



**U.S. Department of Energy
Energy Efficiency
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Wind & Hydropower Technologies Program

Tracking and Understanding Trends in the U.S. Wind Power Market:

2007 Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends

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DOE/NREL Wind Powering America Webinar

July 9, 2008



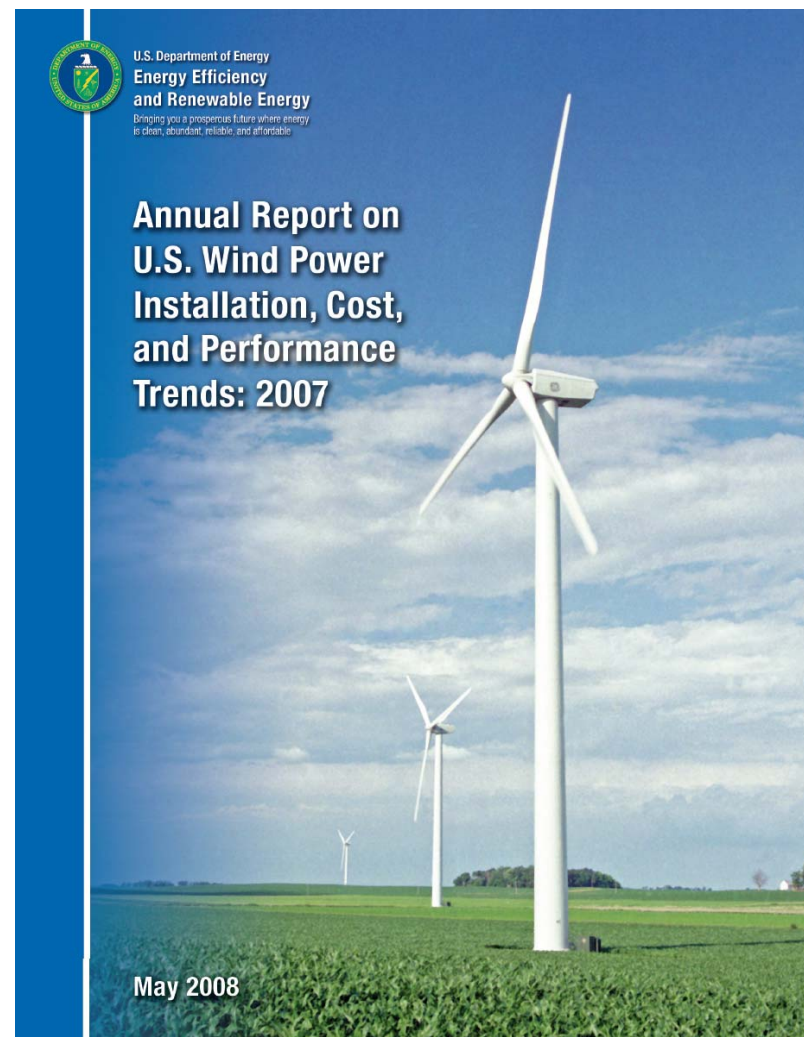
Annual Market Data Report, 2007: Second Issue in Annual Series

- Goal is to publish annual, publicly available report summarizing key trends in the U.S. wind market
 - Build from AWEA's efforts in this regard, seeking to provide comprehensive data on the U.S. wind sector
- Current report focuses on 2007; 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
- Evolution of wind pricing
- Installed wind project costs
- Wind turbine transaction prices
- Wind project performance
- O&M cost trends
- Integration/transmission/policy
- Coming up in 2008



Presentation covers all topics, except integration, transmission and policy, and also updates cost data for early-2008 figures

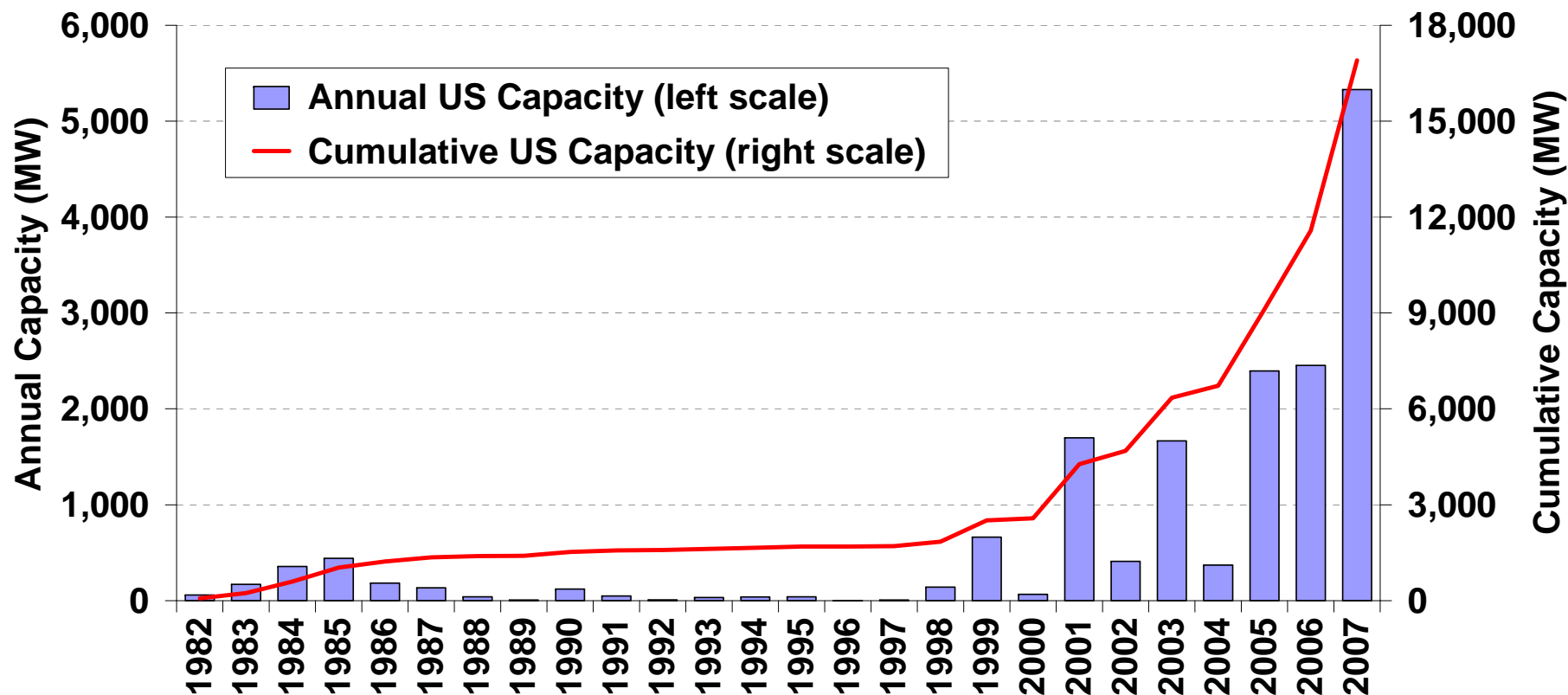


Basic Themes of This Presentation, and the 2007 Report

- 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 puts more dramatic increases in sector growth at some risk



U.S. Wind Power Capacity Up 46% in 2007



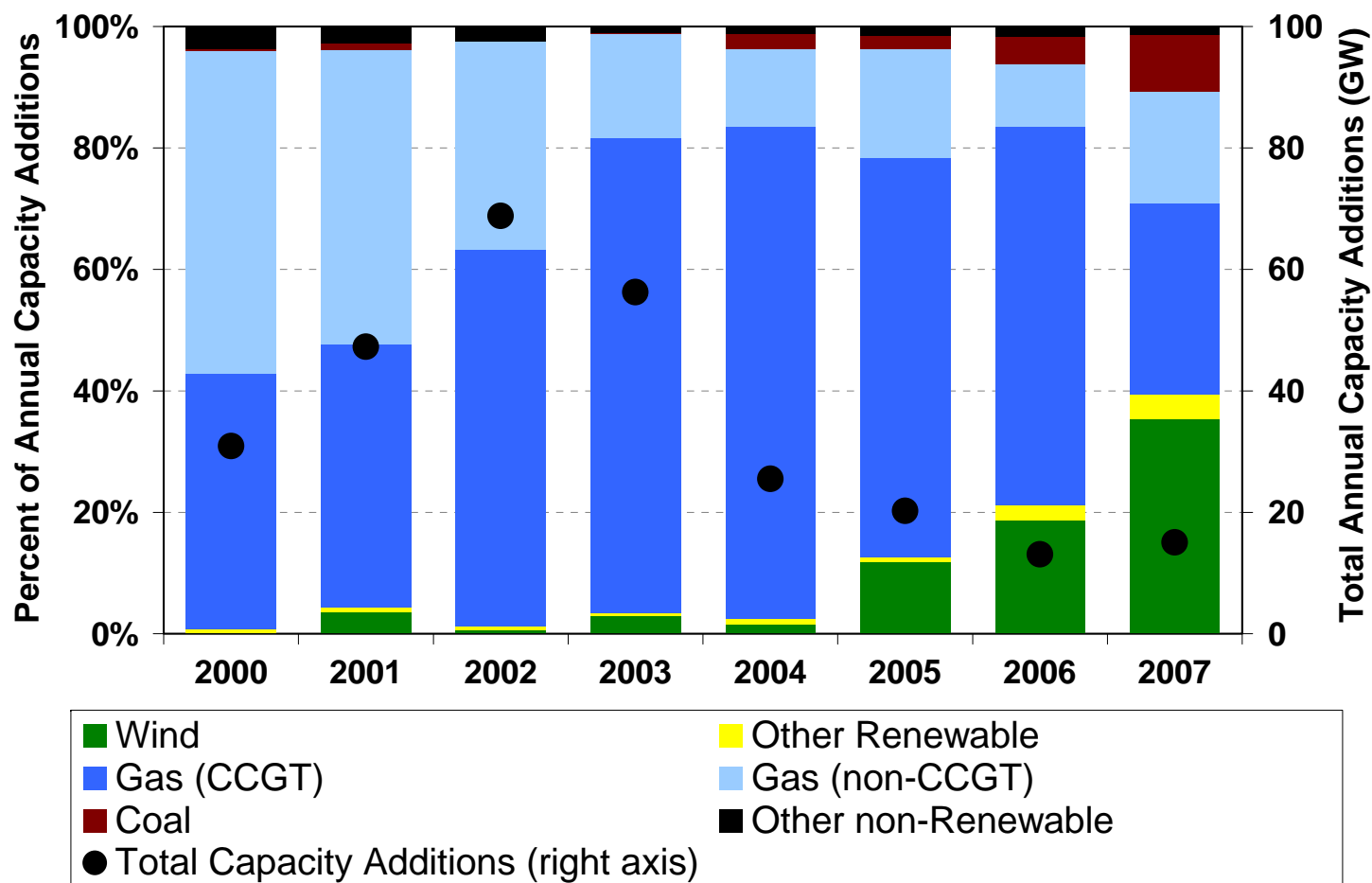
Source: AWEA

Record year for new U.S. wind capacity:

- 5,329 MW of wind added (*more than double* previous record)
- Roughly \$9 billion in investment



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



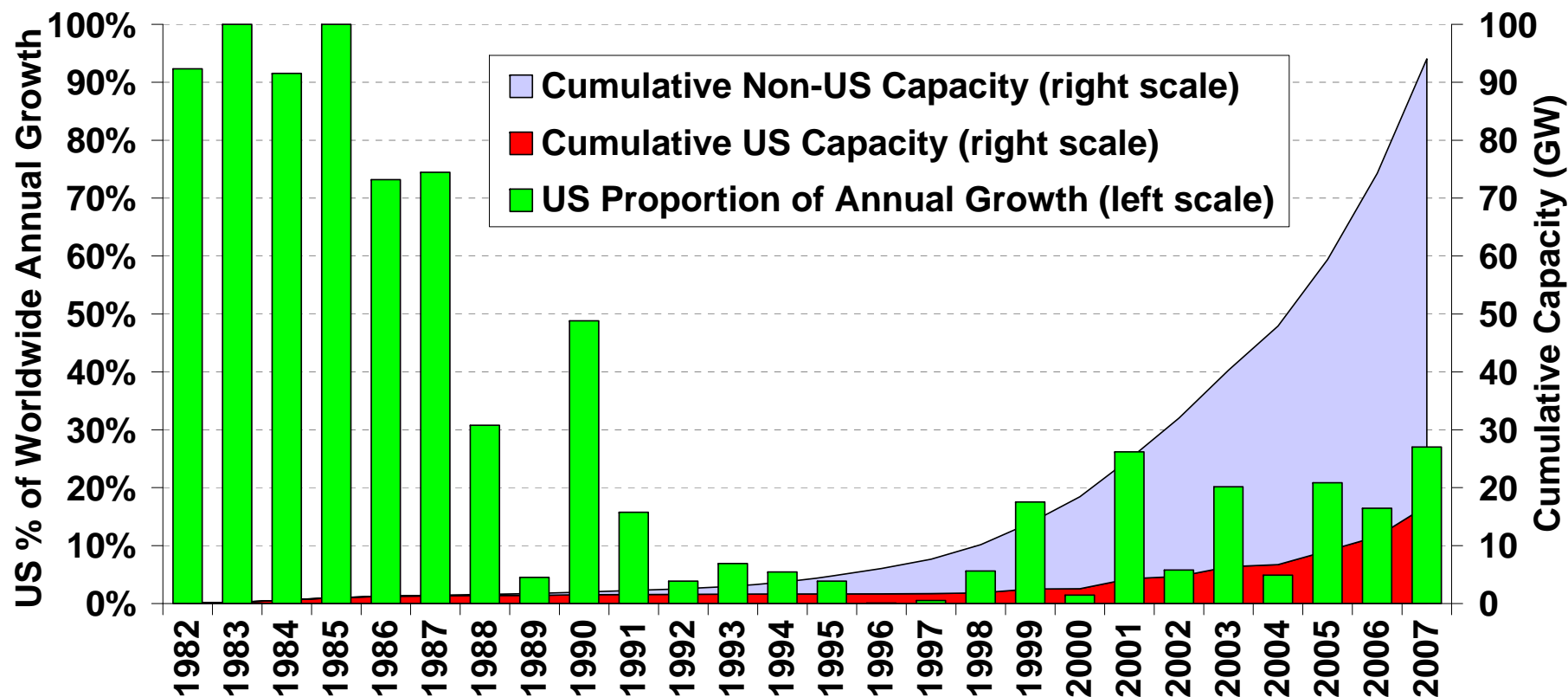
U.S. Led the World in 2007 Wind Capacity Additions; Second in Cumulative Capacity

Incremental Capacity (2007, MW)		Cumulative Capacity (end of 2007, MW)	
U.S.	5,329	Germany	22,277
China	3,287	U.S.	16,904
Spain	3,100	Spain	14,714
Germany	1,667	India	7,845
India	1,617	China	5,875
France	888	Denmark	3,088
Italy	603	Italy	2,721
Portugal	434	France	2,471
U.K.	427	U.K.	2,394
Canada	386	Portugal	2,150
<i>Rest of World</i>	2,138	<i>Rest of World</i>	13,591
TOTAL	19,876	TOTAL	94,030

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



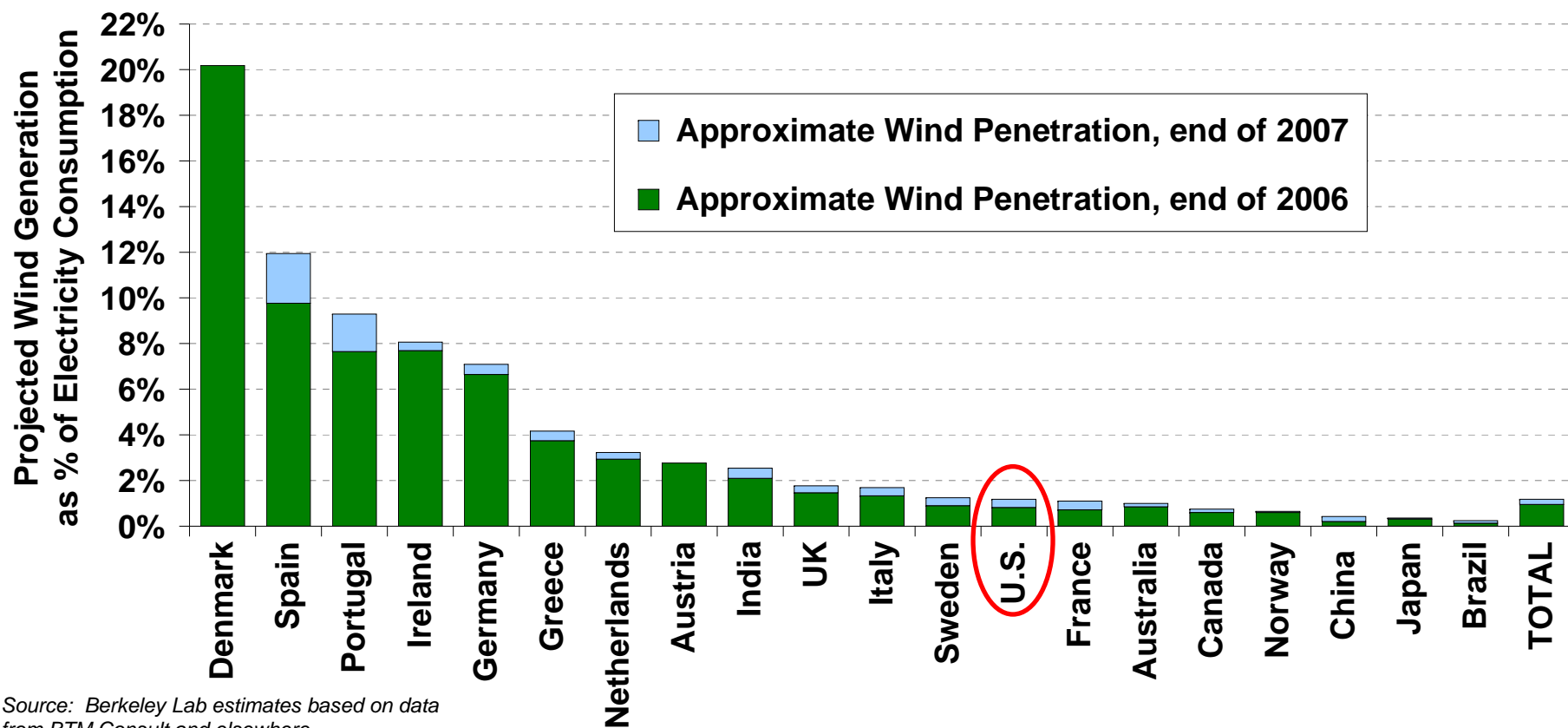
U.S. Share of Global Wind Capacity: 27% of 2007 Additions, 18% of Cumulative



Source: Earth Policy Institute, BTM Consult, AWEA



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

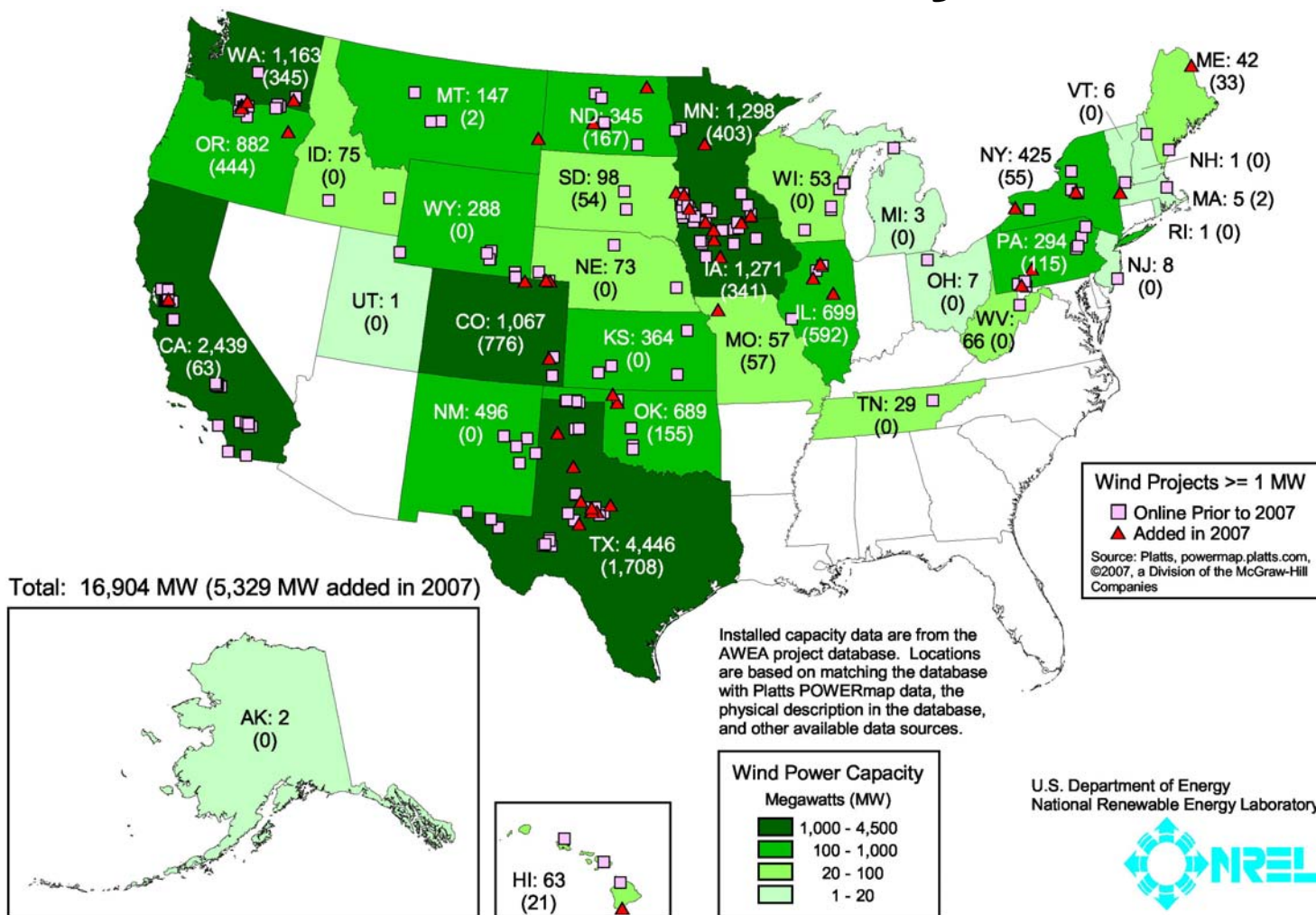


Source: Berkeley Lab estimates based on data from BTM Consult and elsewhere

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



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





Texas Easily Exceeded Other States in Annual Capacity Growth

Incremental Capacity (2007, MW)		Cumulative Capacity (end of 2007, MW)		Estimated Percentage of In-State Generation	
Texas	1,708	Texas	4,446	Minnesota	7.5%
Colorado	776	California	2,439	Iowa	7.5%
Illinois	592	Minnesota	1,298	Colorado	6.1%
Oregon	444	Iowa	1,271	South Dakota	6.0%
Minnesota	403	Washington	1,163	Oregon	4.4%
Washington	345	Colorado	1,067	New Mexico	4.0%
Iowa	341	Oregon	882	North Dakota	3.8%
North Dakota	167	Illinois	699	Oklahoma	3.0%
Oklahoma	155	Oklahoma	689	Texas	3.0%
Pennsylvania	115	New Mexico	496	Washington	2.8%
California	63	New York	425	California	2.8%
Missouri	57	Kansas	364	Kansas	2.3%
New York	55	North Dakota	345	Hawaii	2.3%
South Dakota	54	Pennsylvania	294	Montana	1.9%
Maine	33	Wyoming	288	Wyoming	1.7%
Hawaii	21	Montana	147	Idaho	1.5%
Massachusetts	2	South Dakota	98	Illinois	0.8%
Montana	2	Idaho	75	Maine	0.8%
		Nebraska	73	New York	0.7%
		West Virginia	66	Nebraska	0.7%
Rest of U.S.	0	Rest of U.S.	277	Rest of U.S.	0.05%
TOTAL	5,329	TOTAL	16,904	TOTAL	1.1%

- TX widened its lead over CA in cumulative wind capacity
- 16 states had >100 MW of wind capacity at the end of 2007 (9 had >500 MW)
- 6 states have in-state wind generation that exceeds 4% of total in-state generation: MN, IA, CO, SD, OR, NM

Source: AWEA project database, EIA, Berkeley Lab estimates.



Wind Now >10% of Some Utilities' Sales

Total Wind Capacity (end of 2007, MW)	
Xcel Energy	2,635
MidAmerican Energy	1,201
Southern California Edison	1,026
Pacific Gas & Electric	878
Luminant	704
American Electric Power	543
CPS Energy	501
Puget Sound Energy	428
Alliant Energy	378
Exelon Energy	342
Austin Energy	274
Portland General Electric	225
Great River Energy	218
Last Mile Electric Cooperative	205
Public Service New Mexico	204
MSR Public Power Agency	200
Reliant Energy	199
Seattle City Light	175
Oklahoma Gas & Electric	170
Empire District Electric Company	150

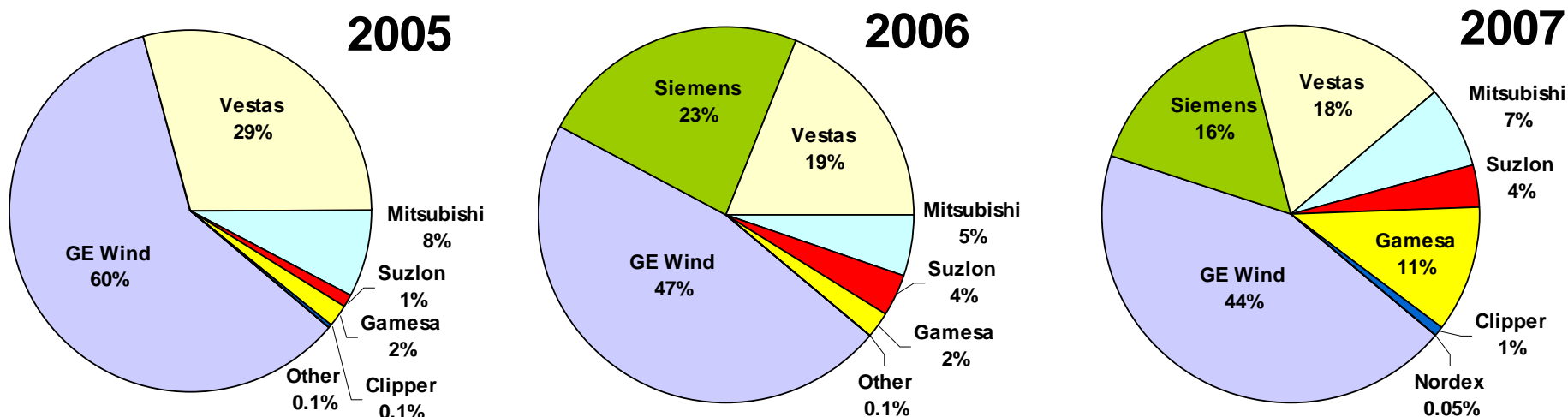
Estimated Percentage of Retail Sales (for utilities with > 50 MW of wind)	
Minnkota Power Cooperative	11.2%
Empire District Electric Company	10.2%
Last Mile Electric Cooperative	10.0%
Xcel Energy	9.3%
MSR Public Power Agency	8.4%
Public Service New Mexico	7.5%
Oklahoma Municipal Power Authority	7.2%
CPS Energy	7.1%
Northwestern Energy	7.0%
Austin Energy	6.6%
Otter Tail Power	6.4%
Great River Energy	6.3%
Nebraska Public Power District	6.0%
Puget Sound Energy	5.2%
Seattle City Light	5.0%
MidAmerican Energy	4.7%
Alliant Energy	4.2%
Western Farmers' Electric Cooperative	3.8%
Luminant Energy	3.6%
Minnesota Power	3.5%

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

Source: AWEA, EIA, Berkeley Lab estimates.



GE Remained the Dominant Turbine Vendor, But Growing Competition is Evident



Source: AWEA project database

Manufacturer	Turbine Installations (MW)		
	2005	2006	2007
GE Wind	1,433	1,146	2,342
Vestas	700	463	948
Siemens	0	573	863
Gamesa	50	50	574
Mitsubishi	190	128	356
Suzlon	25	92	197
Clipper	2.5	0	47.5
Nordex	0	0	2.5
Other	2	2	0
TOTAL	2,402	2,454	5,329

- Although the three largest vendors lost U.S. market share in 2007...
- ...all vendors saw U.S. installations of their turbines grow in 2007



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

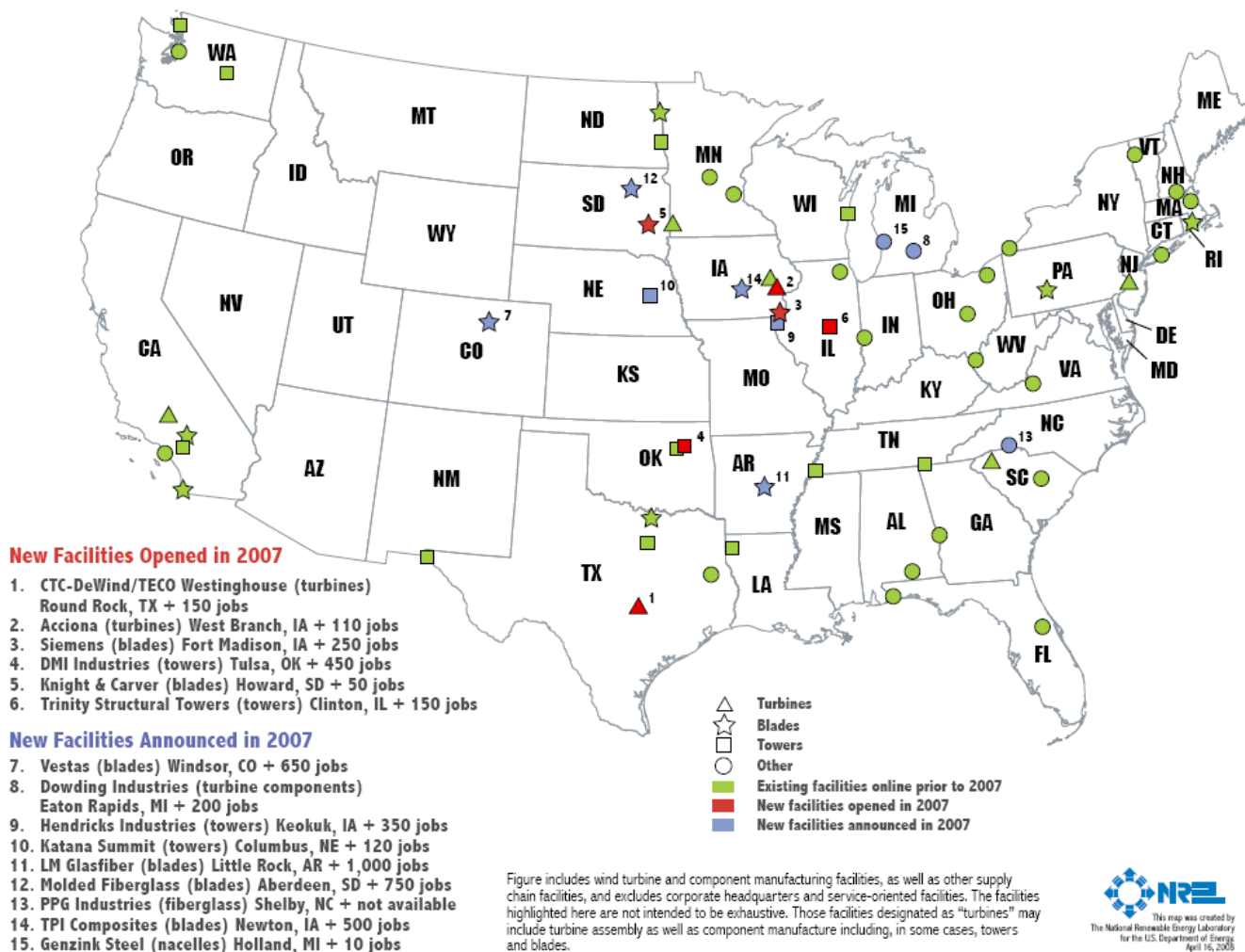


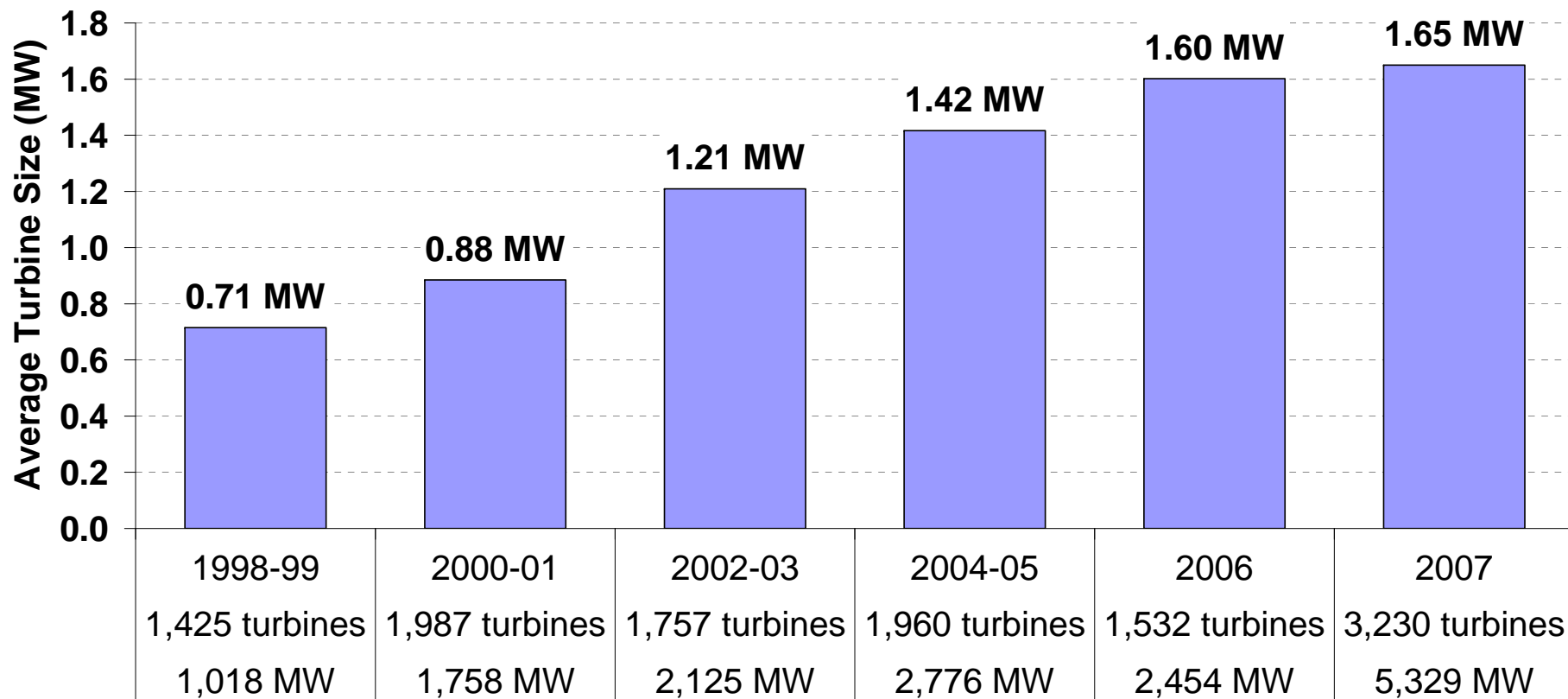
Figure includes wind turbine and component manufacturing facilities, as well as other supply chain facilities, and excludes corporate headquarters and service-oriented facilities. The facilities highlighted here are not intended to be exhaustive. Those facilities designated as "turbines" may include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



Note: Map is not intended to be exhaustive



Average Turbine Size Continued to Grow

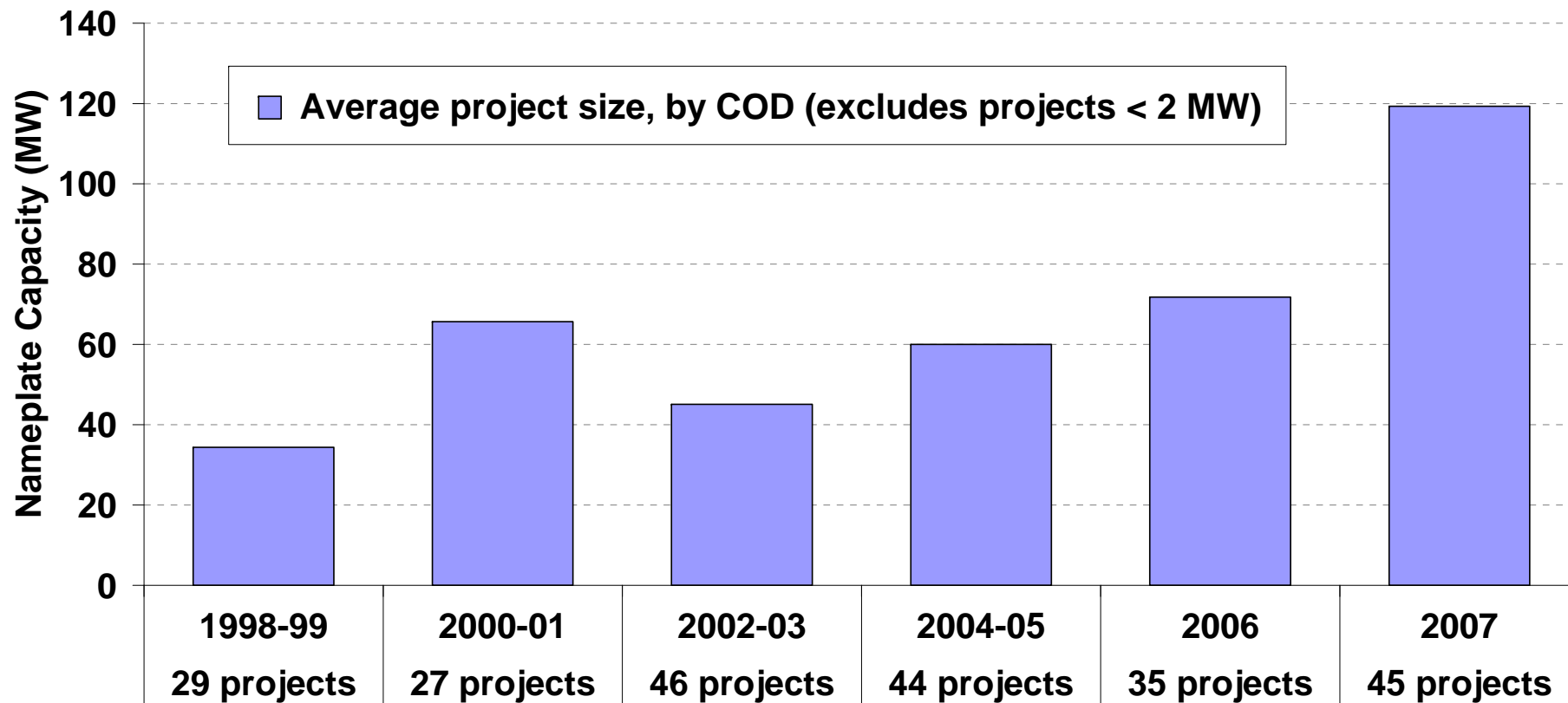


Source: AWEA project database

40% of turbines installed in 2007 were larger than 1.5 MW, up from 34% in 2006 and 24% in 2004/2005



Average Project Size Approached 120 MW



Source: Berkeley Lab analysis of AWEA project database

Average project size has doubled since 2004-2005, and tripled since 1998-1999



Wind Developer Consolidation Continued at a Torrid Pace

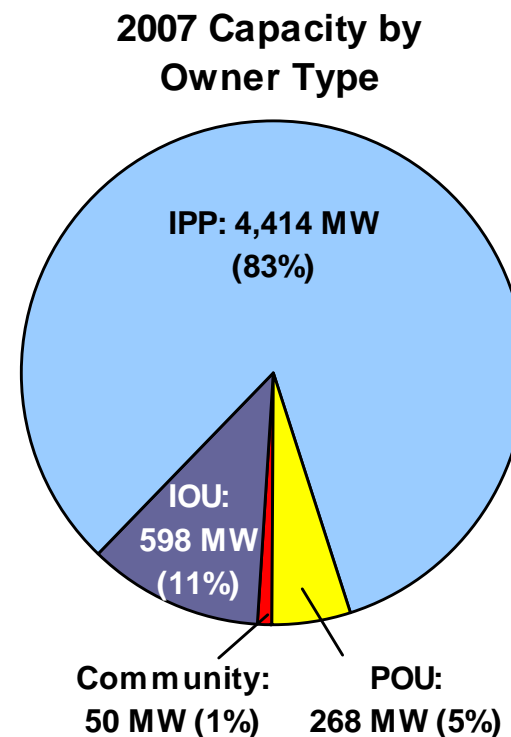
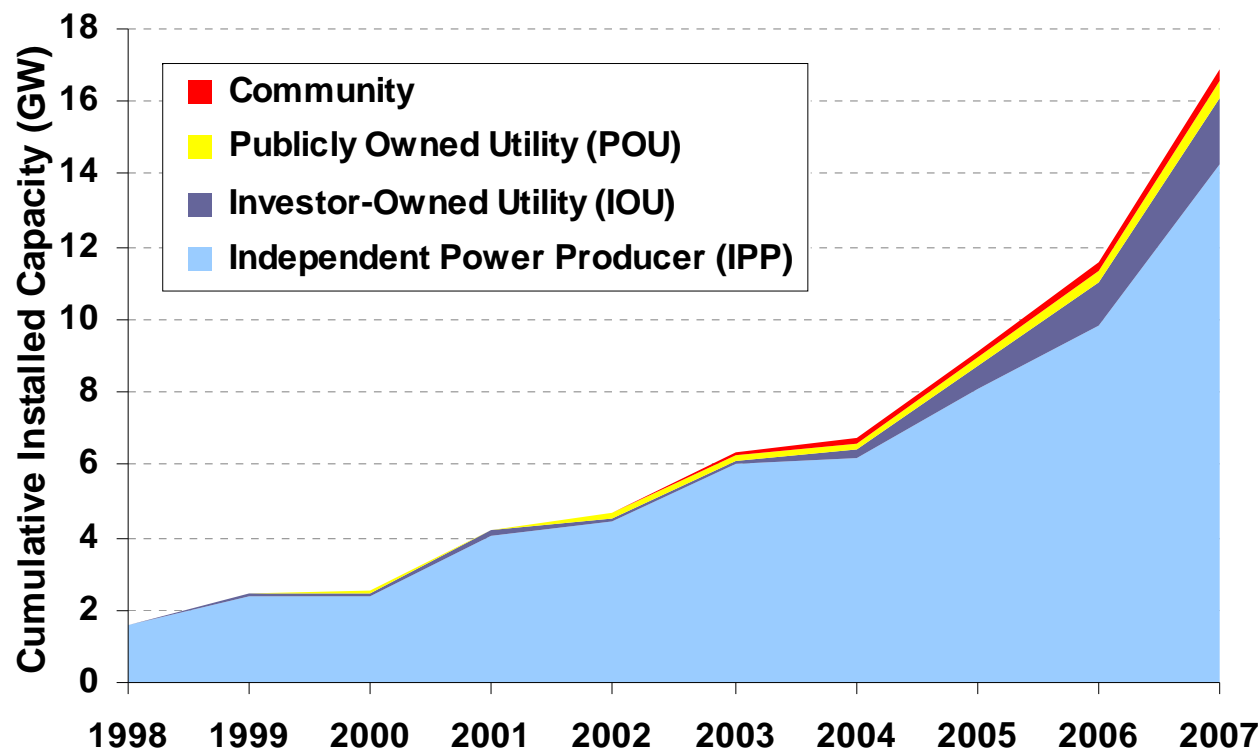
- Acquisition/investment continued strong trend that began in 2005
 - 2007:** 11 deals = 37 GW of wind development pipeline
 - 2006:** 12 deals = 34 GW
 - 2005:** 8 deals = 12 GW
 - 2002-04:** 4 deals = 4 GW
- A number of large companies, including European energy firms, have recently entered the U.S. wind development business

Investor	Transaction Type	Developer	Announced
EDF (SIIF Energies)	Acquisition	enXco	May-02
Gamesa	Investment	Navitas	Oct-02
AES	Investment	US 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

* Select list of announced transactions; excludes joint development activity.
 Source: Berkeley Lab.



IPP Project Ownership Remained Dominant

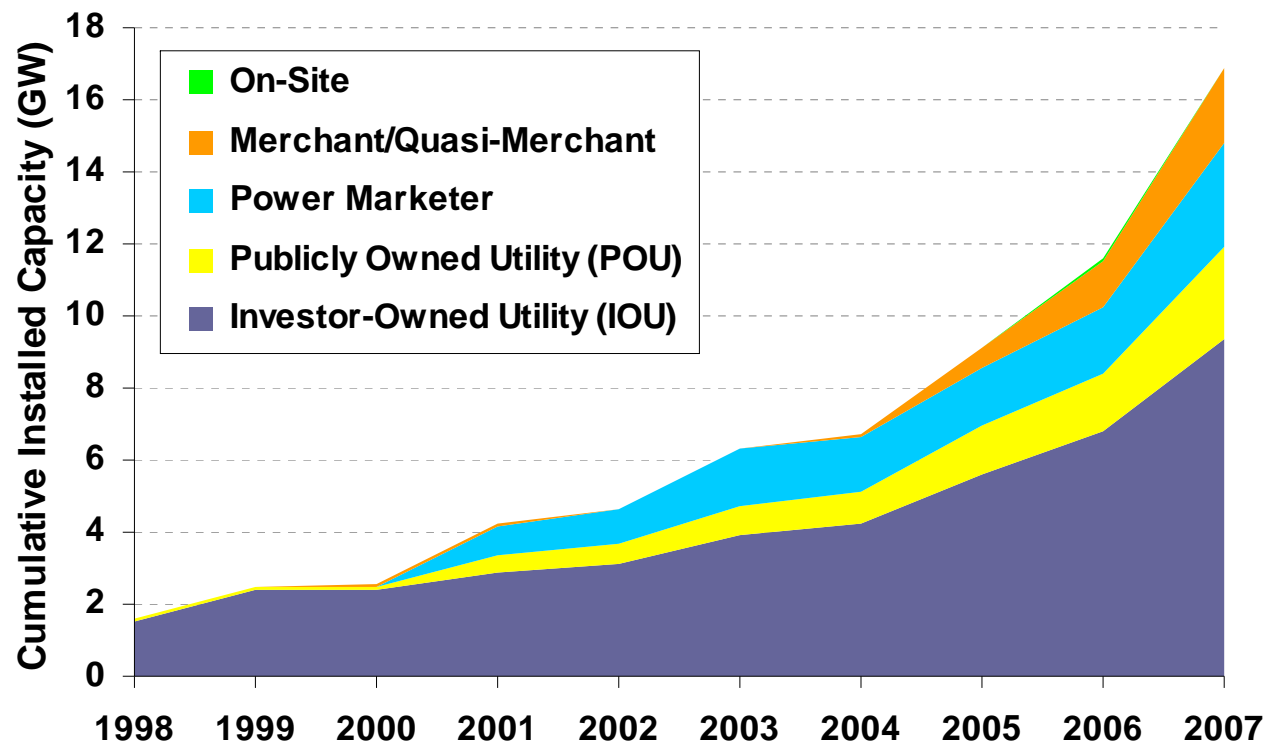


Source: Berkeley Lab estimates based on AWEA project database

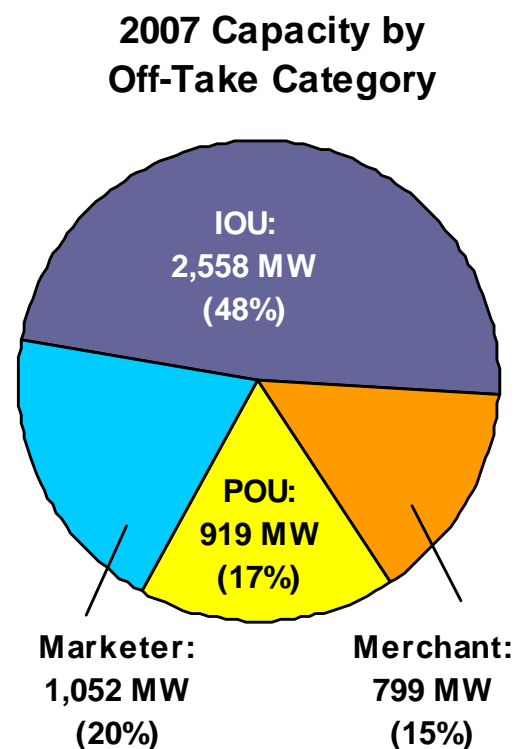
- Utility ownership (both IOU and POU) gained some ground
- Community wind, by our definition, lost market share



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



Source: Berkeley Lab estimates based on AWEA project database



But sales to power marketers are becoming more prevalent, as are “merchant” plants (primarily in TX and NY)

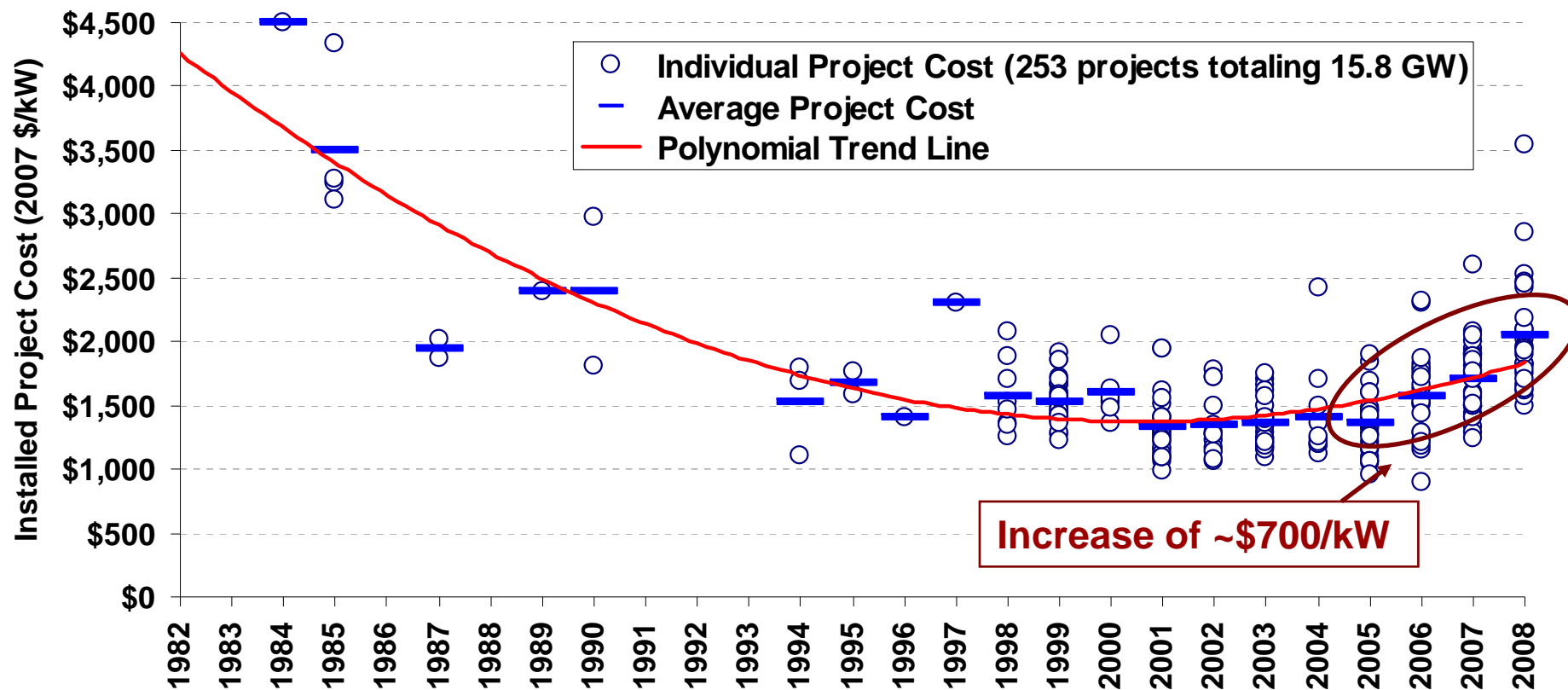


Report Contains Considerable Data on Cost, Performance, and Pricing Trends

- Installed wind project costs
- Wind turbine transaction prices
- Project performance (capacity factor)
- Project O&M expenditures
- Wind power prices



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

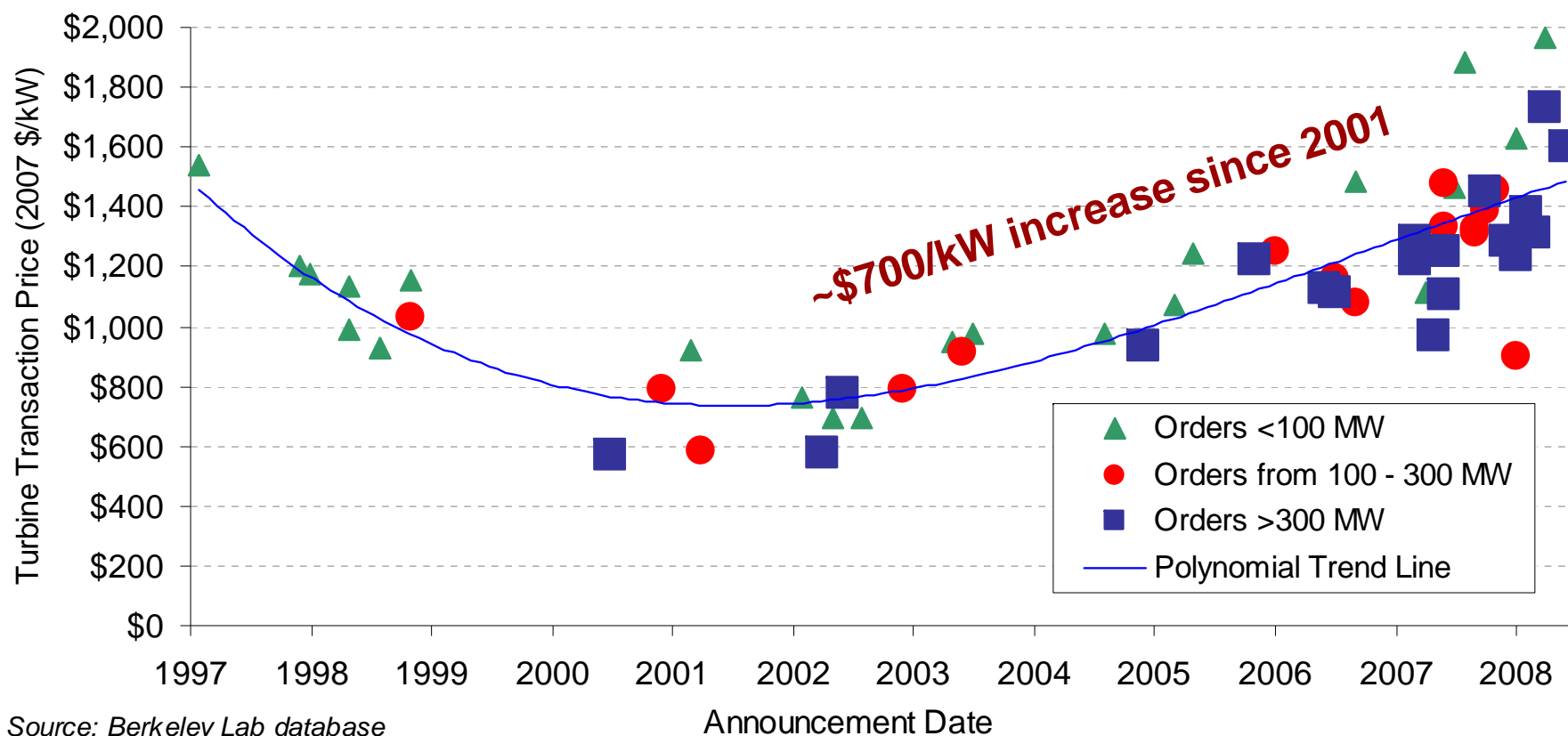


Source: Berkeley Lab database (some data points suppressed to protect confidentiality)

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



Rising Project Costs Are Driven, in Part, By Rising Wind Turbine Prices

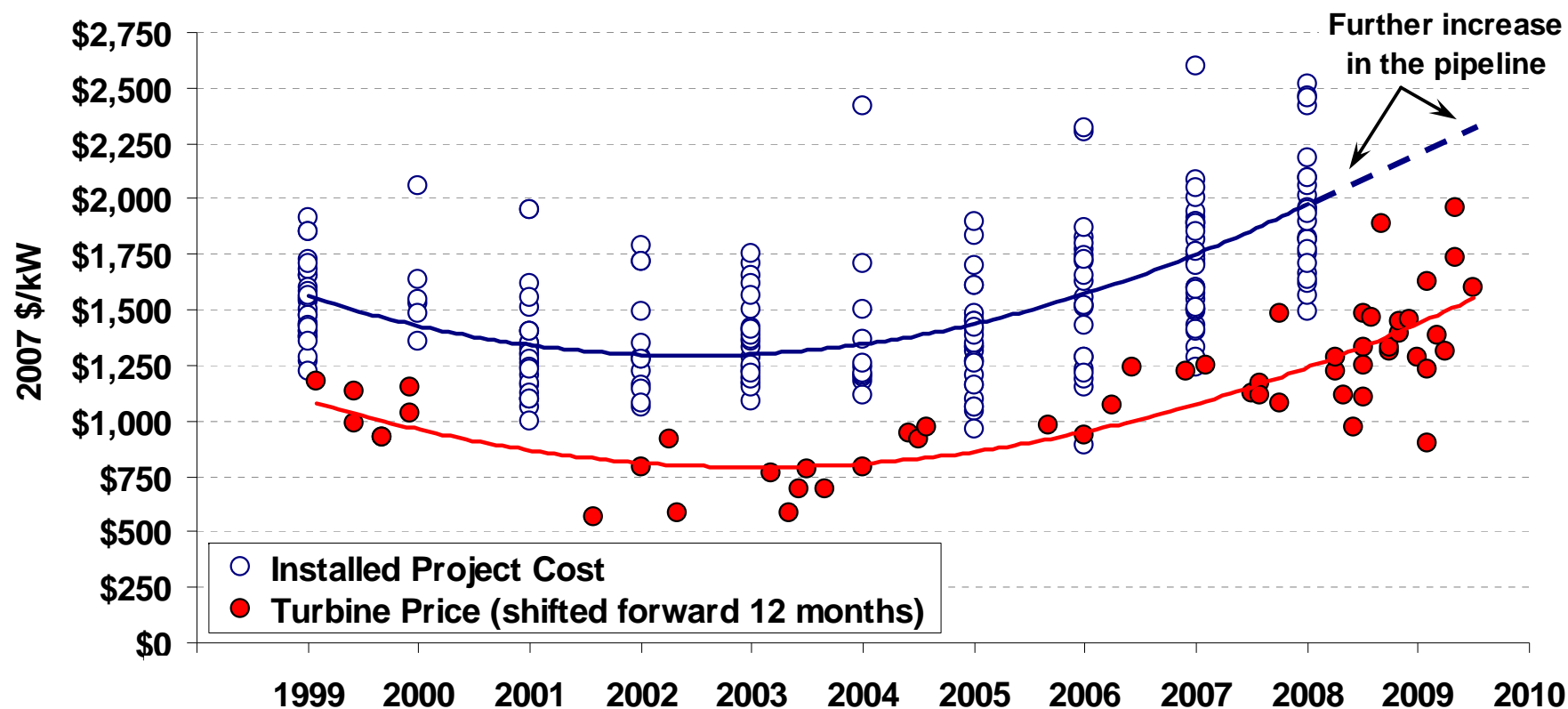


Source: Berkeley Lab database

Note: Sample includes reported wind turbine transactions prices from 57 wind turbine orders totaling 19.9 GW



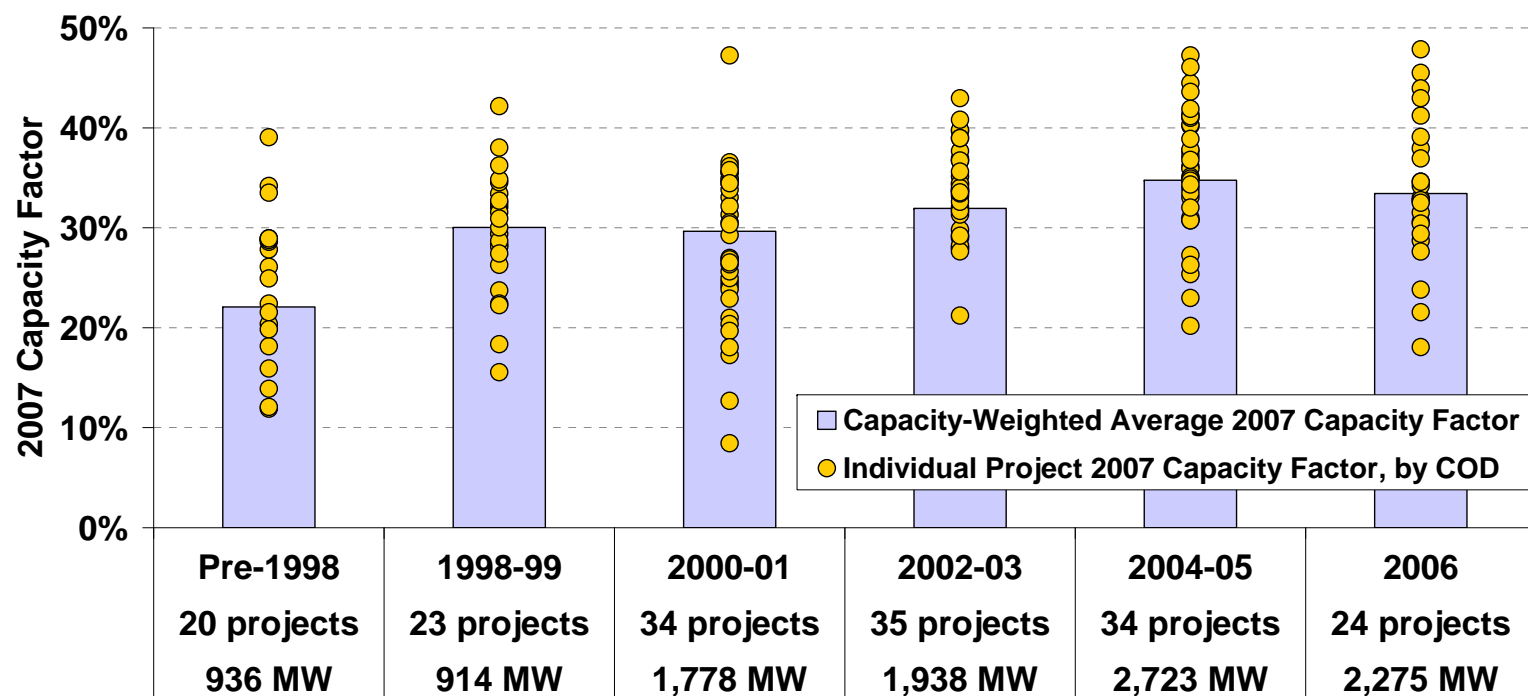
Additional Near-Term Project Cost Increases Are in the Pipeline



Shifting turbine price curve forward by 12 months to account for delivery time suggests further increases in project costs in 2009



Wind Project Performance Is Improving, Somewhat Mitigating Price Rise



Note: Sample consists of 170 wind projects built from 1983-2006, totaling 10,564 MW (91% of U.S. capacity at end of 2006)

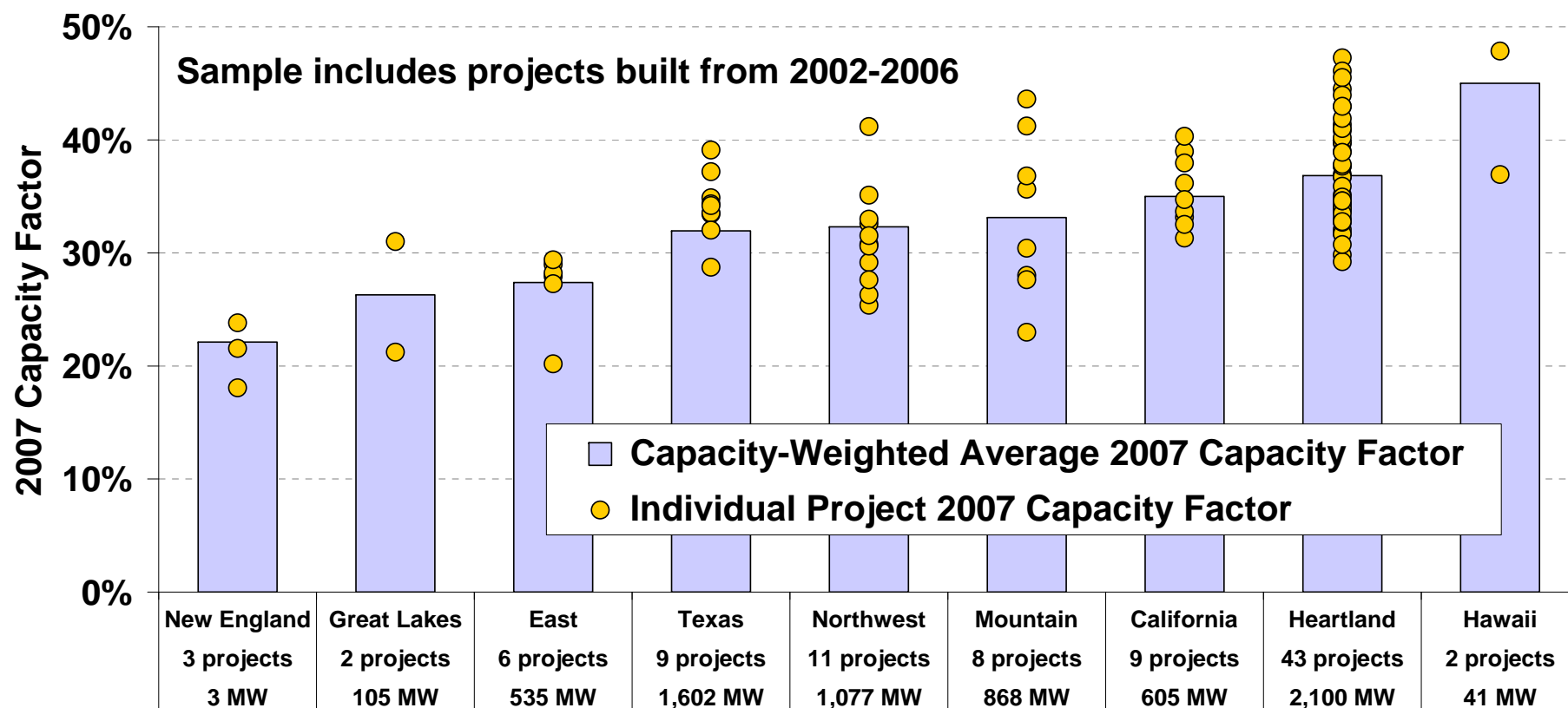
Source: Berkeley Lab database

Of projects installed prior to 2004, **3.6%** had CFs in excess of 40%

Of projects installed from 2004-2006, **25.9%** had CFs in excess of 40%



Regional Capacity Factor Differences Are Apparent

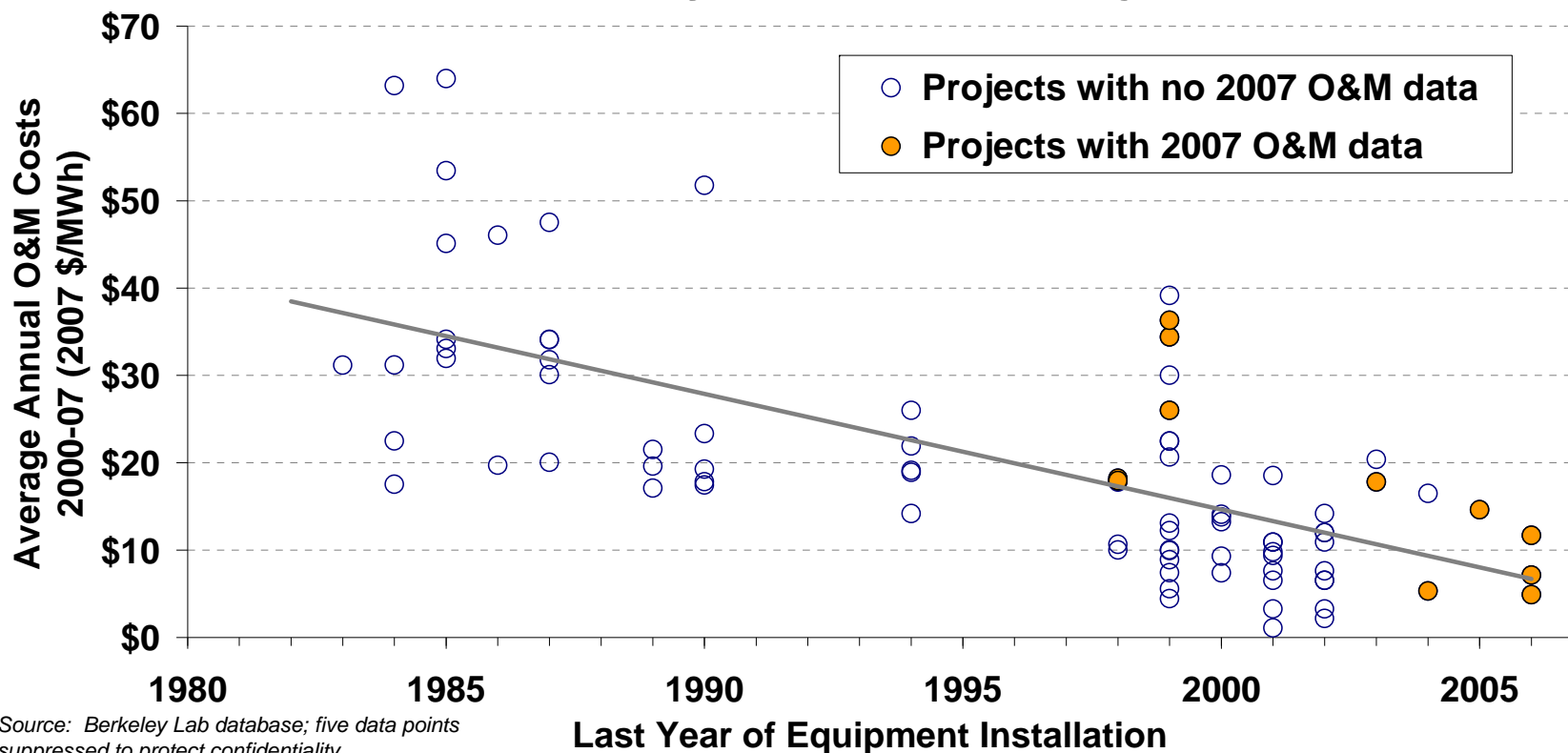


Source: Berkeley Lab database

- Sample size is problematic in several regions (New England, Great Lakes, Hawaii)
- Texas' relatively low average is heavily influenced by a single large project



Recent O&M Costs Appear To Be Lower For More-Recently Built Projects



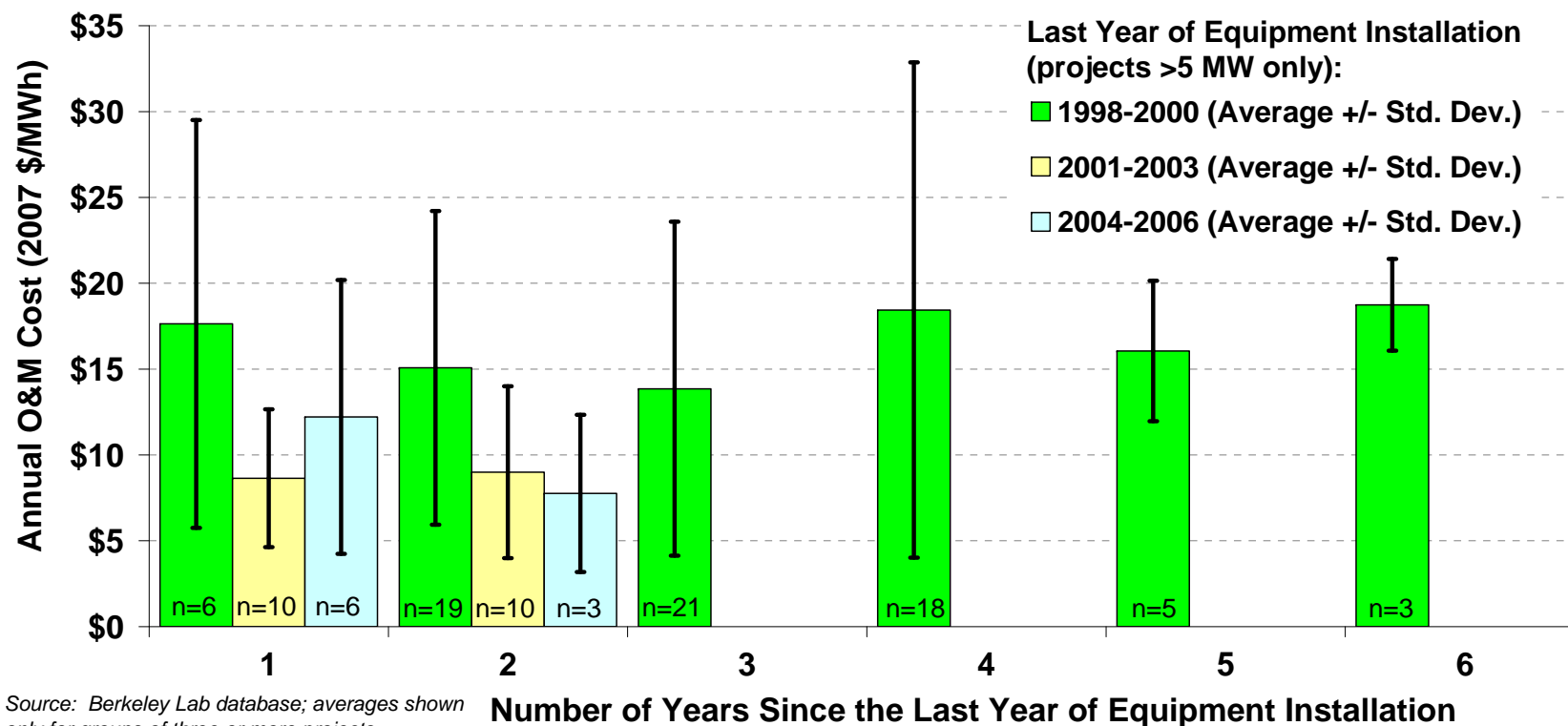
Source: Berkeley Lab database; five data points suppressed to protect confidentiality.

Capacity-weighted average 2000-07 O&M costs for projects built in 1980s equal **\$30/MWh**, dropping to **\$20/MWh** for projects built in 1990s, and to **\$9/MWh** for projects built in 2000s

Note: Sample is limited, and consists of 95 wind projects totaling 4,319 MW; few projects in sample have complete records of O&M costs from 2000-07



O&M Costs Appear to Decrease for Recently Constructed Projects, and Increase with Project Age



Note: Sample size is extremely limited; figure only includes projects over 5 MW in size and built from 1998-2006

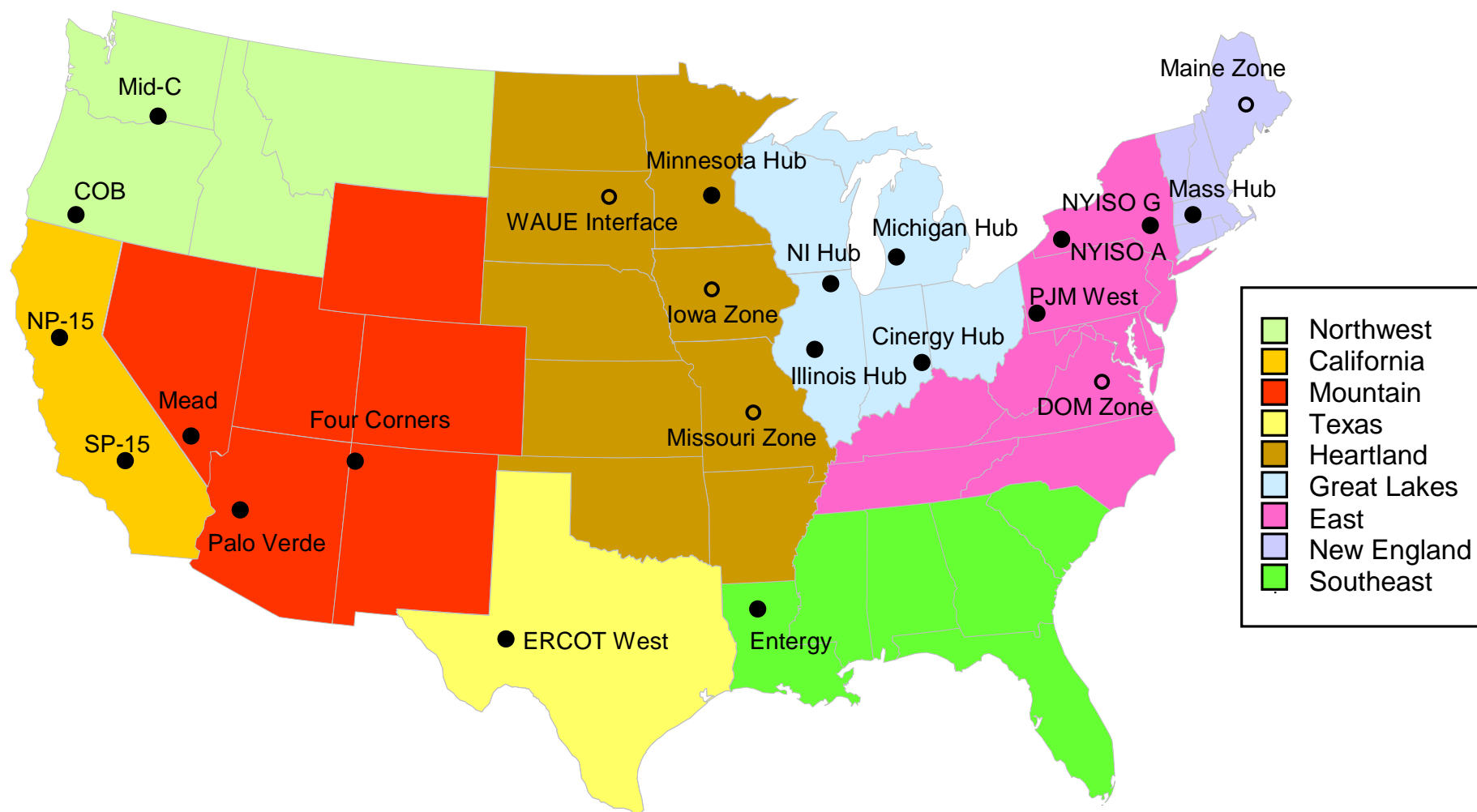


Though Wind's Competitive Position Has Eroded Somewhat Recently, Wind Prices Remained Attractive in 2007

- Berkeley Lab maintains a database of wind power sales prices; next few slides present data from that database
- Sample includes 128 wind projects installed from 1998-2007, totaling 8,303 MW (55% of total added capacity from 98-07)
- Prices reflect price of electricity as sold by project owner (i.e., bus-bar energy prices)
 - Prices reduced by receipt of state/federal incentives (e.g., the PTC) and by any value gained through separate sale of RECs (though only 10 of 128 projects appear to receive additional REC revenue)
 - As a result, prices do not reflect wind energy generation costs; prices would be higher were state/federal incentives and RECs not available

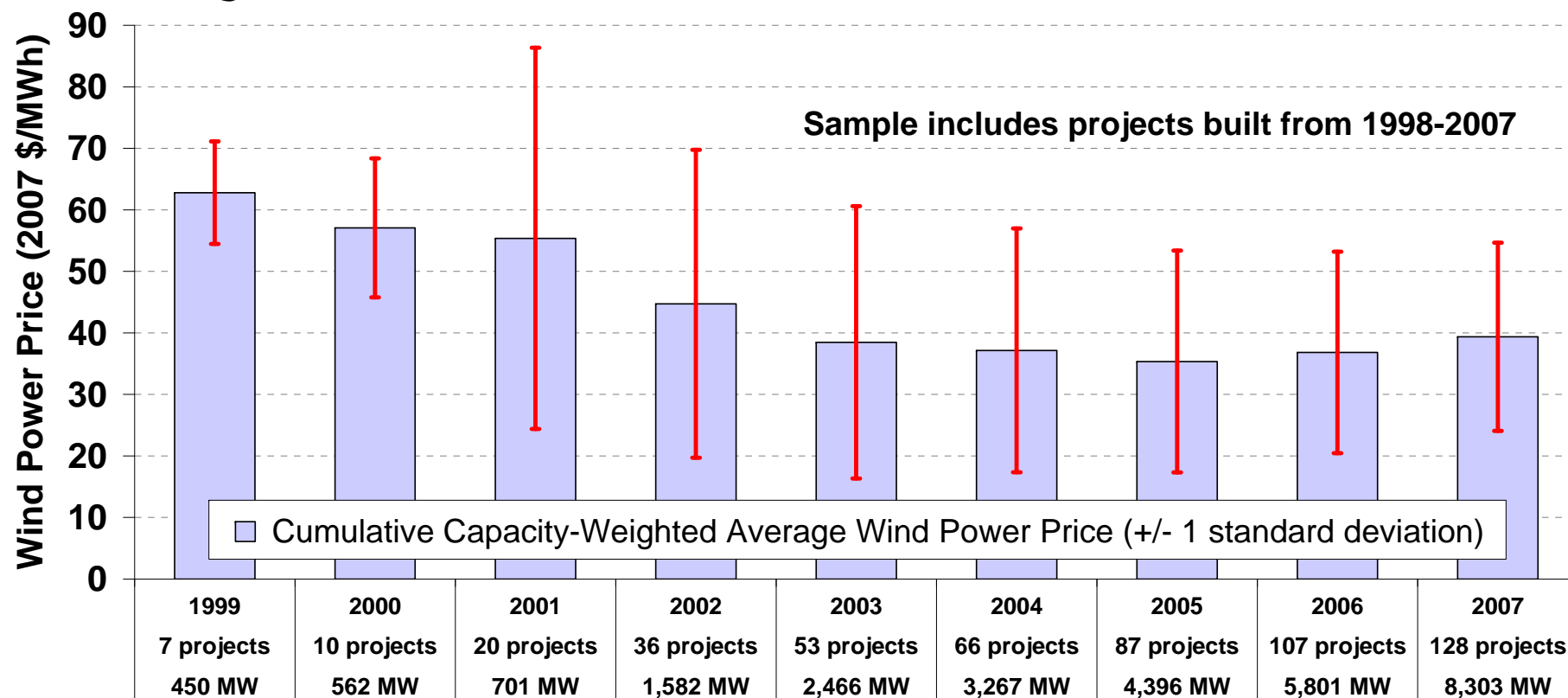


Regions and Wholesale Price Hubs Used in Analysis





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

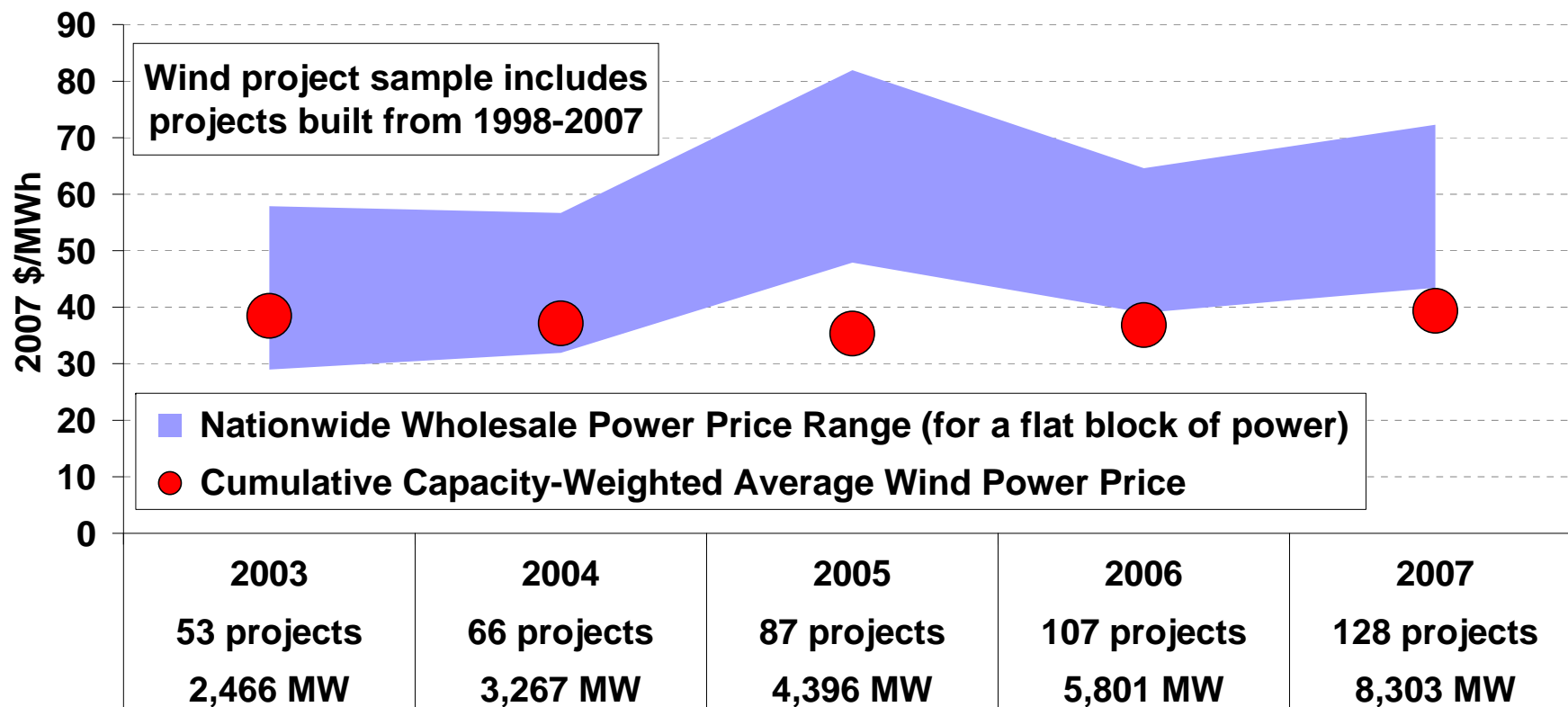


Source: Berkeley Lab database

Small increase in 2006-07 due to rising prices of projects built in those years, but cumulative nature of graphic mutes effect



Wind Has Been Competitive with Wholesale Power Prices in Recent Years

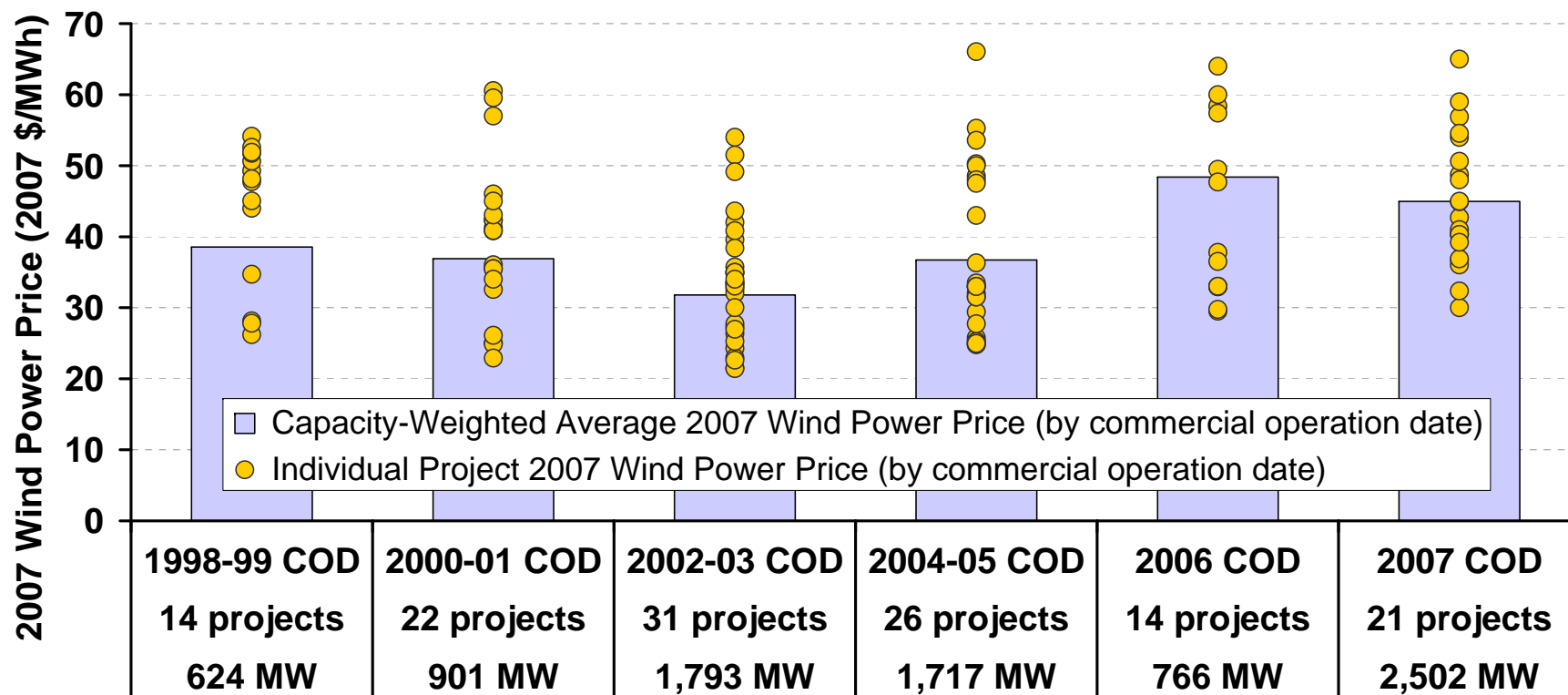


Source: FERC 2006 and 2004 "State of the Market" reports, Berkeley Lab database, Ventyx

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



Binning by COD Shows that Prices Have Increased for Recently Built Projects...

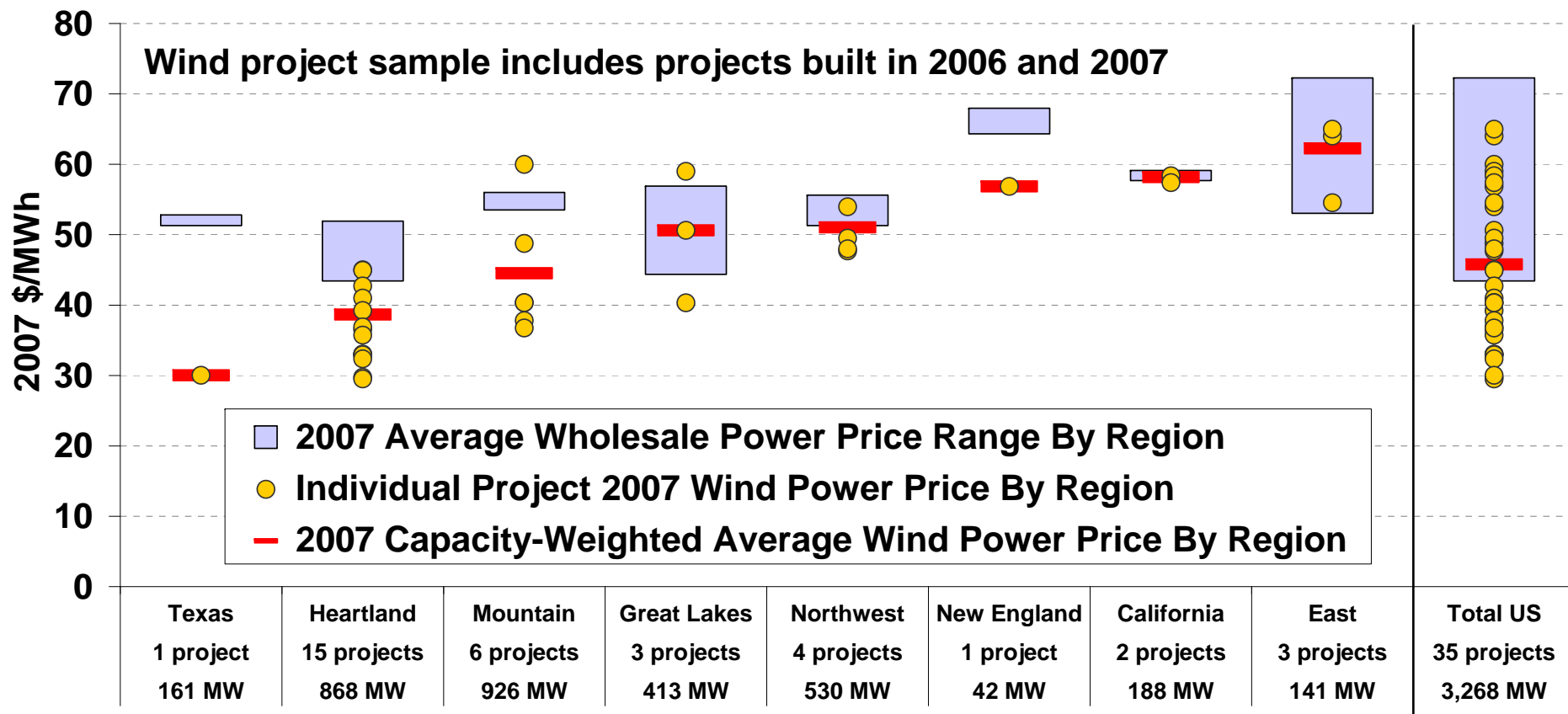


Source: Berkeley Lab database

Average price of **\$32/MWh** for projects built in '02-03, **\$37/MWh** for projects built '04-05, **\$48/MWh** for projects built in '06, and **\$45/MWh** for projects built in '07



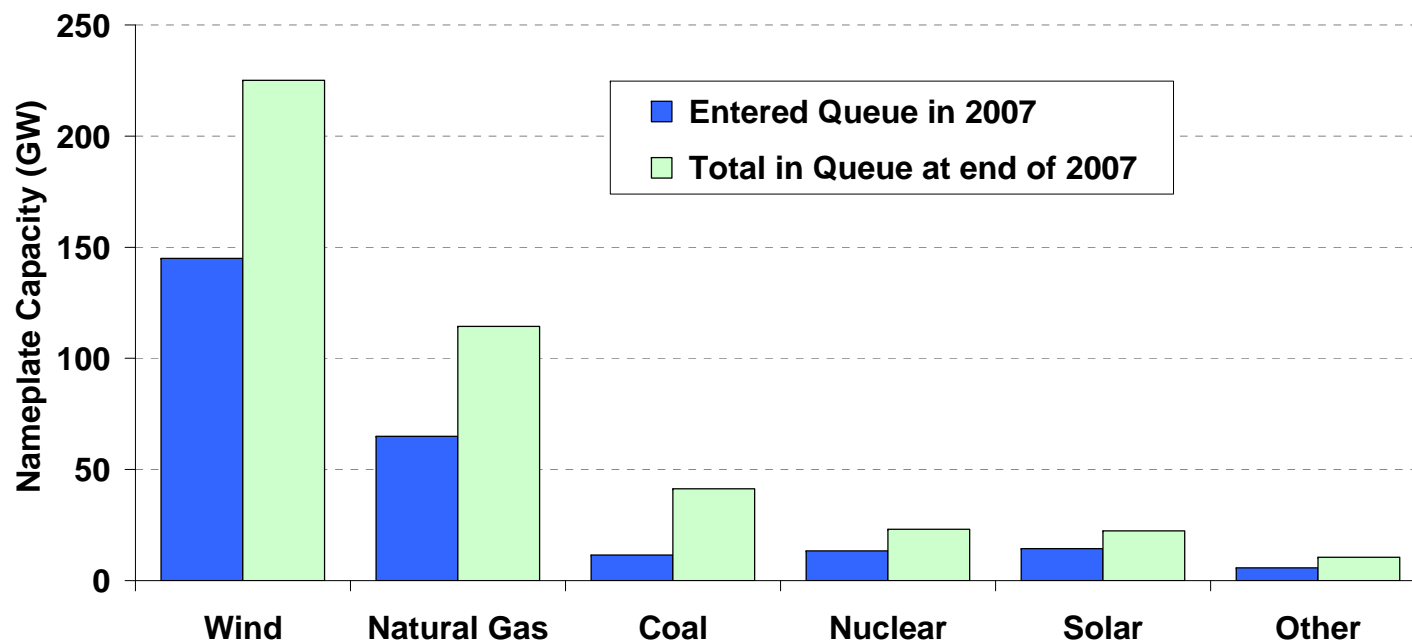
Making Wind Projects Built in 2006-07 *Somewhat* Less Competitive, But Still a Good Value in Most Regions



Source: Berkeley Lab database, Ventyx



Regardless of these Pricing Trends, More than 225 GW of Wind Has Applied for Interconnection



Note: Figure includes data from 11 wind-relevant interconnection queues, so does not represent a truly national picture

Source: Exeter Associates review of interconnection queues

- MISO (66 GW), ERCOT (41 GW), and PJM (35 GW) make up 2/3 of total
- Twice as much wind as next largest resource (natural gas) in these queues
- ***Not all of the capacity will be built, but demonstrates enormous interest***



Expectations for 2008 and Beyond

- Rising wind power prices, transmission availability, siting and permitting conflicts, and other barriers to wind development remain
- Nonetheless, 2008 is expected to be another banner year for the U.S. wind industry, with >5,000 MW projected
- Drivers include rising cost of fossil generation, mounting possibility of carbon regulation, increasing state support for wind, and looming PTC expiration
- Unless the PTC is soon extended beyond 2008, 2009 could be a year of retrenchment



For More Information...

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

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

For a free printed version of the report

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