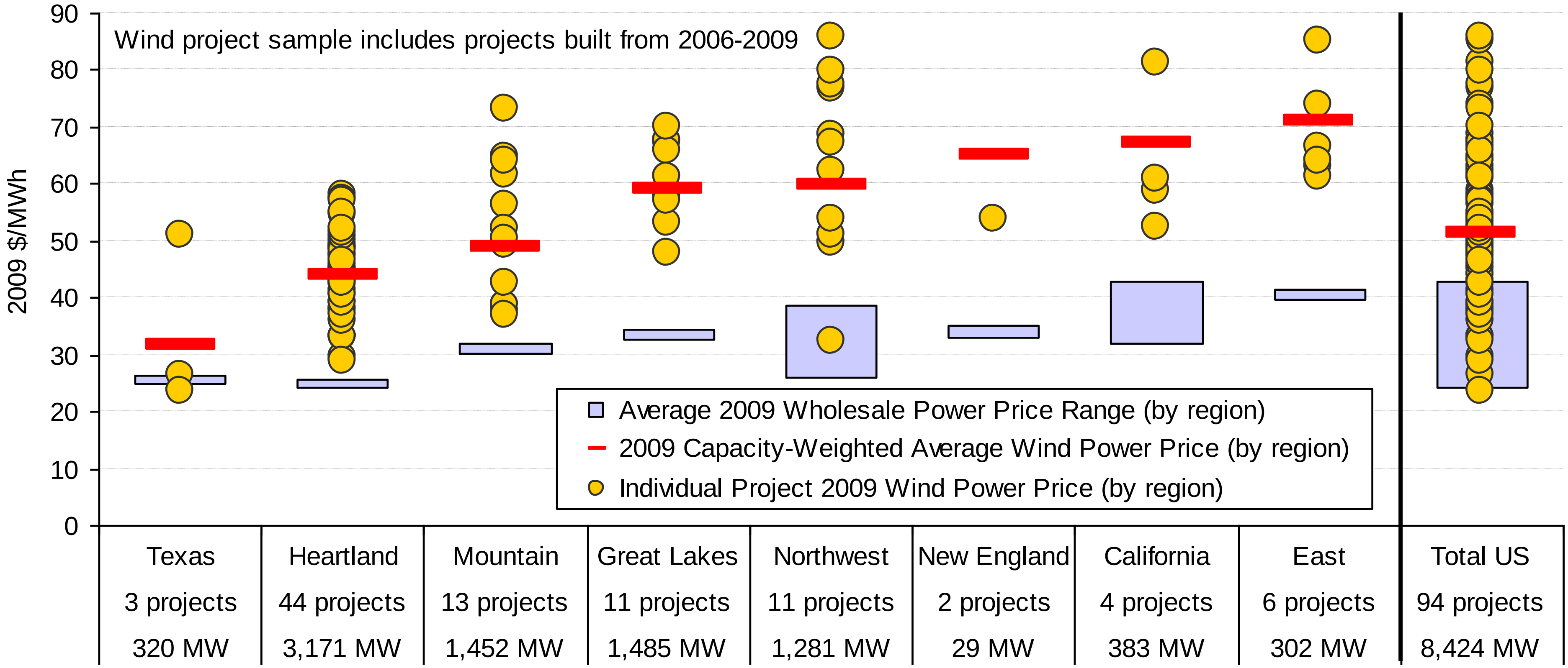


Sharp Drop in Wholesale Power Prices Challenges the Competitiveness of Wind



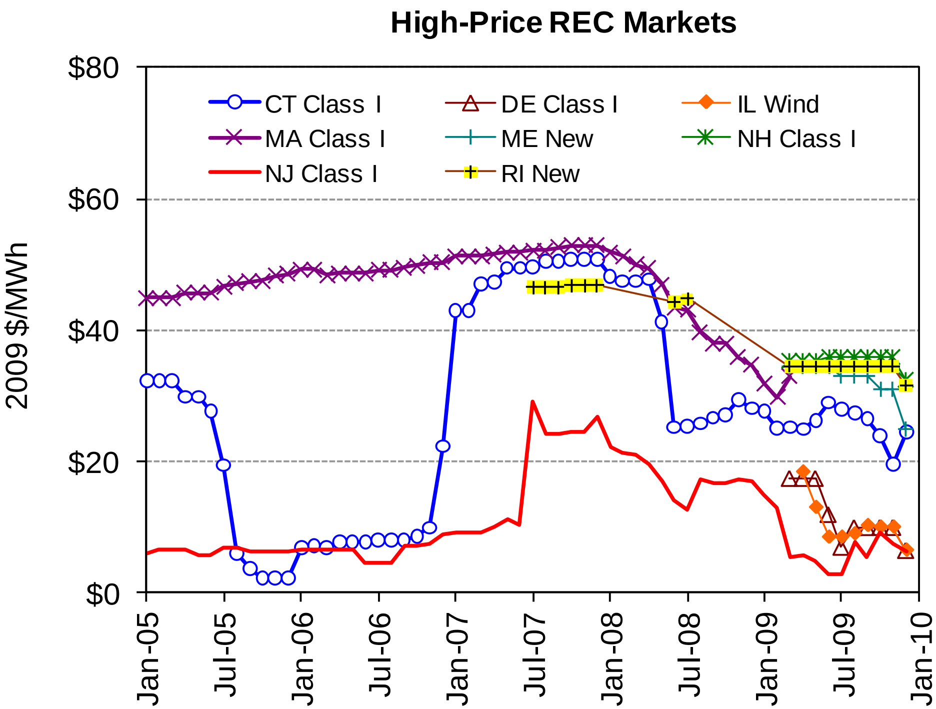
- Wholesale price range reflects flat block of power across 23 pricing nodes (see previous map)
- Wholesale price drop reflects lower natural gas prices, driven by weak economy and shale gas

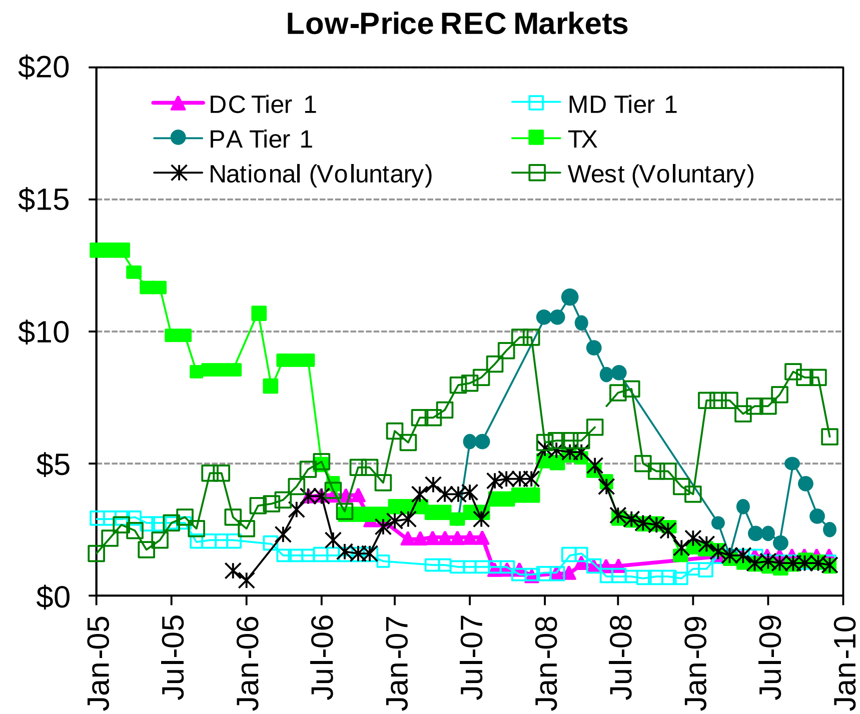
Wind's Struggle to Compete in 2009 Spans All Regions of the U.S.



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

Renewable Energy Certificate (REC) Markets Remain Fragmented and Volatile

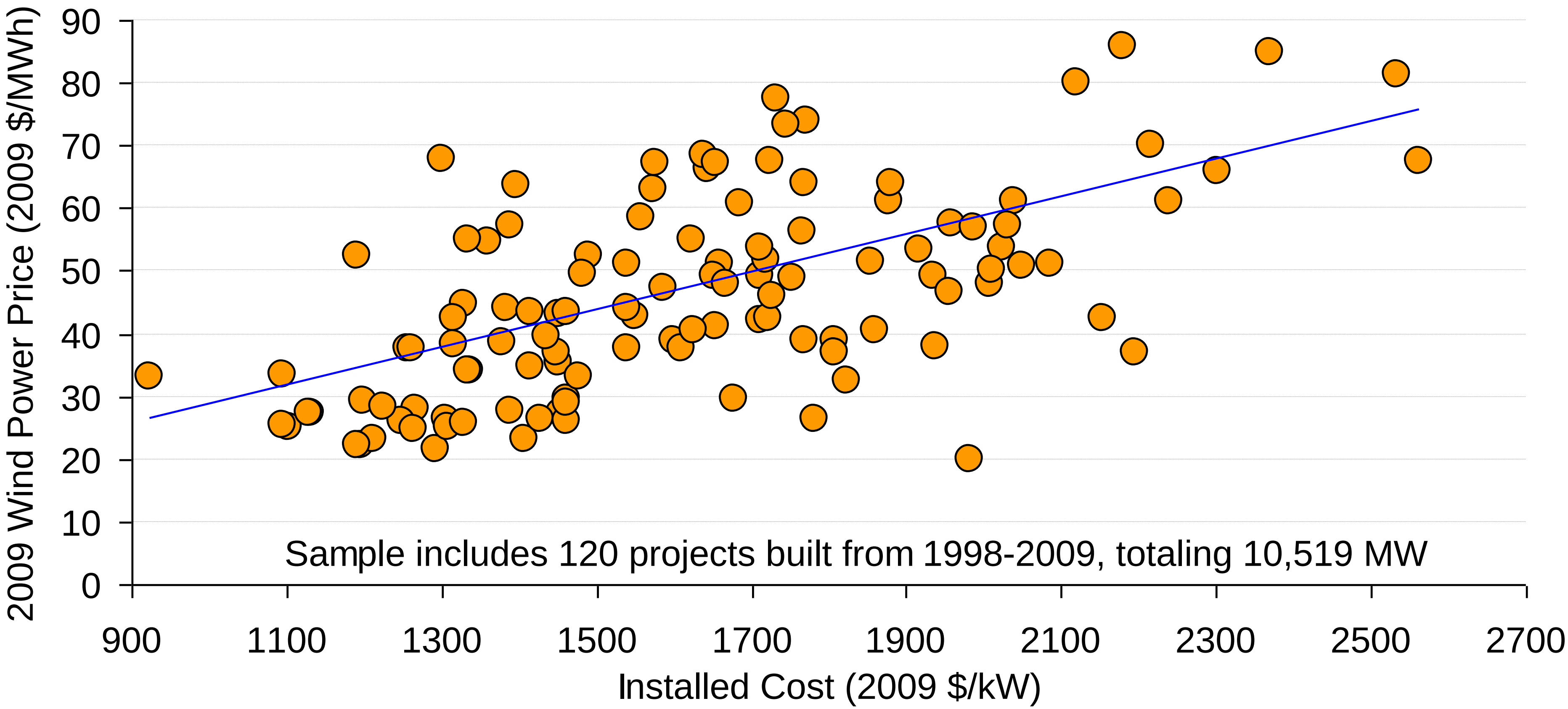




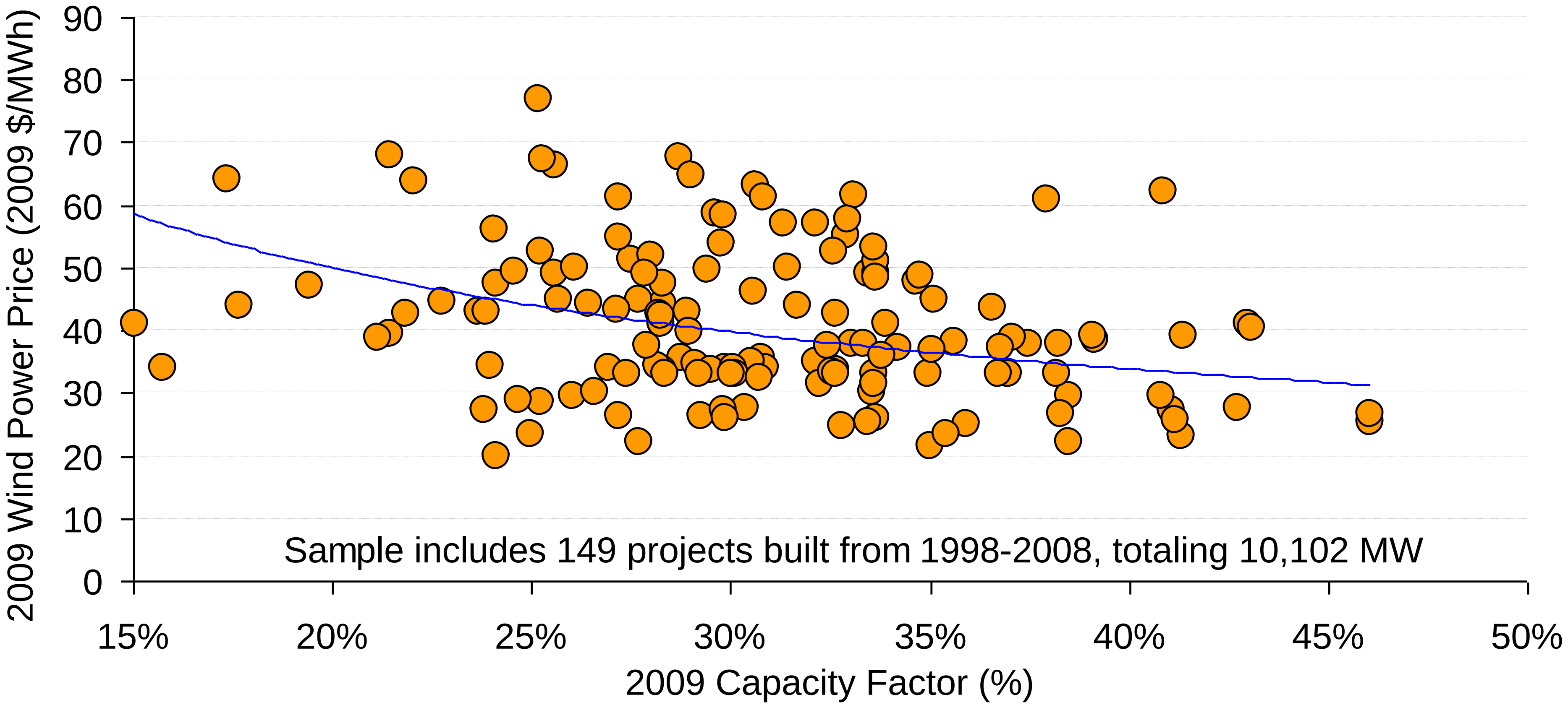
<u>REC prices vary by:</u>

- market type: compliance vs. voluntary
- geographic region
- specific design of state RPS policies

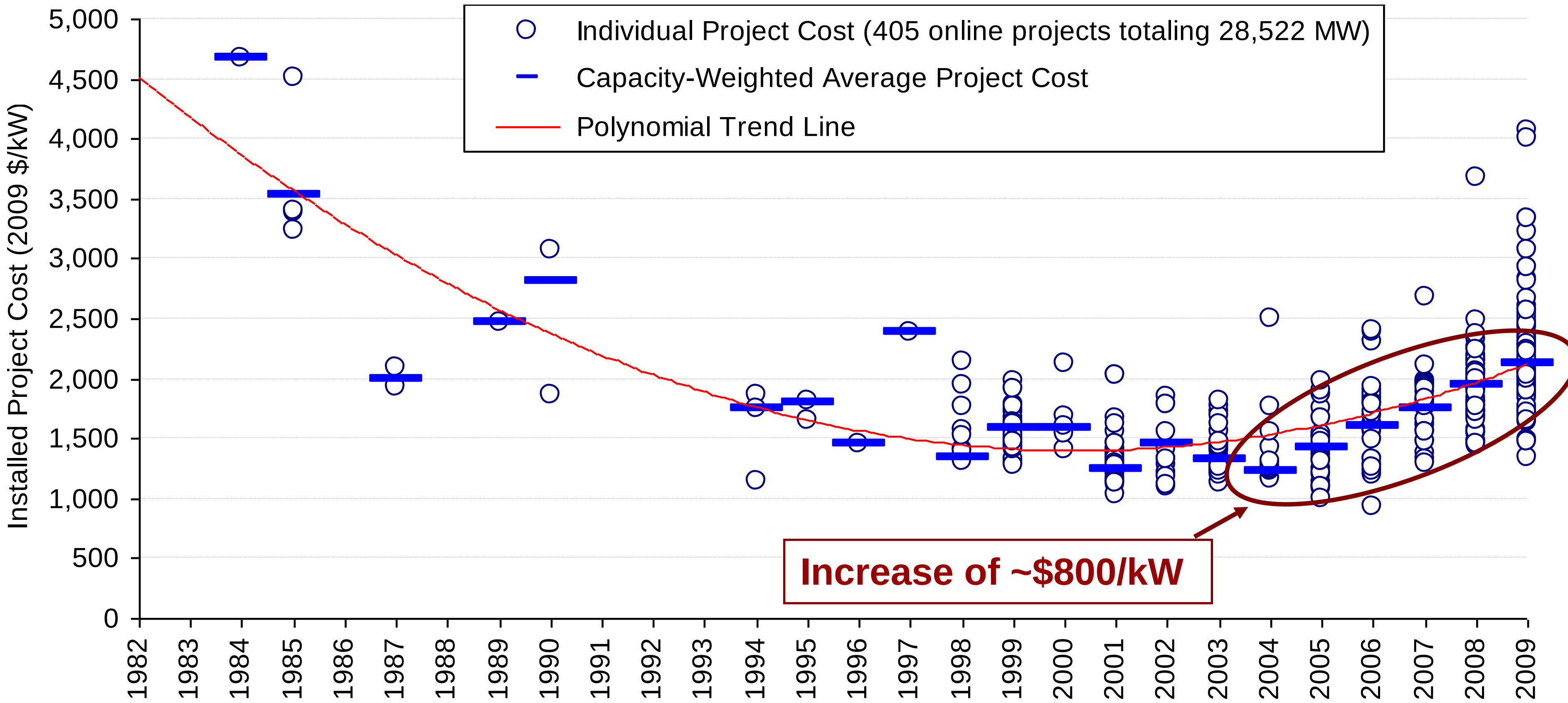
Wind Power Sales Prices Are Affected by Installed Project Costs...



...and by Wind Power Project Performance

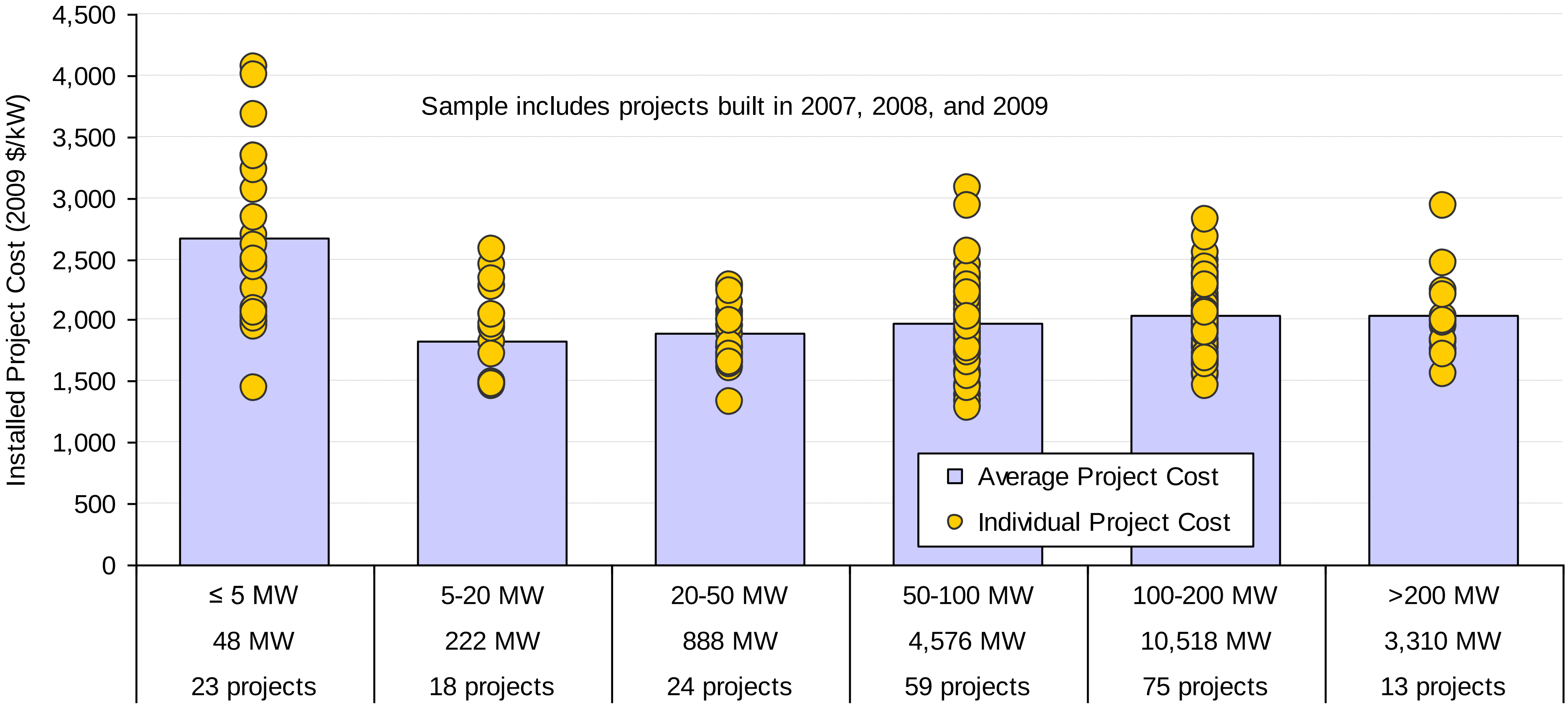


Installed Project Costs Continued to Rise in 2009, After a Long Period of Decline



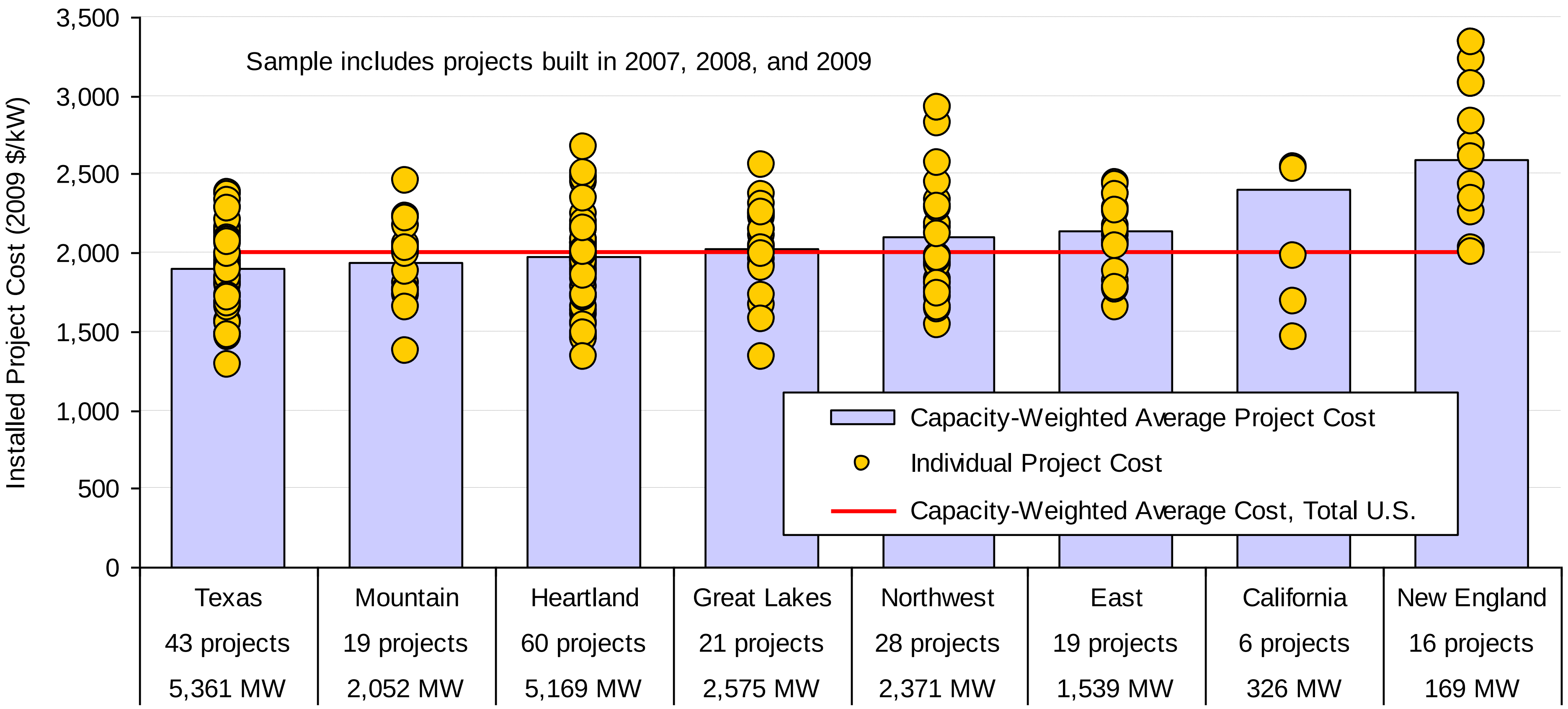
Rumors of cost declines abound, but have not yet been substantiated by the data

Economies of Scale Evident At Low End of Project Size Range



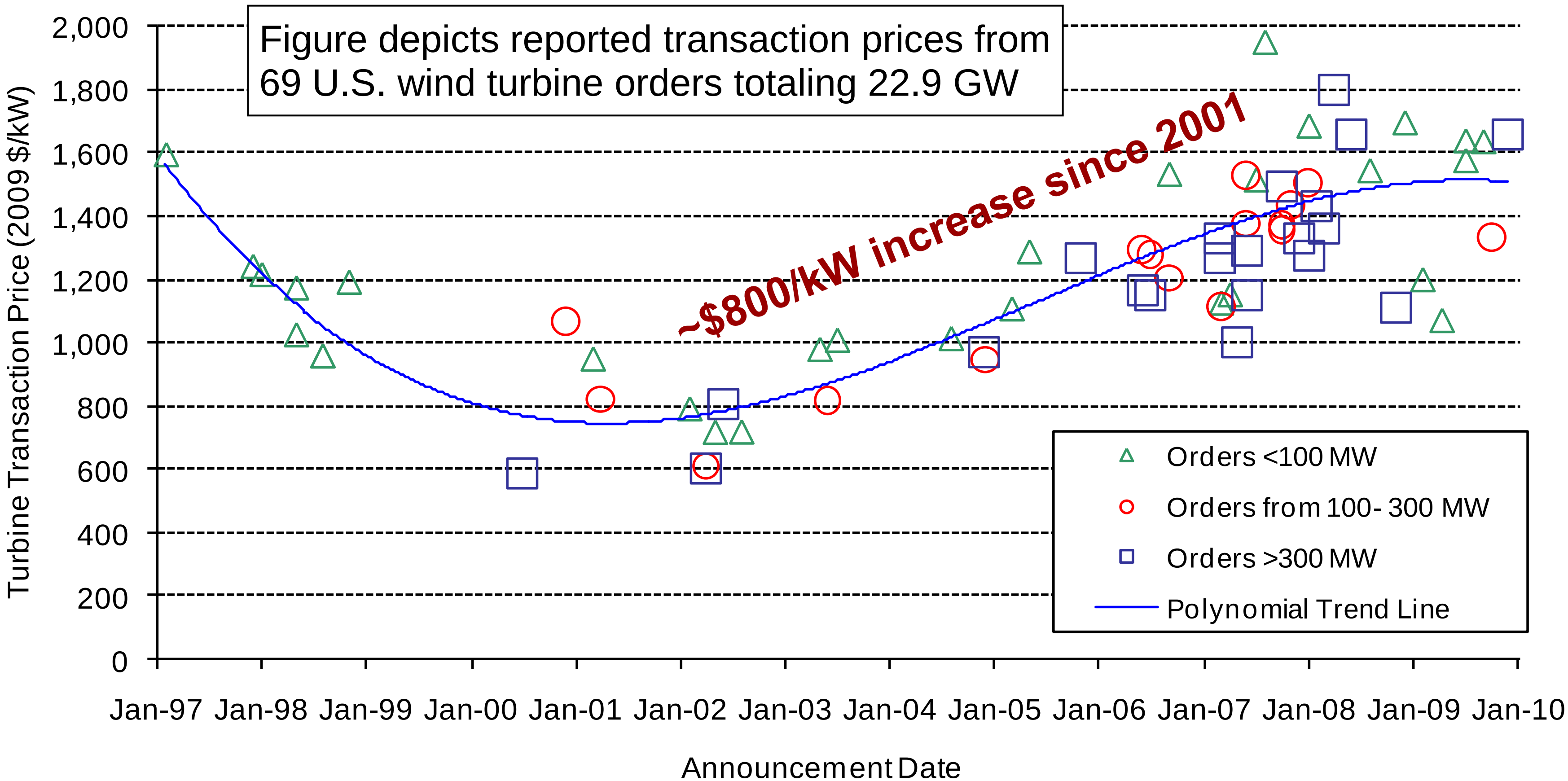
Cost trend essentially flat above 5-20 MW project size range

Some Regional Differences in Wind Power Project Costs Are Apparent



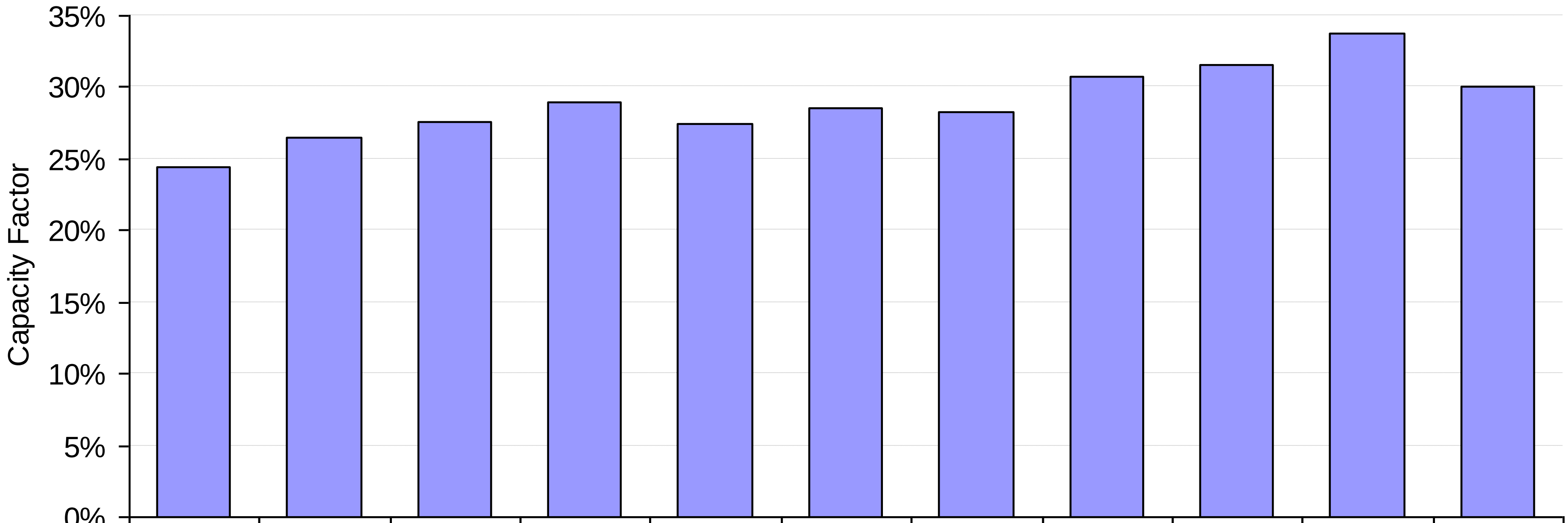
No clear low-cost leaders, but California & New England highest-cost

Project Cost Increases Are a Function of Wind Turbine Prices



Relative dearth of data since 2008 makes it hard to discern any recent trend, though turbine prices are rumored to be lower

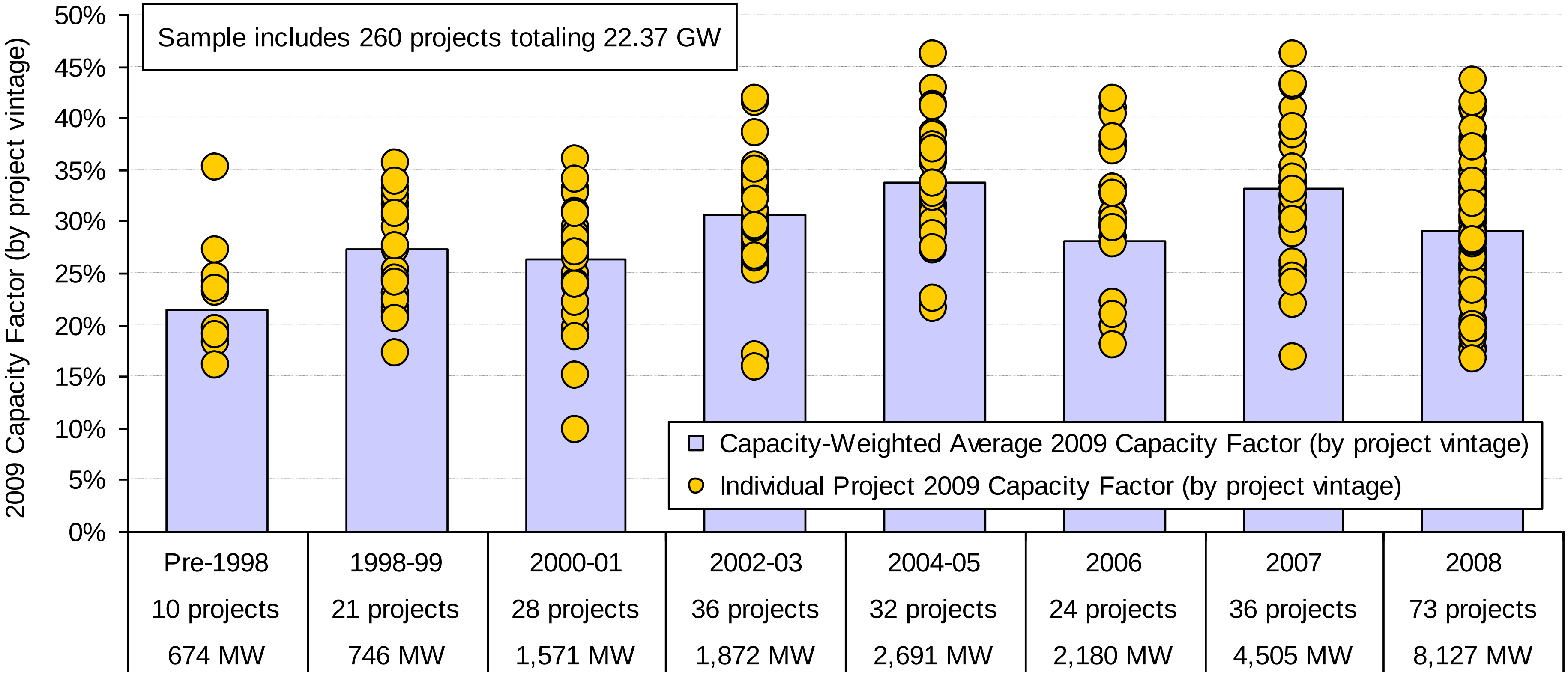
Average Capacity Factors Have Improved Over Time, But Leveled Off in Recent Years



Year:	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Projects:	11	17	77	124	137	163	190	217	258	299	242
MW:	701	1,158	2,199	3,955	4,458	5,784	6,467	9,289	11,253	16,068	22,346

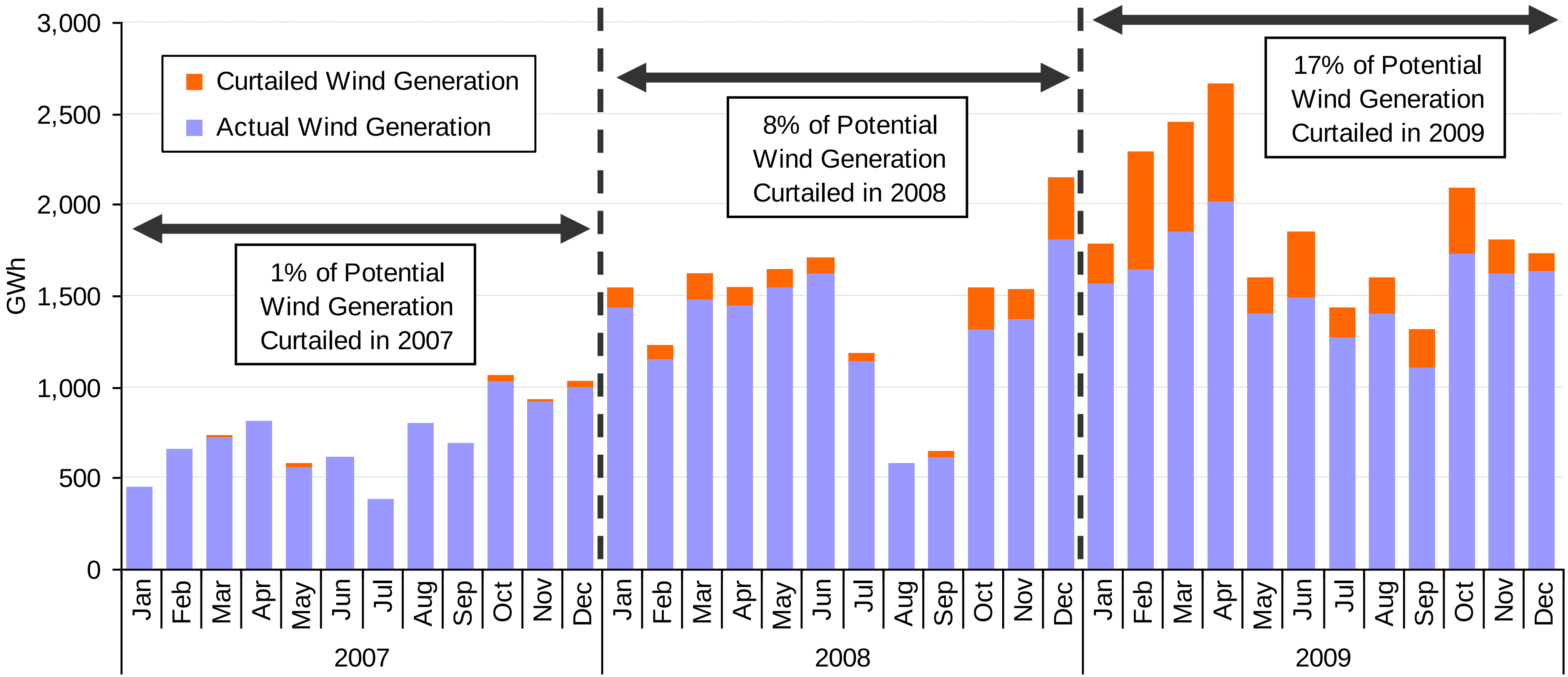
- General improvement reflects increase in hub height and rotor diameter (see slide 24)
- Inter-annual wind resource variation also plays a role: 2009 was a bad wind year
- Curtailment was another major factor in lower 2009 capacity factor (see slide 47)

Binning by Project Vintage and Focusing on 2009 Performance Tells A Similar Story



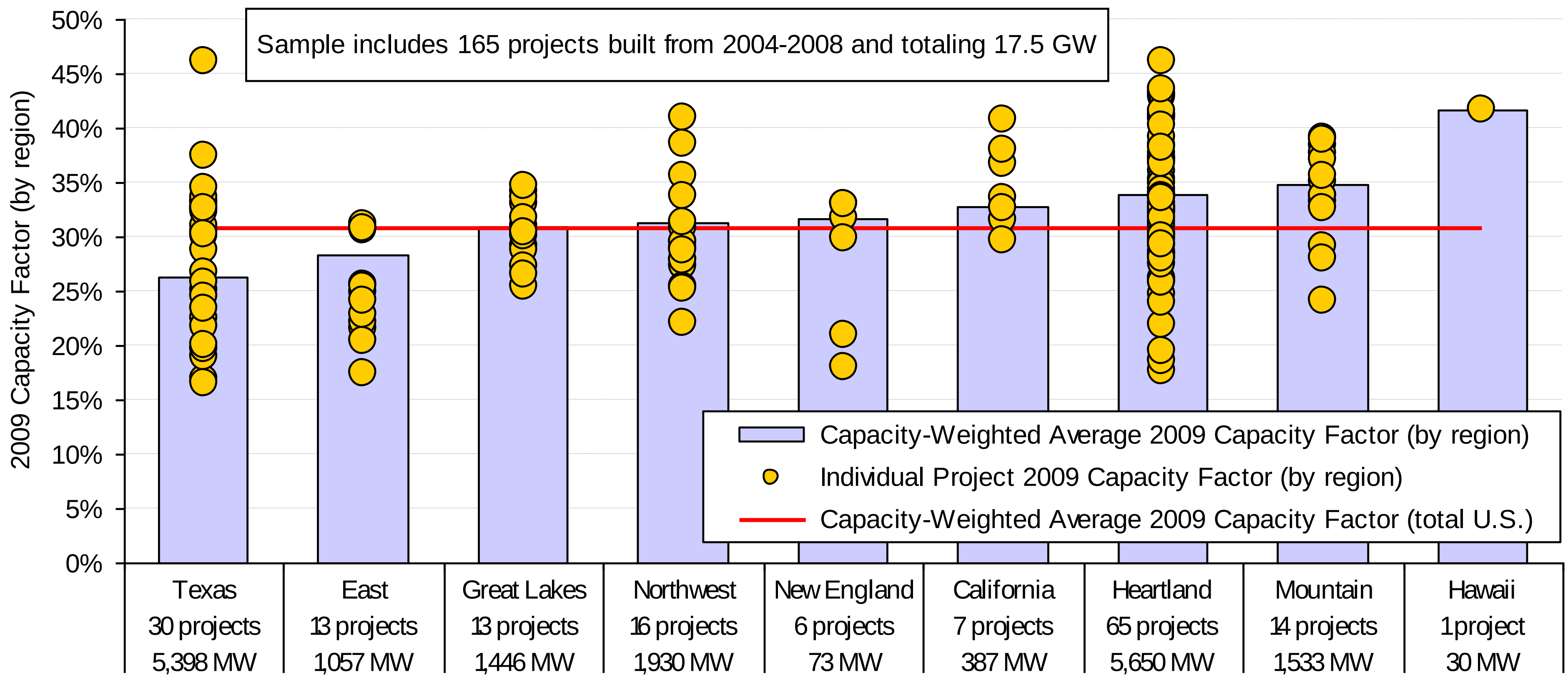
Projects installed since 2005 have bucked the trend of generally increasing capacity factors among more-recently built projects

Curtailment a Major Issue in Texas (ERCOT)



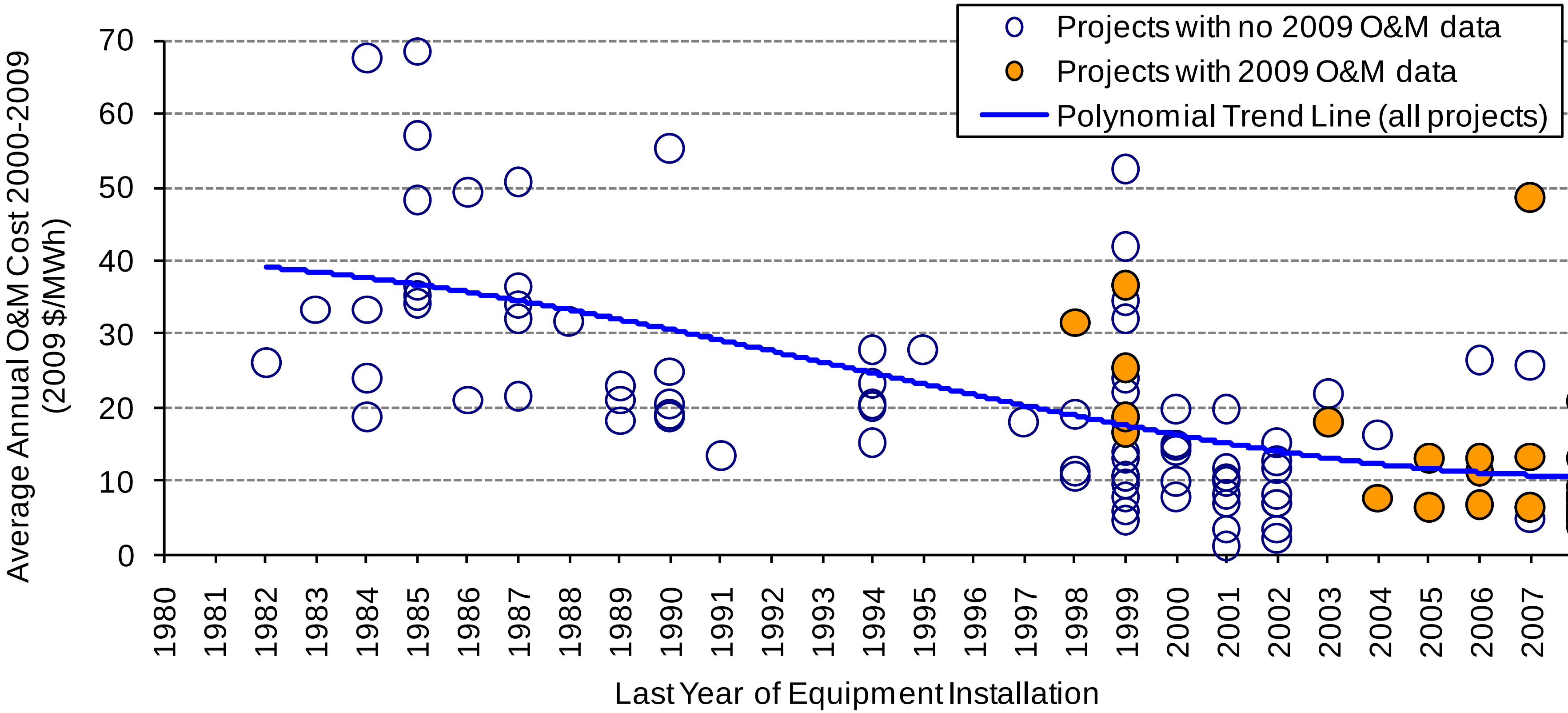
If there had been no curtailment in 2009, ERCOT's fleet-wide wind power project capacity factor would have been 31.1% (rather than 25.8%), raising the national average from 30% to 32%

Regional Performance Differences Are Apparent



Average capacity factors highest in Hawaii and the Mountain region, lowest in Texas (again, due largely to curtailment) and the East

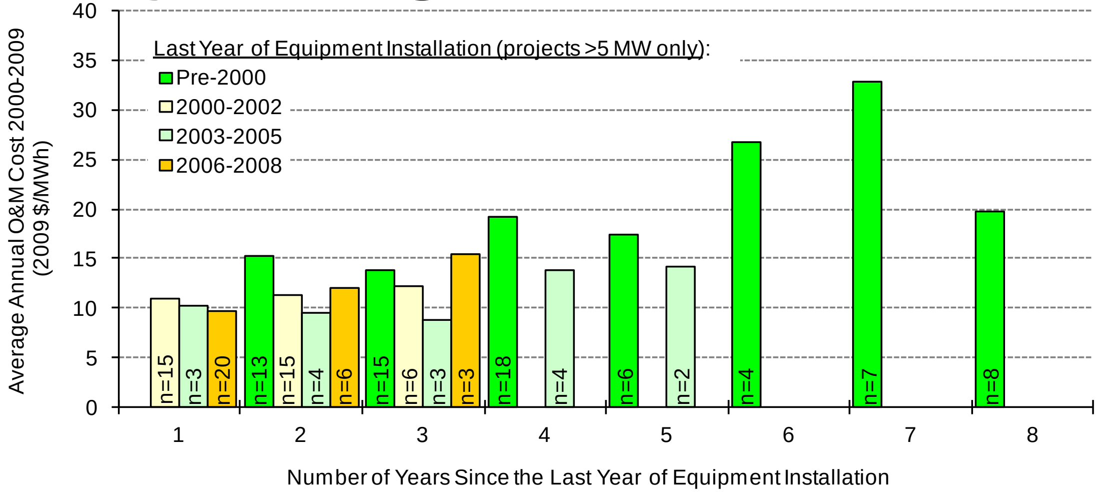
Average O&M Costs from 2000-2009 Are Affected By Year of Installation

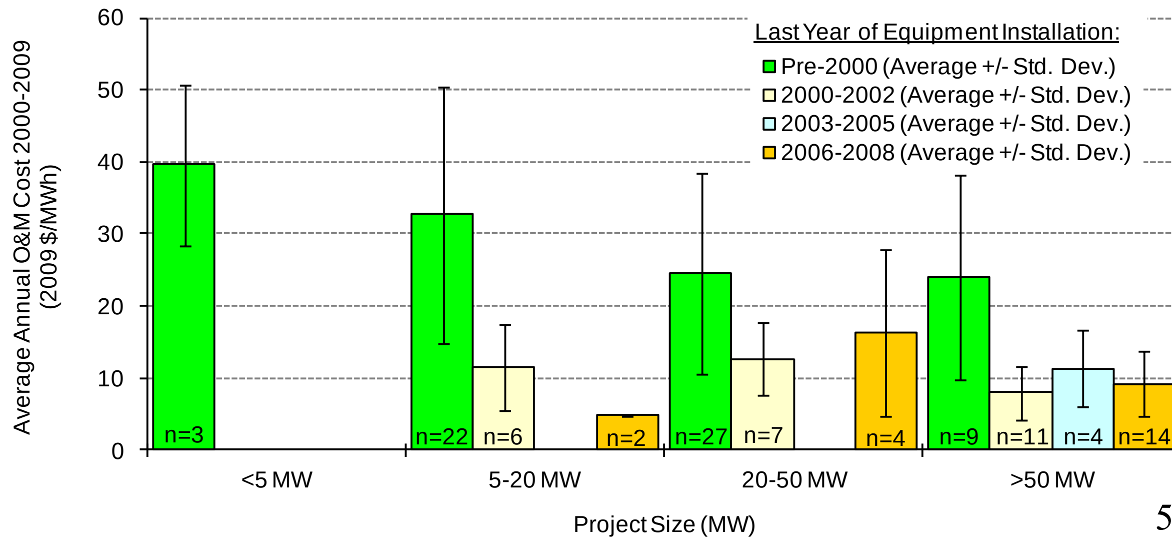


Capacity-weighted average 2000-09 O&M costs for projects built in 1980s equal **$32/MWh**, dropping to **$22/MWh** for projects built in 1990s, and to **$9/MWh** for projects built in 2000s

Note: Sample is limited, and consists of 115 wind power projects totaling 6,097 MW; few projects in sample have complete records of O&M costs from 2000-09

O&M Costs Appear to Increase with Project Age, Decrease with Project Size





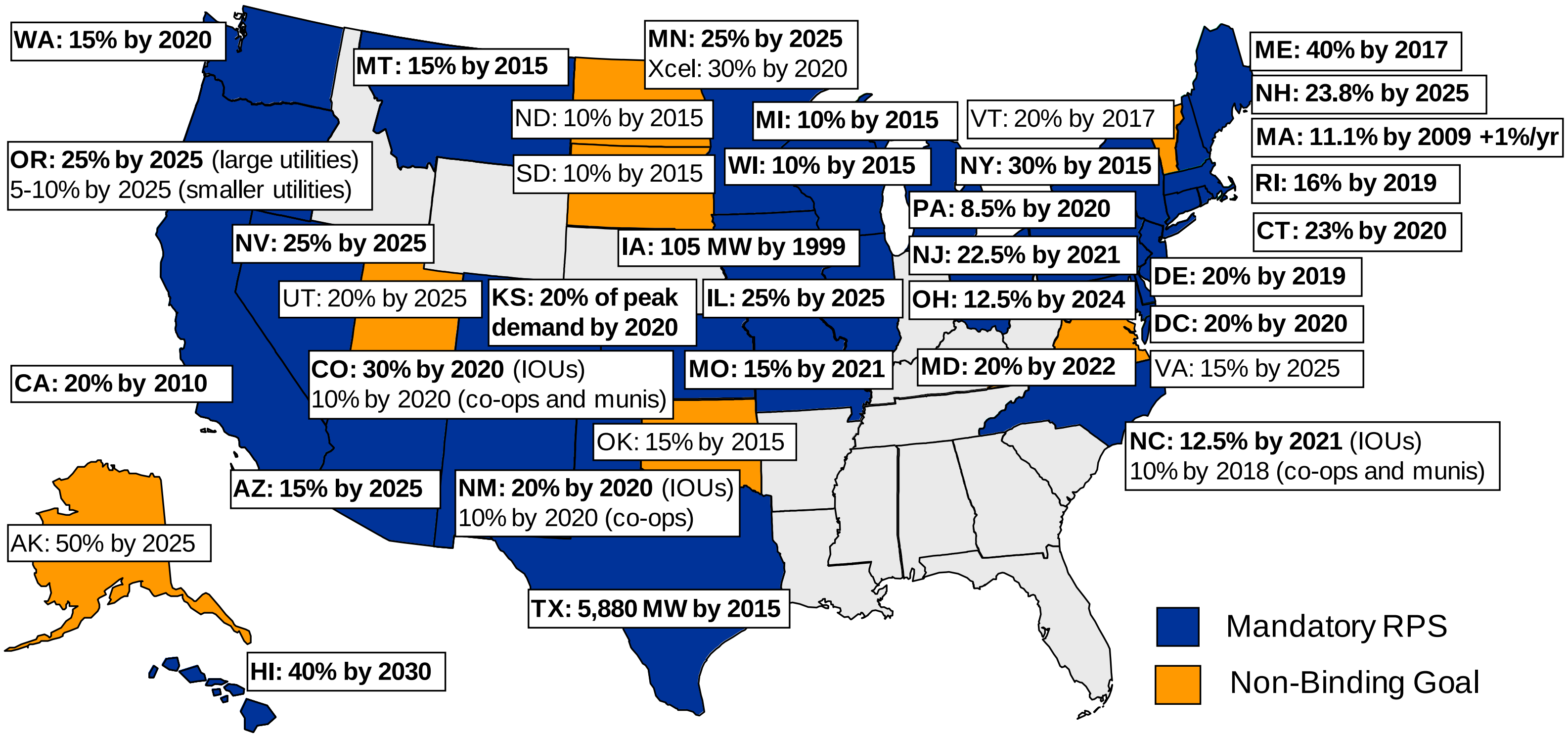
Note: Sample size is extremely limited

Policy and Market Drivers

Federal Policy Is Now More Favorable Than At Any Other Time in the Past Decade

- The Recovery Act established a number of federal policies to support wind
- Federal PTC currently in place through 2012 (longest extension in history)
- 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
- $2.2 billion of new Clean Renewable Energy Bonds allocated
- Expansion and enhancement of Federal loan guarantee program
- $2.3 billion in advanced energy manufacturing tax credits awarded
- Increased R&D funding
- Increased funding for USDA’s Rural Energy for America Program (REAP)
- Efforts to pass an RPS and carbon regulation at the Federal level continue
- But… major policies expire after 2012, leaving uncertainty for future years

State Policies Help Direct the Location and Amount of Wind Power Development



- One new state (KS) established a mandatory RPS in 2009 (total is now 29 states and Washington, D.C.)
- State renewable funds, tax incentives, utility resource planning, voluntary green power, and growing interest in carbon regulation all also played a role in 2009

Despite Progress on Overcoming Transmission Barriers, Constraints Remain

- Cost allocation continues to be a major issue at FERC and among the ISOs/RTOs
- The DOE, states, grid operators, and regional organizations continue to take proactive steps to encourage transmission investment to improve access to renewable resources
- A variety of efforts to proactively plan for transmission, often through analyses of state and regional renewable energy zones, also continued in 2009
- Progress was made in 2009 on some transmission projects that are designed, in part, to support wind power – e.g., Tehachapi in California, and NextEra's 200-mile line in Texas

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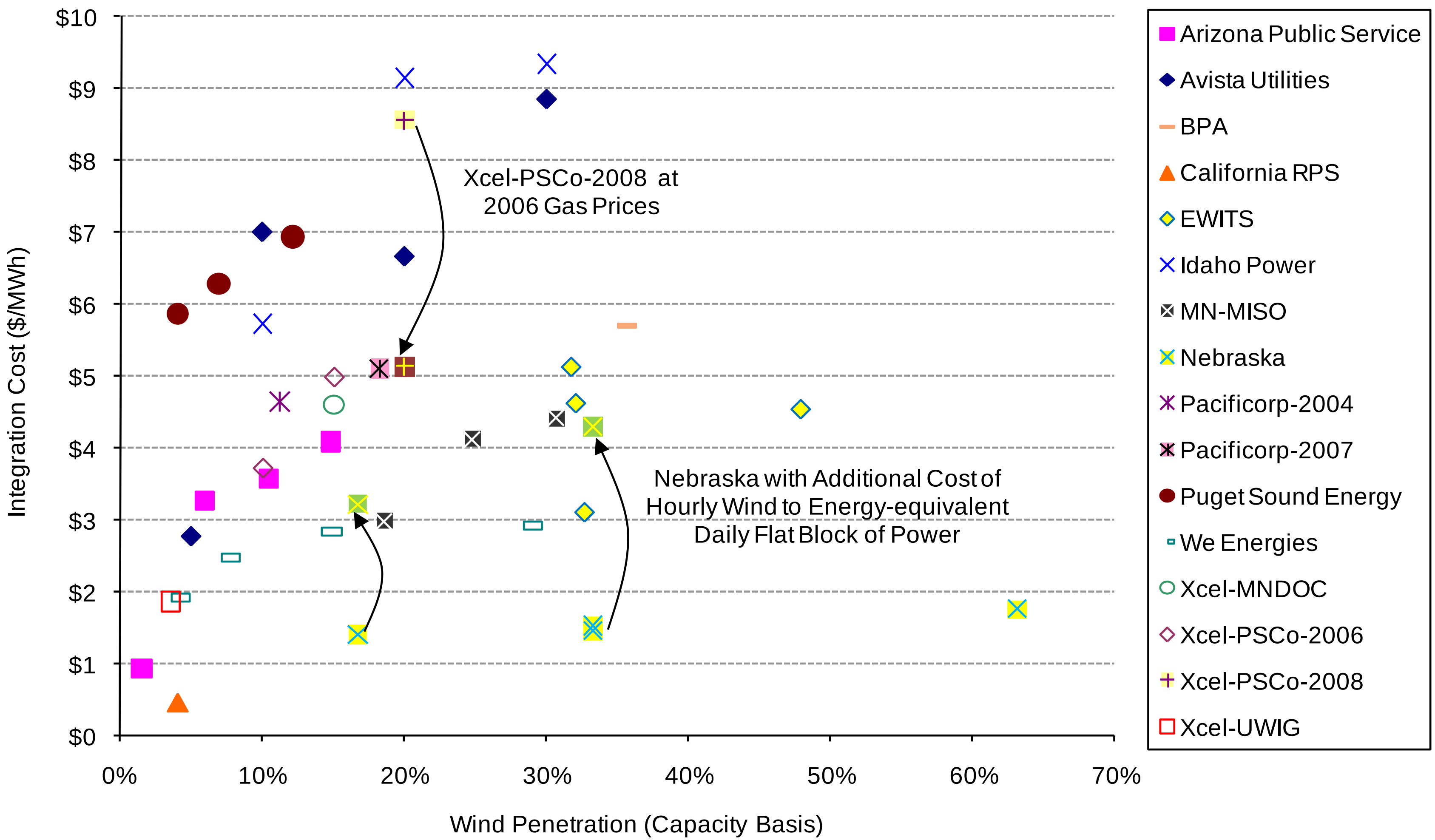
Studies Find that the Cost of Integrating Wind into Power Systems Is Manageable

Year	Study	Wind Capacity Penetration	Integration Cost ($/MWh) Regulation	Load Following	Unit Commit.	Gas Supply	TOTAL
2003	Xcel-UWIG	3.5%	0	0.41	1.44	-	1.85
2003	We Energies	29%	1.02	0.15	1.75	-	2.92
2004	Xcel-MNDOC	15%	0.23	-	4.37	-	4.60
2005	PacifiCorp-2004	11%	0	1.48	3.16	-	4.64
2006	Calif. (multi-year)*	4%	0.45	trace	trace	-	0.45
2006	Xcel-PSCo	15%	0.20	-	3.32	1.45	4.97
2006	MN-MISO**	31%	-	-	-	-	4.41
2007	Puget Sound Energy	12%	-	-	-	-	6.94
2007	Arizona Pub. Service	15%	0.37	2.65	1.06	-	4.08
2007	Avista Utilities	30%	1.43	4.40	3.00	-	8.84
2007	Idaho Power	20%	-	-	-	-	7.92
2007	PacifiCorp-2007	18%	-	1.10	4.00	-	5.10
2008	Xcel-PSCo***	20%	-	-	-	-	8.56
2009	Bonneville (BPA)+	36%	0.22	1.14	-	-	5.70
2010	EWITS++	48%	-	-	1.61	-	4.54
2010	Nebraska+++	63%	-	-	-	-	1.75

* Regulation costs represent 3-year average.
** Highest over 3-year evaluation period.
*** This integration cost reflects a $10/MMBtu natural gas price scenario. This cost is much higher than the integration cost calculated for Xcel-PSCo in 2006, in large measure due to the higher natural gas price: had the gas price from the 2006 study been used in the 2008 study, the integration cost would drop to $5.13/MWh.
\+ Costs in $/MWh assume 31% capacity factor. Aside from regulation and following reserves, the costs of BPA's imbalance reserves are $4.33/MWh.
\++ The unit commitment costs listed in EWITS are the cost of day-ahead wind forecast error; the remaining integration costs included in the total are for shorter term variable reserves that account for regulation and short-term forecast errors (energy imbalance).
\+++ These integration costs only capture regulating reserves and day-ahead forecast error. A sensitivity case in this study shows that integration costs increase if the differences between the actual hourly deliveries of wind energy are compared to daily flat block of power. The increased costs are shown in Figure 39.

- Wind integration costs are < $10/MWh for capacity penetrations of up to or exceeding 40%
- Regulation impacts are small, load-following and unit commitment larger
- Larger balancing areas, intra-hour scheduling and use of wind energy forecasts can ease integration challenges, and grid operators are increasingly relying on these strategies

Studies Find that the Cost of Integrating Wind Rises with Greater Wind Penetration



Future Outlook

Forecasts Predict Slower 2010, with Resurgence in 2011 and 2012

- 2010 expected to be a slower year, due to reduced demand for wind (driven by weak economy and low wholesale prices); 2009 buoyed by projects planned for completion in 2008 but carried over as result of PTC extension
- Predictions for 2010 range from 5,500 MW to 8,000 MW; forecasts predict a market resurgence in 2011-2012
- U.S. expected to retain 2nd-largest market status, after China, from 2010-12
- Beyond 2012, federal policy is uncertain, complicating projections

Source	2010	2011	2012	Cumulative Additions 2010-2012
EIA	7,310	10,200	10,330	27,840
BTM	8,000	10,000	15,000	33,000
IHS EER	7,130	9,830	9,340	26,300
Bloomberg NEF	7,390	8,535	8,610	24,535
Macquarie	7,500	8,100	8,700	24,300
UBS	6,950	9,380	10,780	27,110
AWEA	5,500-7,500	--	--	--

Uncertainties in Near-Term Market Growth Reflect Conflicting Trends

Stronger Growth

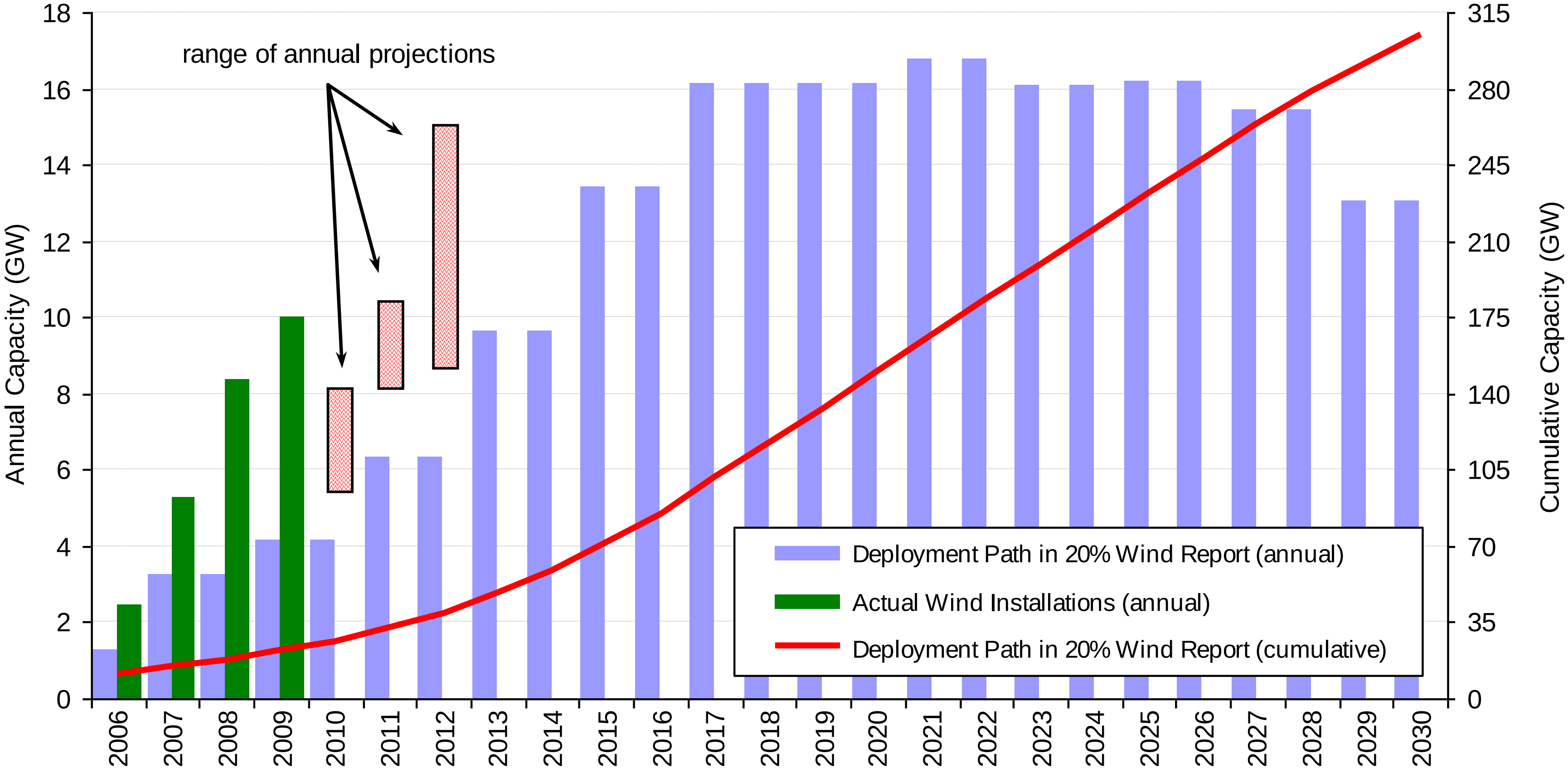
- Stronger federal and state policy support than at any point in last decade
- Possible further federal policy support through extension of Recovery Act programs, RPS, climate, and/or transmission policy
- Falling wind turbine prices may improve comparative economics of wind energy

Weaker Growth

- Treasury grant eligibility expires at end of 2010, but tax equity market not fully recovered
- Natural gas and wholesale power prices / expectations have plummeted
- Softer demand from state RPS markets in near term
- Inadequate transmission infrastructure beginning to constrain new builds
- Increased competition from other renewable energy sources

U.S. Is on a Trajectory that May Lead to 20% of Electricity Coming from Wind

But ramping up further to ~16 GW/year and maintaining that pace for a decade is an enormous challenge, and is far from pre-determined



For More Information...

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

- http://windandwater.energy.gov/

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