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

2009 WIND TECHNOLOGIES MARKET REPORT

EXECUTIVE SUMMARY

AUGUST 2010

2009 Wind Technologies Market Report Executive Summary

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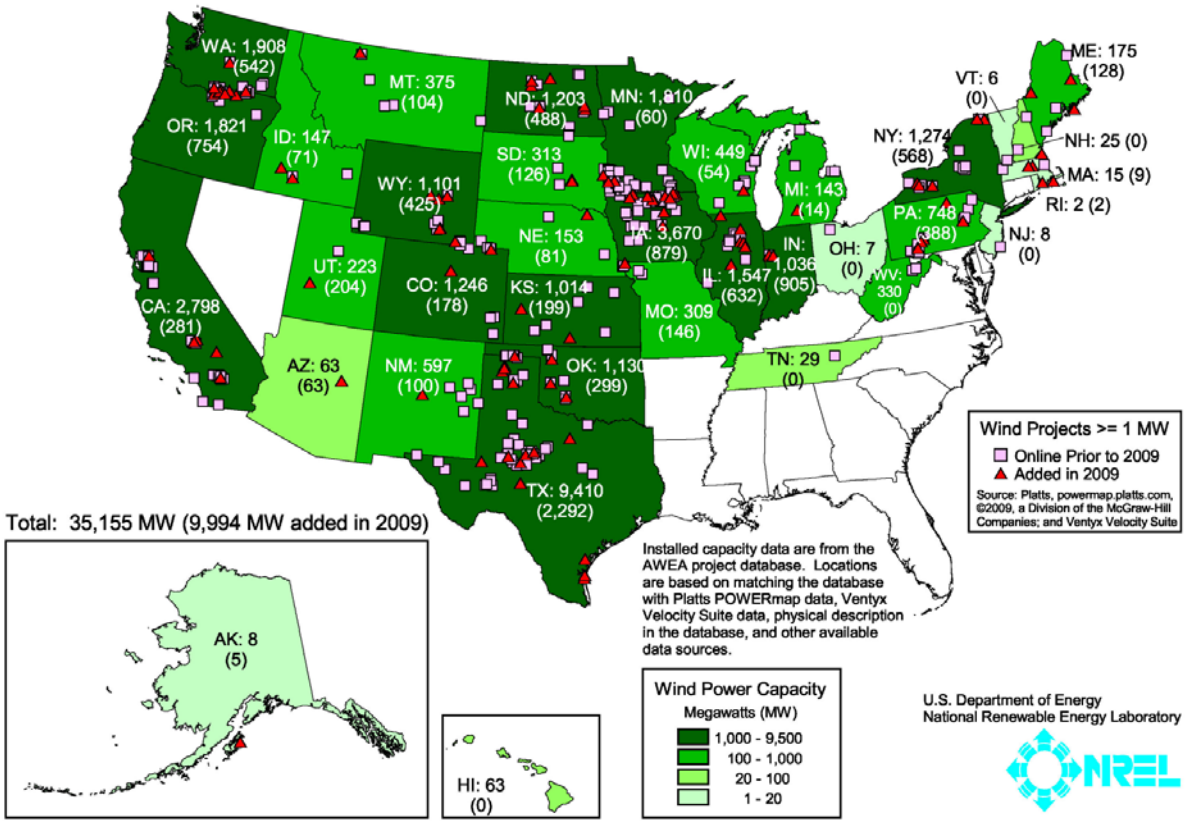
This is the Executive Summary of the full report entitled *2009 Wind Technologies Market Report* available at http://www.nrel.gov/docs/fy10osti/48666.pdf (PDF 3.1 MB)

Executive Summary

Despite grim predictions at the close of 2008, the U.S. wind power industry experienced yet another record year in 2009, once again surpassing even optimistic growth projections from years past. At the same time, the combination of the financial crisis and lower wholesale electricity prices has taken a toll on the wind power industry, dampening expectations for 2010. Key findings from this year's *Wind Technologies Market Report* include:

- **Wind Power Additions in 2009 Shattered Old Records, with roughly 10 Gigawatts (GW) of New Capacity Added in the United States and $21 Billion Invested.** The pace of utility-scale wind power capacity additions in 2009 was 20% higher than the previous U.S. record set in 2008, while cumulative wind power capacity grew by 40%. This was achieved despite the financial crisis that roiled the wind power industry in 2009, and the significant reductions in wholesale electricity prices that began in mid- to late-2008 and have continued to the present. A variety of market drivers allowed year-on-year installation growth to persist in 2009, including: carryover of projects initially planned for completion in 2008; elements of the *American Recovery and Reinvestment Act of 2009* (Recovery Act), including the Section 1603 Treasury Grant Program; the expiration of bonus depreciation rules at the end of 2009; and state renewables portfolio standards.



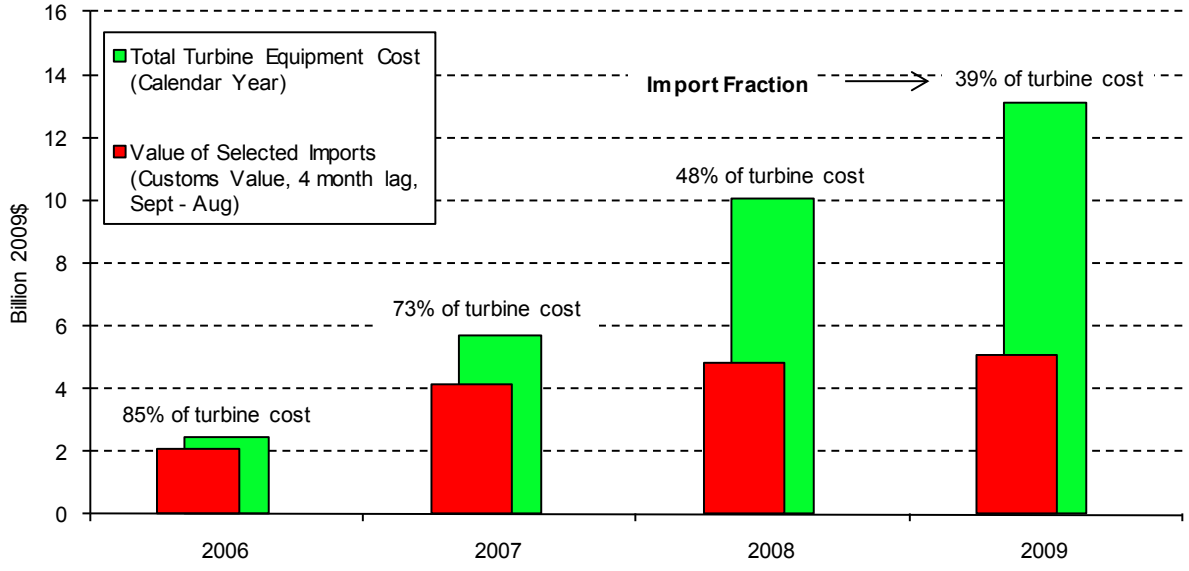
Note: Numbers within states represent cumulative installed wind capacity and, in parentheses, annual additions in 2009.

Location of Wind Power Development in the United States

- **Wind Power Contributed 39% of All New U.S. Electric Generating Capacity in 2009.** This is down from 44% in 2008, but exceeds wind power's contribution of 35% in 2007, 18% in 2006, 12% in 2005, and less than 4% from 2000 through 2004. For the fifth consecutive year, wind power was the second-largest new resource added to the U.S. electrical grid in terms of nameplate capacity, behind natural gas plants, but ahead of new coal power.
- **The United States Continued to Lead the World in Cumulative Wind Power Capacity, but Was Overtaken by China in Annual Additions.** After four years of leading the world in annual wind power capacity additions, the United States dropped to second place in 2009, capturing roughly 26% of the worldwide market (behind China's 36% market share). At the end of 2009, cumulative wind power capacity in the United States stood at more than 35,000 megawatts (MW), ahead of China's 25,853 MW and Germany's 25,813 MW. Several countries are beginning to achieve relatively high levels of wind energy penetration in their electricity grids: end-of-2009 wind power capacity is projected to supply the equivalent of roughly 20% of Denmark's electricity demand, 14% of Spain's and Portugal's, 11% of Ireland's, and 8% of Germany's. In the United States, the cumulative wind power capacity installed at the end of 2009 would, in an average year, be able to supply roughly 2.5% of the nation's electricity consumption.
- **Texas Achieved Higher Annual Capacity Additions than Other States, While Four States Have Surpassed 10% Wind Energy Penetration.** With 2,292 MW installed in 2009 alone, Texas dominated the 28 other states in which new large-scale wind turbines were installed in 2009 (the next highest were Indiana with 905 MW and Iowa with 879 MW). In terms of estimated wind energy supply as a proportion of in-state electricity generation, the front-runners include Iowa (19.7%), South Dakota (13.3%), North Dakota (11.9%), and Minnesota (10.7%). Some utilities are seeing higher percentages of wind energy supply than these state totals, with nine utilities estimated to have in excess of 10% wind energy on their systems.
- **Offshore Wind Power Project and Policy Developments Accelerated in 2009.** To date, all wind power installations in the United States have been located on land, but there is also interest in offshore wind power development and 2,476 MW of offshore projects have advanced significantly in the permitting and development process. Of those projects, three have signed or proposed power purchase agreements with terms and details have been made public. Notably, after nine years in the permitting process, the Cape Wind project was granted approval by the Department of Interior in April 2010, and a variety of other recent project and policy announcements demonstrate accelerated activity in the offshore wind energy sector.
- **Data from Interconnection Queues Demonstrate that an Enormous Amount of Wind Power Capacity Is Under Consideration.** At the end of 2009, there were roughly 300 GW of wind power capacity within the transmission interconnection queues administered by independent system operators, regional transmission organizations, and utilities reviewed for this report – nearly nine times the installed wind power capacity. This wind power capacity represented almost 60% of all generating capacity within these queues at that time, and was nearly three times as much capacity as the next-largest resource (natural gas). Most (93%) of this wind power capacity is planned for the Midwest, Mountain, Texas, PJM, SPP, and Northwest regions. Not all of this capacity will ultimately be built as planned, but these data demonstrate the high level of developer interest in wind power.
- **GE Remained the Top Turbine Manufacturer in the United States Market, but a Growing Number of Other Manufacturers Are Capturing Market Share.** GE secured 40% of U.S. market share (by capacity) in 2009, followed by Vestas (15%), Siemens (12%), Mitsubishi (8%), Suzlon (7%), Clipper and Gamesa (6% each), REpower (3%), Acciona (2%), and Nordex (1%). Manufacturers with modern wind turbines installed in the United States now hail from not just the United States, Europe, and

Japan, but also from India and, for the first time in 2009, China. In 2009, U.S.-owned GE was the second-leading supplier of turbines *globally*, while Clipper was the 13th largest global supplier. On a worldwide basis, perhaps the most significant story of 2009 was the growing market share of Chinese turbine manufacturers; to date, that growth has been based almost entirely on sales to the Chinese market, but Chinese manufacturers began to express strong interest in the U.S. market in 2009.

- **Domestic Wind Turbine and Component Manufacturing Investments Remained Strong in 2009, but the Financial Crisis and Weak Turbine Sales Slowed the Sector's Growth.** Seven of the ten wind turbine manufacturers with the largest share of the U.S. market in 2009 now have one or more manufacturing facilities operating in the United States, and two of the remaining three have announced specific plans to open facilities in the future. These figures compare to just one utility-scale wind turbine manufacturer (GE) assembling nacelles in the United States in 2004. In addition, a considerable number of new component manufacturing facilities were either announced or opened in 2009, by both foreign and domestic firms. Nevertheless, weak demand for new wind turbine orders and the poor state of the U.S. economy led to a net loss of 1,500 wind turbine and component manufacturing jobs in 2009, according to the American Wind Energy Association (AWEA). As a result, AWEA estimates that overall U.S. employment in the wind energy sector held steady at 85,000 full-time jobs in 2009; of these, 18,500 are estimated by AWEA to be turbine and component manufacturing jobs.
- **A Growing Percentage of the Equipment Used in U.S. Wind Power Projects Has Been Sourced Domestically in Recent Years.** U.S. trade data show that the United States remained a large importer of wind power equipment in 2009, but that wind power capacity growth has outpaced the growth in imports in recent years. As a result, a growing amount of the equipment used in wind power projects is being sourced domestically as domestic and foreign companies seek to minimize transportation costs and currency risks by establishing local manufacturing capabilities. Imports of wind turbines and select components in 2009 are estimated at $4.2 billion, down from $5.4 billion in 2008. When presented as a fraction of total equipment-related wind turbine costs, the overall import fraction is estimated to have declined from roughly 50% in 2008 to 40% in 2009 as domestic manufacturing investments outpaced import growth.

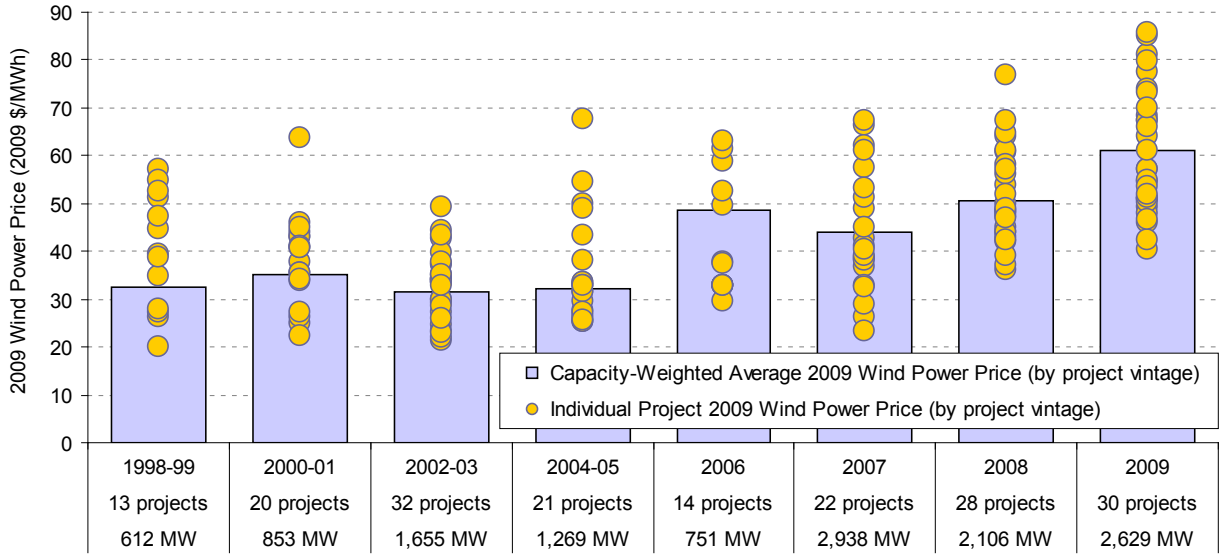


Wind Power Equipment Imports as a Fraction of Total Turbine Cost

- **The Average Nameplate Capacity, Hub Height, and Rotor Diameter of Installed Wind Turbines Increased.** The average nameplate capacity of wind turbines installed in the United States in 2009 increased to roughly 1.74 MW, up from 1.66 MW in 2008 and 1.65 MW in 2007. Since 1998-99, average turbine nameplate capacity has increased by 145%, but growth in this metric has slowed in recent years due to the dominance of GE's 1.5 MW turbine and as a result of the logistical challenges associated with transporting larger turbines to project sites. In addition to nameplate capacity ratings, average hub heights and rotor diameters have also scaled with time, to 78.8 and 81.6 meters, respectively, in 2009. Since 1998-99, the average turbine hub height has increased by 40%, while the average rotor diameter has increased by 69%: these trends are one of several factors impacting the project-level capacity factors highlighted later.
- **The Average Size of Wind Power Projects Resumed its Upward Trend.** Wind power projects installed in 2009 averaged nearly 91 MW, which is below the 120 MW average size of projects built in 2007, but is otherwise larger than in any previous period. Larger project sizes reflect an increasingly mature energy source that is beginning to penetrate into the domestic electricity market in a significant way.
- **Consolidation Among Wind Project Developers Continues.** At least six significant acquisition or investment transactions involving roughly 18 GW of in-development wind power projects were announced in 2009, compared to the five transactions and 19 GW in 2008. This is well below the 11 transactions and 37 GW in 2007, and the 12 transactions and 34 GW in 2006. The more-subdued pace of activity since 2007 may be due to the fact that many of the prime targets for investment and/or acquisition were acquired in earlier years. In addition, some traditional buyers of wind assets may have decided to reign in new investments following aggressive purchases made in previous years, while some developers who might otherwise entertain offers may be holding out for better pricing as the market recovers. Looking ahead, the relatively weak demand for wind energy projected in 2010, coupled with an influx of cash from the Section 1603 Treasury grant program, may help to drive continued consolidation.
- **Treasury Cash Grant Expands Financing Options, Buoys the Wind Sector.** To reduce the market's dependence on scarce and costly third-party tax equity, Section 1603 of the Recovery Act enables wind power projects to temporarily choose a 30% cash grant administered by the U.S. Treasury in lieu of either the production tax credit (PTC) or a 30% investment tax credit (ITC). Owners of more than 6,400 MW of the wind power capacity installed in 2009 elected the grant in lieu of the PTC, and as much as 2,400 MW of this capacity may not have been built in 2009 had the cash grant not been available. Only about seven of the more-than-sixty 2009 projects that elected the grant were financed using third-party tax equity; many of the rest substituted project-level term debt – which became increasingly available as 2009 progressed – in place of third-party tax equity.
- **Private IPP Project Ownership Remained Dominant, but Utility Ownership Increased.** Private independent power producers (IPPs) own 83% of all new wind power capacity installed in the United States in 2009, and also 83% of cumulative capacity. In a continuation of the trend begun several years ago, however, 16% of total wind power additions in 2009 are owned by electric utilities, who now own 15% of the cumulative wind power capacity in the United States. Community wind power projects account for the remaining 2% of both annual and cumulative capacity.
- **Long-Term Contracted Sales to Utilities Remained the Most Common Sales Arrangement, but Merchant Plants Were Surprisingly Abundant in 2009.** Investor-owned utilities continued to be significant purchasers of wind power, with 36% of the new 2009 capacity and 44% of cumulative capacity selling power to these utilities under long-term contract. Publicly owned utilities purchased another 22% and 18%, respectively. Surprisingly, given the tightening of credit requirements in the

wake of the financial crisis, as well as sharply lower wholesale electricity prices, merchant/quasi-merchant projects were abundant in 2009, accounting for 38% of all new capacity and 26% of the cumulative capacity. It is possible that many of these merchant projects may now be seeking longer-term power purchase contracts in order to gain increased revenue stability.

- **Upward Pressure on Wind Power Prices Continued in 2009.** Although some of the cost pressures facing the industry in recent years have eased, it will take time before relief flows through the project development pipeline to impact overall average wind power prices. As such, 2009 was another year of rising wind power prices. The capacity-weighted average 2009 sales price for bundled power and renewable energy certificates, based on projects in the sample built in 2009, was roughly $61/megawatt-hour (MWh in 2009 dollars), up from an average of $51/MWh for the sample of projects built in 2008, and nearly double the average of $32/MWh among projects built during the low point in 2002 and 2003. Among projects in the sample, those in Texas and the Heartland region have the lowest prices on average, while those in New England, California, and the East have the highest prices.

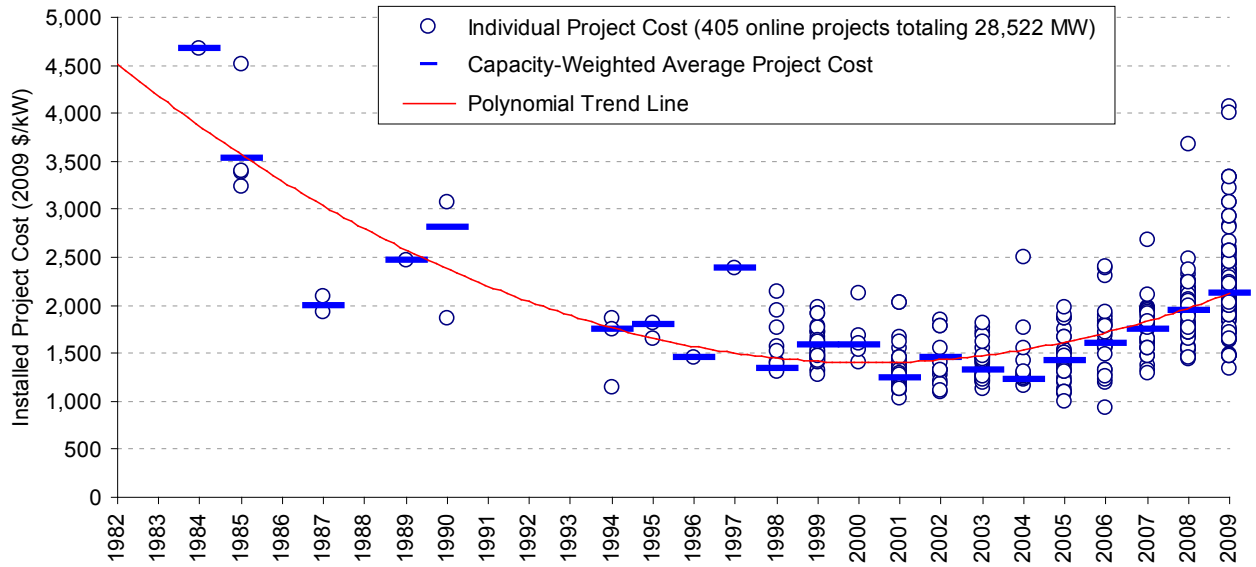


Source: Berkeley Lab database

2009 Wind Power Prices by Project Vintage

- **Sharp Drop in Wholesale Electricity Prices Makes the Near-Term Economics of Wind Energy More Challenging.** The increase in wind power prices in 2009, combined with the deep reduction in wholesale electricity prices (driven by lower natural gas prices), pushed wind energy from the bottom to the top of the wholesale electricity price range in 2009. Although low natural gas prices are, in part, attributable to the recession-induced drop in energy demand, the discovery and early development of significant shale gas deposits has reduced expectations for increases in natural gas prices going forward. As a result, natural gas prices may not rebound to earlier levels as the economy recovers, putting the near-term comparative economic position of wind energy at some risk.
- **The Installed Cost of Wind Power Projects Continued to Rise in 2009, but Reductions May Be on the Horizon.** Among a large sample of wind power projects installed in 2009, reported installed costs had a capacity-weighted average of $2,120/kilowatt (kW). This average increased by $170/kW (9%) from the weighted-average cost of $1,950/kW for projects installed in 2008, and increased by

$820/kW (63%) from the average cost of projects installed from 2001 through 2004. Installed costs may – on average – remain high for a period of time as developers continue to work their way through the dwindling backlog of turbines purchased in early 2008 at peak prices. There are expectations, however, that average costs will decline over time as the cost pressures (e.g., rising materials costs, the weak dollar, turbine and component shortages) that have challenged the industry in recent years ease. Differences in average installed costs among regions and by project size are also apparent in the data.

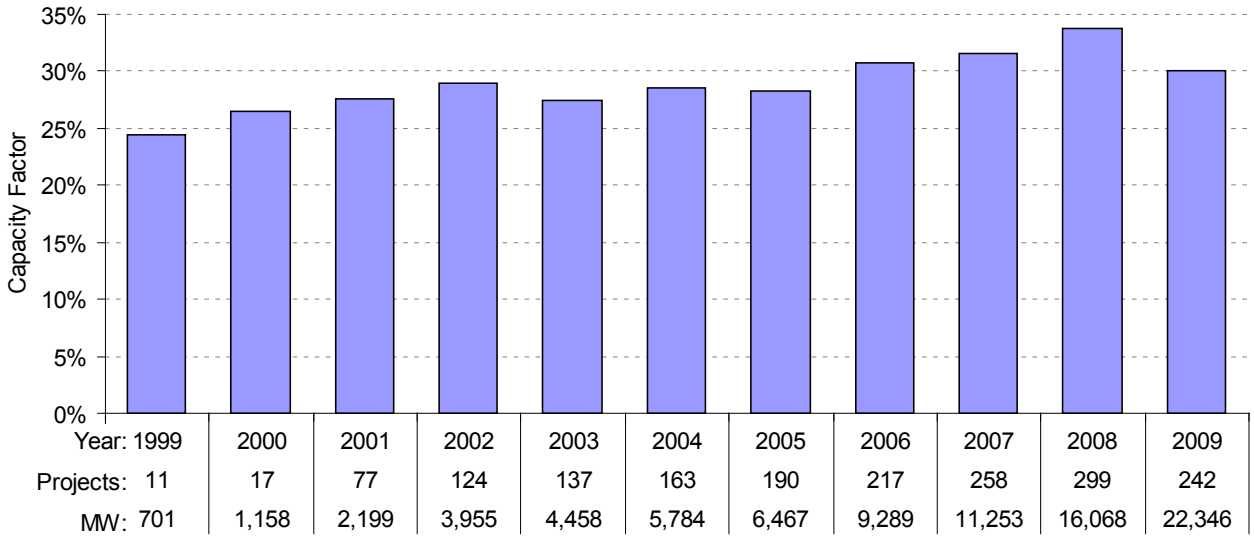


Source: Berkeley Lab (some data points suppressed to protect confidentiality)

Installed Wind Power Project Costs Over Time

- **Wind Turbine Prices Have Begun to Show Signs of Easing, but Remain High By Historical Standards.** Since hitting a low point of roughly $700/kW in the 2000-2002 timeframe, average wind turbine prices have increased by approximately $800/kW (>100%) through 2009. Though turbine price increases have been the rule for a number of years, evidence is beginning to emerge that those days have ended, at least temporarily. Although visibility of turbine transaction prices declined in 2009 as the financial crisis took its toll and developers sat on turbine supply frame agreements that exceeded near-term development plans, cost pressures have eased since mid-2008. As a result, estimates of turbine price declines of as much as 15%, along with more favorable contract terms, have begun to emerge. These price reductions and improved terms can be expected, over time, to exert downward pressure on project costs and wind power prices.
- **Wind Project Performance Has Generally Improved Over Time, but Has Leveled Off in Recent Years.** Boosted primarily by higher hub heights and larger rotor diameters, cumulative sample-wide average capacity factors have, in general, gradually increased over time, from just over 24% in 1999 to a high of nearly 34% in 2008, before dropping back to 30% in 2009. The drop in 2009 is, in part, attributable to a relatively poor wind resource year in many parts of the country along with increasing amounts of wind power curtailment. Curtailment was particularly high in Texas (home to more than one-quarter of the nation's wind power capacity), with 17% of all potential wind energy generation within the Electric Reliability Council of Texas (ERCOT) curtailed in 2009. The sample-

wide average U.S. capacity factor of 30% in 2009 would have reached 32% if not for the curtailment experienced in ERCOT and the Midwest. Other factors that may have slowed the rate of capacity factor increase for projects installed in more recent years include an enhanced emphasis on lower-quality wind resource sites (due to transmission and siting constraints), moderation of the increase in average hub heights and rotor diameters, and some challenges with turbine reliability.



Source: Berkeley Lab

Average Cumulative Sample-Wide Capacity Factor by Calendar Year

- **Operations and Maintenance Costs Are Affected by the Age and Size of the Project, Among Other Factors.** Despite limited data availability, it appears that projects installed more recently have, on average, incurred lower operation and maintenance (O&M) costs than older projects in their first couple of years in operation. Likewise, larger projects appear to experience lower O&M costs than do smaller projects, and O&M costs increase as projects age.
- **The Federal Policy Landscape Is Now More Favorable to Wind Energy than at Any Other Time in the Past Decade.** The Recovery Act of 2009 extended the PTC for wind energy through 2012, and also implemented a number of other policy changes, including an option to elect a 30% cash grant or ITC in lieu of the PTC, the expansion and enhancement of a federal loan guarantee program managed by the U.S. Department of Energy (DOE), and a 30% tax credit for investment in advanced energy manufacturing facilities. In addition, $2.2 billion in new Clean Renewable Energy Bonds were allocated in 2009, and $60 million in U.S. Department of Agriculture (USDA) funding was distributed in the form of grants and loan guarantees, in part to fund wind power projects located in rural areas. Nonetheless, federal policy towards wind energy remains uncertain after 2012.
- **State Policies Play a Significant Role in Directing the Location and Amount of Wind Power Development.** From 1999 through 2009, 61% of the wind power capacity built in the United States was located in states with RPS policies; in 2009, this proportion was 57%. One new state (Kansas) established a mandatory RPS program in 2009, bringing the total to 29 states and Washington D.C. Utility resource planning requirements, voluntary customer demand for "green" power, state clean

energy funds, and state and regional carbon reduction policies also play a role in supporting wind energy deployment.

- **Despite Progress on Overcoming Transmission Barriers, Constraints Remain.** Transmission development appears to be gaining some traction, but siting, planning, and cost allocation issues remain key barriers to transmission investment. In June 2010, the Federal Energy Regulatory Commission (FERC) issued a proposed transmission cost allocation rule aimed at easing planning and cost allocation barriers. States, grid operators, regional organizations, and the DOE continue to take proactive steps to encourage transmission investment to access remote renewable resources. Finally, progress was made in 2009 on a number of transmission projects that are designed, in part, to support wind power.
- **Integrating Wind Energy into Power Systems Is Manageable, but Not Free of Costs, and Market Operators Are Implementing Methods to Accommodate Increased Penetration.** Recent studies show that wind energy integration costs are below $10/MWh – and often below $5/MWh – for wind power capacity levels up to or exceeding 40% of the peak load of the system in which the wind power is delivered. Moreover, a number of strategies that can help to ease the integration of increasing amounts of wind energy – including the use of larger balancing areas, the use of wind forecasts, and intra-hour scheduling – are being implemented by grid operators across the United States.

In conclusion, 2009 continued a string of record-breaking years for the U.S. wind power industry. Looking ahead, expectations are for a slower year in 2010, due to a combination of the financial crisis, lower wholesale electricity prices, and lower demand for renewable energy. Wind power capacity additions in 2009 were buoyed, in part, by projects that were initially slated to be completed in 2008 but that carried over into 2009 when the PTC was extended, somewhat masking the underlying challenges facing the sector. With the extension of federal incentives through 2012, there is less motivation to complete projects in 2010 (though many projects will likely start construction in 2010 in order to be eligible for the 30% Treasury cash grant). Industry analysts project a range from 5,500 MW to 8,000 MW of wind power capacity likely to be installed in the United States in 2010, a drop of 20-45% compared to the nearly 10,000 MW installed in 2009. After a slower 2010, most predictions show market resurgence in 2011 and 2012, as the Recovery Act programs mature and as financing constraints ease. Beyond 2012, however, the picture is considerably less certain, due to the scheduled expiration of a number of federal policies at the end of that year, including the PTC, the ability to elect a 30% ITC in lieu of the PTC, and the ability to receive the 30% Treasury cash grant for projects that initiated construction by the end of 2010.

Wind Energy Web Sites

U.S. Department of Energy Wind and Water Power Program
www.windandwater.energy.gov

Wind Powering America
www.windpoweringamerica.gov

Lawrence Berkeley National Laboratory
http://eetd.lbl.gov/EA/EMP/re-pubs.html

National Renewable Energy Laboratory
www.nrel.gov/wind

Sandia National Laboratories
www.sandia.gov/wind

Pacific Northwest National Laboratory
www.pnl.gov

Lawrence Livermore National Laboratory
www.llnl.gov

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www.ornl.gov

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Idaho National Laboratory
www.inl.gov

Ames Laboratory
www.ameslab.gov

Los Alamos National Laboratory
www.lanl.gov

Savannah River National Laboratory
http://srnl.doe.gov

Brookhaven National Laboratory
www.bnl.gov

American Wind Energy Association
www.awea.org

Database of State Incentives for Rennewables & Efficiency
www.dsireusa.org

International Energy Agency – Wind Agreement
www.ieawind.org

National Wind Coordinating Collaborative
www.nationalwind.org

Utility Wind Integration Group
www.uwig.org

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On the Cover

The 63-MW Dry Lake Wind Power Project installed in Arizona in 2009 is the state's first utility-scale wind power project.

Credit: Klaus Obel, NREL
PIX 16702

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

Prepared by the National Renewable Energy Laboratory (NREL)
NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

DOE/GO-102010-3118
August 2010

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