# ANNEXE 7 - DESCRIPTIFS ET PERFORMANCES DES AÉROGÉNÉRATEURS

Vestas

# 2 MW PLATFORM

## 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.

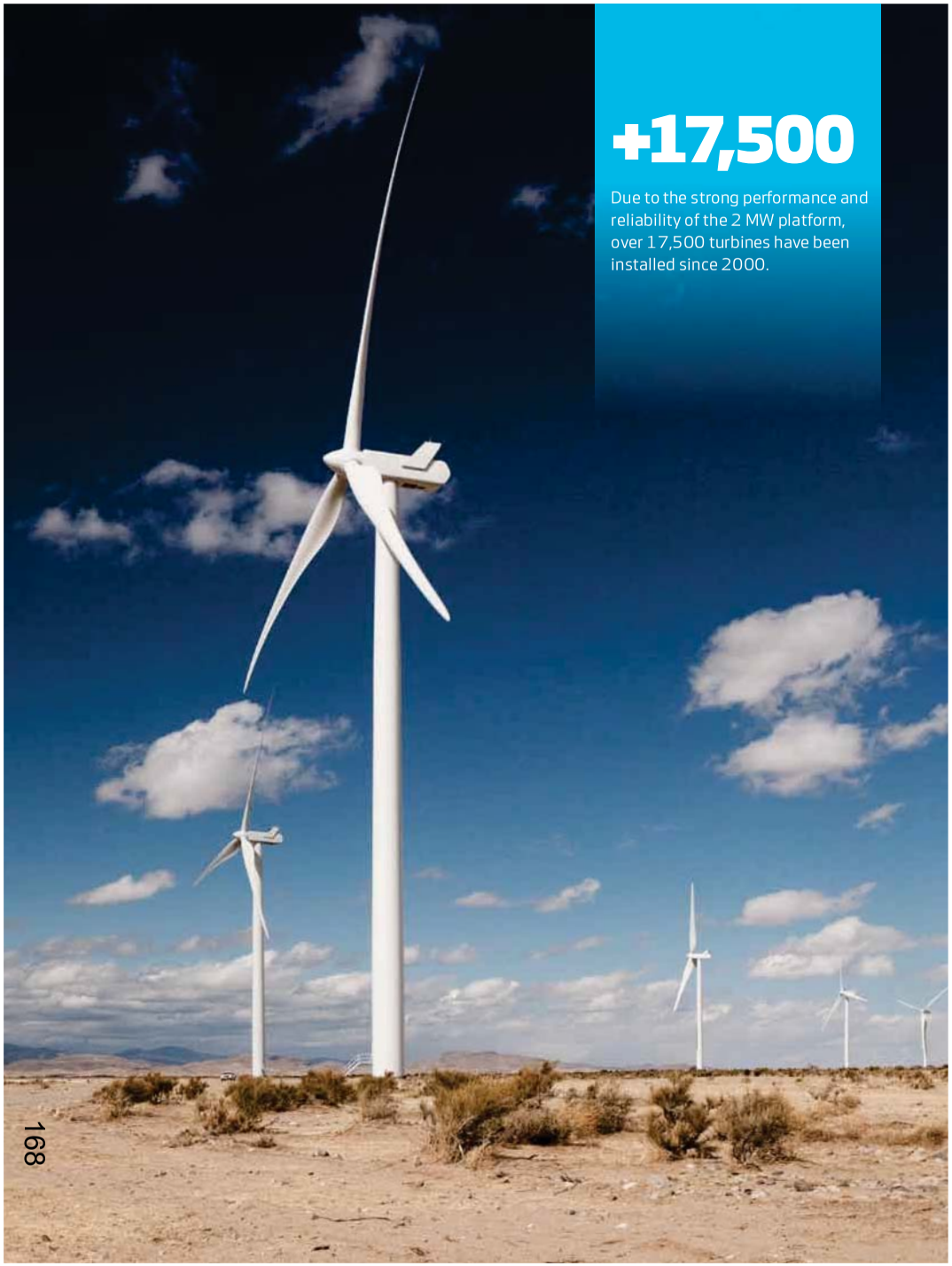
These aren't idle words. We have over 35 years' experience in wind energy. During that time, we've delivered more than 77 GW of installed capacity and we currently monitor over 33,000 wind turbines across the globe. Tangible proof that Vestas is the right partner to help you realise the full potential of your wind site.

**What is the 2 MW platform?**
Our 2 MW platform provides industry-leading reliability, serviceability and availability. Durable and dependable, the platform is built on technology that has been proven in the field over more than a decade. The 2 MW platform reduces your costs, minimises the risk of turbine downtime and helps to safeguard your investment.

You can choose from four turbines on the 2 MW platform:
- V90-1.8/2.0 MW® IEC IIA/IEC IIIA
- V100-1.8/2.0 MW™ IEC IIIA/IEC S
- V100-2.0 MW® IEC IIB
- V110-2.0 MW™ IEC IIIA

Each 2 MW turbine incorporates enhancements that improve performance and reliability, reducing your cost of energy. The platform's predictability allows you to forecast confidently, strengthening the business case for investment, while the tried-and-tested design ensures you can produce energy on low, medium and high-wind onshore sites at the lowest possible cost, even in extreme weather conditions. In addition, remote monitoring and easy servicing keep operational costs at a minimum, while its highly-tested components and power and control systems enhance reliability.

**Wind.** It means the world to us.™



**+17,500**

Due to the strong performance and reliability of the 2 MW platform, over 17,500 turbines have been installed since 2000.

# How does the 2MW platform increase **reliability** and **performance?**

Created with future generations of turbines in mind, the 2 MW platform's single-piece bed frame and stronger main bearing housing provide a better foundation for loads. The toughened frame and housing – each made from single-piece castings – work in conjunction to absorb higher loads from the rotor.

Additionally, the housing ensures correct alignment during bearing assembly, making the process more accurate and efficient and distributing loads evenly. These improvements combine to increase production capabilities and reduce downtime.

**A reliable performer**
The 2 MW platform is an extremely reliable turbine, which is documented through its strong availability performance. With the newest addition of rotor size, the 2 MW platform offers a competitive selection of turbines for all wind segments.

**Thoroughly tested**
The current 2 MW platform is built on unique knowledge from more than a decade of operational experience. We constantly monitor the majority of the installed 2 MW turbines, providing us with very detailed and invaluable information about how the turbine operates under all kinds of site conditions.

Our quality-control system ensures that each component is produced to design specifications and performs to peak potential at site. We also employ a Six Sigma philosophy and have identified critical manufacturing processes (both in-house and for suppliers). We systematically monitor measurement trends that are critical to quality, locating defects before they occur.

**Innovative CoolerTop®**
Our exclusive CoolerTop® technology uses the wind's own energy to generate the cooling required, rather than consuming energy from the wind turbine generator. CoolerTop® has no moving parts and requires little maintenance. Furthermore, the absence of cooling fans contributes to turbine efficiency and makes no noise.

**Load and Power Modes increase energy output**
The 2 MW platform supports Load and Power Modes, used to maximise energy production under specific wind and site conditions. Based on a site analysis, turbines can be configured to run derated when wind conditions require it. Conversely, under mild wind conditions, the turbine can be uprated - maximising annual energy production.

The 2 MW platform covers a wide range of 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) |
|---|---|---|---|
| **2 MW TURBINES** | | | |
| V90-1.8/2.0 MW® IEC IIA/ IEC IIIA | ■ | ■ | ■ |
| V100-1.8/2.0 MW™ IEC IIIA/IEC S | ■ | | |
| V100-2.0 MW® IEC IIB | | ■ | ■ |
| V110-2.0 MW™ IEC IIIA | ■ | ■ | |

■ Standard IEC conditions ■ Site dependent

**Low Balance of Plant, installation and transportation costs**
At Vestas, we use technology tailored to control loads on specific tower heights. We have applied this principle to the 2 MW platform by reducing both the weight of the turbine and the loads on the tower and foundation. This reduces foundation costs, saving you unnecessary expense.

All 2 MW turbines are easy to transport (by rail, truck or ship) to virtually any site around the world. In terms of weight, height and width, all components comply with local and international standard transportation limits, ensuring you incur no unforeseen costs. In addition, 2 MW turbines are built and maintained using tools and equipment that are standard in the installation and servicing industries – minimising maintenance costs.

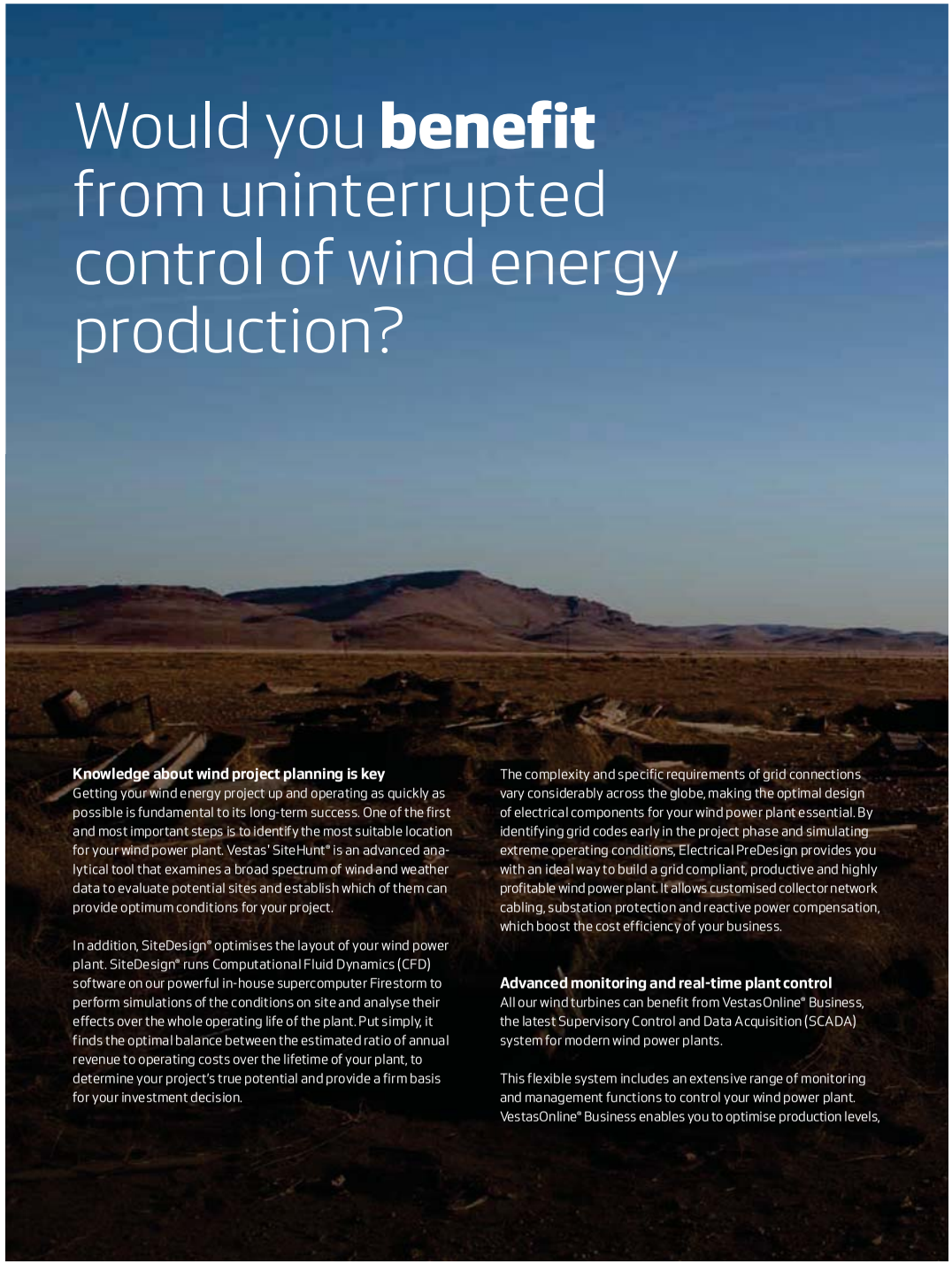
**Vestas Online® Business**
All Vestas wind turbines benefit from Vestas Online® Business, the latest Supervisory Control and Data Acquisition (SCADA) system for modern wind power plants. This flexible system includes an extensive range of monitoring and management functions to control your wind power plant in the same way as a conventional power plant. Vestas Online® Business enables you to optimise production levels, monitor performance, and produce detailed, tailored reports from anywhere in the world. The system's power plant controller provides active and reactive power regulation, power ramping and voltage control.

**24/7 remote surveillance with VMP Global® and Vestas Online® Business**
To reduce the cost of energy, the 2 MW platform is equipped with VMP Global®, our latest turbine control and operation software. Developed to run this latest generation of turbines, VMP Global®, combined with Vestas Online® Business, automatically manages the turbine 24/7 and ensures maximum power generation. The application also monitors and troubleshoots the turbines – both onsite and remotely – saving further expense on servicing.

**Designed for serviceability**
Service is facilitated by the overall design of the 2 MW platform and components are specifically positioned for easy access.

**Options available for the 2 MW platform**
- High Wind Operation
- Condition Monitoring System
- Vestas Ice Detection
- Smoke Detection
- Shadow Detection
- Low Temperature Operation to -30°C
- Aviation Lights
- Aviation Markings on the Blades
- Obstacle Collision Avoidance System (OCAS™)





# 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 trouble-shooting. 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.

# V90-1.8/2.0 MW® IEC IIA/IEC IIIA

## Facts & figures

| | |
|---|---|
| **POWER REGULATION** | Pitch regulated with variable speed |

| **OPERATING DATA** | |
|---|---|
| Rated power | 1,800/2,000 kW |
| Cut-in wind speed | 4 m/s |
| Cut-out wind speed | 25 m/s |
| Re cut-in wind speed | 23 m/s |
| Wind class | IEC IIA/IEC IIIA |
| Standard operating temperature range from -20°C* to 40°C | |

| **SOUND POWER** | |
|---|---|
| Maximum | 104 dB* |
| * Noise modes available | |

| **ROTOR** | |
|---|---|
| Rotor diameter | 90 m |
| Swept area | 6,362 m² |
| Air brake | full blade feathering with 3 pitch cylinders |

| **ELECTRICAL** | |
|---|---|
| Frequency | 50/60 Hz |
| Generator type | 4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings |

| **GEARBOX** | |
|---|---|
| Type | two planetary stages and one helical stage |

| **TOWER** | |
|---|---|
| Hub heights | 80 m (IEC IIA), 95 m (IEC IIA), and 105 m (IEC IIA) |

| **NACELLE DIMENSIONS** | |
|---|---|
| Height for transport | 4 m |
| Height installed (incl. CoolerTop®) | 5.4 m |
| Length | 10.4 m |
| Width | 3.5 m |

| **HUB DIMENSIONS** | |
|---|---|
| Max. transport height | 3.4 m |
| Max. transport width | 4 m |
| Max. transport length | 4.2 m |

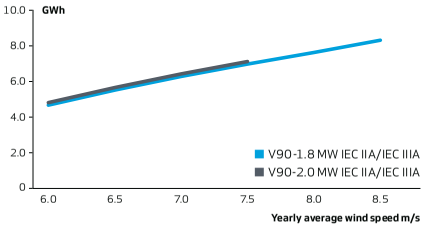
| **BLADE DIMENSIONS** | |
|---|---|
| Length | 44 m |
| Max. chord | 3.9 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- Condition Monitoring System
- Vestas Ice Detection
- Smoke Detection
- Shadow Detection
- Low Temperature Operation to -30°C
- Aviation Lights
- Aviation Markings on the Blades
- 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

# V100-1.8/2.0 MW™ IEC IIIA/IEC S
## Facts & figures

| | |
|---|---|
| **POWER REGULATION** | Pitch regulated with variable speed |

| **OPERATING DATA** | |
|---|---|
| Rated power | 1,800/2,000 kW |
| Cut-in wind speed | 3 m/s |
| Cut-out wind speed | 20 m/s |
| Re cut-in wind speed | 18 m/s |
| Wind class | IEC IIIA/IEC S |
| Standard operating temperature range from -20°C° to 40°C | |

| **SOUND POWER** | |
|---|---|
| Maximum | 105 dB* |
| * Noise modes available | |

| **ROTOR** | |
|---|---|
| Rotor diameter | 100 m |
| Swept area | 7,854 m² |
| Air brake | full blade feathering with 3 pitch cylinders |

| **ELECTRICAL** | |
|---|---|
| Frequency | 50/60 Hz |
| Generator type | 4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings |

| **GEARBOX** | |
|---|---|
| Type | two planetary stages and one helical stage |

| **TOWER** | |
|---|---|
| Hub heights | 80 m (IEC IIB/IEC S), 95 m (IEC IIIB/IEC S) and 120 m (IEC IIIA) |

| **NACELLE DIMENSIONS** | |
|---|---|
| Height for transport | 4 m |
| Height installed (incl. CoolerTop®) | 5.4 m |
| Length | 10.4 m |
| Width | 3.5 m |

| **HUB DIMENSIONS** | |
|---|---|
| Max. transport height | 3.4 m |
| Max. transport width | 4 m |
| Max. transport length | 4.2 m |

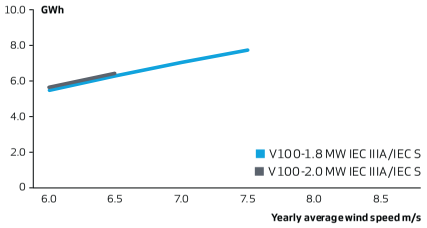
| **BLADE DIMENSIONS** | |
|---|---|
| Length | 49 m |
| Max. chord | 3.9 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- Condition Monitoring System
- Vestas Ice Detection
- Smoke Detection
- Shadow Detection
- Low Temperature Operation to -30°C
- Aviation Lights
- Aviation Markings on the Blades
- 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

# V100-2.0 MW® IEC IIB
## Facts & figures

| | |
|---|---|
| **POWER REGULATION** | Pitch regulated with variable speed |

| **OPERATING DATA** | |
|---|---|
| Rated power | 2,000 kW |
| Cut-in wind speed | 3 m/s |
| Cut-out wind speed | 22 m/s |
| Re cut-in wind speed | 20 m/s |
| Wind class | IEC IIB |
| Standard operating temperature range from -20°C° to 40°C | |

| **SOUND POWER** | |
|---|---|
| Maximum | 105 dB* |
| * Noise modes available | |

| **ROTOR** | |
|---|---|
| Rotor diameter | 100 m |
| Swept area | 7,854 m² |
| Air brake | full blade feathering with 3 pitch cylinders |

| **ELECTRICAL** | |
|---|---|
| Frequency | 50/60 Hz |
| Generator type | 4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings |

| **GEARBOX** | |
|---|---|
| Type | two planetary stages and one helical stage |

| **TOWER** | |
|---|---|
| Hub heights | 80 m (IEC IIB) and 95 m (IEC IIB) |

| **NACELLE DIMENSIONS** | |
|---|---|
| Height for transport | 4 m |
| Height installed (incl. CoolerTop®) | 5.4 m |
| Length | 10.4 m |
| Width | 3.5 m |

| **HUB DIMENSIONS** | |
|---|---|
| Max. transport height | 3.4 m |
| Max. transport width | 4 m |
| Max. transport length | 4.2 m |

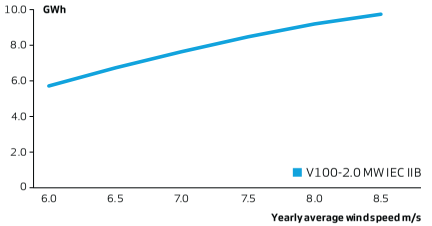
| **BLADE DIMENSIONS** | |
|---|---|
| Length | 49 m |
| Max. chord | 3.9 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- Power Mode (site specfic)
- Condition Monitoring System
- Vestas Ice Detection
- Smoke Detection
- Shadow Detection
- Low Temperature Operation to -30°C
- Aviation Lights
- Aviation Markings on the Blades
- 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

# V110-2.0 MW™ IEC IIIA
## Facts & figures

| | |
|---|---|
| **POWER REGULATION** | Pitch regulated with variable speed |

| **OPERATING DATA** | |
|---|---|
| Rated power | 2,000 kW |
| Cut-in wind speed | 3 m/s |
| Cut-out wind speed | 20 m/s |
| Re cut-in wind speed | 18 m/s |
| Wind class | IEC IIIA |
| Standard operating temperature range from -20°C* to 40°C | |

| **SOUND POWER** | |
|---|---|
| Maximum | 107.6 dB* |

*Noise modes available

| **ROTOR** | |
|---|---|
| Rotor diameter | 110 m |
| Swept area | 9,503 m² |
| Air brake | full blade feathering with 3 pitch cylinders |

| **ELECTRICAL** | |
|---|---|
| Frequency | 50/60 Hz |
| Generator type | 4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings |

| **GEARBOX** | |
|---|---|
| Type | two planetary stages and one helical stage |

| **TOWER** | |
|---|---|
| Hub heights | 80 m (IEC IIIA), 95 m (IEC IIIA/IEC IIIB), 110 m (IEC IIIB), 120 m (IEC IIIB) and 125 m (IEC IIIB) |

| **NACELLE DIMENSIONS** | |
|---|---|
| Height for transport | 4 m |
| Height installed (incl. CoolerTop®) | 5.4 m |
| Length | 10.4 m |
| Width | 3.5 m |

| **HUB DIMENSIONS** | |
|---|---|
| Max. transport height | 3.4 m |
| Max. transport width | 4 m |
| Max. transport length | 4.2 m |

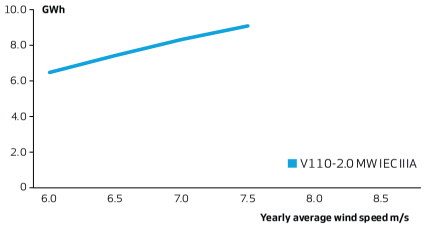
| **BLADE DIMENSIONS** | |
|---|---|
| Length | 54 m |
| Max. chord | 3.9 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- Power Mode (site specific)
- Condition Monitoring System
- Vestas Ice Detection
- Smoke Detection
- Shadow Detection
- Low Temperature Operation to -30°C
- Aviation Lights
- Aviation Markings on the Blades
- 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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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 35 years' experience in wind energy. During that time, we've delivered more than 77 GW of installed capacity in 75 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 3 MW Platform today?**
The 3 MW platform was introduced in 2010 with the launch of the V112-3.0 MW®. Over 11 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.

Since then 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 across the entire platform improving your energy production significantly.

With this expansion, the 3 MW platform covers all IEC wind classes with a variety of rotor sizes and a higher rated output power of 3.45 MW.

You can choose from the following turbines on the 3 MW platform:
- V105-3.45 MW™ – IEC IA
- V112-3.45 MW™ – IEC IA
- V117-3.45 MW™ – IEC IB/IEC IIA
- V126-3.45 MW™ – IEC IIB
- V126-3.45 MW™ – IEC IIA
- V136-3.45 MW™ – IEC IIB/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 superior grid performance.

Our 3 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.


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

**More power for every wind site**
V112-3.45 MW™, V117-3.45 MW™, V126-3.45 MW™ and V136-3.45 MW™ 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 10 per cent nominal power.

**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 58,000 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 V105-3.45 MW™, the V112-3.45 MW™ and on the V117-3.45 MW™. The industry known structural shell blades are used on the V126-3.45 MW™ and V136-3.45 MW™- a technology which is also used on the 2 MW V110-2.0 MW™ variant.

**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 3 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) |
|---|---|---|---|
| **3 MW TURBINES** | | | |
| V105-3.45 MW™ IEC IA | | | ■ |
| V112-3.45 MW™ IEC IA | | | ■ |
| V117-3.45 MW™ IEC IB/IEC IIA | | ■ | ■ |
| V126-3.45 MW™ IEC IIA | | ■ | ■ |
| V126-3.45 MW™ IEC IIB | ■ | ■ | |
| V136-3.45 MW™ IEC IIB/ IEC IIIA | ■ | ■ | |

■ Standard IEC conditions ■ Site dependent

**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:
- High Wind Operation
- Power Optimised Mode
- 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
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- 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 – five 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 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 3 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™, V126-3.45MW™ and 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 3 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, V126-3.45 MW™ IEC IIB, and V136-3.45 MW™ IEC IIB/ IEC IIIA are excellent turbine choices. A combination of the variants can optimise your site layout and improve your production significantly on complex sites.

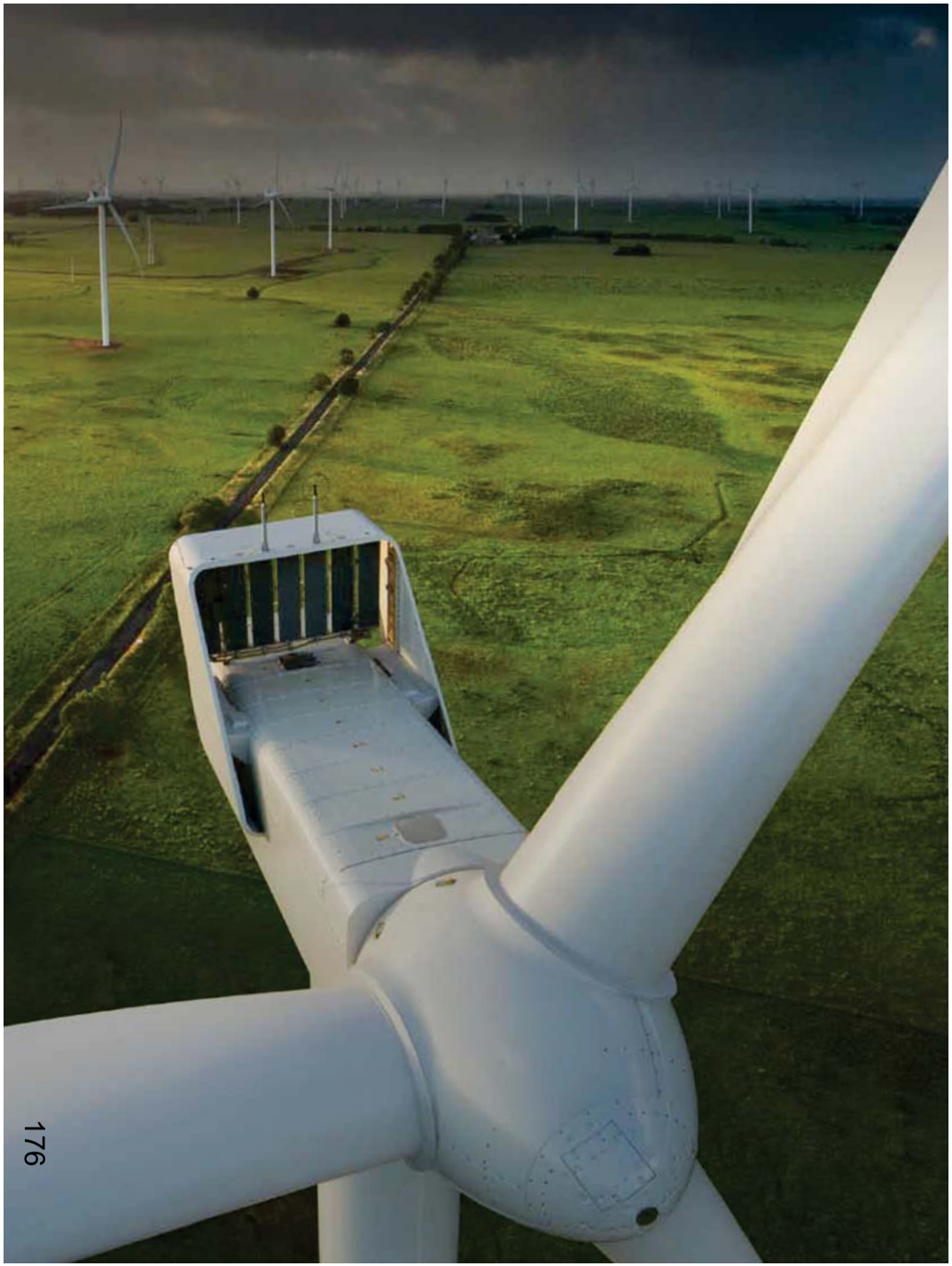
**Low-wind sites**
Built on the same proven technology as the V112-3.0 MW®, the V136-3.45 MW™ IEC IIB/ IEC IIIA is our best performer on low-wind sites. The larger rotor enable greater wind capture, which in turn produces more energy to reduce levelised cost of energy (LCOE). The result is exceptional 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 V136-3.45 MW™ is one of the highest producing low wind turbine available, some old permits may simply be too tight to accept it. Although the V117-3.45 MW™ and V126-3.45 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 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,

## +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 trouble-shooting. 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**

(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 | 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 |

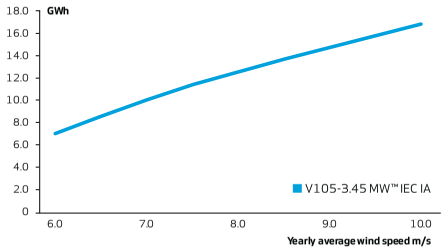
| **BLADE DIMENSIONS** | |
|---|---|
| Length | 51.2 m |
| Max. chord | 4 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- Power Optimised Mode
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Low Temperature Operation to -30°C
- Fire Suppression
- Shadow Detection
- Increased Cut-In
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- 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

# 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**
(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 | 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**

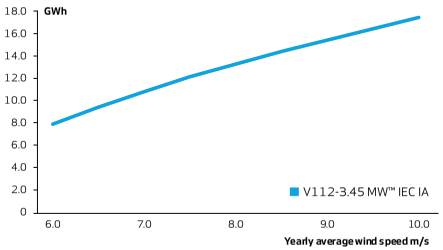
| | |
|---|---|
| Length | 54.7 m |
| Max. chord | 4 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- Power Optimised Mode
- 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
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- 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

# 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**
(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 | 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**

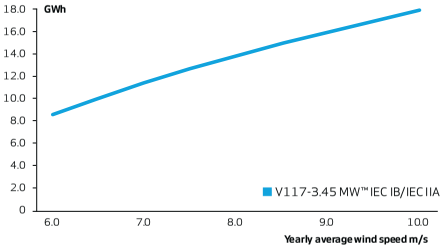
| | |
|---|---|
| Length | 57.2 m |
| Max. chord | 4 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- Power Optimised Mode
- 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
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- 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

# V126-3.45 MW™ IEC IIB
## 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 |

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 | 50/60 Hz |
| Converter | full scale |

**GEARBOX**

| | |
|---|---|
| Type | two planetary stages and one helical stage |

**TOWER**

| | |
|---|---|
| Hub heights | 87 m (IEC IIB), 117 m (IEC IIB) and 137 m (IEC IIIA) |

**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**

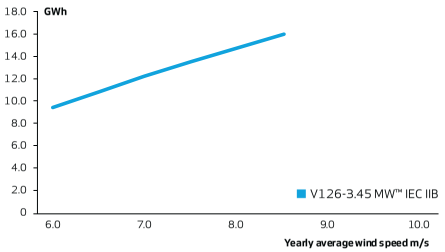
| | |
|---|---|
| Length | 61.7 m |
| Max. chord | 4 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- Power Optimised Mode
- 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
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- 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



# V126-3.45 MW™ 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 IIA |

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 | 50/60 Hz |
| Converter | full scale |

**GEARBOX**

| | |
|---|---|
| Type | two planetary stages and one helical stage |

**TOWER**

| | |
|---|---|
| Hub heights | 87 m (IEC IIA), 117 m (IEC IIA/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**

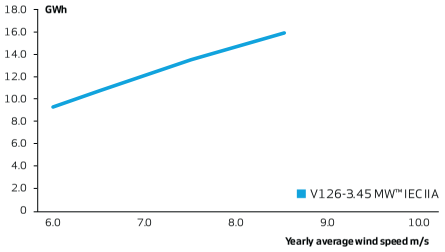
| | |
|---|---|
| Length | 61.7 m |
| Max. chord | 4 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- Power Optimised Mode
- 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
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- 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

# 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**

(Noise 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**

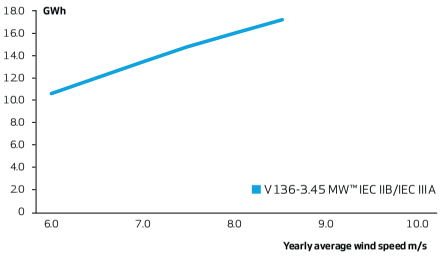
| | |
|---|---|
| Length | 66.7 m |
| Max. chord | 4.1 m |

| | |
|---|---|
| Max. weight per unit for transportation | 70 metric tonnes |

**TURBINE OPTIONS**

- High Wind Operation
- 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
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- 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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10/2016-EN

# Senvion Product Portfolio
# Portfolio Introduction

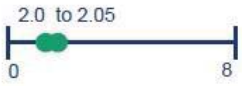
SENVION
wind energy solutions

## MM series

**Comments**

- **MM82:** maximum energy yields in **high wind location** also suitable for height restricted locations.
- **MM92:** best-selling wind turbine model suitable for **medium and low wind locations**
- **MM100:** with high capacity factor - wind power system for **low wind speed locations**

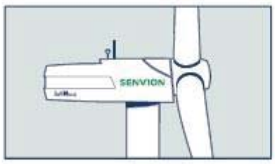
**Rated power (MW)**




**Certification**

**MM82:** up to IEC IA
**MM92:** up to IEC S (based on IB)
**MM100:** up to IEC IIB
up to IEC S (based on IIIA)

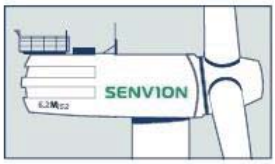
## 3.XM series



- **3.4M104:** advanced turbine for **high and medium wind speeds**
- **3.4M114: improved performance** for medium wind speeds - available with hybrid and steel tower solution even above 100m
- **3.2M114VG:** available with hybrid tower and hub **heights up to 143m** - providing optimal yields even on difficult terrain
- **3.0M122:** maximum efficiency at **low-wind sites** with a rotor diameter of 122m.


**3.4M104:** up to IEC IB
**3.4M114:** up to IEC IIA
**3.2M114VG:** up to IEC IIA
**3.0M122:** IEC IIIA
**3.2M122:** IEC IIIA
**3.4M140:** IEC IIIA

## 6.XM series




- **6.2M126:**
  Tried and tested performance to match the challenges of large **offshore wind farms** and deep waters
- **6.2M152:**
  Optimised performance to provide **20 per cent increased yield** and 25 year life time for offshore projects


**6.2M126**
Onshore: IEC IB, IEC IIA
Offshore: IEC IB, S

**6.2M152**
Onshore: IEC IB
Offshore: IEC S


SENVION
wind energy solutions

## Wind turbines 3.XM-Series
### Portrait

SENVION wind energy solutions

| 3.0M122 | |
|---|---|
| Rated Power: | 3.000 kW |
| Rotor: | 122m |
| Swept Area: | 11,690m² |
| Hub Heights: | 119 m 50 Hz (IEC IIIA, DIBt WZ 3) |
| Electrical System: | Asynchronous Generator (DFIG)<br>Internal Transformer System |
| Operating Temperature: | -20° C to +35° C (optional: +40° C) |
| Max. Logistical Weight: | < 60t (biggest component) |
| Sound Power Level: | 104.5 dB(A) |

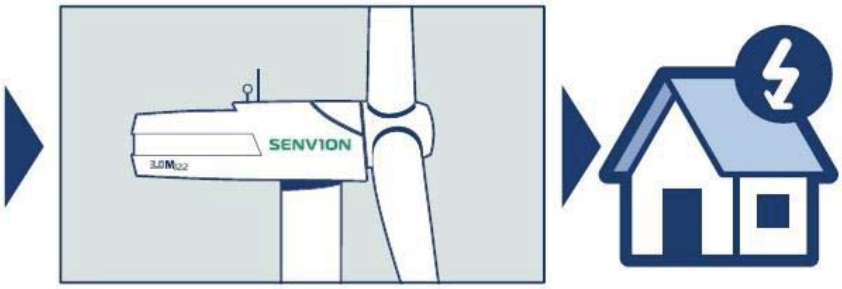
## Technology – product portfolio:
## An example calculation – Onshore 3.0M122

SENVION wind energy solutions

**How many households can be supplied by a 3.0M122 (3 MW) onshore wind turbine?**

**Rated output:**
**3 megawatts (MW)**

- Around 2,500 hours in full-load operation[1]
- 3,000 kilowatts x 2,500 hours
- = 7,500,000 kWh
- 7,500,000 kWh / 3,800 kWh[2]
- **= Approx. 2,000 households**



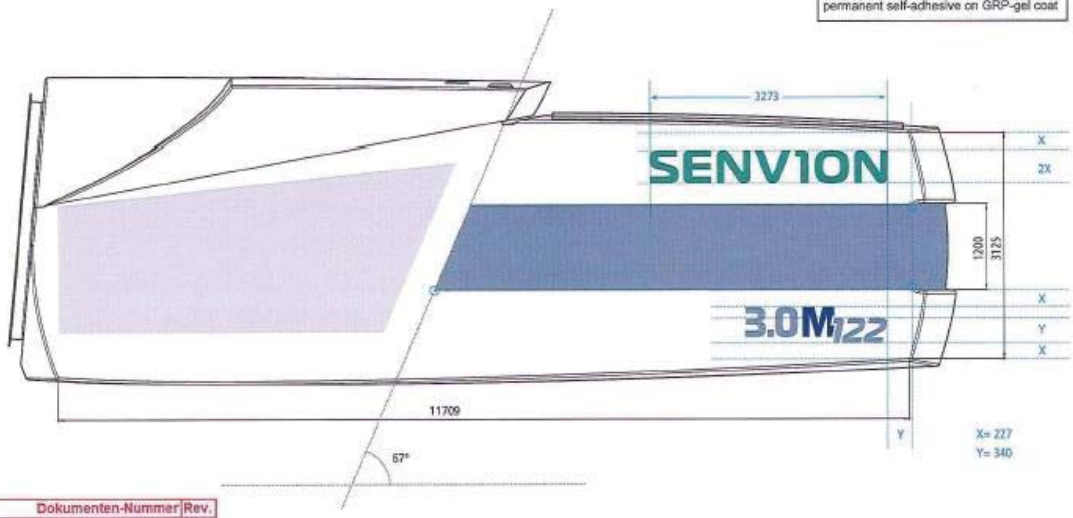

[1] May vary strongly depending on location
[2] Model calculation based on a three person household with an average consumption of electricity of 3,800 kilowatt-hours (kWh) per year

## Product branding / 3.0M122

Co-branding
normal colouring

| Colours | Figurative mark: | Product logo: |
|---|---|---|
| RAL 6024 Verkehrsgrün<br>RAL 5013 Kobaltblau<br>RAL 7046 Telegrau 2 | SE_PMS.eps | SE_3.0M122_PMS.eps |

Foil:
UV resistant, sea air- and weatherproof, permanent self-adhesive on GRP-gel coat

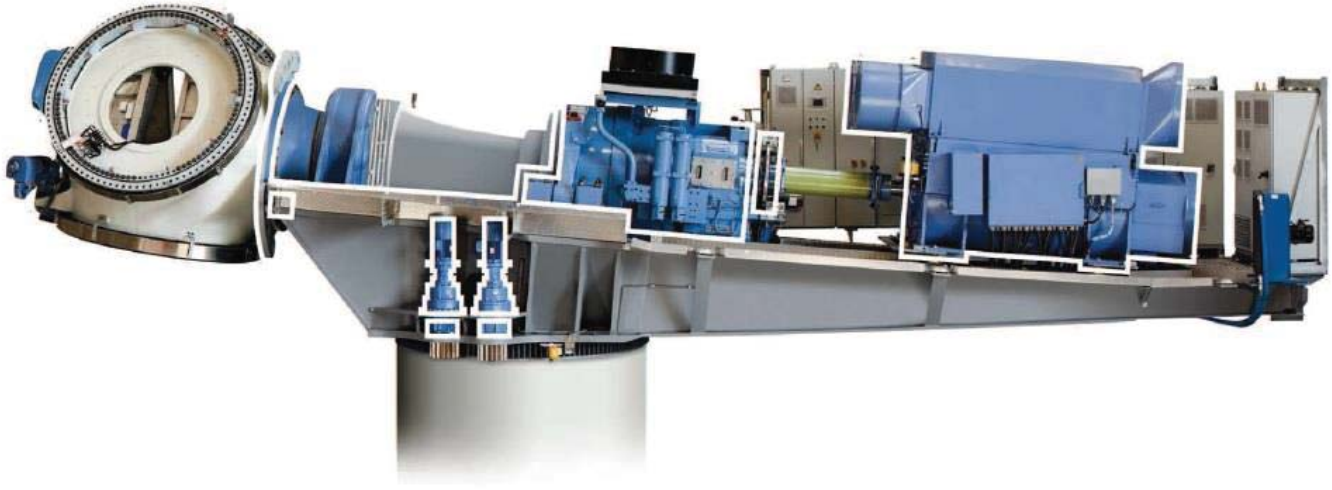


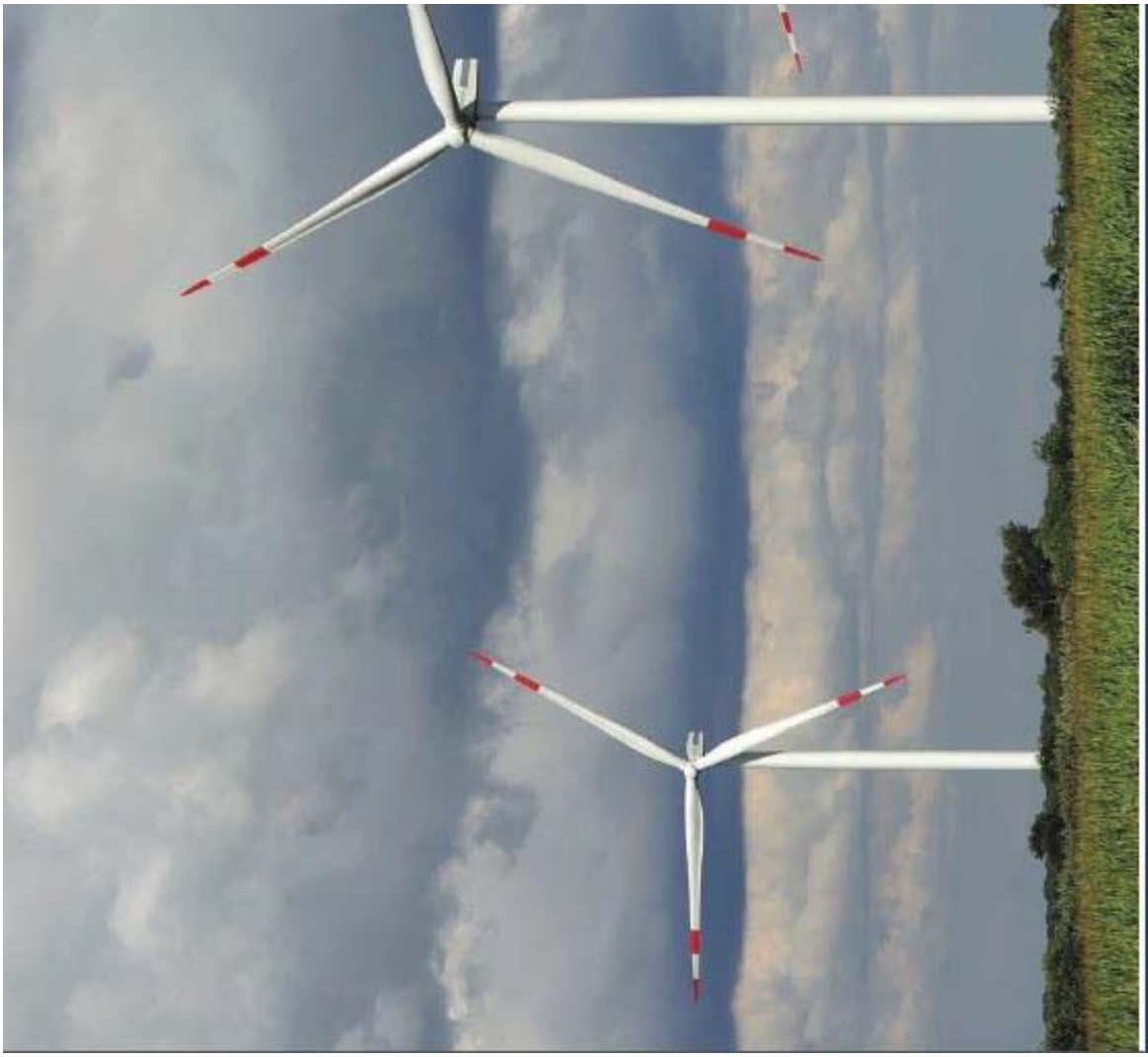

| Dokumenten-Nummer | Rev. |
|---|---|
| Z-3.5-GV.AT.32-B | A |
| Freigabe | Datum |
| | 03.12.2013 |
| Blatt 1/2 | |



## Wind turbine 3.XM
### Serviceability

SENVION
wind energy solutions







Status 09/2016

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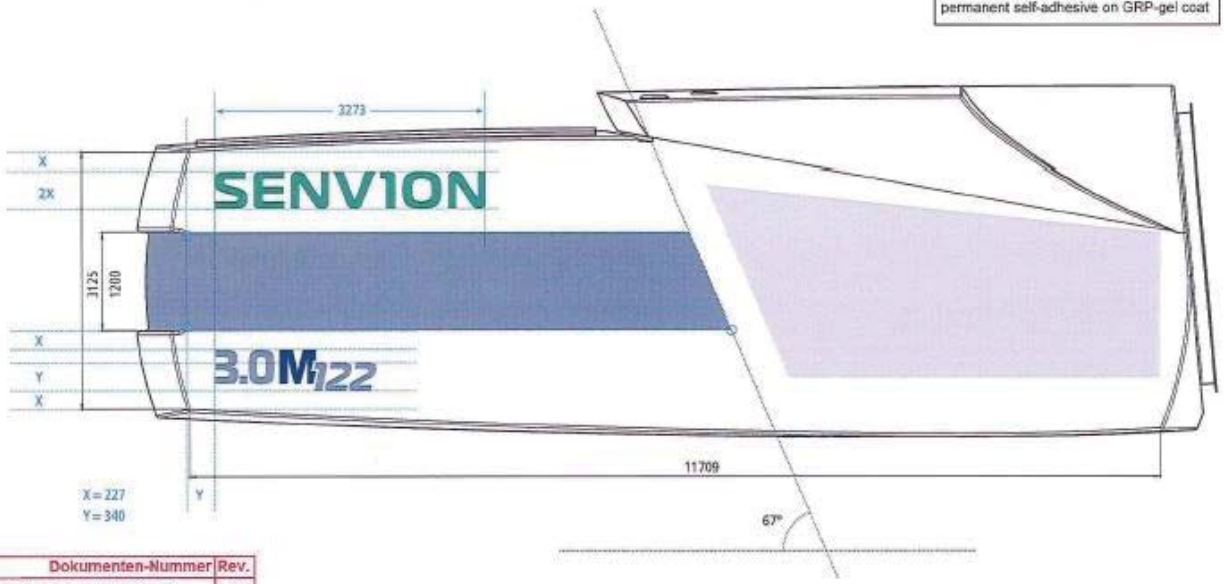
## Product branding / 3.0M122

Co-branding
normal colouring

| Colours | Figurative mark: | Product logo: |
|---|---|---|
| RAL 6024 Verkehrsgrün<br>RAL 5013 Kobaltblau<br>RAL 7046 Telegrau 2 | SE_PMS.eps | SE_3.0M122_PMS.eps |

Foil:
UV resistant, sea air- and weatherproof, permanent self-adhesive on GRP-gel coat




| Dokumenten-Nummer | Rev. |
|---|---|
| Z-3.5-GV.AT.32-B | A |
| Freigabe | Datum |
| | 03.12.2013 |
| Blatt 2/2 | |