

Vestas[®]

EnVentus[™] platform

Wind. It means the world to us.[™]

The **foundation** for the future of wind

We are pioneers. We keep moving and improving. It's what Vestas does. EnVentus™ is the next phase of this journey. By connecting heritage with innovation, Vestas creates solutions that responsibly address tomorrow's energy challenges.

Market opportunities

Our customers are demanding ever more advanced wind turbines, enabling profitable project realisation in increasingly challenging locations as the renewable energy landscape expands and diversifies; larger, more powerful turbines responsive to evolving grid requirements.

Customised to maximise

EnVentus™ represents the next generation in the evolution of wind turbines. It is the architecture from which new variants

will arise. Designed to encompass a wide range of turbine configurations, system designs apply modularity to meet customisation and market demands more efficiently. Combined with the extensive Vestas portfolio of solutions, EnVentus™ variants can maximise the potential of each unique wind site.

On the shoulders of giants

EnVentus™ is the realisation of a vision to connect the best engineering from Vestas. Building on more than 110 GW of tried and tested technology, EnVentus™ aims to ensure continued leadership. Using technology and experience from both on- and offshore, the EnVentus™ platform architecture combines advanced proven system designs that deliver innovation.



+110 GW

By connecting advanced modular design with more than 110 GW of tried and tested technology, EnVentus™ aims to ensure continued technology leadership.



Vestas

40 years of experience

The EnVentus™ platform architecture connects proven system designs from the 2 MW platform, 4 MW platform, and 9 MW platform.

Connecting certainty with innovation

The EnVentus™ platform is the result of meticulous and careful evaluation of an unbroken line of Vestas technology solutions. With more than 110 GW of wind turbine capacity installed and 40 years of experience in relentlessly pursuing better performance through technology and service, EnVentus™ is Vestas' next generation in the evolution of wind turbines.

Proven technology

The EnVentus™ platform architecture connects proven system designs from the 2 MW platform, 4 MW platform and 9 MW platform turbine technology. The result is one versatile platform that delivers a higher level of robustness and performance with the ability to meet varying grid compliance requirements around the world.

System efficiency

The EnVentus™ platform architecture features a full-scale converter, proven from the 4 MW platform, capable of meeting complex and differing grid requirements in local markets. The full-scale converter is matched by a permanent magnet generator for maximum system efficiency and balanced by a medium-speed drivetrain. Known from the 9 MW platform, the EnVentus™ powertrain is optimised to reduce structural loads and has been chosen for reasons of mechanical robustness and flexibility. Combined with advanced load management strategies, the EnVentus™ platform enables siting at increasingly complex project conditions.

Latest solutions

The EnVentus™ platform architecture benefits from the latest developments in control systems, applying the Vestas Control System 8000 currently operating on the 4 MW platform. Similarly, the portfolio of standard towers are based on Tubular Steel Tower (TST), High Tubular Steel Tower (HTST), or Large Diameter Steel Tower (LDST) technology, reaching hub heights of up to 166m.

V138-3.0 MW™, V150-5.6 MW™ and V162-5.6 MW™ blades are the result of incremental improvements to proven

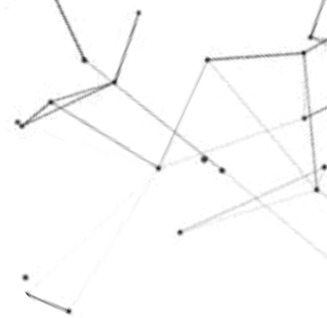
technical solutions. Similar to 2 MW and 4 MW platform variants, all EnVentus™ turbines feature slender profile and pre-bent blades, optimised for weight through application of carbon pultrusion material and a structural shell blade design, enabling the optimisation of the structural loads while increasing the rotor sizes. Vestas' most advanced aerofoil design ensures high aerodynamic performance and excellent sound power levels.

Tested to the limit

By applying reusable modules, versatility in offering can be achieved while adhering to Vestas' rigorous testing standards. The Vestas Test Centre is unrivalled in the wind industry. We test nacelle components using accelerated life testing under mixed and aggregated environmental conditions. For critical components, Highly Accelerated Life Testing (HALT) identifies potential failure modes and mechanisms. Specialised test rigs ensure strength and robustness for the gearbox, generator, yaw and pitch system, lubrication system and accumulators. Our quality control system ensures that each component is manufactured to design specifications and performs at site. We systematically monitor measurement trends that are critical to quality, locating defects before they occur.

We know wind

Vestas is the right partner to help you realise the full potential of your wind site. We have the largest installed capacity in the industry and currently monitor over 30,000 turbines across the globe: Tangible proof of our commitment to making renewable energy solutions that are productive, reliable and economical.



Maximised site potential

The Vestas EnVentus™ platform adds three new variants to the wide range of existing Vestas turbines, providing the ability to create an even more finely matched combination of turbines to harness available wind energy in any specific location.

Versatility at the core

Through advanced modularity in design, EnVentus™ aims to meet customisation needs more efficiently combining reusable modules depending on unique market and project conditions. V138-3.0 MW™, V150-5.6 MW™ and V162-5.6 MW™ are designed with global applicability in mind. EnVentus™ based variants benefit from a full-scale converter enabling compliance with varying market-specific grid code requirements. The wide range of standard hub heights, options, and modes of operation contribute to the ability to meet specific requirements.

Business case flexibility

V150-5.6 MW™ and V162-5.6 MW™ maximise turbine level production, making them specially suitable for projects limited by the number of turbines installed. The relationship between rotor size and rating in V138-3.0 MW™ enhances production at park level while optimising for sound power performance. This makes it particularly appropriate for projects limited by the total capacity installed and for sound sensitive markets. Combining double-digit* annual energy production improvements in low, medium and high wind speeds with 2020 and early 2021 deliveries, V138-3.0 MW™, V150-5.6 MW™ and V162-5.6 MW™ are ready to secure project realisation in auction and permit based environments.

V138-3.0 MW™

With a highly optimised rotor size to rating ratio, the V138-3.0 MW™ strengthens the competitiveness of Vestas' high capacity factor turbines in low to medium wind speed conditions. At 14,957 m² V138-3.0 MW™ features the industry's largest swept area under 152.4m (500ft) tip height while lifting the production potential at WTG level by more than 30 percent compared to the V120-2.2 MW™. The combination of segment leading sound power performance and a full-scale converter makes the turbine highly competitive also in sound sensitive markets. Through new standard towers, the V138-3.0 MW™ meets market specific hub height requirements and offers seamless transportation by using standard systems already proven by the 4 MW platform.

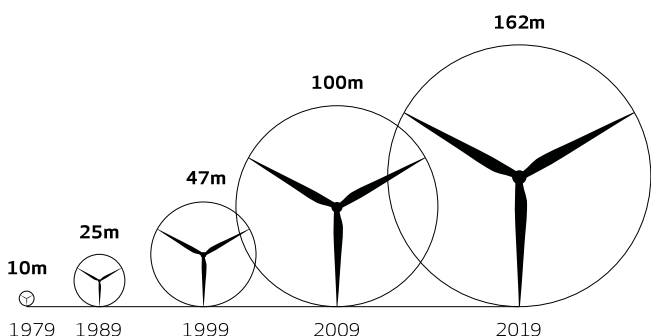
V150-5.6 MW™

The V150-5.6 MW™ lifts the larger rotor introduced with V150-4.2 MW™ into stronger wind speeds. Combined with its higher generator rating, it increases the production potential at WTG level by more than 20 percent compared to V136-4.2 MW™ in medium wind speed conditions. Applying Vestas' most advanced aerofoil blade design combined with lower rotational speeds of the EnVentus™ drivetrain, means realisation of power production potential at very low sound power levels. A comprehensive portfolio of standard and site-specific towers allow for application in tip height constraint markets, varying from 180m to 241m. Utilising Vestas LDST tower technology, V150-5.6 MW™ can take advantage of favourable wind conditions at 166m hub height.

V162-5.6 MW™

With a swept area of over 20,000m², the V162-5.6 MW™ applies the largest rotor size in the Vestas portfolio to achieve industry-leading energy production paired with a high capacity factor. Due to the large operational envelope, the V162-5.6 MW™ has great relative siteability on both turbulence and average wind speeds. With a maximum Sound Power Level of 104dB(A) and over 20 percent higher energy production than the V150-4.2 MW™, the V162-5.6 MW™ establishes a new benchmark in competitiveness.

Rotor size development



*Depending on site specific conditions



WIND CLASSES

Turbine type	Low wind speeds	Medium wind speeds	High wind speeds
EnVentus™ turbines			
V150-5.6 MW™		[Blue gradient bar]	
V162-5.6 MW™	[Blue gradient bar]		
V138-3.0 MW™	[Blue gradient bar]		

All of Vestas

As part of the suite of Vestas offerings, V138-3.0 MW™, V150-5.6 MW™ and V162-5.6 MW™ can be combined with an extensive list of technology options to create customised solutions to suit the needs of each unique project. By adding options to the standard turbine, we can enhance the performance and adaptability of the wind power project and facilitate a shorter permitting cycle at restricted sites. These options can be a decisive factor in realising your specific project and the business case certainty of your investments. Additionally, the well-established Vestas manufacturing and global supply chain setup ensure the ability to deliver, while supporting local requirement.

Options available for the EnVentus™ platform*:

- Aviation Markings on the Blades
- Increased Cut-In Wind Speed
- Aviation Lights
- Condition Monitoring System
- Fire Supression
- Lightning detection
- Load Optimised Modes
- Sound Optimised Modes
- Low Temperature Operation to -30°C
- Oil Debris Monitoring System
- Vestas Shadow Detection System
- Service Personnel Lift
- Vestas Ice Detection™
- Vestas Anti-Icing System™
- Vestas IntelliLight®

*Depending on turbine variant.

The knowledge to control



Knowledge about wind project planning is key

Getting your wind energy project up and operating as quickly as possible is fundamental to its long-term success. One of the first and most important steps is to identify the most suitable location for your wind power plant. Vestas' SiteHunt® is an advanced analytical tool that examines a broad spectrum of wind and weather data to evaluate potential sites and establish which of them can provide optimum conditions for your project.

In addition, a team of specialised siting engineers customise the turbine selection and layout of your wind power plant. We perform simulations of the site conditions, using Computational Fluid Dynamics (CFD) software on our powerful in-house supercomputer, and use advanced load simulations to analyse the lifetime performance of the plant. Put simply, we find the optimal balance between annual revenue and investment over the lifetime of your plant. This will determine your project's true potential and provide a firm basis for your investment decision.

The complexity and specific requirements of grid connections vary considerably across the globe, making the optimal design of electrical components for your wind power plant essential. By identifying grid codes early in the project phase and simulating extreme operating conditions, Electrical PreDesign provides you with an ideal way to build a grid compliant, productive and highly profitable wind power plant. It allows customised collector network cabling, substation protection and reactive power compensation, which boost the cost efficiency of your business.

Advanced monitoring and real-time plant control

All our wind turbines can benefit from VestasOnline® Business, the latest Supervisory Control and Data Acquisition (SCADA) system for modern wind power plants.

This flexible system includes an extensive range of monitoring and management functions to control your wind power plant.



VestasOnline® Business enables you to optimise production levels, monitor performance and produce detailed, tailored reports from anywhere in the world. The VestasOnline® Power Plant Controller offers scalability and fast, reliable real-time control and features customisable configuration, allowing you to implement any control concept needed to meet local grid requirements.

Surveillance, maintenance and service

Operating a large wind power plant calls for efficient management strategies to ensure uninterrupted power production and to control operational expenses. We offer 24/7 monitoring, performance reporting and predictive maintenance systems to improve turbine performance and availability. Predicting faults in advance is essential, helping to avoid costly emergency repairs and unscheduled interruptions to energy production.

Our Condition Monitoring System (CMS) assesses the status of the turbines by analysing vibration signals. For example, by measuring the vibration of the drive train, it can detect faults at an early stage and monitor detected damage. This information allows pre-emptive maintenance to be carried out before the component fails, reducing repair costs and production loss.

Additionally, our Active Output Management® (AOM) concept provides detailed plans and long-term agreements for service and maintenance, online monitoring, optimisation and troubleshooting. It is possible to get a full scope contract, combining your turbines' state-of-the-art technology with guaranteed time or energy-based availability performance targets, thereby creating a solid base for your power plant investment. The Active Output Management® agreement provides you with long-term and financial operational peace of mind for your business.



V138-3.0 MW™ IEC S

Facts & figures

POWER REGULATION Pitch regulated with variable speed

OPERATING DATA

Rated power 3,000 kW
 Cut-in wind speed 3m/s
 Cut-out wind speed* 24m/s
 Wind class IEC S
 Standard operating temperature range from -20°C** to +45°C

*High Wind Operation available as standard

**Subject to different temperature options

SOUND POWER

Maximum* 102.7/106.6 dB(A)**

*Depending on configuration

**Sound Optimised Modes available dependent on site and country

ROTOR

Rotor diameter 138m
 Swept area 14,957m²
 Aerodynamic brake full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency 50/60Hz
 Converter full scale

GEARBOX

Type two planetary stages

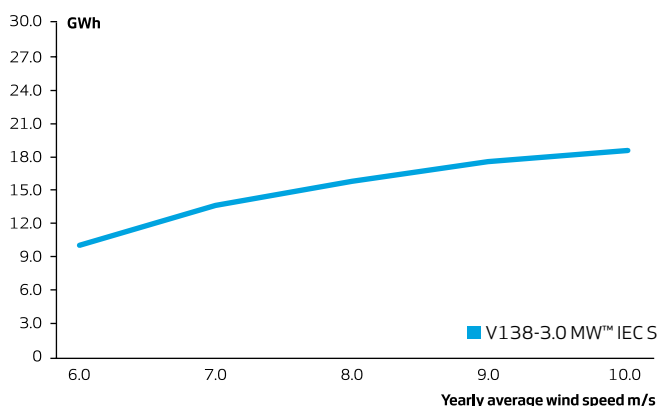
TOWER

Hub height 83m (IEC S), 96m (IEC S)

TURBINE OPTIONS

- Condition Monitoring System
 - Oil Debris Monitoring System
 - Service Personnel Lift
 - Low Temperature Operation to -30°C
 - Vestas Ice Detection™
 - Vestas IntelliLight®
 - Vestas Shadow Detection System
 - Aviation Lights
 - Aviation Markings on the Blades
 - Fire Suppression System
 - Increased Cut-In Wind Speed
 - Lightning Detection System
 - Load Optimised Modes
 - Sound Optimised Modes
-

ANNUAL ENERGY PRODUCTION



Assumptions
 One wind turbine, 100% availability, 0% losses, k factor = 2.5
 Standard air density = 1.225, wind speed at hub height

V150-5.6 MW™ IEC S

Facts & figures

POWER REGULATION Pitch regulated with variable speed

OPERATING DATA

Rated power 5,600 kW
 Cut-in wind speed 3m/s
 Cut-out wind speed* 25m/s
 Wind class IEC S
 Standard operating temperature range from -20°C** to +45°C

*High Wind Operation available as standard

**Subject to different temperature options

SOUND POWER

Maximum 104.9 dB(A)***

***Sound Optimised Modes available dependent on site and country

ROTOR

Rotor diameter 150m
 Swept area 17,671m²
 Aerodynamic brake full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency 50/60Hz
 Converter full scale

GEARBOX

Type two planetary stages

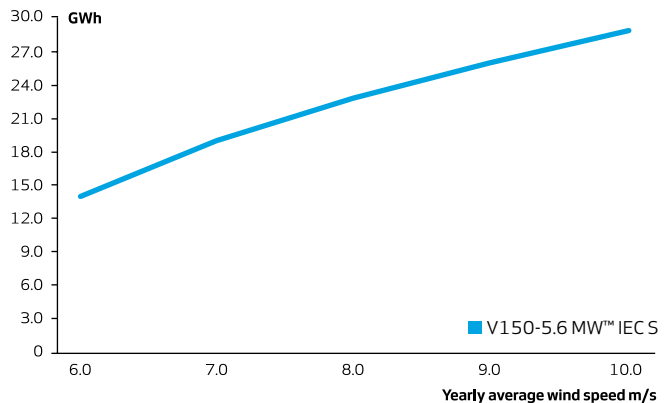
TOWER

Hub height 105m (IEC S), 125m (IEC S/DIBt S),
 148m (DIBt S), 155m (IEC S), 166m (DIBt S)

TURBINE OPTIONS

- Condition Monitoring System
 - Oil Debris Monitoring System
 - Service Personnel Lift
 - Low Temperature Operation to -30°C
 - Vestas Ice Detection™
 - Vestas Anti-Icing System™
 - Vestas IntelliLight®
 - Vestas Shadow Detection System
 - Aviation Lights
 - Aviation Markings on the Blades
 - Fire Suppression System
 - Increased Cut-In Wind Speed
 - Lightning Detection System
 - Load Optimised Modes
-

ANNUAL ENERGY PRODUCTION



Assumptions
 One wind turbine, 100% availability, 0% losses, k factor =2,
 Standard air density = 1.225, wind speed at hub height

V162-5.6 MW™ IEC S

Facts & figures

POWER REGULATION Pitch regulated with variable speed

OPERATING DATA

Rated power 5,600 kW
 Cut-in wind speed 3m/s
 Cut-out wind speed* 25m/s
 Wind class IEC S
 Standard operating temperature range from -20°C* to +45°C

*High Wind Operation available as standard

**Subject to different temperature options

SOUND POWER

Maximum 104dB(A)**

***Sound Optimised Modes available dependent on site and country

ROTOR

Rotor diameter 162m
 Swept area 20,612m²
 Aerodynamic brake full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency 50/60Hz
 Converter full scale

GEARBOX

Type two planetary stages

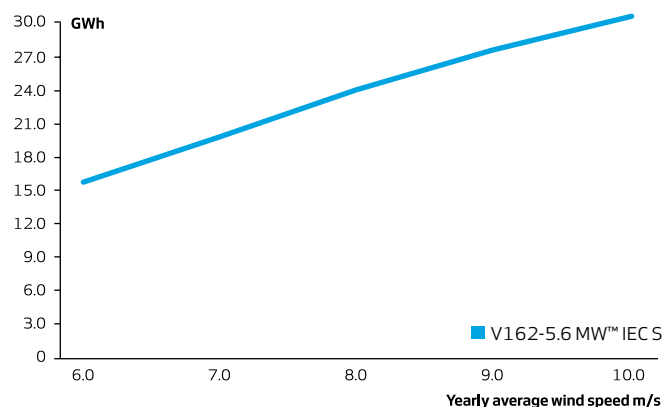
TOWER

Hub height 119m (IEC S/DIBt S), 125m (IEC S), 148m (DIBt S), 149m (IEC S), 166m (DIBt S)

TURBINE OPTIONS

- Condition Monitoring System
 - Oil Debris Monitoring System
 - Service Personnel Lift
 - Low Temperature Operation to -30°C
 - Vestas Ice Detection™
 - Vestas Anti-Icing System™
 - Vestas IntelliLight®
 - Vestas Shadow Detection System
 - Aviation Lights
 - Aviation Markings on the Blades
 - Fire Suppression System
 - Increased Cut-In Wind Speed
 - Lightning Detection System
 - Load Optimised Modes
-

ANNUAL ENERGY PRODUCTION



Assumptions
 One wind turbine, 100% availability, 0% losses, k factor =2,
 Standard air density = 1.225, wind speed at hub height





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