

# Technology



“ Vestas has a clear ambition to lower the cost of energy faster than anyone in the wind power industry by bringing commercially valuable products and services to the market.”

**Anders Vedel**  
Executive Vice President & CTO



## Vestas' technology strategy

Being the global wind power leader requires a long-term line of sight in technology development. Vestas continuously strives to bring commercially competitive products to the market in a profitable way. Vestas' technology strategy derives its strength from market-driven product development and extensive testing at Vestas' test facilities in Denmark – the largest test facilities in the wind power industry – and the UK. This enables Vestas to continuously introduce new and integrate proven technologies to create high-performing products and services in pursuit of the overriding objective: lowering the cost of energy.

By building on the existing 2 MW and 3 MW platforms, Vestas secures an ability to grow profitably and deliver highly competitive and reliable products and services for its customers' projects in all wind classes. For Vestas, industrialisation means moving from a “one-size-fits-all” approach to custom configurations based on modularised building blocks that enable Vestas to offer customers tailored solutions to meet project-specific requirements.

The modularity increases the flexibility of Vestas' product range by combining different modules with standardised interfaces, making it possible to optimally configure the wind turbine as well as the wind power plant for the local wind and grid environment. Vestas' product range can thus match an increasingly wider variety of wind conditions, even within the same wind class, and in this way optimise wind turbine output and strengthen customers' business case.

In addition to industrialisation and modularisation, Vestas works with more than 40 product options to ensure that specific market requirements are met. These range from simple add-ons to fully integrated options. An example of the latter is the de-icing option. To date, more than 1 GW of wind turbines with the de-icing option have been ordered by customers in Austria, Canada, Finland, Germany, Norway, Sweden, and Japan.

With an increased strategic focus, Vestas works more and more with external technology and innovation partners such as suppliers, research institutes, universities as well as adjacent industries. This approach gives Vestas insights and access to new, innovative technologies and materials that may already be in use in other ways. Vestas

integrates these “external” technologies in unique ways that result in new products or configurations that contribute to efficiently increasing power output and lowering the cost of energy.

The efforts made as part of the technology strategy have resulted in steady reductions in the levelised cost of energy year-on-year.

## Lost Production Factor

Percent



### Below 2 percent

In 2016, the Lost Production Factor – the share of the wind not harvested by Vestas' turbines – was 1.8 percent across almost 22,700 wind turbines with performance guarantee.

## Committed to remain the technology leader

Vestas continue to be the technology leader in the wind power industry by translating its global reach and industry knowledge into new investments. Vestas combines its superior technical knowledge and insight in how Vestas maximises components and technical systems to deliver the lowest levelised cost of energy for Vestas customers.

From the design of the first wind turbine on the 3 MW platform years back, comprising just one size and suitable for a single type of site, Vestas has now developed a whole family of wind turbines within the same platform, based on relatively few, interchangeable parts. Rotor diameters now range from 105 to 136 metres and cover all wind classes within the wind segment. Using proven technologies like a full-scale converter, the 3 MW platform meets even the most challenging grid requirements providing excellent energy yield in all wind and weather conditions.

The flexible portfolio means that Vestas can offer the optimal wind turbine configuration and maximise energy production under all types of wind and site conditions across the world, underpinning Vestas' aim to expand its global reach. In September 2015, Vestas introduced the V136-3.45 MW turbine, its latest and as yet largest addition to the 3 MW platform. The V136-3.45 MW turbine has been very well-received after its launch, particularly in the low wind segment across several markets due to the wind turbine's compelling balance between advanced technology and proven performance, enabling an increase in energy output and reduction in the cost of energy.

The 2 MW platform continues to be a preferred choice by many of Vestas' customers. Vestas' 2 MW platform is one of the most trusted platforms in the industry providing customers with great business case certainty. With many new large orders in the USA for the V110-2.0 MW turbine in 2016, the platform once again confirmed its flagship status in the market.

Vestas' two highly competitive turbine platforms – 2 MW and 3 MW – are continuously subject to performance upgrades by introducing new technical features.

#### Vestas wind turbine portfolio - a product for every site

	IEC III (6.0 – 7.5 m/s)	IEC II (7.5 – 8.5 m/s)	IEC I (8.5 – 10.0 m/s)	Above 10.0 m/s
<b>2 MW PLATFORM*</b>				
V90-1.8/2.0 MW* IEC IIA/ IEC IIIA	■	■	■	■
V100-1.8/2.0 MW™ IEC IIIA/ IEC S	■	■	■	■
V100-2.0 MW* IEC IIB		■	■	■
V110-2.0 MW™ IEC IIIA	■	■	■	■
<b>3 MW PLATFORM*</b>				
V105-3.45 MW™ IEC IA			■	■
V112-3.45 MW™ IEC IA			■	■
V117-3.45 MW™ IEC IB/ IEC IIA		■	■	■
V126-3.45 MW™ IEC IIA		■	■	■
V126-3.45 MW™ IEC IIB	■	■	■	■
V136-3.45 MW™ IEC IIB/ IIIA	■	■	■	■

Wind classes - IEC ■ Standard IEC conditions ■ Site dependent

\*Wind turbine application is flexible depending on site specific conditions. All wind turbines can be deployed on sites with lower wind speeds than indicated.

In 2016, the V136-3.45 MW turbine was upgraded to IEC 2B 3.6 MW power mode, while an upgrade of the 2 MW platform has resulted in additional annual energy production on the V110-2.0 MW and improved reactive power capabilities on both V100-2.0 MW and V110-2.0 MW, lowering balance of plant costs.

Vestas' tower roadmap has resulted in new way to customise towers for specific sites, resulting in an improvement of performance, cost, and sustainability for its customers. Further, 2016 also marked updated regulatory certifications of Vestas Obstacle Collision Avoidance System (OCAS) an innovative solution that only activates the aviation lights when an aircraft is operating in the immediate vicinity of a wind power plant. OCAS minimises the visual impact on local environment and opens up new commercial opportunities for sites with regulatory lightning restrictions.

During 2016, Vestas received the first wind turbine certification under the new system administered by the International Electrotechnical

Committee conformity assessment system for Renewable Energy (IECRE). The new certification system creates a clearer, more harmonised and less costly process to certify wind turbines and other renewable energy equipment.

Customers and official bodies require certifications in almost all markets, and with the increasingly broad adoption of the new IECRE certificates, customers will be able to bring wind power projects online more quickly and less expensively. The first wind turbine certificate under the new system was issued on 27 October 2016 by certification body DNV GL for the Vestas 2 MW platform V100-2.0 MW version.

Vestas Customer Advisory Board, which was established in 2013 with participation of selected key customers, is creating great value, working as a compass for the medium- to long-term technology strategy. At the annual meetings, customers provide feedback on the broader product vision and have the opportunity to advise on specific challenges that Vestas can help overcome from a technological standpoint.

#### Investing in digitalisation

Leveraging on Vestas' world-class data collection is key when developing new technologies and solutions to Vestas' customers. Vestas' product development, value chain simulation, and operations & maintenance performance and optimisation, are all founded on high performance data computing. Vestas and its external partners utilise big data in all stages of the innovation and implementation process of new technologies.

Vestas took a big leap forward in the first half of 2000s, with major investments in its supercomputing analytics capabilities. Over time, this included the Vestas Diagnostics and Performance Centre in 2006, introducing the Firestorm supercomputer in 2011, and continuing today integrating an even more powerful new supercomputer.

These investments have contributed to creating the highly data-driven business Vestas is today with an unmatched ability in the wind power industry to create and utilise smart data to lower the cost of energy. Equally important is to use Vestas' knowledge to overcome and eliminate risks associated with new technology.

#### The multi-rotor spins off new knowledge

Continuing to reduce the levelised cost of energy in the long-term will require new solutions and new ways of thinking. In cooperation with the Technical University of Denmark, Vestas has installed a concept demonstrator to test the technical feasibility of operating and controlling a multi-rotor wind turbine.

The multi-rotor concept demonstrator was installed in April 2016 and entered the second test phase mid-September, during an official launch event at the Risø test site in Denmark.

By challenging the scaling rules of wind turbine efficiency and energy output, the aim with the multi-rotor demonstrator is to address two main challenges in the industry:

1. The ability to continuously reduce the Levelised Cost of Energy (LCOE)
2. The ability to continuously improve Annual Energy Production (AEP) without an exponential scaling in cost

The multi-rotor demonstrator uses four refurbished V29-225 kW nacelles, which were produced by Vestas from 1990 to 1997. This nacelle and rotor size was chosen because it is a well-proven product suitable for the concept demonstrator. At the same time, using an existing wind turbine keeps the demonstrator investment as low as possible.

This process of innovation is extremely important for Vestas. It provides essential knowledge that can help Vestas bring down further the cost of clean energy in the future, demonstrating its position as technology leader in the industry.