Where We’ve Been, Where We’re Going

To mark our final print issue, we look back on advancements in key industry areas and see what the future holds.
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It is with great sadness I must inform you that this issue represents the final print edition of NAW.

The business model for print publications has become extremely challenging for publishers in all facets of media, and we are not immune. Changing attitudes about how readers prefer to consume news and information necessitate the need for us to change, too. Going forward, we are shifting to 100% digital – the appetites of the readers and advertisers have changed. Therefore, the website, email newsletter, mobile and other digital media is where everything is turning (and has already largely turned).

The North American wind market has come a long way since the magazine’s founding in 2004. With that mind, we bring to you four features this issue that celebrate how far the wind industry has come. Then again, one feature, from our second issue, is remarkable for how things have not really changed at all.

On a personal note, this issue represents my 105th – and final – issue as the magazine’s editor. Although I’ve never climbed a wind turbine (I have a healthy fear of heights), installed a met tower or filed a county permit, I leave with a healthy respect for it all because of you, the men and women who patiently fielded my calls and endured my inevitable follow-up questions. I’ve said it many times: It’s a big continent out there, and we needed as many feet on the street to help inform our coverage. We truly couldn’t have done the market justice without the help of the American Wind Energy Association and Canadian Wind Energy Association, as well as the countless scores of wind energy executives, suppliers, and in-house communicators and public relations executives. To each of you, I offer a heartfelt thank you.

Lastly, I’d like to recognize my predecessors Bill Opalka and Jennifer Delony. Both were instrumental in establishing the magazine’s style and voice, particularly in its early going. When I inherited the brand in 2009, I vowed only to maintain its high editorial standards. Hopefully, I’ve managed to uphold that promise. And sadly, that’s the best I could do with my editor’s photo. Thanks for reading.

A Death In The Family

Mourning the printed page.

Mark Del Franco

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Feature Story

Repowering Projects Breathe New Life Into Altamont Area

Keeping fingers crossed that tax credits will be reinstated, justifying the expense.

By Linda Anderson

(Editor’s note: This article about repowering the Altamont region of California is reprinted from our March 2004 issue. While repowering is a hot topic today, it’s interesting to look back and see how wind developers were grappling with the issue 15 years ago. As the article details the uncertainty around the production tax credit, it’s also illustrative of how little has changed over time.)

The granddaddy of wind farms in the U.S. – the Altamont Pass Wind Resource Area (APWRA), east of San Francisco – is on its way to getting a partial makeover. Developed in the early 1980s, APWRA is home to about 5,000 wind turbines with an installed capacity of approximately 625 MW. Once cutting-edge wind generating technology, many of these turbines today are showing their age in terms of operational inefficiencies and reduced availability.

The average capacity of 1980s-era turbines ranged from 60 kW to about 150 kW. In contrast, today’s wind turbines boast a capacity up to 1 MW or 2 MW, making a strong case for repowering the dinosaurs of Altamont Pass.

According to the California Energy Commission, the opportunity for increased generation through the repowering of older turbines exists throughout the state, as most of California’s increasingly obsolete, original turbine base falls in the 51 kW to 100 kW size range – far below today’s industry standard. In the 2003 Renewable Resources Development Report, the commission cites the California Wind Energy Association (CALWEA) in estimating “approximately 450-900 MW of existing capacity are good candidates for repowering” statewide.

However, project owners face many issues when deciding whether to repower turbines – not the least of which is the federal production tax credit (PTC) that expired Dec. 31, 2003. The main impact of the PTC is its effect of making prices in power purchase agreements more attractive. According to Nancy Rader, executive director of CALWEA in Berkeley, Calif., even if the tax incentive were renewed as it was written, project owners still would face a restrictive clause, known as the “California fix,” embedded in the old PTC. “The tax code was amended in 1999 to deny the tax credit to repowered projects, unless owners agreed with the purchasing utility to amend their contracts to reduce the purchase price for the incremental power produced,” she says. “That has given the utilities a lot of leverage in the negotiating process, which they’ve used to stymie repowering.”

Rader contends that the provision has prevented much repowering from happening. “Before 1999, 245 MW had been repowered. But in the four years since, only 23 MW have been repowered. The amendment has virtually brought repowering to a halt,” she says. Rader estimates that if the restrictive clause were removed, up to 450 MW of wind capacity might be repowered within three years.

Decommissioning while demand is high

Rick Koebbe, president of Power-Works Inc. in Boise, Idaho, agrees that the PTC is important in deciding whether to repower inefficient projects. But he also points to a project’s economics as another deciding factor. “We have 920 turbines in Altamont that are running at 98 percent availability,” he says. “Given that rate, there is no reason for us to repower now.” He predicts few, if any, projects will be repowered until the PTC is reinstated.

Despite the uncertainty surrounding the PTC, some of the project owners in APWRA have begun the process of repowering some of their projects. These companies, which include G3 Energy in Dallas; enXco, based in Palm Springs, Calif.; and FPL Energy in Juno Beach, Fla., and its partner, have begun the lengthy process. Specifically, G3 Energy and enXco, which jointly own the Buena Vista Project (formerly the defunct Windmaster Project), are planning to repower the 38 MW project this year. FPL, which owns 621 MW of wind capacity in the state and operates about 1,000 MW, is also looking to repower a portion of its Altamont capacity.

George Hardie, president of G3 Energy, says the original plan for the Buena Vista site had been to replace all 180 of the Windmaster turbines by mounting high-quality, used Danish turbines of similar size atop the Windmaster towers. In fact, 74 of the Windmaster towers were brought back to operational status by installing used Nordtank 150 kW and Danwin 160 kW turbines bought from another repowered project in Southern California. More would have been purchased had they been available at the time. “This was a cost-effective way to bring the project back to life,” Hardie says. “However, we were, and still are, only operating the project at about one-third of its total contract capacity.”

Now that California’s energy situation has stabilized, G3 Energy and enXco are moving ahead to repower the entire 38 MW project, including those turbines that were initially
repowered, with new 1 MW Mitsubishi turbines. Total costs, excluding soft costs such as legal and accounting fees, will be about $38 million. Investment firm Babcock & Brown of San Francisco is assisting with the financing.

Because of the larger turbines, Hardie says the number of turbines on-site will be reduced from 179 to 38, greatly reducing the project’s underlying footprint and environmental impact.

Hardie explains they chose the Mitsubishi model because it is efficient and is the largest turbine allowed under the permitting “envelope,” as outlined in the Master or Program Repowering Environmental Impact Review (EIR) for the APWRA.

Both Altamont wind project operators and environmentalists are hoping that fewer, more modern turbines will reduce the number of bird deaths caused by the older turbines. The Center for Biological Diversity in Livermore, Calif., in January filed a lawsuit against FPL Group Inc. and turbine manufacturer NEG Micon, urging the companies to address the bird problem in APWRA. In the organization’s news release, it states, “The issue at Altamont is not wind power versus birds, but rather whether the wind power industry is willing to take simple steps to reduce bird kills.”

The 1998 draft of APWRA’s EIR states, “A reduction in avian mortality can be achieved by reducing the number of turbines in the area, eliminating all perch sites on turbines, reducing the rotational speed of rotors and avoiding certain topographical features when siting turbines.”

Both wind developers are seeking county conditional use permits, which are issued for 25 to 30 years. That process typically involves consulting with numerous local, state and federal regulatory agencies, such as the U.S. Fish & Wildlife Service, the California Department of Fish and Game, and the California Public Utility Commission. It’s not unreasonable to plan on anywhere from eight to 18 months to complete the process.

Finished by year’s end

Hardie adds that his company is proceeding on a “leap of faith,” assuming the PTC will be extended sometime in the next few months. “Our project may be viable without PTCs; however, the variable energy pricing component of our existing SO4 contract makes it difficult to efficiently finance a repower without PTCs,” he says. “Accordingly, it makes sense to wait to order the new turbines until the credit is reinstated.” Assuming the PTC is extended by the first half of 2004, Hardie plans to start construction in late summer and have the project finished by the end of the year.

Although those wanting to repower projects presently do not have the federal tax credit, they may be eligible to receive supplemental energy payments under California’s renewable portfolio standards, adopted in 2002. Under the standards, the capital investment to repower an existing facility must equal at least 80% of the value of the repowered facility in order to qualify.

The California Energy Commission is currently developing rules of implementation and admits in its Renewable Resources Development Report, “The stringency of these rules, and the likelihood of a generator meeting the 80 percent threshold, will be a factor in repowering decisions.”
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The Dramatic Arc Of The PTC
The production tax credit (PTC) is the force that spurred the U.S. wind industry from an immaterial segment of power generation in the early 1990s to providing the fastest-growing job in America – wind turbine technician. At the end of 2016, the total wind capacity in the U.S. was more than 82 GW. Now, like the finale of a Fourth of July fireworks show, the PTC has several more exciting bursts to go and then will, in theory, peter out.

Many newcomers to the wind industry may be surprised to learn that the PTC was not born during the Obama administration or even the Clinton administration. Rather, the PTC was born in 1992, and its proud parents were Sen. Charles Grassley, R-Iowa, and President George H.W. Bush.

The PTC was originally $.015/kWh for the first 10 years of a wind project’s operations. However, the statute provides for an inflation adjustment. Accordingly, 25 years later, the PTC is $.024/kWh, a 60% increase since its inception in 1992, and will continue to be adjusted in future years. The inflation adjustment applies not only to new projects, but also to PTCs generated by operating projects that are still within their 10-year initial operating period.

The drama

The PTC’s life has been worthy of a soap opera. Every few years, it has been slated to lapse (the first time being in 1999), and it has, in fact, lapsed on multiple occasions. But like a soap opera character, the PTC was brought back to life through the valiant efforts of its fans (in Congress), while in other years, the PTC “entertained” the wind industry with the cliff-hanging suspense of a last-minute extension.

Other than its periodic reincarnation, there have been five highlight-worthy changes in PTC policy. The first was the American Jobs Creation Act of 2004 when Congress excluded the PTCs generated in the first four years of a project’s operation from the sinister “alternative minimum tax” rules. This change means that even tax equity investors with many other tax benefits on their tax returns that caused them to pay federal taxes at a rate of less than 20% could still receive full benefit for the PTC generated in the first four years of a project’s life. This change helped keep certain large tax equity investors in the market.

Second, in 2007, the IRS published Revenue Procedure 2007-65 that created a safe harbor for structuring wind tax equity partnerships. This revenue procedure provides the industry with clear structuring guidelines that facilitated a growth in tax equity transactions until the financial crisis hit in late 2008.

Third, Congress enacted the American Recovery and Reinvestment Tax Act of 2009 in response to the financial crisis. Congress recognized that economic losses due to the financial crisis, and their resulting impact on the tax appetite of financial institutions that act as tax equity investors, had virtually shut down the tax equity market and, accordingly, the U.S. wind industry.

To address the condition of the tax equity market, Congress provided the owners of new wind projects with the option to elect a 30% investment tax credit and then the option to receive a cash grant in the same amount from the Treasury in lieu of the investment tax credit. The cash grant was last available for wind projects placed in service in 2012.

However, the 30% investment tax credit election for wind continues to be available but is rarely selected by wind farm owners (other than in the case of offshore projects) due to the high capacity factors of today’s projects that have resulted from improvements in turbine technology.

Further, the Treasury cash grant program provided the wind industry with more drama. After an initial honeymoon period, the Treasury grew skeptical of cash grant requests and started to impose its own judgment as to the appropriate cost of wind projects (and other forms of renewables) and paid reduced cash grants based on the Treasury’s black box valuations. Not surprisingly, this led to litigation. The first wind projects to be litigated were the Alta Wind projects that were developed by the prominent developer Terra-Gen.

During the Alta Wind trial in a Perry Mason moment, it was determined that the government’s expert witness, an MIT professor, had failed to disclose that he published articles in communist East German publications. Due to this lack of candor, the judge disqualified the professor from testifying and precluded the government from replacing him with another expert witness. Not surprisingly, Alta Wind won the case, and the trial judge wrote an opinion that effectively constrained the government’s ability to second-guess the pricing of cash grant (and, presumably, the investment tax credit, too) renewable energy transactions. Alta Wind and the tax bar eagerly await the Federal Circuit’s opinion on the appeal.

Fourth, the American Taxpayer Relief Act of 2012 changed the 20-year-old standard to qualify for PTCs from a project having to be “placed in service” (i.e., operational) by the statutory deadline to “construction” having to “begin” before the statutory deadline. Initially, to qualify for the PTC, construction of the project had to begin before Jan. 1, 2014. This deadline was extended to beginning construction before Jan. 1, 2015, by the Tax Increase and Prevention Act of 2015.

Fifth, neither the 2014 nor the 2015 deadline ended up mattering because the Consolidated Appropriations Act, 2016 extended the start-of-construction deadline and codified a gradual phaseout of the PTC. This statutory change, in conjunction with generally favorable IRS guidance defining the meaning of “begun construction,” gave the wind industry certainty through 2020.
The longest final season

The phaseout provides that wind projects that “began construction” in 2016 (or earlier) are entitled to 100% of the PTC, or the full $.024/kWh; projects that begin construction in 2017 are entitled to 80%, or $.0192/kWh; projects that begin construction in 2018 are entitled to 60%, or $.0144/kWh; and projects that begin construction in 2019 are entitled to 40% of $.0096/kWh. Finally, under current law, there is no PTC for projects that begin construction in 2020 or later.

The key question is, what does it mean to “begin construction”? The IRS generously defined “beginning of construction” to mean spending 5% of the total cost of the project or undertaking “significant physical work,” which was based on rules the Treasury had published to specify eligibility for the cash grant program it administered.

Deep-pocketed developers (e.g., NextEra) opted for the objective 5% approach, as that could be easily implemented and documented with purchase contracts, invoices and wire transfers. However, lightly capitalized developers wanted to play, too, but could not write a check for 5% of the total cost of future projects. Therefore, they were left with the fuzzy “significant physical work” approach.

For a few months, tax advisors wrung their hands about the quantification of “significant.” Then, the IRS issued guidance that provided there is no minimum amount of work required, so long as the work was of the appropriate “nature.” The IRS guidance included useful examples of what types of work qualified – excavating turbine sites, building roads to be used for operations and maintenance purposes, and manufacturing a customized step-up transformation.

The only drawback in the IRS’ guidance is that it imposed a requirement not in the statute: A project owner upon starting construction had to “continuously” progress the project through to completion. This led to more hand-wringing among tax advisors as to the meaning of “continuous.”

The IRS eventually provided some relief and published a safe harbor that the “continuous” requirement would not be applicable so long as the project is in service on Dec. 31 four years after the year construction started; further, that fourth anniversary would not be deemed to be before Dec. 31, 2018, regardless of what work may have occurred prior to 2014. It is reported that between 30 GW and 70 GW of wind projects “began construction” in 2016. NextEra alone stated it “began construction” of 10 GW.

To meet the IRS’ four-year rule, those 30-70 GW will come online between now and Dec. 31, 2020. That will keep manufacturers, construction companies, developers, tax equity investors and their advisors busy for the next 40 months.

What we do not know is if developers, to any material extent, will continue to “begin construction” of additional wind projects between now and the end of 2019 in light of the progressively shrinking PTC, or was that 30-70 GW the last shot?

Final season plot twist

Finally, the wind industry is living through a plot twist of Donald Trump as president. Trump had opposed a wind farm in the vicinity of one of his golf courses and has criticized it for its intermittent nature and purported risk to birds.

Grassley – the father of the PTC – stepped up to protect his baby. At the confirmation hearing for Secretary of the Treasury Steven Mnuchin, the senator asked if Mnuchin supported allowing the PTC phaseout to run its course undisturbed. Mnuchin responded that he did. Thus, it appears the IRS will not be ordered to rescind or negatively alter its “begun construction” guidance, and the administration will not propose a repeal of the phase-out statute.

Now, the wind industry hopes for a wind-friendly Congress in 2019 and beyond and a wind-friendly president in 2021 and beyond. Such a president taking office in 2021 would be just in time to address what seems will be an inevitable lull following the last of the 30-70 GW projects that “started construction” in 2016 being placed in service by the end of 2020 to meet the four-year safe harbor. We can only imagine where the wind industry and tax policy will be in 2021, but history suggests the road there will be an interesting one.
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When I think back on the beginning of my career in wind, it’s amazing to see how far we’ve come in terms of better understanding and predicting wind performance. When you compare how we go about the work of measuring and modeling wind energy today with our methods in the late 1990s and even in the early 2000s, the shift is so dramatic it’s comparable to a cave man finally moving out of his cave into a high-rise apartment. And like that cave dwelling, our methods for evaluating the wind were just as crude.

In the early days, companies sent out grizzled (but experienced) surveyors to the field to look for trees bent over by the wind. They used flares and smoke bombs or used long streamers to watch what the wind did to try to understand turbulence. If the site survey looked promising via a sufficient number of crooked trees, then the gold standard in those days for actually measuring the wind conditions at a site was to erect a 10-meter to 40-meter meteorological tower. Higher heights were not necessary because those were roughly the maximum heights of so-called utility-scale turbines at the time.

Once the wind was measured at the site, the methods for translating those measurements into a long-term estimate of wind speed at every turbine location were also fairly crude. The field of wind resource assessment has long relied on the concept of measure-correlate-predict (MCP) to estimate wind power performance. For those not familiar, this framework collects short-term (months to years) wind measurements at a prospective site, finds a long-term (hopefully decades) wind reference, and uses a statistical approach to correlate the reference with the site measurements to produce a long-term prediction of wind resource at the measurement location.

The next step is to use another set of models, again fairly rudimentary in the early days, to estimate the wind potential.
at each turbine location, as that is always at some distance away from the measurement location. Once the wind resource is understood, we can begin the process of estimating power, which requires an estimation of how turbines interact with each other and how turbine performance varies with different atmospheric conditions. To some degree, all methods of conducting an assessment can be fit into this MCP framework, even those of yore. However, our approaches have come from the nearly laughable to the highly sophisticated.

The old way of conducting MCP used a short met tower at the site for about a year and then correlated the measurements from the tower with a long-term reference dataset, usually from a publicly available airport station. These airport stations were never designed for this purpose and were low in height (10 meters above the ground), frequently too far away from the site, and sometimes only offered short records (five to seven years) or were inconsistent because of changes in the instruments used. Once a point correlation was made at the met tower, very basic methods were used to extrapolate this reference to all of the turbine locations, which were some distance away from the tower.

The field of atmospheric sciences knew that wind flow could be incredibly complex over even short distances and used supercomputers to understand those differences, but in the wind energy industry, that complexity was distilled down to highly simplified models that could run quickly on a consultant’s laptop. It was truly astounding to me and my colleagues that wind development companies and financiers were staking hundreds of millions of dollars on these approaches. With hindsight being 20/20, we now know that the risk was real, as it has shown itself through the dramatic over-prediction of actual performance when using these simplistic techniques.

The MCP framework has certainly evolved over time as the industry has matured in its understanding of risk and the cost benefits of conducting more rigorous wind resource assessments. For measurement, we moved to installing one or two 60-meter towers with good-quality anemometers, at a rough cost of $30,000. Today, most companies are now willing to invest the capital to install one to four 80-meter towers (or even higher to chase the ever-increasing hub heights), where the permitting costs of one tower alone can sometimes exceed $50,000 in the California market.
With modern wind turbines reaching 100 meters or higher, met towers are becoming impractical. They are expensive to permit, install and maintain, and they increase safety risks for everyone working on or near them. If a site is abandoned due to low wind resources, you are then left with a high decommissioning cost or a stranded asset.

Mobile remote sensing technologies, such as ground-based SoDAR and LiDAR that can measure up to 200 meters, overcome these measurement challenges. They can be deployed in the early stages of a prospecting campaign, typically with no permitting required, and then moved to provide better spatial characterization of the site or to a new project if the site is abandoned. They significantly reduce vertical extrapolation uncertainty when used in conjunction with a more cost-effective traditional 60-meter met mast. Today, remote sensing information is sometimes even used as the primary measurement data in securing financing for a wind project. This is something we are seeing much more of, as the industry’s understanding of the technology has matured.

The correlate component has also seen major strides with the transition to gridded re-analysis data archives like NNRP, MERRA, ERA-Interim and so on. Re-analysis data offer much stronger and more consistent references from a variety of observational sources, and they benefit greatly from long-term records of 30-40 years versus only 10. Most developers have also staffed up and now hire more meteorologists, GIS professionals and environmentalists to help uncover fatal flaws to a project, such as endangered species or other siting concerns, much earlier on.

Technologies that more accurately capture weather’s complexity and use advanced approaches to predict the wind speed at turbine locations from the on-site observations have also substantially improved. Physics-based numerical weather prediction (NWP) models, such as WRF (Weather Research and Forecasting), offer realistic wind flow information fed by numerous observational sources and are rapidly processed on powerful supercomputers. These models were initially developed within the realm of atmospheric science and then applied first to wind energy forecasting and later (and now increasingly) to wind energy assessment.

The current state-of-the-art of wind resource assessment combines the rich weather datasets obtained from NWP weather simulation models with numerous on-site measurement locations using modern data mining and machine learning approaches. These data and computationally intensive approaches also offer a much more sophisticated way of modeling turbine

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interactions and the time-varying effects of site weather conditions on turbine performance. All of this effort is designed to scientifically explain the weather and climate at a proposed wind energy project and to dramatically reduce the uncertainties of long-term power production estimates.

However, despite their immense potential and proven application, the technologies of remote sensing and NWP were received with strong skepticism when introduced to the wind industry. They were seen as some kind of voodoo or magic. Yet today, all of the largest players are heavily investing in them either through third-parties or by bringing them in-house. NextEra Energy Resources led the way in 2006 by acquiring WindLogics, an early NWP modeling provider. Now, many others are following that lead and using the most sophisticated technology available.

Today, large players can even leverage 10-15 years of turbine and wind farm operational records and, with the power of “big data” analysis, consider the question, “If we had to do this all over again, what would we do differently?” Which sites produced adequate energy, and which ones didn’t? What do realistic wake effects look like, and how can they be mitigated through different turbine layouts or operational strategies?

Currently, wind leases for most wind projects are 30-50 years because companies know that the technology is going to improve dramatically during that time period. Forward-thinking companies are even signing 99-year leases. This is because they know that turbines will get better, repowering will be increasingly important, and using the latest in wind assessment technology will help them better harness their available wind resources.

So let’s learn from the past and embrace the brave new world that is out there today to better address the challenge of wind resource assessment. This technology is here right now. Advanced approaches for wind resource assessment are ready to go whenever and wherever you are planning your next project.

Lee Alnes is global manager of measurement systems within Vaisala’s energy division and has a wind industry career spanning nearly two decades. Alnes has supported wind energy developers and operators all over the world to better understand wind resource variability for assessment, forecasting and many other applications. Prior to Vaisala’s acquisition of Second Wind, he served as its vice president of sales and marketing. He previously served as chief operating officer at WindLogics. He can be reached at lee.alnes@vaisala.com
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What a difference a year makes. With the successful completion of Deepwater Wind’s 30 MW Block Island Wind Farm in Rhode Island at the end of last year, offshore wind in North America is no longer a dream – it’s reality.

And buoyed by the wind farm’s success in Block Island, several states are moving ahead with their own offshore wind projects. State-based incentives and requests for proposals are paving the way for pilot and commercial-scale offshore wind projects in New York, Ohio, Massachusetts, Maryland and elsewhere. Finally, after many fits and starts, a new industry is starting to take shape.

What’s more encouraging is that the offshore wind industry is beginning to get a handle on lowering costs – a big barrier often used by opponents. However, that argument may be changing. As evidenced by the U.K.’s recent competitive auction, the winning offshore wind bids were revealed to be cheaper than that of gas and nuclear. According to RenewableUK, offshore wind costs are continuing to plummet. In fact, the organization says prices paid for offshore wind are 47% lower than they were just three years earlier.

Granted, the U.S. and Canadian markets are nowhere near as mature as their U.K. and European counterparts. Nonetheless, the U.K. auction results provide a clear indication that a business case can be made for offshore wind.

That’s why this month, we bring you this special section on offshore wind. The following developers, suppliers and organizations are tasked with solving the myriad challenges remaining to backstop this emerging industry.
Business Network for Offshore Wind:

Offshore wind spun to life when five turbines began generating electricity off the coast of Rhode Island. Several states have continued offshore wind’s momentum and replaced intent with actions that are building the industry, including purchase commitments that total over 5.4 GW.

The pace of progress for U.S. offshore wind is accelerating rapidly within the Mid-Atlantic and Northeast. Massachusetts released a request for proposals for 400-800 MW of offshore wind development, the first project under its MA Energy Diversity Act. The Maryland Public Service Commission approved financing applications for two offshore projects totaling 368 MW. Long Island Power Authority approved a 90 MW offshore wind project. The New York State Energy Research & Development Authority has released the Offshore Wind Master Plan. The industry is also moving forward. DONG Energy partnered with Dominion Energy to construct two 6 MW turbines off the coast of Virginia by 2020, and two Gulf Coast companies have announced they will build the first US Jones Act Compliant Jack Up vessel.

The most significant recent development in the U.S. offshore wind industry is that a price point has finally been set. Until May, the cost of offshore wind has always been speculative. The Maryland Public Service Commission’s approval of the U.S. Wind and Deepwater Wind projects set a $134/MWh price point and provides the industry with a baseline price.

The Business Network for Offshore Wind (Network) actively helps grow and expand the U.S. offshore wind market. The Network was very involved in passing the Maryland legislation that enabled these projects. When this legislation was being debated in 2013, the price point was estimated to be $230/MWh. In four years, U.S. offshore wind has benefited from European experience, resulting in a $96/MWh reduction, without one commercial-scale project in the water.

As the only U.S. nonprofit organization solely focused on offshore wind, the Network closely follows trends and market developments, helping its members make informed business planning decisions. While offshore wind is still higher in costs than solar and land-based wind, the National Renewable Energy Laboratory Annual Technology Baseline and all of the trends point to a rapid offshore wind cost reduction over the next 10 years.

As offshore wind advances in Europe and becomes less reliant on subsidies, investors have become more comfortable with and interested in the offshore wind industry’s movement into the global mainstream renewable market. This comfort and interest is lowering the cost of equity capital, which directly contributes to the lower kilowatt-hour price for the ratepayer. The downward trend of offshore wind costs over the past several years, the continued evolution of innovative turbine technology, and more efficient construction methods have made offshore wind power more viable in the electricity sector than ever before.

During the next year, the U.S. offshore wind industry will see a renewed commitment from Governor Carney in Delaware and a 3,500 MW purchase commitment from a new governor in New Jersey. These actions, combined with additional federal lease auctions – a minimum of one per year – by BOEM, will propel offshore wind into a major U.S. energy industry. We expect to see the federal process for approving permitting to be shortened, helped by new directives and a new offshore wind standard setting process. The intent to accelerate commercial-scale development in the U.S. is clear, and this will attract more European developers and businesses to enter the U.S. market.

Having the European offshore wind industry with its 96,000 jobs to view as a precursor, the U.S. is benefiting from its cost-cutting lessons and its investments in technological advancements, as well as leveraging its experienced, efficient supply chain. The Network will continue to assist with the knowledge transfer from Europe to the U.S. by facilitating transatlantic partnering between governments-to-governments and businesses-to-businesses to expand opportunities, expertise and capacity on both sides of the Atlantic.

The Network is fulfilling its nonprofit mission to establish the U.S. offshore wind supply chain by helping expedite relationship building, connecting businesses with who they need to know, and accelerating meeting the right partner at the right time. The Network is working toward leaving its imprint on the U.S. offshore wind industry by building a thriving U.S. supply chain consisting of experienced companies, U.S. ingenuity and strong partnerships.
The New Bedford Marine Commerce Terminal is a multipurpose facility designed to support the construction, assembly and deployment of offshore wind projects, as well as handle bulk, break-bulk, container and large specialty cargo.

The terminal is located within the port of New Bedford, which is a less congested and more easily accessible shipping center for the Northeastern U.S. market and beyond. It is a 26-acre facility with a 1,200-foot vessel quayside and a new 300-foot-wide navigational channel dredged to -30 feet MLLW; thus, vessel transit from the terminal to open water is free of overhead restrictions.

Whereas many ports have a small quayside area specifically designated as the single hard point, over 21 acres of the main terminal facility has the ability to sustain uniform loads of 4,100 pounds per square foot (20 metric tons per square meter) and concentrated loads of up to 20,485 pounds per square foot (100 metric tons per square meter). This loading capacity allows for cranes of all sizes to be mobile throughout the site, increasing the efficiency of the work and providing logistical flexibility.

The Wind Technology Testing Center (WTTC) offers a full suite of certification tests for turbine blades up to 90 meters in length. WTTC also offers the latest wind turbine blade testing and prototype development methodologies to help the wind industry deploy the next generation of land-based and offshore wind turbine technologies.

- Full suite of static and fatigue tests per IEC61400-23 standard;
- Three test stands and 100-ton overhead bridge crane capacity;
- Blade material testing;
- Dual-axis static or fatigue testing;
- Prototype development and blade repair capabilities;
- Research and development partnerships;
- Hands-on workforce training;
- Strong commitment to client intellectual property protection; and
- Located on a deepwater port to accept all blade sizes.

MassCEC is a publicly funded agency dedicated to accelerating the success of clean energy technologies, companies and projects in the commonwealth while creating high-quality jobs and long-term economic growth for the people of Massachusetts. As part of this mission, MassCEC owns and operates a pair of facilities – the Wind Technology Testing Center and the Marine Commerce Terminal in New Bedford – that assist in the advancement and development of wind energy innovation and deployment.

Since it began operating in 2009, MassCEC has helped clean energy companies grow, supported municipal clean energy projects, and invested in residential and commercial renewable energy installations, creating a robust marketplace for innovative clean technology companies and service providers.
LM Wind Power: Four Reasons To Go Offshore

It’s never been a better time to go offshore – the market demands large renewable energy capacity, offshore system technology is maturing, technology is enabling larger turbines and rotors, costs are rapidly declining, and there is nearly unlimited space to deploy offshore wind. However, the harsh offshore environment comes with additional challenges, and the investment requires careful consideration. Based on decades of experience, LM Wind Power knows what it takes to build blades that will last for more than 25 years in stormy seas. Here are four reasons to invest in the booming offshore market, with LM Wind Power as the partner of choice for the most advanced, reliable wind turbine blades.

1. Leverage research, development and manufacturing scale to reduce costs faster

The offshore industry is already realizing big reductions in cost, and there are more to come as turbines scale up in megawatt capacity and rotor size. This size increase requires investment in technology, manufacturing processes and factories, says Dorte Kamper, deputy head of sales. “To invest, companies need to secure both trust in the future stability of the market and the ability to build scale. Too many players with too little scale won’t enable the step ahead.” LM Wind Power secures this scale by offering similar underlying material technology while tailoring the blade shape to each offshore, strategic partner. This results in a larger number of blades produced using the same technology, although serving different turbines and multiple customers, which ultimately helps to reduce costs.

2. Team up with an experienced partner with a track record

Reducing the cost of energy starts with proven technologies and a long track record. LM Wind Power has been a pioneer in the offshore industry for over 25 years, with nearly 7,000 equivalent blade years of offshore experience. Global reach, with offshore blades installed in all major wind markets, positions the company to capture the strong winds in any of the world’s seas. The first offshore wind farm in the U.S. – the Block Island Wind Farm – is

Infographic courtesy of LM Wind Power. Explore more reasons to go offshore at GoOffshore.lmwindpower.com
The offshore wind industry is born, with LM Wind Power blades installed at the world’s first offshore wind farm in Vindeby, Denmark. The LM 88.4 P launched as the world’s longest blade – at more than 2.5 times the length of a blue whale.

LM Wind Power began blade production in 2004, and since then the company has produced more than 195,000 blades for 1,200 customer turbines across 9/14/17 4:58 PM

FAST FACTS

- LM Wind Power is the world’s leading supplier of rotor blades to the wind industry.
- Approximately every fifth turbine in the world is fitted by blades produced by LM Wind Power.
- LM Wind Power has produced more than 195,000 blades since 1978, corresponding to approximately 84 GW of installed wind power capacity.

SERVICES

More than 30 wind turbine blade types, with 5-7 new blade developments annually.

- Blade Types:
  - 1.5 MW - 2 MW
  - 2.5 MW - 3.3 MW
  - 5 MW - 8 MW
- Maintenance & Repair – Logistics

LEARN MORE:
gooffshore.lmwindpower.com

powered by LM 73.5-meter blades. In China, LM Wind Power has a dedicated offshore blade factory in the Jiangsu province, and in France, the company is currently constructing a dedicated offshore blade factory in Cherbourg. “The new facility responds to demand for new offshore capacity in northern Europe,” says Alexis Crama, vice president offshore. “The plant will manufacture offshore blades for multiple customers, and it is expected to generate 550 direct jobs and further 2,000 indirect local jobs.”

3. Get blades that are made to last

When going offshore, proven reliability is an absolute necessity: It’s what end users and wind farm operators will see as the value driver for their investments in the long run. “Reliability needs to be the No. 1 priority because proposing that blades could be easily repaired or replaced offshore is an absolute no-go,” states Jesper Månsson, senior director of technical business development. First, sea access is difficult and requires special vessels that are expensive for installation, repair and maintenance. Second, offshore blades are longer and, technology-wise, more complex to produce. Finally, higher wind speeds and the sea environment generate more fatigue and erosion. “LM Wind Power’s blades are tested to the extreme, beyond the industry standard, to reduce the need for maintenance and ensure they will survive whatever weather conditions they face,” Månsson says. “Investing in high quality and reliability standards allows for massive savings in operational expenditure over the lifetime of a project.”

4. Produce more energy with advanced designs and technology

As a specialist in ultra-long blades, LM Wind Power is leading the size race. The company has repeatedly set the record for the world’s longest blades – at 61.5 meters, then at 73.5 meters and most recently at 88.4 meters in length. The LM 88.4 P makes up the world’s longest blade set using hybrid carbon technology, with one set of three blades being capable of powering around 10,000 homes. Innovation is in the company’s DNA, and its advances in blade length and performance have not reached their limit. As the offshore industry expands, continue to look to LM Wind Power’s breakthrough technology to pave the way for longer, more powerful offshore blades – producing more energy than ever before.
DONG Energy:  
The subsidiary of the Denmark offshore giant is already demonstrating leadership.

What a year it’s been for Boston-based offshore wind developer DONG Energy Wind Power North America. In addition to the Bay State Wind project, the developer has also ventured into such emerging offshore wind markets as Virginia, New Jersey and British Columbia.

In Dec. 2016, DONG brought on New England transmission builder Eversource Energy to jointly develop, construct and operate the $1 billion Bay State Wind project, a proposed offshore wind farm to be located roughly 15 to 25 miles south of Martha’s Vineyard.

Eversource and DONG each bring specific expertise to the deal. The Massachusetts utility specializes in transmission, and its executives know about the region’s power grid; DONG brings years of experience in building and operating offshore wind farms.

According to DONG, Bay State Wind recently became the first project to receive approval from the Bureau of Ocean Energy Management (BOEM) for its Site Assessment Plan, clearing the way for the developer to deploy its FLiDAR buoy system to record wind and wave speeds in the lease area.

In the meantime, DONG and Eversource Energy are furiously working to meet a December deadline to answer a request for proposals (RFP) put out by Massachu-
setts that mandates that state utilities purchase 1.6 GW of offshore wind power by 2027.

In answering the Massachusetts RFP, however, Bay State Wind could face at least two developers in the bidding for contracts with Massachusetts utilities, as Deepwater Wind and Vineyard Wind also have lease rights to offshore areas south of Massachusetts.

Despite the competition, however, DONG remains confident in its project. “When we set up shop here in Massachusetts, quite quickly, we were having discussions with Eversource about offshore wind and how far it’s gone in Europe,” says Thomas Brostrom, president of DONG Energy North America. “We remain committed to not only building a cutting-edge offshore wind project in the state, but providing the commercial-scale capacity needed for cost-effective energy that brings economic benefits through skilled jobs and manufacturing.”

Further down the Eastern seaboard, DONG Energy has also teamed up with Dominion Energy Virginia on an offshore wind project in a federal lease area off the coast of Virginia Beach, Va.

The agreement calls for the construction and operation of two 6 MW turbines for the newly named Coastal Virginia Offshore Wind project, of which Dominion Energy remains the sole owner.

According to DONG, the Virginia offshore wind farm would be only the second offshore wind project in the U.S. (Deepwater Wind’s Block Island Wind Farm is the first) and the first owned by an electric utility company. Along with renewable energy, the offshore wind farm will provide Dominion with valuable experience in managing offshore wind resources.

This phase-one development will be built approximately 27 miles off the coast of Virginia Beach on a 2,135-acre site leased by the Virginia Department of Mines, Minerals and Energy. Dominion says it will provide operational, weather and environmental experience needed for large-scale development in the adjacent 112,800-acre site leased by Dominion Energy from BOEM. Full deployment could generate up to 2 GW of energy.

The two companies have signed a memorandum of understanding giving DONG Energy exclusive rights to discuss a strategic partnership with Dominion Energy about developing the commercial site (based on the successful deployment of the initial test turbines).

DONG Energy expects to immediately begin engineering and development work in order to support the targeted installation by the end of 2020. The timing for construction depends on many factors, such as weather and protected species migration patterns, notes Dominion.

Finally, DONG is looking at a New Jersey offshore wind area as an area of interest.

According to DONG, it has acquired a lease area for the proposed Ocean Wind, located about 10 miles off the coast of Atlantic City. Recently, the developer began site survey work.

Although New Jersey was one of the first states to come up with a framework to incentivize offshore wind development using offshore renewable energy certificates, the state has yet to officially sign the financial mechanism into law, vexing numerous project developers.

Nonetheless, a DONG spokesperson says the developer will tackle New Jersey in much the same way it did early on with Massachusetts stakeholders.

“As we begin the initial phases of development, we are continuing to educate stakeholders and the community about the benefits of offshore wind.”

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**HISTORY**

DONG Energy has built more than one-quarter of the total offshore wind capacity in the market. By 2020, it aims to have more than doubled its installed capacity compared with 2016 from 3.0 GW to 6.5 GW. The installed capacity in 2020 is equivalent to the annual electricity consumption of 16 million Europeans.

**FAST FACTS: DONG ENERGY**

- 22 offshore wind projects around the world
- 3.9 GW in global offshore wind capacity
- 1,000+ turbines installed worldwide
- 26 years of experience in offshore wind
- First to use 8 MW turbines – the largest in the world
- 50%+ cost reductions in the past seven years
- 7.5 GW in offshore wind capacity by 2020
Wind Power Is poised For The Future
Poised For The Future

Advancements in turbine technology accelerate the growth of the renewable energy technology.

By Robert C. Rugh

Throughout the expansion of the wind power industry, continual technological advancement of wind turbine design and manufacture, coupled with improved installation and operating protocols, has driven growth. Without these technology advancements, wind power would not be on its current growth trajectory. Innovative wind farm siting and design, improved wind resource characterization, advanced techniques in wind farm construction and operation, and innovative equity and debt financing have all complemented wind power’s growing share of the power generation portfolio.

Wind turbine cost of energy competitiveness versus other power generation sources — characterized as levelized cost of energy, wind power system reliability, supply-chain stability, equity investment attractiveness, and minimized financial risk on par with other investments — collectively provides a reference to measure and judge wind power performance.

For the electric power consumer, cost of energy is where the rubber meets the road — the price the consumer pays per kilowatt-hour of electricity. As more productive turbines are brought online, producing more kilowatt-hours of electric power per
nameplate megawatt rating, the cost per kilowatt-hour declines as more is generated per investment dollar (or CAPEX) and per dollar of operating cost (or OPEX), driving the total cost of energy lower and enhancing wind power viability.

Harnessing wind to perform work has been pursued for centuries. Early on, wind milled grain, pumped water and more. Today, electric power generation dominates wind power applications. Wind power generation has existed for a long time, almost from the introduction of electric power generation by Thomas Edison, George Westinghouse and others, from early proof-of-concept turbines to today’s industrial utility-class turbines developed and matured over the last several decades, continuing today to push the technology envelope.

As wind power generation continues to proliferate, technological advancements are bringing cost parity versus other power generation sources.

Technology pathway

Contemporary wind turbine technology has advanced significantly over the past 20 to 30 years, with innovation accelerating in recent years.

Thirty years ago, the largest wind turbines were typically rated 100-200 kW, with some rated a bit higher and many rated lower. Twenty years ago, the largest wind turbines were rated 300-600 kW. Ten years ago, the largest turbines were rated 1.5-2.0 MW.

Today, the nominal rating for an onshore turbine is 2.0-4.0 MW, but many OEMs are pushing the envelope to 5 MW and beyond. Offshore turbines are rated 5 MW to 7 MW, with new turbines approaching or exceeding 10 MW. Over the years, as new size plateaus were reached, many believed turbine ratings had reached their limit, only to see the plateau shattered a short time later by new turbines pushing the size envelope yet again. Therefore, you can expect turbine ratings to continue increasing in the future.

Physical size has grown with the increase in power rating and efficiency. Thirty years ago, rotors were nominally 15-20 meters in diameter; 20 years ago, diameters grew to 40-50 meters; 10 years ago, diameters were 70-90 meters; and today, rotor diameters are 110-130 meters, with some exceeding 150 meters, but not for onshore and offshore applications. Aside
from nameplate power rating, the driver of rotor size is energy capture (capacity factor). The higher the capacity factor, the lower the cost of energy. Milder wind sites require larger rotors to generate power output comparable to higher wind sites; higher wind sites combining larger rotors with advanced turbine operating algorithms to limit loads further energy cost.

Tower heights have also grown. Towers were 30–35 meters high 30 years ago, 50–65 meters high 20 years ago, and 80–100 meters high 10 years ago. Today, they approach 150 meters and higher. Taller towers access better wind resources, higher average wind speeds and reduced wind turbulence.

Control systems are more sophisticated. Thirty years ago, turbines had basic industrial control architecture, utilizing electro-mechanical components lacking onboard logic. A few had PLC-based pitch and yaw operation and SCADA communications. During the intervening years, programmable computer configurations were introduced, as computer technology and miniaturization continued advancing. Variable speed constant frequency systems utilized newly developed power electronics, improving energy capture, and proactive mechanical turbine hardware loads management software was introduced. Today, onboard load management systems manage complex internal turbine loads to optimize energy capture.

Turbine maintenance and safety matured over the decades. Thirty years ago, the sophistication in these areas was, at best, in its infancy. Much effort has been devoted to improvements, including collaboration with OSHA, yielding significant progress today and continuing into the future.

Wind farm site configuration improved over the years as site challenges were resolved – ranging from erosion management, to site environmental impact minimization, to wildlife considerations, to lightning management, to grid compatibility and more – innovating to yield improved site solutions.

Site construction, turbine erection practices and procedures
have all become more sophisticated, as requisite crane size and site management requirements have grown larger and more complex. The application of lean management techniques on construction sites has greatly improved efficiencies and thereby reduced costs during the construction phase of projects, yielding a more competitive cost profile for wind versus other power generation alternatives.

Future optics

Look for turbine ratings and component sizes to continue evolving, enabling milder wind sites while improving capacity factors, with longer blades, higher towers, larger drivetrains, more efficient equipment packaging and designs producing more power out of less mass.

Controller sophistication and capabilities advancements will continue to improve data capture and analysis, enhance capacity factor and machine reliability, reduce downtime, economize operation, and improve forecasting accuracy.

Hybrid configurations incorporating multiple power generation sources (such as wind-solar, wind-gas, etc.) will be considered more rigorously, as power generation market integration economics drive situational lowest cost of generation decisions.

Enhanced development and deployment of energy storage and management systems to facilitate wind-generated power dispatchability, including technology development to more efficiently utilize transmission and distribution systems, will increase grid capacity utilization and reliability.

Turbine buyers and finance entities seek to minimize risk and ensure financial returns. They seriously analyze technology risk, turbine OEM balance sheet size and financial health.
to guide turbine selection, which has driven turbine OEM consolidation, evolving the industry profile to tier-one OEMs versus the others. Configurations deviating from the current industry norm are shied away from, and any turbine OEM lacking a large balance sheet is deemed too risky. Non-tier-one OEMs have an uphill battle to secure market share. Unless or until a disruptor successfully intervenes, designs will continue to align with conventional configurations. In other words, don’t expect to see any broad implementation of such dream ideas as multiple turbines on a single tower, multiple-length blades, vertical axis turbines, etc.

Wind power is approaching an ideal position, with the cutting of the production tax credit/investment tax credit umbilical (arguably a form of commercial/industrial training wheels) resulting in wind power passing an important milestone and becoming market-based, with no government financial assistance, which is in bold contrast to all other competing power generation technologies. No more tax credits or tax equity gambits, and no more controversial public assistance to rally wind opponents — just clear-cut capitalism to drive the best economic power generation solution to market. Ideally, all other forms of power generation will follow suit.

The ideal common denominator is total cost per unit of power consumed, encompassing total lifecycle and value chain costs (technology performance, transmission and distribution, dispatchability/energy storage, applicable taxes, overall cost of the carbon footprint of the manufacture and supply of power generation hardware, site costs, cost for scrubbing air to remove combustion byproducts, storing spent fuel, mitigating local thermal emissions, etc.).

What is the future of wind power? As in any forecast, reality will likely deviate from forecast the further into the future you peer. (We try to project power generation solutions decades into the future, but remember that half a century ago, we went from no space travel to a man on the moon in less than a decade, demonstrating that yes, things can be changed significantly in a very short period of time if we commit to accomplish the change, with failure not an option.) Considering unsolved challenges (energy storage, transmission optimization, etc.), as-yet-unknown technological developments and innovations, and disruptive technologies yet to be identified, a broad spectrum of possible future scenarios emerges.

Viable, objective, commonsense quantitative decision-making criteria should be established — facts- and physics-based, unswayed by political ideology; spin factor influences or echo-chamber noise; or any other factor that might sway power generation evolution from a naturally driven pathway governed by technological advancement and real economics.

Among all forms of power generation, wind is one of only a handful of power generation sources without a significant environmental impact from power generation operations — no thermal, air, water, residual fuel or other waste stream issues.

Robert C. Rugh, former president and CEO at DeWind, wind vice president at Mitsubishi, manufacturing vice president at GE Wind Energy and predecessor companies, and product line manager at Westinghouse Electric, currently provides consulting services to the power industry. He can be reached at robert.rugh@robertrugh.com.
As we celebrate the final print issue of *NAW*, it’s a good time to look back and reflect on what has been a remarkable period for the North American wind industry. As seen through our recent covers, we’ve celebrated the five-year extension of the production tax credit (January 2016) and recognized the wind turbine technician (March 2016). Just the same, we’ve also cautioned owners and operators against growing industry threats, macroeconomic (June 2016) and otherwise (December 2016). As we say farewell to the printed page, *NAW* looks forward to providing the same in-depth, need-to-know information in the digital realm. Therefore, be sure to check us out at nawindpower.
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AMERICAN WIND ENERGY ASSOCIATION

2017 FALL EVENTS

OFFSHORE WINDPOWER CONFERENCE & EXHIBITION
October 24 - 25 | New York, New York, USA

WIND ENERGY FINANCE & INVESTMENT CONFERENCE
October 25 - 26 | New York, New York, USA

WIND ENERGY FALL SYMPOSIUM CONFERENCE
November 7 - 9 | Albuquerque, New Mexico, USA

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