Vestas®

2 MW

GridStreamer™

Wind. It means the world to us.™

The 2 MW GridStreamer™ makes lower cost of energy a **breeze**

Proven track record for complete confidence

Vestas is where cutting-edge innovation meets proven technology. Our 2 MW GridStreamer™ turbines represent the latest stage in our journey to a future where wind takes its place alongside oil and gas as a source of energy.

Our engineers have combined new state-of-the-art components with our existing market-leading technology, merging proven reliability with the ultimate in grid performance and compliance.

Our 2 MW G ridStreamer™ range is an evolution of our earlier trusted models, so you can be confident in the robustness of our technology. Our new turbines are designed to deliver a high level of reliability, meaning minimal operational downtime and a better return on your investment.

Widest possible operational range

The 2 MW GridStreamer™ turbines incorporate a permanent magnet generator that optimises power generation by enabling the widest possible operational wind-speed range. These generators are specifically engineered for strength, serviceability and increased energy production.

Full scale converter meets worldwide requirements

Different markets and project sites have different grid requirements, which is why the 2 MW GridStreamer™ turbines incorporate our full scale converter. This works in tandem with the permanent magnet generator to ensure maximum grid compliance in even the most demanding of environments, helping to future-proof your investment.

By merging new innovations with proven technology, we offer customers leaner logistics and commercial peace of mind. At Vestas, we have moved with the times so that you can too.

Harnessing the **power of wind**

Wind. It means the world to us.™ Wind is all we do. We are relentlessly committed to the success of wind as a source of energy for the world, providing everything you need to succeed in your wind power ambitions.

Energise your investment

Our state-of-the-art permanent magnet generator and full scale converter technology guarantees you highly-efficient power production at a wide range of wind speeds.

Compatible with even the most challenging requirements of modern energy grids, they open up a world of possibilities for investors targeting challenging markets.

Adaptable, versatile and reliable, the 2 MW GridStreamer™ range takes Vestas' commitment to wind power to the next level.

Below you'll see an overview of the key features and benefits that optimise your energy production, lower your operating costs and strengthen your business case for choosing a 2 MW GridStreamer™ turbine.

Fig 1: GridStreamer™ turbines are designed to operate with outstanding efficiency in all wind classes, from high to low wind speeds.

Fig 2: Data measures Annual Energy Production (AEP) across different wind speeds – illustrating optimum outputs for permanent magnet generator and full scale converter technology.

More flexibility

Excellent grid support
– for comprehensive compatibility

Adaptable
– for planning and construction constraint

Technologically versatile
– for operation from -30° to 40°C and certified for installation up to 2,000 m

Lower energy costs

Dynamic CoolerTop® system
– for more efficient operation

Easy-access design
– for low installation and maintenance costs

Substation cost savings
– for reduction/avoidance of statcoms/capacitor bank at the substation

Secure investment

Proven, reliable equipment
– for your peace of mind

Built to latest design standard IEC 61400-1 edition 3
– for cutting-edge quality

Type certificate according to latest standard IEC 61400-22
– for industry assurance

Fig 1. Overview of Vestas wind turbines operating in the various wind classes

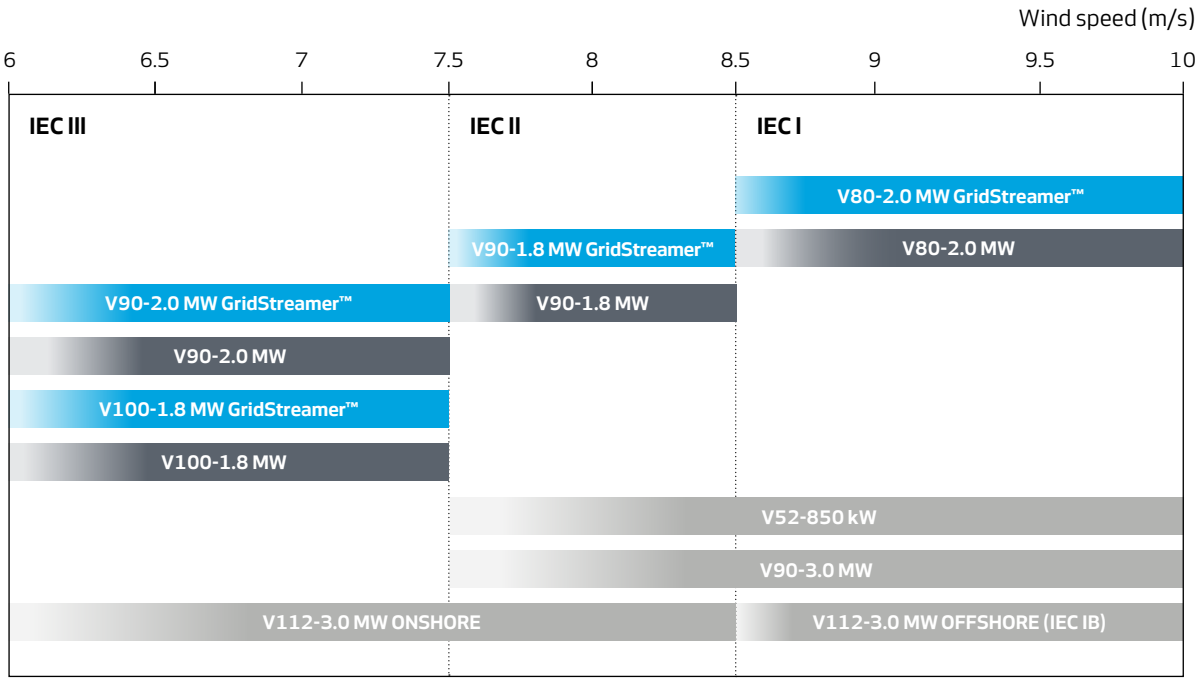
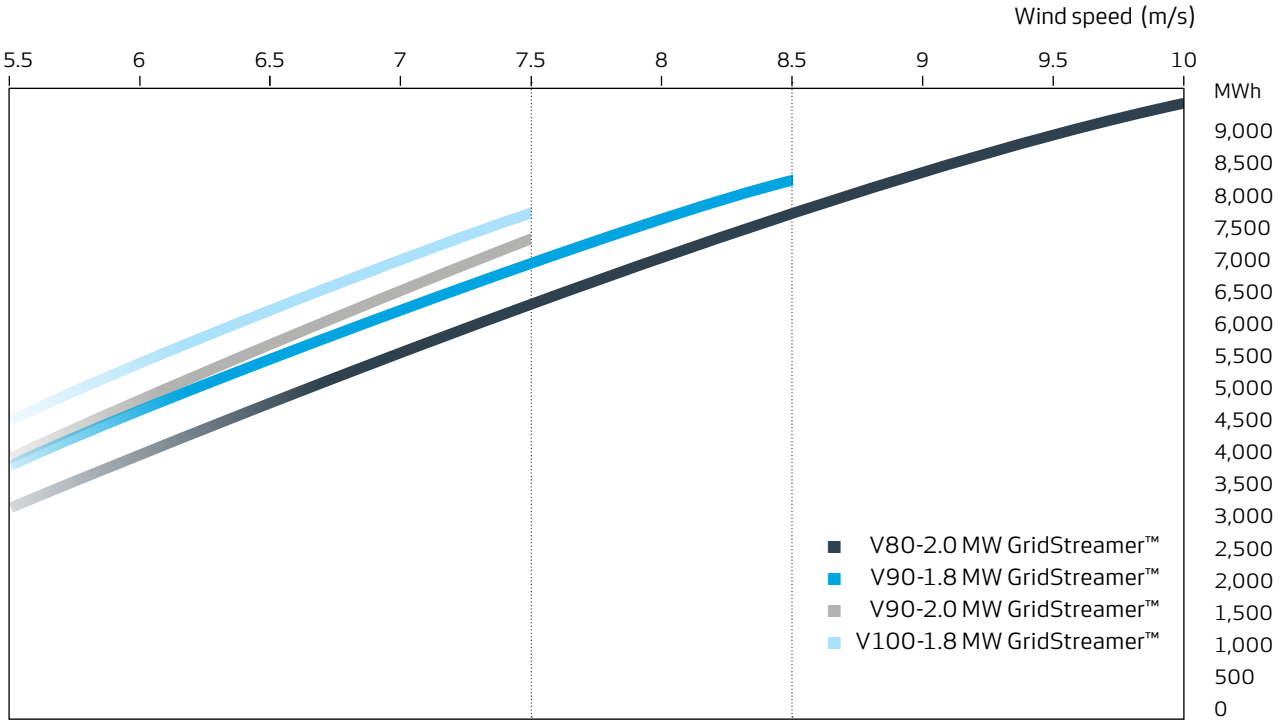


Fig 2. Annual Energy Production (AEP) for the 2 MW GridStreamer™ platform



More flexibility
The **technology** you need – wherever you need it

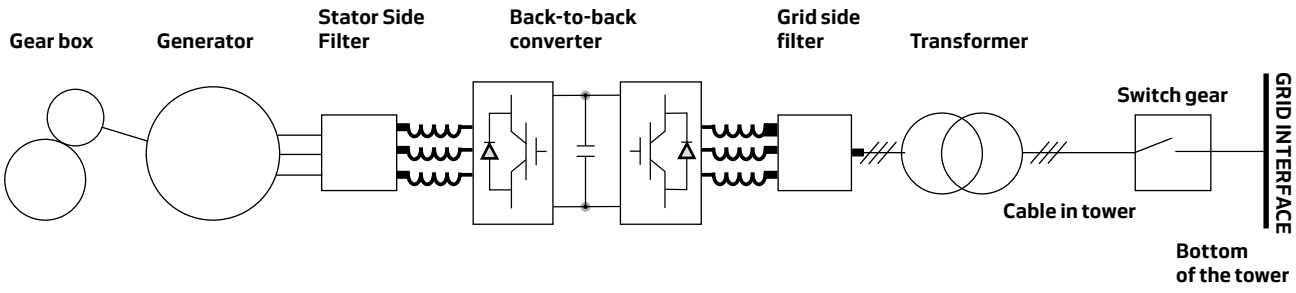
Worldwide grid support

The new permanent magnet generator and full scale converter system affords the V80, V90 and V100 GridStreamer™ turbines comprehensive grid support, compatible with a variety of demands worldwide. With a permanent magnet generators and a full scale converter, the 2 MW GridStreamer™ turbines comply with even the most challenging grid requirements of the modern energy market.

The power system delivers a power factor range of +/-0.9. It is capable of a Low Voltage Ride Through down to 0 V for 0.5 sec. Furthermore, in the event of grid connection being lost, excess power is converted into heat in resistors inside the converter, sparing the drive train components any unnecessary loads.

The 2 MW GridStreamer™ turbines allow you to respond rapidly to changing grid requirements with the added confidence provided by proven technology. At Vestas, we're as renowned for our logistical and planning prowess as for our construction abilities. We deliver your turbines, on time, every time.

EXCELLENT GRID SUPPORT



A green light for generating profits

The 2 MW GridStreamer™ turbines satisfy nearly all your potential planning constraints.

Onshore wind power plants are commonly subject to planning restrictions such as tip height or noise restrictions. The turbines in the 2MW GridStreamer™ range come with three rotor sizes – 80 m, 90 m and 100 m – each optimised for maximum power production for their respective wind regimes. Coupled with multiple tower hub heights and different noise modes, they are engineered to address all major planning challenges.

Scale new heights of investment

The 2 MW GridStreamer™ turbines are designed and certified to operate at altitudes of up to 2,000 m above sea level. This opens up some of the world's most wind-rich locations for efficient power generation. In common with all Vestas turbines, the 2 MW GridStreamer™ turbines can be easily transported (by rail, truck or barge) to almost any potential site globally.

FULL GRID COMPLIANCE

Voltage range:	10-35 kV
Frequency:	50 Hz/60Hz
FRT:	Yes
Reactive current injection:	Yes
Power factor range:	+/- 0.9
Power recovery:	Yes
Fast run back:	Yes
Minimum SCR:	5.0
X/R-range:	1.7-20.0
Short-circuit level:	<1.5 pu
Max short-circuit level:	23 kA

Lower cost of energy Engineered for efficiency, designed for **profitability**

Innovative cooling system

Since our turbines are in the business of generating power, why use energy produced elsewhere to moderate the temperature of the components inside? Our CoolerTop® technology, which comes as standard on our V80-2.0 MW GridStreamer™, V90-1.8/2.0 MW GridStreamer™ and V100-1.8 MW GridStreamer™ models, provides sufficient cooling for all operational needs – even at high ambient temperatures and high altitudes. This makes the 2 MW GridStreamer™ range an ideal choice even for locations which were once deemed unsuitable.

CoolerTop® has no moving parts so requires little servicing, shaving maintenance costs once more. Additionally, the absence of any electrical components ensures that the cooling system simultaneously reduces the turbine's own energy consumption and makes minimal noise – making it the ideal choice for onshore sites near populated areas.

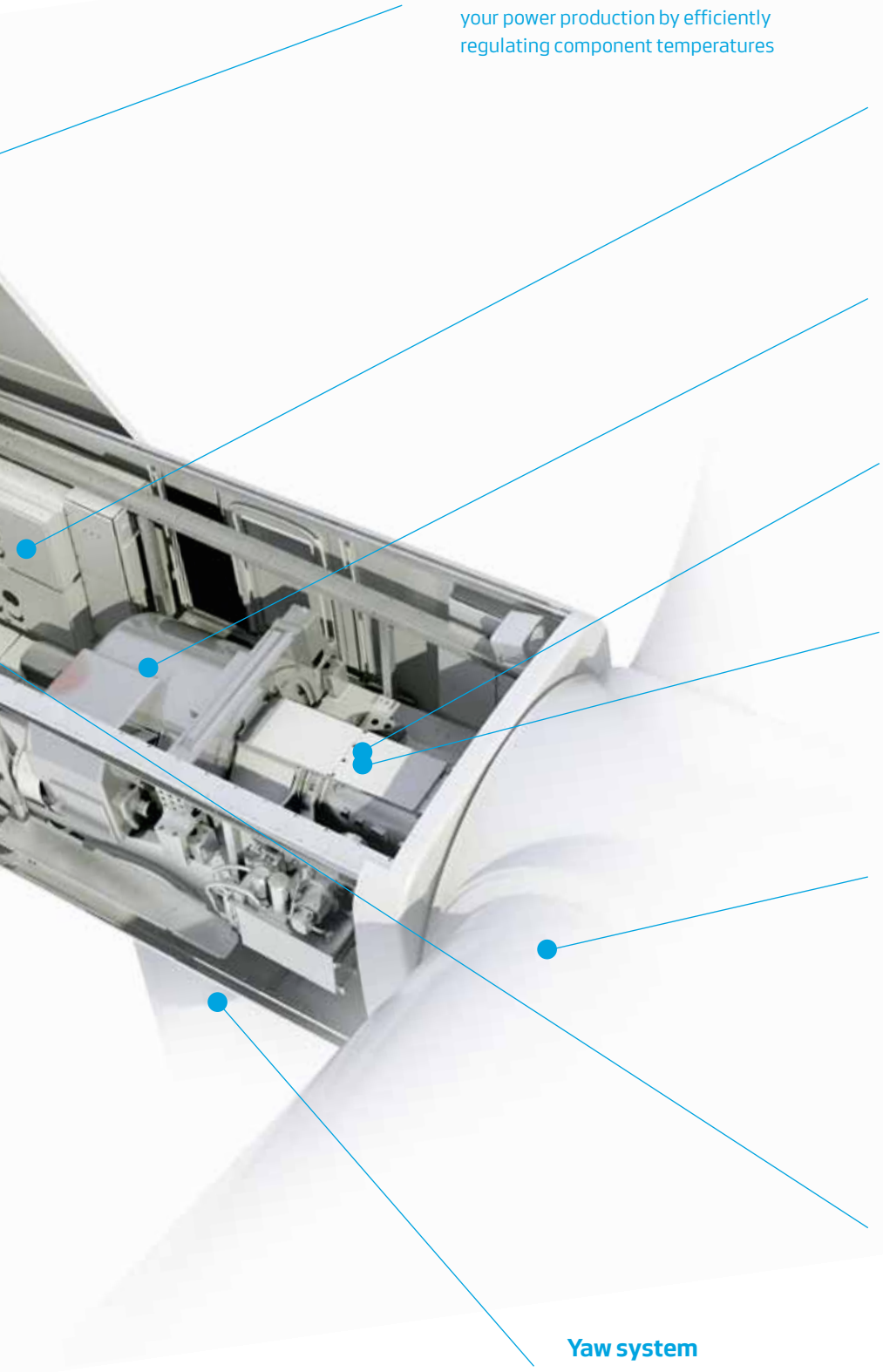
Affordable to install – easier to maintain

Our switchgear technology protects systems against current surges by isolating components. This is now standard in all Vestas 2 MW GridStreamer™ turbines, protecting your asset.

We also use anchor bolts in our foundation design, which allows faster erection on-site and simpler tower realignment.

We have streamlined our design to minimise the number of individual parts, making our equipment more efficient than ever to run and repair. For example, the permanent magnet generators do not use slip rings and brushes, which are susceptible to wear and tear thus reducing scheduled downtime for maintenance. The design of the 2 MW GridStreamer™ nacelles allows for easier access for service staff, saving time, and the yaw systems are automatically lubricated. The converter is modular, too, which makes it fast and easy to replace a module if it fails.

At Vestas, we know that the more time your turbine spends in operation, the greater your profits. We are constantly improving the efficiency of our range to help you achieve your commercial targets.



CoolerTop®

- Our innovative CoolerTop® maximises your power production by efficiently regulating component temperatures

Full scale converter

- Modular layout for improved serviceability
- Internal crane for module replacement
- Water-cooled power components

Gearbox

- One planetary stage and two helical stages

Main shaft

- Forged for robustness

Main-bearing housing

- One moulded piece
- Stronger construction to absorb higher loads from rotor
- All rotating parts shielded

Blades

- Market-leading aerodynamic design
- V80-2.0 MW GridStreamer™ 39m blades made from glass-fibre in epoxy resin – reliable and strong
- V90-1.8/2.0 MW and V100-1.8 MW GridStreamer™ 44m/49m blades made from glass-fibre and carbon fibre in epoxy resin – combining proven and innovative technologies

Permanent magnet generator

- Simple, efficient power system with excellent fault ride-through capacity
- No slip rings or brushes for less maintenance
- Internal ventilation and water jacket cooling
- Vacuum-impregnated windings
- High-capacity bearings (ceramic)

Yaw system

- Six yaw gears
- Automatic lubrication

Securing your **investment** Proven pedigree

+7,800

2 MW turbines installed globally and with more than a 97% availability.

Our nacelle units endure rigorous testing in our unique HALT facility. This ensures that each individual component and assembly performs consistently to the highest quality criteria.

Enviable track record for dependability

Vestas' reputation for reliability makes the new 2 MW GridStreamer™ turbines a low-risk choice for investment. It is a distinction of which we are immensely proud. Since 1999 we have installed more than 7,800 2MW turbines globally, all of which incorporate the major features employed in the 2 MW GridStreamer™ range – including the pitch, yaw and control systems, and the drive train. This rigorous 'in the field' testing means that both our customers and we can be confident in the longevity of our equipment.

Some 40,000 Vestas turbines are now generating power and income around the world. Using some of the industry's most stringently-tested components and systems, we have learned how to minimise downtime and maximise returns on investment, underpinning the whole spectrum of business scenarios.

Vestas – a quality assurance revolution

We care about your investment in wind energy as much as you do.

The Vestas Test Centre is unrivalled in the wind industry. Using our unique Highly-Accelerated Life Testing (HALT) process, we subject our nacelles to stress tests beyond anything they will be expected to encounter on-site. At a critical component level, potential failure modes and mechanisms are identified. We use specialised rigs to ensure strength and robustness for the gearbox, generator, yaw and pitch system, lubricators and accumulators.

Customers benefit from our rigorous quality control, which ensures that each component is produced to precise design specifications and performs in line with expectations. We employ the Six Sigma business philosophy and aim to perform at accredited Six Sigma levels by 2011. We have identified our critical manufacturing processes – both in-house and on behalf of our sub-suppliers – and we systematically monitor data relating to quality, both to identify any variations and to make changes before any defects occur.

All our resources - working for **you**

VestasOnline® Business – putting you in charge

By choosing Vestas to supply your turbines, you will gain access to our cutting-edge Supervisory Control And Data Acquisition (SCADA) system for operating wind power plants. It features a range of monitoring and management functions allowing you to control your 2 MW GridStreamer™ turbines and moderate their output, much in the same way as a conventional power plant. You can adjust production levels, record performance and produce detailed reports from anywhere in the world. Power ramping and voltage control can be regulated using the system's power plant controller.

At Vestas, innovation and technical accomplishment isn't limited to the raw mechanics of turbine production. Our tailored business package puts you in control, giving you the opportunity to maximise energy production and ensure a high return on your investment. We provide a level of service unparalleled in the industry – and we're getting even better all the time.

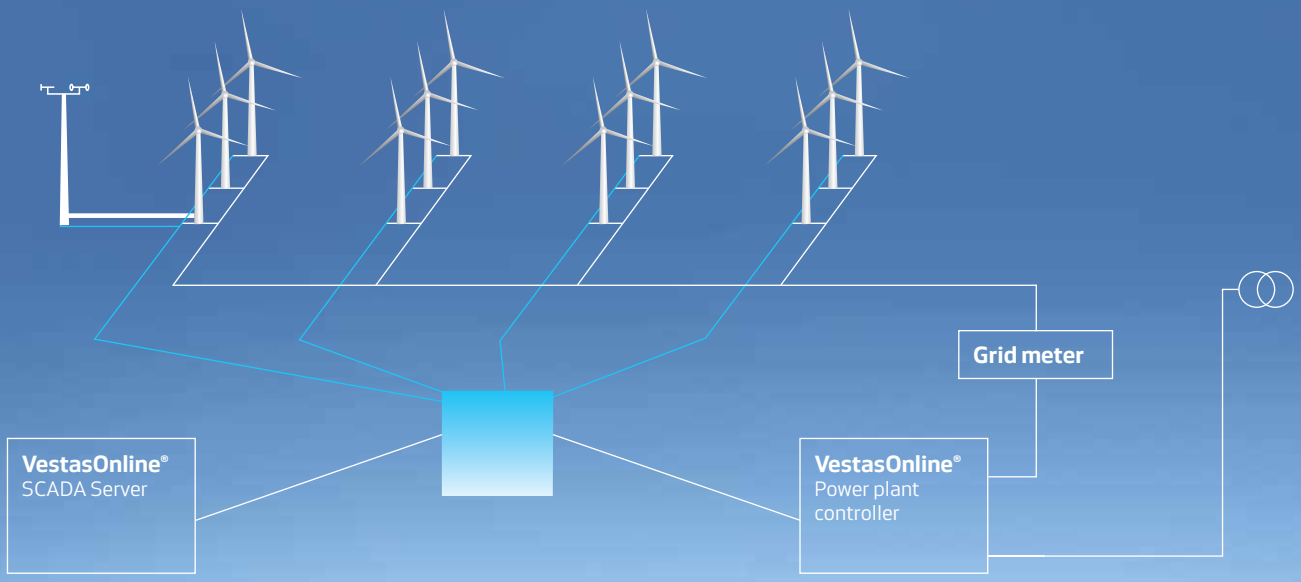
Knowledge is power – guaranteed

With a few straight-forward management strategies, you will be able to keep your wind power plant productivity high and maintenance costs low – the perfect formula for commercial success. That is why we provide 24/7 performance reporting and a predictive maintenance system. Anticipating when critical components are most likely to fail is essential for improving efficiency, because it helps avoid emergency repairs and interruptions to energy production.

The Vestas Condition Monitoring System measures signals such as vibrations and temperatures. For example, by recording the vibration of the drive train, it can detect faults at an early stage and monitor the progress of any damage. This means maintenance work can be carried out before the component breaks down, reducing repair costs and production loss.

An Active Output Management® (AOM) system provides detailed plans for servicing, online monitoring, equipment optimisation and troubleshooting. It also includes a competitive insurance scheme. For complete peace of mind, a 'full availability guarantee' is offered, under which we pay compensation if the turbine fails to meet agreed availability targets.

VestasOnline®
This SCADA system turns a group of wind turbines into a wind power plant



V80-2.0 MW GridStreamer™

Facts and figures

POWER REGULATION pitch regulated with variable speed

OPERATING DATA	
Rated power	2,000 kW
Cut-in wind speed	4.0 m/s
Rated wind speed	14.5 m/s
Cut-out wind speed	25 m/s
Recut-in wind speed	20 m/s
Wind class	IEC IA
Operating temperature range	-20°C to 40°C low temperature turbine: -30°C to 40°C

SOUND POWER MODES	
Mode 0: Max sound power level:	105.2 dB(A)
Mode 1: Max sound power level:	104.6 dB(A)
Mode 2: Max sound power level:	104.1 dB(A)
Mode 3: Max sound power level:	104.1 dB(A)*

*) low noise at low wind

ROTOR	
Rotor diameter	80 m
Swept area	5,027 m^2
Nominal revolutions	16.7 rpm
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL	
Frequency	50/60 Hz
Generator type	permanent magnet generator
Converter	full scale converter

GEARBOX	
Type	one planetary stage and two helical stages

TOWER	
Type	tubular steel tower
Hub heights	65 m and 80 m

BLADE DIMENSIONS	
Length	39 m
Max. chord	3.4 m

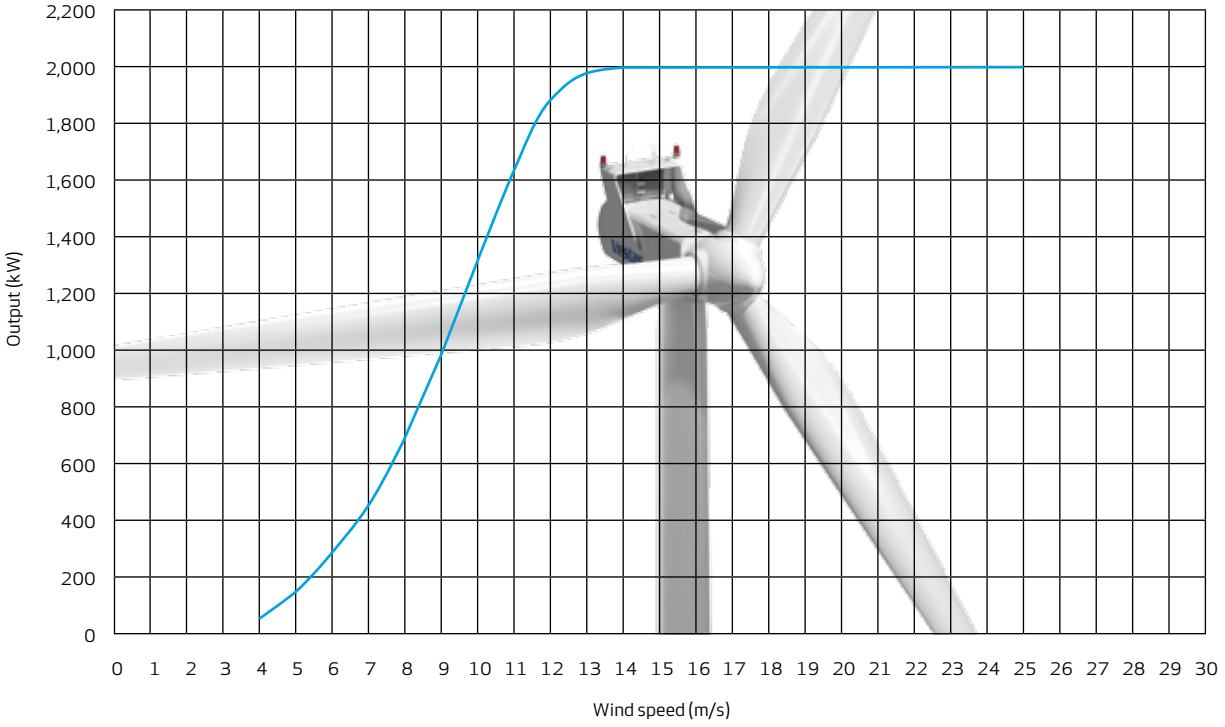
NACELLE DIMENSIONS	
Height for transport	4 m
Height installed (incl. CoolerTop®)	5.4 m
Length	10.4 m
Width	3.4 m

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

Max. weight per unit for transportation	70 metric tonnes

POWER CURVE FOR V80-2.0 MW GridStreamer™

Noise reduced sound power modes are available



V90-1.8/2.0 MW GridStreamer™

Facts and figures

POWER REGULATION pitch regulated with variable speed

OPERATING DATA

Rated power	1,800 kW (V90-1.8 MW GridStreamer™) 2,000 kW (V90-2.0 MW GridStreamer™)
Cut-in wind speed	4.0 m/s
Rated wind speed	13 m/s (V90-1.8 MW GridStreamer™) 13.5 m/s (V90-2.0 MW GridStreamer™)
Cut-out wind speed	25 m/s
Recut-in wind speed	23 m/s
Wind class	IEC IIA (V90-1.8 MW GridStreamer™) IEC IIIA (V90-2.0 MW GridStreamer™)
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 dB(A)
Mode 1: Max sound power level:	103 dB(A)
Mode 2: Max sound power level:	101 dB(A)
Mode 3: Max sound power level:	104 dB(A)*

*) low noise at low wind

ROTOR

Rotor diameter	90 m
Swept area	6,362 m^2
Nominal revolution	14.9 rpm
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Generator type	permanent magnet generator
Converter	full scale converter

GEARBOX

Type	one planetary stage and two helical stages

TOWER

Type	tubular steel tower
Hub heights	80 m, 95 m and 105 m (V90-1.8 MW GridStreamer™) 80 m, 95 m, 105 m and 125 m (V90-2.0 MW GridStreamer™)

BLADE DIMENSIONS

Length	44 m
Max. chord	3.5 m

NACELLE DIMENSIONS

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

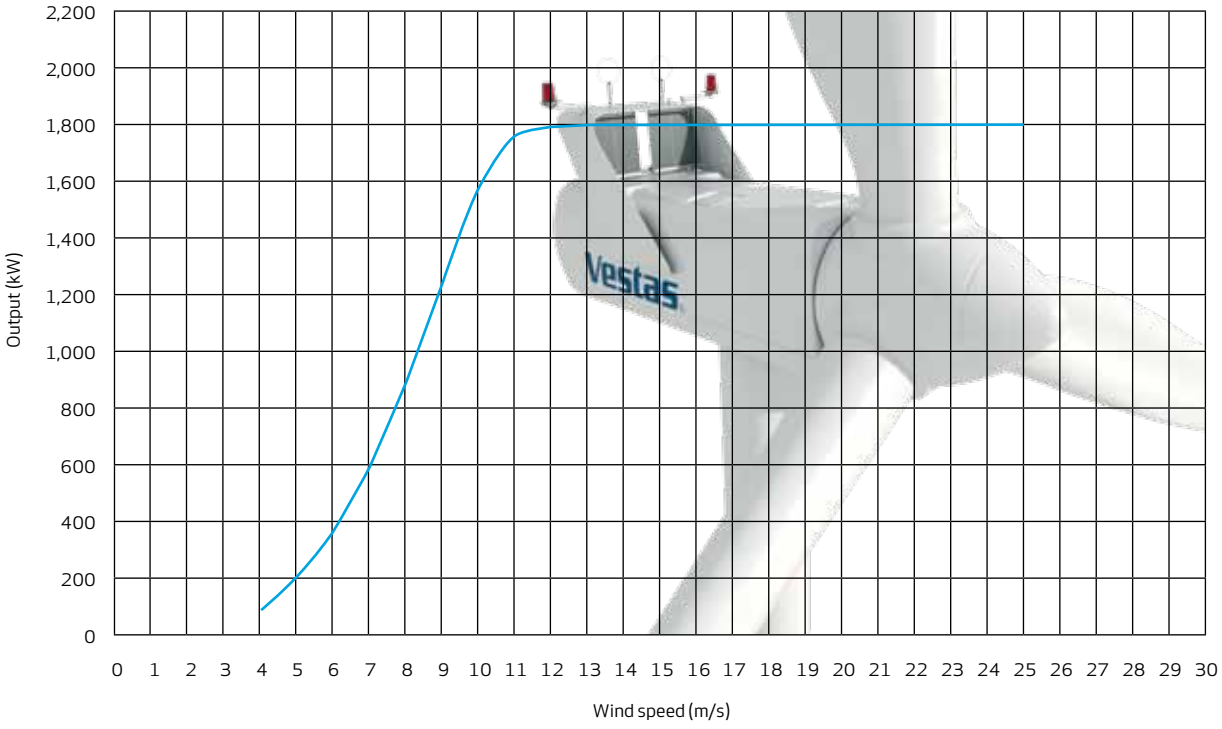
HUB DIMENSIONS

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

Max. weight per unit for transportation	70 metric tonnes

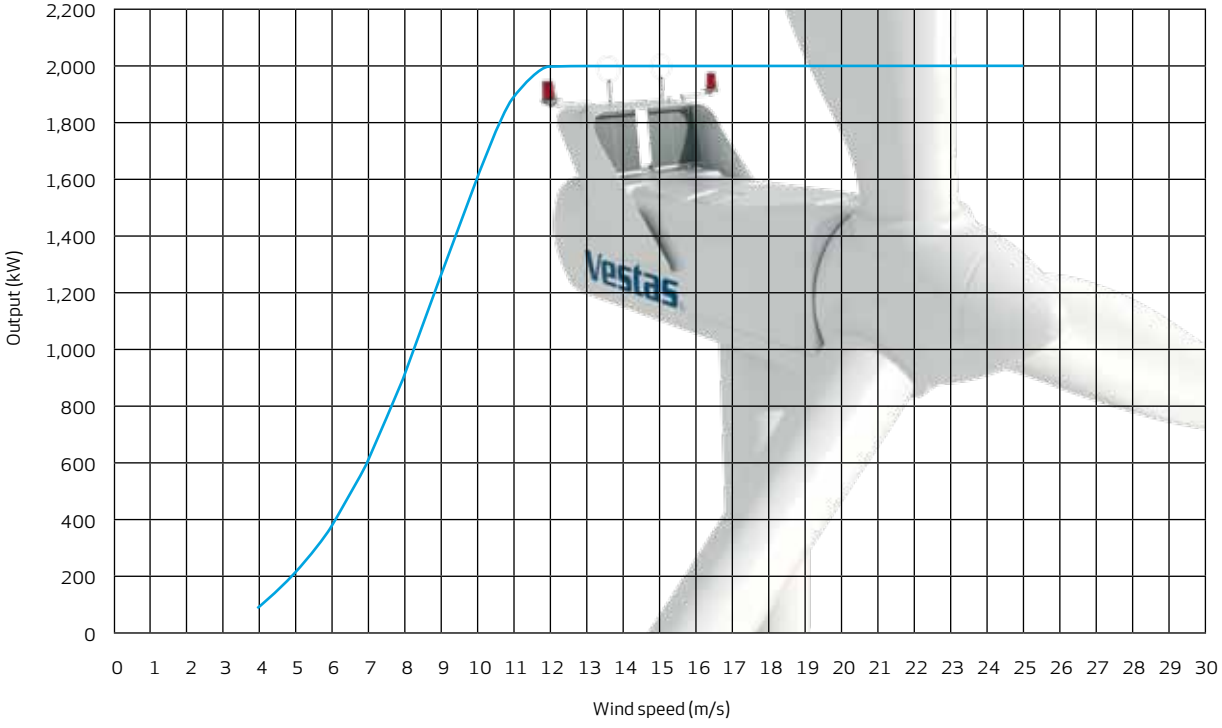
POWER CURVE FOR V90-1.8 MW GridStreamer™

Noise reduced sound power modes are available



POWER CURVE FOR V90-2.0 MW GridStreamer™

Noise reduced sound power modes are available



V100-1.8 MW GridStreamer™
Facts and figures

POWER REGULATION pitch regulated with variable speed

OPERATING DATA	
Rated power	1,800 kW
Cut-in wind speed	3 m/s
Rated wind speed	12 m/s
Cut-out wind speed	20 m/s
Recut-in wind speed	18 m/s
Wind class	IEC S (IEC IIIA average wind/ IEC IIA extreme wind)
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:	105 dB(A)
Mode 1: Max sound power level:	105 dB(A)*
Mode 2: Max sound power level:	103 dB(A)

*) low noise at low wind

ROTOR	
Rotor diameter	100 m
Swept area	7,854 m^2
Nominal revolutions	14.9 rpm
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL	
Frequency	50/60 Hz
Generator type	permanent magnet generator
Converter	full scale converter

GEARBOX	
Type	one planetary stage and two helical stages

TOWER	
Type	tubular steel tower
Hub heights	80 m, 95 m and 125 m

BLADE DIMENSIONS	
Length	49 m
Max. chord	3.9 m

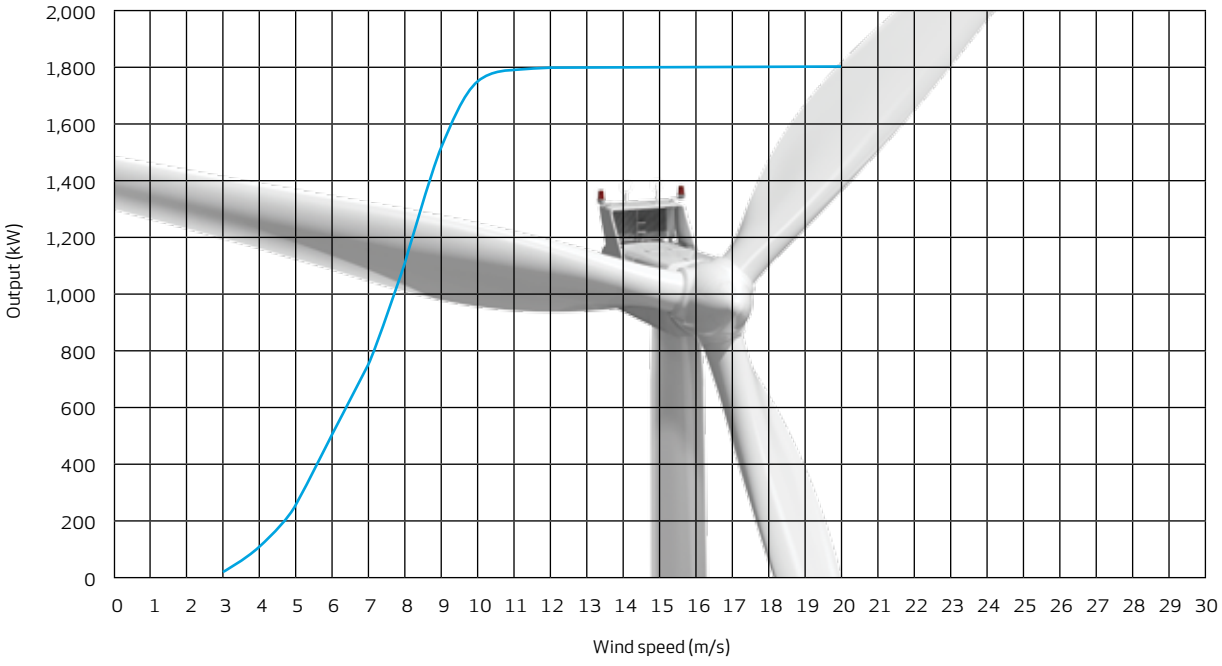
NACELLE DIMENSIONS	
Height for transport	4 m
Height installed (incl. CoolerTop®)	5.4 m
Length	10.4 m
Width	3.4 m

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

Max. weight per unit for transportation	70 metric tonnes

POWER CURVE FOR V100-1.8 MW GridStreamer™

Noise reduced sound power modes are available



Vestas Wind Systems A/S
Alsvej 21 . 8940 Randers SV . Denmark
Tel: +45 9730 0000 . Fax: +45 9730 0001
vestas@vestas.com
vestas.com

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