

MARKET OUTLOOK





Continuing an American Success Story

*Wind power to keep booming
in the years ahead.*

By Hannah Hunt

Over the past few years, wind, solar, and natural gas have made up nearly all new electric generating capacity in the U.S. And earlier this year, wind energy surpassed conventional hydropower to become the country's largest renewable resource, with enough installed to power 25 million homes.

But what about the years ahead? Will this American success story continue, bringing more low-cost clean energy to families and businesses across the country, while creating thousands of new well-paying jobs along the way?

A trio of new data points clearly show the answer to these questions is 'yes.'

ENCOURAGING NEWS

New data from the second quarter of 2017 indicate the wind-energy development pipeline is bigger than ever. More than 25 GW of wind capacity are under construction or in the advanced stages of development — enough to power millions of homes.

From April through June, 5 GW of new wind started construction. Of that, 3 GW came from Wyoming's Chokecherry and Sierra Madre wind farm. Once completed, it will be one of the world's largest wind projects, satisfying demand for renewable energy across the western United States.

Fortune 500 companies also committed to powering more of their operations with wind during the second quarter. Notable buyers included T-Mobile, Goldman Sachs, General Mills, Apple, and Partners HealthCare. Long past the trend stage and now

American wind power will drive more than \$85 billion in economic activity between 2017 and 2020, while wind-related employment will reach 248,000 jobs in 50 states. (Courtesy: AWEA)

firmly entrenched as an important source of market demand, thirst from corporate buyers will play an important role in wind's growth in the years to come.

Because wind's costs have fallen by two-thirds over the last seven years, buying wind helps these businesses boost bottom lines while also helping to meet internal sustainability goals.

"This pursuit of renewable energy benefits our customers and communities through cleaner air while strengthening our business through lower and more stable energy costs," said GM Chairman and CEO Mary Barra, speaking about her company's 100-percent renewable goal.

Fortune 500 companies aren't the only large energy users to recognize the benefits of wind, however. Fort Hood, one of the country's largest military bases, began powering about half of its operations from a hybrid wind solar project earlier this year.

"We need to be autonomous," said Chris Haug, a Fort Hood spokesman. "If the unfortunate thing happened and we were under attack or someone attacked our power grid, you'd certainly want Fort Hood to be able to respond."

Finally, the U.S. continued to establish offshore wind as a new ocean energy resource during the second quarter.

The Maryland Public Service Commission greenlit two projects that put the state at the forefront of U.S. offshore wind development.

The commission approved offshore renewable energy credit (OREC) contracts for 368 MW of capacity spread across two projects, proposed by U.S. Wind and a subsidiary of



New data from the second quarter of 2017 indicate the wind-energy development pipeline is bigger than ever. (Courtesy: AWEA)

Deepwater Wind. The move will allow the financing of both projects to move forward, and takes us one step closer to having a second American offshore wind farm, following Deepwater Wind's groundbreaking Block Island project off the coast of Rhode Island.

BOOM YEARS AHEAD

Second quarter data confirm the earlier findings of a Navigant Consulting report: The U.S. wind industry will see strong growth through 2020.

American wind power will drive more than \$85 billion in economic activity between 2017 and 2020, while wind-related employment will reach 248,000 jobs in 50 states. By 2020, Navigant expects 33,000 Americans will be working in wind-related factories, 114,000 Americans will be building, operating and maintaining wind turbines, and another 102,000 will have jobs supporting the industry.

Beyond job creation, wind's growth will bring enormous economic development opportunities to rural America. Land lease payments for farmers and ranchers hosting wind turbines are expected to grow from \$245 million a year to more than \$350 million by 2020, according to Navigant.

And entire communities stand to benefit from increased revenue, not just landowners. Navigant forecasts that new wind farms built over the next four years will provide \$8 billion in property-, income-, and sales-tax payments, on top of payments from the many projects already in existence.

As Washington continues to look for homegrown success stories it can promote, particularly ones hiring good-paying manufacturing jobs across the Rust Belt and investments in rural America, wind power clearly works for America.

TECHNOLOGY GAINS

Bringing 1980s wind farms into the 21st century also offers another path for wind-energy progress.

American wind power was born in the Golden State, where the first large-scale wind farms were built three decades ago. Many still generate electricity today, more than 30 years later. But through a process known as repowering, companies are starting to

replace vintage turbines with modern equipment.

Good examples of this process occurred during the second quarter of 2017. Salka LLC continues to repower the Summit wind farm in California's Altamont Pass. Just 27 modern wind turbines will replace 569 first-generation machines.

NextEra Energy Resources just broke ground on a full repowering at the Golden Hills North wind farm, replacing 283 turbines from the '80s with just 20 modern ones capable of generating significantly more electricity.

"(This) allows us to breathe new life into an old project, reduce the impact on the environment, and provide good jobs and meaningful economic benefits for the local economy," said Daryl Hart, director of development for NextEra Energy Resources.

Other companies are repowering old California projects, too. EDF Renewable Energy recently upgraded the Shiloh IV wind farm, originally built in 1989. Just 50 new turbines replaced 235 old machines while quadrupling the project's capacity to generate electricity.

Elsewhere in California, 21 modern turbines replaced 145 vintage machines at the San Geronio project in Riverside County in 2015.

Repowering helps these pioneering projects generate more electricity with increasing reliability and lower costs, all while significantly decreasing their environmental footprint. It also boosts the local economy.

"Repowering the Altamont Pass wind farm will have a profound impact on the Alameda County economy," Salka chief executive Jiddu Tapia said. "Not only will the redevelopment process create local jobs, but the energy produced at the site will provide an affordable, dependable way for the east San Francisco Bay Area to meet its expanding power needs for generations to come."

The forecast for American wind power remains strong, though, with wind staying on track to produce 10 percent of the country's electricity by 2020. That means more jobs, low-cost electricity, and economic development. Any way you look at it, wind works for America. ↵



Hannah Hunt is a senior research analyst with AWEA focused on wind-industry data and analysis, with applied GIS experience. Hunt joined AWEA in July 2014 after receiving her master's of public affairs (MPA) degree at the Indiana University School of Public and Environmental Affairs (SPEA), with previous positions at the Tennessee Valley Authority (TVA) and the Government Accountability Office (GAO).

PTC Phase-out Spurs Unprecedented Growth

The 10-year outlook for the U.S. wind industry highlights yet another boom-and-bust cycle.



The Block Island Wind Farm off the coast of Rhode Island was the first offshore wind farm in the U.S. (Courtesy: Deepwater Wind/GE)

By Anthony Logan

The global wind industry is no stranger to seizing opportunity as incentive schemes expire. In key markets, including China and Germany, installation totals ballooned in the months and years before subsidy expirations. The U.S. is no different, and the legislated phase-out of the Production Tax Credit, or PTC, will drive an unprecedented four-year installation total of nearly 40 GW from 2017 to 2020.

In a twist of irony and barring substantial policy changes, the administration of President Donald Trump, a vocal skeptic of wind energy, will oversee the largest four-year rollout of new onshore wind capacity in U.S. history — roughly 5 GW more than was installed from 2009 to 2012 under President Barack Obama’s first term.

A wind market forecast can be broadly spoken of in

terms of key drivers and barriers. Drivers supporting MAKE’s outlook include the PTC, wind’s steadily falling levelized cost of energy (LCOE), capacity retirements, state renewable portfolio standards (RPS), and increasing interest from commercial and industrial off-takers (C&I). Key barriers, by contrast, include persistently low natural gas prices, solar power’s falling LCOE, a dearth of transmission availability, and anemic growth in demand for electricity.

The Trump administration itself remains a potent wildcard for the U.S. wind industry. The president is typically hostile to wind in his public statements, but many of his signature policy proposals affect wind in unexpected ways, sometimes benefiting and hindering wind in a single stroke. The case of corporate tax reform

illustrates this duality: A sharp reduction in the corporate tax rate, in this case from 35 percent to the 15 percent preferred by the president, would reduce overall tax equity appetite and starve projects of critical funding, but if the reform encourages a broad repatriation of overseas assets, a large pool of firms with a tremendous one-time tax liability could be eager to leverage the PTC to reduce their overall tax burdens.

POLICY AND TECHNOLOGY

The sense of urgency caused by its looming phase-out is not the only characteristic of the PTC that is driving wind-installation growth. The Internal Revenue Service (IRS) provided a particularly generous guidance for the implementation of this final PTC extension, allowing developers four years to complete projects after initial qualification. This extended run time, well in excess of the typical one- or two-year completion runway in previous iterations of the PTC, mitigates the impact of the de facto cap on the U.S.' annual installation potential, which is set by the availability of project sites, engineering, procurement and construction (EPC) resources, investor appetite, and manufacturing capacity, among other variables, and allows for roughly 20 GW more wind capacity than a two-year runway would have. Additionally, the market stability engendered by a four-year runway for project installation and a four-year phase-out has created a markedly improved investment climate that would have boosted investor confidence more, but for the post-election uncertainties in tax reform and trade.

The unsubsidized LCOE of on-shore wind will continue to decrease, driven by improved turbine technology and increasing rotor diameters. LCOE, as well as the PTC, whose

passage through Congress on bipartisan terms in 2015 gives it some much-needed staying power, are generally "fixed" drivers that are not anticipated to react dramatically to likely market or political developments. The scale and pace of non-renewable capacity retirements, state RPS expansions and C&I participation in wind off-take arrangements, on the other hand, are key "variable" drivers that can fluctuate widely based on political and market conditions.

An international uproar over Trump's decision to step back from the Paris Agreement was echoed in several states, mostly those with Democratic majorities in their state legislatures. Many of these states have existing RPS programs that are nearing the end of their mandates or are modest in aim compared to more recent RPS policies enacted in oth-

er states. Amid federal abdication on climate change policy, MAKE anticipates several left-leaning or otherwise environmentally-minded states to increase their RPS mandates substantially in the near-term to provide a counterpoint to the Trump administration while avoiding unnecessary compliance costs by leveraging expiring wind and solar tax credits.

NON-RENEWABLE RETIREMENTS

The pace of non-renewable retirements is primarily dependent on plant-level economic decisions, but the administration's statements and actions carry weight in some circumstances nevertheless. In early 2016, before both the election results and the dimming prospects of Obama's Clean Power Plan (CPP), more than 80 GW of coal assets were expected to

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retire before 2026. The apparent demise of the CPP and Trump's pro-coal policy measures incentivize utilities and IPPs to slow coal retirements. While a promising number of coal retirements have been announced or reaffirmed since November, a substantial percentage of the anticipated retirement capacity will be deferred, especially facilities in Midwestern and Northeastern markets that succeed in winning at capacity auctions.

An increase in the pace of in nuclear retirements will pick up some of this slack in coal retirements. As nuclear facilities increasingly fail to win at those same capacity auctions, states are forced to either heavily subsidize nuclear generation, typically the decision when the state has an RPS or other carbon-reducing aim, or retire them ahead of license expiration. Much of the retired capacity in the PJM and MISO markets will be replaced with new gas-fired capacity, but retirements in New York and New England may translate to substantial demand for new wind capacity, given those states' commitment to reduce carbon emissions and the severe disparity between wind and nuclear capacity factors.

SYNTHETIC PPAS AND THE C&I SPACE

While contract volume from C&I off-takers has not increased as steadily as many in the industry would like, purchasing wind power, particularly through "synthetic PPAs" in markets that allow them, is an increasingly attractive option for companies. Large, power-hungry manufacturers and technology firms such as Google, Apple, and General Motors have signed several off-take deals in the past three years, and this trend is expected to continue throughout the forecast period. Much work remains, however, by utilities and so-called aggregators to court smaller power consumers, who typically desire smaller or syndicated off-take arrangements for shorter terms.

KEY BARRIERS

Among barriers to wind development, a delay in adequate transmission build out looms large. Virtually all outstanding plans for privately financed HVDC lines, which send electricity generated in the central U.S. "wind belt" toward coastal demand centers, are either delayed or have been otherwise scaled back in scope. Delays abound in other transmission projects as well; developers unable to secure off-take agreements due to lack of transmission availability can sign hedge deals to at least build projects before the PTC expiration, but such arrangements may seem disturbingly cavalier to investors in 2019 and 2020 if it becomes apparent transmission will not be able to close the gap and curtailment begins to occur in increasingly congested regions. Burgeoning utility-scale solar markets, especially in highly irradiated Texas, coupled with a drastic reduction in solar

LCOE — module costs in the U.S. have fallen more than 40 percent since the start of 2016 — will also increasingly threaten wind's market share of new capacity additions.

INSTALLATION TIMELINES

The extended four-year project completion runway under the PTC has generally led to two strategies: One, favored by developers and manufacturers on the supply side, involves reaching commercial operations as quickly as possible to mitigate political risk (border adjustment, tax reform, etc.), secure cash-in-hand and, for projects with off-takers, meet pre-established construction timelines.

On the demand-side, three types of off-takers underpin the 2017-2020 boom: Utilities, often acting on state-level RPS mandates; C&I players, especially owners of large and energy-intensive facilities in manufacturing or data storage; and financial entities, who provide hedging arrangements that are popular in deregulated electricity markets with an excellent wind resource, like the Texas Panhandle. These players generally hold to the opposite strategy, scheduling projects in 2019 and 2020 to fully leverage the IRS' extended installation runway and allow for technology evolution to aid in reducing wind energy's LCOE while hoping for better power pricing as more legacy generation assets are retired to fulfill mandates or meet expected demand projections. The investment decisions of the demand-side ultimately decide market size, but these players should be careful to consider the risks inherent in delayed project executions.

THE COMING MARKET RECALIBRATION

Installations in 2021 will be subject to the 80 percent PTC value, which keeps wind power competitive in most states, though most developers will avoid intentionally using the lower-value PTC, and utilities complying with RPS requirements are likely to focus on solar investments in 2021, the last year for that technology's full-value tax credit, which is subject to a similar phase-out to the PTC on a delayed schedule. The 60 percent and 40 percent PTC values erode the economics of new capacity additions, and MAKE does not expect either value to pencil out for most developers, leading to a severe drop in 2022 installations as the U.S. begins a transition to an "economic build" market, dependent upon LCOE competition, except for in a handful of RPS-driven markets.

In this post-PTC environment, the quality of a project's wind resource will be paramount in achieving the low LCOE required to wrest market share from new solar and natural gas generation. Developers will particularly prize projects in states with abundant land, favorable wind resources, and access to transmission given the impact those project parameters have on LCOE. What were once minor

hurdles under the PTC, such as state-level tax policies and permitting difficulties, threaten to become project-killing obstacles in the new marginal environment. In all, onshore wind installations from 2022 to 2026 will number a fraction of the 2017 to 2020 total, almost entirely confined to a handful of states in the center of the country, on land far from the largest U.S. load centers. As a result, regional transmission development, whether through successful private investment or a federal infrastructure policy, will be critical in realizing post-PTC wind power installations.

THREATS TO WATCH

The wind industry must take care to guard against what might be termed myopic oversight, in which individual players or sectors within the wind market are unaware of a threat that appears eminently obvious to other players and sectors, and vice versa. An EPC contractor, for example, may be keenly aware of a coming labor and equipment shortage, and may succeed in communicating this to a developer client, but a small regional utility drafting its integrated resource plan may be completely unaware of the coming disruption. Opportunities for such oversights abound in the next decade of wind development; notable examples include the dangers in tax reform, the lack of EPC resource availability, disruptions to the wind supply chain in the event of a trade action under Trump, and an oversupply of the U.S. electricity market in the face of anemic growth in demand for electricity.

The U.S. market is more dependent on tax equity investment than at any other point in its history, so a decline in investor interest from a sharp drop in the corporate tax rate would have outsize effects on the broader wind market. It must be noted, however, that the threat of tax reform is rapidly receding as Congressional gridlock fails to move healthcare reform legislation to the president's desk and distracts from meaningful work on taxes. If reform is delayed past 2017, Republicans are unlikely to risk such a major reform package in an election year, meaning a reform package in 2019 would take effect in 2020 and have far less impact on the accelerated depreciation benefits of new wind build. Tax equity providers will continue to be thorough to a fault in due diligence activities; as they grow more confident in these legislative odds, they should be willing to sign off on more projects scheduled for COD in 2018 and 2019.

A labor and equipment shortage is not a purely hypothetical scenario. If projects are pushed into the 2019 and 2020 timeframe en masse, many may well be abandoned as EPC resources fail to cover all desired installations. The previous U.S. installation peak, some 12 GW in 2012, required the import of equipment from Mexico and Canada. In 2020, the Mexican market alone will be larger than the combined Mexican and Canadian markets of 2012. Compounding the shortage, new installations will vie for resources with a partial-scope repowering drive aimed at extending the PTC eligibility of roughly 7 GW of existing wind farms.

The threat of a border adjustment provision in the U.S. tax code follows the fortunes of broader tax reform, but a tariff action remains a real concern: Trump has shown a pointed willingness to use trade as a negotiating tool, particularly with China over its handling of North Korea and with Mexico over his border wall proposals. Either trade action would destabilize a domestic supply chain that has grown increasingly reliant on turbine components sourced from abroad given continued price pressure and PTC instability that resulted in a series of factory closures in 2013 and 2014.

The final oversight affects the post-2020 market: If coal-fired facility operators are particularly loath to retire assets and new natural gas installations do not slow from the 8 GW annual average of the past six years, the subsidized installation booms of both wind and solar power from 2017 to 2021 will substantially oversupply the U.S. market and collapse demand in the later years of the forecast for all utility-scale generation sources, including wind.

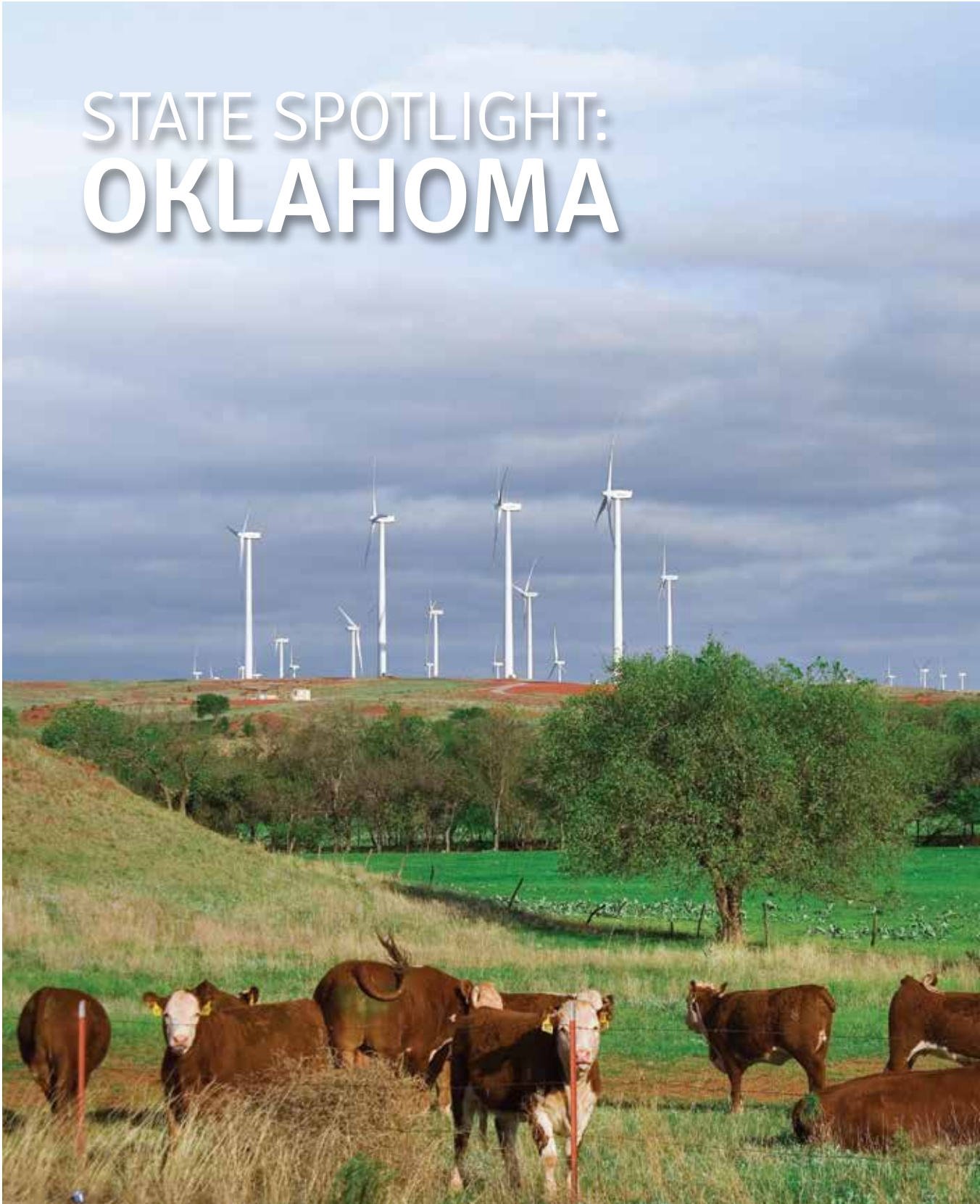
PLENTY OF OPPORTUNITY

Ultimately, the 10-year outlook highlights yet another boom-and-bust cycle for the U.S. wind industry. Still, the boom, unprecedented in scale, offers plenty of potential. The supply side is working furiously: More than enough equipment to cover the four-year outlook qualified for the full-value PTC through safe harboring turbines and turbine components; interconnection queues across the country are bloated, and developers are hunting for high-quality projects. If demand materializes, and supply is not jeopardized by external disruptions, this market looks set to make the most of a loud boom. ↪



Anthony Logan focuses on market developments, future scenarios, supply chain dynamics as well as competitive strategies across the wind power value chain in North America, Central America, and the Caribbean. He is based in MAKE's office in Chicago, Illinois.

STATE SPOTLIGHT: OKLAHOMA





Sooner, Not Later

Oklahoma's wind industry has moved to third in the nation for installed energy, as well as surpassing its renewable energy goal two years ahead of schedule.

By Kenneth Carter
Editor | Wind Systems

Oklahoma, where the wind comes sweepin' down the plain...

Renowned composers Rodgers and Hammerstein are much better known for their iconic musical numbers than being energy prognosticators, but when their first collaboration, "Oklahoma!," premiered on Broadway in 1943, no one could have foreseen their lyrics coincidentally giving a nod to the future of renewable energy in the Midwestern state.

But that wind sweepin' down the plain was exactly the inspiration state officials needed to introduce wind energy to the state.

And introduce it, it did. Since the first wind farm went online in Oklahoma in 2003, the state is now home to 6,600 MW of installed wind power, according to Michael Teague, Oklahoma secretary of Energy and Environment. Those thousands of megawatts of energy now account for more than 25 percent of Oklahoma's total electrical generation.

THIRD IN U.S.

According to the American Wind Energy Association's recent 2016 4th Quarter Report, Oklahoma jumped in the state rankings to become the third-ranked in the U.S. for installed wind energy.

"Oklahoma is historically an energy state with its natural resources," Teague said. "Being home to a top-10 wind resource in the nation, we knew it was just a matter of time before the wind industry would take off in the state. As

Since the first wind farm went online in Oklahoma in 2003, the state is now home to 6,600 MW of installed wind power. (Courtesy: Oklahoma Chamber of Commerce)



Several states in the South purchase power created from wind in Oklahoma, including Gulf Power, Georgia Power, and Alabama Power, according to cleanenergy.org. (Courtesy: Oklahoma Chamber of Commerce)

OKLAHOMA WIND FACTS

- Total installed capacity as of 1Q 2017: 6,645 MW.
- Total wind projects under construction: 1,546 MW.
- No. 2 in nation in new capacity installations in 2016: 1,416 MW.
- No. 3 in nation for installed capacity. Fifth fastest growing wind state in 2016, with 28 percent one-year growth rate in 2016
- Fourth in nation for wind electricity generation: 25.1 percent.
- No. 3 in wind generation, with 19.5 million MWh in 2016 – enough to power 1.8 million homes .
- No. 2 in nation for wind capacity factors: 42.5 percent.
- OG&E ranks eighth in the nation of utilities with wind-power ownership capacity: 449 MW.
- 8,000-9,000 wind industry jobs in the state, according to the AWEA 2016 annual report.
- 3,000 wind turbines in the ground, existing infrastructure, support existing industry.
- A leader in wind training programs through higher education and career tech systems.

with most energy markets, it just took things coming together for the right projects to be built with the interest from the state utilities to purchase the power.”

Wind in Oklahoma is expected to continue to grow, although at a slower pace than in previous years, according to Teague.

“With over a quarter of the state’s electricity coming from wind, future projects and generation will most likely work within the Southwest Power Pool, the regional transmission organization, to move wind-generated electricity to other markets,” he said.

Several states in the South purchase power created from wind in Oklahoma, including Gulf Power, Georgia Power, and Alabama Power, according to cleanenergy.org.

The Oklahoma Chamber of Commerce recently reported that wind farms should provide more than \$1 billion in local property tax revenue, proving that the financial benefits of wind can be found in every nook and cranny.

RENEWABLE ENERGY GOAL

Much of that stems from Oklahoma having already met its renewable energy goal.

“Oklahoma previously had a renewable energy goal of 15 percent renewable energy by 2015,” Teague said. “This was met two years ahead of plan.”

A lot of that extra push for wind more than likely comes from the positive support renewable energy has received from Oklahomans.

“Surveys performed in the state show that residents overwhelmingly support wind,” Teague said. “As wind continues to grow in the state, industry will need to continue the outreach and education efforts to ensure residents are well-educated on the industry.”

As a matter of fact, one such survey noted that 83 percent of Oklahomans were in favor of the state meeting its electricity needs with wind, without any education on the issue. And 91 percent were in favor of developing wind farms for electricity; a figure double that of residents who would want to see further development of coal and nuclear power.

That’s especially true in Elk City, where that Oklahoma city has seen many benefits from wind.

“The growth of wind energy in Oklahoma has led to many rural land owners, including land owned by schools, receiving significant annual royalties,” said Jim D. Mason, director of economic and community development. “A significant number of western Oklahoma schools have received enough royalties to allow them to drop off the state school funding formula. While Elk City has not reached that level, we are in the heart of the Oklahoma wind corridor on Interstate 40 and have two wind farms

fully operational and two more that are in process of being constructed within miles of our city.”

The energy created for the grid has a liberal (unpretentious) permitting process, according to Teague.

“Oklahoma has a history and is known for being a business friendly state,” he said. “That is no different when it comes to the wind industry. There is minimal permitting required at the state level. There are some siting considerations with regards to setbacks from hospitals and schools, as well as bond requirements for decommissioning. These are overseen by the state utility commission.”

WIND EDUCATION

That education is important as wind continues to supply a big part of the state’s energy needs, according to Teague.

“Not only is Oklahoma historically an energy state, we also have a strong CareerTech program,” he said. “Oklahoma is home to multiple nationally recognized wind technician training programs through our CareerTech system. This, combined with our continued growth in the market and Oklahoma being a great place to live due to our low cost of living, makes Oklahoma a prime location for wind techs and other wind-related jobs.”

The future looks bright — and windy — for Oklahoma’s wind industry with few hurdles on the horizon.

“As it relates to production, the state has had minimal challenges,” Teague said. “Wind forecasting has improved over time, and the geographic diversity of wind projects across the state has also enabled integration of the resource into the grid.”



Oklahoma is home to multiple nationally recognized wind technician training programs through its CareerTech system. (Courtesy: Oklahoma Chamber of Commerce)

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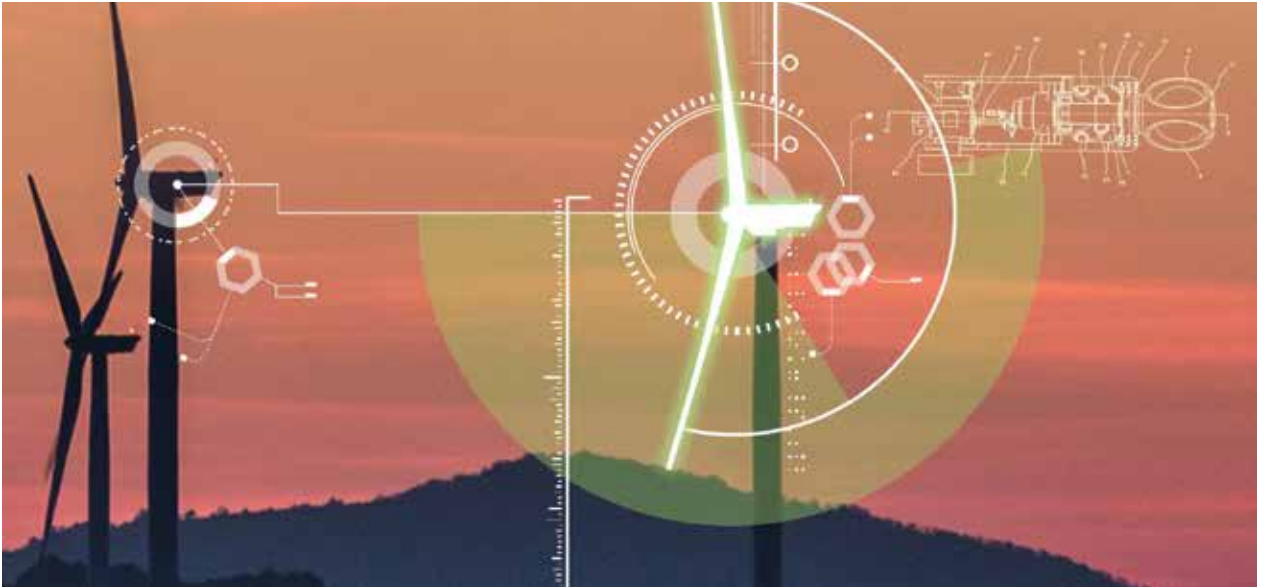
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Wind Boom to Continue

PTC and innovation expected to drive growth in wind market, O&M, and jobs.

By Lisa Cohn



At the May 2017 AWEA Wind Power Conference, the AWEA policy committee concluded that the Trump administration is not targeting renewable energy. (Courtesy: Lisa Cohn)

The wind energy market boom is expected to continue in 2017 as the federal Production Tax Credit (PTC) drives new wind-project development and boosts the already lively O&M market.

In fact, the industry has seen so much growth that “wind-turbine technician” was the fastest growing job in the U.S. last year.

The past year saw the installation of 8.2 GW from new plants. Continued high growth in 2017 is expected, with the additional installation of 7.8 GW in wind energy, said Bruce Hamilton, director of Navigant Research’s energy practice.

This year’s growth will be driven principally by developers who are accelerating wind projects in order to take advantage of PTC subsidies, which will be gradually phased out by 2020. PTC credits in 2017 will be stepped down to 80 percent of 2016 values, 60 percent in 2018, and 40 percent in 2019, Hamilton said.

In a study that Navigant conducted for AWEA, developers and OEMs were interviewed for their near-term plans and reported that many of their planned projects for the 2021-2023 timeframe are being pushed forward in order to be eligible for high PTC subsidiza-

tions, Hamilton said.

“We saw a lot of projects accelerated to qualify for the full PTC, which caused a spike in wind installations in early 2017,” said Hayden Baker, a partner at Sullivan & Worcester. “But there remains a robust pipeline for this year; we expect to see several more sizeable projects announced in the second half of 2017.”

PTC SAFE HARBOR CLAUSE

A vital component of the PTC that’s driving the boom in growth is the 5 percent safe harbor clause. Wind projects are eligible for the current-year PTC subsidy if a minimum of 5 percent of the project’s total capital cost is incurred before the end of that year, Hamilton said. Projects also must comply with the four-year rule, which says that project construction must be completed within four years after starting.

“Virtually all new projects we are seeing in the market are taking advantage of the ‘begin construction’ rules in order to capture the full, rather than the reduced, PTC amount,” said Ed Einowski, renewable energy project finance and development partner at Stoel Rives.

Because one of the largest expenses invested in a

wind project are the turbines, one of the ways to meet the 5 percent requirement is to purchase wind turbines before the end of the current calendar year. This has generated a booming market for turbines, Hamilton said. This safe harbor market was responsible for the 10 GW of turbines ordered last year, which qualified for 100 percent of the PTC that's eligible to be installed any time during the next four years. This year, Navigant predicts the turbine market will drop somewhat because purchases this year will qualify for only 80 percent of the PTC credit.

Navigant predicts the high growth of the wind market will continue for the next four years as more projects are accelerated to take advantage of the PTC. In fact, Navigant predicts that wind-energy growth will increase every year and peak in 2020, which will be the year that accelerated projects — which entered the pipeline in 2016 with a 100 percent subsidy under the PTC — will be required to be completed under the four-year rule.

Increasing state RPS requirements and improved transmission also will contribute to this increase in growth, Hamilton said. Beginning in 2020, after the PTC phases out, the growth will subside over several years. This fall-off will occur as additional projects, whose development was accelerated in order to be eligible for PTC subsidies, are completed.

However, Meghan McIver, business development associate at Apex Clean Energy, sees a rosy long-term forecast for the wind market after the PTC phase-out, especially for O&M.

"Many of the long-term projections forecast wind as the largest source of electricity in the U.S. for a number of reasons, including drastically falling costs," she said. "This means even after the PTC phases

out, wind O&M will likely continue to see new customers."

LONG-TERM GROWTH

Bruce Bailey, vice president of Renewables in UL's energy and power technologies division, said he also sees long-term growth in the wind market after the PTC has expired.


"The PTC makes wind cheaper for customers and was very important in giving wind a shot in the energy markets when the playing field wasn't level," he said. "In a world of much cheaper wind-energy prices and market acceptance, the need for the PTC to promote wind is waning."

Whether the need for the PTC is waning, many wonder how the results of the recent presidential election and the changing political landscape in Washington will affect the U.S. wind-power industry. At the May 2017 AWEA Wind Pow-

er Conference, the AWEA policy committee concluded that the new administration is not targeting renewable energy. This was confirmed by U.S. Treasury Secretary Steven Mnuchin, who, during his nomination hearing, said the current phase-out of the PTC will not change. Further, many of the predominantly windy states, which are led by Republican governors and legislators, won't want to change the timeline of the PTC phase-out because that could undermine those states' economies and jobs.

"Although the Clean Power Plan is pretty much dead, it is encouraging to see that states are already proceeding with their own policies as if those federal requirements are still in effect," Hamilton said.

However, with the elimination of the Clean Power Plan, coal-plant retirements will happen more slowly, and initially will be down by



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30 percent from what was predicted a year ago, he said.

But states are expected to pick up their activity in response to the federal government's withdrawal from the Paris Climate agreement and its killing the Clean Power Plan. Subsidies for wind-project development will increasingly come from individual state RPS requirements. Many states are raising their RPS, which will be a major force in driving wind-energy development after the PTC phase out in 2020, Hamilton said.

MORE INVESTMENT MONEY

In addition to increased attention to renewable energy at the state level, businesses are showing interest in using renewable energy sources for their electricity needs.

"In spite of the current administration, people are going for renewables," said Marlene Motyka, U.S. Global and Renewable Energy Leader for Deloitte. "Climate change and green energy have moved beyond politics; it's past the tipping point. Sixty-one percent of businesses are demanding that their company acquire a portion of their electricity from renewable sources. That won't stop regardless of what's happening on the political front."

This strong interest in renewable energy by businesses has prompted vigorous U.S. investment in wind energy.

"The administration's withdrawal from Paris and reversal on the Clean Power Plan left little doubt about the trajectory of federal policy under (President Donald) Trump, but as a practical matter those measures were not driving wind development or investment," Baker said.

"There is currently a great deal more investment money seeking wind projects than there are wind projects available," Einowski said.

While most of the explosive growth in the U.S. wind-power industry has occurred in the onshore wind market, new offshore wind markets are opening in several key states. In 2016, Massachusetts passed legislation that requires procurement of 1,600 MW offshore wind by 2030. In 2017, New York voted to approve the nation's largest offshore wind farm, a 90-MW development 30 miles southeast of Montauk. This project is part of the state's mandate to produce 50 percent of the state's electricity from renewable energy by 2030.

CONSTRUCTION AND O&M

The high growth of the wind market over the next four years will drive the creation of many new jobs in the wind-power industry. Navigant predicts employment in the wind-power field will reach 248,000 in 2020, up from 180,000 in 2017. These new jobs will be in all aspects of the wind-power industry, including manufacturing, construction, and operations and maintenance, Hamilton said.

The biggest increase in employment in the wind-power industry will be in construction and operations and maintenance, accounting for 114,000 of new jobs. O&M will see an increase of 62,000 jobs while construction jobs will increase by 84,000. Manufacturing jobs will see a somewhat smaller increase of 33,000, Hamilton said.

Navigant's wind-market forecast, prepared for AWEA, notes that the project pipeline at the beginning of 2017 was 28 percent larger than the pipeline at the beginning of 2016. As of January 2017, 9.4 GW were under construction, and 11.6 GW were in advanced development.

The employment boosts over the last year were so high that wind-turbine technician was the fastest growing profession in the country last year, according to the U.S. Department of Labor.

"Wind-turbine operations and maintenance represents a growing sector of the industry, and the future seems even brighter as companies are bringing more wind projects online before the PTC wanes," McIver said

MERGERS AND CONSOLIDATIONS

The high growth and maturation of the wind market is driving consolidations and mergers in O&M, which has traditionally been handled by independent service providers. These companies have not usually been affiliated with OEMs or the owners of wind plants. For example, during 2015-2016, Vestas acquired several independent service providers, including UpWind Technologies, as well as Availon.

"The industry overall has seen a number of buyouts of smaller operations and maintenance companies," McIver said. "These strategic partnerships broaden the offerings of various O&M providers, creating a streamlined contract and process for customers. Instead of working with different businesses for their various needs, customers are now seeing one-stop service providers."

Along with buyouts, wind-power growth is driving the creation of new business offering specialized services. One example is Strat Aero, which uses unmanned drones to perform turbine-blade maintenance inspections. Using unmanned aerial vehicles and advanced proprietary software, the company inspects up to eight turbines per day, which is significantly more turbines compared to the two-per-day of conventional manual inspection methods.

"Throughout the wind-energy industry, drones are becoming more prevalent for site and blade inspection because they offer clear views of every angle of the turbines," McIver said. "Using drones improves our effi-

ciency and enables us to better ensure the health of our turbine blades.”

R&D FOCUS

Other areas of the wind-power industry are the focus of intensive R&D efforts.

One such focus is the use of “smart” data analytics to provide more accurate forecasts of wind, allowing more wind power to be integrated into the existing power grid. This technology helps address fluctuations in wind production that create the need for backup power. When these backup sources are conventional power plants, it’s expensive and inefficient to keep these plants idling. Software developed by the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, can generate accurate forecasts of how much power to expect from a wind farm in 15-minute increments, for up to seven days, allowing more efficient utilization of backup power plants.

According to UL’s Bailey, “Everything is getting smarter, thanks to inexpensive sensors, big data and data analytics, advanced controllers. Smart means better energy productivity, longer component lifetimes, and, consequently, improved economics.”

For example, GE uses big data and analytics to help predict turbine failures and also to help decide when wind can be best used in the market, said Kimberly Brown, head of GE’s product marketing for renewable energy digital solutions.

One example is predictive monitoring, she said. This involves gathering vibration data from sensors on wind turbines.

“We can model analytics and look outward and say, based on the trends, we’re seeing potential escalation and can predict gearbox failures,” she said.

Big data also can be used to make decisions on forecasting and bidding into the market, Brown said.

TALLER TOWER CHALLENGE

In addition to big data, R&D is focused on taller towers

“The wind resource is better the higher you go, but taller towers are more expensive so you have a tradeoff,” said Daniel Laird, director, National Wind Technology Center (NWTC), NREL.

One solution is called “Hexcrete” wind turbine tow-



The use of “smart” data analytics can provide more accurate forecasts of wind, allowing more wind power to be integrated into the existing power grid. (Courtesy: Lisa Cohn)

ers. The towers are assembled from precast concrete panels and columns that are tied together on-site by cables to form hexagon-shaped cells. The cells can be stacked to form towers as high as 140 meters, said Sri Sritharan, Professor, Wilkinson Chair in Engineering, Iowa State University, College of Engineering, who is developing the product.

“Taller towers have benefits in both the wind-rich regions and regions like the Southeast where renewable energy production is fairly low,” he said. “The Hexcrete technology will facilitate the use of tall towers throughout the nation as it eliminates transportation logistics and other challenges that are associated with building them.”

Taller wind-turbine towers will be crucial in expanding wind power nationwide, enabling wind energy production in all 50 states, according to studies by the U.S. Department of Energy’s National Renewable Energy Laboratory, based in Golden, Colorado.

Overall, these R&D efforts are expected to help keep the industry competitive, even after the PTC expires.

“Renewables and wind specifically are born of innovation and change,” Brown said. “What makes it special is the industry understands the need for change and innovates change. What’s really unique is the rate of change.” ↴



Lisa Cohn is a freelance writer who specializes in energy issues. Her work has appeared in Mother Earth News, Natural Home Magazine, Horizon Air Magazine, Oregon Business, the Portland Tribune, The Oregonian, Renewable Energy World, EnergyBiz, and other publications. Visit her at www.RealEnergyWriters.com