WIND AND WATER POWER TECHNOLOGIES OFFICE

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

2014 Wind Technologies Market Report: Summary

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2014 Wind Technologies Market Report

Purpose, Scope, and Data:

- Publicly available annual report summarizing key trends in the U.S. wind power market, with a focus on 2014
- Scope primarily includes wind turbines over 100 kW in size
- Separate DOE-funded annual reports on distributed and offshore wind
- 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

Funded by: U.S. DOE Wind & Water Power Technologies Office

Available at: http://energy.gov/eere/wind

Report Contents

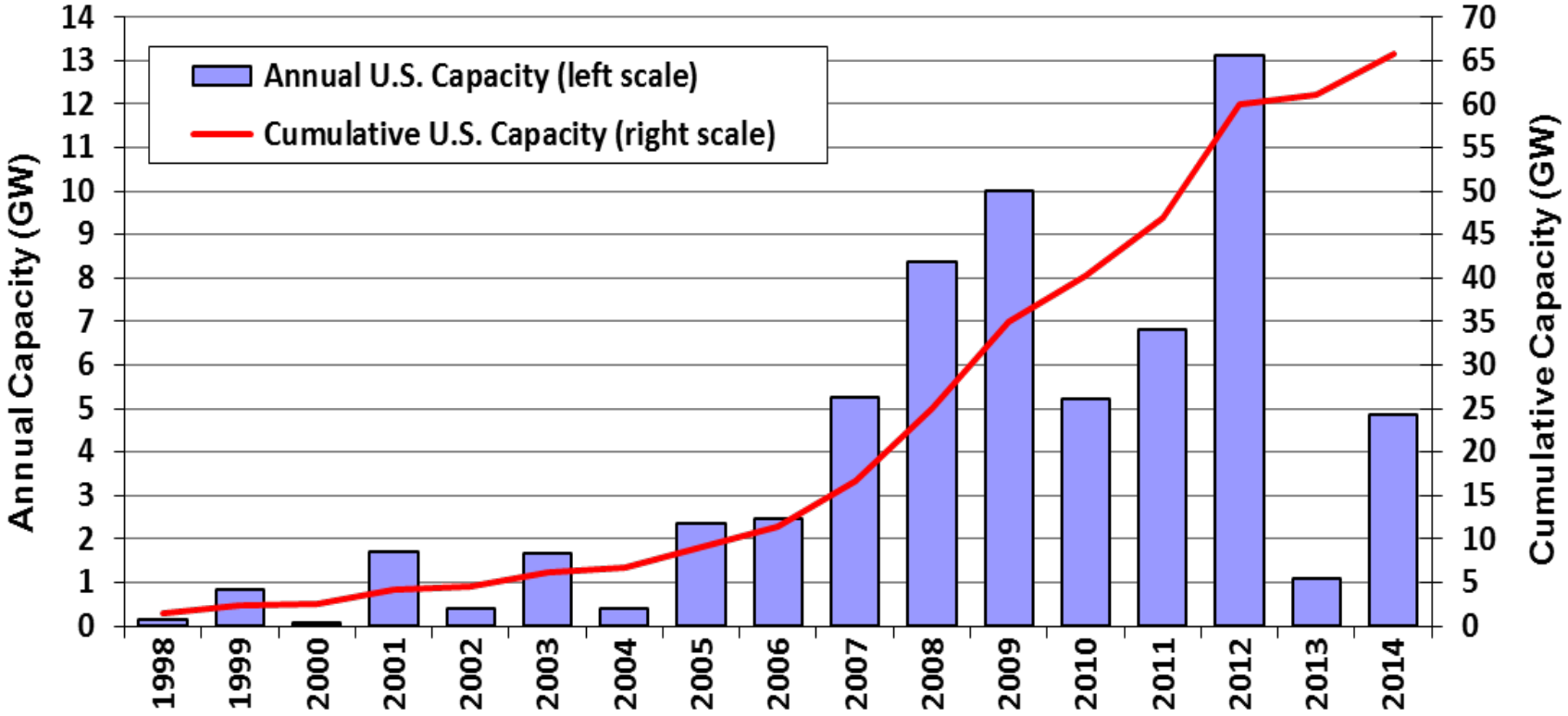
- Installation trends
- Industry trends
- Technology trends
- Performance trends
- Cost trends
- Wind power price trends
- Policy & market drivers
- Future outlook

Key Findings

- Annual wind capacity additions rebounded in 2014, with significant additional new builds anticipated for 2015 and 2016
- Wind has been a significant source of new electric generation capacity additions in the U.S. in recent years
- Supply chain has been under duress, but domestic manufacturing content for nacelle assembly, blades, and towers is strong
- Turbine scaling is boosting expected wind project performance, while the installed cost of wind projects is on the decline
- Wind power sales prices have reached all-time lows, enabling economic competitiveness despite low natural gas prices
- Growth after 2016 remains uncertain, dictated in part by future natural gas prices and policy decisions, though recent declines in the price of wind energy boost future growth prospects

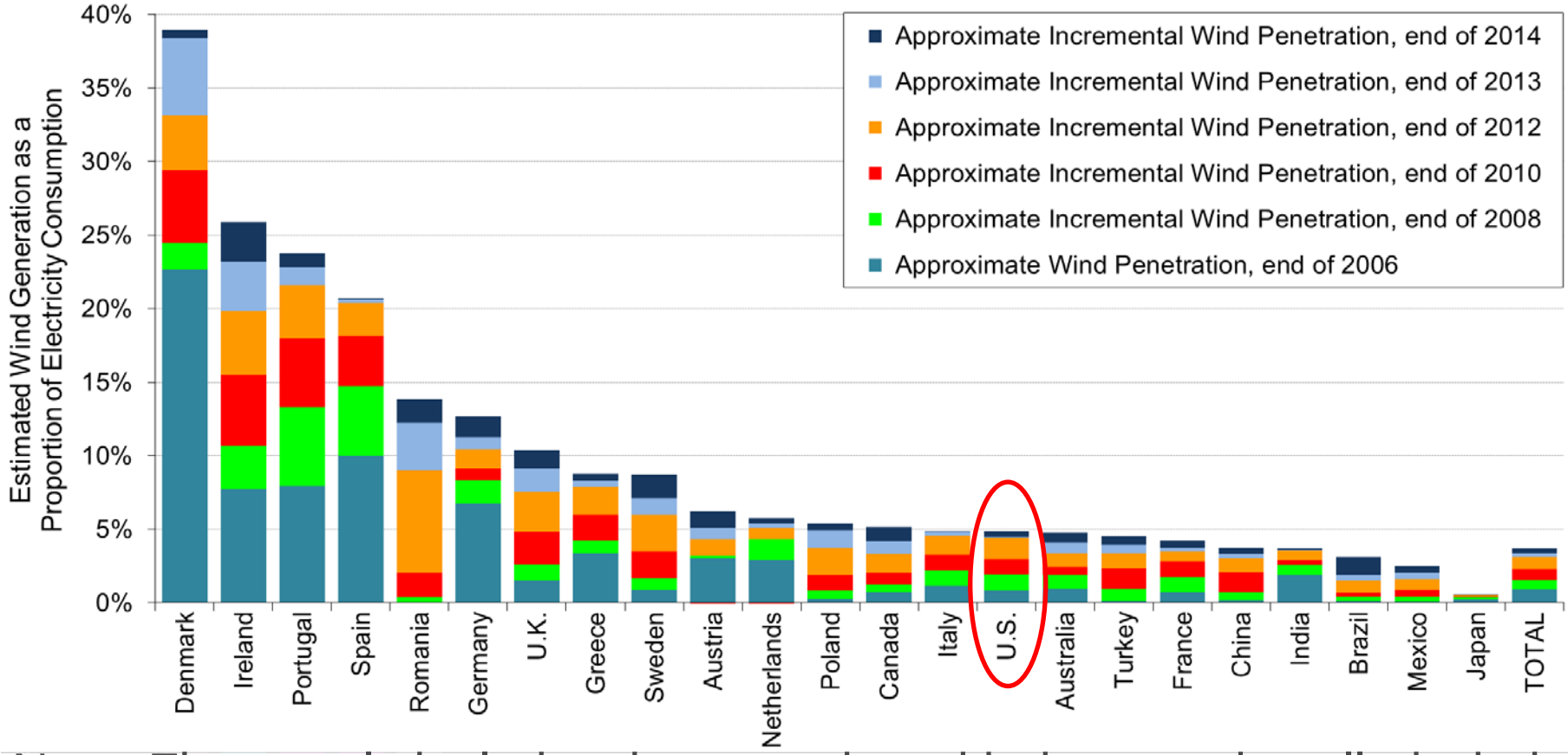
Installation Trends

Wind Power Additions Rebounded in 2014, with 4,854 MW of New Capacity Added



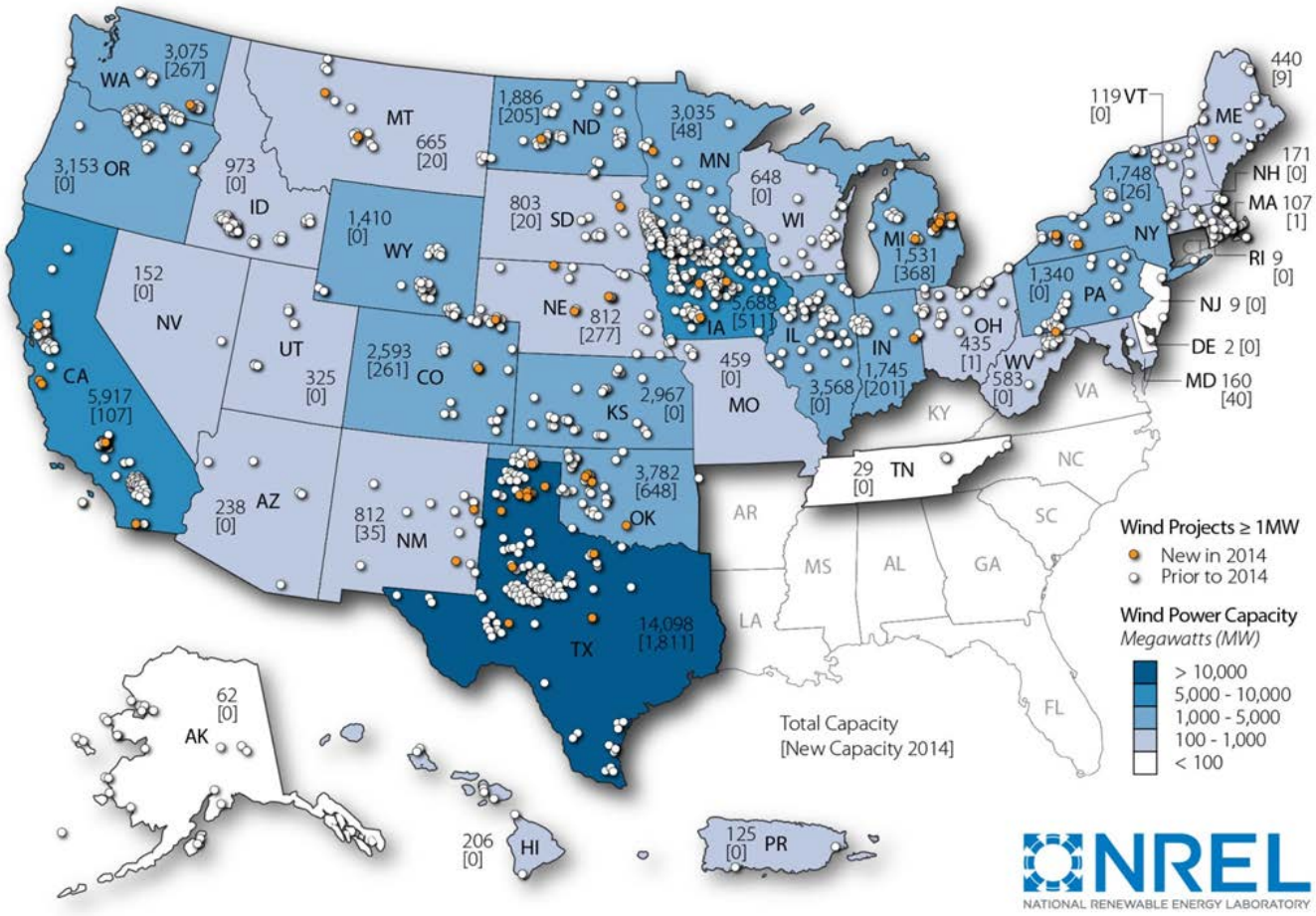
- $8.3 billion invested in wind power project additions in 2014
- Wind build well off annual additions from 2007 through 2012
- Cumulative wind capacity up nearly 8%, bringing total to 65.9 GW

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



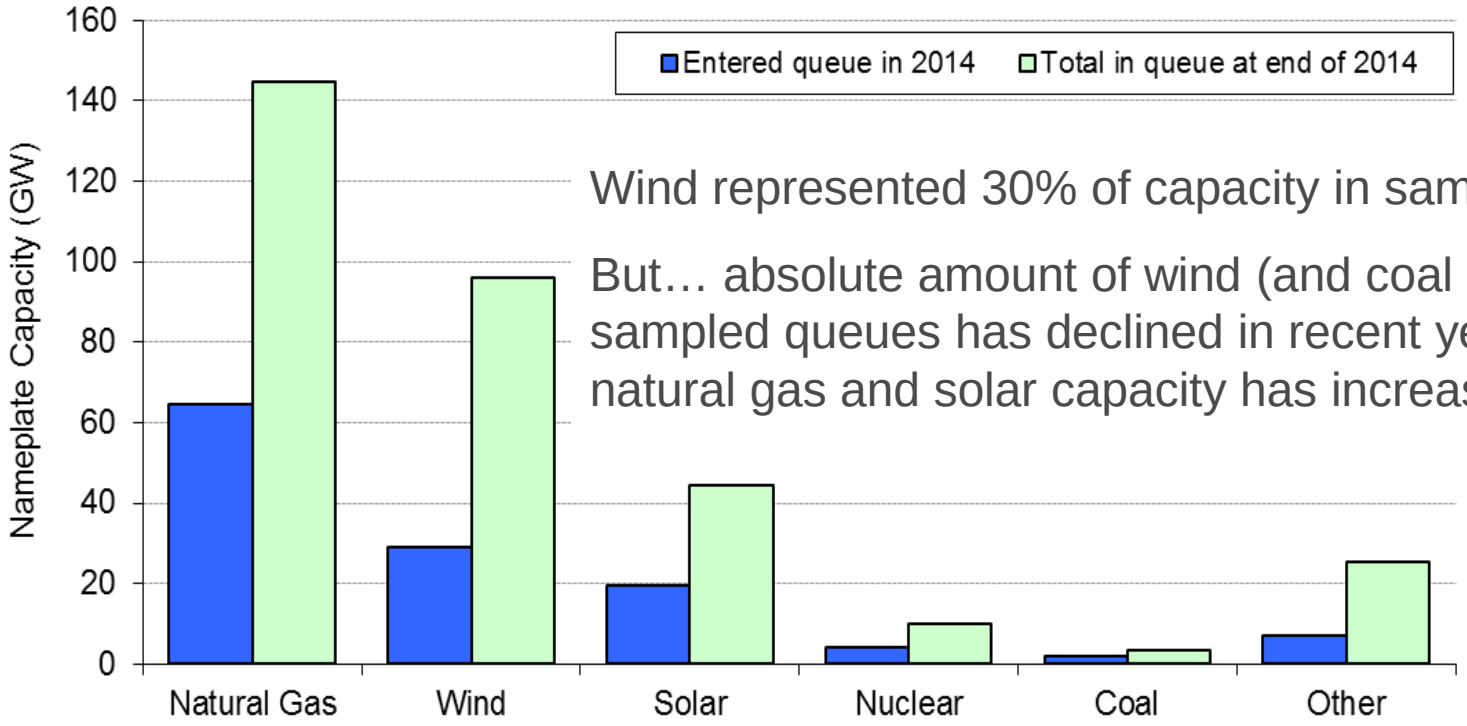
Note: Figure only includes the countries with the most installed wind power capacity at the end of 2014

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



Note: Numbers within states represent cumulative installed wind capacity and, in brackets, annual additions in 2014

Interconnection Queues Demonstrate that a Substantial Amount of Wind Is Under Consideration



Wind represented 30% of capacity in sampled 35 queues

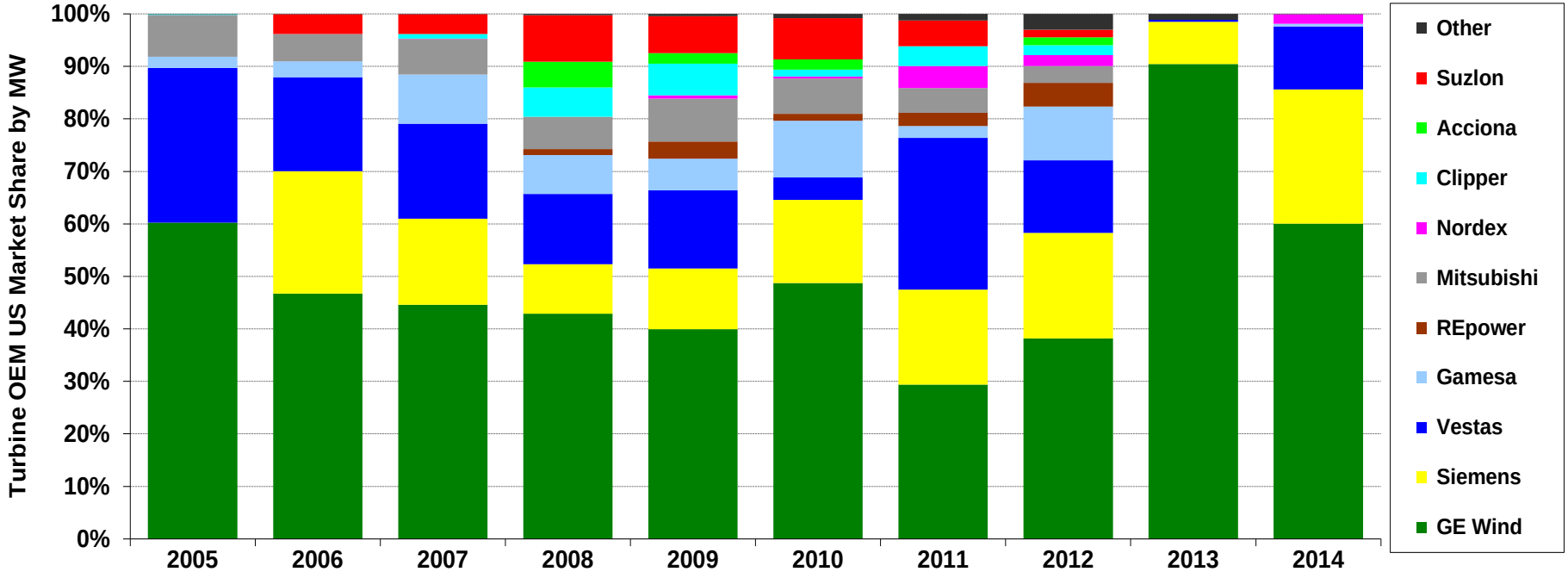
But… absolute amount of wind (and coal & nuclear) in sampled queues has declined in recent years whereas natural gas and solar capacity has increased

Not all of this capacity will be built….

- AWEA reports 13.6 GW of capacity under construction after 1Q2015

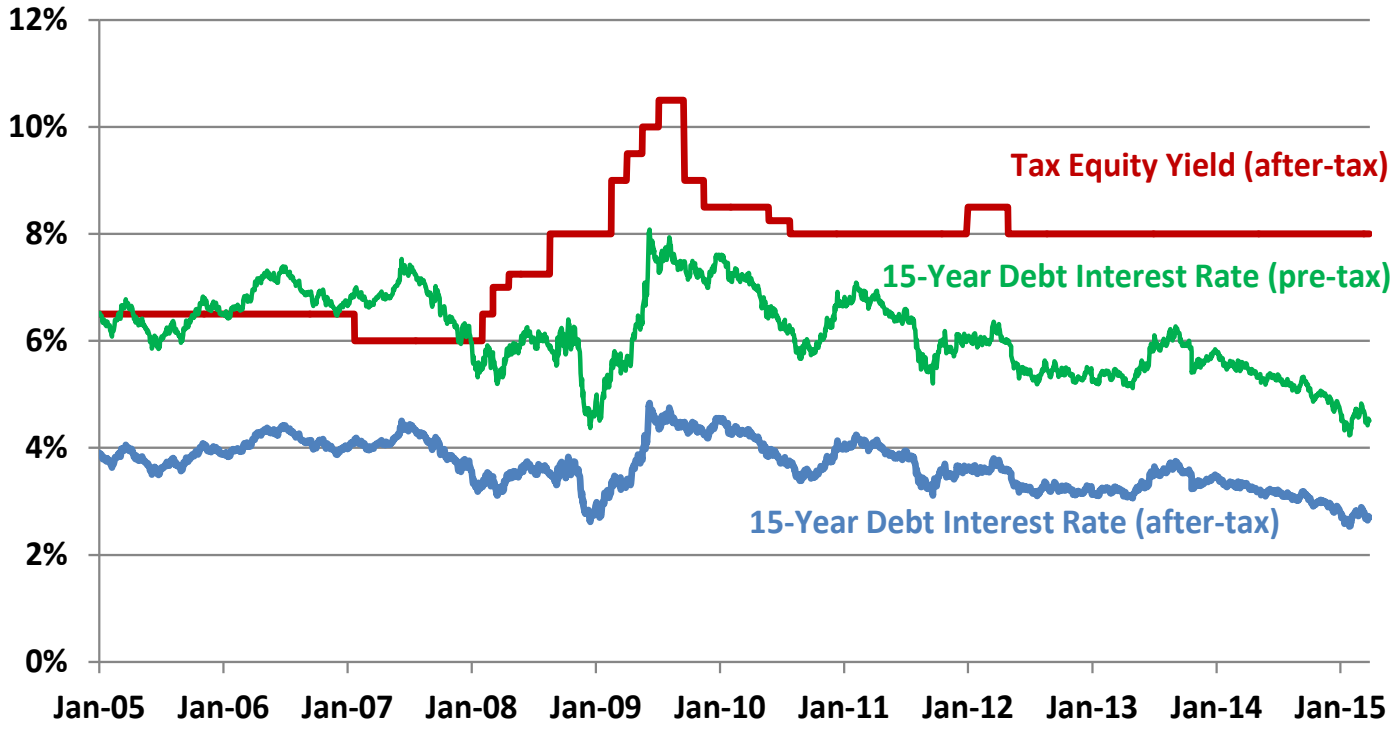
Industry Trends

GE, Siemens, and Vestas Captured 98% of the U.S. Market in 2014



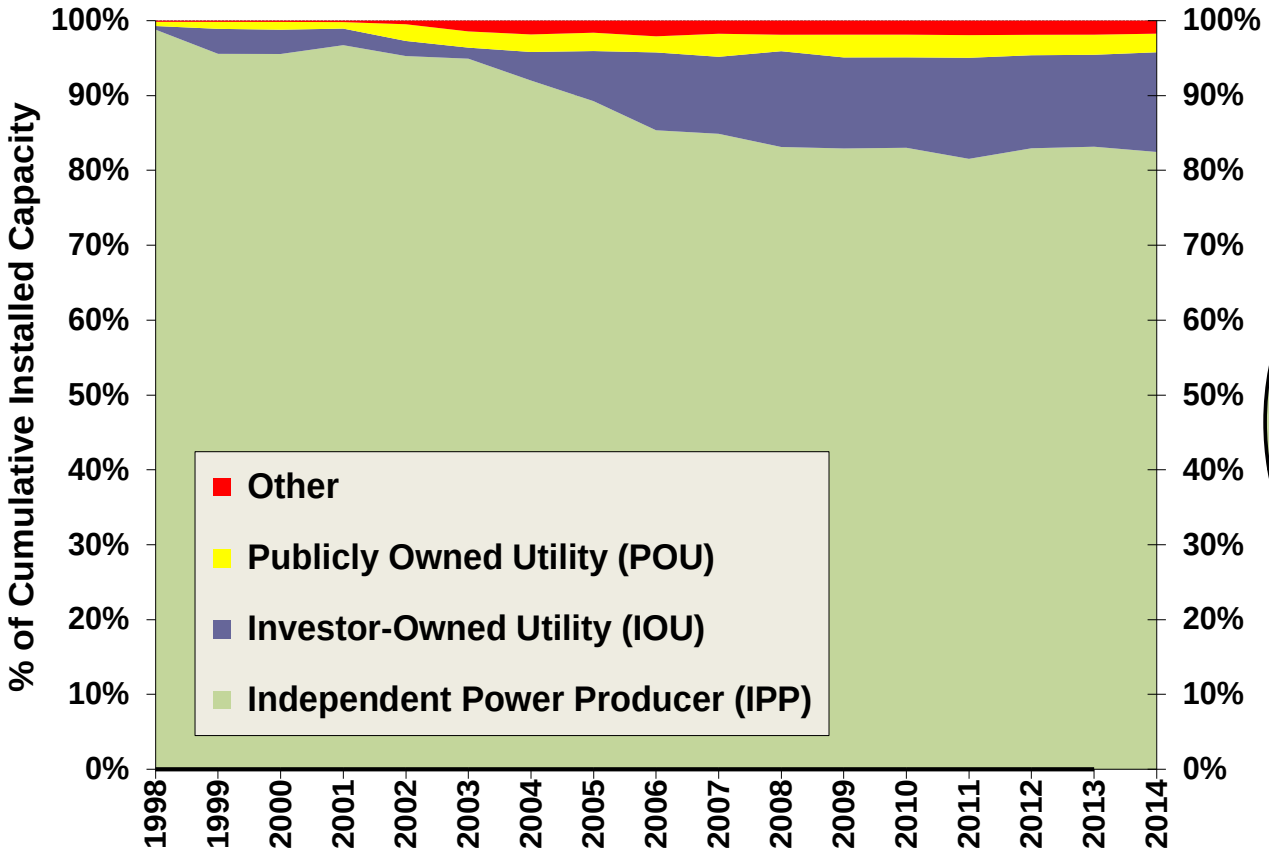
- Recent dominance of the three-largest turbine suppliers in the U.S. market
- Globally, Vestas remained the top supplier, followed by Siemens and GE
- Chinese suppliers occupied 8 of the top 15 spots in the global ranking, based almost entirely on sales within their domestic market

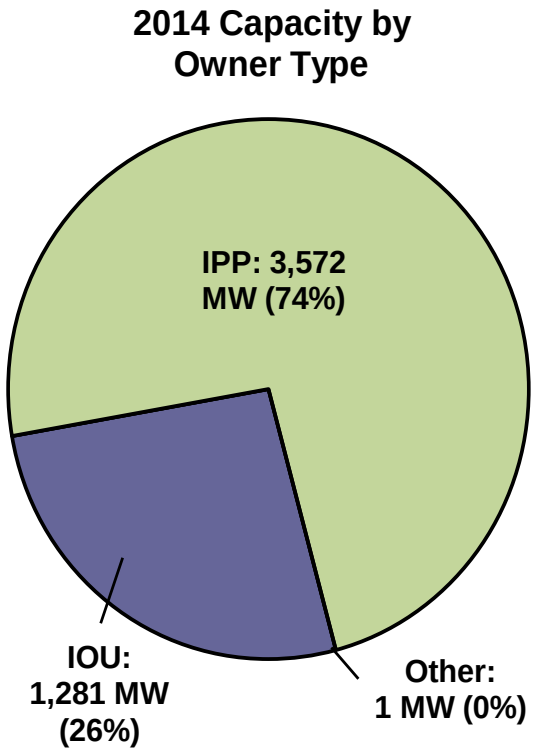
The Project Finance Environment Remained Strong in 2014



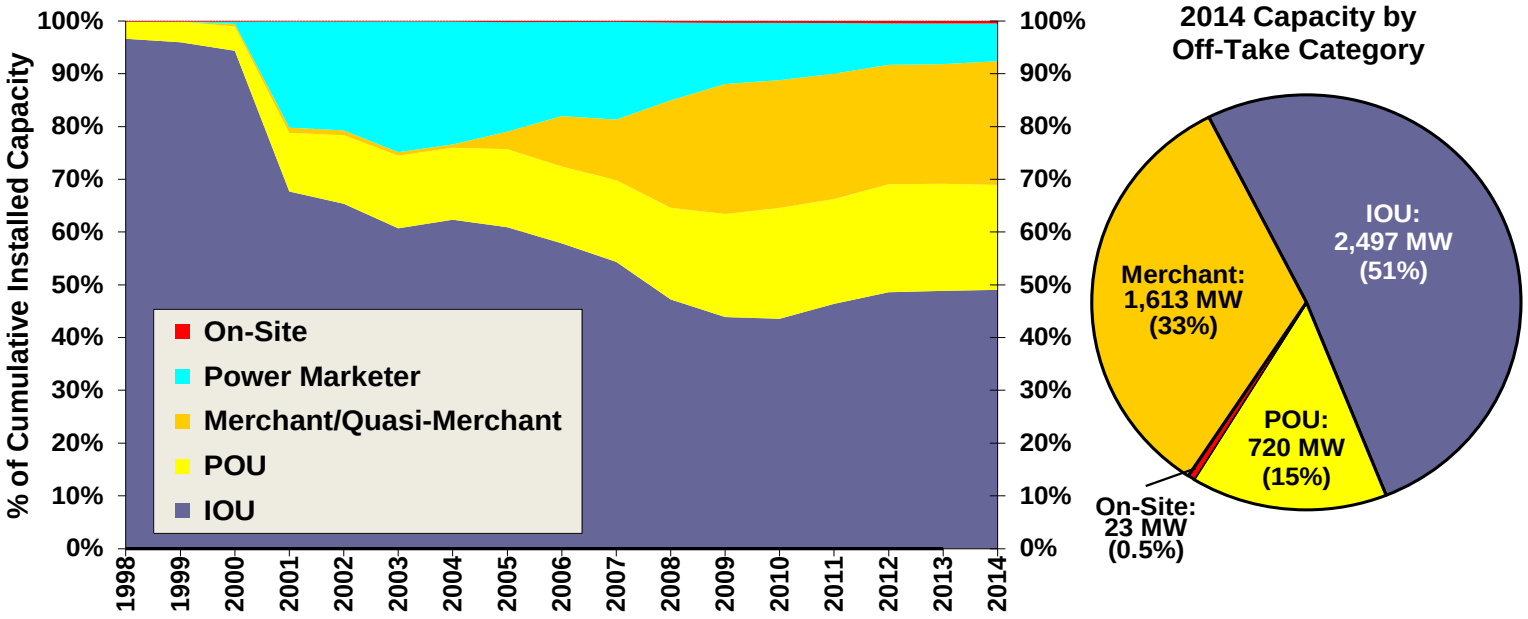
- Project sponsors raised $5.8 billion of tax equity (largest single-year amount on record) and $2.7 billion of debt in 2014
- Tax equity yields held steady, while debt interest rates trended lower

Utility Ownership of Wind Rebounded Somewhat in 2014; IPPs Still Dominate





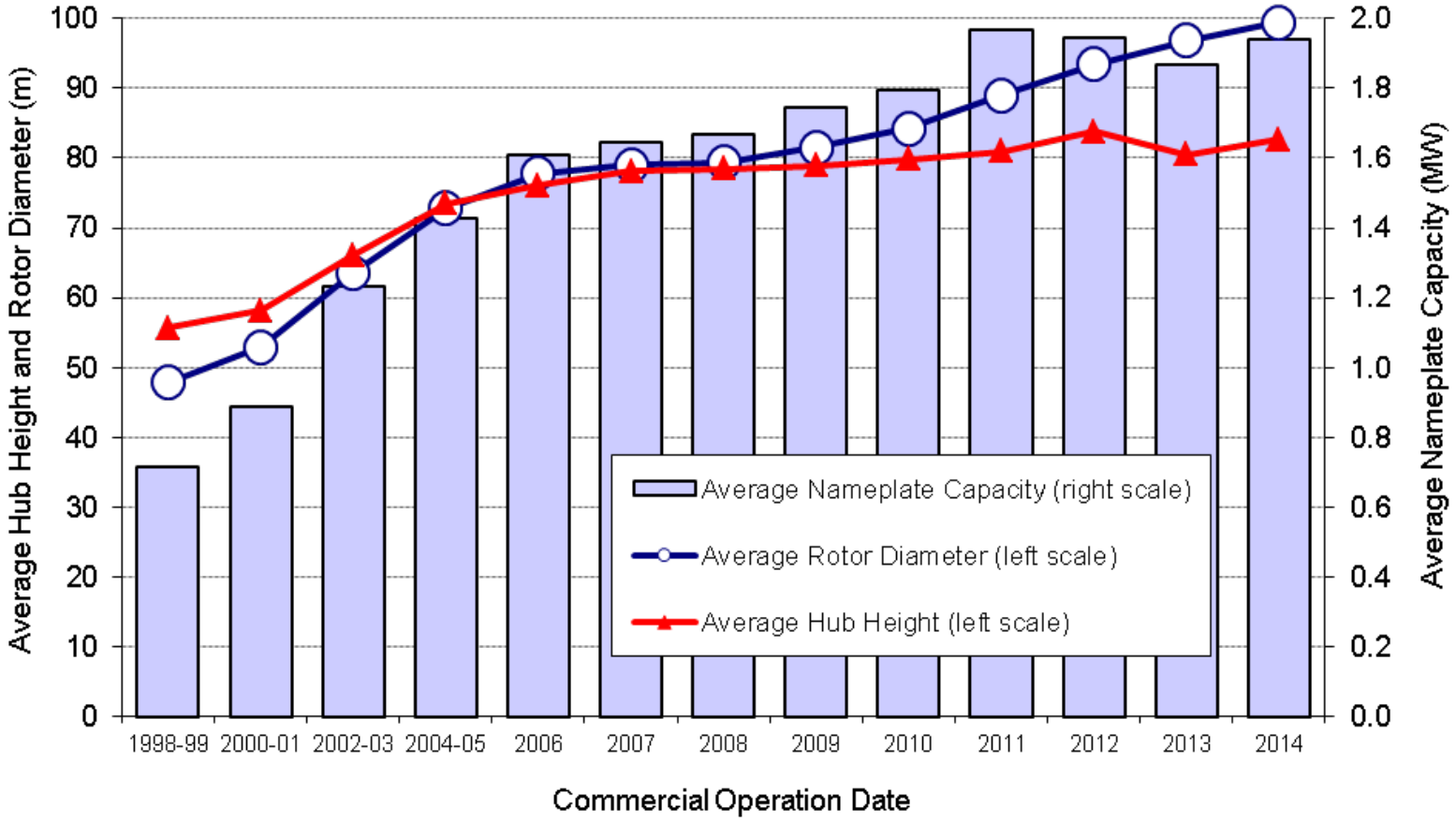
Long-Term Contracted Sales to Utilities Remained the Most Common Off-Take Arrangement, but Merchant Projects Continued to Expand, at Least in Texas



- Recently announced wind purchases of ~2 GW from technology companies and business giants to hospitals, universities, and government agencies

Technology Trends

Turbine Nameplate Capacity, Hub Height, and Rotor Diameter Have All Increased Significantly Over the Long Term



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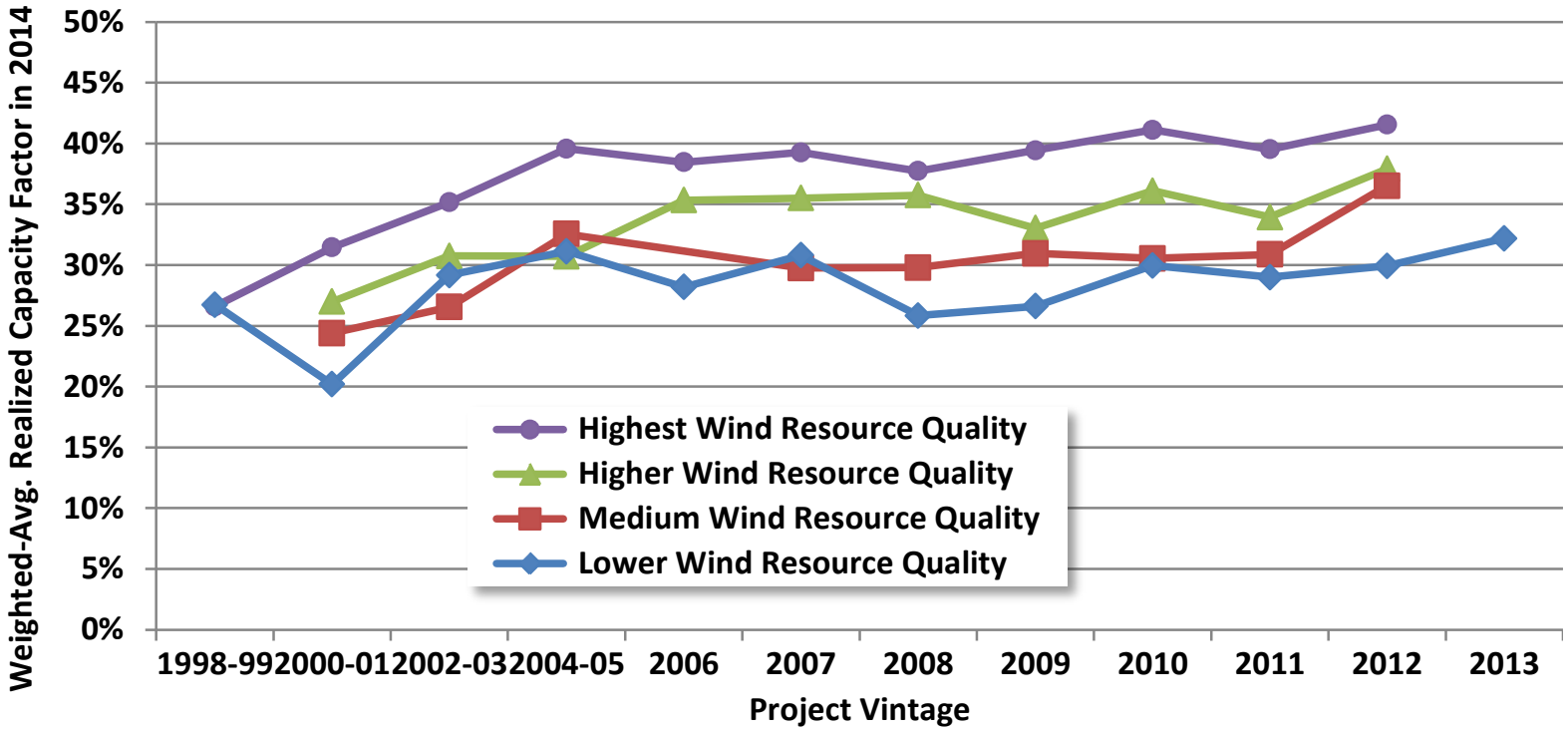
Performance Trends

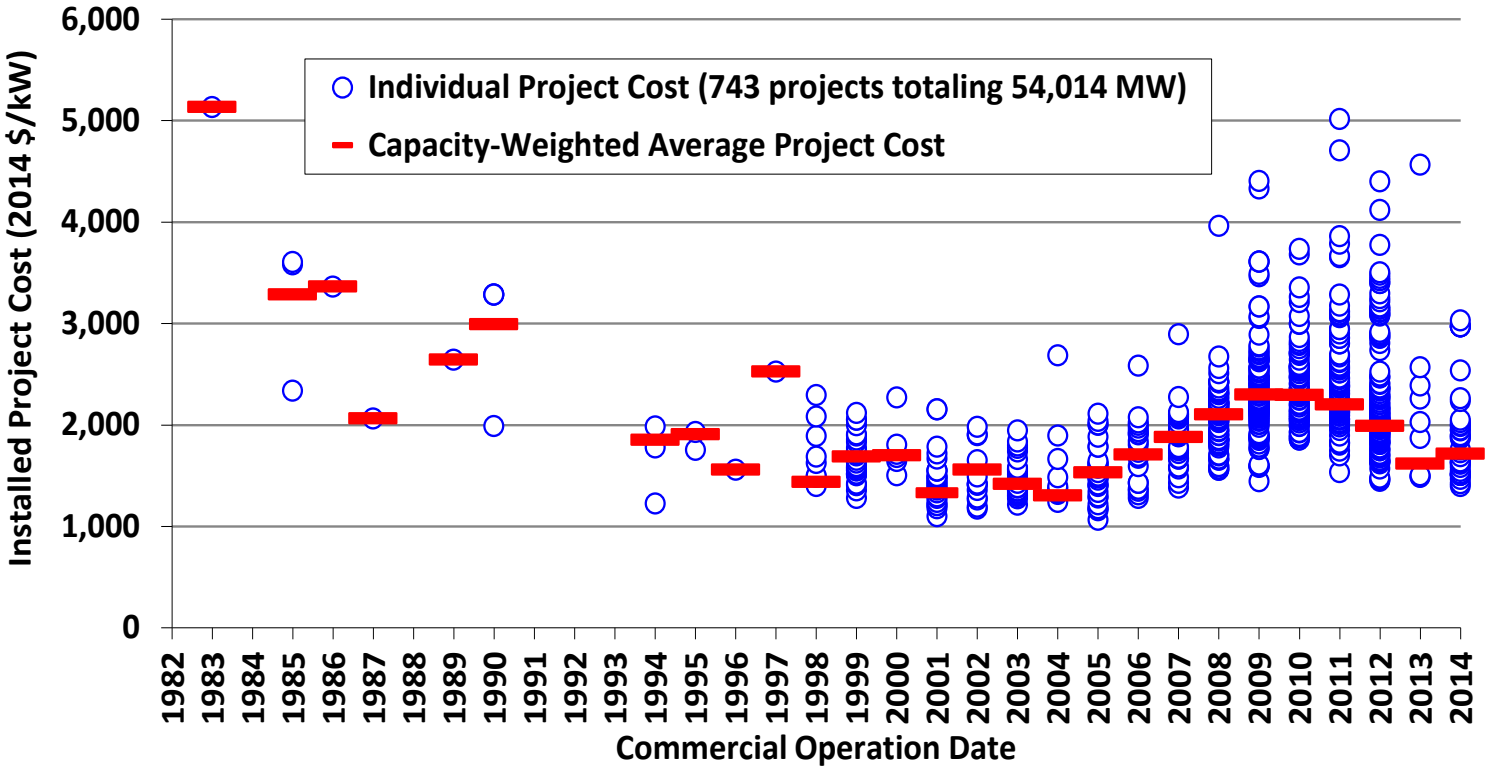
Controlling for Wind Resource Quality and Commercial Operation Date Demonstrates Impact of Turbine Evolution



Notwithstanding build-out of lower-quality wind resource sites, turbine design changes are driving capacity factors higher for projects located in given wind resource regimes

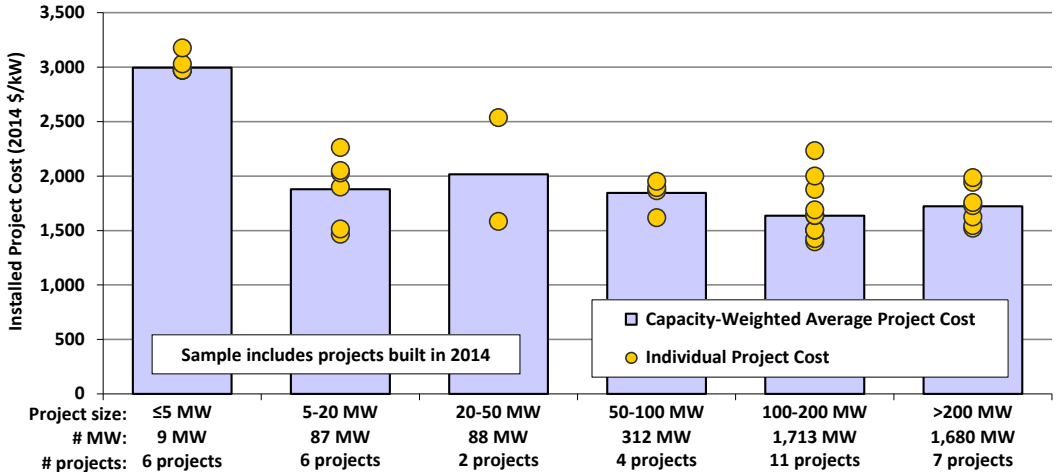
Cost Trends

Lower Turbine Prices Drive Reductions in Reported Installed Project Costs

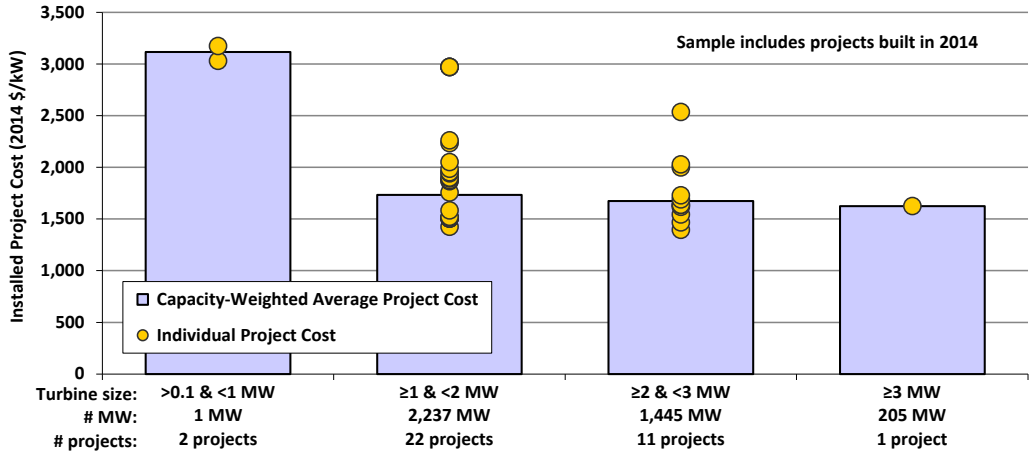


- 2014 projects had an average cost of $1,710/kW, down $580/kW since 2009 and 2010 (up slightly from small sample of 2013 projects)
- Limited sample of under-construction projects slated for completion in 2015 suggest no material change in costs

Economies of Scale Evident, Especially at Lower End of Project & Turbine Size Range

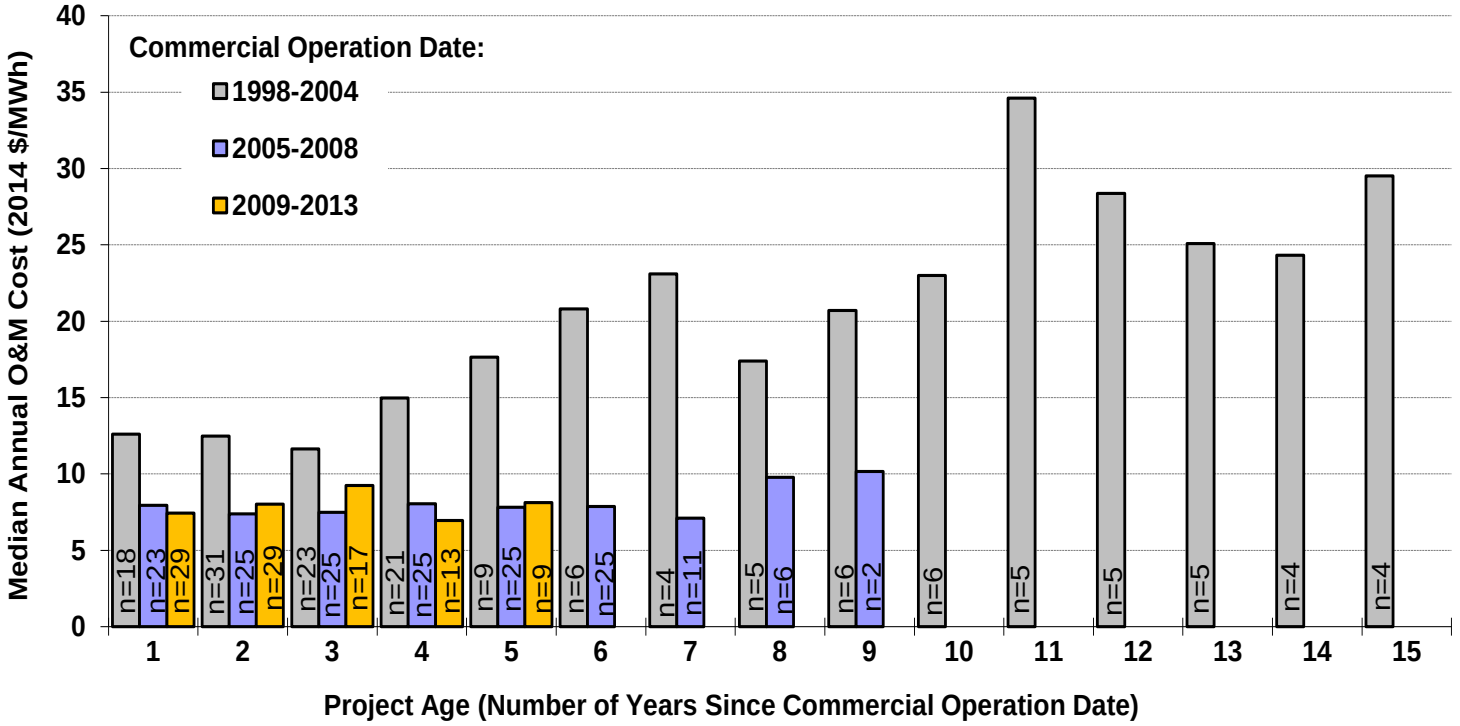


Project Size



Turbine Size

Operations and Maintenance Costs Varied By Project Age and Commercial Operations Date



Note: Sample size is limited

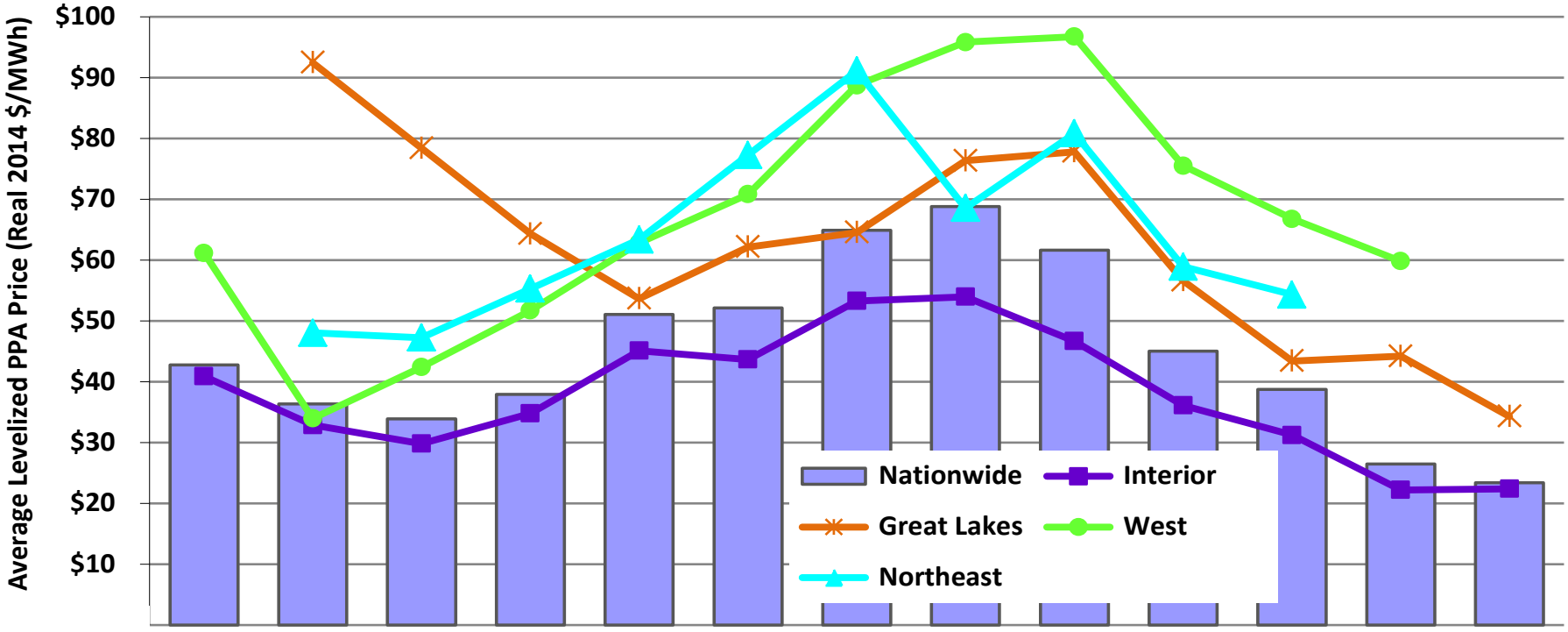
O&M reported in figure does not include all operating costs: Statements from public companies with large U.S. wind asset bases report total operating costs in 2014 for projects built in the 2000s of ~$21-25/MWh

Wind Power Price Trends

Sample of Wind Power Prices

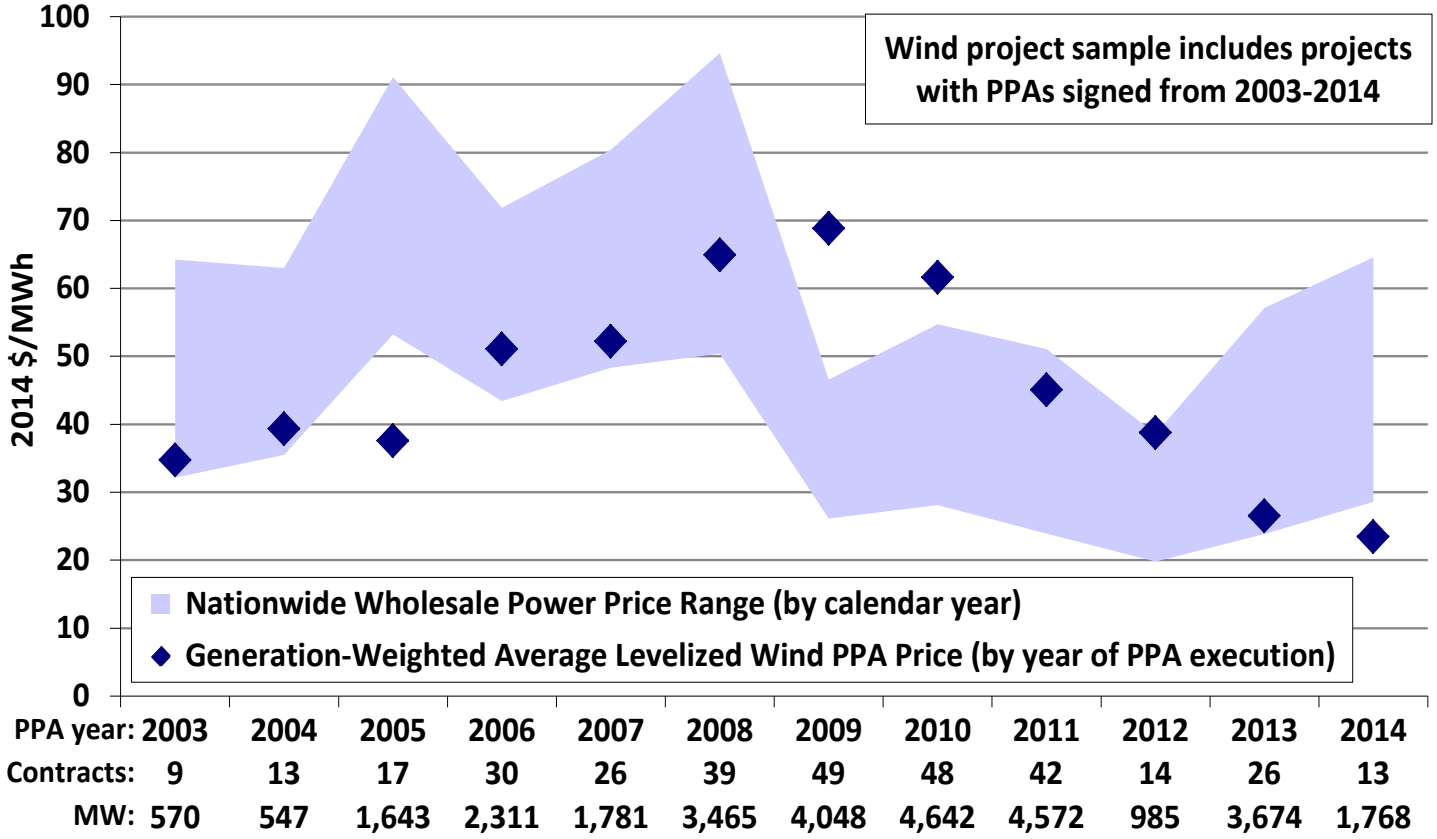
- Berkeley Lab collects data on historical wind power sales prices, and long-term PPA prices
- PPA sample includes 363 contracts totaling 32,641 MW from projects built from 1998-2014, or planned for installation in 2015 or 2016
- Prices reflect the bundled price of electricity and RECs as sold by the 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 well as various local policy and market influences; as a result, prices do not reflect wind energy generation costs

A Smoother Look at the Time Trend Shows Steep Decline in Pricing Since 2009; Especially Low Pricing in Interior Region



PPA Year:	1996-99	2000-01	2002-03	2004-05	2006	2007	2008	2009	2010	2011	2012	2013	2014
Contracts:	10	17	24	30	30	26	39	49	48	42	14	26	13
MW:	553	1,249	1,382	2,190	2,311	1,781	3,465	4,048	4,642	4,572	985	3,674	1,768

Relative Competitiveness of Wind Power Improved in 2014: Comparison to Wholesale Electricity Prices



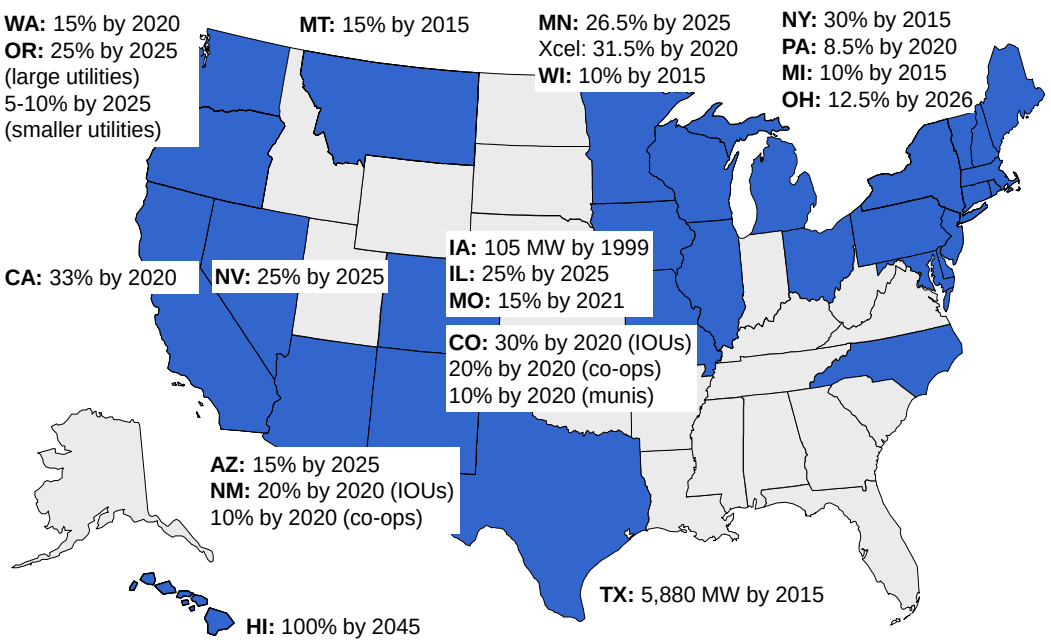
- Wholesale price range reflects flat block of power across 23 pricing nodes across the U.S.
- Price comparison shown here is far from perfect – ***see full report for caveats***

Policy and Market Drivers

Availability of Federal Incentives for Wind Projects Built in the Near Term Has Is Leading to a Resurgent Domestic Market, but a Possible Policy Cliff Awaits

- Near-term availability of the PTC/ITC for those projects that reached the “under construction” milestone by the end of 2014 will enable solid growth in 2015 and 2016; uncertain prospects after that
- Prospective impacts of more-stringent EPA environmental regulations, including those related to power-sector carbon emissions, may create new markets for wind energy

State Policies Help Direct the Location and Amount of Wind Development, but Current Policies Cannot Support Continued Growth at Recent Levels



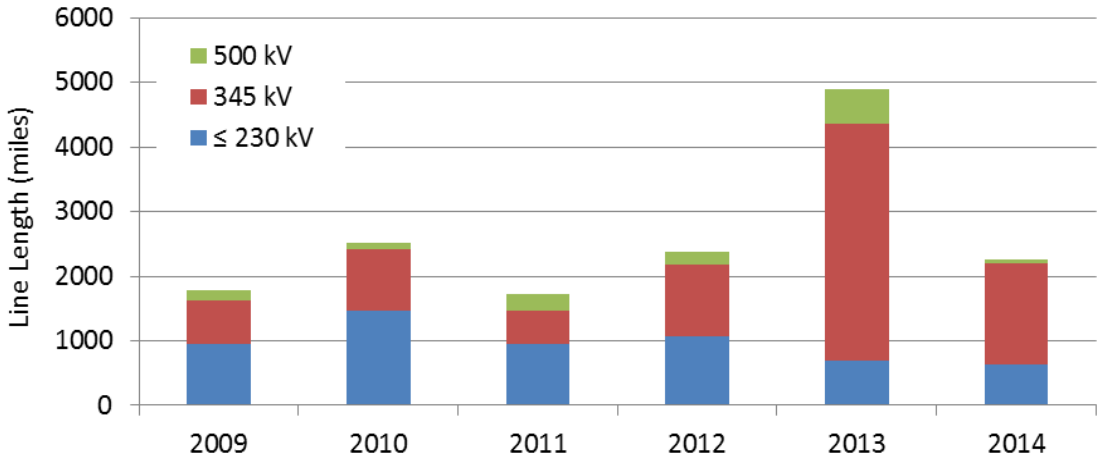
ME: 40% by 2017
NH: 24.8% by 2025
VT: 75% by 2032
MA: 11.1% by 2009 +1%/yr
RI: 16% by 2019
CT: 23% by 2020
DE: 25% by 2025
NJ: 22.5% by 2020
DC: 20% by 2020
MD: 20% by 2022
NC: 12.5% by 2021 (IOUs), 10% by 2018 (co-ops and munis)

Source: Berkeley Lab

- 29 states and D.C. have mandatory RPS programs
- State RPS' can support ~4-5 GW/yr of renewable energy additions on average through 2025 (less for wind specifically)

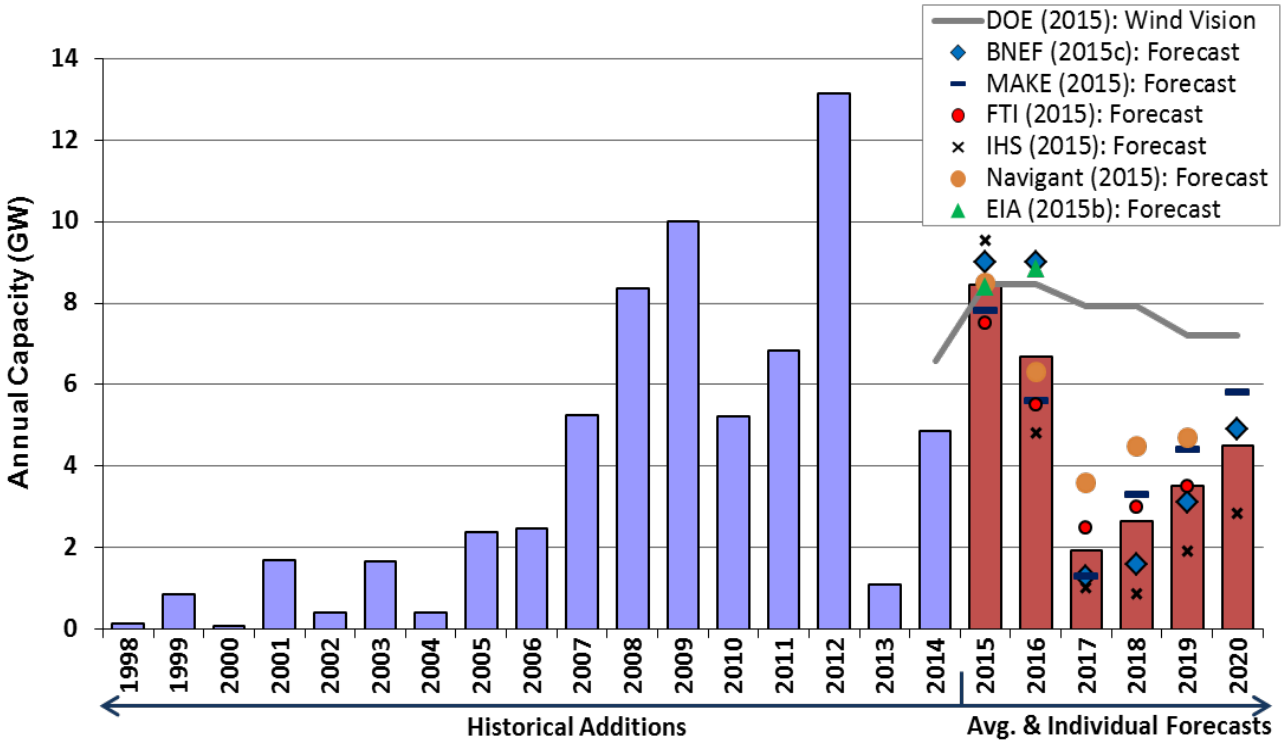
Solid Progress on Overcoming Transmission Barriers Continued

- Over 2,000 circuit miles of new transmission built in 2014; lower than 2013 but consistent with 2009-2012
- 22,000 additional circuit miles proposed by March 2017, with half having a high probability of completion
- AWEA has identified 18 near-term transmission projects that – if all were completed – could carry 55-60 GW of additional wind power capacity
- FERC continued to implement Order 1000, requiring public utility transmission providers to improve planning processes and determine a cost allocation methodology for new transmission investments



Future Outlook

Sizable Wind Additions Anticipated for 2015 & 2016; Downturn and Increased Uncertainty in 2017 and Beyond



Wind additions in 2014 and anticipated additions from 2017-2020 fall below the deployment trajectory analyzed in DOE's *Wind Vision* report

Current Low Prices for Wind, Future Technological Advancement and New EPA Regulations May Support Higher Growth in Future, but Headwinds Include…

- Lack of clarity about fate of federal tax incentives
- Continued low natural gas and wholesale electricity prices
- Modest electricity demand growth
- Limited near-term demand from state RPS policies
- Inadequate transmission infrastructure in some areas
- Growing competition from solar in some regions

Conclusions

- Annual wind capacity additions rebounded in 2014, with significant additional new builds anticipated for 2015 and 2016
- Wind has been a significant source of new electric generation capacity additions in the U.S. in recent years
- Supply chain has been under duress, but domestic manufacturing content for nacelle assembly, blades, and towers is strong
- Turbine scaling is boosting expected wind project performance, while the installed cost of wind projects is on the decline
- Wind power sales prices have reached all-time lows, enabling economic competitiveness despite low natural gas prices
- Growth after 2016 remains uncertain, dictated in part by future natural gas prices and policy decisions, though recent declines in the price of wind energy boost future growth prospects

For More Information...

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

- http://energy.gov/eere/wind

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