

**Appendix A: Vestas 126, 3.45 MW Series Wind Turbine Brochure**

**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 70 GW of installed capacity in 75 countries. That is more than 15 per cent of total wind turbine capacity installed globally – and over 15 GW more than our closest competitor. We currently monitor over 28,000 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<sup>®</sup>. Over 8 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 extent 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<sup>™</sup> – IEC IA
- V112-3.45 MW<sup>™</sup> – IEC IA
- V117-3.45 MW<sup>™</sup> – IEC IB/IEC IIA
- V126-3.45 MW<sup>™</sup> – IEC IIB
- V126-3.45 MW<sup>™</sup> – IEC IIA
- V136-3.45 MW<sup>™</sup> – IEC IIIA

All variants of the 3 MW platform are based on the proven technology of the V112-3.0 MW<sup>®</sup> 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.



**+56,000**

The V112-3.45 MW<sup>®</sup> and the other 3 MW variants advance the already proven technology powering over 56,000 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™, 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 56,000 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)
<b>3 MW TURBINES</b>			
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
V126-3.45 MW™ IEC IIA		Standard IEC conditions	Site dependent
V126-3.45 MW™ IEC IIB	Standard IEC conditions	Standard IEC conditions	
V136-3.45 MW™ IEC IIIA	Standard IEC conditions	Site dependent	

■ 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:

- 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™, V126-3.45 MW™ 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 and V126-3.45 MW™ IEC IIB 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 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,





# +28,000

The Vestas Performance and Diagnostics Centre monitors more than 28,000 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

(Noise modes dependent on site and country)

#### ROTOR

Rotor diameter	105 m
Swept area	8,659 m <sup>2</sup>
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
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#### TOWER

Hub height	72.5 m (IEC IA)
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#### 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

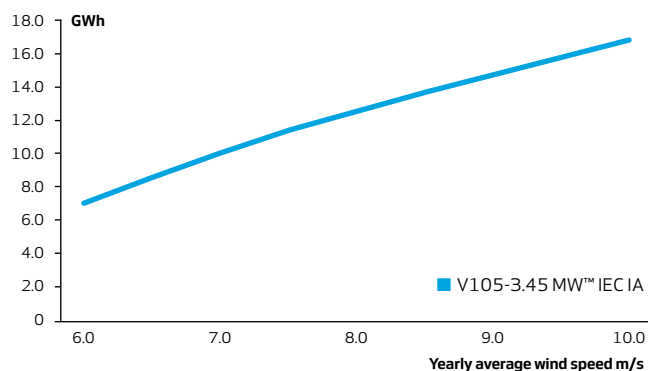
Length	51.2 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes
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#### TURBINE OPTIONS

- 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 m <sup>2</sup>
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
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#### TOWER

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

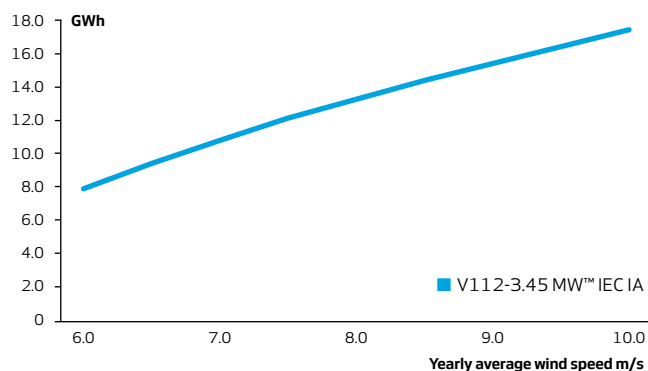
Length	54.7 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes
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#### TURBINE OPTIONS

- 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 m <sup>2</sup>
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
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#### TOWER

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

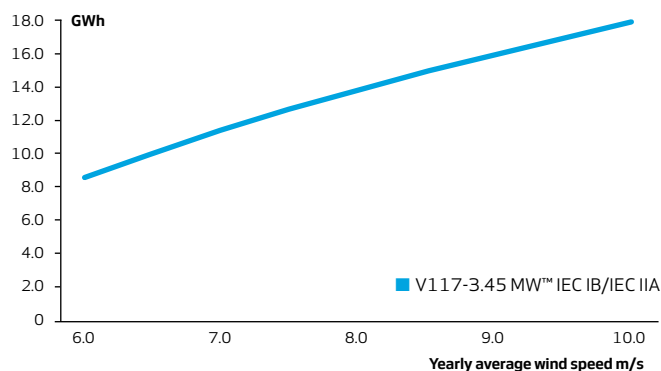
Max. weight per unit for transportation

70 metric tonnes

#### TURBINE OPTIONS

- 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 m <sup>2</sup>
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
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#### TOWER

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

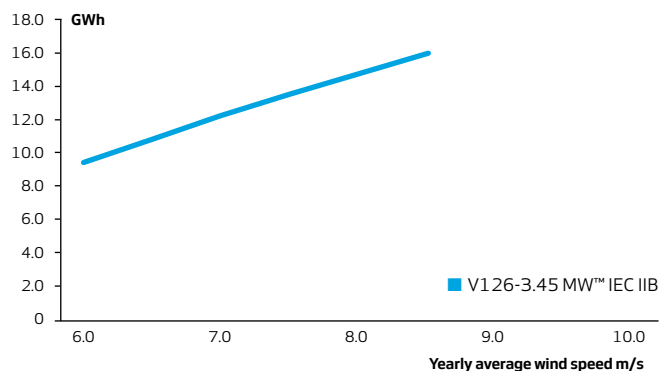
Length	61.7 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes
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#### TURBINE OPTIONS

- 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 m <sup>2</sup>
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
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#### 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)
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#### 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

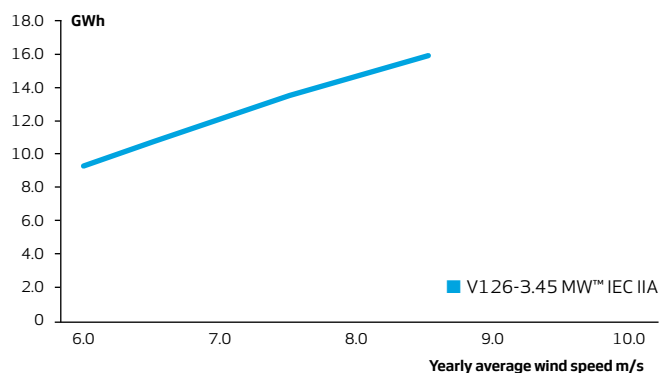
Max. weight per unit for transportation

70 metric tonnes

#### TURBINE OPTIONS

- 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 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 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 m <sup>2</sup>
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
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#### TOWER

Hub heights	82 m (IEC IIIA), 112 m (IEC IIIA), 132 m (IEC IIIA/DIBt2) and 149 m (DIBtS)
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#### 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

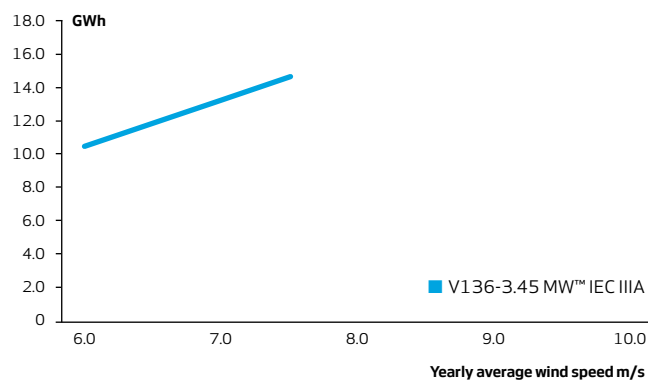
Max. weight per unit for transportation

70 metric tonnes

#### TURBINE OPTIONS

- 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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