Vestas®

3 MW PLATFORM

Wind. It means the world to us.™

Are you looking for the maximum return on **your investment** in wind energy?

Wind energy means the world to us. And we want it to mean the world to our customers, too, by maximising your profits and strengthening the certainty of your investment in wind power.

That's why, together with our partners, we always strive to deliver cost-effective wind technologies, high quality products and first class services throughout the entire value chain. And it's why we put so much emphasis on the reliability, consistency and predictability of our technology.

We have more than 30 years' experience in wind energy. During that time, we've delivered more than 60 GW of installed capacity in 73 countries. That is more than 20 per cent of all wind turbines installed globally – and over 15 GW more than our closest competitor. We currently monitor over 25,000 wind turbines across the globe. All tangible proof that Vestas is the right partner to help you realise the full potential of your wind site.

What is the 3 MW Platform?

The 3 MW platform was introduced in 2010 with the launch of the V112-3.0 MW®. Since then close to 3 GW of the 3 MW Platform has been installed all over the world onshore and offshore making it the obvious choice for customers looking for highly flexible and trustworthy turbines.

In 2013, the 3 MW platform was upgraded and new variants were introduced utilising untapped potential of the platform. All variants carry the same nacelle design and the hub design has been re-used to the largest extend possible. In addition, our engineers have increased the nominal power by 10% across the entire platform optimizing your energy production significantly.

With this expansion, the 3 MW platform now covers all wind classes with a variety of rotor sizes and a higher rated output power of 3.3 MW.

You can choose from the following turbines on the 3 MW platform:

- V105-3.3 MW™ – IEC IA
- V112-3.3 MW™ – IEC IB
- V112-3.3 MW™ – IEC IIA
- V117-3.3 MW™ – IEC IIA
- V126-3.3 MW™ – IEC IIIA

All variants of the 3 MW platform are based on the proven technology of the V112-3.0 MW® with a full-scale converter, providing you with the industry's best grid performance.

Our 3 MW platform is designed for a broad range of wind and site conditions, onshore and offshore enabling you to mix turbines across your site or portfolio of sites, delivering industry-leading reliability, serviceability and exceptional energy capture optimising your business case.

All turbine variants are equipped with the same ergonomically designed and very spacious nacelle which makes it easier for maintenance crews to gain access, so they can reduce the time spent on service while maximizing the uptime without compromising safety. All turbines can be installed and maintained using standard installation and servicing tools and equipment further reducing the operation and maintenance costs by minimising your stock level of spare parts.

+51,000

The V112-3.0 MW® and the other 3 MW variants advance the already proven technology powering over 51,000 installed Vestas turbines worldwide - more than any other supplier.

How does our technology generate **more energy?**

More power for every wind site
All turbines of the 3 MW platform are available with several noise modes to meet sound level restrictions with an optimised production. The power system enables superior grid support and it is capable of maintaining production across severe drops in grid voltage, while simultaneously minimising tower and foundation loads. It also allows rapid down-rating of production to 20 per cent. With a full-scale converter, the 3 MW platform meets even the most challenging grid requirements around the world.

Proven technologies - from the company that invented them
The 3 MW platform is a low-risk choice. It is based on the proven technologies that underpin more than 51,000 Vestas turbines installed around the world. Using the best features from across the range, as well as some of the industry's most stringently tested components and systems, the platform's reliable design minimises downtime – helping to give you the best possible return on your investment.

With an operating range that covers all wind classes, our 3 MW platform delivers unrivalled energy production. The proven blade technology from the V112-3.0 MW® is used on the new V105-3.3 MW™, the V112-3.3 MW™ and on the V117-3.3 MW™. The industry known structural shell blades are used on the V126-3.3 MW™- a technology which is also used on other Vestas platforms.

Reliable and robust
The Vestas Test Centre is unrivalled in the wind industry. We test most nacelle components using Highly Accelerated Life Testing (HALT) to ensure reliability. For critical components, 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 produced to design specifications and performs at site. We systematically monitor measurement trends that are critical to quality, locating defects before they occur.

The 3 MW platform covers all wind segments enabling you to find the best turbine for your specific site.

WINDCLASSES - IEC

TURBINE TYPE	Low wind speed	Medium wind speed	High wind speed
3 MW TURBINES			
V105-3.3 MW™ IEC IA			
V112-3.3 MW™ IEC IB			
V112-3.3 MW™ IEC IIA			
V117-3.3 MW™ IEC IIA			
V126-3.3 MW™ IEC IIIA			

Turbulence level A Turbulence level B

Options available for the 3 MW platform

An option is an extra feature that can be added to the turbine to suit a project's specific needs. 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. The options can even be a decisive factor in realising your specific project, and the business case certainty of the investment.

Here is a list of the options available for the 3 MW platform:

- Condition Monitoring System
- Service personnel lift
- Aviation lights
- Aviation markings on the blades
- Low temperature operation to - 30°C
- Ice detection
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Vestas De-Icing System
- Obstacle Collision Avoidance System (OCAS™)

Life testing

The Vestas Test Centre has the unique ability to test complete nacelles using technologies like Highly Accelerated Life Testing (HALT). This rigorous testing of new components ensures the reliability of the 3 MW platform.

Is the 3 MW platform the optimal choice for **your specific site?**

One common nacelle – four different rotor sizes
The wind conditions on a wind project site are often not identical. The 3 MW platform features a range of turbines that cover all wind classes and combined across your site they can maximise the energy output of your wind power plant.

Tip-height restrictions and high grid requirements
With a rotor size of 105 m, the new V105-3.3 MW™ IEC IA is the turbine that fits the most severe wind conditions. It has an extremely robust design for tough site conditions and is especially suited for markets with tip-height restrictions and high grid requirements.

The V105-3.3 MW™ blade is a shortened version of the proven and tested pre-preg blade used on the V112-3.0 MW®, the V112-3.3 MW™ and the V117-3.3 MW™.

Like all the other 3 MW turbines, the V105-3.3 MW™ is equipped with a full-scale converter ensuring full compliance with the challenging grid codes in countries like the UK and Ireland.

Cold climates
The V112-3.3™ MW can be combined with the Vestas De-Icing System ensuring optimum production in cold climates.

The Vestas De-Icing System is fully SCADA integrated and can be triggered automatically or manually depending on your de-icing strategy. Automatic control protects your investment, optimising the trigger point so the turbine only stops to de-ice when there is an expected net power production gain.

High- and medium-wind sites
The V112-3.3 MW™ IEC IB is a high-wind turbine and has a very high capacity factor. Similar to the other 3 MW turbines, the V112-3.3 MW™ IEC IB turbine makes efficient use of its grid compatibility and is an optimal choice for sites with MW constraints.

On medium wind-sites the V112-3.3 MW™ IEC IIA and V117-3.3 MW™ IEC IIA are excellent turbine choices. A combination of the two variants can optimise your site layout and improve your production significantly.

Low-wind sites
Built on the same proven technology as the V112-3.0 MW®, the V126-3.3 MW™ IEC IIIA is our best performer on low-wind sites. Equipped with the industry known structural shell blades, the blades of the V126-3.3 MW™ turbine do not weigh more than those of the V112-3.0 MW®. The 126 m rotor enables greater wind capture, which in turn produces more energy at a reduced cost. The result is exceptional profitability in areas with low wind, and new frontiers for wind energy investment.

Large Diameter Steel Towers (LDST) support the added rotor size and rating of Vestas turbines to increase Annual Energy Production on low-wind sites.

LDST is specially designed with a larger diameter in the bottom section that allows for optimal strength at heights that exceed 140 m.

Maximising old permits and tight spacing
Although the V126-3.3 MW™ is one of the highest producing low wind turbines available, some old permits may simply be too tight to accept it. Although the V112-3.3 MW™ and V117-3.3 MW™ are medium-wind turbines, they still deliver an excellent business case on low-wind sites, especially with the Vestas extensive range of high towers.

Due to the similar electrical properties, sounds emissions and nacelle design, it is easy to mix and match the turbines from the 3 MW platform to maximise production on heavily constrained sites.

Would you **benefit** from uninterrupted control of wind energy production?

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, SiteDesign® optimises the layout of your wind power plant. SiteDesign® runs Computational Fluid Dynamics (CFD) software on our powerful in-house supercomputer Firestorm to perform simulations of the conditions on site and analyse their effects over the whole operating life of the plant. Put simply, it finds the optimal balance between the estimated ratio of annual revenue to operating costs over the lifetime of your plant, to 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,

+25,000

The Vestas Performance and Diagnostics Centre monitors more than 25,000 turbines worldwide. We use this information to continually develop and improve our products and services.

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 any 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 case.

V105-3.3 MW™ IEC IA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,300 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IA

Standard operating temperature range from -20°C to +45°C with de-rating above 30°C*

*subject to different temperature options

SOUND POWER
(Noise modes dependent on site and country)

ROTOR

Rotor diameter	105 m
Swept area	8,659 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub height	site specific

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.8 m
Length	12.8 m
Width	4.0 m

HUB DIMENSIONS

Max. transport height	3.74 m
Max. transport width	3.75 m
Max. transport length	5.42 m

BLADE DIMENSIONS

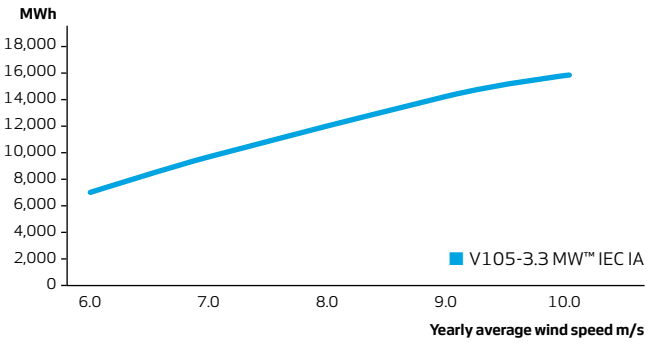
Length	51.5 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- Condition Monitoring System
- Service personnel lift
- Aviation lights
- Aviation markings on the blades
- Low temperature operation to - 30°C
- Ice detection
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Obstacle Collision Avoidance System (OCAS™)

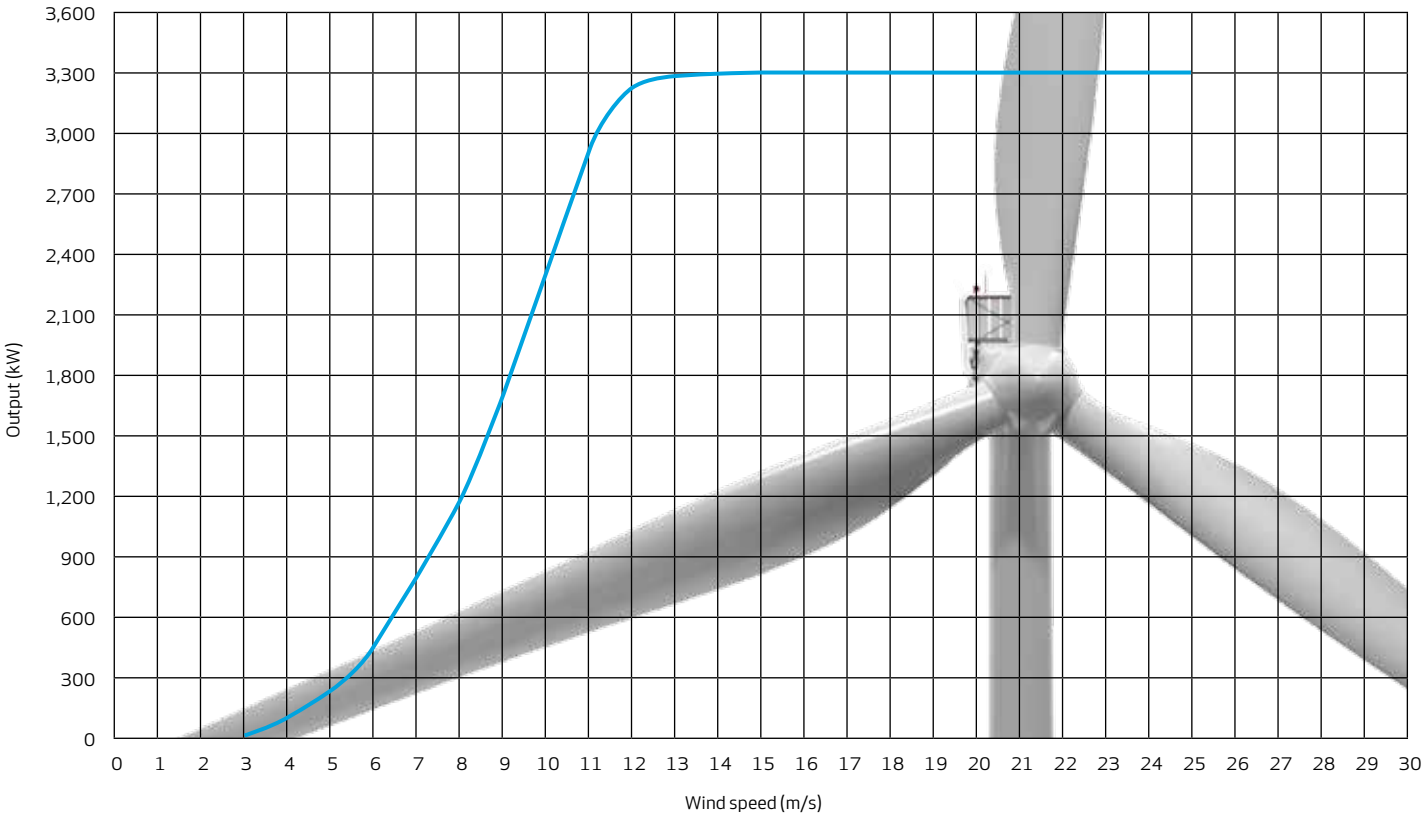
ANNUAL ENERGY PRODUCTION



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

POWER CURVE FOR V105-3.3 MW™ IEC IA

Noise reduced sound power modes are available



V112-3.3 MW™ IEC IB
Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	3,300 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IB

Standard operating temperature range from -20°C to +45°C with de-rating above 30°C*

*subject to different temperature options

SOUND POWER
(Noise modes dependent on site and country)

ROTOR

Rotor diameter	112 m
Swept area	9,852 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub height	site specific

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.8 m
Length	12.8 m
Width	4.0 m

HUB DIMENSIONS

Max. transport height	3.74 m
Max. transport width	3.75 m
Max. transport length	5.42 m

BLADE DIMENSIONS

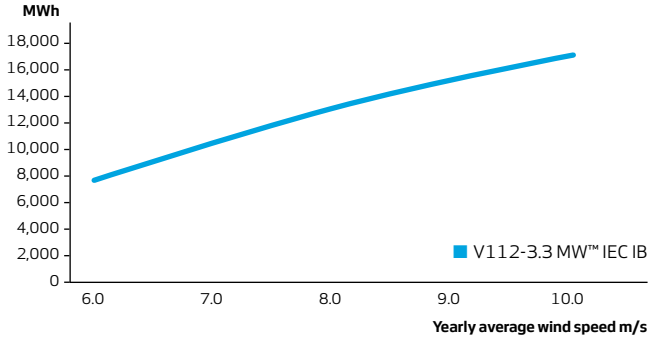
Length	54.65 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- Condition Monitoring System
- Service personnel lift
- Aviation lights
- Aviation markings on the blades
- Low temperature operation to - 30°C
- Ice detection
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Vestas De-Icing System
- Obstacle Collision Avoidance System (OCAS™)

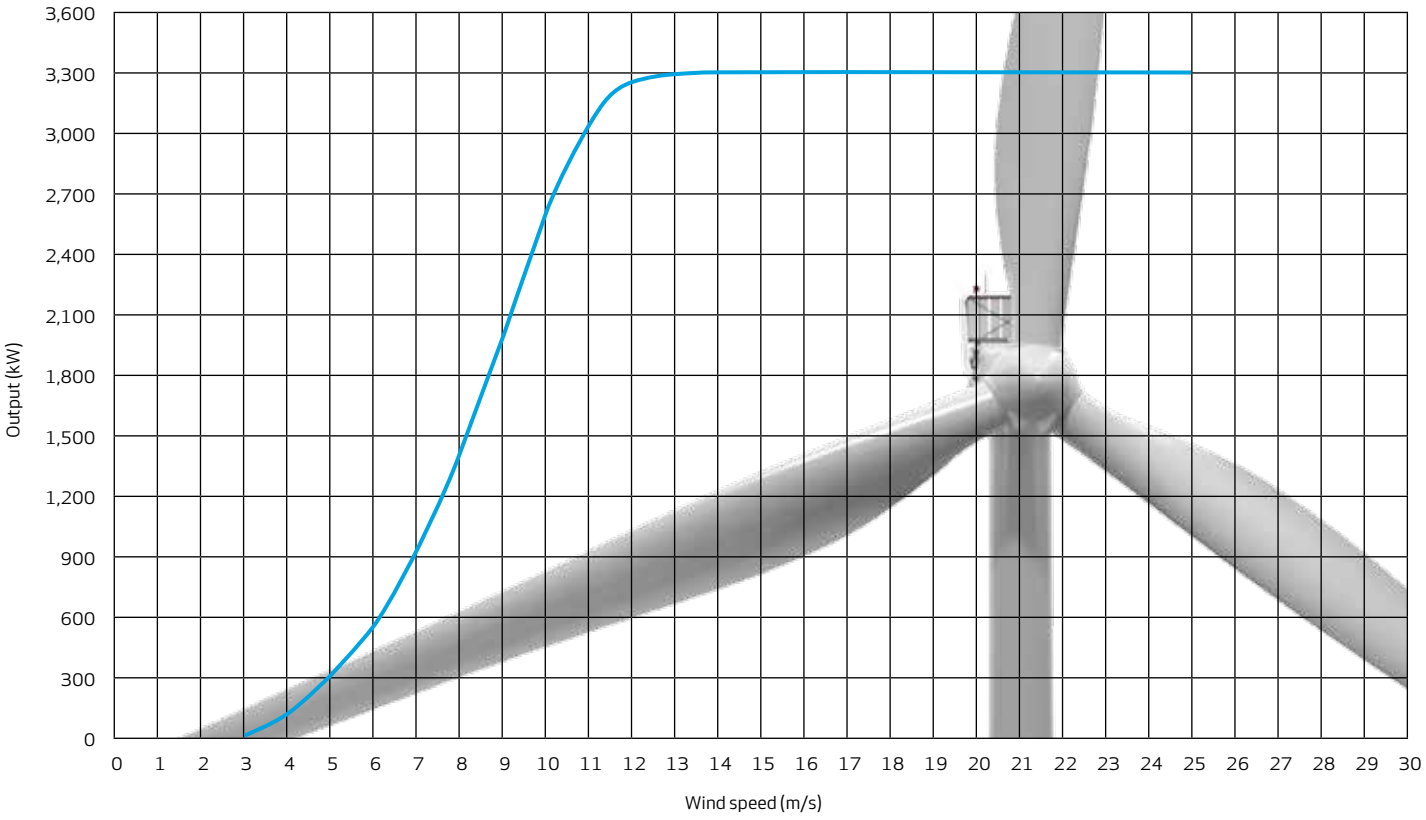
ANNUAL ENERGY PRODUCTION



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

POWER CURVE FOR V112-3.3 MW™ IEC IB

Noise reduced sound power modes are available



V112-3.3 MW™ IEC IIA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,300 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IIA/DIBt3

Standard operating temperature range from -20°C to +45°C with de-rating above 30°C*

*subject to different temperature options

SOUND POWER

(Noise modes dependent on site and country)

ROTOR

Rotor diameter	112 m
Swept area	9,852 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	84 m (IEC IIA), 94 m (IEC IIA/DIBt3), 119 m (IEC IIIA/DIBt3) and 140 m (IEC IIIA /DIBt2)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.8 m
Length	12.8 m
Width	4.0 m

HUB DIMENSIONS

Max. transport height	3.74 m
Max. transport width	3.75 m
Max. transport length	5.42 m

BLADE DIMENSIONS

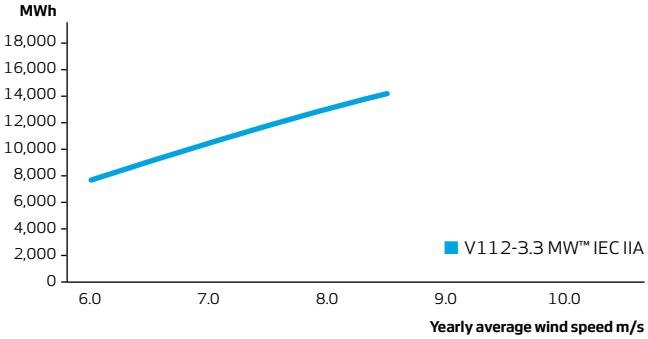
Length	54.65 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- Condition Monitoring System
- Service personnel lift
- Aviation lights
- Aviation markings on the blades
- Low temperature operation to - 30°C
- Ice detection
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Vestas De-Icing System
- Obstacle Collision Avoidance System (OCAS™)

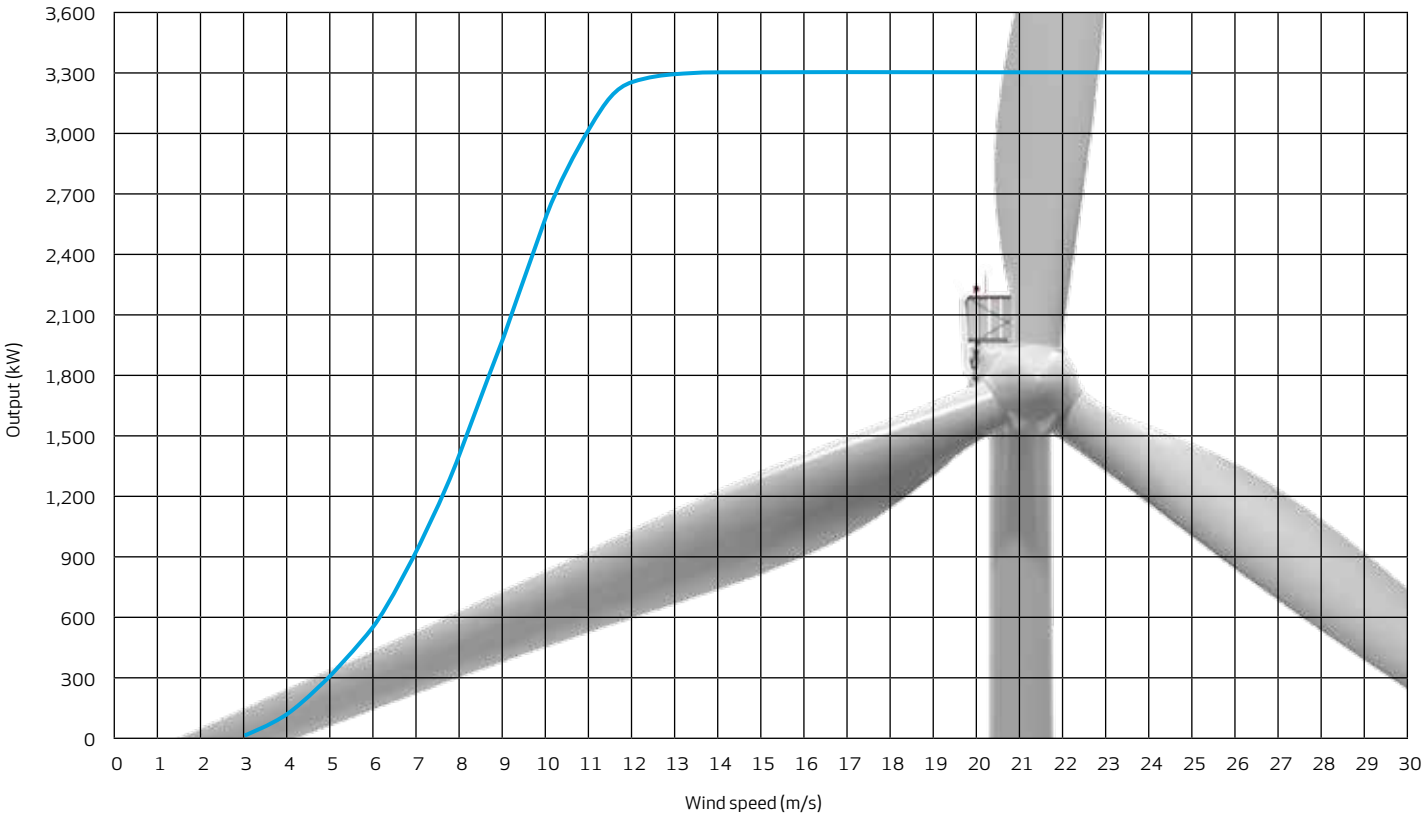
ANNUAL ENERGY PRODUCTION



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

POWER CURVE FOR V112-3.3 MW™ IEC IIA

Noise reduced sound power modes are available



V117-3.3 MW™ IEC IIA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,300 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IIA/DIBt3

Standard operating temperature range from -20°C to +45°C with de-rating above 30°C*

*subject to different temperature options

SOUND POWER
(Noise modes dependent on site and country)

ROTOR

Rotor diameter	117 m
Swept area	10,751 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	91.5 m (IEC IIA/DIBt3) 116.5 m (IEC IIA) 141.5 m LDST (DIBt2)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.8 m
Length	12.8 m
Width	4.0 m

HUB DIMENSIONS

Max. transport height	3.74 m
Max. transport width	3.75 m
Max. transport length	5.42 m

BLADE DIMENSIONS

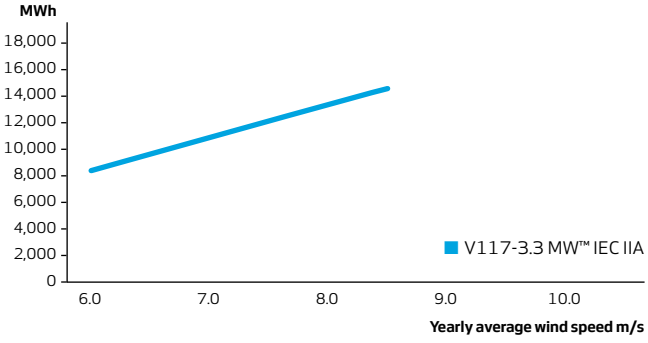
Length	57.15 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- Condition Monitoring System
- Service personnel lift
- Aviation lights
- Aviation markings on the blades
- Low temperature operation to - 30°C
- Ice detection
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Obstacle Collision Avoidance System (OCAS™)

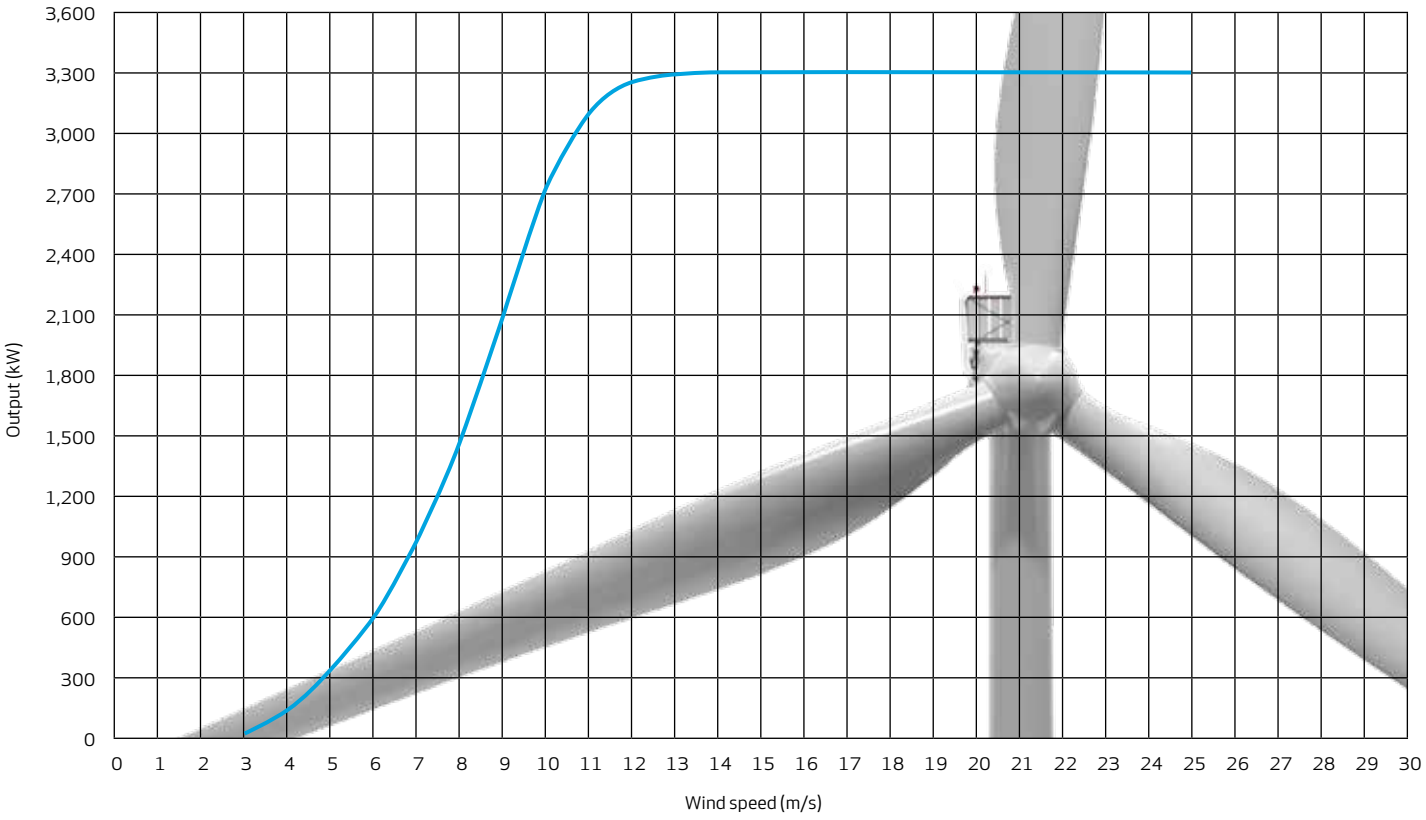
ANNUAL ENERGY PRODUCTION



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

POWER CURVE FOR V117-3.3 MW™ IEC IIA

Noise reduced sound power modes are available



V126-3.3 MW™ IEC IIIA
Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	3,300 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIIA/DIBt2

Standard operating temperature range from -20°C to +45°C with de-rating above 30°C*

*subject to different temperature options

SOUND POWER

(Noise modes dependent on site and country)

ROTOR

Rotor diameter	126 m
Swept area	12,469 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	117 m (IEC IIIB) 137 m LDST (IECIIIA/DIBt2)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.8 m
Length	12.8 m
Width	4.0 m

HUB DIMENSIONS

Max. transport height	3.74 m
Max. transport width	3.75 m
Max. transport length	5.42 m

BLADE DIMENSIONS

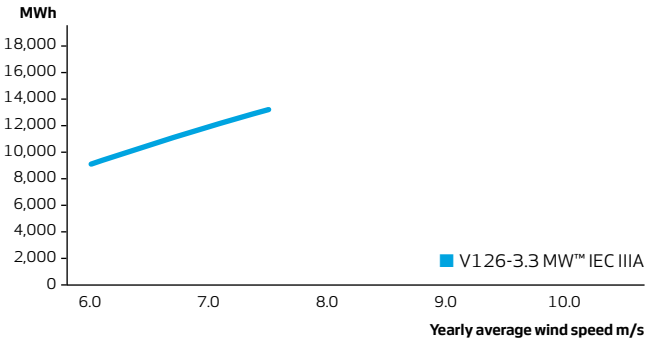
Length	62 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- Condition Monitoring System
- Service personnel lift
- Aviation lights
- Aviation markings on the blades
- Low temperature operation to - 30°C
- Ice detection
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Obstacle Collision Avoidance System (OCAS™)

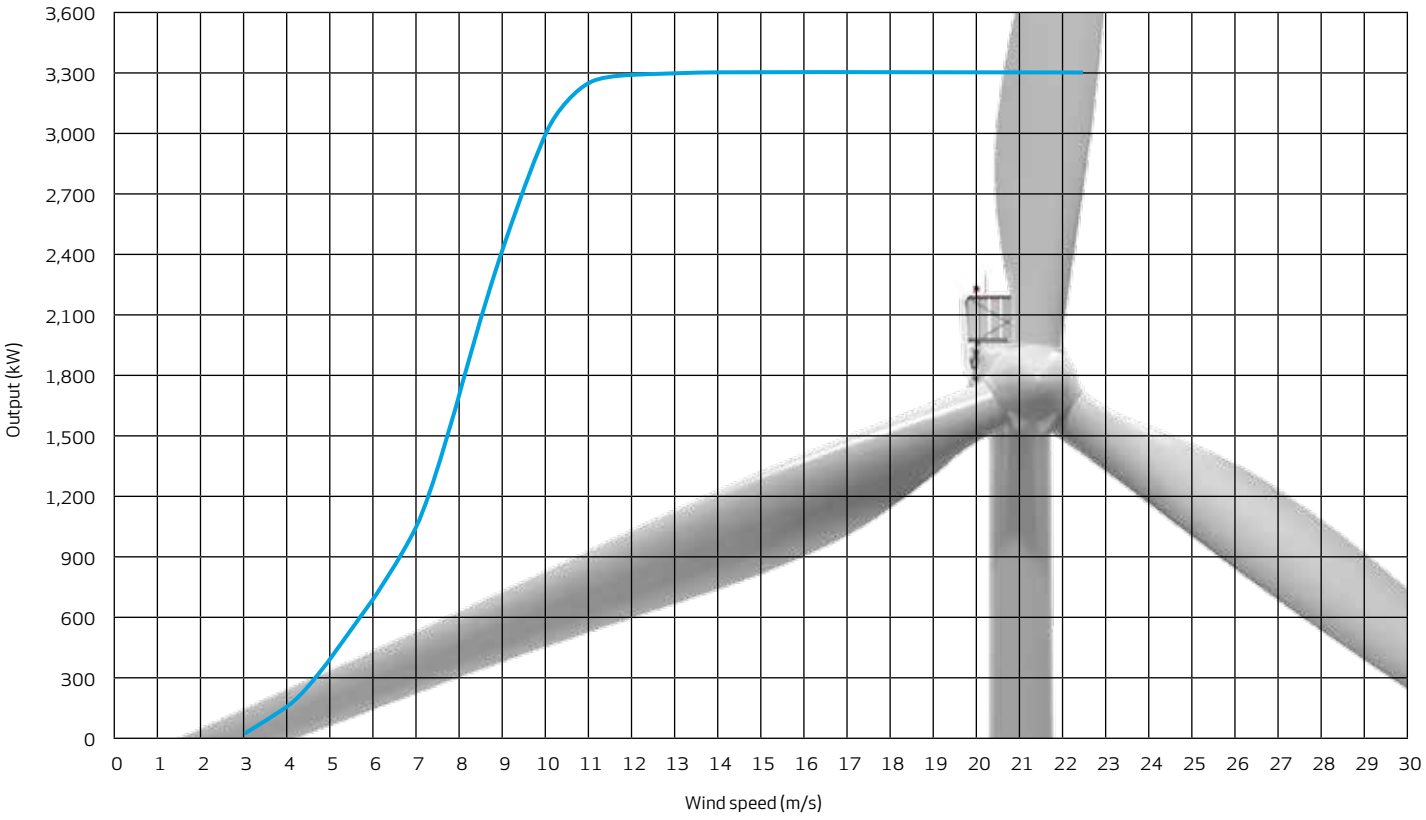
ANNUAL ENERGY PRODUCTION



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

POWER CURVE FOR V126-3.3 MW™ IEC IIIA

Noise reduced sound power modes are available



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GE Renewable Energy

-Original-

Technical Documentation
Wind Turbine Generator Systems
3MW Platform - 50/60 Hz

Technical Description and Data

Applicable for Wind Turbine Generators from 2.5 MW to 3.2 MW

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1 Introduction

This document summarizes the technical description and specifications of the 3MW Platform wind turbines. The 3MW Platform offers the following product variants: 2.5, 2.75, 2.85 and 3.2. Due to improvements in the control system and the electrical system the power rating of the turbine is above these values, which were considered for the original naming. The maximum power for each variant is listed in a table in section 3.

2 Technical Description of the Wind Turbine and Major Components

The 3MW Platform is three-bladed, upwind, horizontal-axis wind turbines with rotor diameters of 103 or 120 meters. The turbine rotor and nacelle are mounted on top of a tubular tower with the following hub heights.

	2.5-120	2.75-120	2.5/2.75/2.85-103	3.2-103
50 Hz:	85 m 98.3 m 110 m 120 m 139 m	75 m 85 m 98.3 m 110 m 139 m	98.3 m 85 m 75 m 70 m	98.3 m 85 m 75 m 70 m
60 Hz:	85 m 110 m	85 m 110 m	98.3 m 85 m	98.3 m

Table 1: 3MW Platform hub heights depending on 50 or 60 Hz market

The 3MW Platform employs active yaw control (designed to steer the wind turbine with respect to the wind direction), active blade pitch control (to regulate turbine rotor speed) and a variable speed generator with a power electronic converter system.

The 3MW Platform features a modular drive train design where the major drive train components including main shaft bearing, gearbox, generator and yaw drives are attached to a bedplate.

2.1 Rotor

The rotor diameter is 103 meters with a swept area of 8,332 m^2 or 120 m with a swept area of 11,310 m^2. The rotor is designed to operate between 5 and 15 revolutions per minute (rpm) for the 103 m rotor or between 8 and 13 rpm for the 120 m rotor. Rotor speed is regulated by a combination of blade pitch angle adjustment and generator/converter torque control. The rotor spins in a clockwise direction under normal operating conditions when viewed from an upwind location.

Full blade pitch angle range is approximately 90 degrees, with the zero degree position being with the blade flat to the prevailing wind. Pitching the blades to a full feather pitch angle of approximately 90 degrees accomplishes aerodynamic braking of the rotor, thus reduces the rotor speed.

2.2 Blades

There are three rotor blades used on each 3MW Platform wind turbine. The airfoils transition along the blade span and with the thicker airfoils being located inboard towards the blade root (hub) and gradually tapering to thinner cross sections out towards the blade tip. Values below are typically needed to perform shadow casting calculations.

	Rotor Diameter	
	103 m	**120 m**
Longest chord	3.64 m	3.98 m
Chord at 0,9 x rotor radius	1.05 m	1.08 m

In order to optimize noise emissions, the rotor blades can be equipped with Low-Noise-Trailing-Edges (LNTE's) at the pressure side of the blade's rear edge. LNTE's are thin jagged plastic strips. The rotor blades of the 2.75-120 are equipped with these strips at the factory. All other models can be retrofitted.

Abb. 1: LNTE's at the WTG

2.3 Blade Pitch Control System

The rotor utilizes a pitch system to provide adjustment of the blade pitch angle during operation.

The active pitch controller enables the wind turbine rotor to regulate speed, when above rated wind speed, by allowing the blade to "spill" excess aerodynamic lift. Energy from wind gusts below rated wind speed is captured by allowing the rotor to speed up.

Independent back up is provided to drive each blade in order to feather the blades and shut down the wind turbine in the event of a grid line outage or other fault. By having all three blades outfitted with independent pitch systems, redundancy of individual blade aerodynamic braking capability is provided.

2.4 Hub

The hub is used to connect the three rotor blades to the turbine main shaft. The hub also houses the blade pitch system and is mounted directly to the main shaft. To carry out maintenance work, the hub is entered through a hatch.

2.5 Gearbox

The gearbox in the wind turbine is designed to transmit torsional power between the low-rpm turbine rotor and high-rpm electric generator. The gearbox is a multi-stage planetary/helical design. The gearbox is mounted to the wind turbine bedplate. The gearbox mounting is designed to reduce vibration and noise transfer to the bedplate. The gearbox is lubricated by a forced, cooled lubrication system and a filter assist to maintain oil cleanliness.

2.6 Bearings

The blade pitch bearing is designed to allow the blade to pitch about a span-wise pitch axis. The inner race of the blade pitch bearing is outfitted with a blade drive gear that enables the blade to be driven in pitch. The main shaft bearing is a two-bearing system, designed to provide bearing and alignment of the internal gearing shafts and accommodate radial and axial loads.

2.7 Brake System

The blade pitch system acts as the main braking system for the wind turbine. Braking under normal operating conditions is accomplished by feathering the blades out of the wind. Only two feathered rotor blades are required to decelerate the rotor safely into idling mode, and each rotor blade has its own backup to drive the blade in the event of a grid line loss.

2.8 Generator

The generator is a doubly fed induction generator. It is mounted to the bedplate with a mounting so designed as to reduce vibration and noise transfer to the bedplate.

2.9 Gearbox/Generator Coupling

To protect the drive train from excessive torque loads, a special coupling including a torque-limiting device is provided between the generator and gearbox output shaft.

2.10 Yaw System

A bearing attached between the nacelle and tower facilitates yaw motion. Yaw drives mesh with the gear of the yaw bearing and steer the wind turbine to track the wind in yaw. The yaw drive system contains an automatic yaw brake. This brake engages when the yaw drive is not operating and prevents the yaw drives from being loaded due to turbulent wind conditions.

The controller activates the yaw drives to align the nacelle to the wind direction based on the wind vane sensor mounted on the top of the nacelle.

The wind turbine records nacelle yaw position following excessive rotation in one direction, the controller automatically brings the rotor to a complete stop, untwists the internal cables, and restarts the wind turbine.

2.11 Tower

The wind turbine is mounted on top of a tubular steel tower (70, 75, 85, 98.3, 110 or 120 m hub height). For 139 m hub height GE has developed a hybrid tower. Access to the turbine is through a door at the base of the tower. Internal service platforms and interior lighting is included. A ladder provides access to the nacelle and also supports a fall arrest safety system.

Optional climb assist or service lifts are available upon request.

2.12 Nacelle

The nacelle houses the main components of the wind turbine generator. Access from the tower into the nacelle is through the bottom of the nacelle. The nacelle is ventilated, and illuminated by electric lights. A hatch provides access to the blades and hub.

2.13 Wind Sensor and Lightning Rod

An ultrasonic wind sensor and lightning rod are mounted on top of the nacelle housing. Access is accomplished through the hatch in the nacelle.

2.14 Lightning Protection (according to IEC 61400-24 Level I)

The rotor blades are equipped with lightning receptors mounted in the blade. The turbine is grounded and shielded to protect against lightning; however, lightning is an unpredictable force of nature and it is possible that a lightning strike could damage various components notwithstanding the lightning protection employed in the wind turbine.

2.15 Wind Turbine Control System

The wind turbine can be controlled locally. Control signals can also be sent from a remote computer via a Supervisory Control and Data Acquisition System (SCADA), with local lockout capability provided at the turbine controller.

Service switches at the tower top prevent service personnel at the bottom of the tower from operating certain systems of the turbine while service personnel are in the nacelle. To override any wind turbine operation, emergency-stop buttons located in the tower base and in the nacelle can be activated to stop the turbine in the event of an emergency.

2.16 Power Converter

The wind turbine uses a power converter system that consists of a converter on the rotor side, a DC intermediate circuit, and a power inverter on the grid side.

The converter system consists of a power module and the associated electrical equipment.

2.17 Medium Voltage Transformer and Switch Gear

To connect each turbine to the collector system, a medium voltage transformer and medium-voltage switchgear are required. These devices may be either installed in the tower (GE scope) or external to the tower as part of a Pad Mount Transformer (customer scope).

3 Technical Data for the 3MW Platform

Turbine	2.5-120		2.75-120	2.5/2.75/ 2.85-103	3.2-103
Rated output [MW]	2.53		2.78	2.85	3.23
Rotor diameter [m]	120		120	103	103
Number of blades	3				
Swept area [m²]	11,310		11,310	8,332	8,332
Rotational direction (viewed from an upwind location)	Clockwise				
Maximum speed of the blade tips [m/s]	120 m HH	73.2	78.5	79.7	79.7
	All other HH	78.5			
Orientation	Upwind				
Speed regulation	Pitch control				
Aerodynamic brake	Full feathering				
Color of outer components	RAL 7035 (light grey)				
Reflection degree/Gloss degree. Nacelle, Hub, Steel tower	30 - 60 units measured at 60 ° per ISO 2813				
Reflection degree/Gloss degree. Rotor blades	60 – 80 Gloss units measured at 60 ° as per ISO 2813				
Reflection degree/gloss degree. Hybrid Tower	Concrete gray (similar RAL 7035); gloss matte		Concrete gray (similar RAL 7035); gloss matte		

Table 2: Technical Data 3MW Platform

Atmospheric corrosion protection (corrosion categories as defined by ISO 12944-2:1998)					
		Standard		Enhanced (Option)	
		Internal	External	Internal	External
Americas	Tower shell	C-2	C-3	C-4	C-5M
	All other components	C-2	C-3	C-2	C-3
Europe	Tower shell	C-4	C-5M		
	All other components	C-2	C-3		

Table 3: Atmospheric corrosion protection

3.1 Operational Limits

Turbine	2.5-120/ 2.75-120 75 m HH	2.5-120/ 2.75-120 85 m HH	2.5-120/ 2.75-120 98.3 m HH	2.5-120/ 2.75-120 110 m HH	2.5-120/ 120 m HH	2.5-120/ 2.75-120 139 m HH
Rotor diameter	120 m	120 m	120 m	120 m	120 m	120 m
Hub height	75 m (50Hz)	85 m	98.3 m (50Hz)	110 m	120 m (50 Hz)	139 m (50Hz)
Wind turbine design standard	2.5 Series: IEC 61400-1, second edition 2.75 Series: IEC 61400-1, third edition 2.5-120 m HH, 2.5/2.75-120 110, 139 m HH: DIBt 2012					DIBt 2012
Height above sea level	Maximum 1000 m with the maximum standard operational temperature of +40 °C. Above 1000 m, the maximum operational temperature is reduced per DIN IEC 60034-1 (e.g., maximum operational temperature reduced to +30 °C at 2000 m). For installations above 1000 m isolation distances of medium voltage terminals must also be re-evaluated.					
Standard Weather Option (STW) from 15°C to +40°C, resp. 5°F to +104°F)	For operational details refer to General Description: High Temperature Survive temperature of -20°C to +50°C, resp. -4°F to +122°F without the grid. Survive means: turbine not in operation including the heat transfer system due to lack of energy supply by the grid					
Cold Weather Option (CWE from -30°C to +40°C resp. -22°F to +104°F)	For operational-details refer to Technical Description: CWE Adaptations Survive extreme temperature of -40ºC to +50ºC, resp. -40ºF to +122ºF without the grid. Survive means: turbine not in operation including the heat transfer system due to lack of energy supply by the grid..					CWE option not available
Wind conditions according to IEC 61400-1 for the standard temperature range	7.5 m/s average wind speed					
Maximum extreme gust (10 min) according to IEC 61400-1 for the standard temperature range	40.0 m/s					
Design guideline and wind class	IEC TC S: 7.5 m/s average wind speed; 14%-turbulence German DIBt site specific					German DIBt site specific

Turbine	2.5/2.75/2.85-103 70 m HH	2.5/2.75/2.85-103 75 m HH	2.5/2.75/2.85-103 85 m HH	2.5/2.75/2.85-103 98.3 m HH	3.2-103 70 m HH	3.2-103 75 m HH	3.2-103 85 m HH	3.2-103 98.3 m HH
Rotor diameter	103 m	103 m	103 m	103 m	103 m	103 m	103 m	103 m
Hub height	70 m (50Hz)	75 m (50Hz)	85 m	98.3 m	70 m (50Hz)	75 m (50Hz)	85 m (50Hz)	98.3 m
Wind turbine design standard	IEC 61400-1, second edition				IEC 61400-1, Third edition			
Height above sea level	Maximum 1000 m with the maximum standard operational temperature of +40 °C. Above 1000 m, the maximum operational temperature is reduced per DIN IEC 60034-1 (e.g., maximum operational temperature reduced to +30 °C at 2000 m). For installations above 1000 m isolation distances of medium voltage terminals must also be re-evaluated.							
Standard Weather Option (STW) from 15°C to +40°C, resp. 5°F to +104°F)	For operational details refer to General Description: High Temperature Survive temperature of -20°C to +50°C, resp. -4°F to +122°F without the grid. Survive means: turbine not in operation including the heat transfer system due to lack of energy supply by the grid							
Cold Weather Option (CWE) from -30°C to +40°C resp. -22°F to +104°F)	For operational details refer to Technical Description: CWE Adaptations. Survive extreme temperature of -40°C to +50°C, resp. -40°F to +122°F without the grid. Survive means: turbine not in operation including the heat transfer system due to lack of energy supply by the grid							
Wind conditions according to IEC 61400-1 (ed. 2) for the standard temperature range	8.5 m/s average wind speed							
Maximum extreme gust (10 min) according to IEC 61400-1 (ed. 2) for the standard temperature range	42.5 m/s							
Design guideline and wind class	IEC TC S: 8.5 m/s average wind speed; B-turbulence IEC TC S: 7.5 m/s average wind speed; A-turbulence							

Table 4: Operational limits

Vestas®

4 MW PLATFORM

Wind. It means the world to us.™

Are you looking for the maximum return on **your investment** in wind energy?

Wind energy means the world to us. And we want it to mean the world to our customers, too, by maximising your profits and strengthening the certainty of your investment in wind power.

That's why, together with our partners, we always strive to deliver cost-effective wind technologies, high quality products and first class services throughout the entire value chain. And it's why we put so much emphasis on the reliability, consistency and predictability of our technology.

We have more than 35 years' experience in wind energy. During that time, we've delivered 87 GW of installed capacity in 76 countries. That is more than anyone else in the industry. We currently monitor over 33,000 wind turbines across the globe. All tangible proof that Vestas is the right partner to help you realise the full potential of your wind site.

What is the 4 MW Platform today?
The Vestas 4 MW platform* was introduced in 2010 with the launch of the V112-3.0 MW®. Over 15 GW of the 4 MW platform has been installed all over the world onshore and offshore making it the obvious choice for customers looking for highly flexible and trustworthy turbines.

Since then the 4 MW platform was upgraded and new variants were introduced utilising untapped potential of the platform. All variants carry the same nacelle design and the hub design has been re-used to the largest extend possible. In addition, our engineers have increased the nominal power across the entire platform improving your energy production significantly.

With this expansion, the 4 MW platform covers all IEC wind classes with a variety of rotor sizes and a higher rated output power of up to 4.2 MW.

You can choose from the following turbines on the 4 MW platform:
- V105-3.45 MW™ – IEC IA
- V112-3.45 MW® – IEC IA
- V117-3.45 MW® – IEC IB/IEC IIA
- V117-4.2 MW™ – IEC IB/IEC IIA/IEC S
- V126-3.45 MW® – IEC IIB/IEC IIA
- V136-3.45 MW® – IEC IIB/IEC IIIA
- V136-4.2 MW™ – IEC IIB/IEC S
- V150-4.2 MW™ – IEC IIIB/IEC S

All variants of the 4 MW platform are based on the proven technology of the V112-3.0 MW® with a full-scale converter, providing you with superior grid performance.

Our 4 MW platform is designed for a broad range of wind and site conditions, enabling you to mix turbines across your site or portfolio of sites, delivering industry-leading reliability, serviceability and exceptional energy capture, optimising your business case.

All turbine variants are equipped with the same ergonomically designed and very spacious nacelle which makes it easier for maintenance crews to gain access, so they can reduce the time spent on service while maximizing the uptime without compromising safety. All turbines can be installed and maintained using standard installation and servicing tools and equipment further reducing the operation and maintenance costs by minimising your stock level of spare parts.

*Formerly named the Vestas 3 MW platform

+62,000

The V112-3.45 MW® and the other 4 MW variants advance the already proven technology powering over 62,000 installed Vestas turbines worldwide - more than any other supplier.

How does our technology generate **more energy?**

More power for every wind site
V112-3.45 MW®, V117-3.45 MW®, V117-4.2 MW™, V126-3.45 MW®, V136-3.45 MW®, V136-4.2 MW™ and V150-4.2 MW™ are available with several Sound Optimised Modes to meet sound level restrictions with an optimised production. The power system enables superior grid support and it is capable of maintaining production across severe drops in grid voltage, while simultaneously minimising tower and foundation loads. It also allows rapid down-rating of production to 10 per cent nominal power.

Proven technologies - from the company that invented them
The 4 MW platform is a low-risk choice. It is based on the proven technologies that underpin more than 62,000 Vestas turbines installed around the world. Using the best features from across the range, as well as some of the industry's most stringently tested components and systems, the platform's reliable design minimises downtime – helping to give you the best possible return on your investment.

With an operating range that covers all wind classes, our 4 MW platform delivers unrivalled energy production. The proven blade technology from the V112-3.0 MW® is used on the V105-3.45 MW™, the V112-3.45 MW®, V117-3.45 MW® and V117-4.2 MW™. The industry known structural shell blades are used on the V126-3.45 MW®, V136-3.45 MW®, V136-4.2 MW™ and V150-4.2 MW™- a technology which is also used on the 2 MW V110-2.0 MW®, V116-2.0 MW™ and V120-2.0 MW™ variants.

Reliable and robust
The Vestas Test Centre is unrivalled in the wind industry. We test most nacelle components using Highly Accelerated Life Testing (HALT) to ensure reliability. For critical components, 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.

The 4 MW platform covers all wind segments enabling you to find the best turbine for your specific site.

WINDCLASSES - IEC

TURBINE TYPE	IEC III (6.0 - 7.5 m/s)	IEC II (7.5 - 8.5 m/s)	IEC I (8.5 - 10.0 m/s)
4 MW TURBINES			
V105-3.45 MW™ IEC IA			■
V112-3.45 MW® IEC IA			■
V117-3.45 MW® IEC IB/IEC IIA		■	■
V117-4.2 MW™ IEC IB/IEC IIA/IEC S		■	■
V126-3.45 MW® IEC IIA/ IEC IIB	■	■	■
V136-3.45 MW® IEC IIB/ IEC IIIA	■	■	■
V136-4.2 MW™ IEC IIB/IEC S	■	■	■
V150-4.2 MW™ IEC IIIB/IEC S	■	■	

■ Standard IEC conditions ■ Site dependent

Options available for the 4 MW platform

An option is an extra feature that can be added to the turbine to suit a project's specific needs. 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. The options can even be a decisive factor in realising your specific project, and the business case certainty of the investment.

Here is a list of the options available for the 4 MW platform:

- Power Optimised Modes
- Load Optimised Modes
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

Life testing

The Vestas Test Centre has the unique ability to test complete nacelles using technologies like Highly Accelerated Life Testing (HALT). This rigorous testing of new components ensures the reliability of the 4 MW platform.

Is the 4 MW platform the optimal choice for **your specific site?**

One common nacelle – six different rotor sizes
The wind conditions on a wind project site are often not identical. The 4 MW platform features a range of turbines that cover all wind classes and combined across your site they can maximise the energy output of your wind power plant.

Tip-height restrictions and strict grid requirements
With a rotor size of 105 m, the V105-3.45 MW™ IEC IA is the turbine that fits the most severe wind conditions. It has an extremely robust design for tough site conditions and is especially suited for markets with tip-height restrictions and high grid requirements.

Like all the other 4 MW turbines, the V105-3.45 MW™ is equipped with a full-scale converter ensuring full compliance with the challenging grid codes in countries like the UK and Ireland.

Cold climates
The V112-3.45 MW®, V117-3.45 MW® , V117-4.2 MW™, V126-3.45MW®, V136-3.45 MW® can be combined with Vestas De-Icing and Vestas Ice Detection ensuring optimum production in cold climates.

The Vestas De-Icing System is fully SCADA integrated and can be triggered automatically or manually depending on your de-icing strategy. Automatic control protects your investment, optimising the trigger point so the turbine only stops to de-ice when there is an expected net power production gain.

High- and medium-wind sites
The V112-3.45 MW® IEC IA is a high-wind turbine and has a very high capacity factor. Similar to the other 4 MW turbines, the V112-3.45 MW® IEC IA turbine makes efficient use of its grid compatibility and is an optimal choice for sites with MW constraints.

On medium wind-sites, the V117-3.45 MW® IEC IB/IEC IIA, V126-3.45 MW® IEC IIA/IEC IIB, V136-3.45 MW® IEC IIB/IEC IIIA and V136-4.2 MW IEC IIB/IEC S are excellent turbine choices. A combination of the variants can optimise your site layout and improve your production significantly on complex sites.

Low-wind sites
Built on the same proven technology as the V112-3.0 MW®, the V150-4.2 MW™ IEC IIIB/IEC S is our best performer on low-wind sites. The larger rotor enable greater wind capture, which in turn produces more energy to reduce levelised cost of energy (LCOE). The result is exceptional profitability in areas with low wind, and new frontiers for wind energy investment.

Large Diameter Steel Towers (LDST) support the added rotor size and rating of Vestas turbines to increase Annual Energy Production on low-wind sites. LDST is specially designed with a larger diameter in the bottom section that allows for optimal strength at high hub heights.

Maximising old permits
Although the V150-4.2 MW™ is one of the highest producing low wind turbines available, some old permits may simply be too tight to accept it. Although the V117-3.45 MW®, V126-3.45 MW®, V136-3.45 MW® and V136-4.2 MW™ are medium-wind turbines, they still deliver an excellent business case on low-wind sites.

Due to the similar electrical properties and nacelle design, it is easy to mix and match the turbines from the 4 MW platform to maximise production on heavily constrained sites.

Would you **benefit** from uninterrupted control of wind energy production?

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, SiteDesign® optimises the layout of your wind power plant. SiteDesign® runs Computational Fluid Dynamics (CFD) software on our powerful in-house supercomputer Firestorm to perform simulations of the conditions on site and analyse their effects over the whole operating life of the plant. Put simply, it finds the optimal balance between the estimated ratio of annual revenue to operating costs over the lifetime of your plant, to 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,

+33,000

The Vestas Performance and Diagnostics Centre monitors more than 33,000 turbines worldwide. We use this information to continually develop and improve our products and services.

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 any 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 case.

V105-3.45 MW™ IEC IA

Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*Subject to different temperature options

SOUND POWER

Maximum	104.5 dB(A)**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	105 m
Swept area	8,659 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub height	72.5 m (IEC IA)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

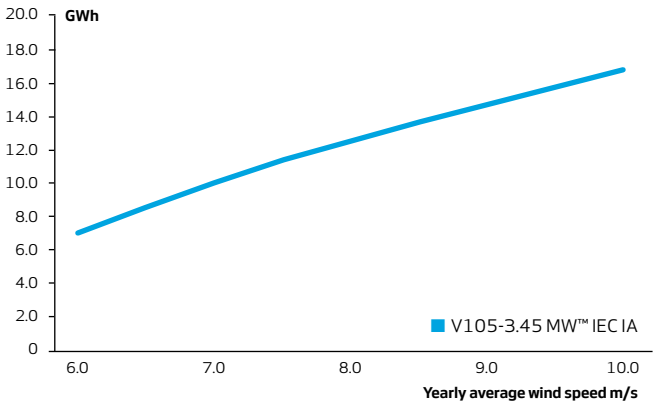
Length	51.2 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Low Temperature Operation to -30°C
- Fire Suppression
- Shadow Detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



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

V112-3.45 MW® IEC IA

Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	105.4 dB(A)**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	112 m
Swept area	9,852 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub height	69 m (IEC IA) and 94 m (IEC IA)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

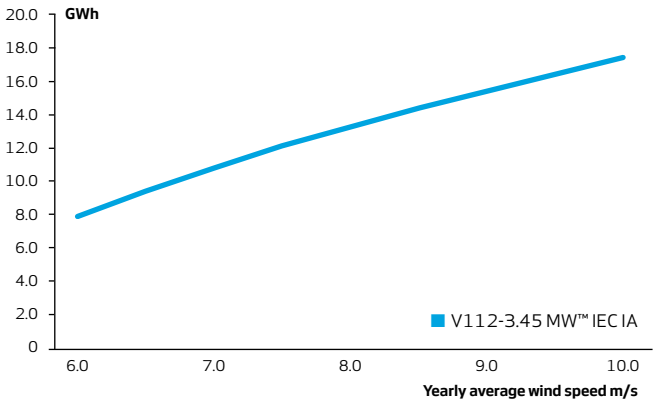
Length	54.7 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



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

V117-3.45 MW®
IEC IB/IEC IIA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IB/IEC IIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	106.8 dB(A)**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	117 m
Swept area	10,751 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	80 m (IEC IB), 91.5 m (IEC IB) and 116.5 m (IEC IB/IEC IIA/DIBtS)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

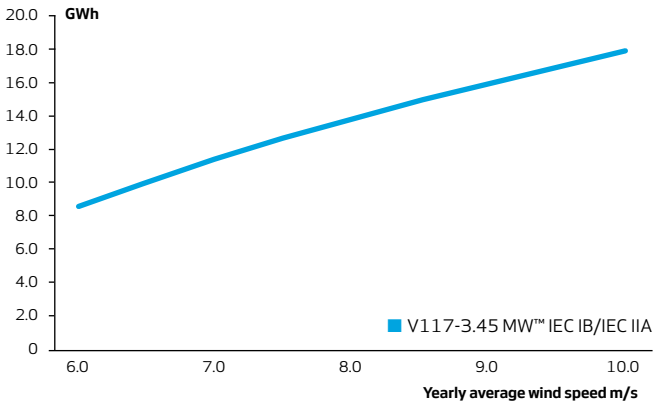
Length	57.2 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



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

V117-4.2 MW™ IEC IB/IEC IIA/IEC S

Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	4,000 kW/4,200 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IB/IEC IIA/IEC S

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C (4,000 kW)

*subject to different temperature options

SOUND POWER

Maximum	106 dB(A)**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	117 m
Swept area	10,751 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	91.5 m (IEC IB) 84 m (IEC IIA)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

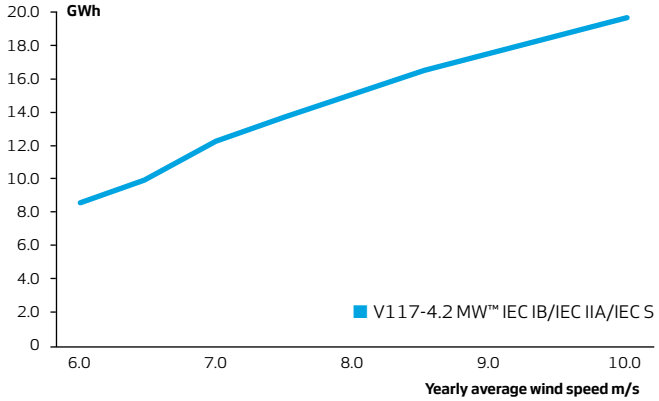
Length	57.2 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- 4.2 MW Power Optimised Mode (site specific)
- Load Optimised Modes down to 3.6 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight®

ANNUAL ENERGY PRODUCTION



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

V126-3.45 MW®
IEC IIB/IEC IIA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIB/IEC IIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	104.4 dB(A)**/ 107.3 dB(A)**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	126 m
Swept area	12,469 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights 87 m (IEC IIB/IEC IIA),117 m (IEC IIB/IECIIA/DIBtS), 137 m (IEC IIIA/DIBtS), 147 m (IEC IIIA), 149 m (DIBtS) and 166 m (DIBtS)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

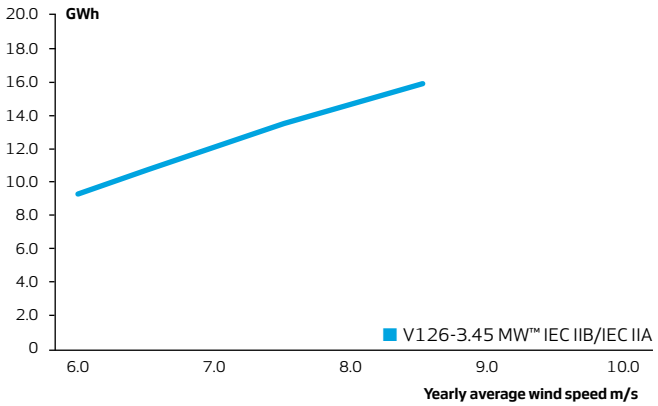
Length	61.7 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



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

V136-3.45 MW®
IEC IIB/IEC IIIA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIB/IEC IIIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	105.5 dB(A)**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	136 m
Swept area	14,527 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights 82 m (IEC IIB/IEC IIIA), 105 m (IEC IIIA), 112 m (IEC IIB/IEC IIIA), 132 m (IEC IIB/IEC IIIA/ DIBt2), 142 m (IEC IIIA), 149 m (DIBtS), and 166 m (DIBtS)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

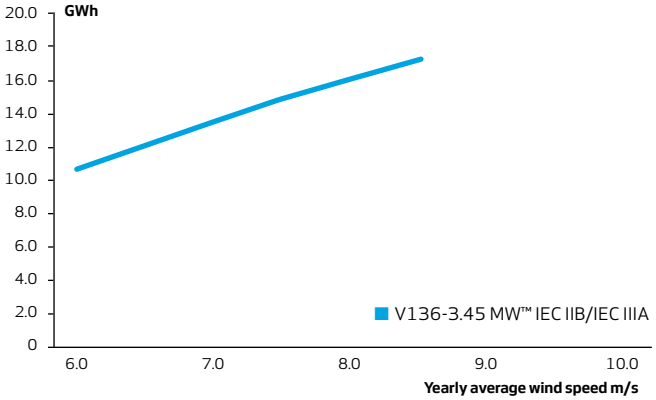
Length	66.7 m
Max. chord	4.1 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



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

V136-4.2 MW™ IEC IIB/IEC S

Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	4,000 kW/4,200 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IIB/IEC S

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C (4,000 kW)

*subject to different temperature options

SOUND POWER

Maximum	103.9 dB(A)**

**Sound Optimised modes dependent on site and country

ROTOR

Rotor diameter	136 m
Swept area	14,527 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	Site and country specific

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

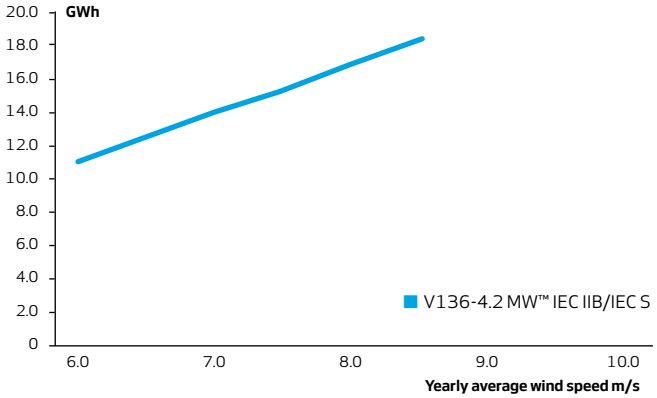
Length	66.7 m
Max. chord	4.1 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- 4.2 MW Power Optimised Mode (site specific)
- Load Optimised Modes down to 3.6 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight®

ANNUAL ENERGY PRODUCTION



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

V150-4.2 MW™ IEC IIIB/IEC S

Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	4,000 kW/4,200 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIIB/IEC S

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C (4,000 kW)

*subject to different temperature options

SOUND POWER

Maximum	104.9 dB(A)**

**Sound Optimised modes dependent on site and country

ROTOR

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

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	Site and country specific

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

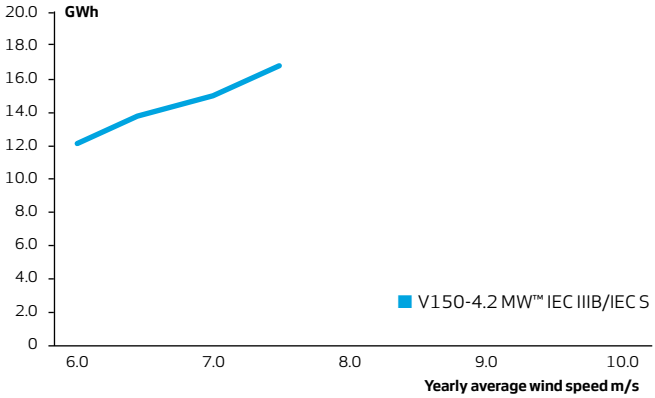
Length	73.7 m
Max. chord	4.2 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- 4.2 MW Power Optimised Mode (site specific)
- Load Optimised Modes down to 3.6 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight®

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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09/2017-EN

GAMESA **2.5 MW**

	G106-2.5 MW	G114-2.5 MW	G126-2.5 MW
ROTOR			
Diameter	106 m	114 m	126 m
Swept area	8,825 m^2	10,207 m^2	12,469 m^2
Rotational speed	7.7 - 14.6 rpm	7.7 - 14.6 rpm	7.1 - 12.9 rpm
BLADES			
Number of blades	3	3	3
Length	52 m	56 m	62 m
Airfoils	Gamesa	Gamesa	Gamesa
Material	Fiberglass reinforced with epoxy or polyester resin	Fiberglass reinforced with epoxy or polyester resin	Fiberglass reinforced with epoxy or polyester resin
TOWER			
Type	Modular	Modular	Modular
Height	72, 80, 93 m and and site specific	80, 93, 125 m and and site specific	84, 102, 129 m and and site specific
GEAR BOX			
Type	2 planetary stages 1 parallel stage	2 planetary stages 1 parallel stage	2 planetary stages 1 parallel stage
Ratio	1:129.7 (50 Hz) 1:103.8 (60 Hz)	1:129.7 (50 Hz) 1:103.8 (60 Hz)	1:98 (50 Hz) 1:118 (60 Hz)
GENERATOR			
Type	Doubly-fed machine	Doubly-fed machine	Doubly-fed machine
Rated power	2.5 MW	2.5 MW	2.5 MW
Voltage	690 V AC	690 V AC	690 V AC
Frequency	50 Hz/60 Hz	50 Hz/60 Hz	50 Hz/60 Hz
Protection class	IP 54	IP 54	IP 54
Power factor	0.95 CAP-0.95 IND throughout the power range*	0.95 CAP-0.95 IND throughout the power range*	0.95 CAP-0.95 IND throughout the power range*

* Power factor at generator output terminals, on low voltage side before transformer input terminals.

intelligent evolution

G114-2.5 MW

Boosting production in medium wind sites

The goal to continually reduce the Cost of Energy in the 2.0-3.0 MW market segment is central to Gamesa's product design philosophy and has led the evolution within the 2.0 MW platform with the introduction of the G114-2.5MW wind turbine.

With the offer of a large rotor for medium wind sites, new tower options and a power boost to 2.5 MW, the G114-2.5 MW Class II turbine complements the 2.0 MW product series and promises to become a mainstay of Gamesa's growing product portfolio.

- PROVEN TECHNOLOGY
- OVER 14% MORE ENERGY PRODUCTION*
- 10% NOMINAL REDUCTION IN CoE*
- **G114-2.625 MW** ALSO AVAILABLE

* As compared with G114-2.0 MW.

GLOBAL TECHNOLOGY
EVERLASTING ENERGY

Gamesa

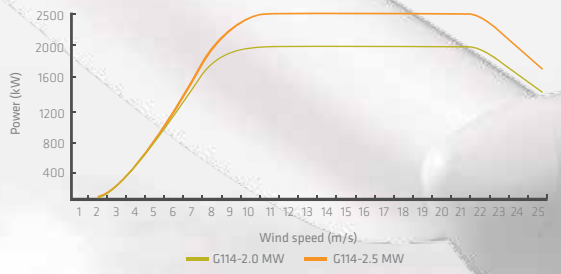
NEW G114-2.5 MW
Boosting production in medium wind sites

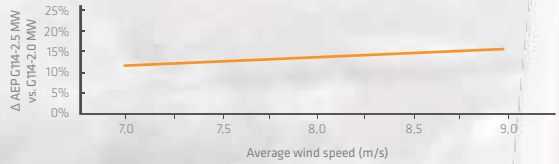
As part of the evolutionary development process of the Gamesa 2.0 MW platform, the G114-2.5 MW turbine will inherit the technologies, components, and subsystems previously deployed and proven through the reliable operation of 26 GW of Gamesa's high-performing 2.0 MW turbines.

Features of the G114-2.5 MW include:

- Variable pitch and speed technology for maximum energy capture.
- Active yaw system for optimum adaptation to complex terrain.
- Gamesa SMP predictive maintenance system.
- Gamesa NRS® noise control system to minimize noise emissions.
- Gamesa WindNet® remote control and monitoring system.

By incorporating technology enhancements, including a new 2.5 MW generator and Gamesa's new 56m reinforced blade, the G114-2.5 MW Class II turbine promises to deliver nearly 30% more energy along with a 10% nominal reduction in Cost of Energy, making it one of the most profitable solutions available in the market today.





SPECIFICATIONS

General Details	G114-2.5 MW	G114-2.625 MW
Rated power	2.5 MW	2.625 MW
Wind class	IIA	IIA
Rotor diameter	114 m	114 m
Swept area	10,207 m^2	10,207 m^2
Power density	244,93 W/m^2	257,18 W/m^2
Control	Pitch and variable speed	Pitch and variable speed
Gearbox	3 stages	3 stages
Generator	Doubly fed	Doubly fed
Frequency	50 Hz / 60 Hz	50 Hz / 60 Hz
Blades		
Length	56 m	56 m
Airfoil	Gamesa	Gamesa
Towers		
Height	68, 80, 93, 125 m and site specific	68, 80, 93, 125 m and site specific

Gamesa

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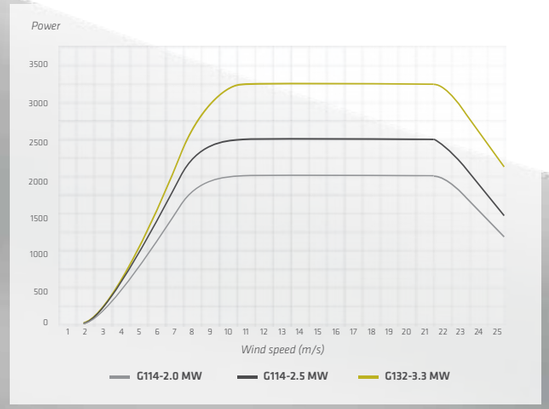
GAMESA 3.3 MW, OPTIMUM **CoE**

Thanks to the operative experience accumulated by Gamesa throughout more than 20 years in the wind energy market, the Gamesa 3.3 MW platform enables the company to guarantee the highest levels of reliability.

- The best CoE in the 3.0-3.3 MW segment.
- New 3.3 MW platform based on mature technologies proven in the Gamesa portfolio.
- 34% larger swept area*.
- Installation of the first G132-3.3 MW prototype is expected by mid-2016.
- Optimum solution for medium wind sites.
- Improvement of the production capacity thanks to a nominal power of 3.3 MW and a greater rotor swept area.
- 64.5 m fibreglass blade, optimized for Class II sites and with aerofoils that have already been thoroughly tested and validated in the G132-5.0 MW IIA wind turbine.
- New model G132-3.3 MW that guarantees maximum energy production and low noise emission levels.
- Extensive portfolio of towers with heights ranging from 84 m to 134 m, which enables it to comply with the different maximum blade tip height restrictions in certain markets.



* Vs. G114-2.0 MW and G114-2.5 MW models.

GAMESA **3.3 MW**

	G132-3.3 MW
ROTOR	
Diameter	132 m
Swept area	13,685 m^2
Rotational speed	6.82 - 10.9 rpm
BLADES	
Number of blades	3
Length	64.5 m
Airfoils	Gamesa
Material	Fiberglass reinforced with epoxy or polyester resin
TOWER	
Type	Modular
Height	84, 97, 114, 134 m and site specific
GEAR BOX	
Type	3 stages
Ratio	1:102.75 (50 Hz) 1:123.3 (60 Hz)
GENERATOR	
Type	Doubly-fed machine
Rated power	3.3 MW
Voltage	690 V AC
Frequency	50 Hz/60 Hz
Protection class	IP 54
Power factor	0.95 CAP-0.95 IND throughout the power range*

* Power factor at generator output terminals, on low voltage side before transformer input terminals.

G132-3.3 MW

Optimum CoE for sites with medium winds

One of the keys to Gamesa's success is the constant development of new and advanced products adapted to customers' needs in any type of site and with maximum profitability.

With this purpose in mind the new Gamesa 3.3 MW platform has been launched with its first model: the G132-3.3 MW wind turbine for Class II sites. A new generation of multi-megawatt turbines that reaches the market to become the best solution in terms of Cost of Energy in the 3.0-3.6 MW segment, one of the most competitive and demanding. This new platform, together with the current Gamesa 2.0 MW, Gamesa 2.5 MW and Gamesa 5.0 MW, makes the company product portfolio one of the most complete and versatile in the market and allows Gamesa to assure the best solution for customers' projects.

Thanks to the operative experience accumulated by Gamesa throughout more than 20 years in the wind energy market, the G132-3.3 MW wind turbine enables the company to guarantee the highest levels of reliability. The use of mature and proven technology available in Gamesa's current portfolio has resulted in the first G132-3.3 MW prototype installed in 2016.

- The BEST CoE in the 3.0-3.6 MW segment
- New platform based on MATURE and PROVEN TECHNOLOGY
- 34% LARGER SWEPT AREA*
- **G132-3.465 MW** ALSO AVAILABLE

** vs. G114-2.0 MW and G114-2.5 MW.*

GLOBAL TECHNOLOGY
EVERLASTING ENERGY

Gamesa

NEW G132-3.3 MW IIA WIND TURBINE

The G132-3.3 MW IIA wind turbine is integrated in the portfolio of Gamesa with a clear objective: to complement the product offer for medium-wind sites in markets where the customers require solutions with nominal powers higher than 3 MW.

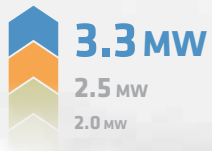
The G132-3.3 MW turbine improves on the production capacity of the models G114-2.0 MW and G114-2.5 MW, available for Class II sites, both boosting the nominal power up to 3.3 MW and increasing the rotor swept area by 34%, which makes it one of the most efficient and cost-effective solutions for medium-wind sites.

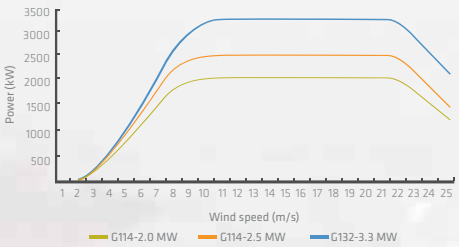
With a 64.5 m fiberglass blade, optimized for Class II sites and with airfoils that have already been thoroughly tested and validated in the G132-5.0 MW IIA wind turbine (first prototype installed in Alaiz -Spain- in the second quarter of 2015), the new model G132-3.3 MW guarantees maximum energy production and low noise emission levels, with maximum theoretical value for this turbine fixed at 105.7 dBA.

Gamesa incorporates proven technology into this model, such as the combination of a three-stage gearbox (two planetary stages and one parallel) and a doubly-fed induction generator, the same solution used in the Gamesa 2.0 MW platform, which has 26 GW installed worldwide.

The G132-3.3 MW wind turbine also has an extensive portfolio of towers with heights ranging from 84 m to 154 m, which enables it to comply with the different maximum blade tip height restrictions in certain markets.

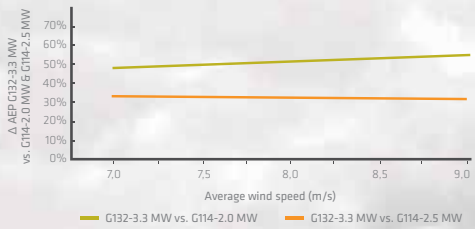
NOMINAL POWER INCREASE





SWEPT AREA INCREASE

AEP INCREASE



SPECIFICATIONS

General Details	G132-3.3 MW	G132-3.465 MW
Rated power	3.3 MW	3.465 MW
Wind class	IIA	IIA
Rotor diameter	132 m	132 m
Swept area	13,685 m²	13,685 m²
Power density	241.14 W/m²	253.20 W/m²
Control	Pitch and variable speed	Pitch and variable speed
Gearbox	3 stages	3 stages
Generator	Doubly fed	Doubly fed
Frequency	50 Hz / 60 Hz	50 Hz / 60 Hz
Blades		
Length	64.5 m	64.5 m
Airfoil	Gamesa	Gamesa
Towers		
Height	84, 97, 114, 134, 154 m and site specific	84, 97, 114, 134, 154 m and site specific

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GE Renewable Energy

GE's 2 MW Platform

A CUSTOMIZABLE PLATFORM TO ENHANCE SITING EFFICIENCY

www.gerenewableenergy.com

Since entering the wind industry in 2002, GE Renewable Energy has invested more than $2.5 billion in next-generation wind turbine technology to provide more value to customers—whether at the turbine, plant or grid level. Through the use of advanced analytics, GE Renewable Energy is redefining the future of wind power, delivering with proven performance, availability and reliability. With the integration of big data and the industrial internet, we can help customers manage the variability that comes with this resource for smooth, predictable power. Our onshore product portfolio includes wind turbines with rated capacities from 1.6-3.8 MW and flexible support services that range from basic operations and maintenance to farm- or fleet-level enhancements.

For more information visit our website:
www.gerenewableenergy.com

2.0-2.5 MW Platform

GE's 2.0-2.5 MW, 116-meter rotor wind turbine offers a 27% increase in swept area when compared to the 1.7-103 turbine, resulting in an up to 38% increase in Annual Energy Production (AEP) at 7.5 m/s (at a 2.3 rating). This increase in blade swept area allows greater energy capture and improved project economics for wind developers[†]. GE's 2.0-116 turbine has a 53.3% gross capacity factor at 7.5 m/s, a class leading performance. GE's proprietary 56.9-meter blade is specifically for the 2.0-2.3 MW rating of this platform, enabling longer length, lower loads and improved performance.

GE's stringent procedures result in a turbine engineered for high performance and availability. The use of selected components from both the 1.x and 2.x platforms ensures the consistent workhorse performance and reliability that GE wind turbines are known for. The 2.0-2.5 MW platform utilizes the same drivetrain and electrical system architecture as GE's 1.x series, with both systems scaled and upgraded to provide improved performance along with greater wind turbine energy production. Other critical components have been scaled from the existing platforms to meet the specific technical requirements of this evolutionary turbine.

Ensuring consistent performance, reliability and efficiency, GE's new 2.0-2.5 MW platform of wind turbines is an advanced evolution of the 1.x platform series, scaling and developing 1.x platform electrical system upgrades to increase the rating of the turbine from 1.7 MW to range from 2.0-2.5 MW, allowing higher energy production.

[†] Comparative statements refer to GE technology unless otherwise stated.

Building Upon the Proven 1.x and 2.x Platforms

The evolution of GE's 1.5 MW turbine began with the 1.5i turbine introduced in 1996. The 65-meter rotor diameter turbine soon was increased to 70.5-meters in the 1.5s, then to 77-meters in the 1.5sle turbine that was introduced in 2004. Building on the exceptional performance and reliability of the 1.5sle, GE introduced the 1.5xle with its 82.5-meter diameter in 2005. Subsequent improvements led to the introduction of the 1.6-82.5 turbine in 2008—followed by the 1.6-87 in 2011, and ultimately the 1.85-82.5 and 1.85-87 in 2013. Ongoing investment in the industry workhorse resulted in the introduction of GE's 1.6-100 and 1.7-100, wind turbines with a 100-meter rotor. This product evolution provides increased capacity factor while increasing AEP by 20–24% over the previous models. Built from the maturity of its predecessors, the 2.0-2.5 MW platform evolution provides increased capacity factor while increasing AEP and application space of GE's 1-2 MW platform of products.

Significant component enhancements to the 1.x models have resulted in a substantial performance increase, enabling the use of a 2 MW-116 rotor and 116-meter rotor on the 1.x series, and a nameplate range of 2.0-2.5 MW (with applicable rotor). These enhancements include new aerodynamics enabling a greater blade length (116-meter rotor), larger bedplate, generator frame and gearbox, controls improvements, and enhanced power conversion capabilities resulting in an increase in nameplate and AEP. Made for high reliability, GE's 2.0-2.5 MW platform can provide excellent availability, comparable with the 1.x series units operating in the field today.

Technical Description

GE's 2.0-2.5 MW platform, is a three-blade, upwind, horizontal axis wind turbine with a rotor diameter of either 2 MW-116 rotor or 116 meters. The turbine rotor and nacelle are mounted on top of a tubular steel tower, providing a hub height of either 80, 90 or 94 meters. The turbine uses active yaw control to keep the blades pointed into the wind. The 2.0-2.5 MW platform operates at a variable speed and uses a doubly fed asynchronous generator with a partial power converter system.

Specifications:

- 2.2-2.4MW, 2 MW-116 rotor wind turbine: engineered to IEC 61400-22 ed 3, Class IIS
- Standard and cold weather extreme options
- Standard tower corrosion protection: C2 internal and C3 external with internal and external C4/C5 options available
- Rotational direction: Clockwise viewed from an upwind location
- Speed regulation: Electric drive pitch control with battery backup
- Aerodynamic brake: Full feathering of blade pitch

Features and Benefits

- 2.2-2.4MW, 2 MW-116 rotor: higher AEP than its 1.x predecessors by incorporating a larger gearbox scaled from GE's 2.x platform and longer 52.2-meter blades
- 2.0-2.3MW, 116-meter rotor: GE proprietary 56.9-meter blade; highest capacity factor in its class
- Engineered to meet or exceed the 1.x platform's historic high availability
- Grid friendly options are available
  - Enhanced Reactive Power, Voltage Ride Thru, Power Factor Control
- Wind Farm Control System; WindSCADA*
- Available in both 50 Hz and 60 Hz versions for global suitability

Construction:

Towers: Tubular steel sections provide a hub height of 80, 90 or 94 meters

Blades: GE 52.2 meter blades (2 MW-116 rotor), and GE 56.9m meter blades (116-meter rotor)

Drivetrain components: GE's 2.0-2.5 MW platform uses an enhanced gearbox, main shaft, and generator with appropriate improvements to enable the 2 MW-116 rotor diameter rotor in medium winds, and the 116-meter rotor in lower wind speeds

Enhanced Controls Technology

The 2.0-2.5 MW wind turbine products employ enhanced control features including:

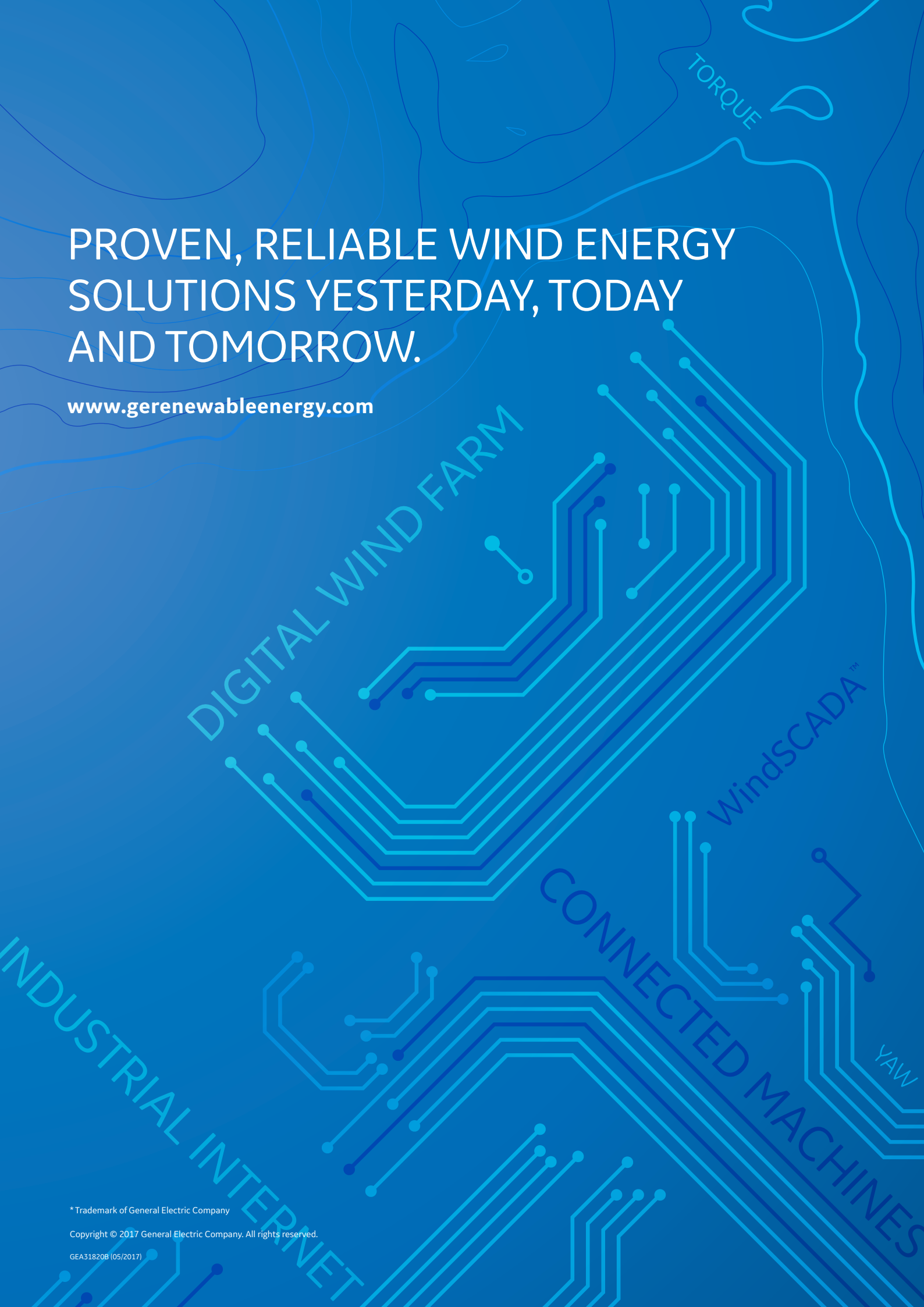
- GE's patented Advanced Loads Control reduces loads on turbine components by measuring stresses and individually adjusting blade pitch.
- Controls developed by GE Global Research to reduce extreme loads, including those near rated wind speeds, to improve Annual Energy Production (AEP).

Condition Monitoring System (option)

GE's Condition Monitoring System* (CMS) and SCADA Anomaly Detection Services, a complementary suite of advanced condition monitoring solutions, proactively detect impending drivetrain and whole-turbine issues enabling increased availability and decreased maintenance expenses. Built upon half a century of power generation drivetrain and data anomaly monitoring experience, this service solution is now a standard feature available on GE's 2.0-2.5 MW platform, for both rotor types.

PROVEN, RELIABLE WIND ENERGY SOLUTIONS YESTERDAY, TODAY AND TOMORROW.

www.gerenewableenergy.com



GEA31820B (05/2017)

GE Renewable Energy

GE's 3 MW Platform

POWERFUL AND EFFICIENT

www.gerenewableenergy.com

GE'S **3 MW PLATFORM**

Since entering the wind industry in 2002, GE Renewable Energy has invested more than $2.5 billion in next-generation wind turbine technology to provide more value to customers—whether at the turbine, plant or grid level. Through the use of advanced analytics, GE Renewable Energy is redefining the future of wind power, delivering with proven performance, availability and reliability. With the integration of big data and the industrial internet, we can help customers manage the variability that comes with this resource for smooth, predictable power. Our onshore product portfolio includes wind turbines with rated capacities from 1.6-3.8 MW and flexible support services that range from basic operations and maintenance to farm- or fleet-level enhancements.

For more information visit our website:
www.gerenewableenergy.com

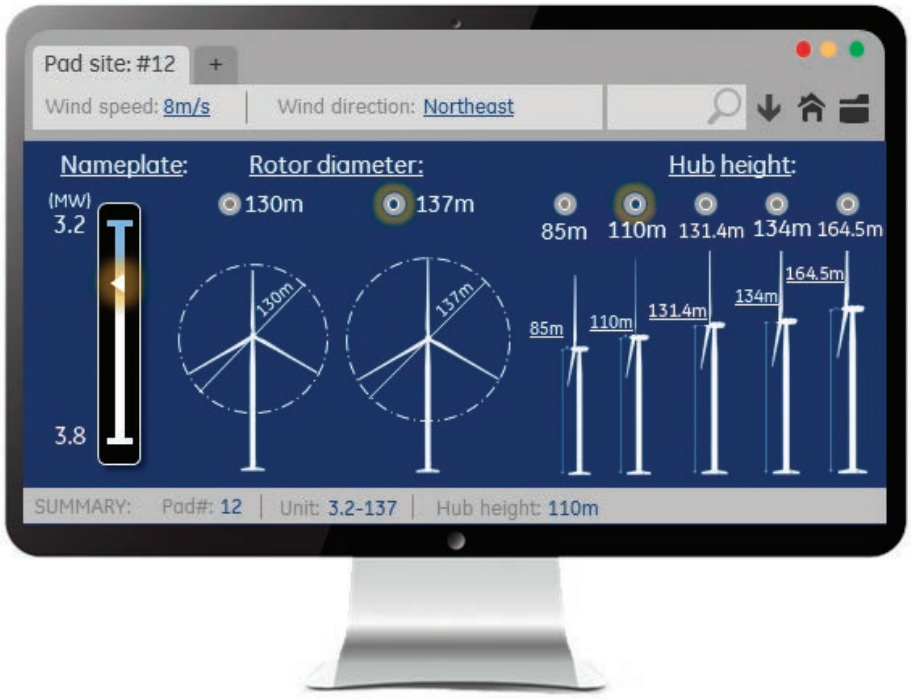
GE's 3 MW Platform

Extending the capability of the Digital Wind Farm to our 3 MW machines, GE's powerful and efficient 3.2–3.8 platform is adaptable to a full spectrum of wind regimes. The platform includes the 3.6-137, our highest performing turbine for Class III winds.

GE has employed selected legacy components with proven performance for the 3 MW platform, helping to ensure the consistent performance and reliability for which GE wind turbines are known. Turbine models within the 3 MW platform share drivetrain and electrical system architecture, with both systems scaled and upgraded for improved performance and greater energy production, as compared to previous models.

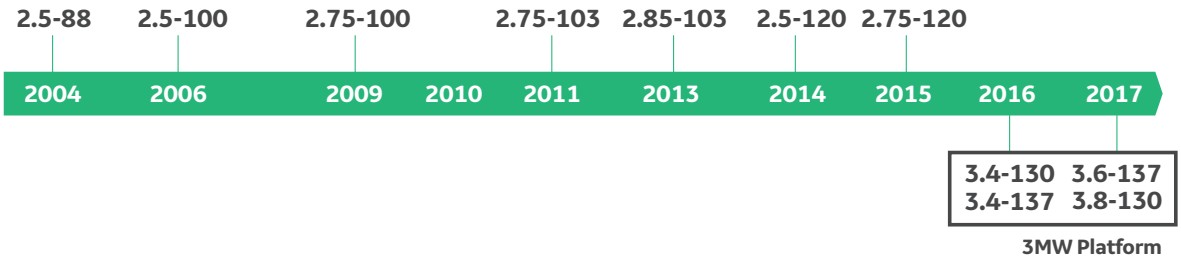
Parameters of the 3 MW Platform

GE's 3MW platform can be customized based on nameplate, rotor diameter and hub height.



Building Upon Proven Technology

Model introduction
in Europe



Built from the maturity of its predecessors, the 3 MW platform increases the capacity factor, annual energy production (AEP) and application space. Component enhancements to the 2.5 MW models have resulted in a substantial performance increase, enabling the use of a 130- and 137- meter rotor on the 3 MW series and a nameplate ranging from 3.2–3.8 MW. These enhancements include gearbox and controls improvements, and a new aerodynamic structure enabling a greater blade length (130–137 meter rotor). Crafted for high reliability, GE's 3 MW platform offers excellent availability that is comparable to the 2.5 MW series units operating in the field today.

Technical Description

GE's 3 MW platform machines are three-blade, upwind, horizontal axis wind turbines with a rotor diameter ranging from 130 to 137 meters. The turbine rotor and nacelle are mounted on top of a tubular steel tower, with a range of hub height options that includes 85-, 110-, 131.4-, 134- and 164.5-meter variants. The turbines use active yaw control to keep the blades pointed into the wind. The 3 MW platform is engineered to operate at variable speeds and uses a doubly fed asynchronous generator with a partial power converter system.

Specifications

3 MW Platform

- Standard and cold weather extreme options
- Standard tower corrosion protection: C2 internal and C3 external with internal and external C4/C5 options available
- Rotational direction: Clockwise viewed from an upwind location
- Speed regulation: Electric drive pitch control with battery backup
- Aerodynamic brake: Full feathering of blade pitch

GE's 3.2-130 IEC 2B/3A

- Up to 20% higher output than GE's 2.5-120
- Improved load management system and more efficient drive train technology
- Same electrical system as 3.2-103 turbine
- Sound power level of 106 db(A), reduced noise modes available
- Tip heights include 150 m, 175 m, and 199 m rotor

GE's 3.8-130 IEC2B

- Up to 30% higher output than GE's 3.2-103
- Increased electrical rating of 3.4 MW combined with 130-meter rotor
- 107 dB(A) normal operation sound power level, reduced noise modes available
- Tip heights include 150 m, 175 m, 199 m, and 233 m

GE's 3.6-137 IEC3B

- Up to 28% higher output than GE's 2.75-120
- New blade for more efficient production in low wind conditions
- Sound power level of 106 db(A), reduced noise modes available
- Tip heights include 178.5 m, 199 m, and 223 m

Features and Benefits

- Engineered to meet or exceed the 2.5 MW platform's historic high availability
- Available grid-friendly options:
  - Enhanced Reactive Power, Low & Zero Voltage Ride Thru, Power Factor Control, WindFreeReactive Power
- Wind Farm Control System; WindSCADA*
- Available in both 50 Hz and 60 Hz versions

Construction

Towers:

- Tubular steel sections provide a hub height of 85 m, 110 m, and 131 m
- Hybrid pre-cast concrete/tubular steel towers for multiple hub heights
- Logistic friendly tower for a hub height of 85 m, 110 m, 131.4 m, 134 m, and 164.5 m

Blades:

- 63.7-meter blades (130-meter rotor); 67.2-meter blades (137-meter rotor)

Drivetrain components:

- GE's 3 MW platform uses an enhanced gearbox, main shaft with double bearings, and generator with appropriate improvements to enable the 130- and 137-meter diameter rotor in medium and lower wind speeds.

Enhanced Controls Technology

The 3 MW platform uses enhanced controls features:

- GE's patented Advanced Loads Control reduces loads on turbine components by measuring stresses and individually adjusting blade pitch.
- Controls were developed by GE Global Research to reduce extreme loads, including those near rated wind speeds, to improve annual energy production (AEP).

Condition Monitoring System

GE's Condition Monitoring System (CMS) and SCADA Anomaly Detection Services, a complementary suite of advanced condition monitoring solutions, proactively detects impending drive train and whole-turbine issues, enabling increased availability and decreased maintenance expenses. Built upon half a century of power generation drivetrain and data anomaly monitoring experience, this service solution is now standard on GE's 3 MW platform.

PROVEN, RELIABLE WIND ENERGY SOLUTIONS YESTERDAY, TODAY AND TOMORROW.

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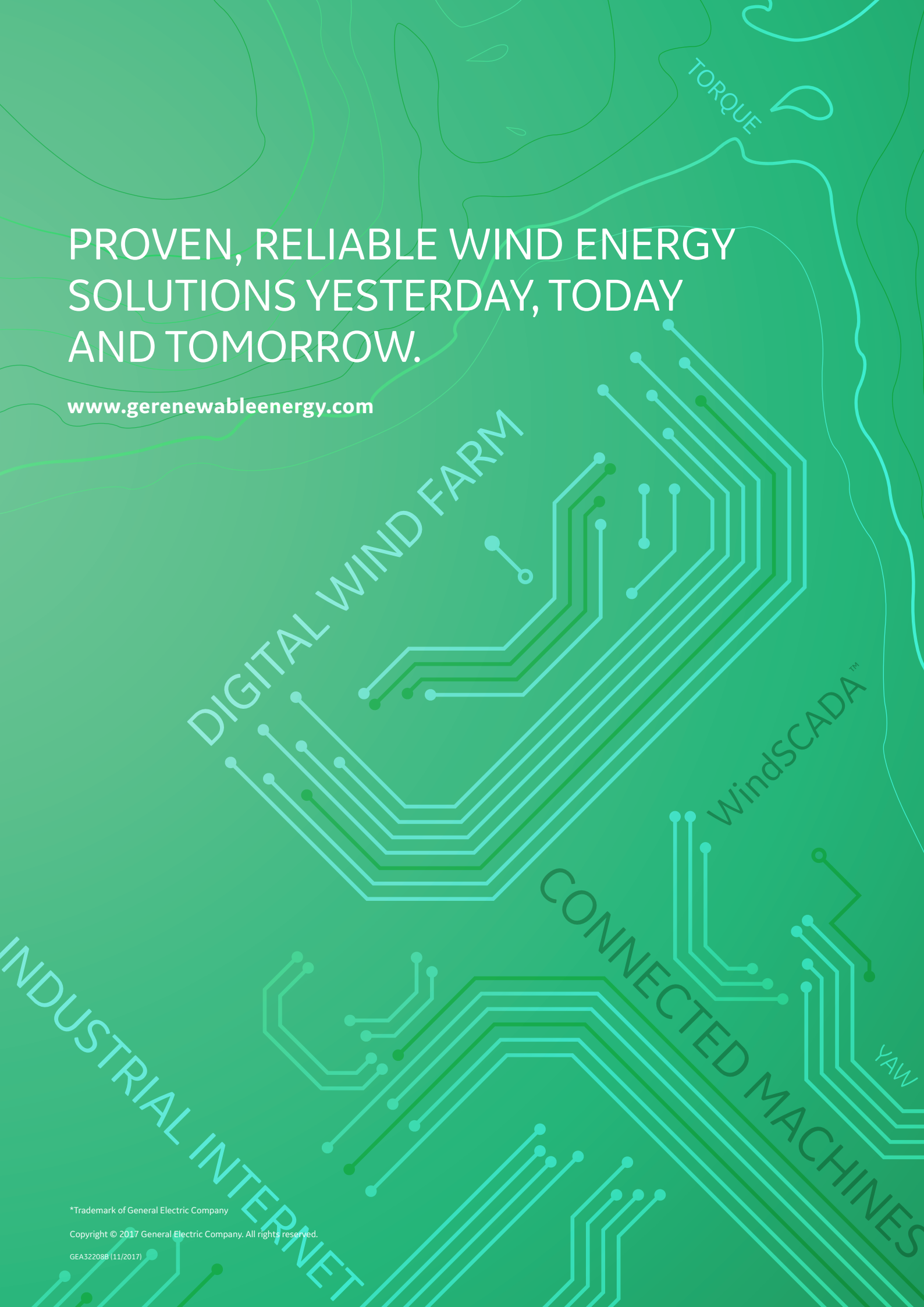

GEA32208B (11/2017)

N117/3600 (3,6 Megawatt)

The N117/3600 is designed for medium wind speeds (IEC-2) and has a 20 percent greater nominal output compared with its sister model. Yet, despite this substantial increase in output, sound power levels have remained stable at 105 dB(A). Nordex offers the turbine with serrations, which reduce the sound emissions by an additional 1.5 dB(A).

Thanks to the high towers and optimised technical systems, the N117/3600 generates high yields at IEC-2 locations.

With the N117/3600, Nordex customers are able to benefit from our more than 16 years of experience in the multi-megawatt segment.

Brief description

Greater nominal output
With a nominal output of 3.6 MW, the N117/3600 has a 20 percent greater capacity than its sister model. This results in strong additional yields in medium wind speeds.

Proven rotor blade design - increased rotor surface
Nordex is using the proven aerodynamic design of its own NR58.5 rotor blade with carbon-fibre girders for the N117/3600.

Taller hub height
The turbine comes with taller hub heights, enabling additional gains in annual energy production and opening up complex forested sites for wind turbine installations. Thus, Nordex offers towers with a hub height of 91 up to 141 metres.

Stable sound power levels
Despite the substantial increase in output, sound power levels have remained stable at 105 dB(A). What is more, Nordex offers numerous noise-optimised operating systems for particularly noise-critical locations. Thank to the improved sector-cut-out modes, an optimum yield is still achieved.

Proven drive train concept
The drive train concept is based on the proven 3-point bearing structure. The optimised drive train geometry reduces the forces impacting the individual components, thus lowering the strain on the robust rotor bearings.

Economical electrical system
As with the first wind power systems using Nordex's multi-megawatt platform, the N117/3600 is fitted with a double-fed asynchronous generator and frequency converter. This system is characterised by superior reliability and economic efficiency.

Internally produced control system
Over 2,000 Nordex turbines have already been fitted with Nordex's own proven Nordex Control™ system, which controls, regulates and monitors the wind power systems. Permanent and protected access to the turbine and wind farm data on site or remotely is browser-based, interactive and secure. With its modular structure and standardised interfaces, Nordex Control™ can be adjusted flexibly to meet the customer's SCADA requirements.

Accustomed grid compatibility
The N117/3600 meets the grid requirements of the international markets. The German System Service Ordinance (SDLWindV) is one of the most demanding grid codes in Europe. With their fault ride-through capabilities, the turbines can effortlessly bridge any disruptions in voltage and thus fully comply with all requirements for the system service bonus. What is more, the Nordex Windfarm Management System allows the grid operator to directly control the active and reactive power of the windfarm in the grid.

Extended standard operating conditions

The turbine can be operated at sites with average temperatures in a normal climate range and even at temperatures of as low as -20 degrees Celsius, thus enhancing the annual yield at your site. The proven Nordex Cold Climate Package additionally helps to open up high-yield cold locations. The cold-climate version of the turbine has an extended operating range of temperatures down to -30 degrees Celsius.

Anti-Icing System
The Anti-Icing System heats the aerodynamically most important surfaces of the rotor blades, thus reducing ice formation efficiently, resulting in considerable yield gains at sites characterised by frequent ice formation.

A safe and spacious work place
The turbine nacelle provides particularly safe and roomy space to work with extended escape and rescue routes. This helps to lower maintenance-induced downtimes:

- Readily accessible systems for maintenance
- On-board crane for replacing components <=1 ton
- Swift and weather-protected access to the hub thanks to complete encapsulation

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Products & Services

› Wind turbines
- N149/4.0-4.5
- N131/3900
- **N131/3600**
- N131/3000
- N117/3600
- N117/3000
- N117/2400
- N100/3300
- N100/2500
- N90/2500
- AW140/3000
- AW132/3000
- AW125/3000
- AW116/3000
- AW100/3000
- AW1500

Project services

Service

Why Nordex?

Sales contact

N131/3600 (3.6 megawatts)

The N131/3600 is specially designed for medium wind locations (comparable to IEC 2). With its 131m rotor the available rotor swept area in this wind regime has risen by more than 25 percent. Despite the substantial increase in rotor length, the sound power level is limited to max. 104.9 dB(A) through rotor blades equipped with serrated trailing edges.

The N131/3600 is available with tower heights of 84 to 134 metres.

The N131/3600 is based on Nordex' proven turbine design of Generation Delta. With the N131/3600, Nordex customers are able to benefit from our more than 17 years of experience in the multi-megawatt segment.

Downloads

› Platform brochure Delta Generation

Brief description

Greater nominal output
With a nominal output of 3.6 MW, and a 14m bigger rotor the N131/3600 delivers up to 15 percent higher yield than its predecessor, the N117/3600. It is our most efficient medium wind turbine.

Proven rotor blade design - increased rotor surface
The N131/3600 features the in-house developed own NR65.5 rotor blade with 13,478 square meters rotor sweep. Compared to its predecessor an increase of more than 25 percent in the medium wind speed regime.

Optimized hub heights
Hub heights of 84 to 134 meters help to achieve greater yields.

Reduced power levels
Despite the substantial increase in output, sound power level is limited to max. 104.9 dB(A). What is more, Nordex offers numerous noise-optimised operating systems for particularly noise-critical locations. Thanks to the improved sector-cut-out modes, an optimum yield is still achieved..

Proven drive train concept
The drive train concept is based on the proven 3-point bearing structure. The optimised drive train geometry reduces the forces impacting the individual components, thus lowering the

strain on the robust rotor bearings.

Economical electrical system
As with the first wind power systems using Nordex's multi-megawatt platform, the N131/3600 is fitted with a double-fed asynchronous generator and frequency converter. This system is characterised by superior reliability and economic efficiency.

Internally produced control system
Over 4,500 Nordex turbines have already been fitted with Nordex's own proven Nordex Control™ system, which controls, regulates and monitors the wind power systems. Permanent and protected access to the turbine and wind farm data on site or remotely is browser-based, interactive and secure. With its modular structure and standardised interfaces, Nordex Control™ can be adjusted flexibly to meet the customer's SCADA requirements.

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The turbine nacelle provides particularly safe and roomy space to work with extended escape and rescue routes. This helps to lower maintenance-induced downtimes:

- Readily accessible systems for maintenance
- On-board crane for replacing components <=1 ton
- Swift and weather-protected access to the hub thanks to complete encapsulation

Senvion

3.4M122 NES

Best for Mid-Speed Winds

Along with an increase in nominal power to 3,400 kilowatts, the successor to the 3.2M122 is also certified for wind class IEC IIA and locations in wind zone 4. The energy yield at mid-speed winds and a hub height of 139 meters is up to 2.4 percent higher. This new system provides improvements in two essential areas. Firstly, it further increases the efficiency of energy production and secondly, it helps integrate renewable energies more sustainably into power networks, by improving electrical capabilities.

- Nominal power: 3,400 kW
- Rotor diameter: 122 m
- Hub height: 86 - 139 m
- Wind class: Low to Medium Wind
- Operating temperature range: -20 – +40 °C
- Rotor surface: 11,690 m²

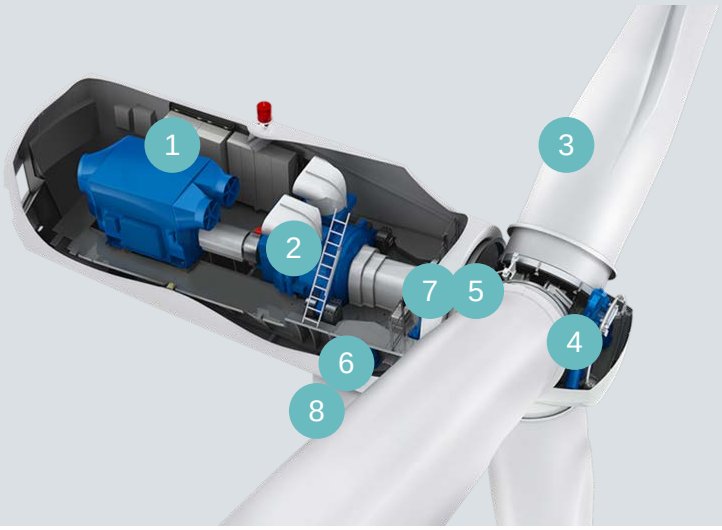
Senvion Technology

The 3.XM series features a well-proven modular and evolutionary technology concept. The smart and robust design results in a highly efficient and reliable turbine concept: from the aerodynamically optimized rotor

blade, compact and efficient drivetrain, advanced control technology right through to the transformer. This flawless interplay delivers high energy yields while keeping sound emissions low.

The NES platform - An electrical system for any grid requirements

Our turbines, which are equipped with the Next Electrical System (NES), already fulfil the grid requirements of tomorrow. All NES turbines are based on the tried and tested MM and 3.XM series construction concept.



Technical data

Design data

Nominal power	3,400 kW
Cut-in wind speed	3 m/s
Nominal wind speed	12.5 m/s
Cut-out wind speed	22 m/s
Operating temperature range	-20 – +40 °C

Certification

Hub	Wind class	DIBt

Electrical system

Nominal power	3,400 kW
Nominal voltage	580 V
Nominal frequency	50 Hz
Generator	Asynchronous generator (squirrel cage rotor)
Generator protection	IP 54

height		Wind zone
86 – 89 m	IEC S (based on IEC IIA)	WZ 4, GK II
116 – 119 m	IEC S (based on IEC IIIA)	WZ 3, GK II
136 – 139 m	IEC S (based on IEC IIIA)	WZ 3, GK II

Rotor

Diameter	122 m
Rotor area	11,690 m²
Rotor speed	6.1 – 11.3 1/min (+15 %)
Power control	Electrical pitch

Rotor blade

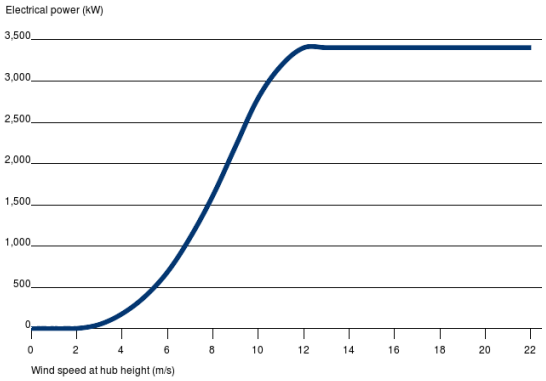
Blade length	59.8 m
Type	Glass fiber-reinforced plastic (GFRP)
Max. chord width	3.9 m

class	
Converter type	Full scale converter with direct voltage intermediate circuit

Sound power level

Maximum sound power level	104.5 db (A)

Power curve



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3.4M140 EBC

More renewable energy in the grid

The 3.4M140 EBC was developed for low-wind locations. With a rotor diameter of 140 m, a swept surface of 15,394 m² and hub heights between 110 and 130 meters, it achieves a 20% higher energy yield compared to our 3.0M122 turbine. The Eco Blade Control label (EBC) represents significant design and performance improvements including an extended operational lifespan of 25 years, a low, maximum sound power level of 104 dB(A) and a light-weight blade construction. The 3.4M140 EBC is also available as a cold-climate version which can be operated in extreme conditions at temperatures of down to -30°C.

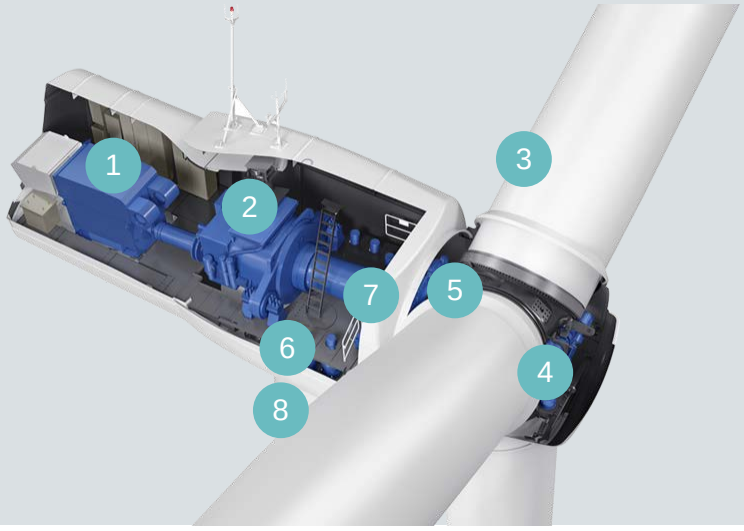
- Nominal power: 3,400 kW
- Rotor diameter: 140 m
- Hub height: 110 / 130 m
- Wind class: Low to Medium Wind
- Operating temperature range: -20 – +40 °C
- Rotor surface: 15,394 m²

Senvion Technology

The 3.XM series features a well-proven modular and evolutionary technology concept. The smart and robust design results in a highly efficient and reliable turbine concept: from the aerodynamically optimized rotor blade, compact and efficient drivetrain, advanced control technology right through to the transformer. This flawless interplay delivers high energy yields while keeping sound emissions low.

The EBC platform - Dependable, durable and suitable for higher wind classes

The Eco Blade Control generation of turbines, based on the EBC platform, was introduced in 2015. It boasts high yields at low-wind locations, an outstanding operational lifespan of 25 years, and a low sound power level. Light weight construction of the blade due to our Rodpack Technology and an advanced load management technology completes the benefits of this turbines.



Technical data

Design data

Nominal power	3,400 kW
Cut-in wind speed	3 m/s
Nominal wind speed	11 m/s
Cut-out wind speed	22 m/s
Operating temperature range	-20 – +35 °C
Operating temperature range optional	-30 – +40 °C

Certification

Hub height	Wind class	DIBt Wind zone
110 m	IEC IIIA	-
130 m	IEC IIIA	-

Rotor

Diameter	140 m
Rotor area	15,394 m²
Rotor speed	6.3 – 9.6 1/min (+25 %)
Power control	Electrical pitch

Rotor blade

Blade length	68.5 m
Type	Glass fiber-reinforced plastic (GFRP)
Max. chord width	4 m

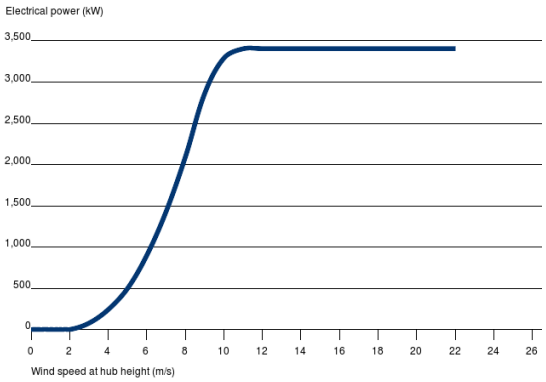
Electrical system

Nominal power	3,400 kW
Nominal voltage	750 V
Nominal frequency	60 Hz
Generator	Induction generator (squirrel cage rotor)
Generator protection class	IP 54
Speed range	780 – 1,440 1/min
Converter type	Full converter with DC intermediate circuit

Sound power level

Maximum sound power level	104 db (A)

Power curve



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3.6M140 EBC

A Power Boost for the Leading Model

The predecessor of this model, the 3.4M140 Eco Blade Control (EBC), already offered a yield more than 20 percent higher than other turbines in the 3 MW class. The latest increase in nominal power to 3,600 kilowatts enables a further 3 percent potential increase in yield. Moreover, the turbine is suitable for locations assigned wind class IEC IIIA and IECS based on IEC IIB. The new hub height of 160 meters has a higher energy yield to match and enables efficient operation even in locations with low winds.

- Nominal power: 3,600 kW
- Rotor diameter: 140 m
- Hub height: 107 - 163 m
- Wind class: Low to Medium Wind
- Operating temperature range: -20 – +35 °C
- Rotor surface: 15,394 m²

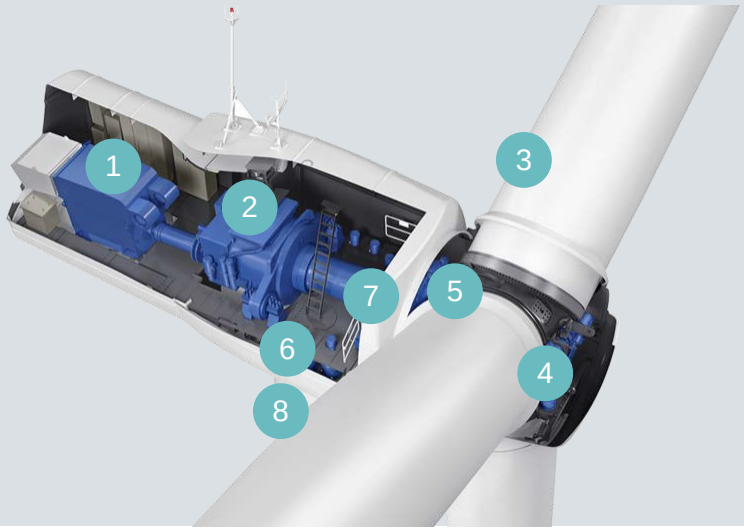
Senvion Technology

The 3.XM series features a well-proven modular and evolutionary technology concept. The smart and robust design results in a highly efficient and reliable turbine

concept: from the aerodynamically optimized rotor blade, compact and efficient drivetrain, advanced control technology right through to the transformer. This flawless interplay delivers high energy yields while keeping sound emissions low.

The EBC platform - Dependable, durable and suitable for higher wind classes

The Eco Blade Control generation of turbines, based on the EBC platform, was introduced in 2015. It boasts high yields at low-wind locations, an outstanding operational lifespan of 25 years, and a low sound power level. Light weight construction of the blade due to our Rodpack Technology and an advanced load management technology completes the benefits of this turbines.



Technical data

Design data

Nominal power	3,600 kW
Cut-in wind speed	3 m/s
Nominal wind speed	11 m/s
Cut-out wind speed	22 m/s
Operating temperature range	-20 – +40 °C

Electrical system

Nominal power	3,600 kW
Nominal voltage	600 V
Nominal frequency	50 Hz
Generator	Asynchronous generator

Certification

Hub height	Wind class	DIBt Wind zone
107 – 110 m	IEC S (based on IEC IIB)	WZ 3, GK II
127 – 130 m	IEC IIIA	WZ 2, GK II
157 – 160 m	IEC IIIA	WZ 2, GK II

Rotor

Diameter	140 m
Rotor area	15,394 m²
Rotor speed	6.3 – 9.6 1/min (+25 %)
Power control	Electrical pitch

Rotor blade

Blade length	68.5 m
Type	Glass fiber-reinforced plastic (GFRP)
Max. chord width	4 m

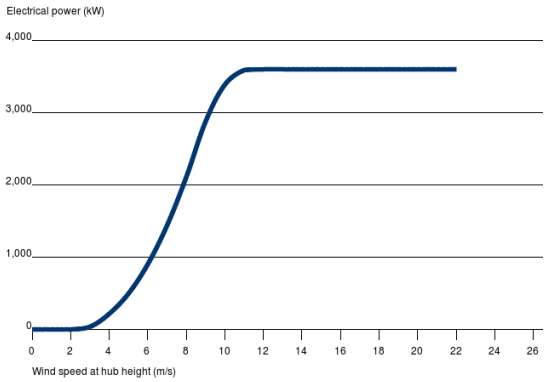
(squirrel cage rotor)

Generator protection class	IP 54
Converter type	Full scale converter with direct voltage intermediate circuit

Sound power level

Maximum sound power level	104 db (A)

Power curve



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SIEMENS

Wind Turbine SWT-2.5-120

Technical specifications

Product Name: SWT-2.5-120
Application: Onshore
Technology: Geared drive
Wind Class: IIS

Operating data

Rated power	2.5 MW
Cut-in wind speed	3 m/s
Cut-out wind speed	22 m/s
Nominal power at	11-12 m/s
Operating (range) rotational speed	5.5-13.1 m
Wind class	IEC IIS

Power regulation

Power regulation	Pitch regulation with variable speed

Sound power

Sound power	Alternative noise modes available dependent on site and country

Rotor

Diameter	120 m
Swept area	11,310 m^2
Blade length	59 m
Max. chord	3.8 m

Aerodynamic brake

Type	Full span pitching
Activation	Active, hydraulic

Product Name: SWT-2.5-120
Application: Onshore
Technology: Geared drive
Wind Class: IIS

Generator

Type	Asynchronous
Voltage	690 V
Frequency	50 Hz and 60 Hz

Mechanical brake

Type	Hydraulic disc brake
Position	Gearbox high speed shaft

Controller

Type	Microprocessor
SCADA system	WPS

Lightning protection

Lightning protection	In compliance with IEC 61400-24

Tower

Type	Tubular steel tower
Hub height	85.1 m

Published by
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Summary: Application Exhibit A - Turbine brochures electronically filed by Mr. Ryan D. Elliott on behalf of Buckeye Wind LLC and Champaign Wind LLC