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

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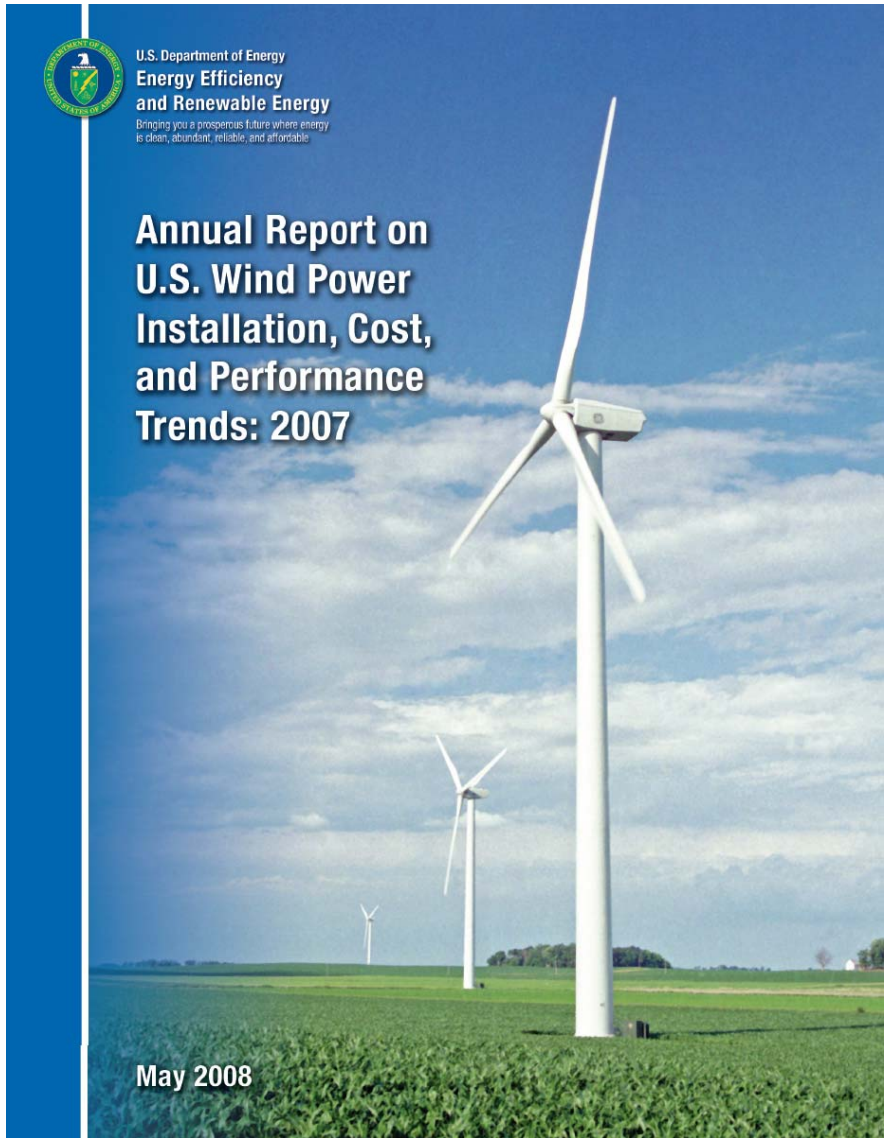
- Report Summary -

May 2008

Presentation Overview

- Introduction to 2007 edition of U.S. wind market data report
- 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



2007 Annual Market Data Report

Purpose, Scope, and Data:

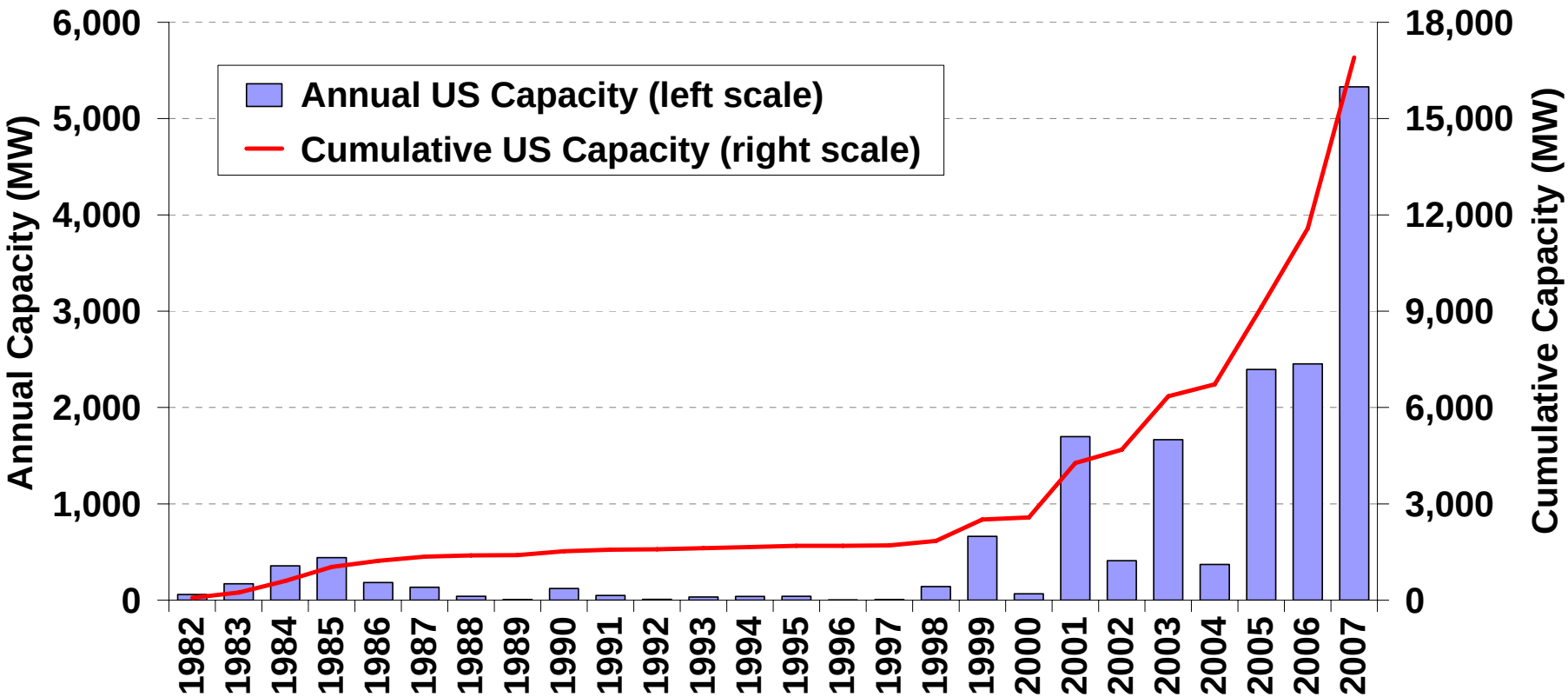
- With a focus on 2007, summarize trends in the U.S. wind power market, including information on wind installations, industry developments, power sales prices, project costs, performance, O&M costs, policy trends
- Scope primarily includes wind turbines and projects over 50 kW in size
- Data sources include AWEA, EIA, FERC, SEC, etc. *(see full report)*

Report Authors:

- Primary Authors: R. Wiser and M. Bolinger, Berkeley Lab
- Contributions from others at Berkeley Lab, AWEA, NREL, DOE, Exeter Associates, George Washington University

Available at: http://www1.eere.energy.gov/windandhydro/

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

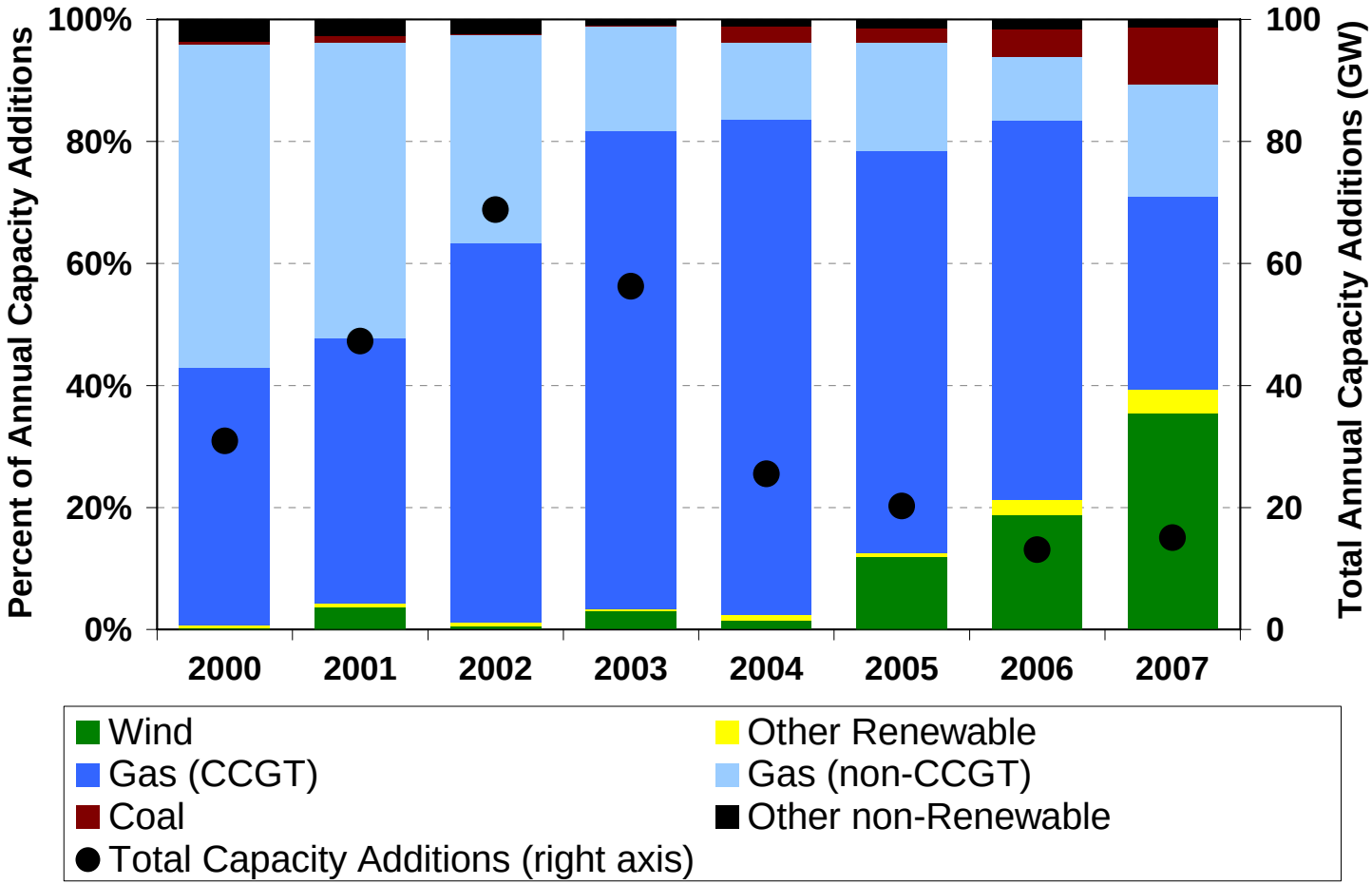


Source: AWEA

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

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

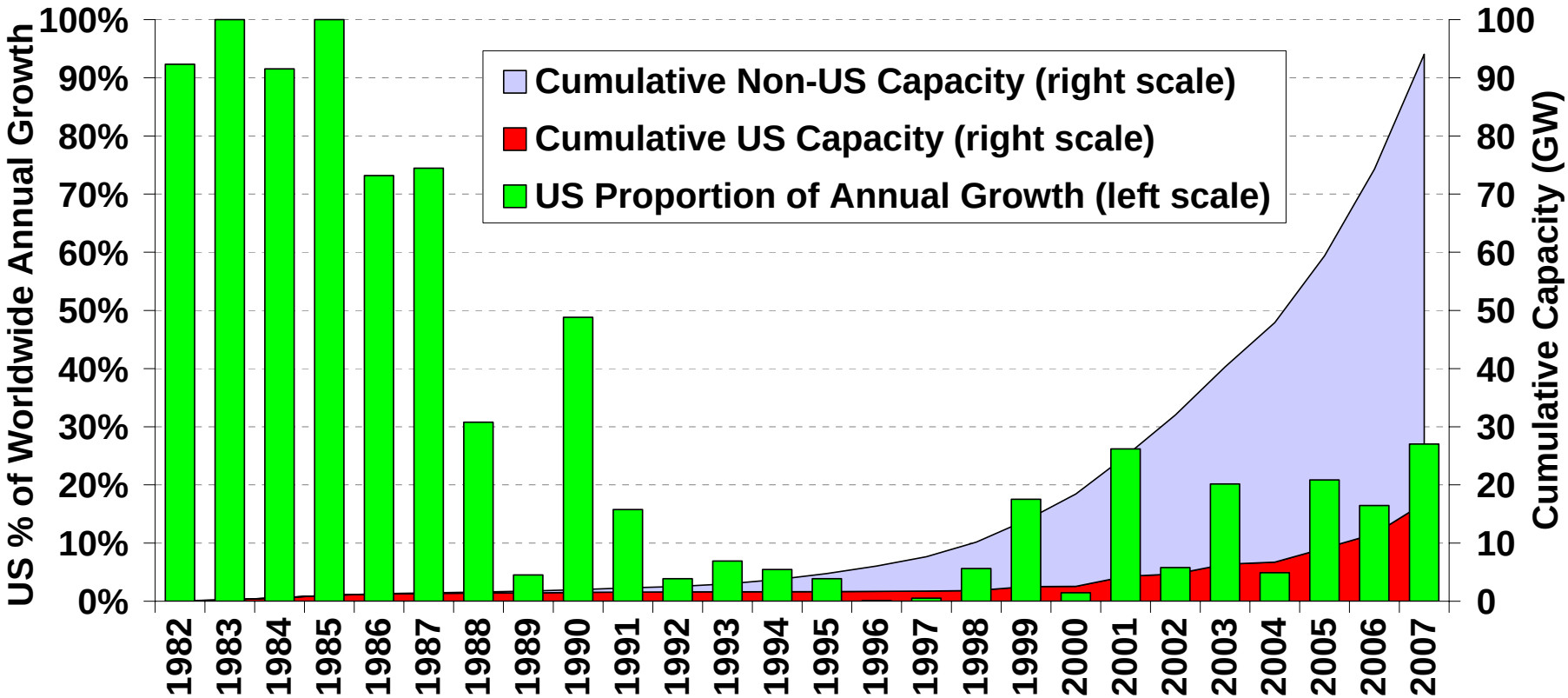
U.S. Led the World in 2007 Wind Capacity Additions; Second in Cumulative Capacity

Incremental Capacity (2007, MW)	
U.S.	**5,329**
China	3,287
Spain	3,100
Germany	1,667
India	1,617
France	888
Italy	603
Portugal	434
U.K.	427
Canada	386
Rest of World	2,138
TOTAL	**19,876**

Cumulative Capacity (end of 2007, MW)	
Germany	22,277
U.S.	**16,904**
Spain	14,714
India	7,845
China	5,875
Denmark	3,088
Italy	2,721
France	2,471
U.K.	2,394
Portugal	2,150
Rest of World	13,591
TOTAL	**94,030**

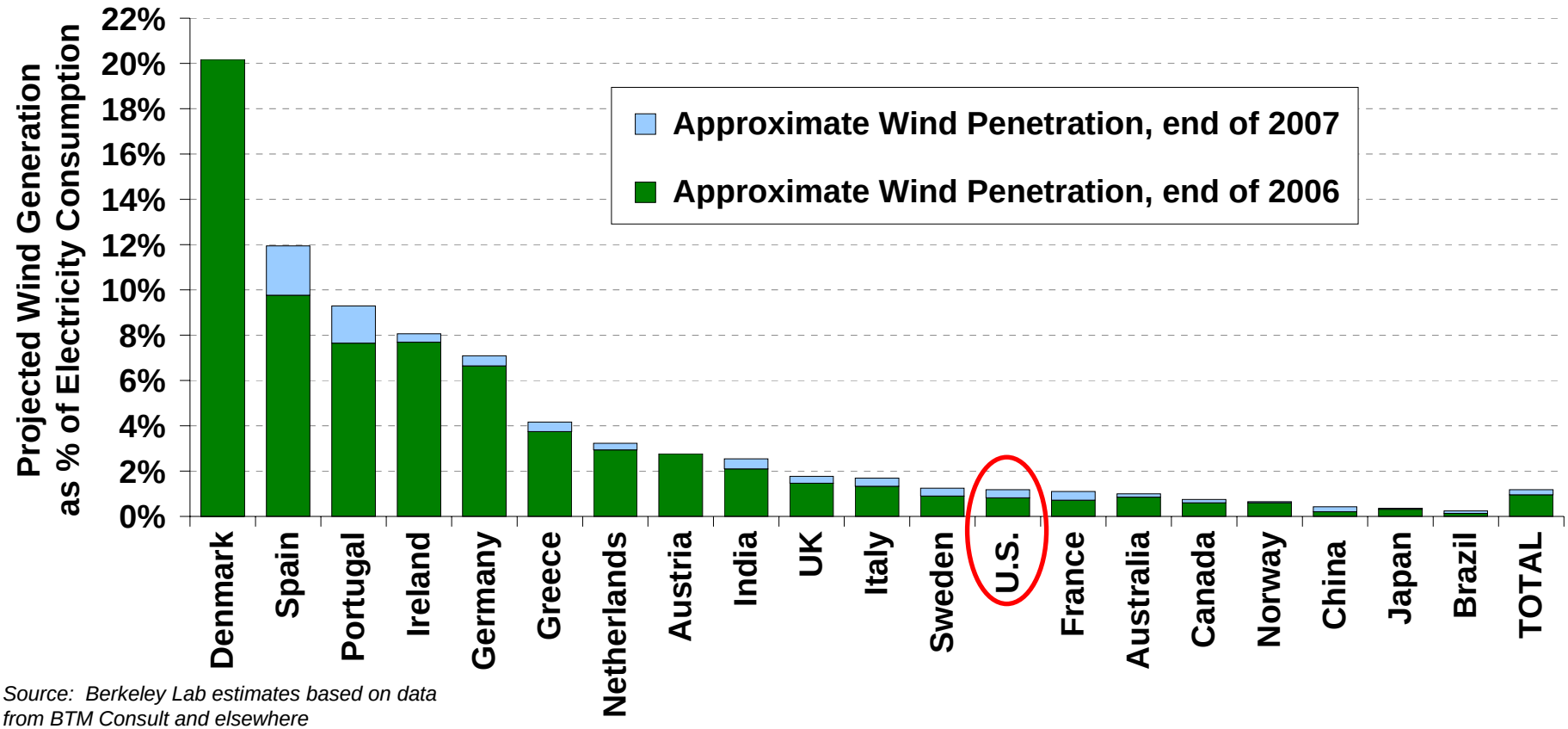
Source: BTM Consult; AWEA project database for U.S. capacity.

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



Source: Earth Policy Institute, BTM Consult, AWEA

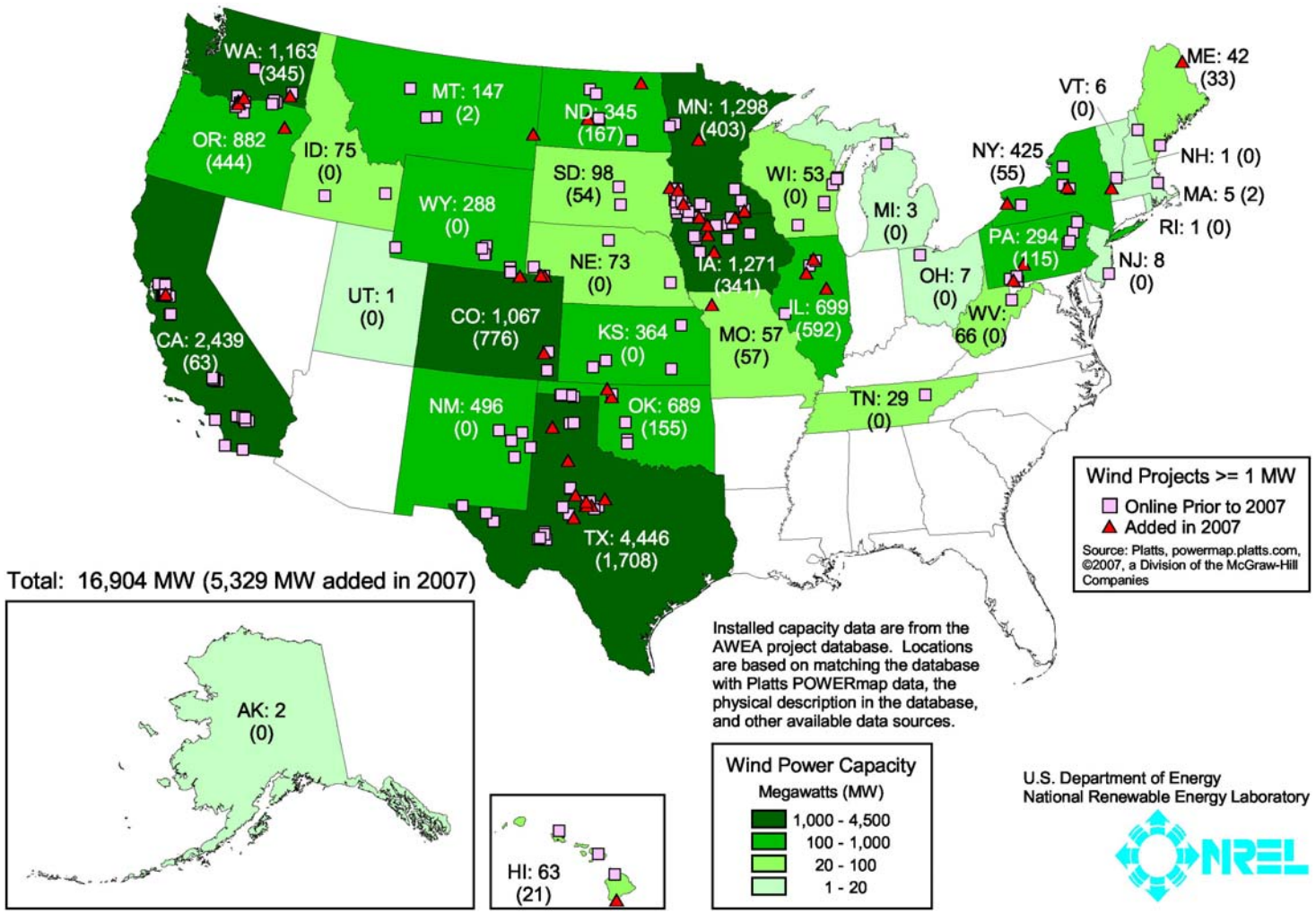
U.S Lagging Other Countries in Wind As a Percentage of Electricity Consumption



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)	
Texas	1,708
Colorado	776
Illinois	592
Oregon	444
Minnesota	403
Washington	345
Iowa	341
North Dakota	167
Oklahoma	155
Pennsylvania	115
California	63
Missouri	57
New York	55
South Dakota	54
Maine	33
Hawaii	21
Massachusetts	2
Montana	2
Rest of U.S.	0
TOTAL	**5,329**

Cumulative Capacity (end of 2007, MW)	
Texas	4,446
California	2,439
Minnesota	1,298
Iowa	1,271
Washington	1,163
Colorado	1,067
Oregon	882
Illinois	699
Oklahoma	689
New Mexico	496
New York	425
Kansas	364
North Dakota	345
Pennsylvania	294
Wyoming	288
Montana	147
South Dakota	98
Idaho	75
Nebraska	73
West Virginia	66
Rest of U.S.	277
TOTAL	**16,904**

Estimated Percentage of In-State Generation	
Minnesota	7.5%
Iowa	7.5%
Colorado	6.1%
South Dakota	6.0%
Oregon	4.4%
New Mexico	4.0%
North Dakota	3.8%
Oklahoma	3.0%
Texas	3.0%
Washington	2.8%
California	2.8%
Kansas	2.3%
Hawaii	2.3%
Montana	1.9%
Wyoming	1.7%
Idaho	1.5%
Illinois	0.8%
Maine	0.8%
New York	0.7%
Nebraska	0.7%
Rest of U.S.	0.05%
TOTAL	**1.1%**

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

- 16 states had >100 MW of wind capacity at the end of 2007 (9 had >500 MW)
- TX widened its lead over CA in cumulative wind capacity
- Neither TX nor CA was in the top tier of states for wind as a % of in-state generation
- 6 states have in-state wind generation that exceeds 4% of total in-state generation: MN, IA, CO, SD, OR, NM

Wind Now >10% of Some Utilities' Sales

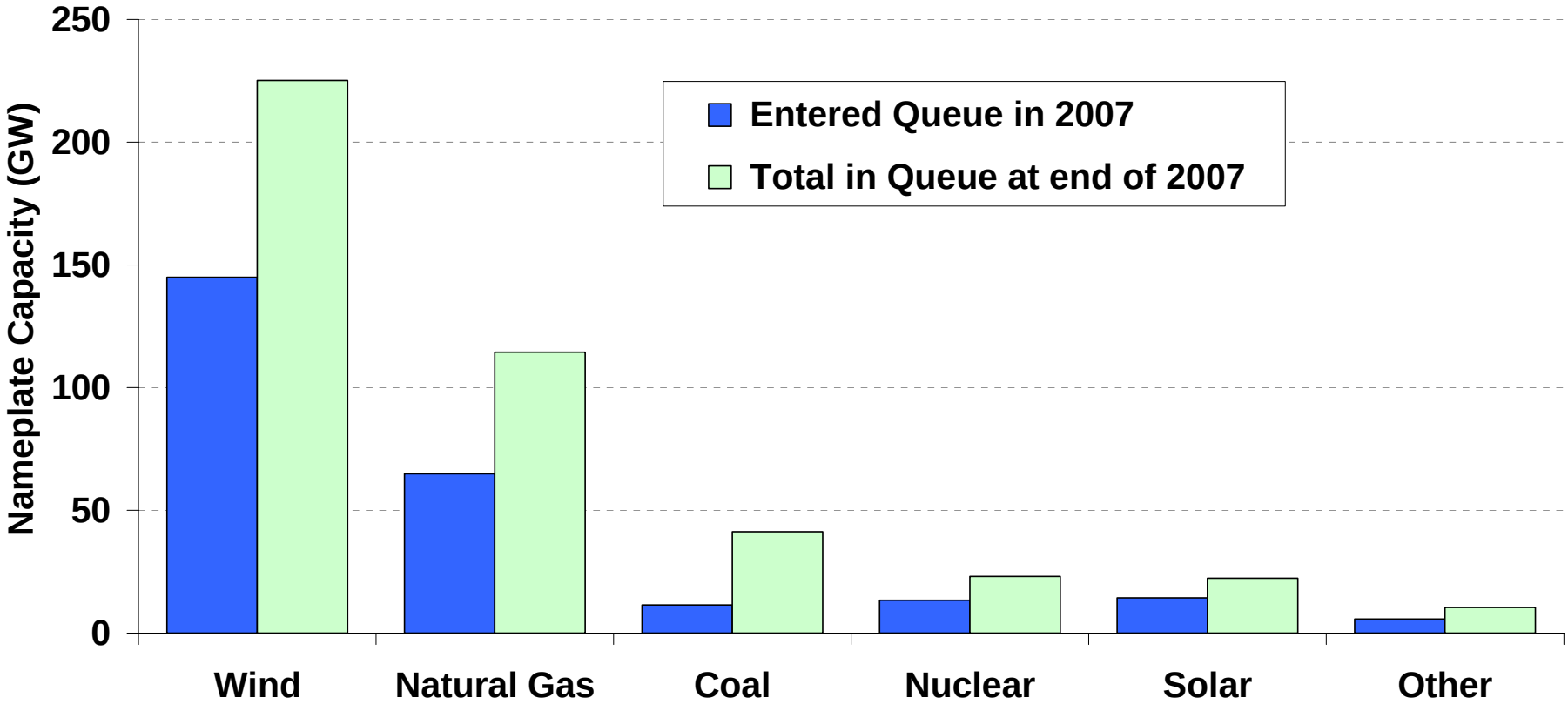
Total Wind Capacity (end of 2007, MW)	
Xcel Energy	2,635
MidAmerican Energy	1,201
Southern California Edison	1,026
Pacific Gas & Electric	878
Luminant	704
American Electric Power	543
CPS Energy	501
Puget Sound Energy	428
Alliant Energy	378
Exelon Energy	342
Austin Energy	274
Portland General Electric	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.

>225 GW of Wind in Interconnection Queues



Source: Exeter Associates review of interconnection queues

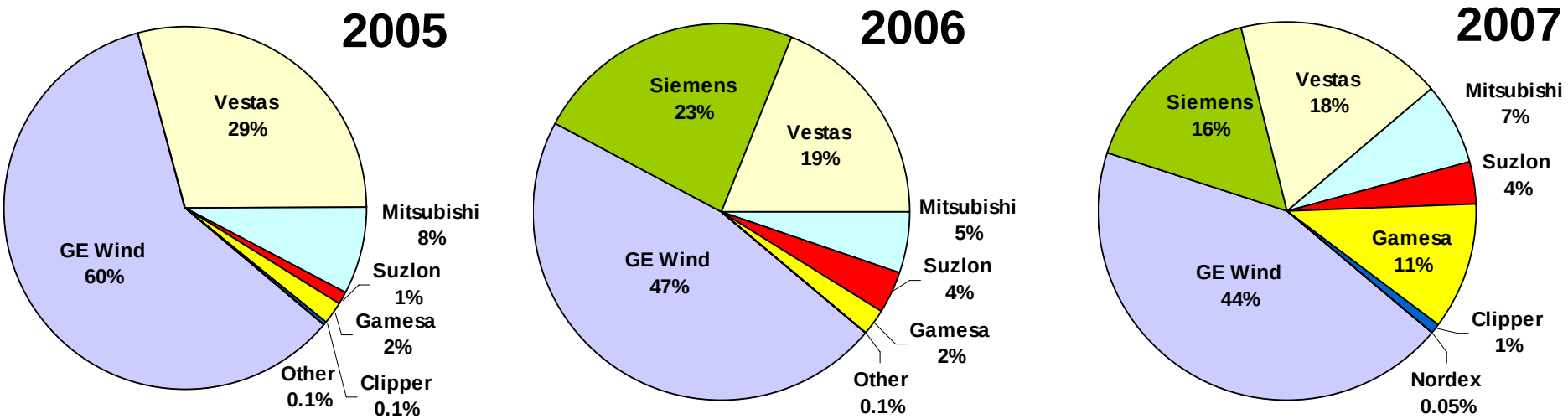
- MISO (66 GW), ERCOT (41 GW), and PJM (35 GW) make up 2/3 of total
- Twice as much wind as next largest resource (natural gas) in queues
- ***Not all of this capacity will be built….***

Interest in Offshore Wind Continues in the U.S., but No Such Projects Are Yet Online

State	Proposed Offshore Wind Capacity
Massachusetts	783 MW
Delaware	450 MW
New Jersey	350 MW
New York	160 MW
Texas	150 MW
Ohio	20 MW
Georgia	10 MW
TOTAL	**1,923 MW**

- All wind projects installed in the U.S. to date are land-based
- Some interest exists in offshore wind in several parts of the U.S.
- Several projects were put at risk in 2007 due to concerns about high and uncertain costs
- Projects presented in table to right are in various stages of development

GE Remained the Dominant Turbine Vendor

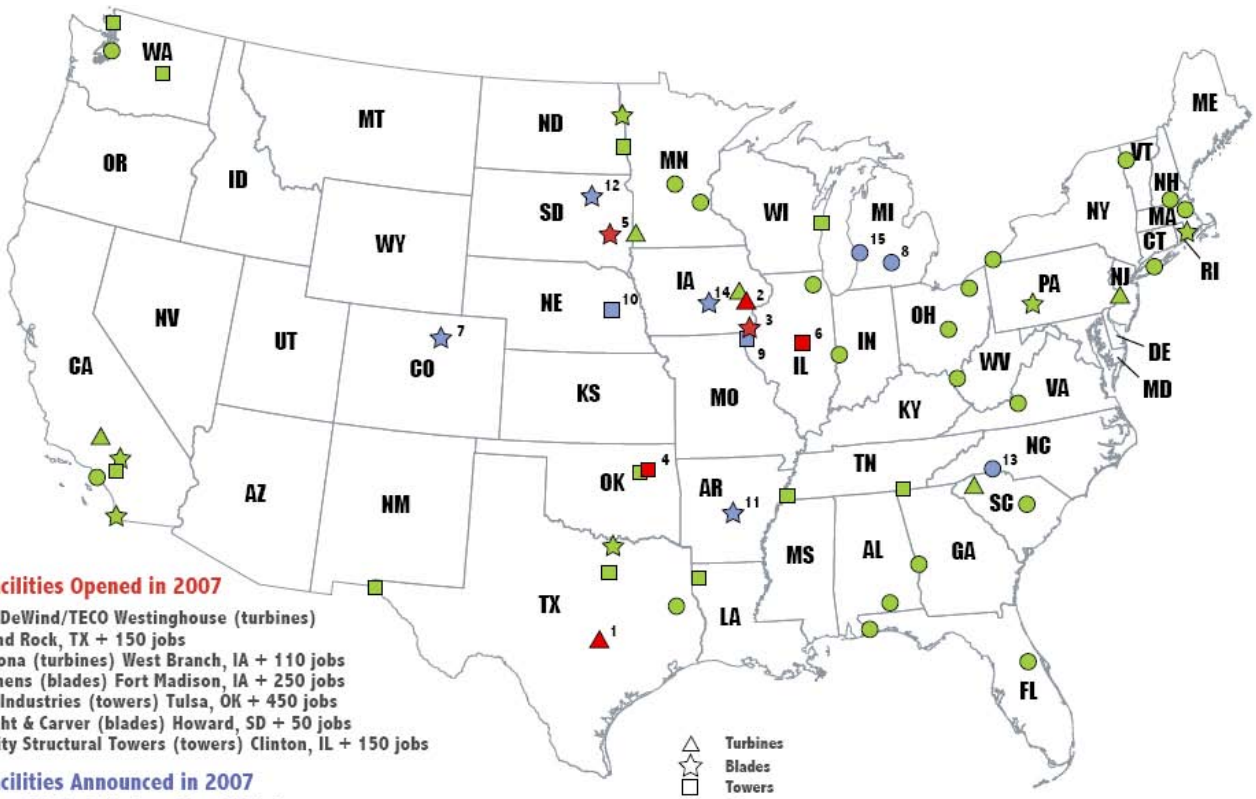


Source: AWEA project database

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



New Facilities Opened in 2007

1. CTC-DeWind/TECO Westinghouse (turbines) Round Rock, TX + 150 jobs
2. Acciona (turbines) West Branch, IA + 110 jobs
3. Siemens (blades) Fort Madison, IA + 250 jobs
4. DMI Industries (towers) Tulsa, OK + 450 jobs
5. Knight & Carver (blades) Howard, SD + 50 jobs
6. Trinity Structural Towers (towers) Clinton, IL + 150 jobs

New Facilities Announced in 2007

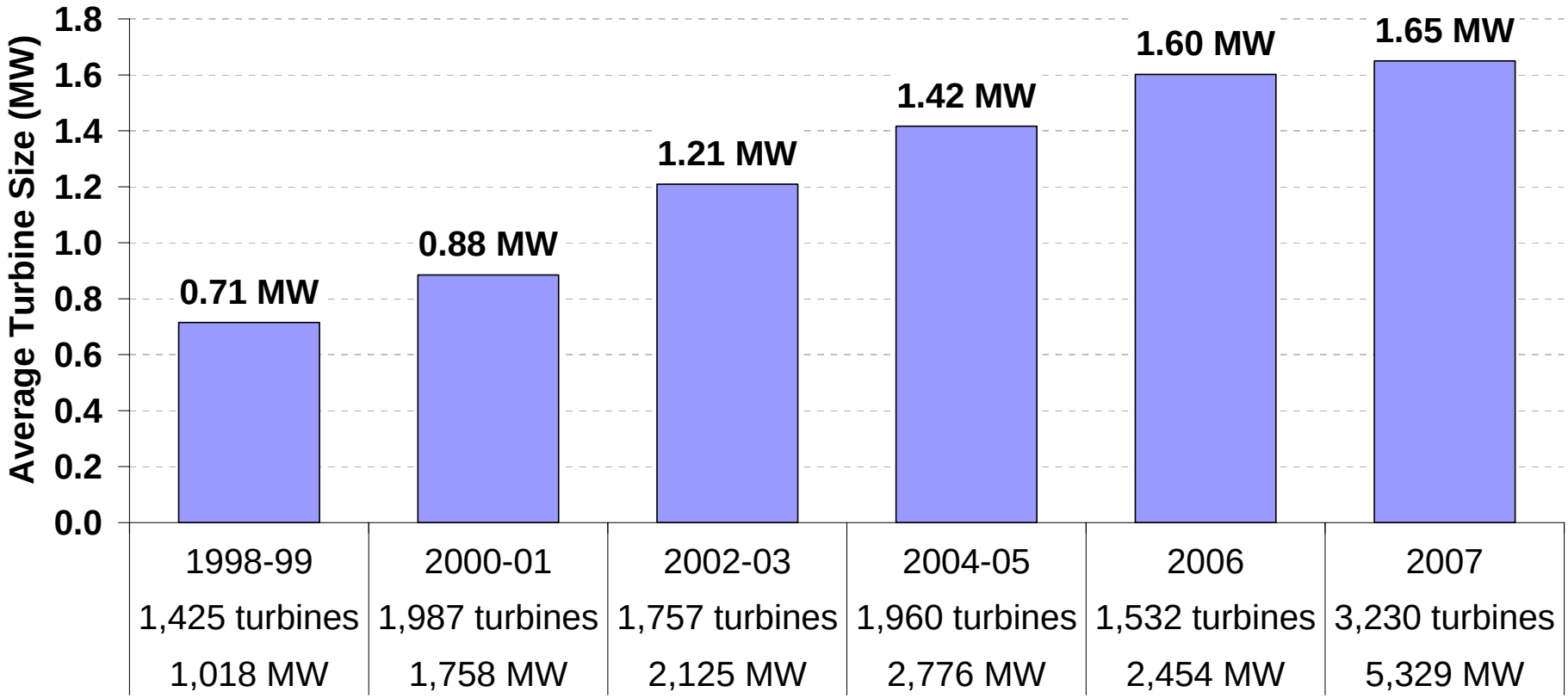
7. Vestas (blades) Windsor, CO + 650 jobs
8. Dowding Industries (turbine components) Eaton Rapids, MI + 200 jobs
9. Hendricks Industries (towers) Keokuk, IA + 350 jobs
10. Katana Summit (towers) Columbus, NE + 120 jobs
11. LM Glasfiber (blades) Little Rock, AR + 1,000 jobs
12. Molded Fiberglass (blades) Aberdeen, SD + 750 jobs
13. PPG Industries (fiberglass) Shelby, NC + not available
14. TPI Composites (blades) Newton, IA + 500 jobs
15. Genzink Steel (nacelles) Holland, MI + 10 jobs

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.

This map was created by The National Renewable Energy Laboratory for the U.S. Department of Energy April 16, 2008

Note: Map is not intended to be exhaustive

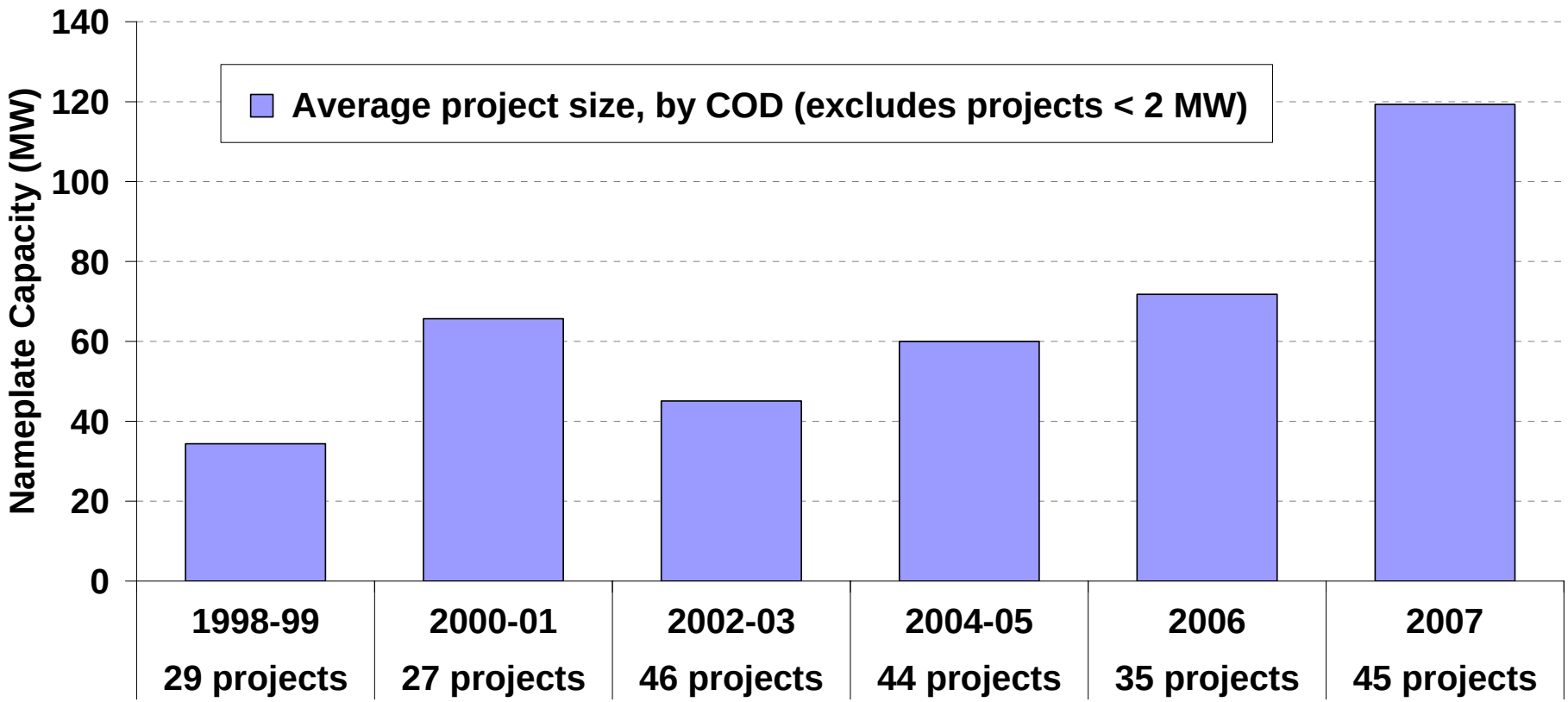
Average Turbine Size Continued to Grow



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

Developer Consolidation Continued at a Torrid Pace

- Acquisition and investment activity 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, foreign companies have entered the U.S. wind development business in recent years

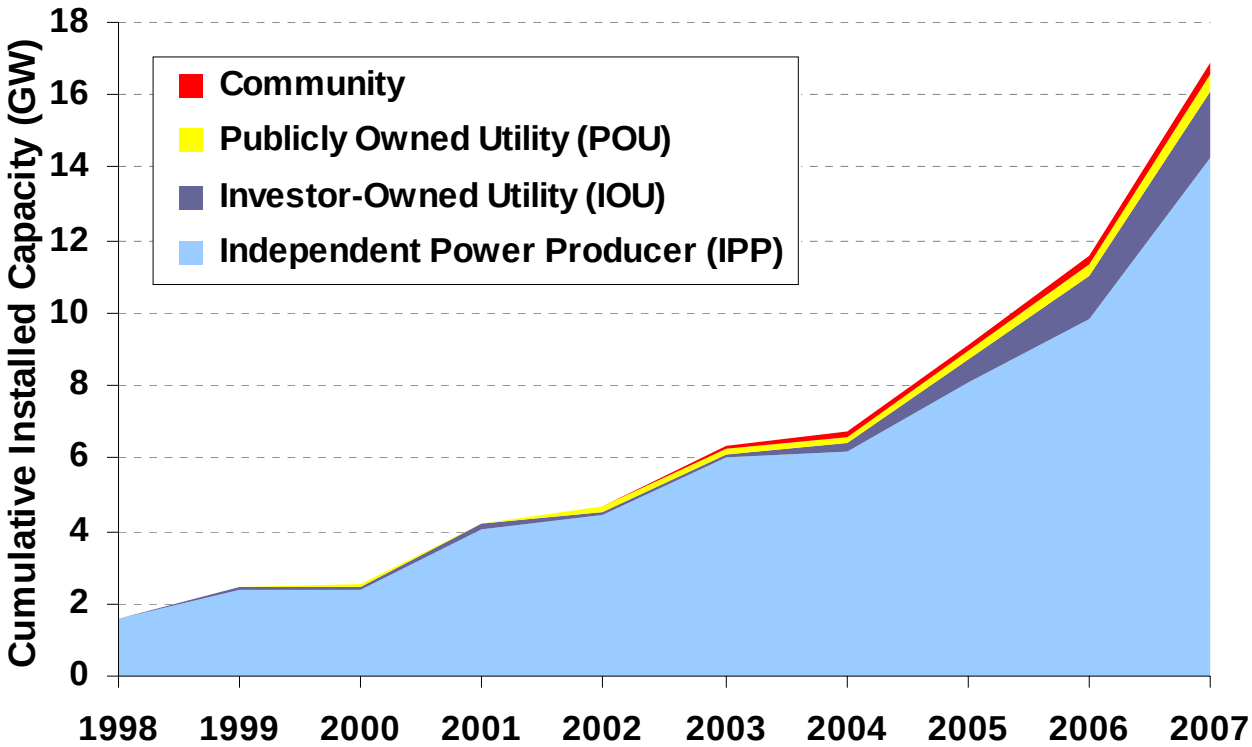
Investor	Transaction Type	Developer	Announced
EDF (SIIF Energies)	Acquisition	enXco	May-02
Gamesa	Investment	Navitas	Oct-02
AES	Investment	US Wind Force	Sep-04
PPM (Scottish Power)	Acquisition	Atlantic Renewable Energy Corp.	Dec-04
AES	Acquisition	SeaWest	Jan-05
Goldman Sachs	Acquisition	Zilkha (Horizon)	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

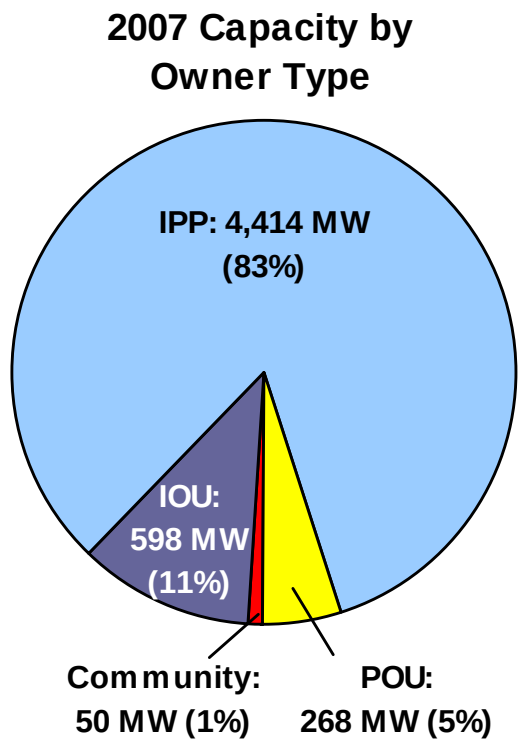
* Select list of announced transactions; excludes joint development activity.
Source: Berkeley Lab.

Comfort With and Use of Innovative Financing Structures Increased

- IRS Revenue Procedure 2007-65 provides "safe harbor" guidelines for wind projects using "institutional investor flip" structure
  - More than a dozen institutional tax investors active in 2007
  - Some tax investors becoming comfortable with project-level debt
- 2007 also saw a first-of-its-kind tax equity structure geared towards municipal utilities and cooperatives (White Creek)
- But…growing dependence on 3rd-party tax investors has left the U.S. wind sector vulnerable to the global credit crisis
  - Institutional tax investors lately have fewer profits to shelter
  - Demand for affordable housing tax credits drying up, driving yields sharply higher – will this spillover into wind?

IPP Project Ownership Remained Dominant

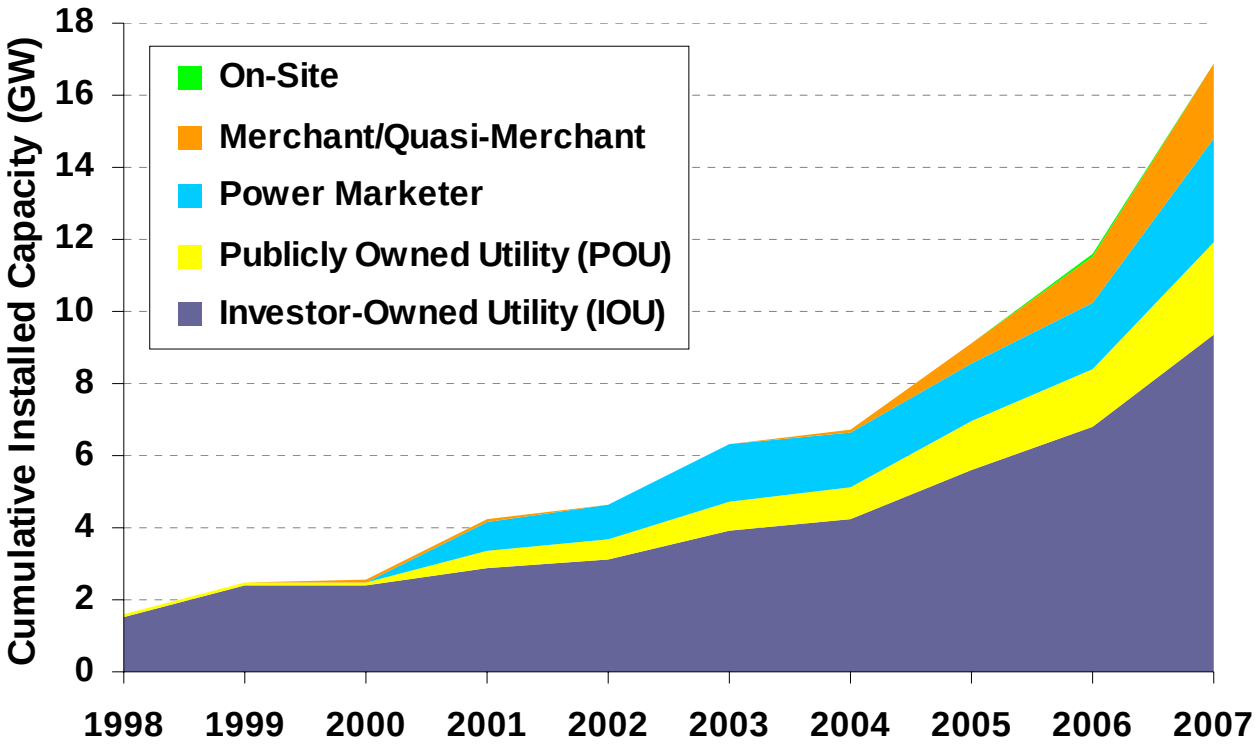


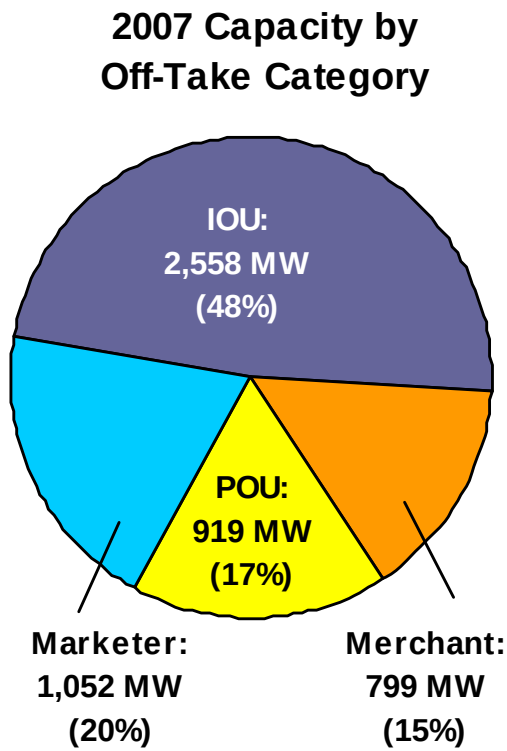


Source: Berkeley Lab estimates based on AWEA project database

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

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





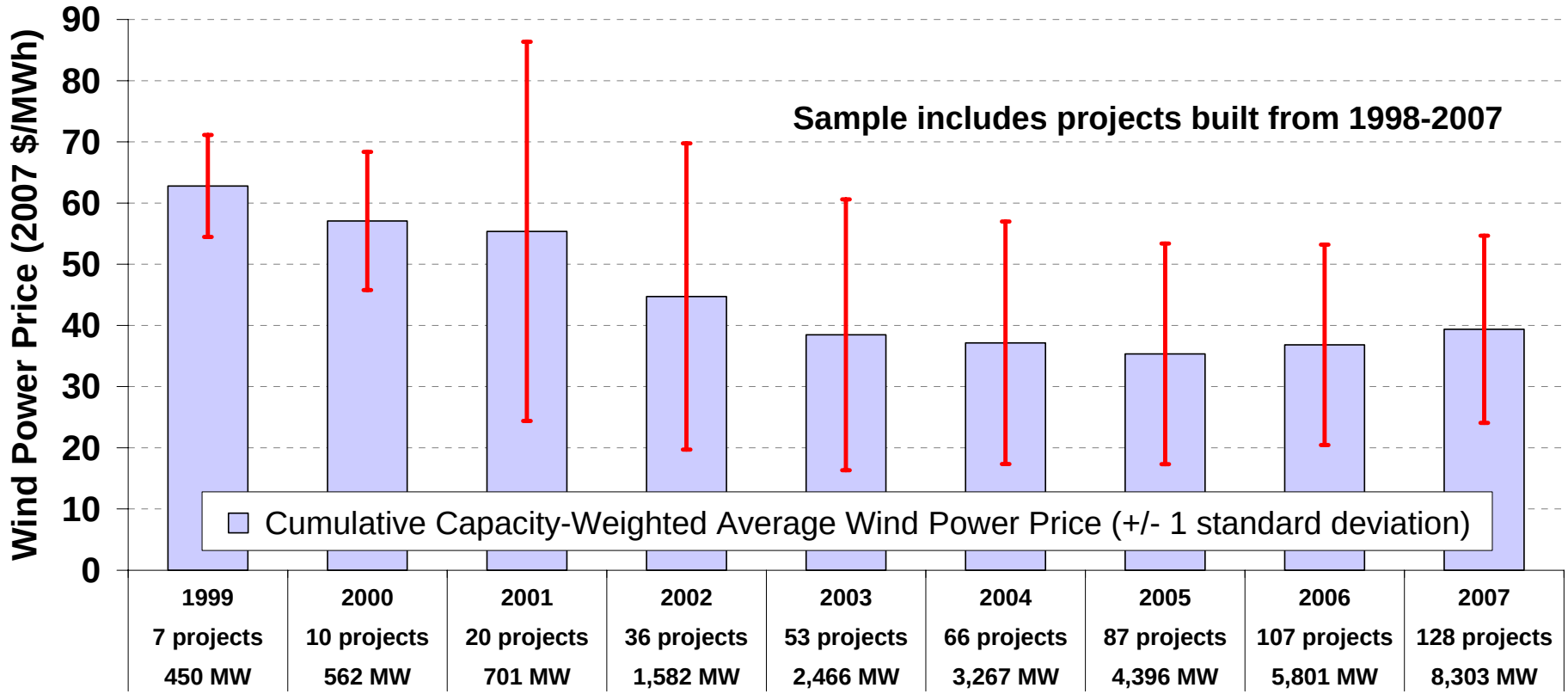
Source: Berkeley Lab estimates based on AWEA project database

- But sales to power marketers are becoming more prevalent
- So are "merchant" plants – primarily in TX and NY

Upward Pressure on Wind Power Prices Continued 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 over that timeframe)
- Prices reflect price of electricity as sold by project owner (i.e., busbar 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

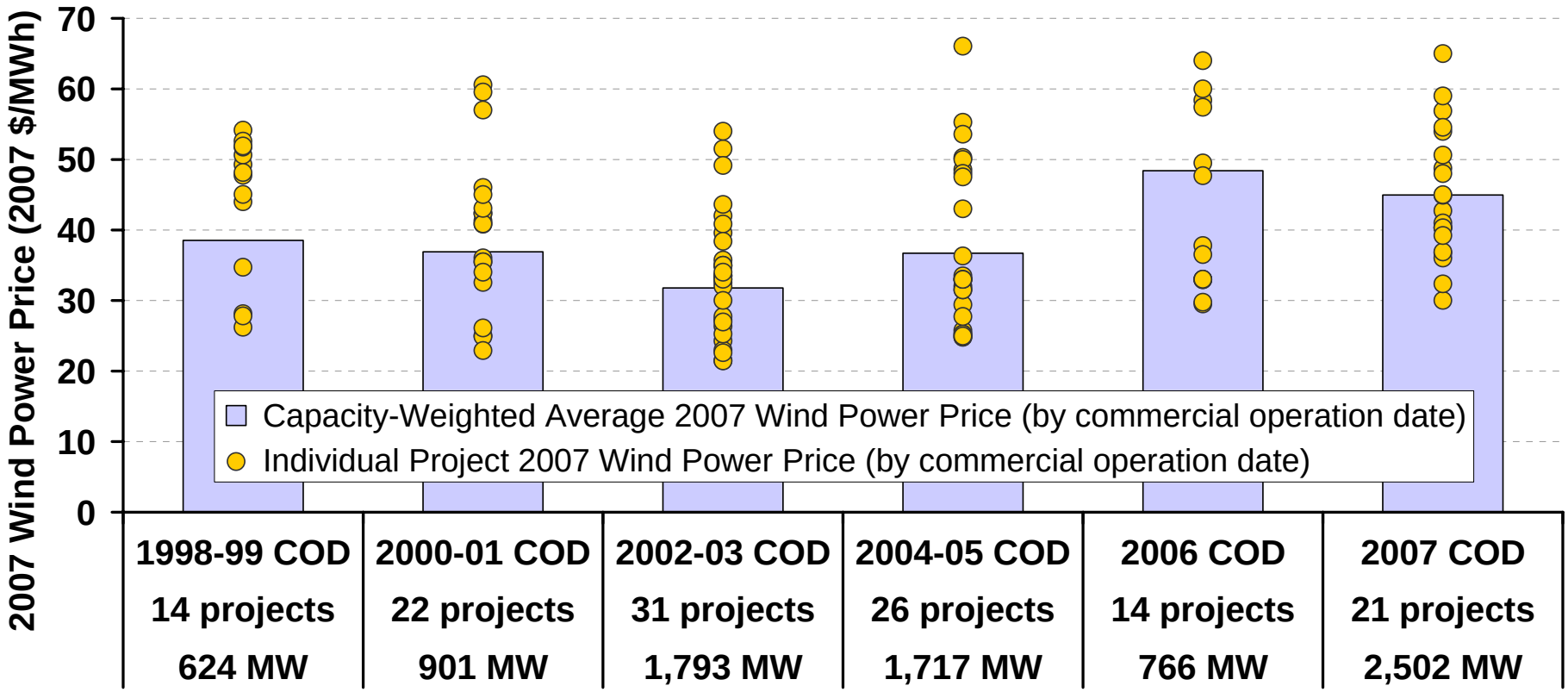
Cumulative Average Sales Price for Sample of Projects Built After 1997 Remains Low



Source: Berkeley Lab database

Small increases in 2006 and 2007 are due to rising prices from newly built projects, but cumulative nature of graphic mutes degree of price increase

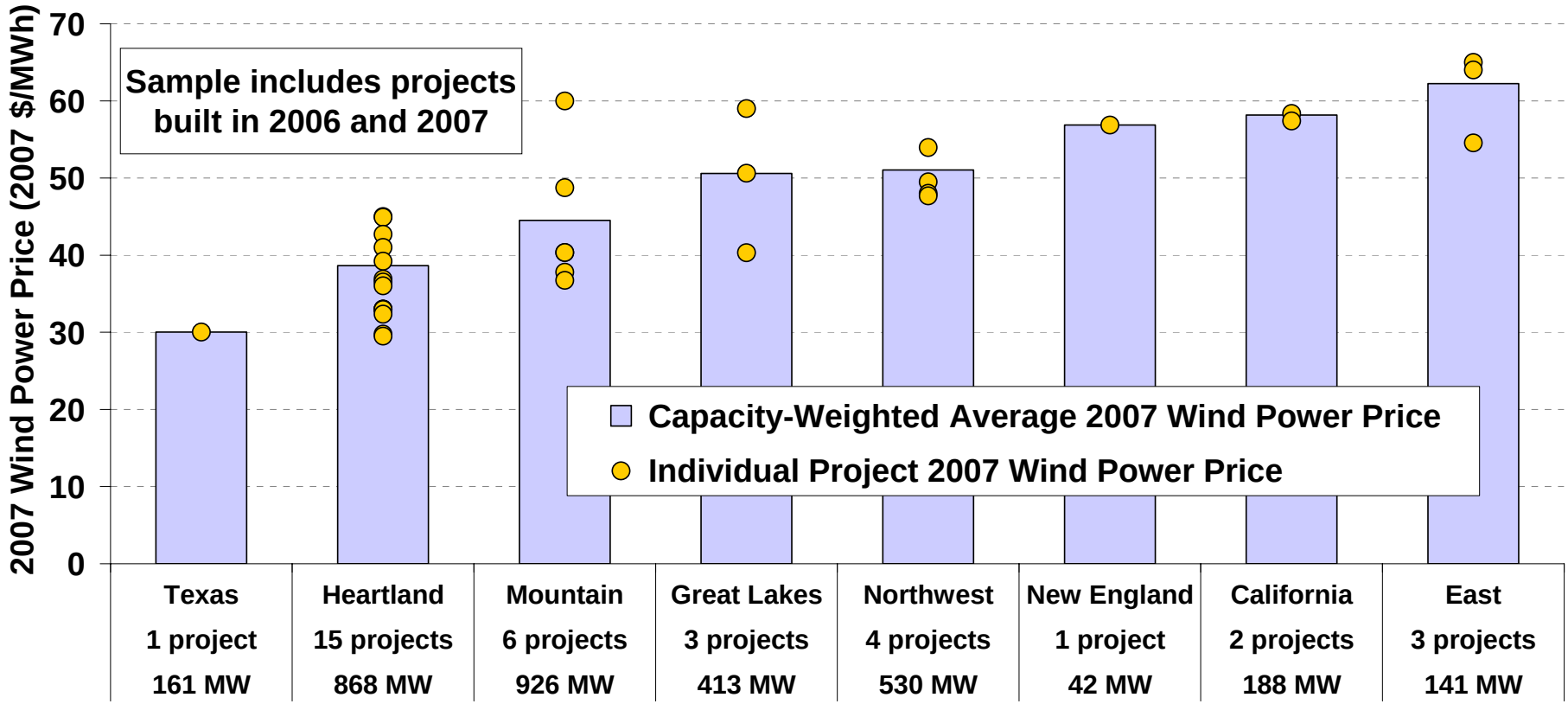
Binning by Commercial Operation Date Shows that Prices Have Increased Recently



Source: Berkeley Lab database

- Graphic shows prices in 2007 from projects built from 1998-2007
- Prices will likely rise further to more fully reflect turbine price increases

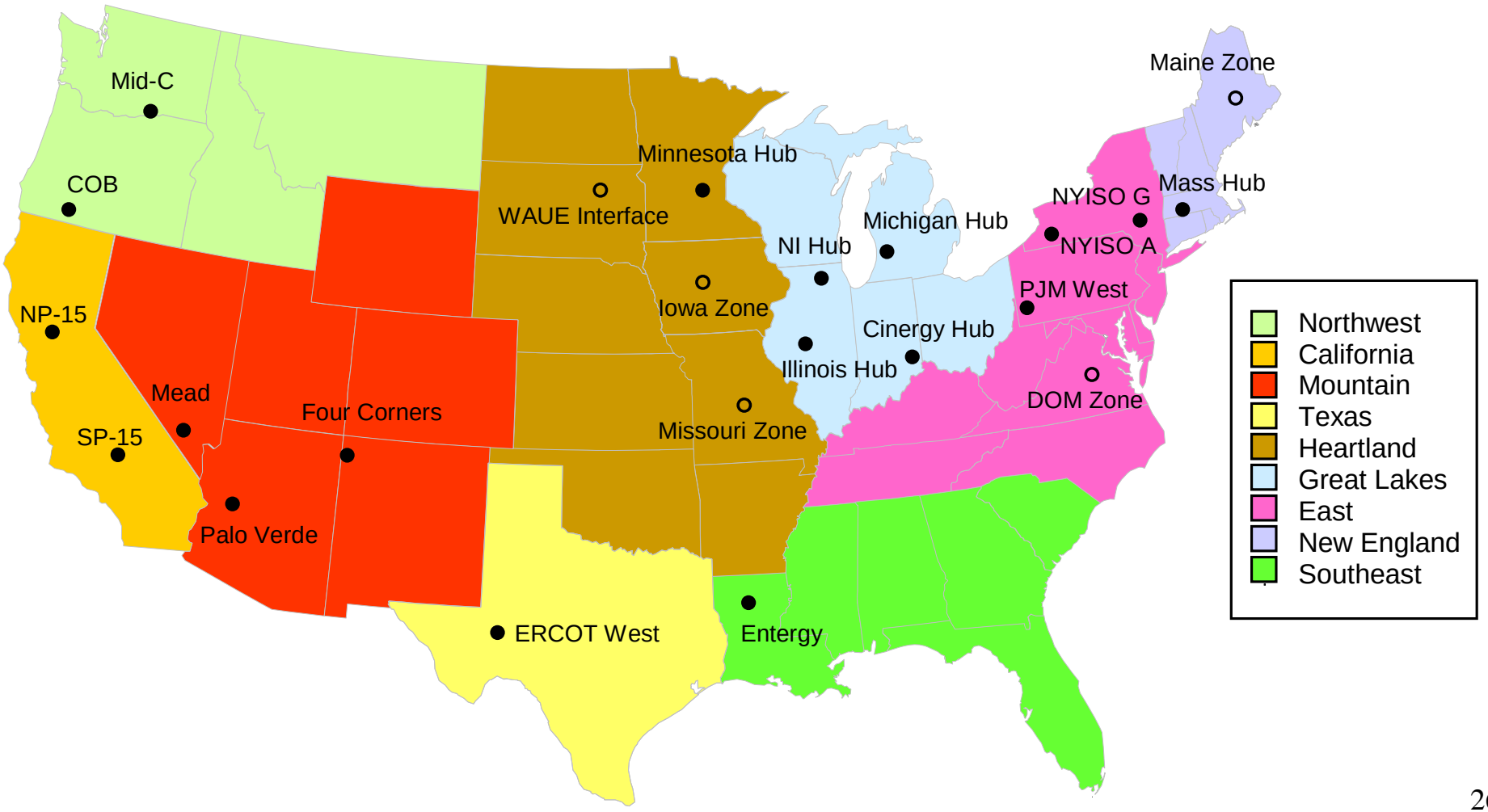
Regional Differences Explain Some of the Underlying Variability in Wind Sales Prices



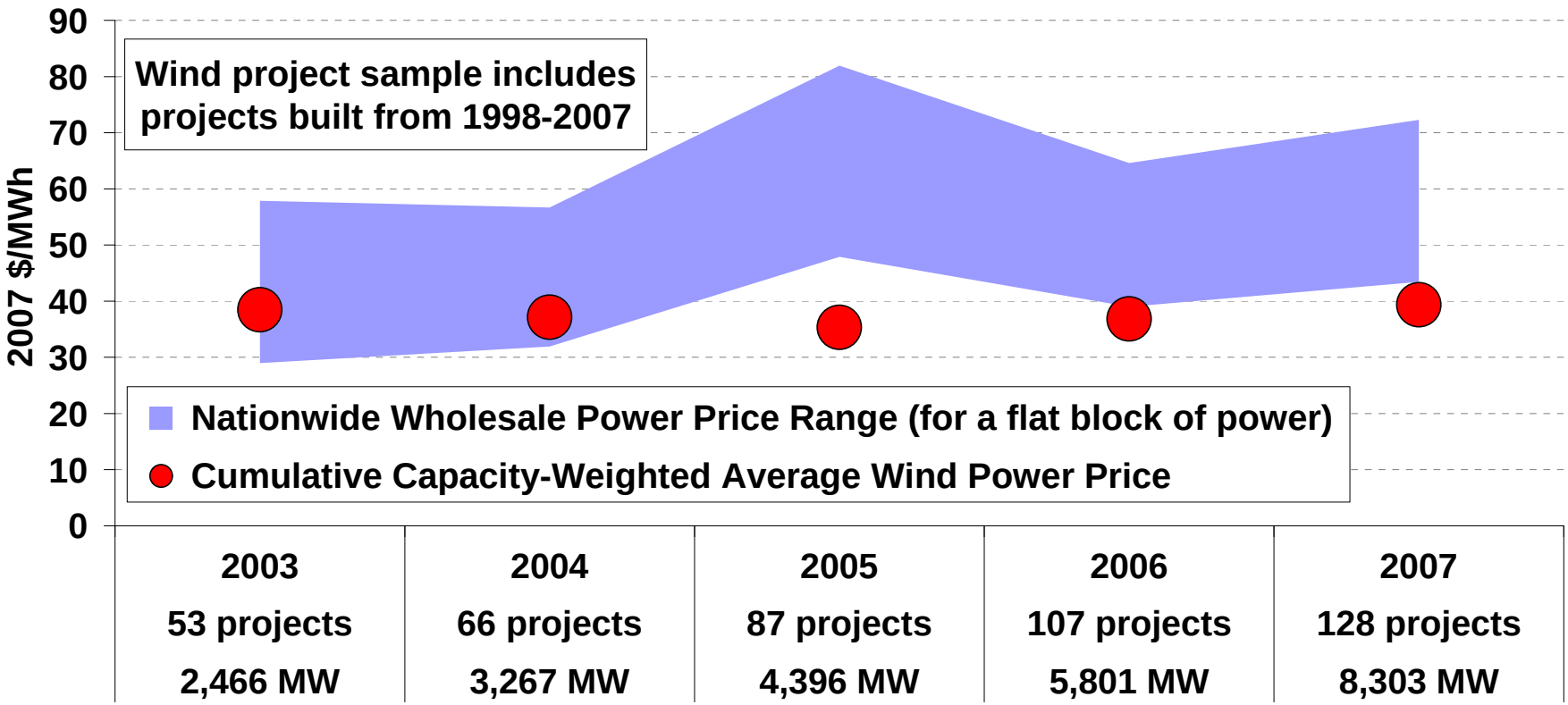
Source: Berkeley Lab database

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

Regions and Wholesale Price Hubs Used in Analysis



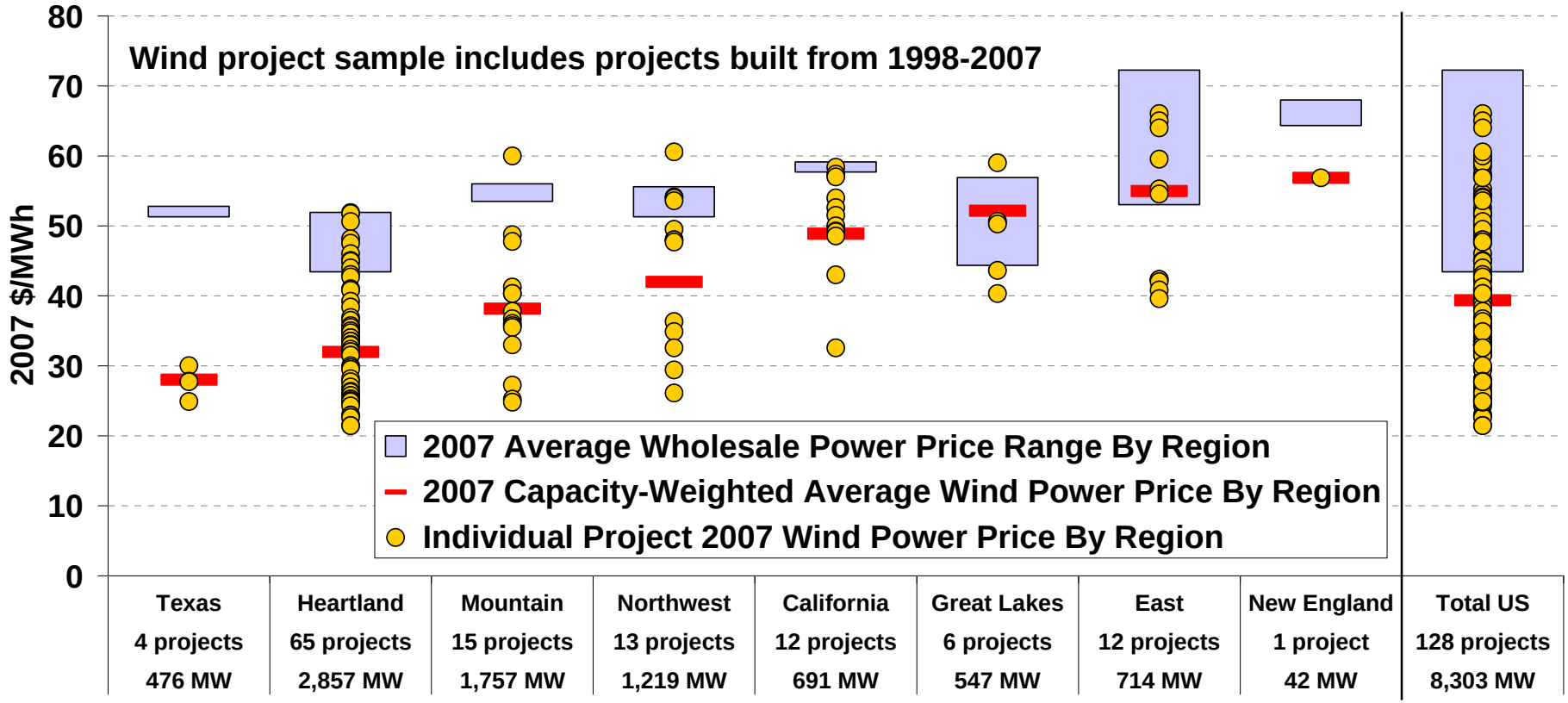
Wind Has Been Competitive with Wholesale Power Prices in Recent Years



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

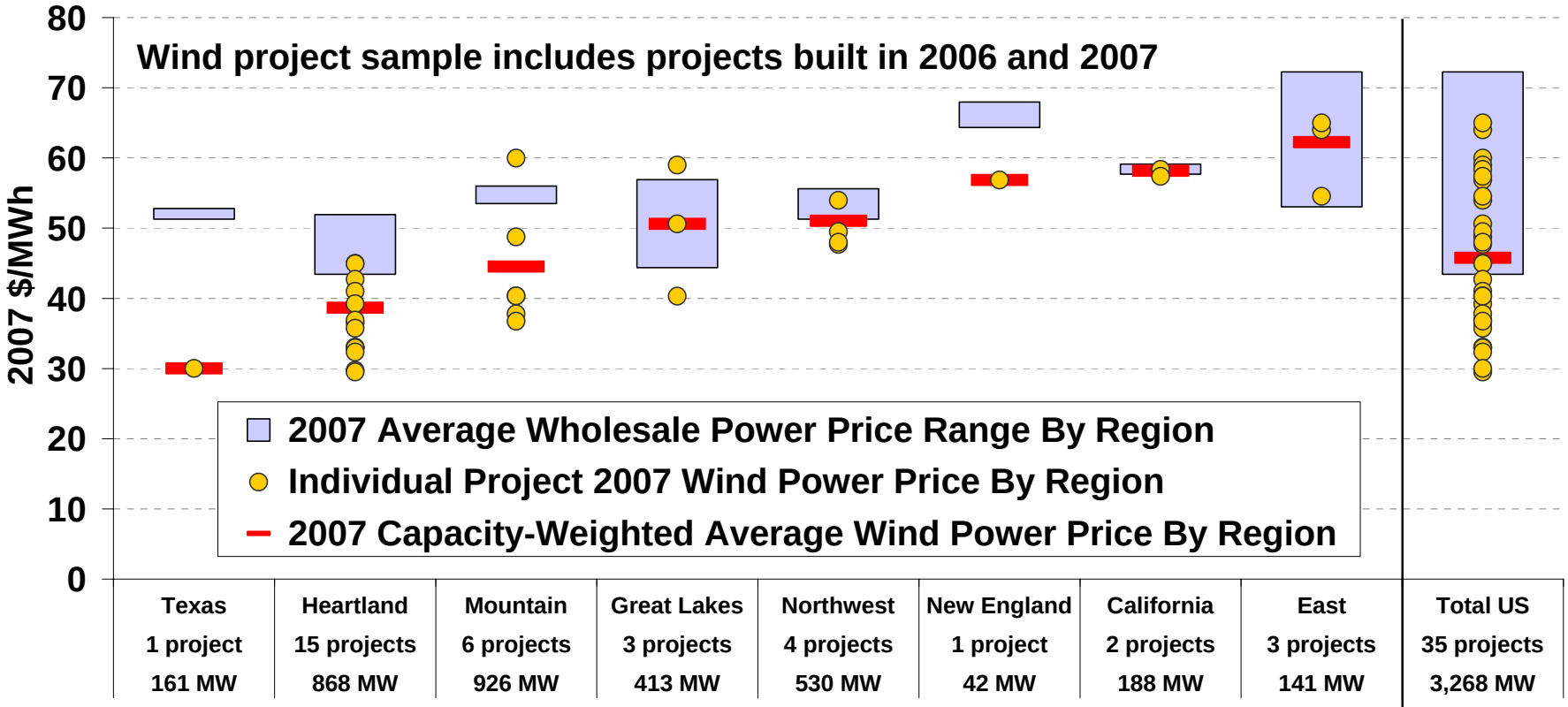
Wind Built After 1997 Was Competitive with Wholesale Prices in Most Regions in 2007



Source: Berkeley Lab database, Ventyx

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)

Focusing Just on Wind Projects Built in 2006 and 2007 Tells a More Cautious Story



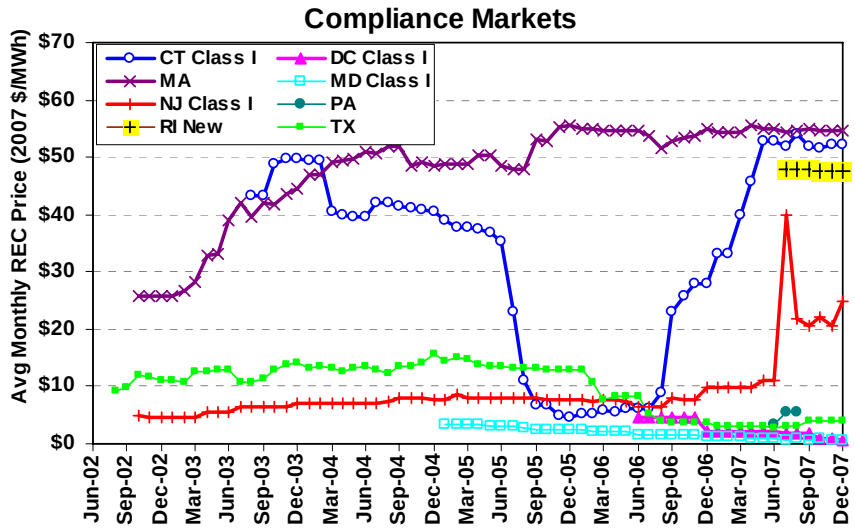
Source: Berkeley Lab database, Ventyx

The recent rise in wind prices is making wind somewhat less competitive in wholesale markets throughout the U.S., though wind prices remain at the lower end of the wholesale price range

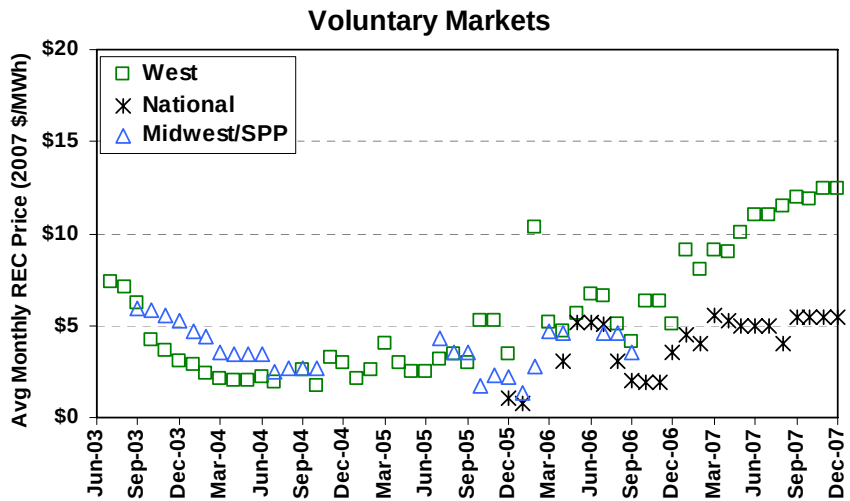
REC Markets Remain Fragmented and Volatile

Renewable energy certificate (REC) markets have experienced significant price variations by:

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

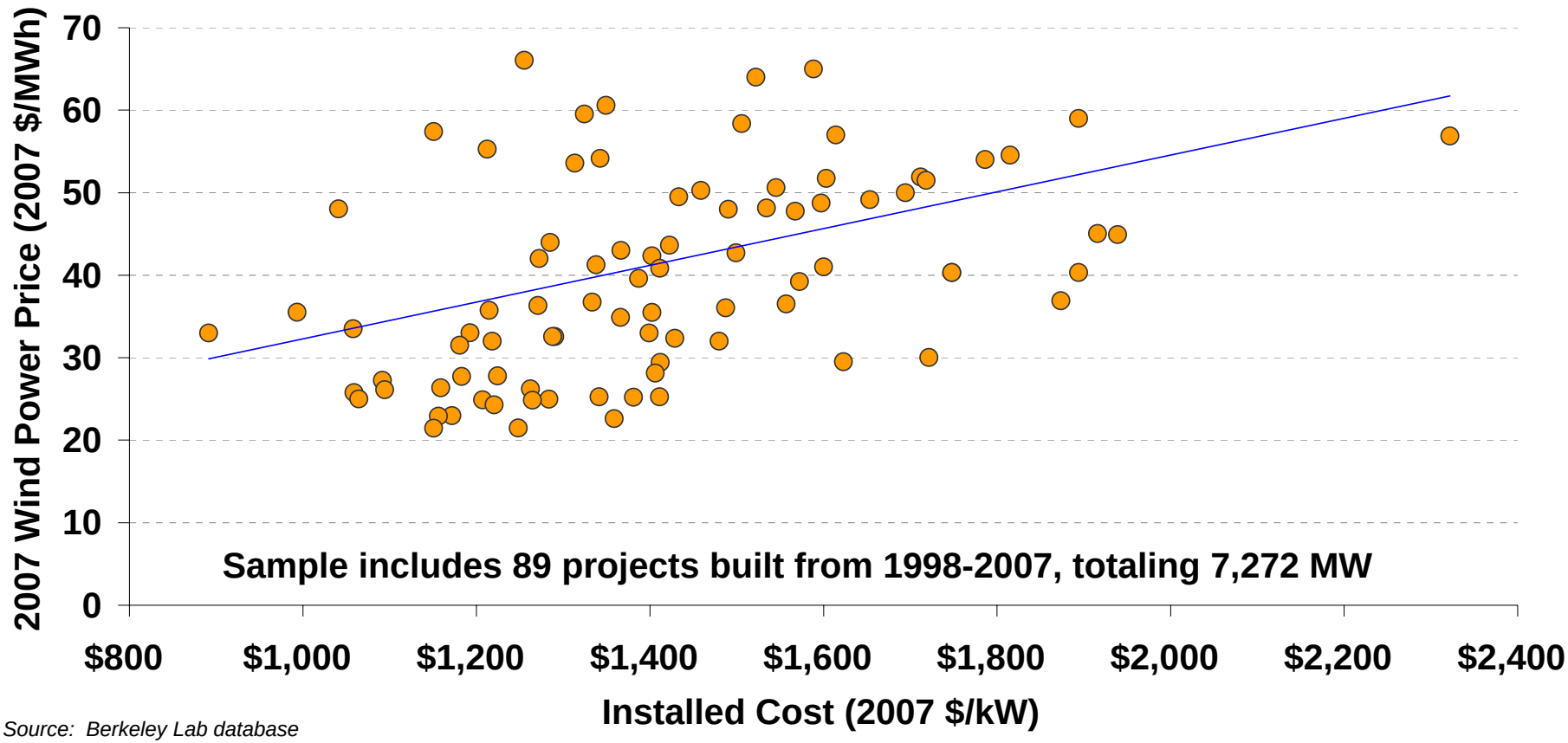


Source: Evolution Markets



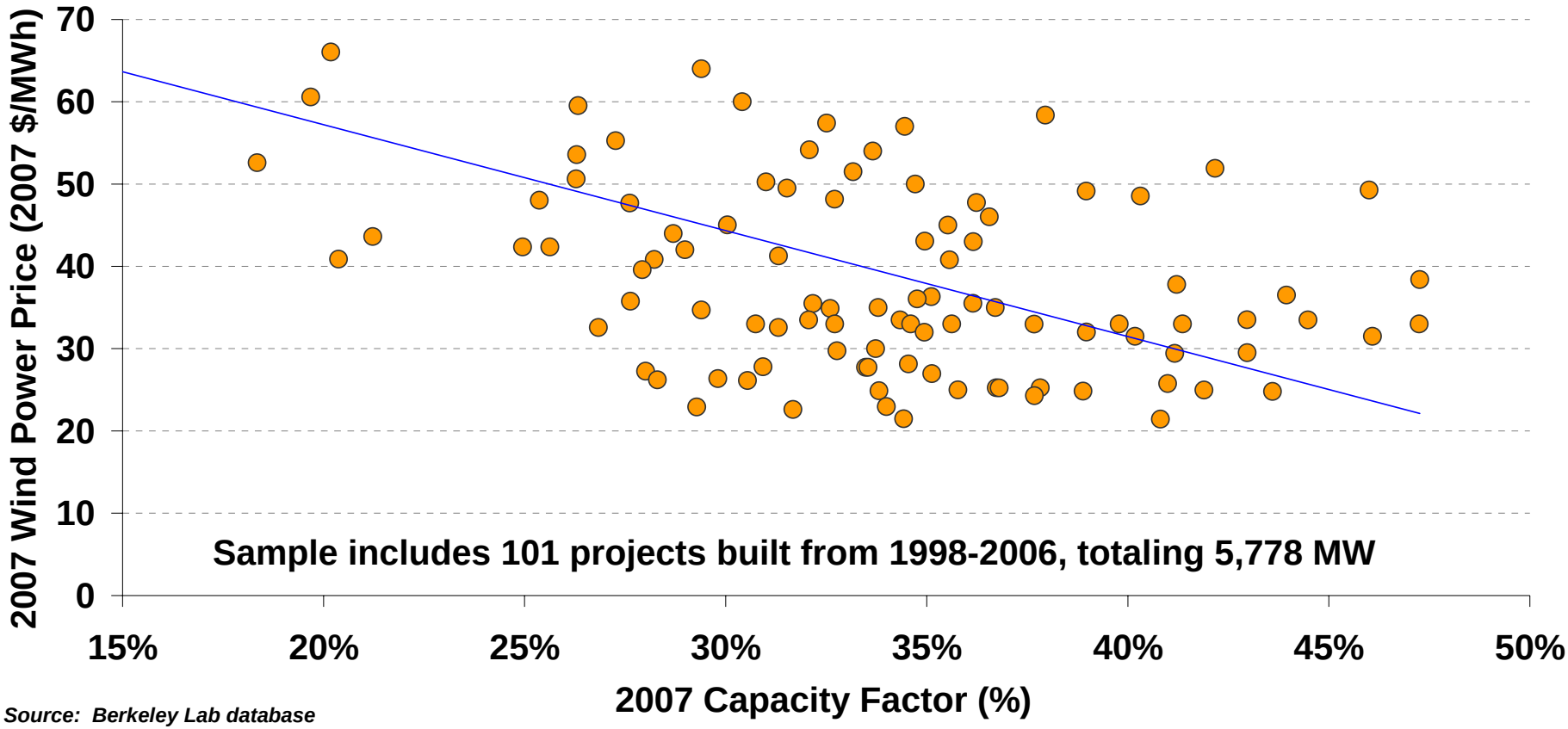
Source: Evolution Markets

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



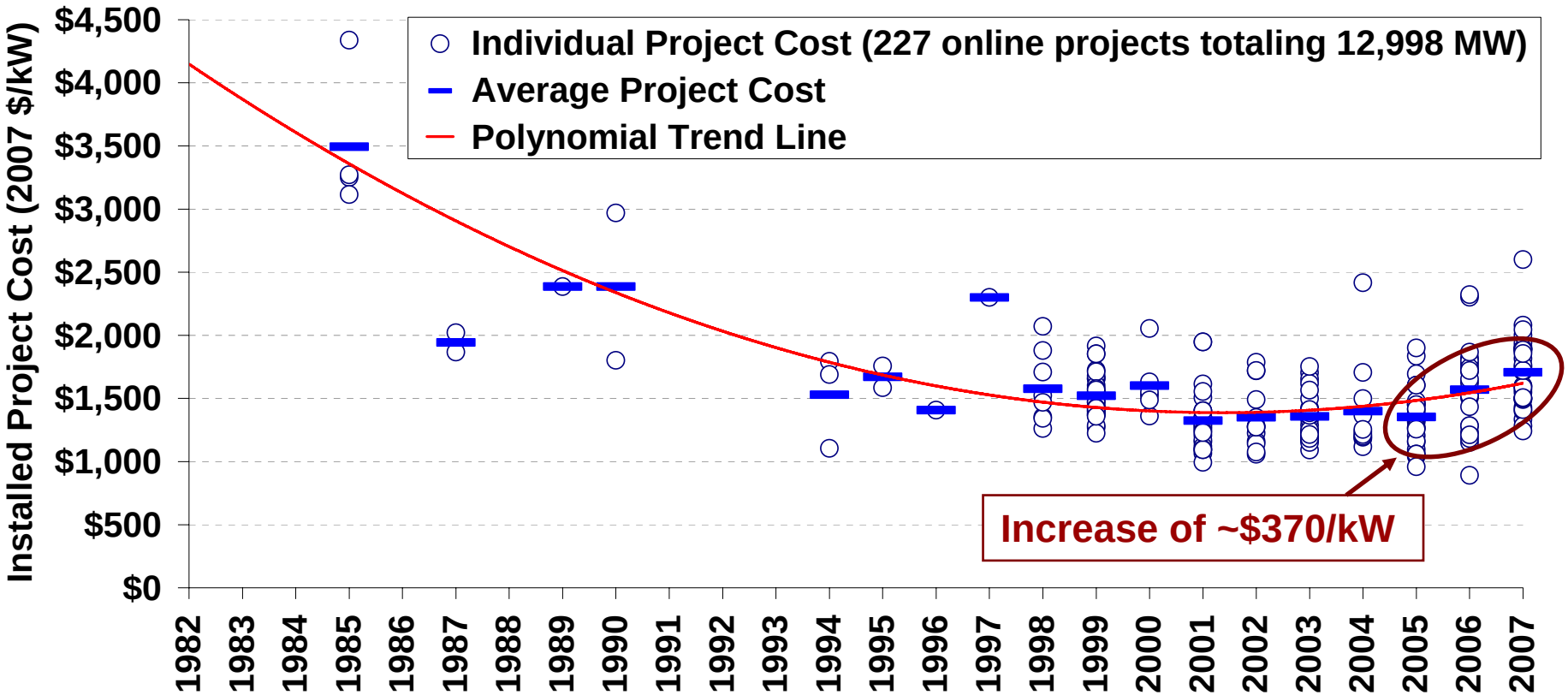
Source: Berkeley Lab database

...and by Project Performance



Source: Berkeley Lab database

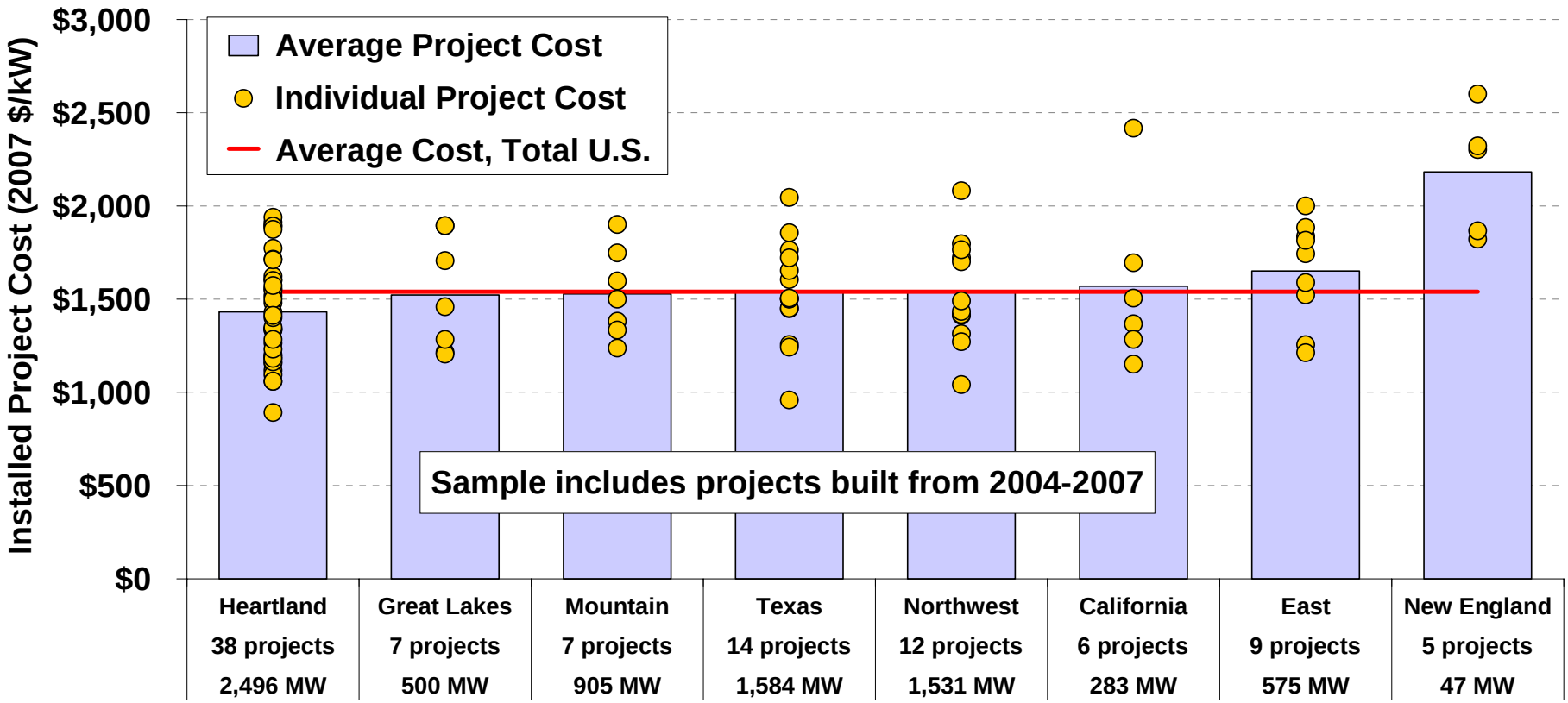
Installed Project Costs Are On the Rise, After a Long Period of Decline



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

Projects proposed for construction in 2008 (not shown in graphic) are ~$210/kW higher still (averaging ~$1,920/kW)

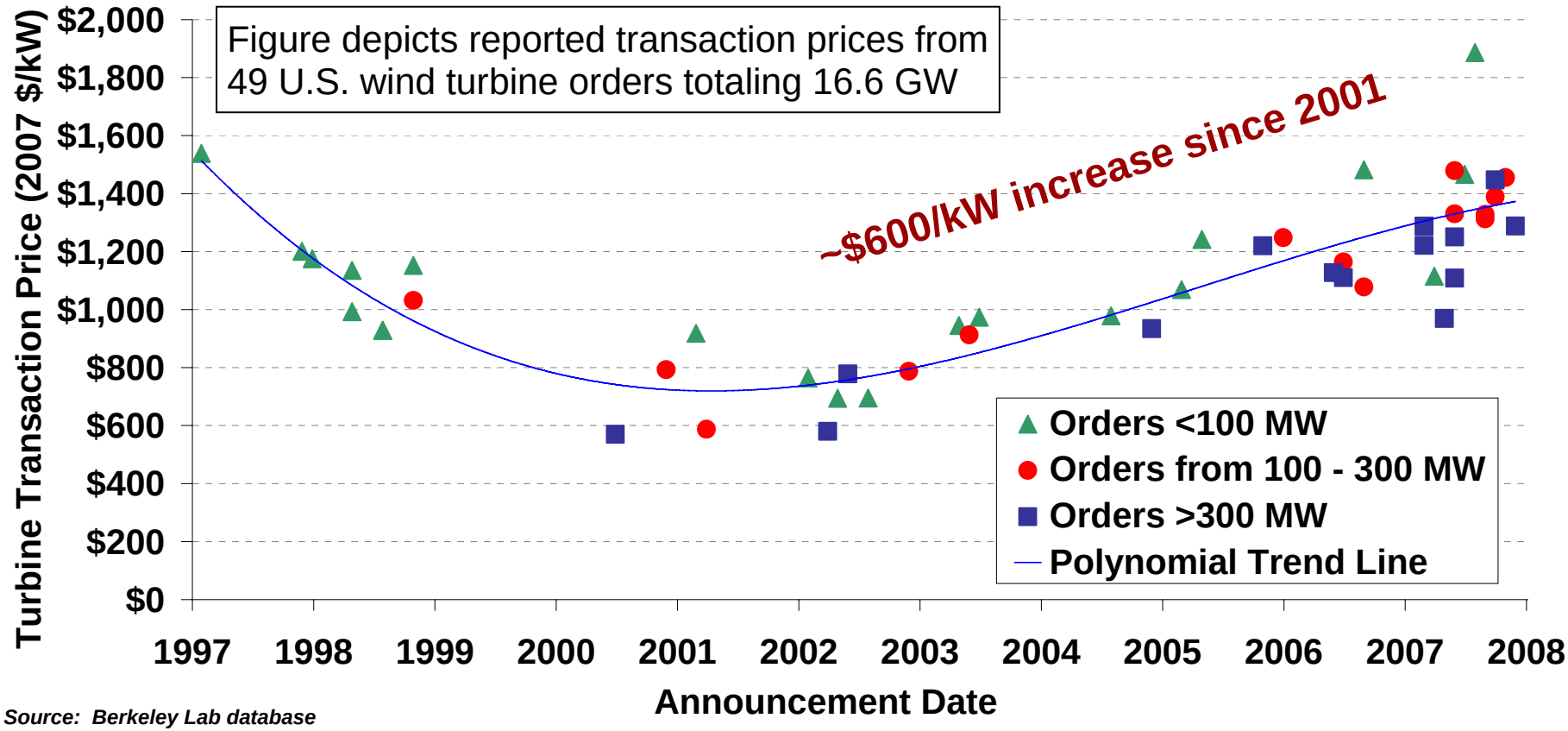
Regional Differences in Wind Project Costs Are Apparent



Source: Berkeley Lab database

Heartland low-cost region, East and New England high-cost

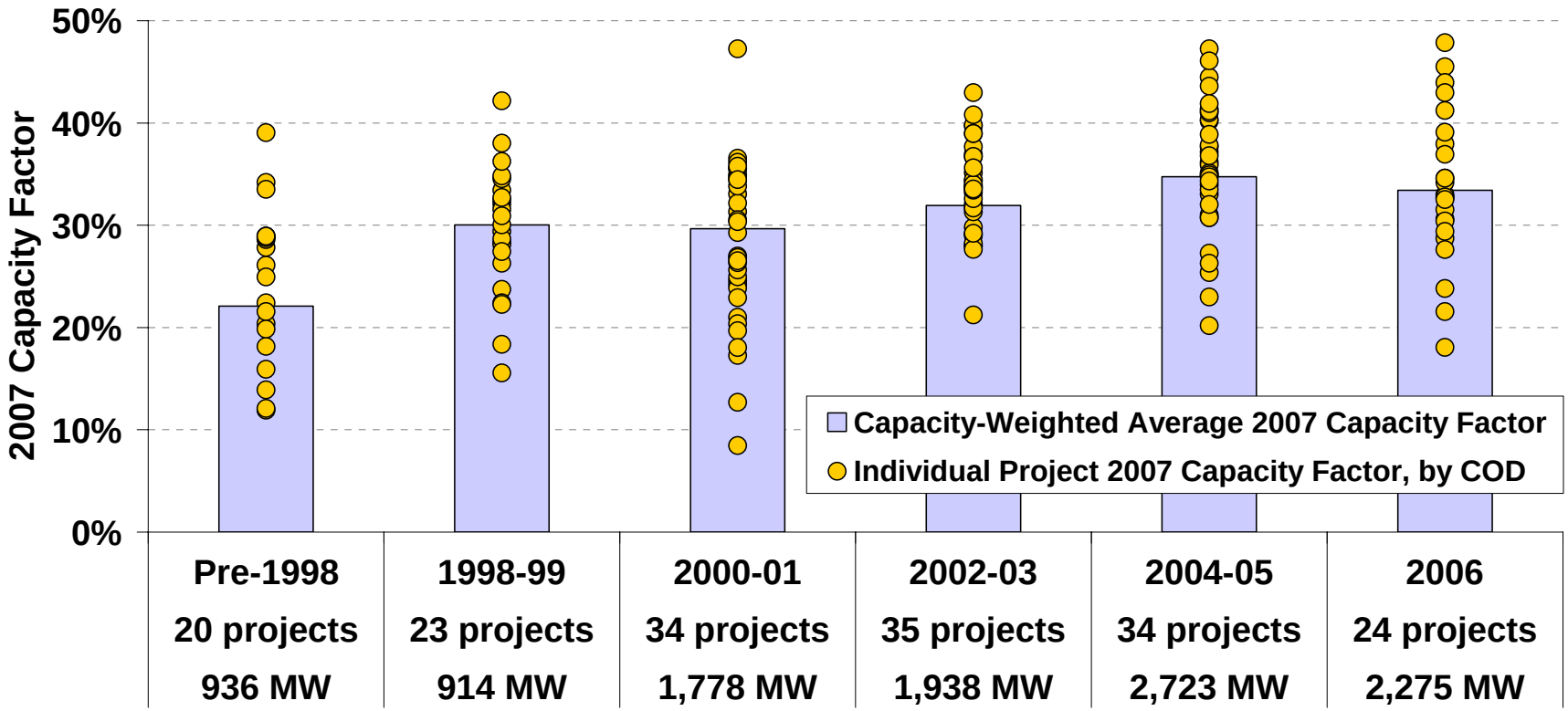
Project Cost Increases Are a Function of Wind Turbine Prices



Source: Berkeley Lab database

Since turbines are often ordered 12 or more months in advance, further project cost increases are expected

Wind Project Performance Is Improving

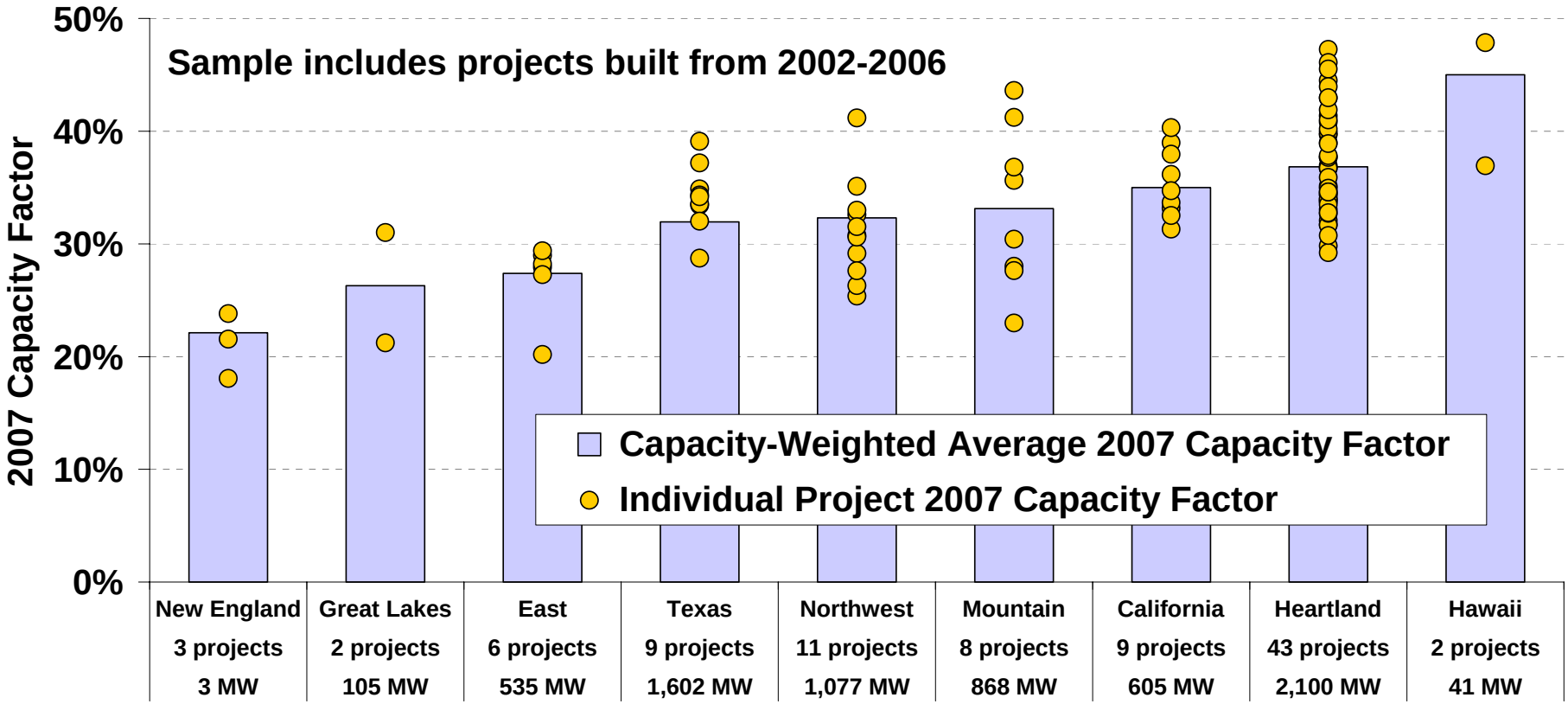


Source: Berkeley Lab database

Of the projects installed prior to 2004, 3.6% had capacity factors in excess of 40%; of the projects installed from 2004-2006, 25.9% had capacity factors in excess of 40%

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

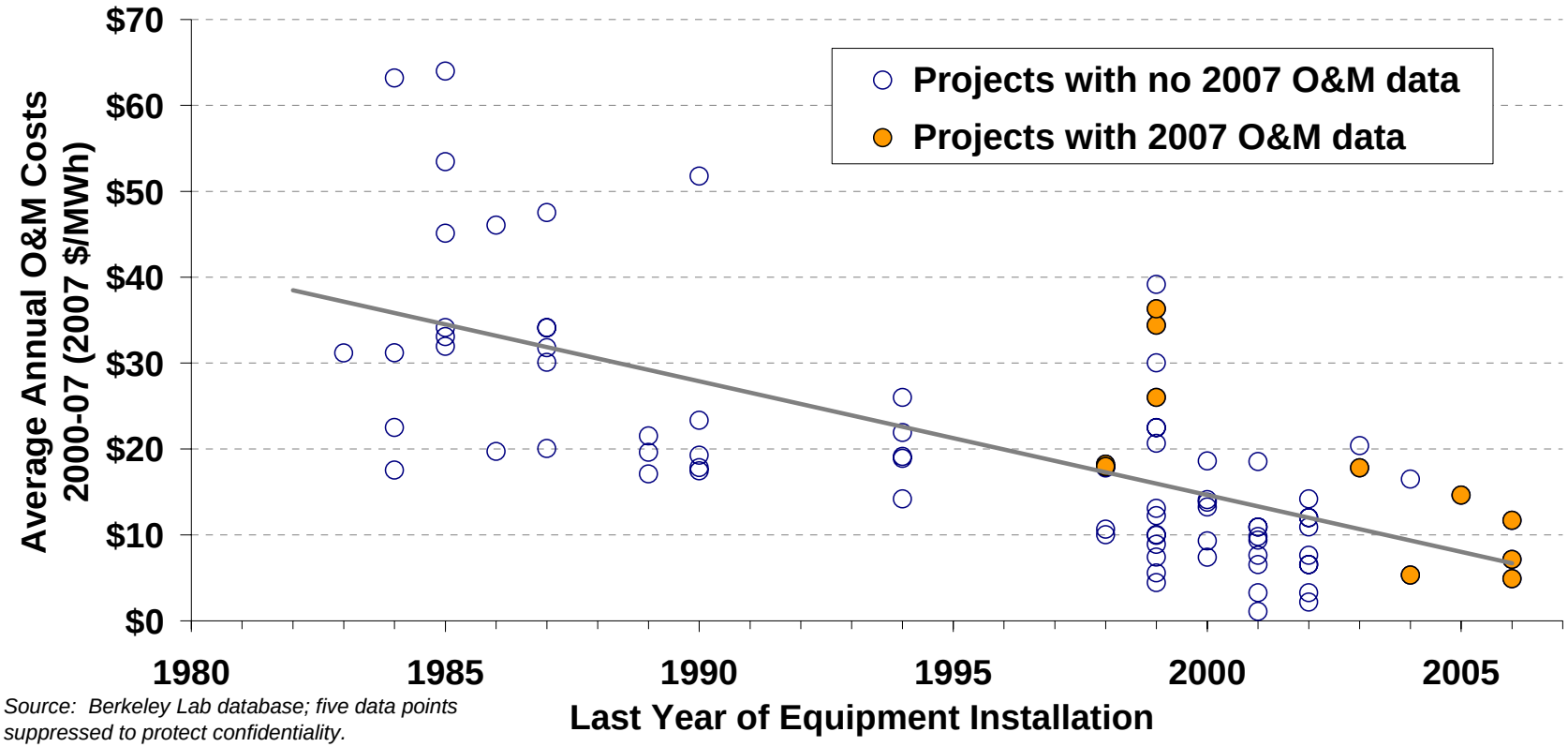
Regional Performance Differences Are Apparent



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

Average Wind Project O&M Costs from 2000-07 Are Affected By Year of Installation

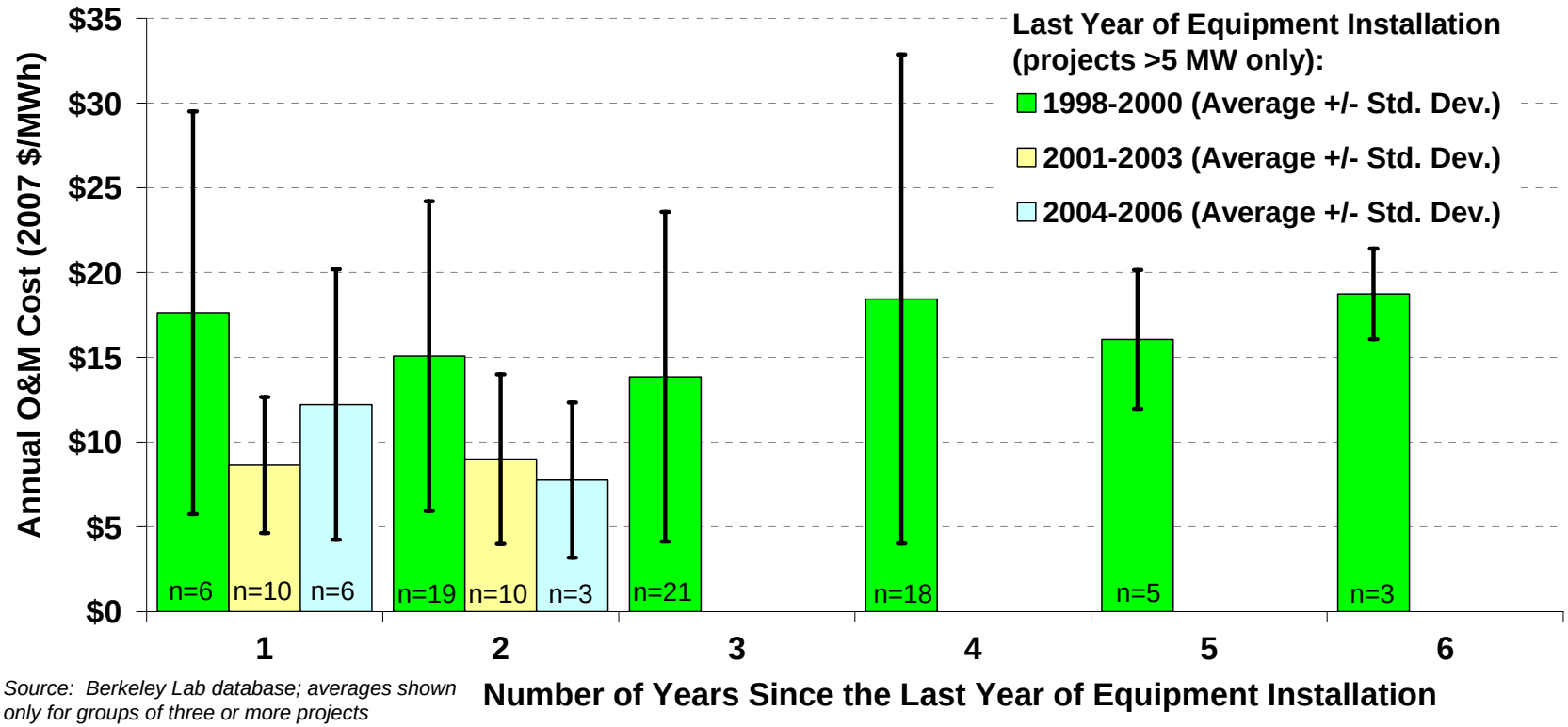


Source: Berkeley Lab database; five data points suppressed to protect confidentiality.

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

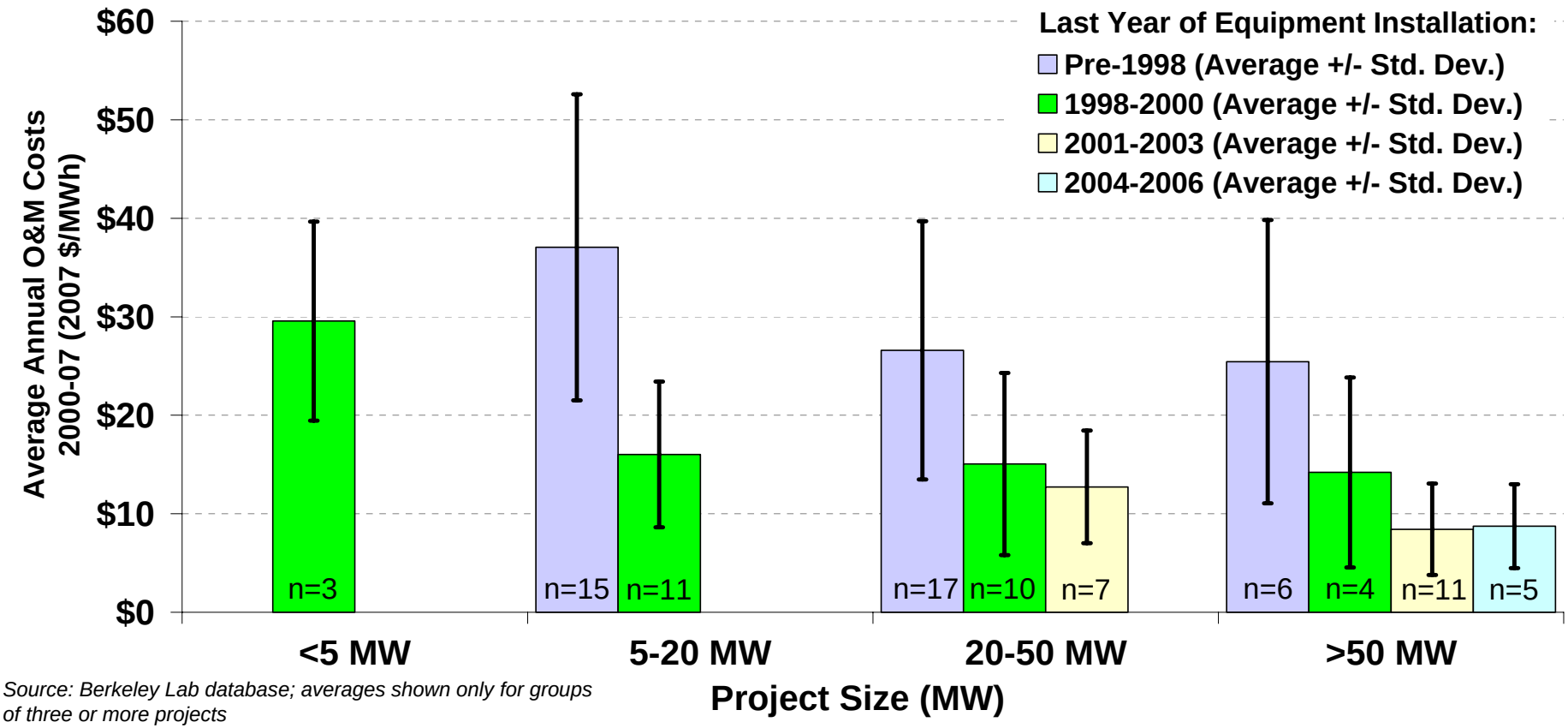
O&M Costs Appear to Decrease for Recently Constructed Projects, and Increase with Project Age



Source: Berkeley Lab database; averages shown only for groups of three or more projects

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

Smaller Projects Appear to Experience Higher O&M Costs, on a $/MWh Basis



Source: Berkeley Lab database; averages shown only for groups of three or more projects

Note: Sample size is extremely limited

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

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	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	1.60	3.00	na	4.60
2006	CA RPS (multi-year)*	4%	0.45	trace	trace	na	0.45
2006	Xcel-PSCo	15%	0.20	na	3.32	1.45	4.97
2006	MN-MISO**	31%	na	na	na	na	4.41
2007	Puget Sound Energy	10%	na	na	na	na	5.50
2007	Arizona Public Service	15%	0.37	2.65	1.06	na	4.08
2007	Avista Utilities***	30%	1.43	4.40	3.00	na	8.84
2007	Idaho Power	20%	na	na	na	na	7.92

** regulation costs represent 3-year average*
*** highest over 3-year evaluation period*
**** unit commitment includes cost of wind forecast error*

Source: Berkeley Lab based, in part, on data from NREL.

- Wind integration costs are < $10/MWh for capacity penetrations of up to ~30%
- Regulation impacts are small, load-following and unit commitment larger
- Larger balancing areas and use of wind forecasts ease integration challenges

Solutions to Transmission Barriers Began to Emerge in 2007, but Constraints Remain

- U.S. DOE *National Electric Transmission Congestion Report* designated two "national interest" corridors, in Southwest and Mid-Atlantic
- FERC issued Order 890 in February 2007
  - Adopts cost-based energy imbalance policy
  - Requires transmission providers to participate in local/regional planning process
  - Requires transmission providers to examine re-dispatch and conditional firm service
- FERC approved California ISO proposal for new interconnection category for location-constrained resources (e.g., Tehachapi wind)
- Several states began to proactively develop transmission infrastructure for wind
  - Texas PUC designated 5 Competitive Renewable Energy Zones (CREZ), with a potential 23 GW of wind, to which transmission could be built in advance of generation
  - Colorado initiated a similar process to identify Energy Resource Zones (ERZ)
  - Likewise, California launched the Renewable Energy Transmission Initiative (RETI) to identify renewable energy zones and prepare transmission plans to them
- Large number of transmission projects planned that include wind

Federal and State Policy Efforts in 2007 Continued to Drive Wind Development

- Federal PTC currently in place through 2008
- $170 million of Clean Renewable Energy Bonds to 102 wind projects
- $2.7 million of USDA 9006 grant awards to 7 “large wind” projects (8.2 MW)
- Four new state RPS policies (IL, NH, NC, OR), and many revisions to existing state RPS policies (additional state RPS activity has occurred in 2008)
- State renewable funds, tax incentives, utility planning, green power, and growing interest in carbon regulation all also played a role in 2007

Coming Up in 2008

- 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/

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