

**Vestas®**

# V90

## 1.8/2.0 MW

**Wind.** It means the world to us.™

# V90-1.8/2.0 MW

## Providing a stable return on investment

### **Reliable technology proven over generations**

This turbine builds on proven technology over several generations ensuring industry-leading reliability, serviceability and availability. What's more, the V90-1.8/2.0 MW builds on proven technology to ensure component reliability and durability, reducing the risk of downtime and helping ensure the stability of your investment.

### **Getting a solid grasp on your investment forecast**

Already proven over several generations and with an average contractual availability above 97% in 2009, this turbine takes the reduction of cost and business risk to an unparalleled level. The high level of availability of the V90-1.8/2.0 MW allows you to forecast confidently and strengthens the business case for investment, while its design and performance ensure that you can produce energy from low- to medium-wind onshore sites at the lowest cost.

The latest generation of this turbine incorporates key innovations – including Load and Power Modes, an improved yaw system and a redesigned bed frame and main bearing housing – to lower your operating costs by improving turbine serviceability.

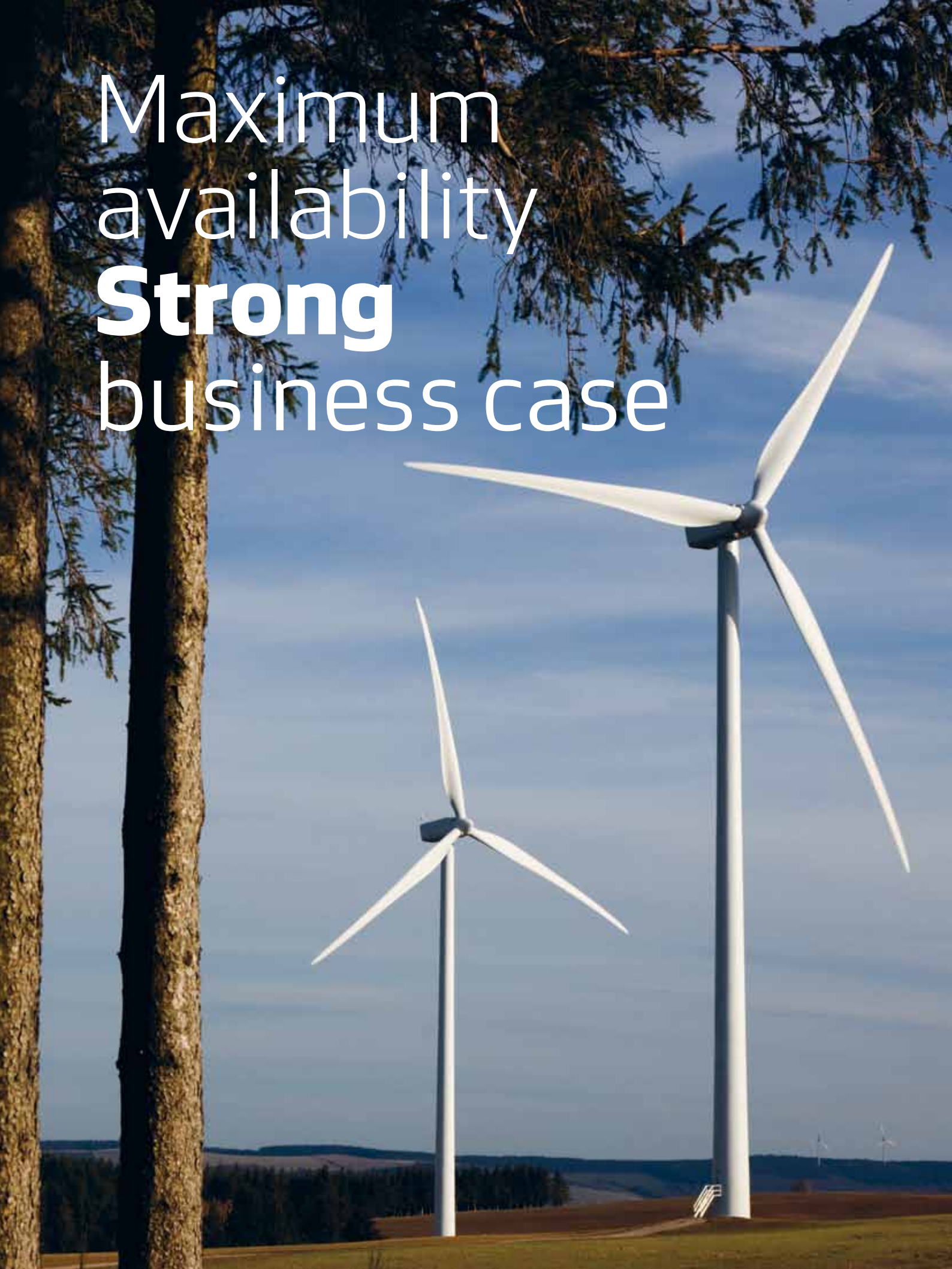
# +97%

availability

+3,800 units delivered

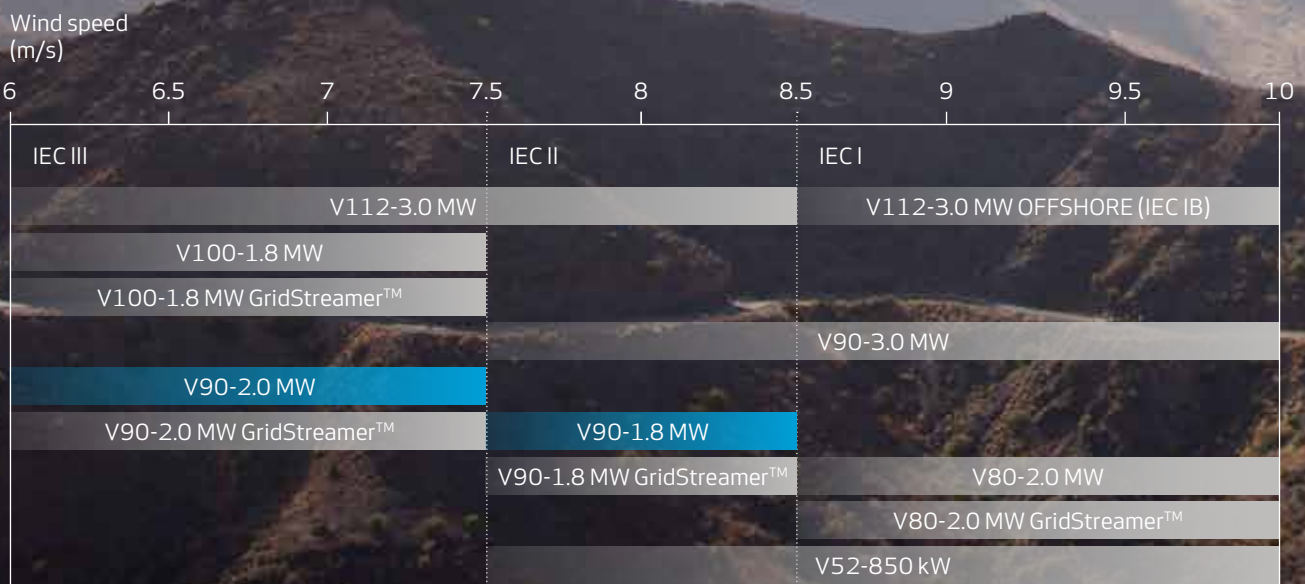
+7.5 GW installed

Maximum  
availability  
**Strong**  
business case



# Unprecedented productivity, reliability and performance

If you want to ensure the yield of your low-wind (IEC IIIA) and medium-wind location (IEC IIA), the reliable V90-1.8/2.0 MW is an excellent choice.



- – 90 m rotor diameter
- – 1.8/2.0 MW rated power



## **Optimise energy production**

- Designed for high productivity
- Noise mode that minimises noise at low-wind with minimal impact on power production
- Excellent grid support
- Load and Power modes

## **Reduce energy costs**

- Low Balance of Plant (BOP), installation and transportation costs
- 24/7 remote control with VMP Global®
- Innovative CoolerTop®
- Designed for serviceability

## **Secure your investment**

- Proven technology
- Reliable and robust product
- Redesigned bed frame and main bearing housing
- Improved yaw system

Here's an overview of selected benefits that optimise your energy production, lower energy costs and strengthen the business case for choosing the V90-1.8/2.0 MW.

# Industry-leading technology generates **more energy**

## **Designed for high productivity**

In comparison with other turbines in the IEC II/III class covering low- and medium-wind sites, the V90-1.8/2.0 MW has a very good productivity record.

Vestas uses a combination of well-known technology and new processes to create this turbine's innovative 44 m blades. Made of glass fibre and carbon fibre in an epoxy resin, the blades also include lightning receptors and an internal grounding cable, increasing safety. As a result of these developments to the blades, the V90-1.8/2.0 MW produces an improved performance with increased output while reducing the loads transferred to the nacelle.

## **Noise mode that minimises noise at low-wind with minimal impact on power production**

The V90-1.8/2.0 MW has various noise modes to meet the operational sound-level restrictions specific to any site.

Thanks to the Vestas Converter System (VCS), the turbine is able to reduce the rotor speed and therefore the noise, which is a significant factor when considering the suitability of this turbine for an onshore site with low to medium winds.

In fact, you can run this turbine in site-specific configurable modes, and keep within defined decibel ranges, without significantly reducing productivity. So even in areas where sound-level restrictions are in place, the V90-1.8/2.0 MW is a very versatile option.

## **Excellent grid support**

The VCS inside the V90-1.8/2.0 MW delivers a constant and consistent output to the grid.

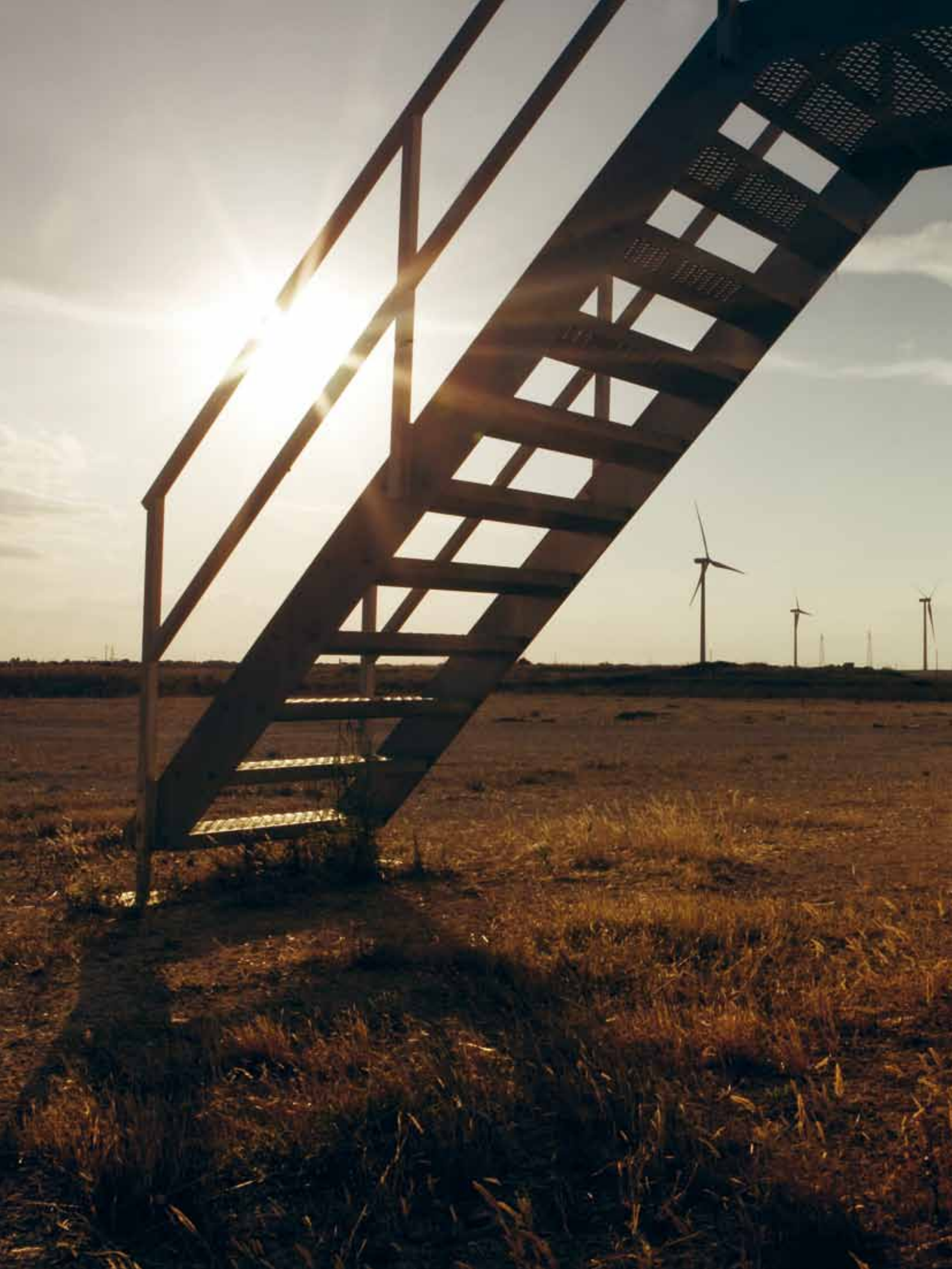
The system is able to maintain grid stability by quickly regulating the turbine's power provision when needed. It swiftly responds to faults and other grid disturbances. VCS also lessens the load on the gearbox and other key components, reducing wear and tear.

## **Load and Power Modes**

The V90-1.8/2.0 MW supports Load and Power Modes which is used to maximise the energy production under certain wind and site conditions.

Based on a site analysis, the turbine can be configured so that it under complex wind condition, e.g. extreme turbulence, can run de-rated, instead of being shut down. Conversely, under benign wind conditions the turbine can be up-rated - all-in-all maximising the annual energy production.





# Reduce wind energy costs by design

## **Low Balance of Plant (BOP), installation and transportation costs**

Using technologies that deliver effective load control on specific tower heights is vital to Vestas, and we have applied this principle to the V90-1.8/2.0 MW by reducing both the weight of the turbine and the loads on the tower and foundation. This has a direct impact on the foundation costs, saving you unnecessary expense.

The fact that the tower is made of steel also has multiple advantages. You do not have to dispose of tonnes of concrete when dismantling the tower, and can gain from its scrap metal price too. Steel towers also benefit the environment, as they can be recycled.

Just like the other turbines in the Vestas 2 MW series, it's possible to easily transport the V90-1.8/2.0 MW (by rail, truck or barge) to virtually any site around the world. In terms of weight, height and width, all of its components comply with local and international limits for standard transportation. This ensures that you incur no unforeseen or unusual costs for getting the turbine on site.

In addition, this turbine can be built and maintained using tools and equipment that are standard within the installation and servicing industries – minimising the ongoing maintenance costs.

## **24/7 remote control with VMP Global®**

To reduce the cost of energy, the V90-1.8/2.0 MW is equipped with VMP Global®, the latest turbine control and operation software from Vestas.

Developed to run this latest generation of Vestas turbines, the modular VMP Global® software package automatically manages the turbine around the clock and ensures that you're always able to generate the maximum power from your V90-1.8/2.0 MW. In addition, the application supports your site management by monitoring and troubleshooting the wind turbines – both onsite and remotely – to keep maintenance costs as low as possible.

## **Innovative CoolerTop®**

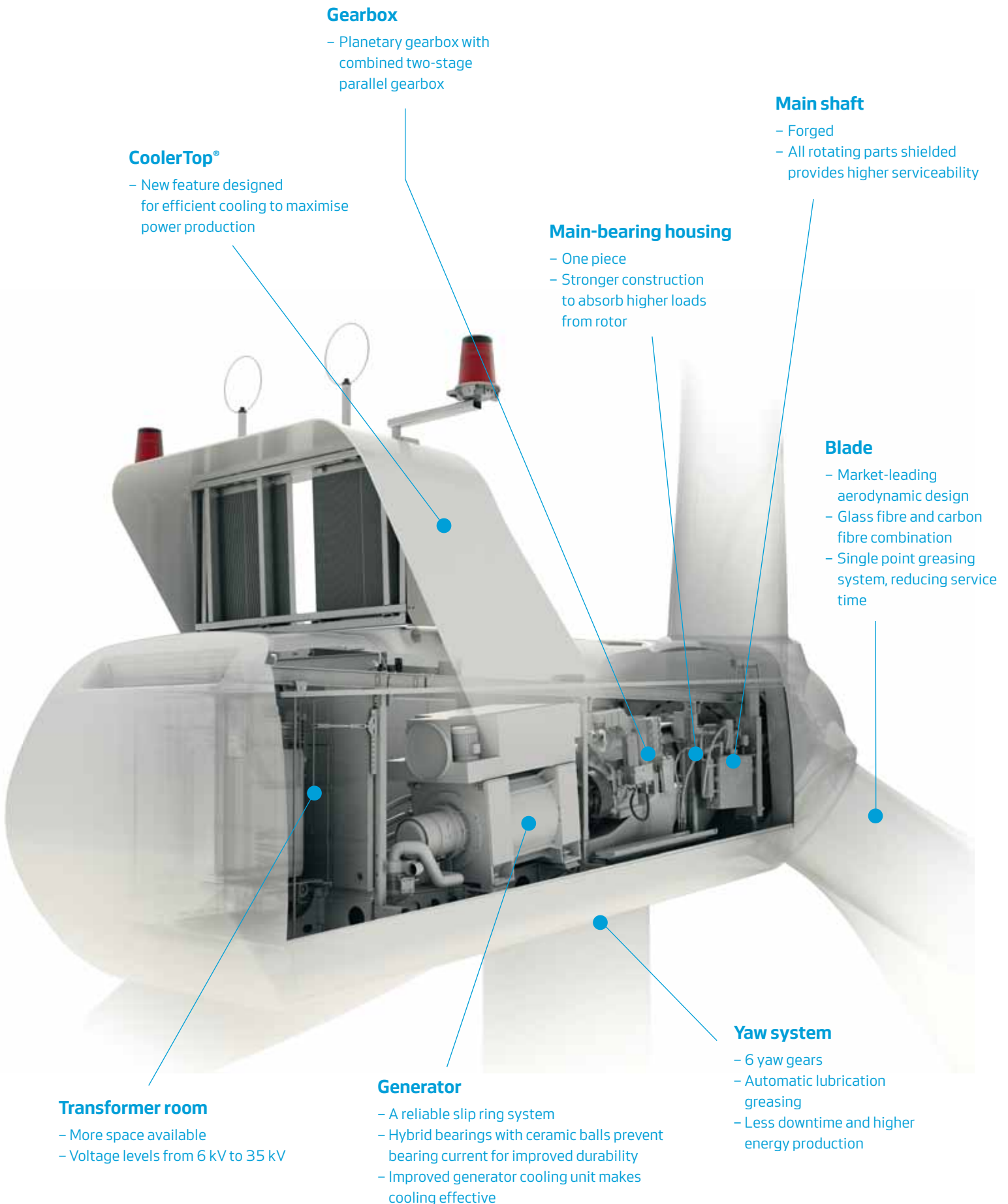
The CoolerTop® installed on the latest version of the V90-1.8/2.0 MW uses the wind's own energy to generate the cooling required, rather than consuming energy generated elsewhere. The fact that the CoolerTop® has no moving parts means that it requires little maintenance, shaving costs once more. In addition, the absence of any electrical components ensures that the cooling system makes no noise and reduces the nacelle's energy consumption.

The CoolerTop® also allows for a temperature range of up to 40° centigrade without de-rating and without needing a high temperature option that would inevitably compromise the amount of space available within the nacelle.

## **Designed for serviceability**

The service crews are helped by the overall design of the V90-1.8/2.0 MW, which, like all other Vestas turbines, shields every rotating part and positions components for easy access.





### Gearbox

- Planetary gearbox with combined two-stage parallel gearbox

### CoolerTop®

- New feature designed for efficient cooling to maximise power production

### Main shaft

- Forged
- All rotating parts shielded provides higher serviceability

### Main-bearing housing

- One piece
- Stronger construction to absorb higher loads from rotor

### Blade

- Market-leading aerodynamic design
- Glass fibre and carbon fibre combination
- Single point greasing system, reducing service time

### Yaw system

- 6 yaw gears
- Automatic lubrication greasing
- Less downtime and higher energy production

### Generator

- A reliable slip ring system
- Hybrid bearings with ceramic balls prevent bearing current for improved durability
- Improved generator cooling unit makes cooling effective

### Transformer room

- More space available
- Voltage levels from 6 kV to 35 kV

Our passion and  
commitment are  
your **guarantee**  
for safer business  
investments



### **Proven technology from the company that proved it**

Since 1995, Vestas has installed over 7,800 of its reliable 2 MW turbines around the world. This total includes more than 3,800 V90-1.8/2.0 MW turbines – each one designed to optimise the commercial viability of low- to medium-wind onshore sites, even under extreme weather conditions. Because it's based on such a mature and well-established platform, this turbine is a sound, low-risk choice.

Using the best features from across the range, as well as some of the industry's most stringently tested components and systems, this turbine's reliable design minimises downtime – helping to give you the best possible return on your investment.

### **Reliable and robust product**

The Vestas Test Centre is unrivalled in the wind industry and has the unique ability to test complete nacelles using a.o. Highly Accelerated Life Testing (HALT) to ensure reliability. At the critical component level, potential failure modes and mechanisms are identified, and specialised test rigs are used to ensure strength and robustness for the gearbox, generator, yaw and pitchsystem, lubrication system and accumulators. The Vestas quality-control system ensures that each component is produced to validated design specifications, and performs at site. We also employ a Six Sigma philosophy and aim to perform at Six Sigma levels by late 2011. We have identified critical manufacturing processes (both in-house and for sub-suppliers), and we systematically monitor measurement trends that are critical to quality, to identify variation and make changes before any defects occur.

### **Redesigned bed frame and main bearing housing**

Created with future generations of turbine in mind, the new single bed frame and stronger main bearing housing of the V90-1.8/2.0 MW provide a better foundation for loads.

The strengthened frame and housing – each made from single-piece castings – work in conjunction to absorb higher loads from the rotor. In addition, the housing ensures correct alignment during bearing assembly, making the process more accurate and efficient, and distributes loads evenly.

These improvements combine to increase the production capabilities of this turbine and to reduce downtime.

### **Improved yaw system**

The last generation of this turbine included a four-gear yaw system. But our commitment to continuous improvement means that today's system is even better – it features a six-gear yaw system and 110 mm yaw rim that's been subjected to induction hardening, making it more robust and reliable than ever before.

The maintenance savings associated with this improvement are boosted yet further by the partly automatic yaw lubrication system now fitted as standard on the V90-1.8/2.0 MW. This partly automated greasing mechanism delivers tangible service savings and raises revenues by increasing your uptime.



# Full control through service experts and our **global surveillance** system

## **VestasOnline® Business**

Vestas wind turbines benefit from the latest Supervisory Control and Data Acquisition (SCADA) system for modern wind power plants: VestasOnline® Business.

This flexible system includes an extensive range of monitoring and management functions that allow you to control your wind power plant in the same way as a conventional power plant. VestasOnline® Business enables you to optimise production levels, monitor performance and produce detailed, tailored reports from anywhere in the world, while the system's power plant controller provides active and reactive power regulation, power ramping and voltage control.

## **Surveillance, maintenance and service**

Vestas provides 24/7 monitoring, performance reporting and predictive maintenance systems to improve turbine uptime, production and availability. Operating a large wind power plant today calls for highly efficient management strategies, to ensure that power production is uninterrupted and that operational and maintenance expenses are controlled. The ability to predict when your critical components are most likely to break down is essential to this effort, as it helps to avoid costly emergency repairs and unscheduled interruptions to energy production.

The Vestas Condition Monitoring System performs this predictive maintenance function, assessing the status of the V90-1.8/2.0 MW by analysing measured signals such as vibrations and temperatures (e.g. in gearbox bearings and the main bearings).

For example, by measuring the vibration of the drive train, the system can detect faults at an early stage and monitor the progress of the damage. This information allows the service organisation to plan and execute the required maintenance work before the component fails, reducing repair costs and production loss.

What's more, our Active Output Management® (AOM) concept provides detailed plans for service and maintenance, online monitoring, optimisation and troubleshooting, and includes a competitive insurance scheme. It is even possible to get a full availability guarantee, under which Vestas pays compensation if the turbine fails to meet the agreed availability targets.

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Vestas turbines include a range of additional features that give you the control you need and ensure a high return on your investment. Thanks to our superior operations and maintenance capabilities, we also provide a level of service unparalleled in the industry.

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# V90-1.8/2.0 MW

## Facts and figures

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### POWER REGULATION

pitch regulated with variable speed

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#### OPERATING DATA

Rated power	IEC IIA - 50 Hz: 1,800 kW IEC IIA - 60 Hz: 1,815 kW IEC IIIA - 50 Hz: 2,000 kW
Cut-in wind speed	4 m/s
Rated wind speed	12 m/s
Cut-out wind speed	25 m/s
Wind class	IEC IIA (V90-1.8 MW) IEC IIIA (V90-2.0 MW)
Operating temperature range	standard turbine: -20 °C to 40 °C low temperature turbine: -30 °C to 40 °C

#### SOUND POWER MODES

Mode 0: Max sound power level:	104.0 dB (A)
Mode 1: Max sound power level:	103.0 dB (A)
Mode 2: Max sound power level:	101.0 dB (A)
Mode 3: Max sound power level:	104.0 dB (A)*
*) low noise at low wind	

#### ROTOR

Rotor diameter	90 m
Swept area	6,362 m <sup>2</sup>
Nominal revolutions	14.5 rpm
Operational interval	9.3 – 16.6 rpm
Air brake	full blade feathering with 3 pitch cylinders

#### ELECTRICAL

Frequency	50 Hz/60 Hz
Generator type	4-pole (50 Hz)/6-pole (60 Hz) doubly fed generator, slip rings
Nominal output	50 Hz: 1,800 kW / 2,000 kW 60 Hz: 1,815 kW

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### GEARBOX

Type	two planetary stages and one helical stage
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#### TOWER

Type	tubular steel tower
Hub heights	
V90-1.8 MW - 50 Hz	80 m, 95 m and 105 m (IEC IIA)
V90-1.8 MW - 60 Hz	80 m and 95 m (IEC IIA)
V90-2.0 MW	80 m, 95 m, 105 m and 125 m (IEC IIIA)
V90-2.0 MW	95 m, 105 m and 125 m (DIBt II)

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#### BLADE DIMENSIONS

Length	44 m
Max. chord	3.5 m

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#### NACELLE DIMENSIONS

Height for transport	4 m
Height installed (incl. CoolerTop®)	5.4 m
Length	10.4 m
Width	3.4 m

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#### HUB DIMENSIONS

Max. diameter	3.3 m
Max. width	4 m
Length	4.2 m

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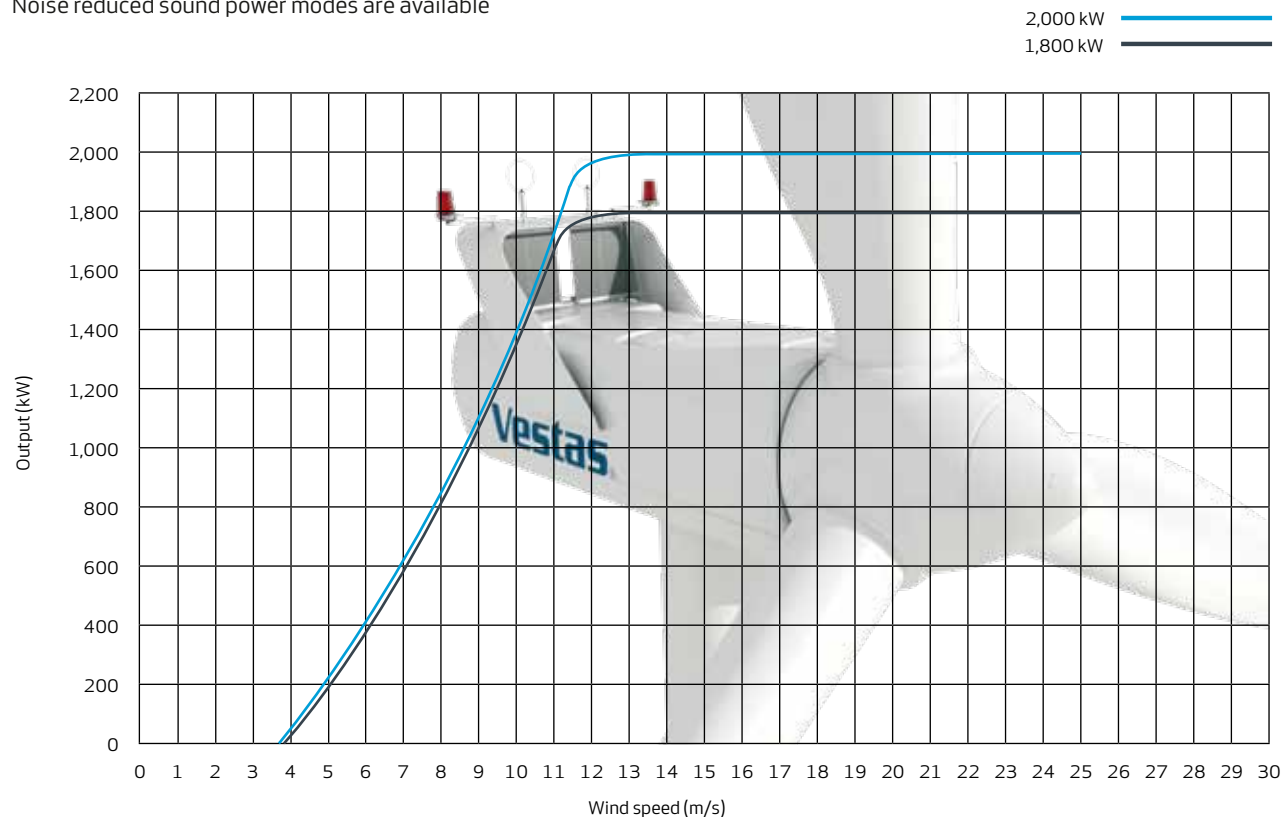
Max. weight per unit for transportation	70 metric tonnes
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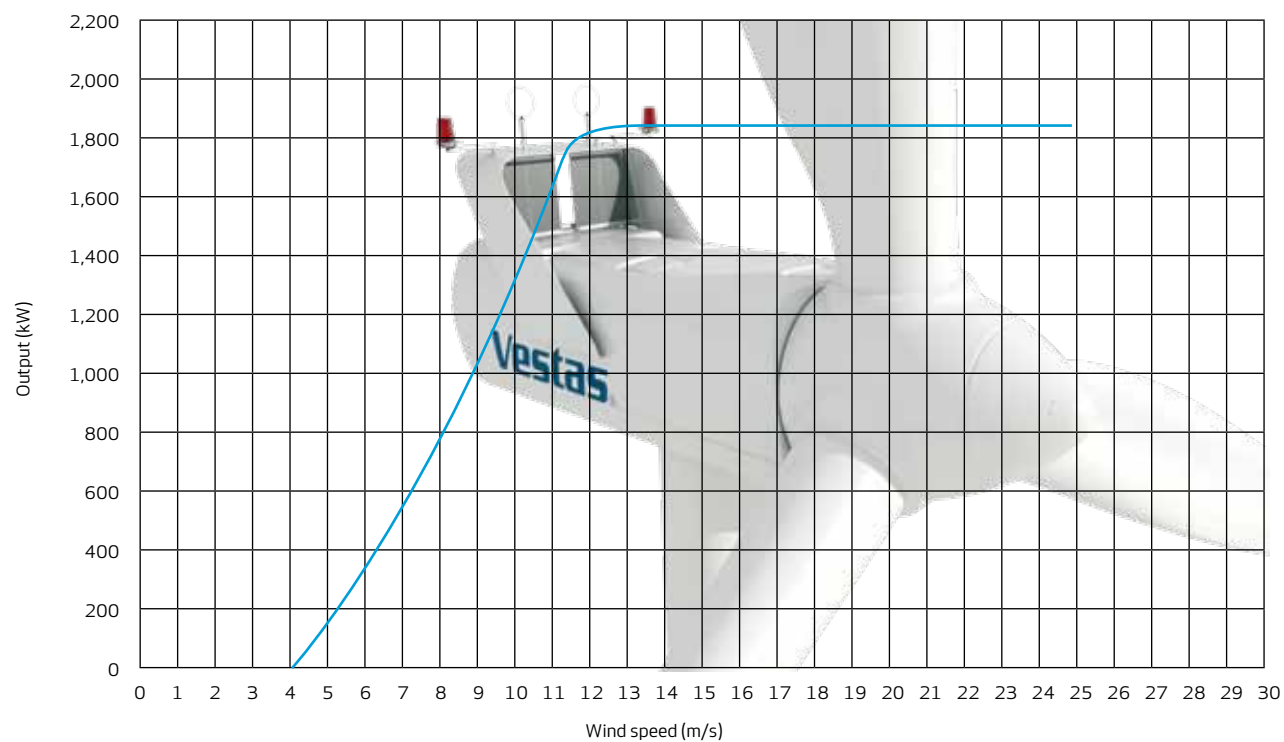
### POWER CURVE V90-1.8/2.0 MW (50 Hz)

Noise reduced sound power modes are available



### POWER CURVE V90-1.8 MW (60 Hz)

Noise reduced sound power modes are available



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