DIRECTION

THE FUTURE OF WIND

New technologies on blade segmentation and turbine erection will unlock previously untapped pockets of the global market. Courtesy: Ad-liftra, creativecommons.org/licenses/by-sa/3.0)

Wind-energy industry R&D spending to top $36.9 billion by 2028

As the wind-turbine market enters a new era driven by subsidy and tax credit free cost parity, a new generation of wind-energy technology is poised to hit the market by 2020. Markets that are shifting toward a competitive tendering process continue to drive the need for higher AEP as well as lower CapEx, OpEx, and LCOE.

Additionally, new technologies on blade segmentation and turbine erection will unlock previously untapped pockets of the global market, in both space constrained sectors or areas of complex terrain where conventional technology is not cost effective.

Collectively, the industry will spend approximately $28.2 billion in private R&D by 2028, matched with approximately $8.7 billion in public R&D funding over the same time-frame. The private investment represents an industry average of approximately 5.3 percent of expected revenue and is a significant increase off the average industry low of approximately 2.7 percent back in 2013.

Regionally, Western Europe, Japan, and China will dominate the R&D and technology development landscape with North America lagging behind due to an unfavorable political environment in the U.S. and lack of meaningful government support for climate-change technology.

India is potentially emerging as a hotbed of technology development as low costs and government initiatives on renewables and manufacturing competency development continue to drive optimism. GCC states also are poised to see an increase in spending on renewable energy technologies in general over the next 10 years.

Australia, New Zealand, Singapore, the Philippines, Malaysia, and Indonesia are likely to see some modest spending on R&D as increased wind penetration increases awareness of technology function and development opportunities.

Eastern Europe, Latin America, and Africa will see minimal R&D spend in the next 10 years, but they have an opportunity to grow as wind-turbine capacity additions increase in those regions and economies recover.

The overall trend in onshore wind-technology development appears to be focused on system integration. This is driven by expected growth in distributed generation technologies as well as the increasing cost competitiveness of solar technology. Wind-turbine OEMs are shifting focus to go beyond just turbine production and incorporate energy storage and solar into turnkey systems with fully integrated controls.

Digitalization also is driving a significant portion of technology development as data analytics companies, turbine OEMs, sub-component suppliers, asset owners, and even ISPs all look to incorporate asset performance optimization, asset health management, and even energy trading/balancing capabilities into their product and service offerings.

Nevertheless, in this era of advanced-technology development for performance enhancement and LCOE reduction, it is also imperative to consider the bankability of new technologies as a guide on the likelihood and timing of commercial adoption. There is a plethora of new ideas stuck in the conceptual and preliminary design phase that appear to be attractive but lack a path and the corresponding investment to become commercially available.

Many major asset owners, as well as turbine OEMs and sub-component suppliers, have rekindled their external technology scouting activities, and these efforts are poised to drive M&A to fill specific gaps. The era of "not invented here" seems to be dwindling as technology partnerships and license agreements are likely to see an increase in the coming years.

There is a significant amount of technology at a mid-range technology readiness (maturity) level and will require the bulk of the total investment. A total of 46.2 percent of all innovations have undergone some type of bench-testing, prototype development, or field testing, while 23.3 percent are commercially available or in a pre-series development stage, and 30.6 percent are still in a design stage.

Companies must continue to focus on R&D spending to ensure their products remain competitive, and governments need to continue to support the companies who make such investments. A strong correlation has long existed in markets that spend the most on R&D and those with the most wind-capacity additions. Ultimately, R&D is a precursor to subsequent technology deployment, and therefore the cost reductions associated with achieving economies of scale in that market.

MORE INFO www.intelstor.com

DNV GL issues study of R&D pathways for supersized blades

DNV GL recently released an in-depth study, commissioned by the U.S. Department of Energy's Lawrence Berkeley National Laboratory, which examines the challenges associated with manufacturing and deploying next-generation, increasingly larger land-based wind turbines. In the past decade, the U.S. wind energy industry has achieved significant improvements in energy production and cost efficiency, driven in part by increased turbine, blade, and tower size. However, the industry is quickly approaching a logistical cost and capability ceiling as turbine components become too large for existing infrastructure and transportation to accommodate.

Currently the largest blades deployed in the U.S. are 67 meters, but blades up to 88.4 meters — or almost

as long as a football field — have been deployed in Europe; blades up to 115 meters are on the horizon. As turbine component sizes increase, logistical constraints can either reduce the number of developable sites or elevate costs, which can make some potential sites economically uncompetitive. Finding new solutions to logistical challenges associated with ever-larger components can enable the wind industry to achieve optimal wind levelized cost of energy (LCOE) options for every region of the United States.

HIGH-VALUE R&D OPPORTUNITIES

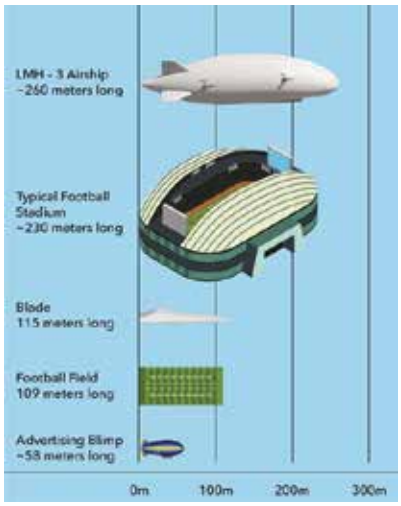
DNV GL explored three innovation pathways to help identify high-value R&D opportunities:

- **Innovative transportation:** To address physical constraints and challenges, new methods can facilitate the transportation of blades from factories to wind projects via road, rail, or air.
- **Segmented blades:** Segmented or modular blades may enable the use of more cost-effective transportation, but must also account for the impacts on blade design, manufacturing, and on-site assembly.
- **On-site manufacturing:** Deploying a temporary blade manufacturing factory at the project site to fabricate blades from raw materials to finished product largely eliminates transportation challenges associated with longer blades.

"DNV GL identified a number of R&D activities that could make contributions to the viable development of supersized blades. These recommendations are feeding into the U.S. Department of Energy-funded 'Big Adaptive Rotor' project to assess and prioritize technology needed to develop a cost-competitive land-based 5-MW turbine with 100-meter-long blades," said Ryan Wiser, senior scientist, Lawrence Berkeley National Laboratory.

ACCELERATION OF R&D

The acceleration of R&D to make supersized blades feasible requires collaboration between researchers in the United States, turbine manufacturers, blade manufacturers, and transportation logistics companies. Blades are the most critical component in determining the technical and economic performance of wind turbines. The logistics associated with supersized blades adds additional levels of complexity into the development process, which the industry and researchers must work collaboratively to address.



"To realize continued progress in making wind energy cost-competitive across all regions in the U.S., the wind industry must accelerate R&D in innovative approaches to blade design, manufacture, and transportation," said Richard S. Barnes, executive vice president, Energy North America at DNV GL. "The good news is that there appears to be fertile ground for R&D and accessible solutions on the near horizon."

High-value R&D areas include:

- Further advances in high-stiffness/low-cost materials like industrial carbon fiber and thermoplastics materials.
- Advanced controls and sensor technologies that could be applied to monitor or enable blade bending in transport or monitor or control segmented blade loads such that lower-weight blades can be achieved.
- Reducing the blade chord dimension would enable operation at higher tip speeds and improves blade transport potential, but issues related to aeroacoustics and leading-edge erosion need further improvement. Advanced aeroelastic modeling of dynamic stability and deflections can enable the development of more slender blades that can allow controlled deflection during transport.
- The pathways identified by this study represent opportunities that, if realized, could significantly enable wide-scale deployment of supersized turbines across all regions of the United States.

MORE INFO www.dnvgl.com/energy

Ardian acquires wind farm from OX2

Ardian, a world-leading private investment house, recently announced a 300 million euro investment to build a wind farm in Åndberg/Härjedalen, Sweden. Ardian acquired the development rights of the project from OX2, a leading Nordic renewable energy developer. Ardian has also engaged OX2 to lead the construction and technical management of the facility. The wind farm will be operational in 2021 and is expected to produce in excess of 800 GWh per year.

The 53-turbine wind farm will be one of the largest in Sweden, which is a world leader in the innovation and development of sustainable energy. Sweden has passed legislation to go "carbon neutral" by 2045, with Denmark, Norway, and Finland all having made similar commitments.

Ardian's portfolio in the Nordics, which already includes two wind-farm investments in Norway and Sweden, will now exceed 400 MW of gross capacity, corresponding to the yearly energy consumption of more than 600,000 electric vehicles. Separately, OX2 is currently building a record of more than 1 GW of wind power in the Nordics, of which approximately 90 percent is in Sweden.

"In OX2, we have found an excellent partner," said Amir Sharifi, managing director at Ardian Infrastructure. "We look forward to together building a state-of-the-art wind farm using the latest available technology. Our goal

OX2's Raskiftet wind farm. Ardian has also engaged OX2 to lead the construction and technical management of a wind farm in Åndberg/Härjedalen, Sweden. (Courtesy: OX2/ Joachim Liljecrantz)

is to achieve solid returns without subsidy and a positive impact on all stakeholders."

"We are very pleased to have established a good business relationship with Ardian after a realization process that was characterized by a high degree of professionalism and spirit of cooperation," said Paul Stormoen, managing director at OX2 Wind. "We are now looking forward to beginning construction together with our sub-contractors. The wind farm is a significant local investment and a further important contribution to the ongoing global transition to a renewable energy sector."

MORE INFO www.ardian.com

President proposes $193.4 million for BOEM in 2020

President Donald Trump recently proposed a $193.4 million fiscal year 2020 budget for BOEM to safely and responsibly manage offshore energy and mineral resources.

The president's budget request reflects careful analysis and focuses on the execution of BOEM's mission, including offshore oil and gas exploration and leasing, offshore renewable energy, marine minerals management, and science-based analyses.

It continues to support efforts vital to advancing the president's Executive Order 13795, Implementing an America-First Offshore Energy Strategy, which requires BOEM to develop and implement a new National Outer Continental Shelf Oil and Gas Leasing Program (National OCS Program) in conformity with the provisions of the OCS Lands Act.

"This Administration calls for boosting domestic energy production to stimulate the nation's economy and strengthen America's energy security, while providing for environmental stewardship," said BOEM's Acting Director Walter Cruickshank. "The FY 2020 budget request allows BOEM to continue its efforts to advance these goals as part of our statutory mission."

With this request, BOEM proposes to focus resources in the following areas:

- **2019-2024 National Outer Continental Shelf Oil and Gas Leasing Program (National OCS Program):** Pursuant to Executive Order 13795 – Implementing an America-First Offshore Energy Strategy – and Secretarial Order 3350 – America-First Offshore Energy Strategy – BOEM initiated efforts to develop a new National OCS Program in FY 2017. These efforts continued through FY 2018 and FY 2019. For FY 2020, BOEM requires additional funds to support personnel and contracts necessary to implement the new National OCS Program. Note: The FY 2020 Budget assumes continued lease sales in areas available under the current OCS 5-Year Program, but does not presume a particular secretarial decision on the 2019-2024 Program.
- **Renewable Energy:** In recognition of the role renewable energy can play in achieving this Administration's America-First Offshore Energy Strategy, BOEM will continue to advance renewable energy through an aggressive leasing program, while ensuring that its environmental review and permitting process for renewable energy projects is coordinated, predictable, and transparent.
- **Marine Minerals:** BOEM facilitates access to and manages OCS marine minerals, which include sand and gravel resources that are used for coastal resilience projects (e.g., hurricane recovery and response, beach nourishment and coastal restoration activities, and protection and restoration of important ecological habitats). BOEM also seeks funding to initiate an OCS Critical Mineral Inventory to assess the nation's offshore supply of critical minerals, potentially reducing the nation's vulnerability to economic disruption, as well as negative national security impacts caused by a lapse in imports.
- **Environmental Analyses:** The need for energy must go hand-in-hand with responsible environmental stewardship. In accordance with Secretarial Order 3355, BOEM is conducting its environmental analyses in a transparent, coordinated, and streamlined fashion to ensure that decisions are informed by the best available science. BOEM will also continue to use environmental science as the foundation for sound policy decisions.

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