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North America

Alternative Energy| Wind Power

Wind Generators To Provide Reactive Power Under Revised Interconnection Agreements

New Requirements Would Level Interconnection Requirements For Synchronous And Non-Synchronous Generators

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Policy Brief

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Key Takeaways:

- Reforms to the Federal Energy Regulatory Commission's (FERC) interconnection requirements will eliminate the current reactive power exemptions for wind generators
- To implement the proposed amendments, each public utility transmission provider would be required to submit a compliance filing within 90 days after the final rule takes effect
- With growing wind energy penetration, grid operators will have to enhance power quality of new wind installations
- Turbines with enhanced inverters will be crucial for voltage control capabilities

Entities Mentioned:

- Bureau of Ocean Energy Management
- California Independent System Operator
- Energy Information Administration
- Environmental Protection Agency
- Department of Energy
- Department of the Interior
- Federal Energy Regulatory Commission
- PJM Interconnection
- Southwest Power Pool

Related Research

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Insight for Industry – FERC Proposes Eliminating Reactive Power Exemptions for Wind Power in Response to Growing Grid Penetration

On November 19, 2015, the Federal Energy Regulatory Commission (FERC) issued a proposed rule to eliminate a decade-old exemption for wind plants from reactive power obligations imposed on other generators. Reactive power is essential to control system voltage to ensure efficient and reliable operations of an alternating current transmission system. The proposal would establish reactive power requirements for all newly interconnecting non-synchronous generators, including generator upgrades that require interconnection requests, as a condition of interconnection.

Synchronous generators have a mechanical rotor which generates voltage that corresponds to the system frequency and produces both real or usable power and reactive power—in simple terms, the ability to ensure the grid remains in phase—in response to system needs. They constitute the central generation around which much of the current grid was developed and have traditionally provided reactive power capability. Examples of synchronous generating facilities include nuclear power plants, large hydro plants, and natural-gas fired generators. Asynchronous resources include renewable resources such as solar and wind that do not produce voltage in sync with the rest of the grid. These resources lack inherent reactive power capability unless the inverters used to condition their output have integrated this feature. The FERC proposal draws on ongoing technological advances that have drastically reduced costs, and could contribute to advancing the role of wind energy in an economically optimal generation mix. According to FERC, if the share of wind generation continues growing or if the synchronous generators currently providing reactive power retire, the reliability of the grid might suffer.

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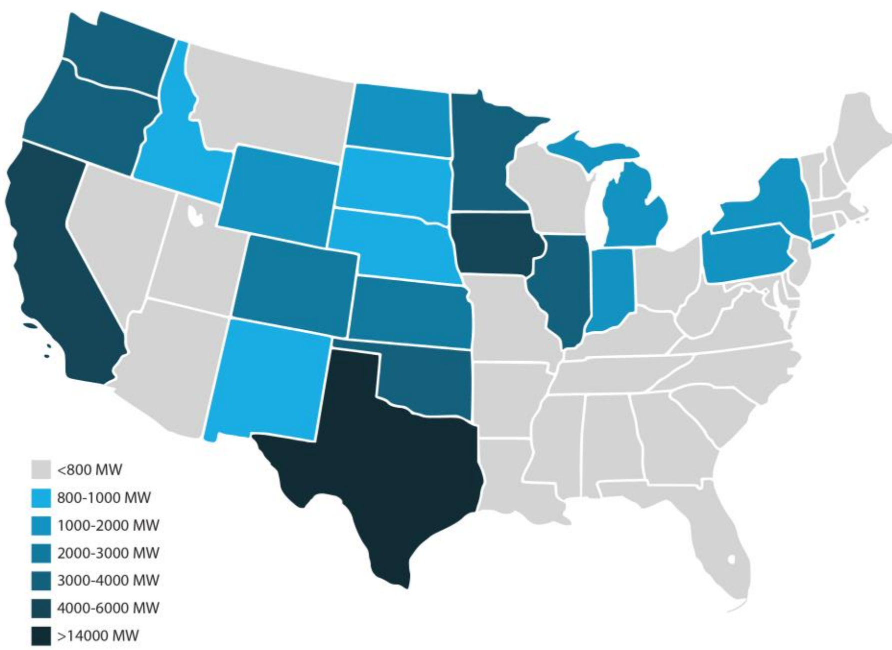
Due to its inherent variability and uncertainty, wind power is not synchronized to the electrical frequency of the power grid and is generally unresponsive to system frequency, unlike conventional thermal and hydropower technologies. The characteristics of variability, uncertainty, and asynchronism have posed challenges to maintaining system reliability. Utilities, balancing area authorities, regional transmission organizations (RTOs), and independent system operators (ISOs) are developing improved strategies for better grid integration of wind and other variable generation. In recent years, demand response, energy storage, and improved wind power forecasting techniques have demonstrated potential for integrating intermittent resources into the grid while maintaining its reliability. These advances, together with reactive power capabilities, will facilitate system flexibility required to address fluctuations in renewable power output, thereby making renewable generation more predictable, controllable, and dispatchable.

Moving forward, with rising wind energy penetration, grid operators must explore ways of integrating large quantities of wind energy into system operations, while developing capabilities that enable new wind installations to actively enhance the power quality of the electric grid. Installed wind power capacity grew at a rate of eight percent in 2014 in the U.S., bringing the total to approximately 66 gigawatts (GW) and 4.9 percent of the U.S. end-use electricity demand (Figure 1). In addition, low wind energy prices are now competitive with wholesale power prices and traditional sources across several regions in the nation.

Figure 1 - Total U.S. Installed Wind Capacity in 2014



Source: DOE

FERC Proposes Requirement for Wind Generators to Have Dynamic Reactive Power Capability; Cites Cost Decreases in Equipment as Minimizing Hurdles

The FERC proposal (RM16-1-000) would establish reactive power requirements for non-synchronous generation by modifying the two pro forma interconnection agreements – Large Generator Interconnection Agreement (LGIA) and Small Generator Interconnection Agreement (SGIA) – to eliminate the reactive power exemption for wind generators. It would require all wind generators to have dynamic reactive power capability and maintain reactive power within a power factor (ratio of real power to apparent power — the vector sum of real and reactive power) range of 0.95 leading to 0.95 lagging or the FERC-approved standard range adopted by the transmission provider, measurable at the point of interconnection. However, such generators would be required to maintain the required power factor range only when the generator's real power output exceeds 10 percent of its nameplate capacity, as, according to FERC, inverters used by non-synchronous generators are not capable of producing reactive power when operating below that level.

Newly interconnecting non-synchronous generators would be eligible for the same payments for reactive power as other generators, with compensations based on the cost of providing reactive power

Newly interconnecting non-synchronous generators would be eligible for the same payments for reactive power as other generators, with compensations based on the cost of providing reactive power. The proposal would not apply to non-synchronous generators that have executed an LGIA or SGIA before the final rule takes effect, unless they propose upgrades that require new interconnection requests. To implement the proposed amendments, each public utility transmission provider would be required to submit a compliance filing revising its SGIA and LGIA as necessary, within 90 days after the final rule takes effect.

According to the FERC, the exemption from providing reactive power could cause grid reliability issues if wind gains a substantial share in the generation mix or if many of the resources that currently provide reactive power retire. In addition, maintaining the exemption could unduly burden synchronous generators to supply reactive power, absent a reasonable technological or cost-based distinction between synchronous and non-synchronous generators.

The ability to adjust the power factor allows system operators to maintain scheduled voltages within allowed tolerances and maintain the reliability of the transmission system. Reliable operation of a transmission system requires system operators to maintain a tight control of voltages at all points on the system.

FERC originally exempted wind generators from reactive power requirements under Order Nos. 2003, 661, and 2006 due to the inability of older wind turbine generators to produce and control reactive power without costly equipment, with the intention of preventing unnecessary obstacles to the growth of wind generation. However, in issuing its latest proposal, FERC cited the reduced cost of reactive power equipment for wind generators that is now comparable to that of a traditional generator, saying that requiring newly interconnecting wind generators to provide reactive power would no longer hinder the growth of wind generation.

Comments on the proposal are due 60 days after publication in the federal register.

Requiring wind generators to operate in the required power factor range would remove undue discrimination and place them on equal footing with other generators, thereby satisfying basic interconnection requirements

Wind Technology Advancements Prompt FERC to Approve PJM's Reactive Power Obligations for Non-Synchronous Resources

Due to technology improvements and reduced costs for providing reactive power, FERC said that requiring wind generators to operate in the required power factor range would remove undue discrimination and place them on equal footing with other generators, thereby satisfying basic interconnection requirements. In May, FERC accepted a proposal by PJM Interconnection (PJM) to effectively remove the wind generator exemption from the PJM tariff, recognizing these advancements in wind technology. Specifically, FERC accepted PJM's proposal to require interconnection customers seeking to interconnect non-synchronous generators, including wind generators, to use enhanced inverters with the capability to provide reactive power. In proposing the revisions, PJM explained that the voltages generated from the variable output of non-synchronous resources fluctuate more than those of legacy generation resources, raising potential grid reliability issues. Although legacy equipment has helped manage such voltage swings, increasing penetration of non-synchronous resources makes it increasingly difficult to control the magnitude and frequency of voltage swings without reactive power support from non-synchronous resources. The installed capacity megawatt value of non-synchronous resources on the PJM system increased from approximately 8,000 MW in the 2007-2008 delivery year to nearly 12,000 MW in the 2013-2014 delivery year. PJM has approximately 25,000 MW of expected maximum net capability of non-synchronous resources in its interconnection queue in future delivery years. Although the capacity of the individual resources is relatively smaller than large scale legacy generating units, their aggregated capacity can have a significant impact on the electric system.

The need for uniform reactive power obligations is gaining prominence, as grid operators are seeking ways to address voltage adequacy issues resulting from increasing integration of renewable generation, especially in areas far from load centers

The need for uniform reactive power obligations is gaining prominence, as grid operators are seeking ways to address voltage adequacy issues resulting from increasing integration of renewable generation, especially in areas far from load centers. ERCOT has adopted a reactive power standard to integrate the development of Competitive Renewable Energy Zones (CREZs) and support supply transfer within the ERCOT region. In March, the California Independent System Operator (CAISO) launched a stakeholder initiative to consider reactive power requirements for asynchronous resources, which are transforming the region's resource mix.

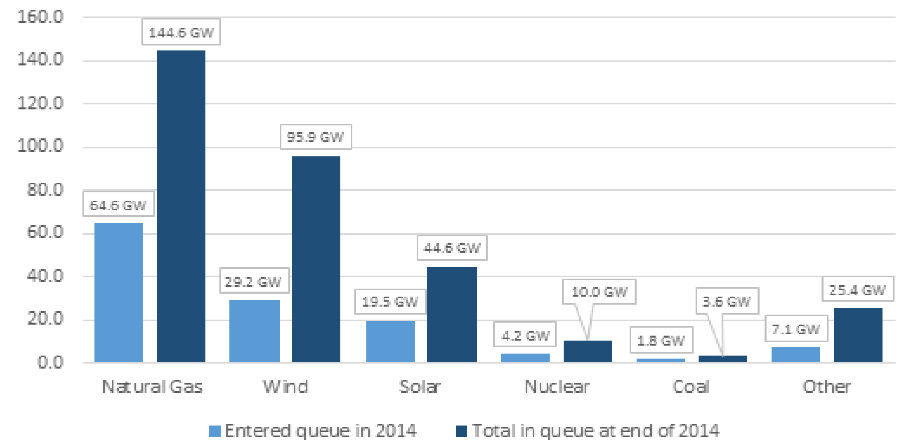
The PJM decision highlights the impacts from changes in wind technology. Currently installed wind turbines are generally Type III and Type IV inverter-based turbines capable of producing and controlling dynamic reactive power, a significant advancement from 2005 when FERC made the exemptions. In 2014, 94 percent of new installations used IEC Class 3 and Class 2/3 turbines and only 6 percent of turbines were Class 2 or lower. In addition, Class 3 wind turbines feature a larger rotor, which results in increased energy capture and greater output in low-wind areas.

Onshore Wind Development Reflects Technology Improvements

The Department of Energy's (DOE) 2014 Wind Technologies Market Report underscores the continued interest in onshore wind energy development as evident from the substantial amount of wind power in major interconnection queues across the nation. The DOE assessed 35 different interconnection queues administered across ISOs, RTOs, and utilities, finding that there was 96 GW of wind power capacity within the transmission interconnection queues at the end of 2014, representing 30 percent of generating capacity within these queues. In 2014, 29 GW of gross wind power capacity entered the interconnection queues, compared to 65 GW of natural gas and 20 GW of solar (Figure 2).

Total wind capacity in interconnection queues has declined by 68 percent since 2009, partly due to efforts by FERC, ISOs, RTOs, and utilities to reduce speculative projects that have previously congested these queues. However, the current level—96 GW at the end of 2014—still indicates a significant amount of planned development.

Figure 2 - DOE Assessment of Nameplate Resource Capacity (GW) in 35 Selected Interconnection Queues

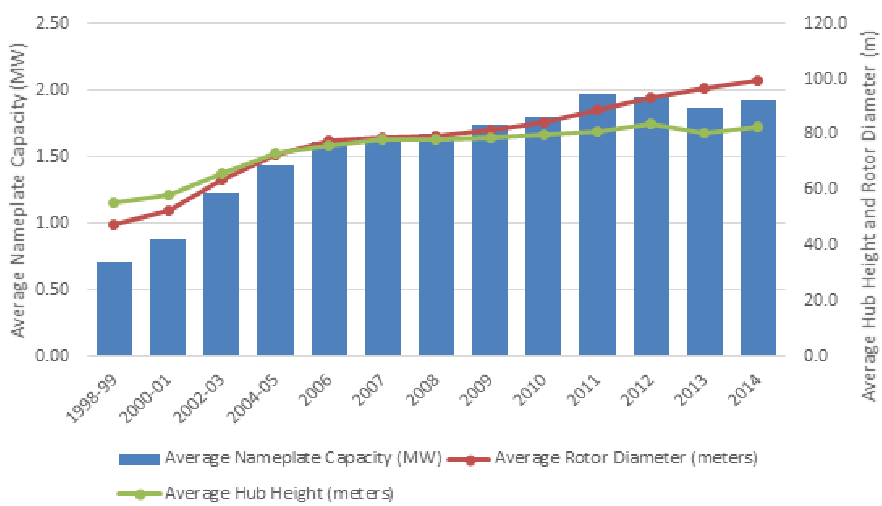


Source: DOE

Wind technology has significantly improved over the long term, as evident from the increase in turbine nameplate capacity, hub height, and rotor diameter

Evidently, wind technology has significantly improved over the long term, signified by the increase in turbine nameplate capacity, hub height, and rotor diameter. The average nameplate capacity of newly installed wind turbines in the U.S. in 2014 was 1.9 MW, an increase of 172 percent from 1998–1999. The average hub height in 2014 was 82.7 meters, an increase of 48 percent from 1998-1999, while the average rotor diameter was 99.4 meters, a 108 increase over the same period (Figure 3).

Figure 3 - Average Nameplate Capacity, Rotor Diameter, and Hub Height for Turbines >100kW, 1998-2014



Source: DOE

These types of turbine design changes are significantly increasing capacity factors within different wind resource areas. Wind project capacity factors have increased to an average of 32.9 percent from 2011-2014, compared to

31.8 percent from 2006-2010 and 30.3 percent from 2000-2005. And, significantly, the degree of wind curtailment has declined in the historically problematic areas. For example, only 0.5 percent of wind generation within the Electricity Reliability Council of Texas (ERCOT) was curtailed in 2014, a significant decline from the 17 percent peak in 2009.

Wind turbine prices have also dropped substantially, despite increases in hub heights and rotor diameters. While average turbine prices increased to more than $1,500/kW by the end of 2008, recently announced transactions are in the $850–$1,250/kW pricing range. These price reductions, together with improved turbine technology, have reduced project costs and wind power prices. Wind power purchase agreement (PPA) prices signed in 2014 were below the bottom of the wholesale power price range due to the continued decline in average levelized wind PPA prices and continued rebound in wholesale power prices. The national average levelized price of wind PPAs that were signed in 2014 – focused on DOE's sample of projects in the lowest-priced interior region – dropped to a new low of approximately $23.5/MWh nationwide from nearly $70/MWh for PPAs executed in 2009.

Wind Industry Growth Shows Resurgence Nationwide after 2013 Setback

After a setback in 2013 following the expiration and delayed renewal of the federal renewable energy production tax credit (PTC), the U.S. wind industry recovered in 2014, with wind representing the third largest source of new generation capacity after natural gas and solar, accounting for 24 percent of capacity additions (Figure 4).

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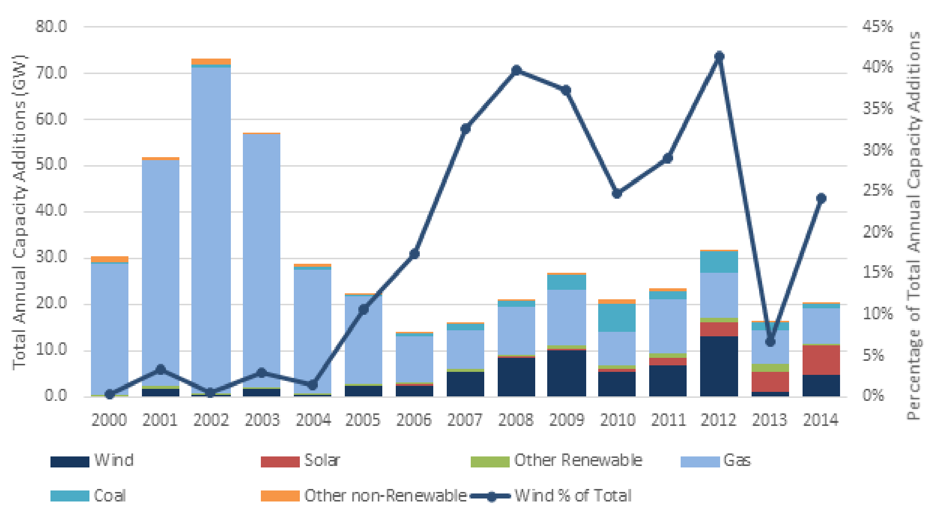
Figure 4 - Relative Contribution of Generator Types in 2014 Capacity Additions (GW)



Source: DOE

This increase in wind capacity has impacted multiple regions. The United States installed 1,500 MW of wind capacity in 2013 through May 2014, and more than 7,700 MW from June 2014 through August 2015. An additional

4,600 MW is planned to be installed by the end of 2015. In the ERCOT region, less than 100 MW of wind capacity was installed from January 2013 through May 2014, but more than 4,000 MW was installed in from June 2014 through September 2015. An additional 1,000-2,000 MW is planned to be installed by the end of 2015. The industry added 4,854 MW of new capacity in 2014 with an investment of $8.3 billion. Cumulative wind power capacity grew by nearly eight percent, bringing the total to 65,877 MW (Figure 5).

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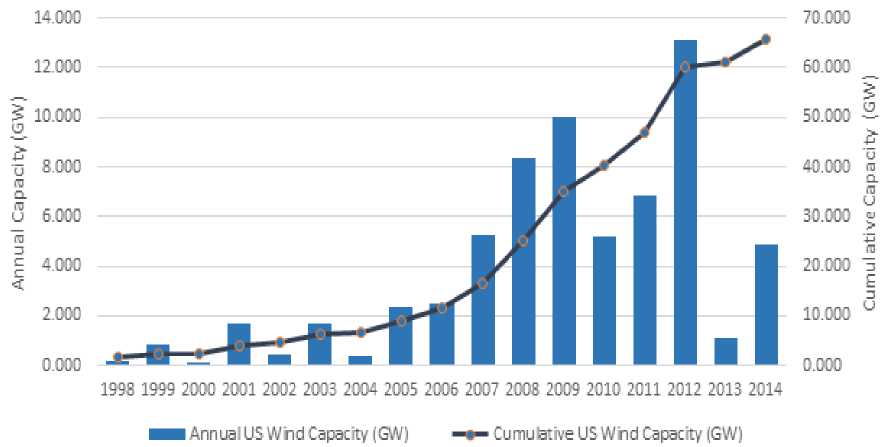
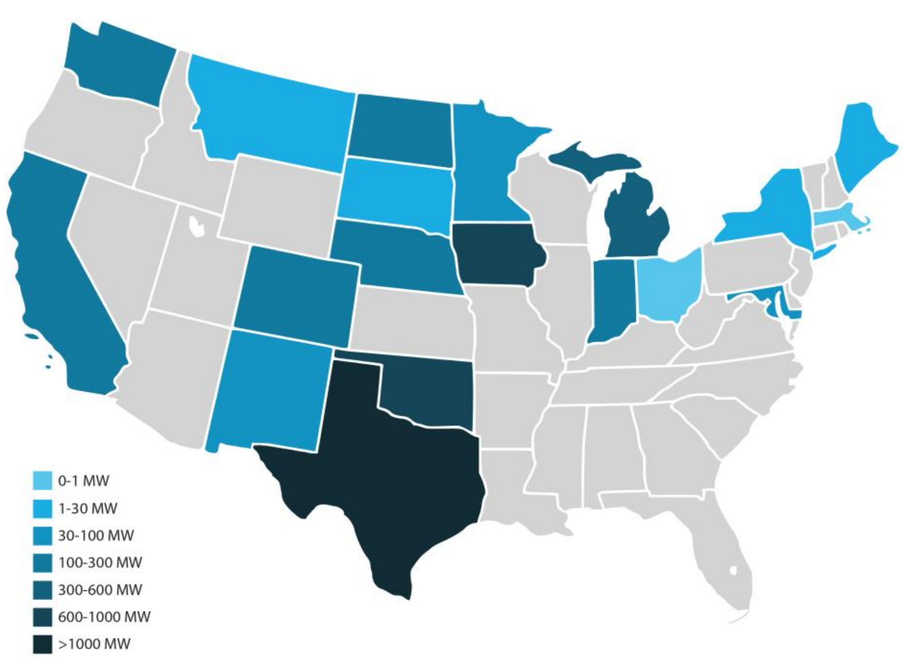
Figure 5 – Annual and Cumulative Growth in U.S. Wind Power Capacity (GW)



Source: DOE

Texas installed the most capacity in 2014 with 1,811 MW (Figure 6).

Figure 6 - Wind Capacity Added in 2014



Source: DOE

Nine states exceeded 12 percent in wind energy penetration. Notably, the wind power capacity installed in Iowa and South Dakota supplied approximately 28 percent and 25 percent, respectively, of in-state electricity generation in 2014 (Figure 7). New utility-scale wind turbines were installed in nineteen states in 2014. Utility ownership of wind assets increased to 26 percent of all new wind capacity installed in 2014, up from just 4 percent in 2013 and 10 percent in 2012. Independent power producers own the remainder of new 2014 capacity.

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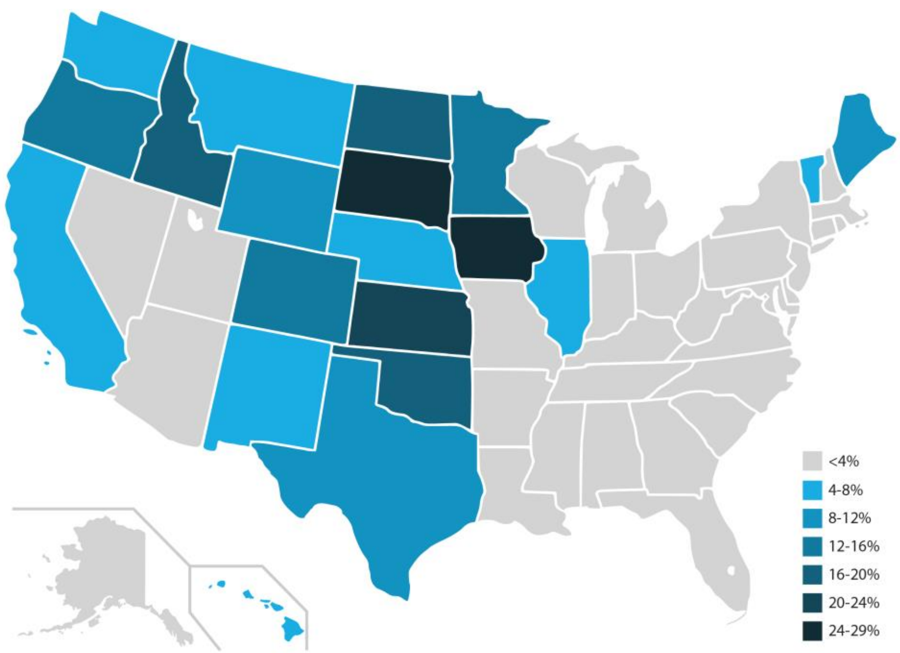
Figure 7 - Percentage of In-State Generation, 2014



Source: DOE

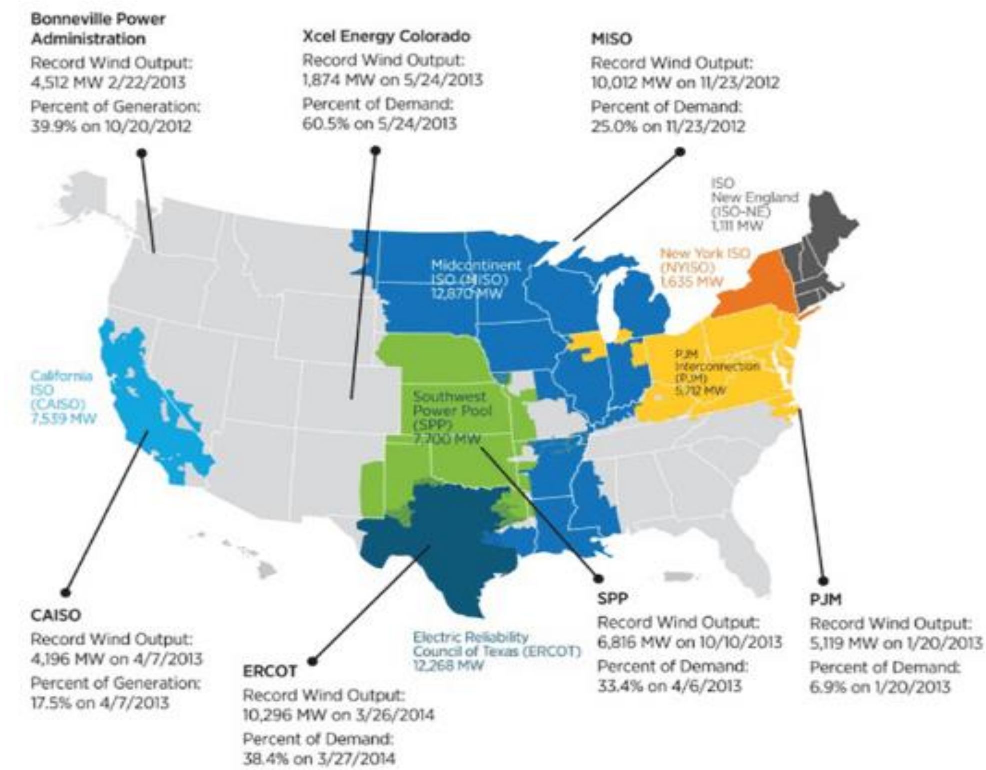
Capacity development is only as useful as transmission development keeps pace, and transmission development has followed suit. Approximately 2,000 miles of transmission lines came online in 2014 and an additional 22,000 miles of new transmission lines or line upgrades are proposed to come online by March 2017.

Transmission is of particular importance for wind energy as areas with favorable wind speeds could be distant from load centers. Lack of transmission can hinder new wind power development, while inadequate transmission capacity in areas where wind projects are already built can result in curtailment. In Texas, the elimination of transmission constraints, largely attributed to the state's CREZ program, has helped wind generation reach new heights in recent years, such as the March 2014 peak output of more than 10,000 MW (Figure 8). The CREZ includes almost 3,600 circuit miles of transmission lines and will accommodate up to 18,500 MW of wind power. As CREZ transmission expansions have allowed wind power to flow to more

In Texas, the CREZ program has helped wind generation reach new heights in recent years, such as the March 2014 peak output of more than 10,000 MW

electricity demand areas, curtailments of wind generation on the Texas electric grid have steadily dropped since 2011 and occurrences of wind-related negative real-time electricity prices have declined.

Figure 8 – Regional Records in Wind Output (2012-2014)



Source: DOE

Favorable Federal and State Policies Could Position Wind Industry to Meet Voltage Control Requirements

Federal and state policy support has been instrumental in expanding the U.S. wind power market, alongside federal investments in wind energy research and development. The PTC – originally enacted through the 1992 Energy Policy Act – provided a $0.023/kWh tax credit for the first 10 years of utility-scale wind electricity generation. The renewable energy investment tax credit (ITC) – available as of 2013 – provides a credit for 30 percent of investment costs, in lieu of the PTC. The accelerated tax depreciation enables wind project owners to depreciate the majority of their investments over a five- to six-year period for tax purposes. In addition, bonus depreciation schedules have been periodically available since 2008. As part of its initiatives to increase renewable energy generation, the Department of the Interior (DOI) has permitted 11 utility-scale wind energy projects and associated infrastructure since 2009.

The extension of the PTC and ITC in December 2014 – allowing projects that began construction in 2014 to apply for the credit – has spurred strong growth in wind capacity additions in 2015 and is expected to continue throughout 2016

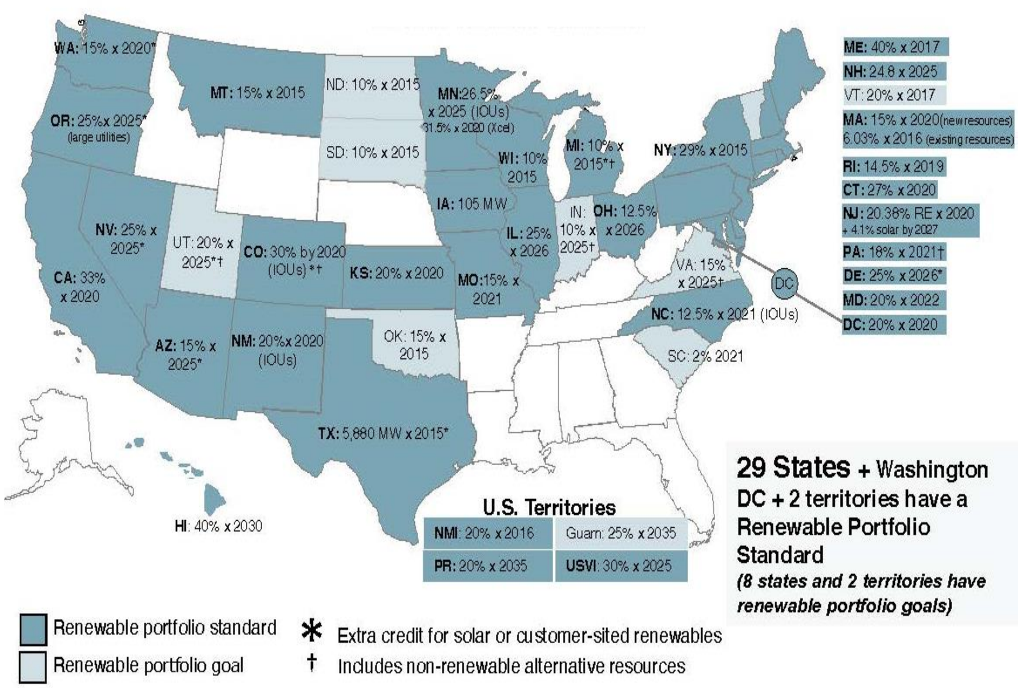
The extension of the PTC and the investment tax credit (ITC) in December 2014 – allowing projects that began construction in 2014 to apply for the credit – has spurred strong growth in wind capacity additions in 2015 and is expected to continue throughout 2016. Expirations and short-term extensions of the federal tax incentives have created notable fluctuations in wind deployment. In January 2013, the PTC and ITC were extended through the American Taxpayer Relief Act, allowing projects larger than 100 kW qualify if construction commenced before January 1, 2014 (turbines under 100 kW are eligible until 2016) and placed into service by 2015 year-end. The PTC expiration and uncertainty over its renewal create uncertainties for wind deployment beyond 2016, despite the notable growth in the absence of stable and long-term federal incentives.

At the state level, renewable portfolio standards (RPS) and renewable energy standards (RES) that set targets for near- and long-term procurement of renewable generation have facilitated wind penetration. According to DOE roughly 54 percent of wind power capacity built in the U.S. from 1998-2014 has been delivered to load serving entities with RPS obligations. In 2014, wind capacity additions delivered in RPS states stood at 31 percent. As of March 2015, mandatory RPS programs existed in 29 states and Washington D.C. State renewable energy funds and tax incentives provide financial and technical support for wind power projects in some regions (Figure 9).

Roughly 54 percent of wind power capacity built in the U.S. from 1998-2014 has been delivered to load serving entities with RPS obligations

Texas policy support serves as an example of state role in spurring wind growth. Texas state legislature passed RES in 1999, and subsequently, in 2005, the legislature strengthened the RES and added a transmission policy that led to the creation of the CREZ program, which facilitated wind-generated electricity transmission from west Texas to the heavy load centers in the east and south.

Figure 9 – State Renewable Portfolio Standards, March 2015



Source: DSIRE

Ongoing Efforts by Regional System Operators Support Growing Share of Wind Energy

FERC continues to implement Order 1000, which intends to improve intra- and inter-regional transmission planning and cost allocation. Order 1000 requires public utility transmission providers to participate in a regional transmission planning process and coordinate with neighboring planning regions in identifying transmission based on public policy requirements. Transmission expansion in wind-rich areas, such as Texas, is moderating integration challenges. Addressing planning, siting, and cost-allocation remains a key concern for transmission development. System operators have been implementing methods to accommodate increased wind energy penetrations, including centralized wind forecasting, treating wind as dispatchable, shorter scheduling intervals, and balancing areas consolidation and coordination.

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Currently, all ISO/RTO regions and a growing number of utilities have centralized wind energy forecasting systems. With enhanced forecasting and experience, many ISO/RTO areas treat wind as dispatchable in the real-time market, thereby reducing the need for manual curtailments by system operators and improving integration into wholesale power markets. In response to FERC Order 764, ISOs are refining scheduling and commitment processes, such as the shift from hour-ahead to 15-minute scheduling in the California Independent System Operator (CAISO) region. ISOs are also implementing changes consider flexibility needs in operational decisions and adequacy assessments. Similarly, transmission upgrades in the Southwest Power Pool (SPP) have facilitated a better-integrated system with higher diversity and greater flexibility to manage high levels of wind energy.

In addition, efforts are underway to consolidate balancing authorities or improve coordination between balancing authorities. For example, the SPP consolidated into one balancing authority in March 2014. The Energy Imbalance Market (EIM) between CAISO and PacifiCorp allows for increased transfers between the two balancing authorities and increases resource diversity. According to CAISO, as of Q1 2015, the EIM benefit averaged $1.75 million per month and reduced renewables curtailment by an average of 3 GWh/month. The North American Reliability Council's (NERC) new reliability standard for power balancing control performance is expected to reduce wear and tear on generation units, lower the cost of integrating variable generation, and result in lower levels of renewable energy curtailment.

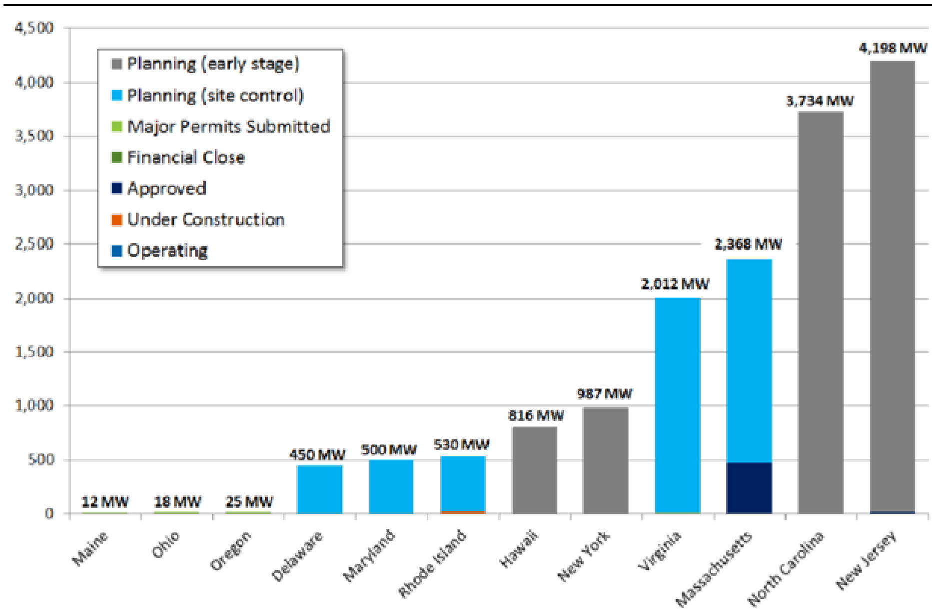
Concerns regarding climate impacts continue to spur interest in carbon-reduction policies. For example, the Northeast Regional Greenhouse Gas Initiative (RGGI) and California greenhouse gas cap-and-trade program support carbon-free generation technologies. Although carbon pricing has not gained adequate attention to drive significant wind energy growth, the EPA's Clean Power Plan, which outlines the first emission guidelines for fossil fuel-fired power plants, could create additional markets for wind energy.

Offshore Wind under Significant Progress to Overcome Cost and Infrastructure Barriers

The Department of the Interior's (DOI) responsibilities in granting offshore leases and the DOE's funding for demonstration projects endeavor to develop the offshore wind industry. Most recently, on November 23, the Bureau of Ocean Energy Management (BOEM) issued a Call for Information and Nominations to assess industry interest in acquiring commercial wind leases in four areas offshore South Carolina, totaling more than 1,100 square miles on the Outer Continental Shelf. The BOEM's offshore program has awarded nine commercial wind energy leases off the Atlantic coast, including seven issued as a result of competitive lease sales. Two lease awards from the most recent competitive sale offshore New Jersey are under review. Competitive lease sales have generated more than $15.7 million in revenue for more than one million acres in federal waters, including the recent New Jersey offshore wind auction.

As of June 20, 2015, 21 U.S. offshore wind projects are underway, representing 15,650 MW of offshore wind. Out of these projects, 13 projects, comprising 5,939 MW, have obtained site control or reached an advanced development phase (Figure 10).

Figure 10 - Offshore Wind Projects by State and Development Phase (MW), 2015



Source: DOE

In July, Deepwater Wind, an offshore wind developer, installed the foundation for the first offshore wind farm in the U.S., three miles southeast of Block Island, Rhode Island

In July, Deepwater Wind, an offshore wind developer, installed the foundation for the first offshore wind farm in the U.S., three miles southeast of Block Island, Rhode Island. With five turbines totaling 30 MW of generation capacity, the Block Island Wind Farm is expected to come online in 2016. Deepwater Wind is also planning two larger offshore projects along the Atlantic Coast though their timelines are uncertain.

Meanwhile, projects in Massachusetts, New Jersey, and Virginia, have experienced setbacks despite significant progress in project development. For example, Cape Wind, a 486-MW project proposed in 2001, halted due to significant challenges and litigation despite passing important regulatory milestones. In 2014, National Grid and Eversource Energy terminated the power purchase agreements with Cape Wind citing missed project development deadlines.

As part of its 2011 National Offshore Wind Strategy, DOE created a new initiative to provide support for regionally diverse Offshore Wind Advanced Technology Demonstration (ATD) Projects through collaborative public and private partnerships. In May 2014, the DOE selected three projects – Dominion Power's Virginia Offshore Wind Technology Advancement Project, Fishermen's Atlantic City Windfarm, and Principle Power's WindFloat Pacific – to advance the second phase of the ATD program. The ATD projects, targeted to achieve commercial operation by 2017, aim to demonstrate the potential of innovative systems to lower costs, while establishing test capabilities, validate infrastructure, exercise regulatory processes, and address investor risk perceptions.

Offshore wind turbines leverage more consistent wind speeds over the ocean, facilitating higher utilization rates for generation capacity when compared with similarly sized onshore wind turbines

According to the National Renewable Energy Laboratory (NREL), the U.S. has 4,200 GW of developable offshore wind potential, compared to its estimate of 11,000 GW of onshore wind potential. Measuring the power density of wind based on a scale of zero to seven, the NREL finds that more than 66 percent of offshore wind in the U.S. is in class six or seven — the highest two measures for overall wind power density. In addition, offshore wind turbines leverage more consistent wind speeds over the ocean, facilitating higher utilization rates for generation capacity when compared with similarly sized onshore wind turbines.

However, the high cost of domestic offshore wind projects has made them economically unattractive, despite the availability of federal tax incentives and state policies to promote use of renewable energy. When compared with onshore wind projects, offshore projects involve more challenging tasks such as transporting equipment and workers to the sites, securing turbines to the seafloor, operating in fewer periods of fair weather, and expensive maintenance.

Reactive Power Standards Key to Advancing Wind Generation

Moving forward, grid operators must explore ways to address increasing wind energy penetration and the growing interest in wind generation. In addition to exploring ways to better integrate large quantities of wind energy into the grid, it will also be crucial to support modern inverter technologies that enable non-synchronous resources to serve as a reliable source of reactive power and voltage control.

Recent wind purchases from technology companies Google, Microsoft, and Amazon, as well as from business giants Walmart and DOW Chemical indicate how maturing technology and favorable costs have renewed customer interest in wind generation. Transactions with these burgeoning commercial customers involve long-term PPAs, shorter-term REC purchases, as well as direct ownership of wind projects on or off the customer's site.

According the American Wind Energy Association's (AWEA) Q3 2015 market report, nearly 600 MW of PPAs signed in the third quarter pertain to corporate purchasers, cities and expansions in the Southeast, bringing total PPA contracts signed since the beginning of 2013 to more than 13,000 MW. Although the extent of support for wind projects from such offtake arrangements remains unclear, commercial purchases demonstrate a growing source of demand for the U.S. wind industry.

New technologies, coupled with growing corporate demand for wind energy and state-level policies in response to EPA environmental regulations, could motivate investments in both offshore and onshore wind energy development

FERC's proposal to require reactive power will spur the use of advanced inverter-based turbines to equip wind generators with the ability to produce and control dynamic reactive power. This stimulation to new technologies – coupled with growing corporate demand and state-level policies in response to EPA environmental regulations— could provide the necessary motivation to spur investments in both offshore and onshore wind energy development.

Disclosures Section

RESEARCH RISKS

Regulatory and Legislative agendas are subject to change.

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