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.

www.gerenewableenergy.com

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GEA32208B (11/2017)

*The **POWER PACKAGE** for successful projects*

DELTA4000

MAXIMUM FLEXIBILITY. MAXIMUM OUTPUT.

N149/4.0-4.5

NORDEX

acciona Windpower

OPTIMISED YIELDS
Through flexible site adjustments

In developing the N149/4.0-4.5, there was one primary focus: the sustainable reduction of electricity generation costs (COE). In comparison to the N131/3600, the N149/4.0-4.5 achieves up to 28 per cent higher yields at locations with light to moderate wind speeds. This is a significant improvement that maximises the chances of success in auction processes.

Highest efficiency

The rotor diameter has been enlarged by 18 metres, to 149 metres, compared to the largest rotor of the Delta Generation. This means the rotor sweep has been increased by 30 per cent – for maximum efficiency in areas with light to moderate wind speeds. While the aerodynamic shape of the rotor blade has been adapted to meet the new requirements, the construction of the one-piece blade has remained essentially the same.

Flexible site adjustments

As the maximum output of the turbine varies between 4.0 and 4.5 megawatts, it is ideal for adapting to the grid operator's individual requirements, local wind conditions and noise restraints. This also means that it's possible to optimise the overall yield of a wind farm by means of the different maximum output of individual turbines, thus always exploiting the full potential of each turbine position within each single wind farm. This is an advantage, among other things, with large-scale projects that often come with different wind conditions and complex topography.

Acoustically optimised operating modes

The N149/4.0-4.5 can master particularly demanding locations thanks to different operating modes. Its sound power level ranges from 103.6 to 106.1 decibels, depending on the maximum output. When operated at a reduced output level, the sound power reaches a maximum level of 96.5 decibels.

Advantages at a glance

- **+ 28% improved output**
- **+ 30% enlarged rotor area**
- **Site-specific performance modes available from 4.0 to 4.5 MW**
- **103.6 dB(A) at a nominal power level of 4.0 MW**
- **Service life of up to 25 years possible, depending on the site**

PROVEN CONCEPTS
One step ahead through experience

With the Delta4000 product line, the Nordex Group relies on tried-and-tested series-production technology, based on experience of the Delta Generation. The Nordex Group currently has an installed capacity of 1 gigawatt of this platform in operation and more than 1 gigawatt is in installation. In the process, we remain faithful to established principles and attach great importance to the reliability of all system components.

Electrical system maintained

Nordex had already equipped the first multi-megawatt system with a double-fed asynchronous generator and a partial converter in the year 2000. With the Delta4000 product line, we have remained faithful to this proven and highly economical electrical system.

Reliable drivetrain concept

The drivetrain concept is based on a modular build system with three-point suspension. We have successfully implemented this system from the very outset. Together with our qualified suppliers, we are continuously enhancing our drivetrain components. This not only ensures the required performance, but also a high degree of availability.

Over 1 GW in worldwide installations of the Delta platform

Grid compatibility guaranteed

Like its predecessor generation, the turbines of the Delta4000 product line meet the grid requirements of international markets. In addition, they provide grid-stabilising system services.

Tapping into colder locations

The proven Nordex Cold Climate Package enables particularly cold locations to be developed. Turbines of the cold climate variant (CCV) are operational in outside temperatures of down to minus 30 degrees Celsius and can also be equipped with the proven rotor blade anti-icing system.

N149/4.0-4.5
For light- and medium-wind locations

For the Delta4000 product line, we took over the Delta Generation's fundamental design and transferred it to the 4 megawatt class, with the help of performance-enhancing concept adaptations. At the same time, we kept an eye on consequently reducing electricity generation costs.

New dimensions
With a rotor sweep of 17,460 square metres and a nominal output of 4.0 to 4.5 megawatts, the N149/4.0-4.5 achieves output gains of up to 28 per cent. The variable generator setting permits the individual customisation of each turbine to the site conditions, thereby improving the overall output of the wind park.

Optimised power transfer
Unlike the Delta Generation, the converter and transformer are no longer located in the tower base, but in the nacelle. This minimises electrical losses and simplifies installation efforts in the field.

More powerful yaw system
The yaw concept has been adapted for the increased nominal output and the larger rotor. Two additional drive systems compensate for the stronger loads acting on the system.

Reduced service effort
The technical concept of the N149/4.0-4.5 minimises service requirements over its entire service life. We rigorously designed each component for lower maintenance effort. In addition, the turbine provides a mobile crane solution for replacing components.

TECHNICAL DATA

	N149 / 4.0-4.5
Operating data	
Rated power	4,000–4,500 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	20 m/s
Rotor	
Diameter	149.1 m
Swept area	17,460 m²
Operating range rotational speed	6.4–12.3 rpm
Rated rotational speed	9.8–11.0 rpm
Tip speed	76.5–86.0 rpm
Speed control	Variable via microprocessor
Overspeed control	Pitch angle
Gearbox	
Type	3-stage gearbox (planetary-planetary-spur gear)
Generator	
Construction	Doubly fed asynchronous generator
Cooling system	Liquid/air cooling
Voltage	660 V
Grid frequency	50/60 Hz
Brake system	
Main brake	Aerodynamic brake (pitch)
Holding brake	Disc brake
Lightning protection	Fully compliant with IEC 61400-24
Hub height	
	105 m/IEC S, DIBt S 125 m/IEC S, DIBt S 164 m/IEC S, DIBt S

Compared to the N131 / 3600, the N149 / 4.0-4.5 generates additional annual yields of up to 28 per cent.

Calculation of AEP based on air density of 1.225 kg/m³, wind shear of 0.2 and Weibull shape parameter of k = 2.0

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As of: 09 / 2017

For contact details please visit our homepage

NORDEX

acciona Windpower

4.XM series
Evolution incites revolution

SENVION
wind energy solutions

4.2M140

Design data	
Nominal power	4200 kW
Cut-in wind speed	3.0 m/s
Cut-out wind speed	22.0 m/s
Operating temperature range	-20°C to 45°C

Certification	
Hub height	**Wind class**
project specific	IEC S (based on IIB)

Rotor	
Rotor area	15,394 m²
Rotor speed	4.6 - 10.5 min^{-1}
Power control	Electrical Pitch System
Rotor diameter	140 m

Rotor blade	
Blade length	68.5 m
Type	Glass-fiber reinforced plastic (GRP)

Electrical system	
Generator	Squirrel cage induction generator
Generator protection class	IP54
Nominal speed	1650 min^{-1}
Converter type	Full converter with DC intermediate circuit

Sound power level	
Maximum sound power level	approx. 105 dB (A)

The product data is preliminary and can change.

4.2M148

Design data	
Nominal power	4200 kW
Cut-in wind speed	3.0 m/s
Cut-out wind speed	22.0 m/s
Operating temperature range	-20°C to 45°C

Certification	
Hub height	**Wind class**
project specific	IEC S based on IIIB

Rotor	
Rotor area	17,203 m²
Rotor speed	5.0 - 10.5 min^{-1}
Power control	Electrical Pitch System
Rotor diameter	148 m

Rotor blade	
Blade length	72.5 m
Type	Glass-fiber reinforced plastic (GRP)

Electrical system	
Generator	Squirrel cage induction generator
Generator protection class	IP54
Nominal speed	1650 min^{-1}
Converter type	Full converter with DC intermediate circuit

Sound power level	
Maximum sound power level	approx. 105 dB (A)

The product data is preliminary and can change.

Evolution incites revolution – meet our 4.XM series

Our 4 MW series is based on our innovative 3.XM EBC platform and generates more power at low and medium wind sites.

With an updated gearbox design, significantly longer blades and an advanced pitch bearing, as well as a generator and full converter system, the 4.2M140 and 4.2M148 stand for more efficiency, higher availability and lower service costs.

It´s all about evolution: Our proven and robust technology, experience and substantial track-record bring trust, reliability, and more power to our customers.

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Please contact the relevant company within the Senvion Group to check the availability of a given product in your country.

Last updated 05/2018

SG 4.2-145
New SGRE turbine with the best-in-class LCoE >4 MW

SIEMENS Gamesa
RENEWABLE ENERGY

First onshore launch of SGRE. Medium-wind design covering a broad range of sites

SG 4.2-145: low technological risk based on Siemens Gamesa's broad know-how of wind turbine technology

Siemens Gamesa, your trusted technological partner

One of the key aspects to Siemens Gamesa's success is the continuous development of new and advanced products adapted to the business case of every customer. We strive to provide the best technological solutions for each project, while driving down the LCoE. We know that needs vary greatly. In response to those needs, we offer an extensive catalog of proven solutions for different site conditions and financial performance indicators. Our solutions are backed by:

- Our reputation as a trusted and stable partner (+84.5 GW installed worldwide).
- A proven track record spanning over 35 years that makes Siemens Gamesa a benchmark for wind projects.
- The recognition of the wind power sector.

AEP increase SG 4.2-145 vs. SG 3.4-132 (preliminary)

Swept area increase

New SG 4.2-145 wind turbine

The SG 4.2-145 is the first Siemens Gamesa onshore product launch and the first proposal of the Siemens Gamesa 4.X platform. Exemplar of a new generation of turbines, it is based on the operational experience accumulated by the company in the wind power market, and on the application of proven technological solutions. This new model fits into our catalog with a clear objective: to complement the product offer in the markets in which our clients require solutions with nominal powers greater than 4 MW, and with an excellent Cost of Energy. Given these premises and based on a design optimized for medium-wind speeds, its modularity and flexibility enable it to adapt to a wide range of sites.

Proven Siemens Gamesa technology

The knowledge acquired through our latest products, specifically in the optimization of design and industrialization processes, has been a key factor in the development of the SG 4.2-145 turbine. Siemens Gamesa has adopted proven technologies into this model, such as the combination of a three-stage gearbox (two planetary and one parallel) and a doubly-fed induction generator, greatly reducing technological risks. The inclusion of an optional premium converter also allows for compliance with the most demanding grid connection requirements.

It also has a new 71-meter blade made of fiberglass reinforced with epoxy resin, and integrates the aerodynamics and noise reduction know-how of Siemens legacy turbines. This is how, thanks to the incorporation of DinoTails® Next Generation technology, the SG 4.2-145 turbine guarantees a high production of energy and reduced noise emission levels.

Greater efficiency and profitability

The SG 4.2-145 model includes control technology and strategies from the Siemens legacy, which optimize the efficiency of the wind turbine depending on the site conditions. It offers a flexible power rating between 4.0 MW and 4.5 MW depending on the noise requirements, temperature and electrical properties of the project. With an increase of 21% of the swept area, and more than 21% of AEP over the SG 3.4-132 wind turbine, this new model will become a reference in the market for its high levels of efficiency and profitability.

The first SG 4.2-145 prototype installation is planned for 2018, and the Type Certificate is expected for the first half of 2019.

Technical specifications

General details	
Rated power	4.2 MW
Wind class	IEC IIA
Control	Pitch and variable speed
Standard operating temperature	Range from -20ºC to 35ºC [1]
Rotor	
Diameter	145 m
Swept area	16,513 m^2
Rotational speed	10.77 rpm
Power density	254.35 W/m^2
Blades	
Length	71 m
Airfoils	Siemens Gamesa
Material	Fiberglass reinforced with epoxy resin
Tower	
Type	Multiple technologies available
Height	107.5, 127.5, 157.5 m and site-specific
Gearbox	
Type	3 stages
Ratio	1:103.99 (50 Hz) 1:124.79 (60 Hz)
Generator	
Type	Doubly-fed induction machine
Voltage	690 V AC
Frequency	50 Hz/60 Hz
Protection class	IP 54
Power factor	0.9 CAP-0.9 IND throughout the power range [2]

[1] Different versions and optional kits are available to adapt machinery to high or low temperatures and saline or dusty environments.

[2] Power factor at generator output terminals, on low voltage side before transformer input terminals.

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02/2018

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 90 GW of installed capacity in 77 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 17 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

+63,000

The V112-3.45 MW® and the other 4 MW variants advance the already proven technology powering over 63,000 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			Standard IEC conditions
V112-3.45 MW® IEC IA			Standard IEC conditions
V117-3.45 MW® IEC IB/IEC IIA		Standard IEC conditions	Standard IEC conditions
V117-4.2 MW™ IEC IB/IEC IIA/IEC S		Standard IEC conditions	Standard IEC conditions
V126-3.45 MW® IEC IIA/ IEC IIB	Standard IEC conditions	Standard IEC conditions	Site dependent
V136-3.45 MW® IEC IIB/ IEC IIIA	Standard IEC conditions	Standard IEC conditions	Site dependent
V136-4.2 MW™ IEC IIB/IEC S	Standard IEC conditions	Standard IEC conditions	Site dependent
V150-4.2 MW™ IEC IIIB/IEC S	Standard IEC conditions	Site dependent	

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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