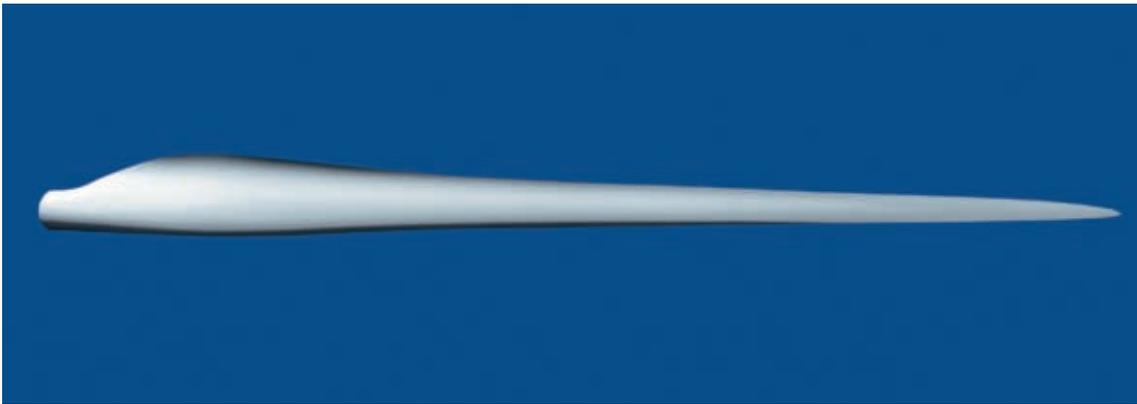


V90-1.8 MW & 2.0 MW

Built on experience



Vestas



Innovations in blade technology

Optimal efficiency

The OptiSpeed®* generators in the V90-1.8 MW and the V90-2.0 MW have been adapted from those in Vestas' highly successful V80 turbine. OptiSpeed® represents a significant advance in wind turbine efficiency as it allows the rotor speed to vary within a range of approximately 60 per cent in relation to nominal rpm. This means that with OptiSpeed®, the rotor speed can vary by as much as 30 per cent above and below synchronous speed. Its purpose is simple: to maximise energy output.

It does this by tapping the higher efficiency of slow and variable rotation, storing excess energy in rotational form and exploiting the full force of transient gusts. All told, OptiSpeed® boosts annual energy production.

As an added benefit, OptiSpeed® also reduces wear and tear on the gearbox, blades and tower on account of lower peak loading. Moreover, as turbine noise is a function of wind speed, the lower rotation speeds made possible by OptiSpeed® naturally reduce sound levels.

Finally, OptiSpeed® helps our V90s deliver better quality power to the grid, with rapid synchronisation, reduced harmonic distortion and less flicker.

3×44 metres of leading edge

Vestas blades have always been among the lightest on the market, and with the V90 turbines, we have once again raised the bar. The new blades feature several new light-weight materials, most notably carbon fibre for the load-bearing spars. Not only is carbon fibre lighter than the fibre-glass used in previous blades, but its strength and rigidity have also made it possible to reduce the amount of material required. This means that even though our V90s have 27 per cent more swept area than our V80s, the longer blades actually weigh about the same.

The V90 blades also have a new profile that is aerodynamically superior to the previous generation. Vestas engineers developed this technologically advanced profile by optimising the relationship between the overall load impact on the turbine and the power generated annually. The fruit of

their labours was an entirely new plane shape and a curved back edge.

The resulting airfoil improves energy production, while making the blade profile less sensitive to dirt on its leading edge and maintaining a favourable geometrical relationship between successive airfoil thicknesses. For the V90 turbine, this translates into an increase in output combined with a decrease in load transfers - as well as improvements on the bottom line.

Proven Performance

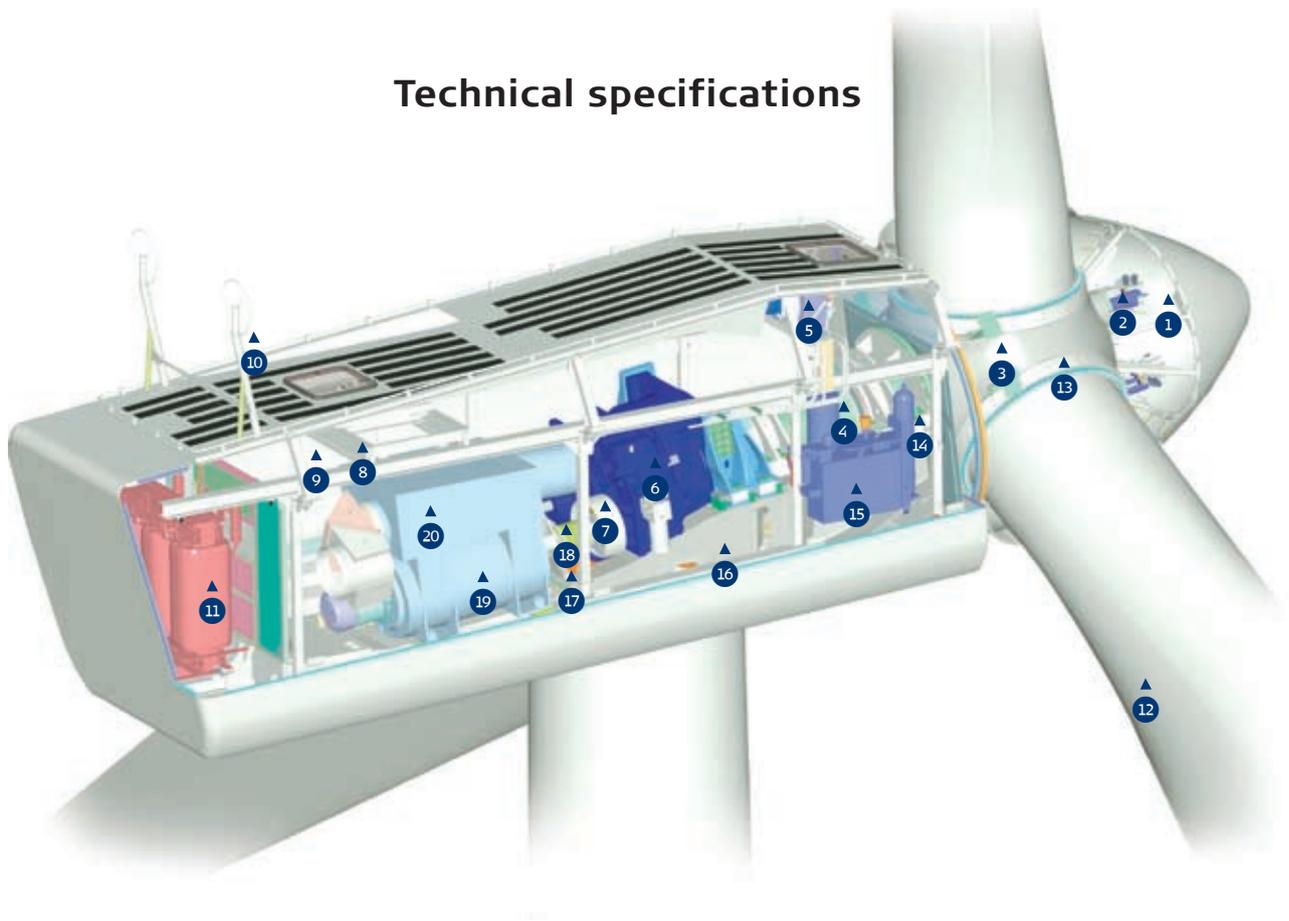
Wind power plants require substantial investments, and the process can be very complex. To assist in the evaluation and purchasing process, Vestas has identified four factors that are critical to wind turbine quality: energy production, operational availability, power quality and sound level.

We spend months testing and documenting these performance areas for all Vestas turbines. When we are finally satisfied, we ask an independent testing organisation to verify the results - a practice we call Proven Performance. At Vestas we do not just talk about quality. We prove it.

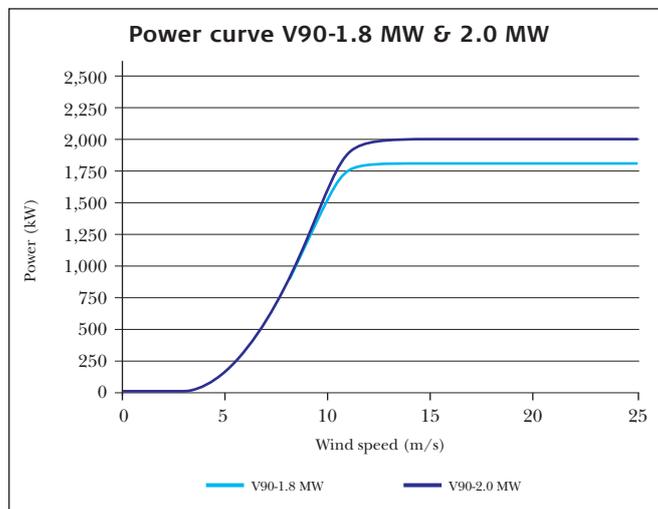


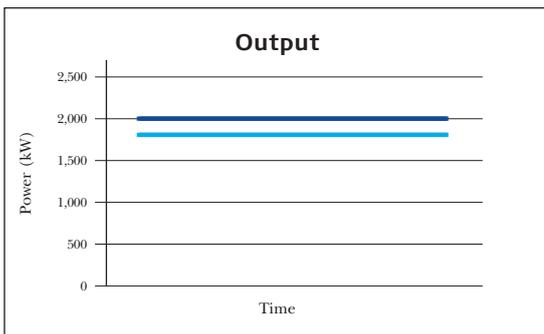
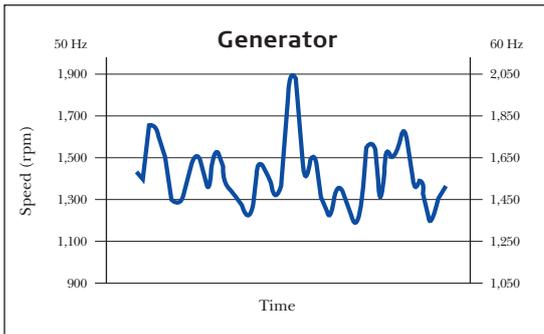
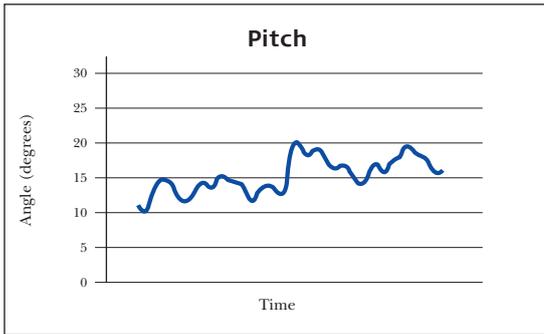
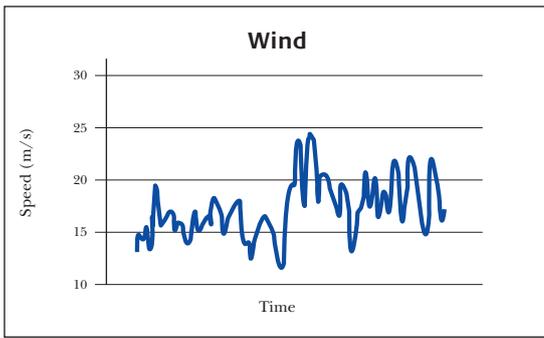
** Vestas OptiSpeed® is not available in the USA and Canada*

Technical specifications



- 1 Hub controller
- 2 Pitch cylinders
- 3 Blade hub
- 4 Main shaft
- 5 Oil cooler
- 6 Gearbox
- 7 Mechanical disc brake
- 8 Service crane
- 9 VMP-Top controller with converter
- 10 Ultrasonic wind sensors
- 11 High voltage transformer
- 12 Blade
- 13 Blade bearing
- 14 Rotor lock system with converter
- 15 Hydraulic unit
- 16 Machine foundation
- 17 Yaw gears
- 18 Composite disc coupling
- 19 OptiSpeed® generator
- 20 Air cooler for generator





OptiSpeed® allows the rotor speed to vary within a range of approximately 60 per cent in relation to nominal rpm. Thus with OptiSpeed®, the rotor speed can vary by as much as 30 per cent above and below synchronous speed. This minimises both unwanted fluctuations in the output to the grid supply and the loads on the vital parts of the construction.

Rotor

Diameter:	90 m
Area swept:	6,362 m ²
Nominal revolutions:	14.9 rpm
Operational interval:	9.0-14.9 rpm
Number of blades:	3
Power regulation:	Pitch/Optispeed
Air brake:	Full blade pitch by three separate hydraulic pitch cylinders

Tower

Hub height:	80 m, 95 m, 105 m
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Operational data

	IEC IIA:	IEC IIIA/DIBt II:
Cut-in wind speed:	3.5 m/s	2.5 m/s
Nominal wind speed:	12 m/s	13 m/s
Cut-out wind speed:	25 m/s	25 m/s / 21 m/s

Generator

	IEC IIA:	IEC IIIA/DIBt II:
Type:	Asynchronous with Optispeed	Asynchronous with Optispeed
Nominal output:	1,800 kW	2,000 kW
Operational data:	50 Hz/60 Hz 690 V	50 Hz/60 Hz 690 V

Gearbox

Type:	Planetary/helical stages
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Control

Type:	Microprocessor-based control of all the turbine functions with the option of remote monitoring. Output regulation and optimisation via OptiSpeed and OptiTip pitch regulation.
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Weight

Nacelle:	68 t		
Rotor:	38 t		
Towers:			
Hub height:	IEC IIA	IEC IIIA	DIBt II
80 m	150 t	150 t	-
95 m	-	-	200 t
105 m	-	-	225 t

t = metric tonnes

DIBt towers are only approved for Germany.

All specifications subject to change without notice.

Built on experience



State-of-the-art wind turbines are not developed in a vacuum. To create the new V90-1.8 MW and V90-2.0 MW turbines for low and medium wind, we have drawn on the vast experience gained as the leading supplier of wind energy systems in the world. In particular, we applied successful design elements from our existing range of turbines.

We began with the nacelles of our tried and tested V80 wind turbines, which feature OptiSpeed® generators for maximum productivity. To these, we fitted the revolutionary new blades from our high-wind V90-3.0 MW. We then modified the components to ensure optimal harmonisation and to make the very most of the target conditions.

The resulting V90-1.8/2.0 MW turbines are optimised for sites with low turbulence and low and medium winds. These innovative wind turbines are so successful that they can actually generate 25 per cent more energy than the corresponding V80s.

Naturally, the new integrated turbines feature innovations of their own innovations. For instance, Vestas engineers spent two years designing a more efficient and more

robust gearbox. Moreover, while the 90-metre rotor weighs approximately the same as the V80 rotor, the longer blades mean higher loads, so we also reinforced the transmission and other major components of the V90.

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