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PROGETTO

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PROGETTO DEFINITIVO

COMMITTENTE:

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SENVION M114

Senvion 3.4M114

[50Hz]

Product Description

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SENVION
wind energy solutions

Disclaimer [European Market]

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SENVION wind energy solutions

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Applicable Documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Title	Document-No.
Electrical Properties according to FGW	t.b.a.
Electrical Properties according to IEC	t.b.a.
General Information Lightning Protection, Earthing and potential equalization	GI-2.5-EC.LP.01-A-*-EN
Internal Transformer System [3.XM/50Hz/Europe and Australia only] – Product Description	PD-3.1-EC.TS.01-A-*-EN
Standard Conditions of Use [3.4M114/IEC/50Hz]	SD-3.7-WT.SC.00-A-*-EN
Standard Grid Conditions [3.XM/50Hz]	SD-3.1-EC.GR.01-B-*-EN

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of Abbreviations and Units

Abbreviations/Units	Description
ETS	External Transformer System
f_N	Nominal frequency
GL	Germanischer Lloyd
GRP	Glass-fibre reinforced plastic
HV	High voltage (nominal grid voltage ≥ 60 kV)
IEC	International Electrotechnical Commission
IGBT	Insulated Gate Bipolar Transistor
I_N	Nominal current
LV	Low voltage (nominal grid voltage ≤ 1 kV)
MV	Medium voltage (nominal grid voltage > 1 kV and < 60 kV)
n	Rated generator speed
NEC	National Electrical Code
PG	Nominal active power of the generator
P_N	Nominal active power of the WTG
PPE	Personal Protective Equipment
PT	Nominal active power of the transformer
RAL	German Institute for Quality Assurance and Certification e.V.
SCADA	Supervisory Control and Data Acquisition
U	Voltage
UL	Underwriters Laboratories
U_N	Nominal voltage
WTG	Wind Turbine Generator

1 General Information

The Senvion 3.XM series is the latest Senvion product platform for onshore wind turbines (WTG). It was developed on the basis of the continuous ongoing development and operating experience of more than 2000 installed wind turbines of the series MD and MM and the series 5M/6M. The development of the Senvion 3.XM series is based without change on the advantages of the MD and MM series, such as ease of maintenance, conservative design loads and powerful components that are adapted to the distribution of forces, environmental friendliness and excellent grid properties.

The first product in the series is the Senvion 3.4M104. This is a WTG with a nominal power of 3,370 kW on the medium voltage side of the transformer (corresponding to 3,400 kW on the low voltage side of the transformer). Another version in the series is the Senvion 3.2M114. This is a wind turbine with a nominal power of 3,170 kW on the medium voltage side of the transformer (corresponding to 3,200 kW on the low voltage side of the transformer) which is now also available with a rated power of 3,400 kW, as 3.4M114.

1.1 Technical Design

After intensive analysis of existing and new turbine and component technologies the design of the series Senvion 3.4M114 represents an evolutionary further development based on the experiences from the MD and MM series. The characteristics of the technical design of the Senvion 3.4M114 are therefore:

- Variable generator speed control system with a six pole doubly-fed asynchronous generator (DIFG)
- Ease of maintenance
- Liquid-cooled converter system
- Transport requirements similar to those of 2 MW wind turbines (e.g., series Senvion MM)
- Individual electric pitch adjustment with “fail-safe” design
- 3-point bearing of the drive train
- "Tilted cone" design and rotor blades pre-bent to the front for the best possible weight distribution and safe load transmission
- Reliable gearbox design
- Ladder-guided service lift (standard)
- Internal dry type cast resin transformer system with forced air cooling

2 Mechanical System

2.1 Rotor

The rotor consists of three rotor blades that are flange-mounted on the cast hub via a pivoted double row four-point contact bearing. The rotor blades can thus be adjusted along their linear axis via electrical pitch drives that rotate with the blades. The electrical blade pitch is used to limit the rotational speed of the rotor and the power output. Furthermore, the pitch system is the main brake of the WTG. In order to ensure the continued operation of the blade adjustment in the event of a power failure or malfunction, each blade has its own, independent storage battery set that rotates with the blade.

In the partial load range, i.e. when the WTG is operated below the rated power, the turbine works at a constant blade pitch and variable speed to exploit the optimum rotor aerodynamics. Within the nominal load area, i.e. when the WTG has reached its maximum rotor speed, it operates with a constant nominal torque which is given by the generator. Changes of the wind speed are controlled by the blade pitch. Wind energy from strong gusts can be stored by an acceleration of the rotor and only then converted into damped electrical energy via the blade pitch and fed into the grid.

The use of the “tilted-cone” concept with a 4° tilted blade connection on the hub and pre-bent rotor blades in conjunction with a 5° incline of the whole drive train allow an extremely short overhang of the nacelle between the rotor and the tower. This provides a good weight balance of the whole nacelle and a safe load transfer into the tower top without transmitting a high flux of force over a long distance via the main frame.

In case of a major component replacement near the drive train the rotor may remain in the wind turbine (see also chapter 2.2.2 "Suspension Concept").

To assist with maintenance work at the rotor hub it is accessible directly from the nacelle through openings between the blade root connections.

Technical Data Rotor	
Rotor diameter	114 m
Swept area	10,207 m^2
Speed range	6.6 to 12.06 (+15 %) min^{-1}
Max. tip speed	72.2 m/s
Rotor axis inclination	5°
Rotor cone angle	4°
Sense of rotation	Clockwise (right)
Rotor position	Up-wind

2.1.1 Rotor Blades

The blade design of the Senvion 3.4M114 combines a rigid structure, capable of even withstanding strong gusts, with a lightweight construction to minimize the transfer of forces onto the nacelle. This is made possible by using a sandwich construction from glass-fiber reinforced plastic (GRP) with the necessary material properties.

The rotor blades of the Senvion 3.4M114 have been adjusted with a view to a high aerodynamic efficiency and reduction of noise emissions. Vortex generators of the latest design are used to ensure aerodynamic performance and stability of the Senvion 3.4M114.

A special blade coating protects them against the negative effects of UV radiation and moisture. To prevent erosion the blade leading edges are further protected by additional measures (e.g., anti-erosion film etc.).

The rotor blades are in the blade color light gray (RAL 7035), a bright standard color for the tower and the nacelle also. This reduces the effects of reflections without affecting the power characteristic of the Senvion 3.4M114. The rotor blade can optionally have rotor blade markings applied.

Senvion SE reserves the right to select and modify, at its sole discretion, the manufacturer or type of blades without consulting the customer.

Technical Data Rotor Blade	
Number of rotor blades	3
Rotor blade length	55.8 m
Rotor blade material	Glass-fiber reinforced plastic (GRP) in sandwich construction
Rotor blade color	RAL 7035

2.1.2 Blade Pitch System

The rotor blades are connected to the rotor hub via the blade bearings in a pivotable manner and can be adjusted individually around the longitudinal axis using the pitch system. For this purpose each rotor blade has its own pitch system. The co-rotating blade pitch drives are designed as DC motors and act via the planetary gearbox and pinion on the external gearing of the bearing.

A quickly operating synchronizing controller is used to synchronize the individual pitch systems. To ensure safe operation also during grid failure or a fault, each rotor blade has its own co-rotating battery set.

Technical Data Blade Pitch System	
Principle	Electric individual blade pitch
Power control	Blade pitch and speed control
Maximum blade angle	91°
Pitch rate at safety shut-down	approx. 6-7 °/s
Pitch drives	DC motors, battery-buffered, synchronized

2.2 Nacelle

To meet the demand for an innovative wind turbine, the nacelle of the Senvion 3.4M114 has – as with all current Senvion wind turbines – been designed by a renowned designer. The result is an aerodynamically adapted design that, based on existing experience, offers improvements for service and maintenance. Maintenance can be performed with the nacelle closed, but it can also be partially opened for major component replacements.

The entry from the tower into the nacelle can be obtained via one hatch in the main frame. An additional maintenance platform has been installed to reach the components below the main frame.

The control cabinets of the converter system and the corresponding cooling system in the Senvion 3.4M114 are housed in the nacelle.

All systems can be operated via the control system from the nacelle. An emergency stop push-button has been installed for safety. All rotating/moving parts within the nacelle are generally protected by covers to prevent the risk of injury.

Glass-fibre reinforced plastic (GRP) has been chosen as material for the nacelle enclosure, as it offers a reliable protection and is lightweight. The nacelle enclosure also has the additional functions of noise insulation and maintaining the operating temperature.

2.2.1 Yaw System

The nacelle is connected to the tower via a four point contact bearing. The yaw system of the nacelle is provided by four electric gear motors. Hydraulic brake calipers hold the nacelle in the wind direction and the adjustment motors during idle free from loads that may e.g., result from an inclined air flow towards the rotor. In the de-energized state the brakes are engaged.

Electronic wind direction sensors with corresponding software control the activation times and the direction of rotation of the motors. They also ensure the automatic cable untwist if the wind turbine has rotated several times in the same direction during changed wind directions. If the yaw motors are active, the brakes are released.

Technical Data Yaw System	
Type	4 gear motors, 18 brake calipers
Yaw rate	0.4 °/s
Bearing	Four point bearing with external gearing

2.2.2 Suspension Concept

The drive train is supported at three points immediately above the head flange of the tower. The foreside suspension is carried out by a generously dimensioned spherical roller bearing. The two other suspension points are the torque arms of the gearbox which are balanced by elastomer bushings. The three point suspension allows a safe load transfer along with a significant tolerance of the drive train alignment.

2.2.3 Gearbox

The gearbox has been designed as a planetary/spur gearbox. The gearing has been adjusted for efficiency and noise emission. The torque support of the gearbox is supported by elastic bushings on the main frame which rest on the main frame on pads. The elastic suspension permits effective noise and vibration decoupling from the main frame. The gearbox design was carried out in accordance with the Senvion gearbox guidelines. These demand greater safety factors than e.g., the DIN/ISO or GL (Germanic Lloyd) guidelines. Furthermore, the gearbox is equipped with an electrical and a mechanical oil pump to ensure sufficient oil flow, even under idling conditions.

Technical Data Gearbox	
Type	Planetary/spur gear system
Nominal power	approx. 3,690 kW
Nominal torque	approx. 2,940 kNm
Gear ratio	1:99.5

2.3 Tower

The tower has been designed as a steel tower at 93 m hub height and as a 143 m concrete-steel hybrid tower. A door opening is provided in the tower base to allow for a weather-proof ascent inside the tower. The ascent to the nacelle is an integrated service lift. Each tower segment is equipped with platforms and emergency lighting.

The transformer is located in the tower base and is protected against unauthorized access. The wind turbine can also be operated via a control display from the tower base. To make the ascent to the upper sections of the wind turbine safe and comfortable, there is the using an integrated service lift.

The energy transmission within the tower takes place via shielded busbars that also contribute to minimizing electromagnetic interference.

Technical Data Tower	
Hub height*	93 m, 119 m** and 143 m
Design	93 m: Tubular steel tower 143 m: Concrete-steel hybrid tower

* The hub heights depend on the foundation design and extension.

** The hub height 119 m is currently under development.

2.4 Service Lift

Each Senvion 3.4M114 is equipped with a service lift. The service lift may be used by max. two persons and may not exceed a maximum load of 250 kg. The ladder-guided service lift has been designed for a comfortable transport as it contributes to a lower fatigue for the service personnel and thereby assists in maintenance work.

The ascent and descent with the service lift are via a stop/go push-button system using a dead man's switch installed in the service lift. Automatic operation is also possible for the transportation of materials and tools. In addition to the top tower platform below the nacelle, all other internal platforms, such as the lowest level above the electrical system, are accessible via the service lift. The service lift cables and safety cables are connected to the cross bracing at the top of the tower.

2.5 Chain Hoist

The nacelle also features a chain hoist, which can be used for maintenance tasks to lift tools or components weighing up to 500 kg. The back of the nacelle features a crane hatch which is secured with a safety gate. The chain hoist should not, under any circumstances, be used for lifting persons.

2.6 Corrosion Protection

All parts of the WTG are protected against corrosion and other environmental influences by a special multilayer coating. The coating system complies with requirements of DIN EN ISO 12944.

3 Electrical System

3.1 Principle of Operation

The system is equipped with a variable speed generator/converter system. This facilitates an operation of ± 40 % of the synchronous speed. The variable speed operation offers in connection with the electric pitch system very good results with regard to energy yield, efficiency, mechanical load, and quality of the power output. The system prevents overvoltages and load peaks to the best possible extent. The generator control enables an even power output with minimum fluctuation during partial load operation. During nominal load operation the wind turbine power output is almost constant. The principal ability to generate reactive power facilitates the targeted reactive power management in accordance with the requirements of the customer and the grid operator through optional products.

The principle of operation of this variable speed generator is based upon the concept of the asynchronous double-fed induction generator with a converter using IGBT technology. The system ensures the continuous power output by means of voltage and frequency values that have been adapted to the grid independently from the rotor speed. Speed and power adjust automatically to the prevalent wind conditions. The wind turbine is accordingly operated in the following operating ranges:

- The generator supplies 100 % of the electrical power to the energy supply grid in the sub-synchronous range (partial load range). Slip power which is fed from the generator via the slip rings of the generator to the rotor is provided additionally.
- The generator directly supplies approx. 83 % of the electrical power to the energy supply grid in the super-synchronous range (nominal load range). Management via the converter is not required in that context. The remaining approx. 17 % of the power is fed from the rotor via the converter into the energy supply grid.

Besides many other system benefits, the low losses, permitting a high total efficiency, and the excellent availability, resulting from the compact design with a minimum number of components, should be mentioned.

3.2 Technical Data of the Medium Voltage Side of the Wind Turbine

3.2.1 Standard Wind Turbine Configuration

The Senvion 3.4M114 standard design has been defined as shown in the following table.

Standard configuration at medium voltage side of the WTG

Parameter	Value
Nominal power	P_N = 3,370 kW on the medium voltage side of the transformer. This corresponds to a power of approx. 3,400 kW on the low voltage side of the transformer.
Power factor	cos φ ~ 1
Nominal voltage (MV side)	10 kV / 20 kV / 30 kV
Terminal voltage range (MV side)* of the wind turbine (cos φ = 1)	90 % ≤ U_N ≤ 110 %
Nominal frequency	f_N = 50 Hz
Nominal current at cos φ = 1 and nominal voltage	I = 195 A [10 kV] I = 97 A [20 kV] I = 65 A [30 kV]
Nominal generator speed	n = 1,200 rpm

NOTE: * The automatic tap changer of the wind farm transformer in the medium-voltage system must assure that line voltage does not drop below nominal voltage for a longer period of time. If the line voltage is below nominal voltage for a longer period of time, electrical power production could be reduced.

The Senvion wind turbine remains connected to the grid during stationary operation even with frequency fluctuations between 47.5 Hz and 52.0 Hz within a permissible voltage range. In the frequency range of 47.0 Hz to 47.5 Hz the Senvion wind turbine also remains connected to the grid for max. one minute. The following figure is a graphic depiction of both the stationary and dynamic frequency range in relation to the active power.

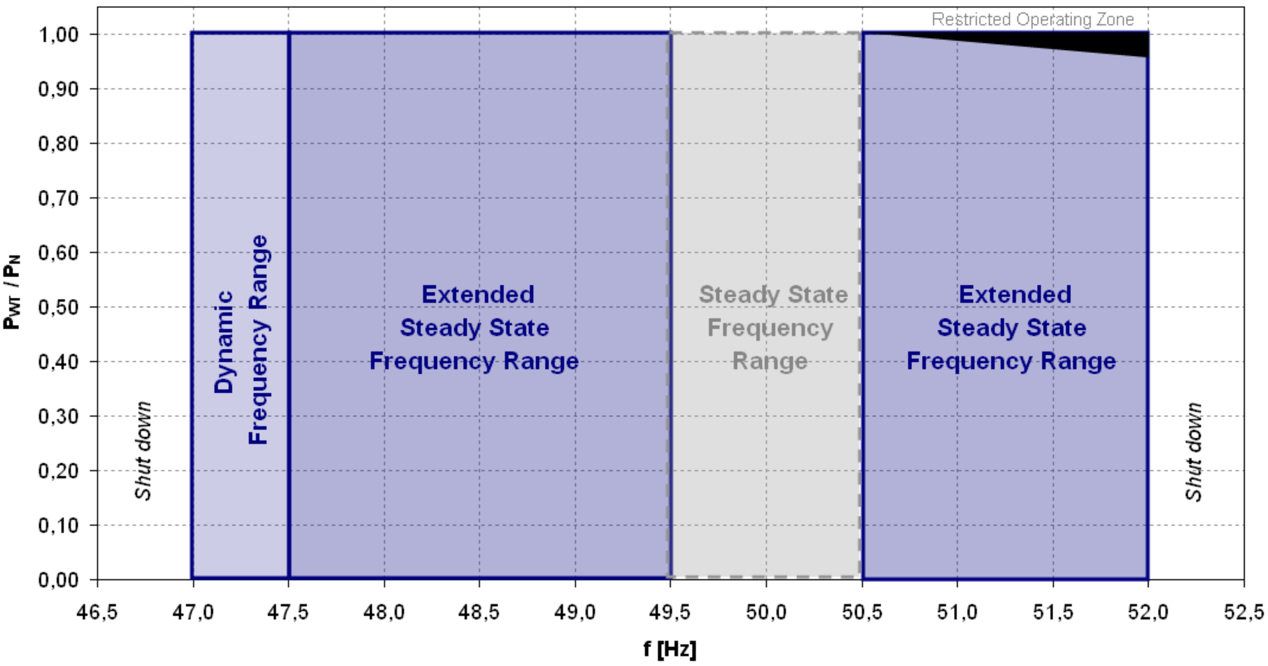

Fig. 3.2.1 - 1: Steady State & Dynamic Frequency Range

The standard protection configuration for the wind turbine for minimum and maximum frequencies are adjustable parameters that can be chosen in accordance with the permissible ranges shown in the figure above.

Within the "Restricted Operating Zone" (black area in the figure above) the active power output might be reduced. The reactive power range of the wind turbine can be limited in the extended stationary and dynamic frequency range. During extreme situations a disconnection from the grid is possible.

The capability and control options of the wind turbine or wind farm can be extended by adding optional Senvion Grid Products and/or Senvion SCADA products to contribute to compliance with project-specific grid requirements and control the wind farm as a power plant.

The electrical properties of the Senvion 3.4M114 are defined in the documents "Electrical Properties according to FGW" and "Electrical Properties according to IEC", see chapter "Applicable Documents" in this document.

The values in table above can be maintained if the grid quality matches the parameters specified in the document “Standard Grid Conditions", see chapter "Applicable Documents" in this document.

3.2.2 Standard Wind Turbine Grid Protection

The grid protection of the control system measures the current and voltage in each phase, guaranteeing a three-phase grid monitoring. The grid monitoring analyzes the currents, voltages and time graphs to disconnect the generator and converter from the grid for their own protection as soon as one of the events listed in the following table occurs.

Standard grid protection settings at medium voltage side of the WTG

Trigger criterion	Typical trigger value	Comment
Over voltage [U >] (symmetrical/asymmetrical)	1.1*U_N	Setting values shall be defined together with the responsible network operator
Under voltage [U <] (symmetrical/asymmetrical)	0.9*U_N	Setting values shall be defined together with the responsible network operator
Over Frequency [f >]	50.5 Hz	Setting values shall be defined together with the responsible network operator
Under Frequency [f <]	49.5 Hz	Setting values shall be defined together with the responsible network operator
Max. current asymmetry		Trigger period ≤ 5 s
Phase angle deviation	±6°	Without delay

The standard grid protection configuration can be adjusted project-specific dependent on the additionally acquired Senvion Grid Products. Without Grid Products the wind turbine will shut down immediately according to the above mentioned trigger values.

The standard protection configuration for the wind turbine for minimum and maximum frequencies are adjustable parameters that can be chosen in accordance with the permissible ranges shown in the figure of the previous chapter.

After one of the events in the table above occurs, the wind turbine automatically re-synchronizes with the grid as soon as it is available again.

3.3 Main Electrical Components

3.3.1 Generator

Technical Data Generator	
Concept	Asynchronous double-fed generator with rotor power recovery to the grid via the frequency converter. The stator winding is synchronised to the low-voltage side and is connected directly to the grid with a soft cut-in.
Nominal power/speed	P_G = ~3,600 kW at n = 1,200 rpm (±50 kW depending on manufacturer)
Speed range	n = 600 - 1,200 (dyn. +200) rpm To each speed a specific maximum power value is assigned whose average value may not be exceeded for design reasons.
Design	Double-fed asynchronous generator
Model	IM B3 according to DIN IEC 60034 code I IM 1001 according to DIN IEC 60034 code II
Size	630
Protection class	IP 54 (slip ring: IP 23)
Cooling	Cooling via air/air heat exchanger. Cooling air flow is generated by an external fan. Cooling air induction from the nacelle.

Technical Data Generator	
Sensors	PT 100 to monitor the bearing temperature PT 100 to monitor the winding temperature Brush wear warning
Miscellaneous	Covers prevent the contact with rotating components. Grounded generator housing to prevent static charges. To minimize vibration and noise emissions the generator is supported on the main frame on sound and vibration decoupled elements.

3.3.2 Converter

Technical Data Converter	
Concept	Frequency converter for double-fed induction generator with DC link.
Operating mode	Control/regulation of active and reactive power. Recovery of the rotor power via the generator and converter on the grid side inverter.
Power transistor	IGBTs
Protection class	IP 54, induction field: IP 21
Cooling	Air flow cooling of the converter housing. Liquid cooling system for IGBTs.

3.3.3 Transformer System

The transformer and the medium voltage switchgear are installed inside the tower. For the customer this has the advantage of no further planning permissions being required for an additional building.

For further details please see the document “Internal Transformer System [3.XM/50Hz/Europe and Australia only]”.

3.4 Own Consumption

The own consumption of the wind turbine in standby mode is made up of the individual consumption of the following components:

- Control system (control computer and converter)
- Yaw system
- Hydraulic pump
- Heating for gearbox, generator and control cabinets
- Battery charger
- Pitch drive during different operating states
- Obstacle light

The own consumption is approx. 40 kW (10 minute average value). The requirement depends largely on the installation location of the wind turbine. The own consumption is particularly high if the wind speed is less than 4 m/s whilst temperatures are below freezing.

Consumption values may differ by several units dependent on location, near the coast or further inland. As a rough estimate between 8,300 and 16,000 kWh per annum may be assumed for locations with average wind speeds, with up or down deviations possible. These details do not take the requirement of connected components (e.g., transformer, auxiliary units and medium and low voltage cabling) into account.

4 Safety Device

4.1 General Safety

As all Senvion wind turbines, the Senvion 3.4M114 has been designed with a view to highest operational safety. This generally includes:

- Aerodynamic brake in fail-safe design through independent individual pitch adjustment
- Protection against the escape of fluid through labyrinths and collection containers
- Control-independent safety chains
- Covers for rotating components in the machine to protect individuals
- Generous space in the nacelle for maintenance and service
- Access to the rotor hub from inside the nacelle

4.2 Safety Chain

The safety chain is a hard-wired circuit in which all contacts for triggering an emergency stop are connected in series. If the safety chain is interrupted, the WTG shall stop immediately. A reset can only be done, when the cause for the interruption has been rectified (excepting emergency stops due to grid loss).

The following safety chain contacts can trigger an emergency stop:

- Emergency stop button on top box (nacelle)
- Emergency stop button on portable control unit (nacelle)
- Emergency stop button on the control cabinet in the tower base
- Overspeed switchgear for rotor speed
- Overspeed switchgear for gearbox speed
- Vibration switch
- Cam switch (azimuth revolutions counter)
- "Enable manual pitch" switch on the top box
- Hardware contact on the system management computer

4.3 Brakes

The brake system consists of the primary aerodynamic brake system and the secondary mechanical brake system.

Braking is aerodynamic by moving the rotor blades into the 90° position. Each individual adjustment device of the three rotor blades operates entirely independently. In case of a grid failure the adjustment motors are supplied by their independent battery sets.

The movement of a single rotor blade is sufficient to move the wind turbine into a safe speed range. This results in a triple redundant system.

The mechanical rotor holding brake system is installed at the high-speed shaft as an active system. It is activated if the primary safety systems fails partially or totally and stops the rotor in conjunction with the blade adjustment system. It is also used to fix the rotor once the aerodynamic braking system has stopped the rotor to secure it during maintenance work.

The brake systems are designed as fail-safe systems. This means that if only one of the brake system components fails or malfunctions the wind turbine immediately moves into a safe state.

4.4 Lightning Protection

The wind turbine is equipped with a lightning protection system designed by lightning protection experts and complies with protection class 1 required by the international standard IEC 61400-24 Edit.1 “Wind turbines - section 24: lightning protection" and IEC 62305-1 "Lightning protection - paragraph 1: General". The discharge is from the rotor over slip rings and dischargers on the tower. This way, the current of the bolt of lightning is discharged via foundation and/or deep grounding mechanisms into the ground.

5 Control System

5.1 Cut-In/Cut-Out Strategy

The design parameters for the wind turbine operation are within the range of the following 10 minute average values of the wind speed:

Technical Data Cut-In/Cut-Out Strategy	
Cut-In wind speed	3.0 m/s
Rated wind speed	12.0 m/s
Cut-Out wind speed	22.0 m/s

5.2 Control System

The control system Senvion Control permits an integration of the Senvion 3.4M114 into the Senvion SCADA system Senvion SCADA Solutions. Senvion Control is a microprocessor-based control system. Optical fibers are used for signal transmission. The wind turbine must be equipped with SCADA Access Monitoring Advanced or Professional as default. SCADA Access Monitoring permits the direct access to the control system Senvion Control and other Senvion SCADA components installed at the location, such as Power Management Unit or Meteo Station. Dependent on the user access level SCADA Access Monitoring visualizes current operating data as well as data saved on the control device.

The control device is installed in the nacelle. An additional display permits operational control from the tower base.

Technical Data Control System	
Principle	Microprocessor
Signal transmission	Optical fiber
Remote monitoring	SCADA Access Monitoring

5.3 Measures in Case of Ice Accretion

As ice accretion on wind turbines, especially on rotor blades, may lead to an increased hazard to the environment, different measures can be taken in order to reduce this hazard caused by ice throw.

5.3.1 Ice Detection

Senvion wind turbines are equipped with a redundant and state-of-the-art ice detection system as assessed by TÜV Nord, which enables the turbine operating system to detect ice during operation as well as during stand still. This is realized by the following means:

- Comparison measurement of anemometers
- Analysis of the measured values during turbine operation
- Wind turbine protection by vibration monitoring

These monitoring functions trigger status codes in Senvion's turbine control system.

5.3.2 Turbine Behavior in Case of Ice Detection

In case of ice detection, the wind turbine automatically shuts down. The restart of the turbine is conducted automatically when icing conditions can be excluded.

If the absence of ice has been reported after a visual on-site inspection, it is also possible to restart the turbine manually under specific conditions.

Shutdown and restarting of the wind turbine are recorded in the operating computer’s event protocol and are available for subsequent verification purposes.

The configuration of Senvion's measures in case of ice accretion can be adapted turbine specifically in case an annual wind turbine site assessment has been carried out and the resultant risk class allows different turbine behaviour.

6 Dimensions and Weights

The Senvion 3.4M114 has been generally designed for ease of transport and erection. For this reason the weights are roughly within the range of the Senvion MM series. The option to install, and where necessary transport, the nacelle and drive train separately permits the use of comparable crane equipment as for the wind turbines of the 2 MW class (e.g. Senvion MM series).

6.1 Weights

Weights	
Rotor blade	approx. 15.0 t
Rotor hub (incl. pitch system)	approx. 25.0 t
Nacelle (excl. rotor and drive train)	approx. 58.0 t
Drive train	approx. 52.0 t

6.2 Dimensions

Dimensions Rotor Blade	
Length	approx. 55.8 m
Height	approx. 2.8 m

Dimensions Rotor Hub	
Diameter	approx. 4.2 m
Height	approx. 3.8 m

Dimensions Nacelle	
Length	approx. 13.0 m
Depth	approx. 4.3 m
Height	approx. 4.2 m

Dimensions Drive Train (rotor, bearing, shaft and gearbox)	
Length	approx. 6.9 m
Depth	approx. 3.1 m
Height	approx. 3.4 m

Power Curve & Sound Power Level

[3.6M114NES/50Hz/open]

Doc. no.: SD-3.9-WT.PC.00-B-C-EN
2016-09-21

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Disclaimer [European Market]

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Possible work procedures described in this product description comply with German, and Senvion's, safety provisions and regulations The laws of other countries may provide for additional safety specifications.

It is essential that all safety measures, both project and country-specific, be strictly complied with. It is the duty of each customer to inform itself, implement and comply with these measures.

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1 Applicable Documents

The documents referred to in the table below are included for information only. Reference to them in this document does not make them part of the contract.

Title	Document-No.

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

2 Introduction

This document shows the power curve and sound power level of the Senvion 3.6M114 NES and the corresponding measurement conditions.

3 Conditions for the measurement and scope of the power curve and sound power level

3.1 General information

Rotor diameter:	114 m
Cut in wind speed:	3.0 m/s
Cut out wind speed:	22.0 m/s
Wind speed at hub height:	10 min. mean value

3.2 Conditions for the measurement and scope of the power curve

Verification according to IEC 61400-12-1: 2005

Turbulence intensity:	6 to 20 %
Terrain:	not complex acc. to IEC 61400-12-1: 2005
Vertical wind shear coefficient (measured between hub height and lower blade tip):	0 to 0.3
Air density at location (10 min. mean value):	≥ 1,13 kg/m^3
Temperature range:	acc. to related standard conditions of use
Anemometer type:	Thies First Class Advanced
Blades:	clean, without ice or snow formation

For obstacle assessment, IEC 61400-12-1: 2005 Annex A.2 together with the MEASNET procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed. In addition, no obstacles with a height greater than 1/3 of the distance between the ground and the lowest blade tip position shall exist in the measurement sector within 0-4 rotor diameters of the WTG or met mast.

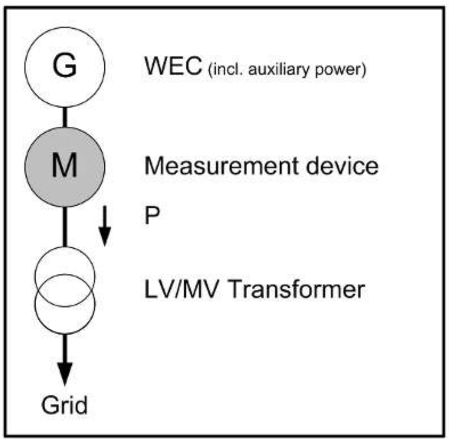

Fig. 3.2 - 1: Arrangement of a measuring unit for the PC measurement

3.3 Conditions for the measurement and scope of the sound power level

Verification acc. to	IEC 61400-11 Ed.3
Roughness length (average peak):	0.05 m

4 Electrical power curve and sound power level

4.1 Electrical power curve

Values related to an air density of 1.225 kg/m³

Wind speed v [m/s]	Power P [kW]	Thrust coefficient c_S [-]	Power coefficient c_P [-]
3.0	43	0.88	0.255
4.0	162	0.85	0.405
5.0	344	0.82	0.440
6.0	608	0.82	0.450
7.0	981	0.82	0.457
8.0	1482	0.80	0.463
9.0	2077	0.74	0.456
10.0	2684	0.66	0.429
11.0	3214	0.56	0.386
12.0	3525	0.45	0.326
13.0	3600	0.35	0.262
14.0	3600	0.27	0.210
15.0	3600	0.22	0.171
16.0	3600	0.18	0.141
17.0	3600	0.15	0.117
18.0	3600	0.13	0.099
19.0	3600	0.11	0.084
20.0	3600	0.09	0.072
21.0	3600	0.08	0.062
22.0	3600	0.07	0.054

The electrical power is valid for pure active power set points.

The electrical power is valid for the low-voltage side of the transformer.

4.2 Sound power level according to IEC

Sound Power Level according to IEC for wind speed at hub height

Wind Speed v [m/s]	Sound Power Level L_{WA} [dB(A)]
4.0	95.0
4.5	95.9
5.0	96.7
5.5	97.5
6.0	98.4
6.5	99.8
7.0	101.2
7.5	102.6
8.0	103.7
8.5	104.1
9.0	104.2
9.5	104.2
10.0	104.2
10.5	104.2
11.0	104.2
11.5	104.1
12.0	103.9
12.5 – 22.0	103.8

Sound Power Level according to IEC for wind speed at 10 m height

Wind Speed v_{10} [m/s]	Sound Power Level L_{WA} [dB(A)]	
	93 m	**119 m**
3.0	95.5	95.8
3.5	96.7	97.0
4.0	97.8	98.2
4.5	99.5	100.2
5.0	101.5	102.2
5.5	103.3	103.8
6.0	104.1	104.2
6.5	104.2	104.2
7.0	104.2	104.2
7.5	104.2	104.2
8.0	104.1	104.0
8.5	103.9	103.8
9.0 - v_{out}	103.8	103.8

The sound power level given below exclude measurement uncertainty. With the established sound measurement methods (see chapter 2.3) there might be deviations of around +/- 1 dB(A) due to the measurement uncertainty.

In case an approving authority or an external consultant does not consider uncertainty or considers an uncertainty of less than 1 dB(A) for the sound propagation modelling, a measurement uncertainty of at least 1 dB(A) shall be added instead to the sound power levels provided below. The measurement uncertainty has to be taken into account for the maximum sound power level within permits.

There is no tonal audibility $\Delta L_{a,k}$ >2 dB (for $V_{10} \geq$ 6m/s).

4.3 Sound power level at 95 % of rated power

Independently of the hub height, the sound power level at 95 % of the rated power is:

$$L_{WA,95\%} = 104.2 \text{ dB(A)}$$

This sound power level excludes measurement uncertainty. With the established sound measurement methods (see chapter 2.3) there might be deviations of around +/- 1 dB(A) due to the measurement uncertainty.

In case an approving authority or an external consultant does not consider uncertainty or considers an uncertainty of less than 1 dB(A) for the sound propagation modelling, a measurement uncertainty of at least 1 dB(A) shall be added instead to the sound power level provided above. The measurement uncertainty has to be taken into account for the maximum sound power level within permits.

SENVION M140

Product Specification

[4.XM140/50Hz]

Sales Document

Doc. no.: PD-3.52-WT.WT.00-A-EN-D
2019-04-01

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1 Technical Description

1.1 Rotor system

The rotor consists of the rotor hub and three rotor blades that are flanged via pivotable blade bearings to the rotor hub. The rotor blades can be individually adjusted along the longitudinal axis using an individual pitch system. Maintenance work on the casted rotor hub is facilitated by the fact that it is directly accessible from the nacelle through openings between the blade root connections.

The rotor blades are made of glass-fibre reinforced plastic in a sandwich construction. In the spar caps, the RodPack technology is used, which are cured pultruded rods placed on nonwoven fabric, to enable an optimized blade design and higher quality blade production. The blade design has been optimized with regard to improved aerodynamic efficiency and a reduction in noise emissions.

A special coating protects the rotor blades against the negative effects of UV radiation and moisture. To prevent erosion, the blade leading edges are further protected by additional measures (e.g. anti-erosion film). The rotor blade can optionally have blade markings applied.

To ensure aerodynamic performance and stability, as well as low noise emissions, vortex generators and additional sound reducing add-ons are used.

1.2 Pitch and communication

The wind turbine generator is controlled by microprocessor-based industrial controls. The pitch system is an integral part of the wind turbine generator's operation and load management system, ensuring reliable and safe control of the turbine at all times. Fast communication is ensured by data transfer by means of optical fiber cables. An additional safety controller ensures high availability and reliability of the control system. The rotor has three independent electric pitch motors and battery controllers to adjust the blade angles during operation. The equipment of the turbine with three independent pitch systems ensures a redundancy of the individual aerodynamic braking possibilities.

1.3 Mechanical Drivetrain

The gearbox has been designed as a planetary/spur gearbox. The torque bracket of the gearbox is supported by elastic bushings on the main frame. The elastic suspension permits effective noise and vibration decoupling from the main frame. In addition, the gearbox has one electrical and one mechanical oil pump in order to ensure sufficient lubrication when idle.

The mechanical braking system consists of a disk brake which is installed on the fast gearbox shaft as an active working system. During maintenance work the mechanical brake is used in addition to the rotor lock after the aerodynamic brake system has stopped the rotor.

The main shaft is mounted at three points above the head flange of the tower. The front bearing is designed as a self-aligning roller bearing. The two rear bearing points are the torque arms of the gearbox.

1.4 Electrical Drivetrain

The wind turbine generator is equipped with an asynchronous generator with squirrel cage and a liquid-cooled full scale converter with DC link. The converter decouples the generator from the grid, regulates the active and reactive power and meets the strictest grid requirements.

1.5 Nacelle

The nacelle has been optimized for safe and comfortable access to all service-relevant positions. The nacelle access is made possible by the tower and the nacelle floor. A hatch at the front end of the nacelle provides access to the rotor blades and the hub. The nacelle cover consists of GFRP. The rotor can be secured with a mechanical rotor lock.

1.6 Yaw

The nacelle is connected to the tower via a four-point contact bearing. The tower bearing consists of an outer ring gear with a ball bearing. The yaw system of the nacelle is carried out by a series of electric gear motors. Hydraulic brake calipers keep the nacelle in wind direction.

1.7 Control incl. switchgear

The wind turbine generator works fully automatically. As soon as the activation wind speed is reached, the turbine starts the operation and adapts automatically to the wind conditions according to the power curve. When the deactivation wind speed is reached, the system shuts down automatically and goes to a safe state. The wind turbine generator will continue to operate as soon as the wind falls below the restart wind speed.

The wind turbine generator is continuously connected to the Senvion SCADA Solutions Online Portal, which enables remote control of the system as well as access to a variety of system and sensor data, e.g. operating data, status codes, condition monitoring data, meteorological data, power generation data and grid information.

1.8 Tower

The wind turbine generator is designed as standard as a tubular tower or as a hybrid tower, a combination of a concrete and steel tower. The towers have an internal ladder, direct access to the yaw system and into the nacelle. Each tower segment is equipped with platforms and emergency lighting. The towers are equipped market-specifically with an internal or external transformer.

1.9 Lightning protection

The wind turbine generator complies with the international standard IEC 61400-24 "Wind turbine generators - Part 24: Lightning protection" and IEC 62305-1 "Protection against lightning strike - Part 1: General principles" required lightning protection class 1.

1.10 Icing measures

Ice accretion on a wind turbine generator and in particular its rotor blades may result in a danger to the environment (humans, animals, traffic) and a danger to the wind turbine generator itself. An environmental hazard arises if lumps of ice are thrown into the surroundings from the rotor blades. The wind turbine generator itself is at risk because ice accretion alters the rotor blades' aerodynamic profile, meaning that increased loads may occur on the system.

Senvion wind turbine generators are categorized in risk class II by default. Classification in risk class I is only possible following a site assessment. The document entitled "Actions in the event of ice accretion" provides detailed information on this process.

1.11 Auxiliary power

The power required by the wind turbine generator in a parking position includes the individual requirements of the following components:

- Control (control computer and converter)
- Yaw system
- Hydraulic pump
- Heating for gearbox, generator and control cabinets
- Battery charger
- Pitch drive in different operating modes
- Aviation lights

The auxiliary power of the system depends to a large extent on the location. The energy requirements are particularly high when the wind speed is less than 4 m/s and the ambient temperature is below freezing. The own requirement is about 40 kW (10 minutes average value).

2 Technical Specifications

Rotor	Value		Unit
	4.2MW	4.5MW power mode	
Diameter	140	140	m
Swept rotor area	15.394	15.394	m^2
Nominal speed	10.6	11.0	rpm
Rotor axis inclination	5	5	°
Rotor cone angle	4	4	°
Direction of rotation	clockwise (right)	clockwise (right)	-
Rotor position	upwind	upwind	-

Blades	Value	Unit
Number of rotor blades	3	
Rotor blade length	68.5	m
Material	Glass-fiber reinforced plastic (GFRP) in sandwich construction	
Rotor blade color	light grey (RAL 7035)	

Pitch system	
Type	Electric individual blade pitch
Power control	Blade pitch and speed control
Drive	DC motors, battery-buffered, synchronized

Yaw	Value
Type	6 gear motors, 24 brake calipers
Bearing	Four-point bearing with external gearing

Gearbox	Value		Unit
	4.2MW	4.5MW power mode	
Type	Planetary/spur gear	Planetary/spur gear	-
Nominal mechanical power	4.696	5.070	kW

Generator	Value		Unit
	4.2MW	4.5MW power mode	
Type	Asynchronous generator (squirrel cage rotor)	Asynchronous generator (squirrel cage rotor)	-
Nominal power	4.200	4.500	KW
Protection class	IP 54	IP 54	-
Cooling system	Cooling via air/air heat exchanger. Cooling air flow is generated by an external fan. Cooling air induction from the na-celle.	Cooling via air/air heat exchanger. Cooling air flow is generated by an external fan. Cooling air induction from the na-celle.	

Converter	Value
Type	Full scale converter with direct voltage intermediate circuit.
Operating mode	Control/regulation of active and reactive power.
Protection class	IP 54, brake resistor: IP 21
Cooling system	Air flow cooling of the converter housing. Liquid cooling system for IGBTs.

Electrical parameters	Value		Unit
	4.2MW	4.5MW power mode	
Nominal voltage	660	660	V
Voltage range of the WTG	90 ≤ UN ≤ 110	90 ≤ UN ≤ 110	%
Nominal frequency	50	50	Hz

Tower	Value	Unit
Type	Tubular steel tower	
Hub height	110, 130, project specific	m
Corrosion protection	Project specific	

Operational Data	Value	Unit
Cut-in wind speed	3.0	m/s
Nominal wind speed	-	m/s
Cut-out wind speed	22.0 (26.0 with derating)	m/s
Cut-back-in wind speed	-	m/s

Weights (approximately)	Value	Unit
Rotor blade	16.5	t
Rotor hub	47.0	t
Drive train	70.0	t
Generator	12.0	t
Main frame	28.1	t
Yaw	9.5	t
Covers	6.5	t
Electrical components	5.0	t

Dimensions (approximately)	L	W	H	Unit
Rotor blade	68.5	4.25	-	m
Rotor hub	5.8	5.1	4.4	m
Nacelle	12.8	4.8	5.1	m
Drive train	7.3	3.8	3.1	m

3 Standard Conditions of Use

The data below shows the Standard Conditions of Use of the Senvion 4.2M140. Only after a project-specific check and explicit, written approval by Senvion, the wind turbine generator (WTG) can also be installed and operated on sites that differ from the standard defined in this document.

3.1 Design Conditions

Parameter	**Value**			
	4.2MW		**4.5MW power mode**	
Cut-in wind speed v_{in} [m/s]	3.0	3.0	3.0	3.0
Rated wind speed $v_{r,turb}$ [m/s]	11.0	11.0	-	-
Cut-out wind speed v_{out} [m/s]	22.0 (26.0 with derating)	22.0 (26.0 with derating)	22.0 (26.0 with derating)	22.0 (26.0 with derating)
Tower type	Tubular steel tower	Tubular steel tower	Tubular steel tower	Tubular steel tower
Hub height[1] [m]	110	130	110	130
IEC class[2]	IEC S (based on IEC IIB)	IEC S (based on IEC IIB)	Needs to be checked project-specifically	Needs to be checked project-specifically
Rated power[3] [kW]	4,200	4,200	4,500	4,500

NOTE 1. Depending on the foundation design.

NOTE 2. International Standard IEC 61400-22 “Wind turbines – Part 22: Conformity testing and certification”, First edition 2010-05 in combination with IEC 61400-1, Wind Turbine Generator Systems Part 1: “Design Requirements, Third edition, 2005-08 and amendment 1:2010” “Wind turbines – Part 1: Design requirements”.

NOTE 3. The value corresponds to an electrical power at LV-side of the transformer and does not include transformer losses.

3.2 Tolerated Climatic Conditions

Parameter	Value			
	4.2MW		4.5MW power mode	
Ambient temperature range for operation[1] [°C]	-20 to +45 (de-rating from 35°C possible)[4]	-20 to +45 (de-rating from 35°C possible)[4]	-20 to +45 (de-rating from 25°C possible)[4]	-20 to +45 (de-rating from 25°C possible)[4]
Ambient temperature range for structure design[2] [°C]	-20 to +50	-20 to +50	-20 to +50	-20 to +50
Hub height [m]	110	130	110	130
Calculated lifetime [y]	25	20	Project specific	Project specific
IEC class	IEC S (based on IEC IIB)	IEC S (based on IEC IIB)	Project specific	Project specific
Annual average wind speed v_{ave} (10 min) [m/s]	8.5	7.5	Project specific	Project specific
Reference wind speed v_{ref} (10 min) [m/s]	37.5	37.5	37.5	37.5
50 year extreme wind speed v_{e50} (3 s)[3] [m/s]	52.5	52.5	52.5	52.5
Annual wind speed v_{m1} (10 min) [m/s]	30.0	30.0	30.0	30.0
Category of turbulence characteristic	B	B	B	B
Maximum flow inclination angle [°]	8	8	8	8

NOTE 1. For installation altitudes over 1,000 m the maximum operating temperature decreases by 0.75 °C per 100 m. For temperatures below -20 °C the WTG will shut down from operation and will restart at -15 °C. A cut-off at temperatures between -20 °C and approx. +3 °C can occur due to safety reasons because of the detection of ice.

NOTE 2. Temperature can fall below the minimum temperature of structural design of -20 °C down to minimum ambient temperature of -30 °C provided that this situation does not occur more often than 9 days/year in a long term average, as specified in „GL Guideline for the Certification of Wind Turbines, Edition 2003, paragraph 4.4.5.(1)“.

NOTE 3. Informative value not covered by the guideline.

NOTE 4. During operation from 35 °C to 40 °C the full load range power is reduced to a minimum of 3,570 *kW depending on the state of components in order to prevent overheating. During operation from 40 °C to 45 °C the full load range power is reduced to a minimum of 1,050 kW depending on the state of components in order to prevent overheating.*

3.3 General Conditions

Parameter	Value
Distances between WTGs in wind farms	A minimum distance of 5 rotor diameters (700 m) between turbines should generally be observed.
Maximum slope within an area of 100 meters [°] (%)	10 (17.6)
Maximum installation altitude over sea level [m]	2,000 - hub height
Maximum medial vertical wind shear coefficient	0.2
Roughness class (Roughness length) [m]	2.5 (0.2)
Air density[1] [kg/m^3]	1.225
Solar radiation [W/m^2]	1,000

NOTE 1. Standard air density: 1.225 kg/m^3 at temperature 15 °C at hub height and air pressure 1013 hPa.

3.4 Quality Requirements at Grid Connection Point

The requirements on the quality of the electrical parameters of the grid connection point to be provided by the customer must at least correspond to EN 50160:2007 "Voltage characteristics of electricity supplied by public distribution networks" in its current version. This standard specifies the minimum limits and reference values for the supply voltage to be expected at the connection points at public low-voltage and medium voltage systems.

According to IEC 61400-1 in its current version, long-term grid failures may occur no more than 20 times a year for a maximum duration of 6 h and once a year for a maximum duration of 1 week. If the specified limits and reference values cannot be met at the grid connection point, the customer is obliged to inform Senvion of this in time in writing and to take appropriate measures to protect the wind turbine in consultation with Senvion.

Power Curve & Sound Power Level

[4.2M140 EBC/50Hz/open mode]
(preliminary)

Doc. no.: SD-3.52-WT.PC.01-B-EN-A
2018-04-11

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1 Introduction

This document shows the power curve and sound power level of the Senvion 4.2M140 EBC and the corresponding measurement conditions.

2 Conditions for the measurement and scope of the power curve and sound power level

2.1 General information

Rotor diameter:	140 m
Cut in wind speed:	3.0 m/s
Cut out wind speed:	26.0 m/s
Wind speed at hub height:	10 min. mean value

2.2 Conditions for the measurement and scope of the power curve

Verification according to IEC 61400-12-1: 2005

Turbulence intensity:	6 to 12 %
Terrain:	not complex acc. to IEC 61400-12-1: 2005
Vertical wind shear coefficient (measured between hub height and lower blade tip):	0 to 0.3
Air density at location (10 min. mean value):	≥ 1.13 kg/m^3
Inflow angle (vertical)	±2°
Temperature range:	acc. to related standard conditions of use
Anemometer type:	Thies First Class Advanced
Blades:	clean, without ice or snow formation

For obstacle assessment, IEC 61400-12-1: 2005 Annex A.2 together with the MEASNET procedure “Power Performance Measurement Procedure – Version 5, December 2009” chapter 3.9 has to be followed. In addition, no obstacles with a height greater than 1/3 of the distance between the ground and the lowest blade tip position shall exist in the measurement sector within 0-4 rotor diameters of the WTG or met mast.

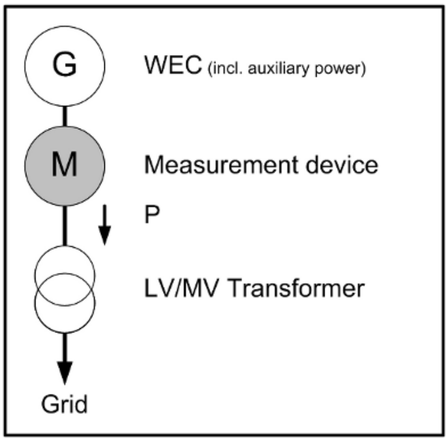

Fig. 1: Arrangement of a measuring unit for the PC measurement

2.3 Conditions for the measurement and scope of the sound power level

Verification acc. to:	IEC 61400-11 Ed.3
Roughness length (average peak):	0.05 m
Turbulence intensity:	6 to 12 %
Terrain:	not complex acc. to IEC 61400-12-1: 2005
Vertical wind shear coefficient (measured between hub height and lower blade tip):	0 to 0.3
Blades:	clean, without ice or snow formation

3 Electrical power curve and sound power level

3.1 Electrical power curve

Values related to an air density of 1.225 kg/m³

Wind speed v [m/s]	Power P [kW]	Thrust coefficient c_T [-]	Power coefficient c_P [-]
3.0	33	0.87	0.130
4.0	215	0.82	0.356
5.0	494	0.79	0.419
6.0	911	0.80	0.447
7.0	1456	0.79	0.450
8.0	2159	0.78	0.447
9.0	3058	0.72	0.445
10.0	3808	0.61	0.404
11.0	4182	0.47	0.333
12.0	4200	0.36	0.258
13.0	4200	0.27	0.203
14.0	4200	0.21	0.162
15.0	4200	0.17	0.132
16.0	4200	0.14	0.109
17.0	4200	0.12	0.091
18.0	4200	0.10	0.076
19.0	4200	0.09	0.065
20.0	4200	0.08	0.056
21.0	4200	0.07	0.048
22.0	3948	0.06	0.039
23.0	3360	0.04	0.029
24.0	2520	0.03	0.019
25.0	1680	0.02	0.011
26.0	840	0.01	0.005

The electrical power is valid for pure active power set points.

The electrical power is valid for the low-voltage side of the transformer.

3.2 Electrical power curve dependent on the Air Density

The tables below show the power curve dependent on different air densities applicable at the low-voltage side of the transformer and the related thrust curve.

Power curves at the low-voltage side of the transformer (excludes transformer losses)

Wind speed (at hub height) v [m/s]	Electrical power P [kW]									
	1.00 kg/m³	1.03 kg/m³	1.06 kg/m³	1.09 kg/m³	1.12 kg/m³	1.15 kg/m³	1.18 kg/m³	1.21 kg/m³	1.24 kg/m³	1.27 kg/m³
3	15	17	20	22	24	27	29	31	34	36
4	164	171	178	184	191	198	205	211	218	225
5	391	405	419	432	446	460	474	487	501	515
6	734	758	781	805	829	852	876	899	923	946
7	1182	1219	1256	1292	1329	1365	1401	1438	1474	1510
8	1764	1817	1870	1922	1975	2028	2080	2133	2186	2238
9	2506	2580	2654	2728	2802	2875	2949	3022	3094	3164
10	3267	3355	3437	3517	3591	3659	3722	3780	3835	3887
11	3879	3943	4001	4054	4097	4131	4155	4174	4189	4200
12	4166	4188	4200	4200	4200	4200	4200	4200	4200	4200
13	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
14	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
15	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
16	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
17	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
18	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
19	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
20	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
21	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
22	3948	3948	3948	3948	3948	3948	3948	3948	3948	3948
23	3360	3360	3360	3360	3360	3360	3360	3360	3360	3360
24	2520	2520	2520	2520	2520	2520	2520	2520	2520	2520
25	1680	1680	1680	1680	1680	1680	1680	1680	1680	1680
26	840	840	840	840	840	840	840	840	840	840

Thrust curves according to the power curves shown above

Wind speed (at hub height) v [m/s]	Thrust coefficient c_T [-]									
	1.00 kg/m³	1.03 kg/m³	1.06 kg/m³	1.09 kg/m³	1.12 kg/m³	1.15 kg/m³	1.18 kg/m³	1.21 kg/m³	1.24 kg/m³	1.27 kg/m³
3	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
4	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
5	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
6	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
7	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
8	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
9	0.73	0.73	0.73	0.73	0.73	0.73	0.72	0.72	0.72	0.72
10	0.66	0.65	0.65	0.64	0.63	0.63	0.62	0.61	0.60	0.60
11	0.56	0.55	0.54	0.53	0.52	0.50	0.49	0.48	0.47	0.45
12	0.44	0.42	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34
13	0.34	0.33	0.32	0.31	0.30	0.29	0.28	0.28	0.27	0.26
14	0.26	0.26	0.25	0.24	0.23	0.23	0.22	0.22	0.21	0.21
15	0.21	0.21	0.20	0.19	0.19	0.18	0.18	0.18	0.17	0.17
16	0.17	0.17	0.16	0.16	0.16	0.15	0.15	0.15	0.14	0.14
17	0.15	0.14	0.14	0.13	0.13	0.13	0.12	0.12	0.12	0.12
18	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10
19	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.08
20	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07
21	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.06
22	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
23	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04
24	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
25	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
26	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

This overview is for information only in order to illustrate the influence of the air density on the power curve.

Please note: For a power curve out of the range of the air density given in this document special project specific considerations are required. In this case please refer to your Senvion GmbH sales representative.

3.3 Sound power level according to IEC

The sound power level given below exclude measurement uncertainty. With the established sound measurement methods [► Page 6] there might be deviations of around +/- 2 dB(A) due to the measurement uncertainty.

In case an approving authority or an external consultant does not consider uncertainty or considers an uncertainty of less than 2 dB(A) for the sound propagation modelling, a measurement uncertainty of at least 2 dB(A) shall be added instead to the sound power levels provided below. The measurement uncertainty has to be taken into account for the maximum sound power level within permits.

There is no tonal audibility $\Delta L_{a,k}$ >2 dB (for $V_{10} \geq$ 6m/s).

Sound Power Level according to IEC for wind speed at hub height

Wind speed v [m/s]	Sound Power Level L_{WA} [dB(A)]
3.0	94.0
3.5	94.0
4.0	94.0
4.5	94.0
5.0	94.2
5.5	96.2
6.0	98.0
6.5	99.7
7.0	101.2
7.5	102.6
8.0	104.0
8.5	105.0
9.0	105.0
9.5	105.0
10.0	105.0
10.5	105.0
11.0	105.0
11.5	105.0
12.0	105.0
12.5	105.0
13.0	105.0
13.5	105.0
14. 0 – 26.0	105.0

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Sound Power Level according to IEC for wind speed at 10 m height

Wind speed v_{10} [m/s]	Sound Power Level L_{WA} [dB(A)]		
	110 m	130 m	165 m
3.0	94.0	94.0	94.0
3.5	94.4	94.9	95.6
4.0	97.4	97.8	98.4
4.5	99.8	100.3	100.9
5.0	102.0	102.4	103.0
5.5	103.9	104.3	104.9
6.0	105.0	105.0	105.0
6.5	105.0	105.0	105.0
7.0	105.0	105.0	105.0
7.5	105.0	105.0	105.0
8.0	105.0	105.0	105.0
8.5	105.0	105.0	105.0
9.0	105.0	105.0	105.0
9.5	105.0	105.0	105.0
10.0	105.0	105.0	105.0
10.5	105.0	105.0	105.0
11.0	105.0	105.0	105.0
11.5	105.0	105.0	105.0
12.0 - v_{out}	105.0	105.0	105.0

3.4 Sound power level at 95 % of rated power

Independently of the hub height, the sound power level at 95 % of the rated power is:

$$L_{WA,95\%} = 105.0 \text{ dB(A)}$$

This sound power level excludes measurement uncertainty. With the established sound measurement methods [► Page 6] there might be deviations of around +/- 2 dB(A) due to the measurement uncertainty.

In case an approving authority or an external consultant does not consider uncertainty or considers an uncertainty of less than 2 dB(A) for the sound propagation modelling, a measurement uncertainty of at least 2 dB(A) shall be added instead to the sound power level provided above. The measurement uncertainty has to be taken into account for the maximum sound power level within permits.

There is no tonal audibility $\Delta L_{a,k}$ >2 dB (for $V_{10} \geq 6$m/s).

4 Octave band data

4.1 Introduction

Octave and third octave bands give a more detailed description of the frequency content of the turbine noise.

This document describes the expected octave band and third octave band data for a Senvion 4.2M140 EBC.

Please note that measurement uncertainties are not included in the values presented in this document.

This document is intended to provide information only and therefore acts only as a preliminary non-committal guide. All values mentioned below can be subject to a change based on subsequent calculations or measurements. No rights and obligations of any nature whatever can be derived from general information given in this document. Senvion is not responsible for any claims in conjunction with this information.

4.2 Methodology

The described octave bands and third octave bands are derived from measurements which have been performed on a Senvion 3.XM turbine with serrations of a similar length compared to 4.2M140 EBC . The values are average values for each band and have been standardized to the guaranteed sound power level (L_{WA} [dB(A)]).

The data processing of the noise level has been performed in accordance with the requirements of the IEC 61400-11: 2002 + A1: 2006.

4.3 Octave Bands from 31.5 Hz to 8,000 Hz

Octave sound power spectrum for wind speeds referenced to hub height

Frequency	Octave Band Data in dB(A) for wind speed at hub height						
	6.0 m/s	6.5 m/s	7.0 m/s	7.5 m/s	8.0 m/s	8.5 m/s	9.0 m/s
31.5 Hz	72.3	72.5	74.1	76.5	77.9	79.2	79.4
63 Hz	80.9	81.3	83.8	85.3	86.8	88.3	88.4
125 Hz	84.3	86.0	88.9	90.8	92.4	94.3	94.1
250 Hz	87.4	89.1	92.6	94.6	96.0	97.3	97.1
500 Hz	90.2	91.9	93.8	95.6	97.1	98.3	98.1
1000 Hz	94.1	95.8	96.4	97.5	98.5	99.4	99.4
2000 Hz	91.2	92.9	94.1	95.3	96.9	97.8	97.9
4000 Hz	86.6	88.3	89.6	90.4	92.4	91.5	92.2
8000 Hz	66.8	68.6	71.2	72.4	75.8	76.8	77.3
L_{WA} [dB(A)]	98.0	99.7	101.2	102.6	104.0	105.0	105.0

Frequency	Octave Band Data in dB(A) for wind speed at hub height						
	9.5 m/s	10.0 m/s	10.5 m/s	11.0 m/s	11.5 m/s	12.0 m/s	12.5 m/s
31.5 Hz	79.2	79.2	79.2	78.9	79.5	78.4	78.4
63 Hz	88.6	88.5	88.2	88.0	87.9	87.1	87.1
125 Hz	94.2	94.2	93.8	93.1	93.5	93.0	93.0
250 Hz	97.0	96.8	96.6	96.3	96.2	96.0	96.0
500 Hz	98.0	97.9	97.8	97.6	97.6	97.6	97.6
1000 Hz	99.4	99.3	98.9	98.7	98.8	99.0	99.0
2000 Hz	98.1	98.2	98.4	98.6	98.5	98.5	98.5
4000 Hz	92.6	93.1	94.8	96.0	95.9	96.3	96.3
8000 Hz	78.0	79.2	81.0	81.9	81.6	80.5	80.5
L_{WA} [dB(A)]	105.0	105.0	105.0	105.0	105.0	105.0	105.0

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4.4 Third Octave Bands from 20 Hz to 10,000 Hz

Third octave sound power spectrum for wind speeds referenced to hub height

Fre-quency	Third Octave Band Data in dB(A) for wind speed at hub height						
	6.0 m/s	6.5 m/s	7.0 m/s	7.5 m/s	8.0 m/s	8.5 m/s	9.0 m/s
20 Hz	57.8	58.0	59.3	61.6	62.9	64.4	64.4
25 Hz	62.1	62.3	63.4	65.8	67.3	68.6	68.8
31.5 Hz	66.5	66.7	68.1	70.7	72.0	73.4	73.4
40 Hz	70.4	70.6	72.3	74.6	76.1	77.4	77.6
50 Hz	73.5	73.7	75.4	77.6	79.2	80.7	80.8
63 Hz	76.5	76.7	78.2	80.4	81.8	83.5	83.6
80 Hz	77.5	78.2	81.5	82.4	83.8	85.2	85.4
100 Hz	78.0	79.7	82.7	85.1	86.6	88.7	88.2
125 Hz	79.0	80.7	83.4	86.0	88.1	89.7	89.7
160 Hz	81.0	82.7	85.8	86.7	88.0	90.0	90.0
200 Hz	81.5	83.2	86.8	89.1	90.2	90.9	90.7
250 Hz	81.9	83.7	87.8	89.0	90.4	91.9	91.9
315 Hz	84.0	85.7	88.7	91.1	92.6	94.1	93.9
400 Hz	84.1	85.9	88.5	90.9	92.6	94.1	93.7
500 Hz	85.7	87.5	88.4	89.3	90.9	92.0	91.8
630 Hz	86.1	87.8	90.1	91.8	93.1	94.1	94.1
800 Hz	88.9	90.6	91.0	92.0	93.2	94.1	94.0
1000 Hz	89.7	91.4	92.1	93.0	94.0	94.9	94.9
1250 Hz	89.2	91.0	91.7	93.1	94.0	94.7	94.9
1600 Hz	87.8	89.5	90.7	92.1	93.6	94.6	94.7
2000 Hz	85.1	86.8	88.7	90.2	91.8	92.7	92.8
2500 Hz	86.0	87.7	88.1	88.7	90.4	91.0	91.4
3150 Hz	85.5	87.3	88.3	88.8	90.1	89.5	90.0
4000 Hz	78.8	80.5	83.1	84.6	87.4	86.1	87.0
5000 Hz	73.7	75.4	76.1	77.2	81.7	81.0	81.6
6300 Hz	66.4	68.2	70.5	71.6	75.0	75.8	76.3
8000 Hz	55.4	57.1	62.2	64.2	67.3	69.3	69.8
10000 Hz	45.4	47.2	53.6	55.8	58.4	61.2	61.8
L_{WA} [dB(A)]	98.0	99.7	101.2	102.6	104.0	105.0	105.0

Fre-quency	Third Octave Band Data in dB(A) for wind speed at hub height						
	9.5 m/s	10.0 m/s	10.5 m/s	11.0 m/s	11.5 m/s	12.0 m/s	12.5 m/s
20 Hz	64.1	64.0	64.0	63.8	64.2	63.3	63.3
25 Hz	68.5	68.4	68.7	68.3	68.7	68.0	68.0
31.5 Hz	73.3	73.2	73.2	73.1	73.6	72.6	72.6
40 Hz	77.4	77.4	77.4	77.1	77.7	76.5	76.5
50 Hz	80.9	80.7	80.7	80.5	80.8	80.3	80.3
63 Hz	83.7	83.5	83.3	83.2	83.3	82.2	82.2
80 Hz	85.6	85.7	85.2	84.9	84.5	83.7	83.7
100 Hz	88.3	88.4	88.3	87.5	88.5	87.7	87.7
125 Hz	89.8	89.8	89.2	88.7	88.8	88.4	88.4
160 Hz	89.9	90.0	89.4	88.8	88.9	88.4	88.4
200 Hz	90.6	90.5	90.5	90.3	90.2	89.8	89.8
250 Hz	91.7	91.5	91.2	90.9	90.6	90.5	90.5
315 Hz	93.7	93.5	93.3	93.0	93.0	92.7	92.7
400 Hz	93.7	93.6	93.5	93.2	93.3	93.0	93.0
500 Hz	91.7	91.7	91.5	91.4	91.4	91.1	91.1
630 Hz	94.0	93.8	93.8	93.7	93.6	93.9	93.9
800 Hz	93.9	93.9	93.4	93.2	93.3	93.4	93.4
1000 Hz	94.8	94.7	94.4	94.2	94.3	94.7	94.7
1250 Hz	95.0	94.9	94.5	94.3	94.3	94.5	94.5
1600 Hz	94.8	94.8	95.0	94.9	95.0	95.0	95.0
2000 Hz	93.0	93.1	93.0	93.2	92.9	92.8	92.8
2500 Hz	91.7	92.0	92.5	93.1	92.9	93.0	93.0
3150 Hz	90.3	90.7	92.4	93.7	93.7	94.3	94.3
4000 Hz	87.5	88.0	89.9	91.0	90.8	91.1	91.1
5000 Hz	82.5	83.3	84.9	85.8	85.5	84.9	84.9
6300 Hz	77.0	78.2	80.1	81.0	80.7	79.6	79.6
8000 Hz	70.6	71.5	73.3	73.9	73.8	72.7	72.7
10000 Hz	62.7	63.5	65.3	65.6	65.6	64.5	64.5
L_{WA} [dB(A)]	105.0	105.0	105.0	105.0	105.0	105.0	105.0

NORDEX N117

Sales document

Technical description

Wind turbine class K08 delta

N117/3600, N117/3000 Controlled

K0801_074760_EN

Revision 06 / 2018-09-11

- Translation of the original document -

This is a translation from German. In case of doubt, the German text shall prevail.

Document is published in electronic form.

Signed original at Nordex Energy GmbH, Engineering.

Technical modifications

This document was created with utmost care, taking into account the currently applicable standards.

However, due to continuous development, the figures, functional steps and technical data is subject to change without prior notice.

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1. Structure

The Nordex N117/3600 wind turbine (WT) is a speed-variable wind turbine with a rotor diameter of 116.8 m and a nominal power of 3600 kW. It is offered in versions for 50 Hz and 60 Hz, and as N117/3000 Controlled reduced to 3000 kW nominal power. The wind turbine is designed for class S according to IEC 61400-1 and for class 3 according to DIBt.

The wind turbine Nordex N117/3600 and N117/3000 Controlled consists of the following main components:

- Rotor, with rotor hub, three rotor blades and the pitch system
- Nacelle with drive train, generator and yaw system
- Tubular tower with foundation or hybrid tower with foundation
- Medium-voltage transformer (MV transformer) and medium-voltage switchgear (MV switchgear)

1.1 Tower

The Nordex N117/3600 and N117/3000 Controlled is mounted on tubular steel towers or hybrid towers with different hub heights. The cylindrical steel tower has a conical head section and consists of 2 to 6 sections. Corrosion protection is guaranteed by a coating system of the surface according to ISO 12944. A service lift, the vertical ladder with fall protection system as well as resting and working platforms inside the tower allow for a weather-protected ascent to the nacelle. The lower part of the hybrid tower consists of a concrete part on which the two steel sections are mounted.

The size and design of the foundation depend on the ground conditions at the intended site. The tubular steel tower is bolted to the anchor cage embedded in the foundation.

Switch cabinets are integrated in the tower base, which contain important components of the electronic controls, the turbine PC, frequency converter, low-voltage main switch, fuses, the transformer for auxiliary power in the tower base and outputs to the transformer and to the generator. The frequency converter is equipped with a water cooling system. The water heated in the frequency converter is cooled in a water/air heat exchanger. It is located on the outer tower wall.

The MV transformer and MV switchgear may be located in a separate transformer substation near the wind turbine. For the transformer in the tower (TIT) variant, the MV transformer and MV switchgear can also be located in the tower base.
In this case, the components in the tower base of the tubular steel tower are arranged on three different levels:

- The MV transformer on the foundation
- The MV switchgear on the first tower platform
- The switch cabinet with frequency converter on the second tower platform

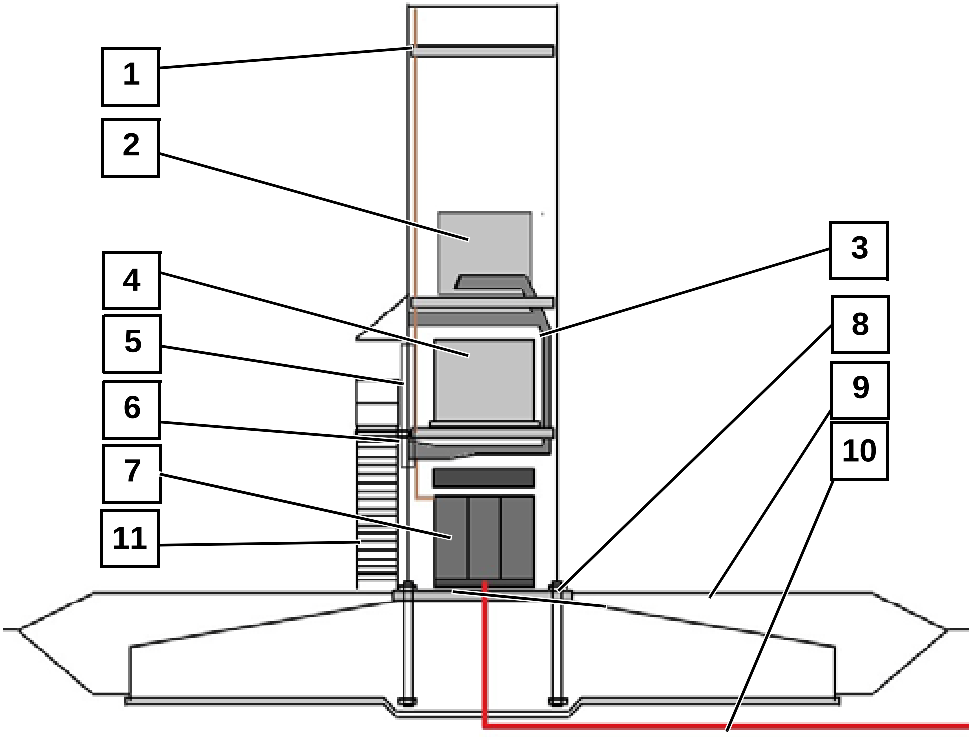

Fig. 1 Section through the tower base, transformer inside tower (TIT) variant

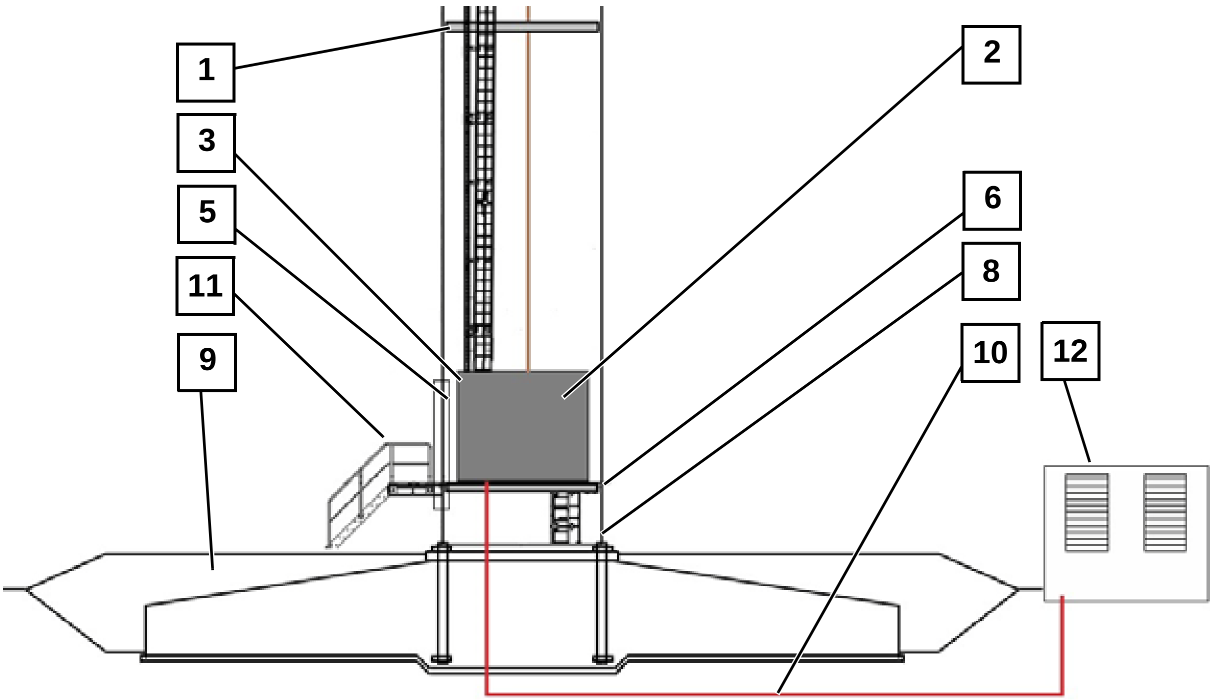

Fig. 2 Section through the tower base, transformer outside tower (TAT) variant

1	Flange tower platform	2	Switch cabinet/converter	3	Ventilation/cooling
4	MV switchgear (TIT)	5	Tower door	6	First tower platform
7	Transformer (TIT)	8	Anchor bolts	9	Soil backfill
10	Power cables in conduits	11	Tower stairs	12	Transformer station with switchgear (TAT)

The hybrid tower is only available in the transformer in the tower variant. All tower base interiors are installed on one level.

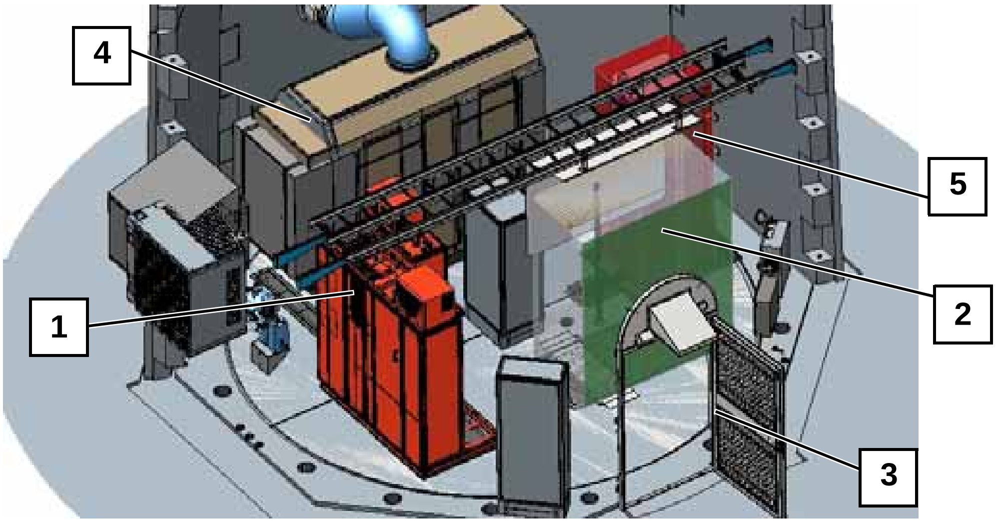

Fig. 3 Hybrid tower base

1	Main converter	2	MV switchgear	3	Tower access
4	MV transformer	5	Service lift		

1.2 Rotor

The rotor consists of the rotor hub with three pitch bearings and three pitch drives for blade adjustment as well as three rotor blades.

The **rotor hub** consists of the base element, support structure and spinner. The base element consists of a stiff cast structure, on which the pitch bearings and the rotor blades are assembled. The rotor hub is covered with the spinner which enables the direct access from the nacelle into the rotor hub.

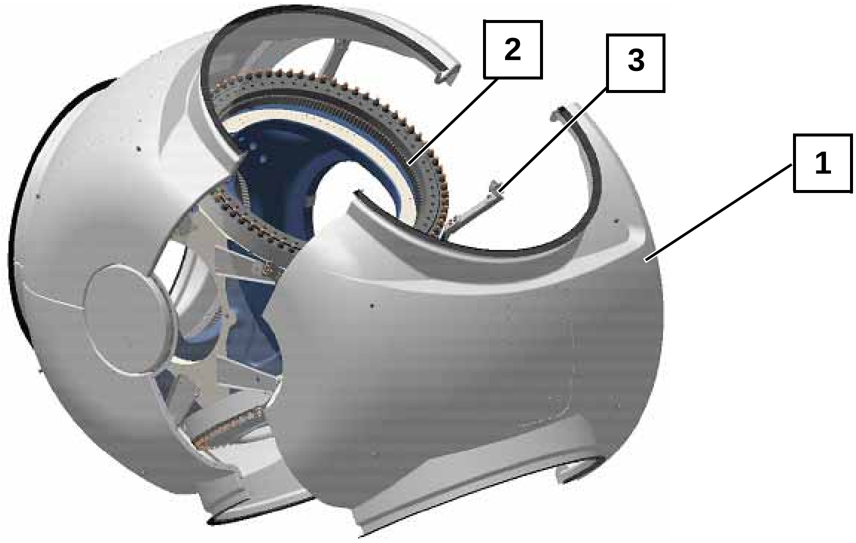

Fig. 4 Rotor hub and spinner of Nordex delta generation wind turbines

1 Spinner segment 2 Rotor hub 3 Spinner support structure

The **rotor blades** are made of high-quality glass fiber-reinforced and carbon-fiber reinforced plastics. The rotor blade is statically and dynamically tested in accordance with the guidelines IEC 61400-23 and GL IV-1 (2010). If requested by the customer, the rotor blades can be equipped with serrations, which optimize the sound power level.

The **pitch system** serves to adjust the pitch angle of the rotor blades set by the control system. For each individual rotor blade the pitch system comprises an electromechanical drive with 3-phase motor, planetary gear and drive pinion, as well as a control unit with frequency converter and emergency power supply. Power supply and signal transfer are realized through a slip ring in the nacelle.

1.3 Nacelle

The nacelle contains essential mechanical and electrical components of the wind turbine. The nacelle can be pivoted on the tower.

The **rotor shaft** is supported in the rotor bearing inside the nacelle. A rotor lock is integrated in the rotor bearing, with which the rotor can be reliably locked in place mechanically.

The **gearbox** increases the rotor speed until it reaches the speed required for the generator.

The bearings and gearings are continuously lubricated with oil. A 2-stage pump enables the oil circulation. A combination filter element with coarse, fine and ultrafine filter retains solid particles. The control system monitors the contamination of the filter element.

The gear oil used for lubrication also cools the gearbox. The temperatures of the gearbox bearings and the oil are continuously monitored. If the optimum operating temperature is not yet reached, a thermal bypass directs the gear oil directly back to the gearbox. If the operating temperature of the gear oil is exceeded it is cooled down.

The gearbox cooling is realized with an oil/water cooler that is installed directly at the gearbox. The heated cooling water is cooled together with the cooling water of the generator in a passive cooler on the roof of the nacelle.

The **generator** is a 6-pole doubly-fed induction machine. An air/water heat exchanger is mounted on the generator. The cooling water is recooled together with the cooling water of the gearbox heat exchanger in a passive cooler on the nacelle roof.

The mechanical **rotor brake** supports the aerodynamic braking effect of the rotor blades as soon as the rotor speed falls below a defined value and finally stops the rotor. The aerodynamic braking effect of the rotor is achieved by adjusting the rotor blades perpendicular to the rotation direction. The rotor brake consists of a brake caliper, which acts on the brake disk assembled behind the gearbox.

The **yaw drives** optimally rotate the nacelle into the wind. The four yaw drives are located on the machine frame in the nacelle. A yaw drive consists of an electric motor, multi-stage planetary gear, and a drive pinion. The drive pinions mesh with the external teeth of the yaw bearing.

Being positioned properly, the nacelle is locked by means of a hydraulic and an electric brake system. It consists of several brake calipers which are fastened to the machine frame and act on a brake disk. In addition, the electric motors of the yaw drives are equipped with an electrically actuated holding brake.

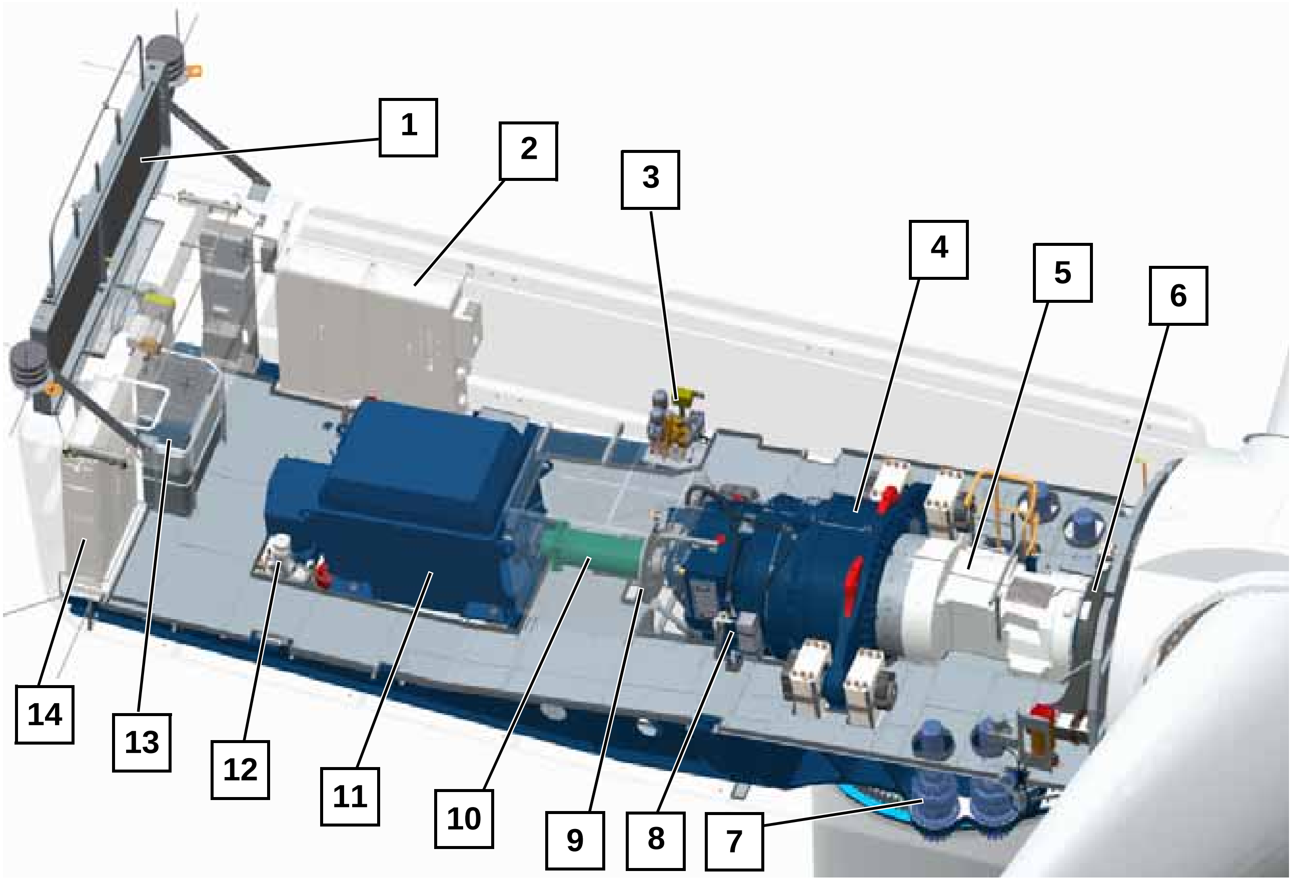

Fig. 5 Nacelle layout drawing

1	Heat exchanger	2	Topbox
3	Hydraulic unit	4	Gearbox
5	Rotor shaft	6	Rotor bearing
7	Yaw drives	8	Gear oil cooler
9	Rotor brake	10	Coupling
11	Generator	12	Coolant pump
13	Hatch for on-board crane	14	Transformer box

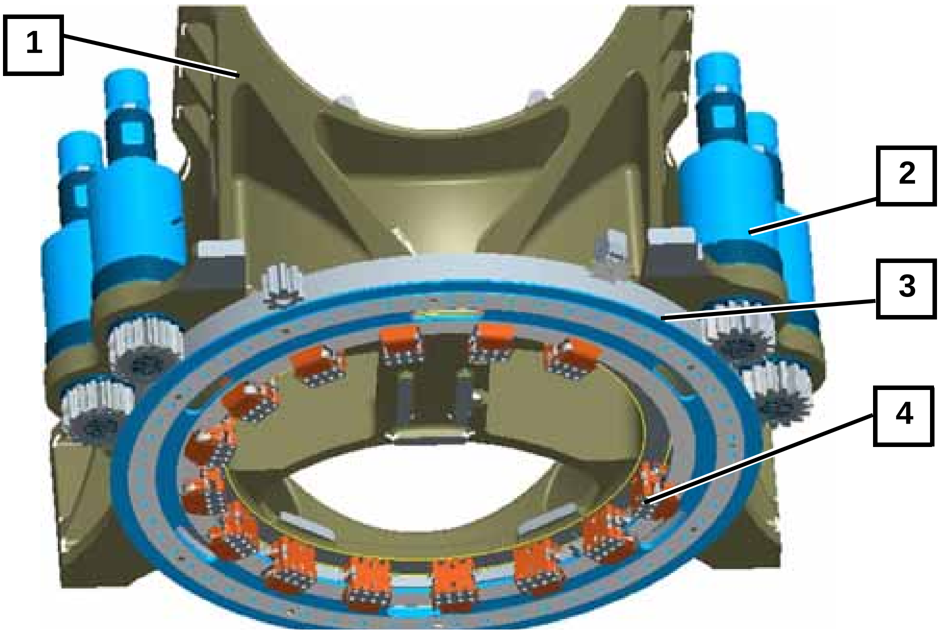

Fig. 6 Components of the yaw system

1	Machine frame	2	Yaw drives
3	Yaw bearing	4	Brake calipers

The **hydraulic unit** provides the oil pressure required for the operation of the rotor brake and the yaw brakes.

1.4 Auxiliary systems

Rotor bearing, generator bearing, gearing of the pitch bearings and gearing of the yaw bearing are each equipped with an **automatic lubrication system**. An automatic raceway lubrication of the pitch bearings can be offered as an option.

The switch cabinets in the nacelle and the tower base of the wind turbine are in part equipped with **air conditioning units**.

Gearbox, generator, hydraulic unit and all switch cabinets are equipped with **heaters**.

An electric **chain hoist** is installed in the nacelle which is used for lifting tools, components and other work materials from the ground into the nacelle. A second, movable **overhead crane** is used for carrying the materials within the nacelle.

Various options of additional equipment are available for the wind turbine.

Cooling system

Gearbox and generator are cooled by a coupled oil/water circulation. At startup the lightly heated gear oil is directly fed back into the gearbox via a thermal bypass and only directed into the plate-type heat exchanger after reaching operating temperature.

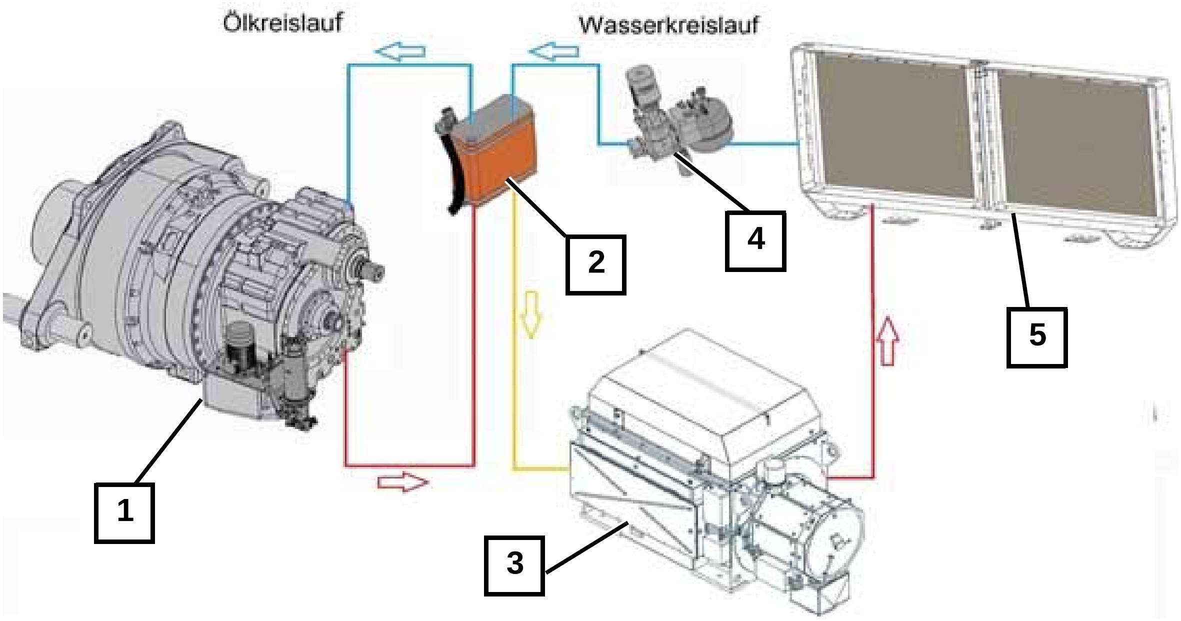

Fig. 7 Schematic diagram of gearbox cooling and generator cooling

1 - Gearbox with oil pump
2 - Plate-type heat exchanger
3 - Generator
4 - Water pump
5 - Passive coolers

The converter in the tower base is cooled by a water/glycol mixture. A pump conveys the mixture through main converter and heat exchanger. The heat exchanger is equipped with a 2-stage fan that is operated depending on the water temperature.

2. Functional principle

The turbine operates automatically. A programmable logic controller (PLC) continuously monitors the operating parameters using various sensors, compares the actual values with the corresponding setpoints and issues the required control signals to the WT components. The operating parameters are specified by Nordex and are adapted to the individual location.

When there is no wind the WT remains in idle mode. Only various auxiliary systems are operational or activated as required: e.g., heaters, gear lubrication or PLC, which monitors the data from the wind measuring system. All other systems are switched off and do not use any energy. The rotor idles. When the cut-in wind speed is reached, the wind turbine will change to the mode 'Ready for operation'. Now all systems are tested, the nacelle turns into the wind and the rotor blades turn into the wind. When a certain speed is reached, the generator is connected to the grid and the WT produces energy.

At low wind speeds the WT operates at part load. During this the rotor blades remain fully turned into the wind (pitch angle 0°). The power produced by the WT depends on the wind speed.

When the nominal wind speed is reached, the WT switches over to the nominal load range. If the wind speed continues to increase, the speed control changes the rotor blade angle so that the rotor speed and thus the power output of the WT remain constant.

The yaw system ensures that the nacelle is always optimally aligned to the wind. To this end, two separate wind measuring systems located at the height of the hub measure the wind direction. Only one wind measuring system is used for the control system, while the second system monitors the first and takes over in case the first system fails. If the measured wind direction deviates too greatly from the alignment of the nacelle, the nacelle is yawed into the wind.

The wind energy absorbed from the rotor is converted into electrical energy using a doubly-fed induction machine with slip ring rotor. Its stator is directly connected to the MV transformer, and its rotor via a specially controlled frequency converter. This offers a significant advantage enabling the generator to be operated in a defined speed range near its synchronous speed.

Safety systems

Nordex wind turbines are equipped with extensive equipment and accessories to provide for personal and turbine safety and ensure continuous operation. The entire turbine is designed in accordance with the Machinery Directive 2006/42/EC and certified as per IEC 61400. For details on the safety devices refer to the current safety manual.

If certain parameters concerning turbine safety are exceeded, the WT will cut out immediately and is put into a safe state. Depending on the cut-out cause, different brake programs are triggered. In case of external causes, such as excessive wind speeds or if the operating temperature is not met, the wind turbine is softly braked by means of rotor blade adjustment.

Lightning protection/surge protection and electromagnetic compatibility (EMC)

The lightning/surge protection of the wind turbine is based on the EMC-compliant lightning protection zone concept, which comprises the implementation of internal and external lightning/surge protection measures under consideration of the standard IEC 61400-24.

The wind turbine falls into lightning protection level I. All components of the internal and external lightning/surge protection are designed in accordance with lightning protection level I.

The wind turbine with the electrical equipment, consumers, the measurement, control, protection, information and telecommunication technology meets the EMC requirements according to IEC 61400-1, item 10.11.

Low-voltage network types

The **660 V low voltage network** as an IT network configuration and three phase rotary current network is insulated against ground and is the primary low voltage energy system of the wind turbine. The bodies of the electrical equipment and measuring instruments of this network are grounded directly or by means of separate protective bonding conductors. As a further protection measure for personal and turbine protection in the 660 V IT network a central insulation monitor has been installed.

The **400 V/230 V low-voltage network** has its neutral point grounded directly at the supplying network transformers as TN system and three-phase system. The equipment grounding conductor PE and the neutral conductor are available separately. The bodies of the electrical equipment and consumers are connected directly and straight to the neutral points of the supplying network transformers via equipment grounding conductors, including the protective equipotential bonding. The 400 V/230 V low voltage network is the auxiliary low voltage system of the wind turbine.

Auxiliary power of the wind turbine

The auxiliary low voltage required by the wind turbine in stand-by mode and feed-in mode is requested by the following consumers:

- Wind turbine control including main converter control
- 400 V/230 V auxiliary power of the main converter
- 230 V AC UPS supply including 24 V DC supply
- Yaw system
- Pitch system
- Hydraulic unit
- Auxiliary drives such as pumps, fans and lubrication units
- Heaters, AC units, lighting

- Auxiliary systems such as service lift, obstacle lights
- Optional systems

Based on measurements, simulations and existing operating experience, a coincidence factor of 0.6 can be estimated for the installed low voltage auxiliary power for the worst load case of the auxiliary low voltage system as well as the feed-in operation mode of the WT. In the worst load case as well as in stand-by mode of the WT, a coincidence factor of 0.2 is estimated. In addition, measurements and simulations show that the average power factor (cos phi) at the supply points of the auxiliary low voltage system does not permanently fall below approx. 0.97 in any WT operating point/load case.

Long-term measurements show that the average base load (average active power) of the auxiliary low voltage system during WT feed-in operation mode is approx. 15 kW, based on one year.

For locations with an average annual speed of 6.5 m/s approx. 10,000 kWh auxiliary consumption arise, however, this value is greatly dependent on location. Auxiliary consumption is defines as the energy consumption of the WT from the grid for a period during which the WT does not supply current to the grid.

3. Technical data

Design	
Design temperature	Default: -20 °C to +45 °C CCV: -40 °C to +45 °C
Operating temperature range	-20 °C to +40 °C*
Betriebstemperaturbereich CCV	-30 °C bis +40 °C*
Stop	Default: -20 °C, restart at -18 °C CCV: -30 °C, restart at-28 °C
Max. height above MSL	2000 m**
Certificate	According to IEC 61400-1 and DIBt
Type	3-blade rotor with horizontal axis Up-wind turbine
Output control	Active single blade adjustment
Nominal power	3000 / 3600 kW*/**
Nominal power starting at wind speeds of (at air density of 1.225 kg/m^3)	Approx. 13.0 m/s
Operating speed range of the rotor	7.9...14.1 rpm
Nominal speed	12.6 rpm
Cut-in wind speed	3.0 m/s
Cut-out wind speed	25 m/s
Cut-back-in wind speed	24.5 m/s
Calculated service life	At least 20 years

* Nominal power is reached up to defined temperature ranges. Limited project-specific operating ranges are possible and must be agreed to with Nordex.

** At installation altitudes above 1000 m, the nominal power is reached up to defined temperature ranges.

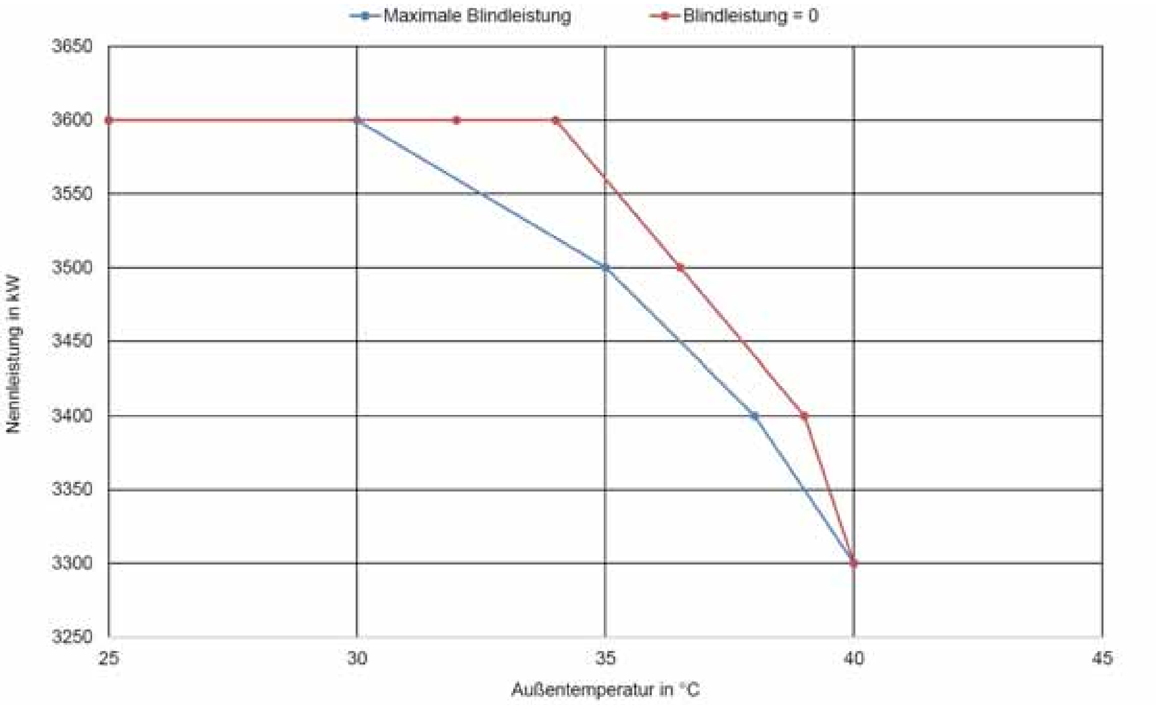

Fig. 8 Power adjustment depending on reactive power and temperature (up to height ≤1000 m above MSL)

Towers	TS91	TS106	TS120	TCS141
Hub height	91 m	106 m	120 m	141 m
Wind class	DIBt 3 / IEC IIA	DIBt 3 / IEC IIA	DIBt 3 / IEC IIA	DIBt 3 / IEC IIA
Number of tower sections	3	4	5	Concrete part + 2 steel sections

Rotor	
Rotor diameter	116.8 m
Swept area	10715 m^2
Nominal power/area	336 W/m^2
Rotor shaft inclination angle	5 °
Blade cone angle	3.5°

Rotor blade	
Material	glass-fiber and carbon-fiber reinforced plastic
Total length	57.3 m
Total weight per blade	Approx. 10.6 t

Rotor shaft/rotor bearing	
Type	Forged hollow shaft
Material	42CrMo4 or 34CrNiMo6
Bearing type	Spherical roller bearing
Lubrication	Continuous and automatic with lubricating grease
Rotor bearing housing material	EN-GJS-400-18-LT

Mechanical brake	
Type	Actively actuated disk brake
Location	On the high-speed shaft
Disk diameter	920 mm
Number of brake calipers	1
Brake pad material	Sintered metal

Gearbox	
Type	Multi-stage planetary gear + spur gear stage
Gear ratio	50 Hz: i = 92.9 60 Hz: i = 110.8
Lubrication	Forced-feed lubrication
Oil type	VG 320
Max. oil temperature	75 °C
Oil change	Change, if required

Electrical system	
Nominal power P_{nG}	3000 / 3600 kW*
Nominal voltage	3 x AC 660 V ± 10 % (specific to grid code)
Rated current I_{nG} at S_{nG}	3521 A*
Rated apparent power S_{nG} at P_{nG}	4025 kVA*
Power factor at P_{nG}	1.00 as default setting 0.899 underexcited (inductive) up to 0.899 overexcited (capacitive) possible
Frequency	50 and 60 Hz

* All values are maximum values; values may vary depending on temperature and reactive power, see Fig. 8

Generator	
Degree of protection	IP 54 (slip ring box IP 23)
Nominal voltage	660 V
Frequency	50 and 60 Hz
Speed range	50 Hz: 730 to 1325 rpm 60 Hz: 876 to 1578 rpm
Poles	6
Weight	Approx. 10.6 t

Gearbox cooling and filtration	
Type	1st cooling circuit: Oil circuit with oil/water heat exchanger and thermal bypass 2nd cooling circuit: Water/air together with generator cooling
Filter	Coarse filter 50 µm / fine filter 10 µm / ultrafine filter <5 µm
Flow rate	Stage 1: approx. 75 l/min Stage 2: approx. 150 l/min

Generator cooling	
Type	Water circuit with water/air heat exchanger
Flow rate	Approx. 160 l/min
Coolant	Water/glycol-based coolant

Converter cooling system	
Type	Water circuit with water/air heat exchanger and thermal bypass
Coolant	Water/glycol-based coolant

Pitch system	
Pitch bearing	Double-row four-point contact bearing
Lubrication of gearing and race	Regular lubrication with grease Optional: Automatic lubrication unit with grease
Drive	3-phase motor incl. spring-actuated brake and multi-stage planetary gear
Emergency power supply	VRLA batteries

Hydraulic system	
Hydraulic oil	VG 32
Oil quantity	Approx. 25 L
Thermal protection	Integrated PT100

Yaw drive	
Motor	Asynchronous motor
Gearbox	4-stage planetary gear
Number of drives	4
Lubrication	Oil, ISO VG 150
Yaw speed	Approx. 0.5 °/s

Yaw brake	
1st type	Disk brake with hydraulic brake calipers
Brake pad material	Organic
Number of brake calipers	14
2nd type	Electric spring-applied brake on every driving motor

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Noise level, Power curves, Thrust curves

Nordex N117/3600

Nordex N117/3600 – Noise level measurement requirements

Basis:	The specified sound power levels are expected values in terms of statistics. Results of single measurements will be within the confidence interval according to IEC 61400-14 [4].
Remarks:	
Verification according to:	Measurements are to be carried out by a measuring institute accredited for noise emission measurements at wind turbines according to ISO/IEC 17025 [3] at the reference position as defined in IEC 61400-11 [1]. The data analysis must be carried out according to the preferred method 1 of IEC 61400-11 [1]. The tonal penalties in the vicinity of wind turbines K_{TN} based on these measurements are to be determined according to „Technische Richtlinien für Windenergieanlagen“ [2].
Tonality:	The noise can be tonal in the vicinity of wind turbines. The specified sound power level includes potential tonal penalties according to „Technische Richtlinien für Windenergieanlagen“ [2], without taking into account any tonality $K_{TN} \leq 2$ dB.

[1] IEC 61400-11 ed. 2: Wind Turbine Generator Systems - Part 11: Acoustic Noise Measurement Techniques; 2002-12

[2] Technische Richtlinie für Windenergieanlagen - Teil 1: Bestimmung der Schallemissionswerte, Revision 18; FGW 2008-02

[3] ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories; 2017-11

[4] IEC 61400-14, Wind turbines - Part 14: Declaration of apparent sound power level and tonality values, first edition, 2005-03

Abbreviations

L_{WA} … A-weighted sound power level

STE … Serrated Trailing Edge

Nordex N117/3600 – Noise level, rated power and available hub heights

operating mode	rated power [kW]	Maximum sound power level over the complete operating range of the turbine L_{WA} [dB(A)]	L_{WA} (STE) [dB(A)]	available hub heights [m] 91	106	120	141
PM1	3675	105.0	103.5	○	○	○	○
Mode 0	3600	105.0	103.5	●	●	●	●
Mode 1	3500	104.5	103.0	●	●	●	●
Mode 2	3420	104.0	102.5	●	●	●	●
Mode 3	3340	103.5	102.0	●	●	–	●
Mode 4	3270	103.0	101.5	●	●	–	●
Mode 5	2910	100.5	99.0	●	●	●	●
Mode 6	2840	100.0	98.5	●	●	●	●
Mode 7	2780	99.5	98.0	●	●	●	●
Mode 8	2720	99.0	97.5	●	●	●	●
Mode 9	2660	98.5	97.0	●	●	●	●
Mode 10	2590	98.0	96.5	●	●	●	●
Mode 11	2530	97.5	96.0	●	●	●	●
Mode 12	2470	97.0	95.5	●	●	●	●

- ● mode available
- ○ Wind class IEC 2S - Suitability of power mode is subject to actual wind and site conditions
- – mode not available

Nordex N117/3600 – Verification conditions power curve

Basis:	These power curve values according to IEC 61400-12-1 are based on aerodynamic calculations by Nordex Energy GmbH.

Determinations for the power curve verification:

Verification according to:	IEC 61400-12-1
Type of anemometer:	Thies First Class (Advanced) or Vector A100
Type of LiDAR:	Windcube V2 or ZephIR V300
Measurement of power:	low voltage side, 660 VAC
Air density:	normalization to the nearest air density shown in the table
Filter of turbulence intesity:	9 % $\leq$ TI $\leq$ 20 %
Filter of wind shear:	0 $\leq \alpha \leq$ 0.3 Wind shear measurement and determination according to the requirements of MEASNET power performance measurement procedure, Version 5, December - 2009, chapter 3.3 and 3.8
Filter of inflow angle:	-2° $\leq \psi \leq$ +2°
Filter of temperature:	$\theta \leq$ 25 °C
Ice / snow on the blades:	No (determined with ice detectors)
Filter of grid reactive power:	Power factor = 1.0
Status signal:	Ready for unlimited operation in the corresponding operational mode without consideration of the cut-out hysteresis

Abbreviations

TI ...	turbulence intesity
α ...	Hellmann exponent
ψ ...	vertical inflow angle
v_H ...	hub height wind speed

Nordex N117/3600 – Power curves – PM1

for hub heights 91 m, 106 m, 120 m and 141 m
(mode on request for 91 m, 106 m, 120 m and 141 m)

wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	109	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	275	283	291	299	307	315
5.5	349	360	370	381	392	403	413	424	435
6.0	465	479	493	507	521	535	549	562	576
6.5	601	619	636	654	672	689	707	724	742
7.0	759	781	803	825	847	869	890	912	934
7.5	940	967	994	1021	1048	1074	1101	1128	1154
8.0	1146	1179	1211	1243	1275	1308	1340	1372	1404
8.5	1372	1410	1449	1487	1526	1564	1602	1640	1678
9.0	1610	1655	1700	1745	1790	1835	1879	1924	1969
9.5	1853	1905	1958	2009	2061	2113	2164	2216	2267
10.0	2097	2157	2216	2275	2335	2393	2451	2510	2569
10.5	2339	2406	2474	2540	2604	2670	2736	2802	2866
11.0	2578	2653	2725	2799	2867	2936	3001	3066	3124
11.5	2811	2894	2970	3040	3105	3166	3220	3274	3322
12.0	3035	3112	3181	3240	3293	3344	3388	3432	3469
12.5	3224	3289	3346	3394	3437	3477	3511	3546	3573
13.0	3373	3426	3473	3510	3543	3573	3597	3621	3639
13.5	3487	3530	3565	3592	3614	3634	3648	3662	3670
14.0	3571	3602	3626	3643	3657	3667	3671	3674	3675
14.5	3628	3648	3663	3668	3674	3675	3675	3675	3675
15.0	3662	3669	3675	3675	3675	3675	3675	3675	3675
15.5	3675	3675	3675	3675	3675	3675	3675	3675	3675
16.0	3675	3675	3675	3675	3675	3675	3675	3675	3675
16.5	3675	3675	3675	3675	3675	3675	3675	3675	3675
17.0	3675	3675	3675	3675	3675	3675	3675	3675	3675
17.5	3675	3675	3675	3675	3675	3675	3675	3675	3675
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21.0	3675	3675	3675	3675	3675	3675	3675	3675	3675
21.5	3675	3675	3675	3675	3675	3675	3675	3675	3675
22.0	3675	3675	3675	3675	3675	3675	3675	3675	3675
22.5	3675	3675	3675	3675	3675	3675	3675	3675	3675
23.0	3675	3675	3675	3675	3675	3675	3675	3675	3675
23.5	3675	3675	3675	3675	3675	3675	3675	3675	3675
24.0	3675	3675	3675	3675	3675	3675	3675	3675	3675
24.5	3675	3675	3675	3675	3675	3675	3675	3675	3675
25.0	3675	3675	3675	3675	3675	3675	3675	3675	3675

Nordex N117/3600 – Power curves – PM1

for hub heights 91 m, 106 m, 120 m and 141 m (mode on request for 91 m, 106 m, 120 m and 141 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	143	146	150	154	158
4.5	219	224	230	236	241	247	253	259
5.0	323	331	339	347	355	363	371	379
5.5	446	456	467	478	489	499	510	521
6.0	590	604	618	632	646	660	674	687
6.5	760	777	795	812	830	847	865	882
7.0	956	978	999	1021	1043	1065	1087	1108
7.5	1181	1208	1234	1261	1287	1314	1341	1367
8.0	1436	1468	1500	1532	1564	1596	1628	1660
8.5	1716	1754	1792	1830	1868	1905	1943	1981
9.0	2013	2057	2101	2145	2188	2231	2272	2312
9.5	2318	2368	2418	2467	2512	2556	2598	2637
10.0	2625	2681	2732	2782	2827	2869	2907	2943
10.5	2919	2975	3022	3068	3108	3141	3172	3199
11.0	3168	3213	3252	3288	3319	3345	3367	3387
11.5	3356	3393	3423	3451	3473	3490	3505	3518
12.0	3495	3522	3543	3563	3577	3587	3596	3604
12.5	3590	3609	3621	3632	3641	3646	3650	3654
13.0	3647	3656	3662	3668	3672	3672	3673	3673
13.5	3671	3673	3674	3675	3675	3675	3675	3675
14.0	3675	3675	3675	3675	3675	3675	3675	3675
14.5	3675	3675	3675	3675	3675	3675	3675	3675
15.0	3675	3675	3675	3675	3675	3675	3675	3675
15.5	3675	3675	3675	3675	3675	3675	3675	3675
16.0	3675	3675	3675	3675	3675	3675	3675	3675
16.5	3675	3675	3675	3675	3675	3675	3675	3675
17.0	3675	3675	3675	3675	3675	3675	3675	3675
17.5	3675	3675	3675	3675	3675	3675	3675	3675
18.0	3675	3675	3675	3675	3675	3675	3675	3675
18.5	3675	3675	3675	3675	3675	3675	3675	3675
19.0	3675	3675	3675	3675	3675	3675	3675	3675
19.5	3675	3675	3675	3675	3675	3675	3675	3675
20.0	3675	3675	3675	3675	3675	3675	3675	3675
20.5	3675	3675	3675	3675	3675	3675	3675	3675
21.0	3675	3675	3675	3675	3675	3675	3675	3675
21.5	3675	3675	3675	3675	3675	3675	3675	3675
22.0	3675	3675	3675	3675	3675	3675	3675	3675
22.5	3675	3675	3675	3675	3675	3675	3675	3675
23.0	3675	3675	3675	3675	3675	3675	3675	3675
23.5	3675	3675	3675	3675	3675	3675	3675	3675
24.0	3675	3675	3675	3675	3675	3675	3675	3675
24.5	3675	3675	3675	3675	3675	3675	3675	3675
25.0	3675	3675	3675	3675	3675	3675	3675	3675

Nordex N117/3600 – Power curves – Mode 0

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	109	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	275	283	291	299	307	315
5.5	349	360	370	381	392	403	413	424	435
6.0	465	479	493	507	521	535	549	562	576
6.5	601	619	636	654	672	689	707	724	742
7.0	759	781	803	825	847	868	890	912	934
7.5	940	967	994	1021	1048	1074	1101	1128	1154
8.0	1146	1179	1211	1243	1275	1308	1340	1372	1404
8.5	1372	1410	1449	1487	1526	1564	1602	1640	1678
9.0	1610	1655	1700	1745	1790	1834	1879	1924	1969
9.5	1853	1905	1957	2009	2061	2112	2164	2215	2267
10.0	2096	2156	2216	2275	2334	2393	2450	2510	2569
10.5	2338	2406	2474	2540	2604	2670	2732	2800	2861
11.0	2577	2652	2725	2799	2865	2930	2991	3053	3105
11.5	2809	2893	2963	3032	3092	3146	3196	3247	3290
12.0	3024	3102	3161	3219	3267	3311	3352	3393	3426
12.5	3201	3266	3315	3362	3400	3434	3465	3496	3520
13.0	3339	3393	3431	3467	3495	3519	3540	3562	3575
13.5	3444	3486	3513	3539	3557	3571	3584	3593	3597
14.0	3518	3549	3565	3581	3591	3595	3599	3600	3600
14.5	3567	3586	3593	3597	3600	3600	3600	3600	3600
15.0	3592	3600	3600	3600	3600	3600	3600	3600	3600
15.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
16.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
16.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
22.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
22.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
23.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
23.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
24.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
24.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
25.0	3600	3600	3600	3600	3600	3600	3600	3600	3600

Nordex N117/3600 – Power curves – Mode 0

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	143	146	150	154	158
4.5	219	224	230	236	241	247	253	259
5.0	323	331	339	347	355	363	371	379
5.5	446	456	467	478	489	499	510	521
6.0	590	604	618	632	646	660	673	687
6.5	760	777	795	812	830	847	865	882
7.0	956	978	999	1021	1043	1065	1086	1108
7.5	1181	1208	1234	1261	1287	1314	1340	1367
8.0	1436	1468	1500	1532	1564	1596	1628	1660
8.5	1716	1754	1792	1830	1868	1905	1943	1980
9.0	2013	2057	2101	2145	2188	2231	2272	2311
9.5	2317	2368	2418	2467	2513	2557	2598	2637
10.0	2625	2682	2732	2780	2824	2866	2904	2940
10.5	2915	2970	3015	3054	3089	3123	3153	3181
11.0	3148	3194	3230	3261	3288	3313	3335	3355
11.5	3325	3361	3389	3411	3429	3447	3461	3474
12.0	3452	3479	3498	3512	3523	3533	3542	3550
12.5	3536	3555	3565	3571	3576	3581	3585	3589
13.0	3583	3593	3597	3597	3598	3599	3599	3599
13.5	3599	3600	3600	3600	3600	3600	3600	3600
14.0	3600	3600	3600	3600	3600	3600	3600	3600
14.5	3600	3600	3600	3600	3600	3600	3600	3600
15.0	3600	3600	3600	3600	3600	3600	3600	3600
15.5	3600	3600	3600	3600	3600	3600	3600	3600
16.0	3600	3600	3600	3600	3600	3600	3600	3600
16.5	3600	3600	3600	3600	3600	3600	3600	3600
17.0	3600	3600	3600	3600	3600	3600	3600	3600
17.5	3600	3600	3600	3600	3600	3600	3600	3600
18.0	3600	3600	3600	3600	3600	3600	3600	3600
18.5	3600	3600	3600	3600	3600	3600	3600	3600
19.0	3600	3600	3600	3600	3600	3600	3600	3600
19.5	3600	3600	3600	3600	3600	3600	3600	3600
20.0	3600	3600	3600	3600	3600	3600	3600	3600
20.5	3600	3600	3600	3600	3600	3600	3600	3600
21.0	3600	3600	3600	3600	3600	3600	3600	3600
21.5	3600	3600	3600	3600	3600	3600	3600	3600
22.0	3600	3600	3600	3600	3600	3600	3600	3600
22.5	3600	3600	3600	3600	3600	3600	3600	3600
23.0	3600	3600	3600	3600	3600	3600	3600	3600
23.5	3600	3600	3600	3600	3600	3600	3600	3600
24.0	3600	3600	3600	3600	3600	3600	3600	3600
24.5	3600	3600	3600	3600	3600	3600	3600	3600
25.0	3600	3600	3600	3600	3600	3600	3600	3600

Nordex N117/3600 – Power curves – Mode 1

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	109	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	275	283	291	299	307	315
5.5	349	360	370	381	392	403	413	424	435
6.0	465	479	493	507	521	535	548	562	576
6.5	601	619	636	654	672	689	707	724	742
7.0	759	781	803	825	846	868	890	912	934
7.5	941	967	994	1021	1048	1074	1101	1128	1155
8.0	1145	1177	1210	1242	1274	1306	1339	1371	1403
8.5	1366	1404	1442	1481	1519	1557	1595	1633	1671
9.0	1595	1640	1685	1729	1774	1818	1863	1907	1951
9.5	1828	1879	1931	1982	2033	2083	2134	2185	2236
10.0	2058	2116	2175	2233	2291	2349	2407	2464	2522
10.5	2285	2351	2416	2484	2549	2612	2677	2740	2798
11.0	2510	2584	2657	2732	2801	2859	2922	2980	3029
11.5	2734	2814	2884	2955	3017	3065	3118	3165	3204
12.0	2942	3015	3074	3133	3185	3223	3266	3304	3334
12.5	3114	3173	3222	3271	3312	3341	3374	3402	3423
13.0	3247	3296	3334	3372	3404	3423	3446	3465	3476
13.5	3350	3388	3415	3442	3463	3472	3486	3495	3497
14.0	3423	3449	3467	3482	3493	3495	3499	3500	3500
14.5	3471	3487	3493	3498	3500	3500	3500	3500	3500
15.0	3496	3500	3500	3500	3500	3500	3500	3500	3500
15.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
16.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
16.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
17.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
17.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
18.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
18.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
19.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
19.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
20.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
20.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
21.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
21.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
22.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
22.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
23.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
23.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
24.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
24.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
25.0	3500	3500	3500	3500	3500	3500	3500	3500	3500

Nordex N117/3600 – Power curves – Mode 1

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	143	146	150	154	158
4.5	219	224	230	236	241	247	253	259
5.0	323	331	339	347	355	363	371	379
5.5	446	456	467	478	489	499	510	521
6.0	590	604	618	632	646	660	673	687
6.5	759	777	795	812	830	847	865	882
7.0	956	978	999	1021	1043	1065	1086	1108
7.5	1181	1208	1234	1261	1288	1314	1341	1367
8.0	1435	1467	1499	1531	1563	1595	1627	1658
8.5	1709	1747	1785	1823	1861	1898	1936	1974
9.0	1995	2040	2084	2128	2173	2216	2259	2300
9.5	2287	2338	2389	2440	2490	2536	2580	2621
10.0	2580	2637	2692	2744	2792	2836	2878	2916
10.5	2858	2912	2957	3001	3040	3076	3109	3139
11.0	3078	3123	3159	3194	3225	3252	3278	3299
11.5	3244	3280	3307	3333	3356	3375	3392	3406
12.0	3364	3391	3410	3427	3441	3452	3462	3470
12.5	3444	3462	3471	3480	3485	3490	3495	3499
13.0	3488	3496	3498	3498	3499	3500	3500	3500
13.5	3500	3500	3500	3500	3500	3500	3500	3500
14.0	3500	3500	3500	3500	3500	3500	3500	3500
14.5	3500	3500	3500	3500	3500	3500	3500	3500
15.0	3500	3500	3500	3500	3500	3500	3500	3500
15.5	3500	3500	3500	3500	3500	3500	3500	3500
16.0	3500	3500	3500	3500	3500	3500	3500	3500
16.5	3500	3500	3500	3500	3500	3500	3500	3500
17.0	3500	3500	3500	3500	3500	3500	3500	3500
17.5	3500	3500	3500	3500	3500	3500	3500	3500
18.0	3500	3500	3500	3500	3500	3500	3500	3500
18.5	3500	3500	3500	3500	3500	3500	3500	3500
19.0	3500	3500	3500	3500	3500	3500	3500	3500
19.5	3500	3500	3500	3500	3500	3500	3500	3500
20.0	3500	3500	3500	3500	3500	3500	3500	3500
20.5	3500	3500	3500	3500	3500	3500	3500	3500
21.0	3500	3500	3500	3500	3500	3500	3500	3500
21.5	3500	3500	3500	3500	3500	3500	3500	3500
22.0	3500	3500	3500	3500	3500	3500	3500	3500
22.5	3500	3500	3500	3500	3500	3500	3500	3500
23.0	3500	3500	3500	3500	3500	3500	3500	3500
23.5	3500	3500	3500	3500	3500	3500	3500	3500
24.0	3500	3500	3500	3500	3500	3500	3500	3500
24.5	3500	3500	3500	3500	3500	3500	3500	3500
25.0	3500	3500	3500	3500	3500	3500	3500	3500

Nordex N117/3600 – Power curves – Mode 2

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	109	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	283	291	299	307	315
5.5	349	360	370	381	392	403	413	424	435
6.0	465	479	493	507	521	535	548	562	576
6.5	601	619	636	654	671	689	707	724	742
7.0	759	781	803	825	846	868	890	912	934
7.5	940	967	994	1021	1047	1074	1101	1128	1154
8.0	1143	1175	1207	1239	1272	1304	1336	1368	1400
8.5	1358	1396	1434	1472	1510	1548	1586	1624	1662
9.0	1579	1624	1668	1712	1756	1800	1845	1889	1932
9.5	1802	1853	1904	1954	2004	2054	2105	2155	2205
10.0	2022	2080	2138	2194	2248	2307	2363	2419	2476
10.5	2240	2305	2367	2429	2487	2556	2615	2677	2735
11.0	2454	2526	2592	2660	2725	2792	2850	2909	2957
11.5	2665	2744	2811	2878	2935	2991	3039	3088	3126
12.0	2866	2938	2996	3053	3098	3145	3183	3222	3252
12.5	3032	3092	3140	3187	3223	3260	3288	3318	3338
13.0	3163	3212	3250	3287	3314	3341	3359	3380	3391
13.5	3263	3301	3329	3356	3375	3390	3403	3414	3416
14.0	3335	3362	3382	3400	3411	3415	3418	3420	3420
14.5	3384	3401	3412	3420	3420	3420	3420	3420	3420
15.0	3412	3417	3420	3420	3420	3420	3420	3420	3420
15.5	3420	3419	3420	3420	3420	3420	3420	3420	3420
16.0	3420	3419	3420	3420	3420	3420	3420	3420	3420
16.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
17.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
17.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
18.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
18.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
19.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
19.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
20.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
20.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
21.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
21.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
22.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
22.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
23.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
23.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
24.0	3420	3420	3420	3420	3420	3420	3420	3420	3420
24.5	3420	3420	3420	3420	3420	3420	3420	3420	3420
25.0	3420	3420	3420	3420	3420	3420	3420	3420	3420

Nordex N117/3600 – Power curves – Mode 2

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	143	146	150	154	158
4.5	219	224	230	236	241	247	253	259
5.0	323	331	339	347	355	363	371	379
5.5	446	456	467	478	488	499	510	521
6.0	590	604	618	632	646	659	673	687
6.5	759	777	795	812	830	847	865	882
7.0	956	977	999	1021	1043	1065	1086	1108
7.5	1181	1208	1234	1261	1287	1314	1340	1367
8.0	1432	1464	1496	1528	1560	1592	1624	1655
8.5	1700	1738	1776	1814	1851	1889	1927	1964
9.0	1977	2021	2065	2109	2153	2196	2240	2283
9.5	2256	2306	2357	2408	2459	2508	2555	2598
10.0	2534	2591	2646	2700	2753	2802	2842	2878
10.5	2793	2852	2900	2944	2989	3028	3061	3089
11.0	3005	3053	3092	3128	3164	3195	3220	3240
11.5	3165	3204	3234	3262	3289	3312	3328	3340
12.0	3281	3311	3333	3351	3370	3384	3392	3397
12.5	3359	3380	3392	3402	3411	3417	3419	3419
13.0	3402	3414	3418	3419	3420	3420	3420	3420
13.5	3418	3420	3420	3420	3420	3420	3420	3420
14.0	3420	3420	3420	3420	3420	3420	3420	3420
14.5	3420	3420	3420	3420	3420	3420	3420	3420
15.0	3420	3420	3420	3420	3420	3420	3420	3420
15.5	3420	3420	3420	3420	3420	3420	3420	3420
16.0	3420	3420	3420	3420	3420	3420	3420	3420
16.5	3420	3420	3420	3420	3420	3420	3420	3420
17.0	3420	3420	3420	3420	3420	3420	3420	3420
17.5	3420	3420	3420	3420	3420	3420	3420	3420
18.0	3420	3420	3420	3420	3420	3420	3420	3420
18.5	3420	3420	3420	3420	3420	3420	3420	3420
19.0	3420	3420	3420	3420	3420	3420	3420	3420
19.5	3420	3420	3420	3420	3420	3420	3420	3420
20.0	3420	3420	3420	3420	3420	3420	3420	3420
20.5	3420	3420	3420	3420	3420	3420	3420	3420
21.0	3420	3420	3420	3420	3420	3420	3420	3420
21.5	3420	3420	3420	3420	3420	3420	3420	3420
22.0	3420	3420	3420	3420	3420	3420	3420	3420
22.5	3420	3420	3420	3420	3420	3420	3420	3420
23.0	3420	3420	3420	3420	3420	3420	3420	3420
23.5	3420	3420	3420	3420	3420	3420	3420	3420
24.0	3420	3420	3420	3420	3420	3420	3420	3420
24.5	3420	3420	3420	3420	3420	3420	3420	3420
25.0	3420	3420	3420	3420	3420	3420	3420	3420

Nordex N117/3600 – Power curves – Mode 3

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	283	291	299	307	315
5.5	349	360	370	381	392	403	413	424	435
6.0	465	479	493	507	521	534	548	562	576
6.5	601	618	636	654	671	689	707	724	742
7.0	759	781	803	825	847	869	890	912	934
7.5	940	967	994	1021	1048	1074	1101	1128	1154
8.0	1139	1171	1204	1236	1268	1300	1332	1364	1396
8.5	1348	1386	1424	1462	1499	1537	1575	1613	1651
9.0	1561	1605	1648	1692	1735	1779	1822	1867	1911
9.5	1773	1823	1872	1921	1970	2019	2070	2120	2171
10.0	1983	2037	2093	2145	2202	2255	2314	2368	2426
10.5	2186	2245	2308	2365	2428	2487	2554	2617	2678
11.0	2386	2452	2520	2584	2654	2713	2778	2840	2891
11.5	2587	2659	2731	2792	2857	2908	2962	3013	3054
12.0	2782	2848	2912	2962	3017	3057	3102	3144	3175
12.5	2944	3000	3054	3094	3139	3171	3206	3238	3260
13.0	3073	3119	3162	3195	3229	3253	3277	3301	3314
13.5	3174	3210	3243	3267	3291	3306	3319	3334	3337
14.0	3249	3276	3298	3313	3328	3334	3337	3340	3340
14.5	3300	3318	3331	3336	3340	3340	3340	3340	3340
15.0	3330	3336	3340	3340	3340	3340	3340	3340	3340
15.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
16.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
16.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
17.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
17.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
18.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
18.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
19.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
19.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
20.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
20.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
21.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
21.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
22.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
22.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
23.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
23.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
24.0	3340	3340	3340	3340	3340	3340	3340	3340	3340
24.5	3340	3340	3340	3340	3340	3340	3340	3340	3340
25.0	3340	3340	3340	3340	3340	3340	3340	3340	3340

Nordex N117/3600 – Power curves – Mode 3

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	143	146	150	154	158
4.5	219	224	230	236	241	247	253	259
5.0	323	331	339	347	355	363	371	379
5.5	446	456	467	478	488	499	510	521
6.0	590	604	618	632	646	659	673	687
6.5	759	777	794	812	830	847	865	882
7.0	956	978	1000	1021	1043	1065	1087	1108
7.5	1181	1208	1234	1261	1287	1314	1340	1367
8.0	1428	1460	1492	1524	1556	1588	1619	1651
8.5	1689	1726	1764	1802	1839	1877	1914	1952
9.0	1955	1998	2042	2085	2129	2172	2216	2259
9.5	2221	2270	2320	2370	2421	2470	2518	2566
10.0	2485	2542	2595	2648	2701	2751	2791	2831
10.5	2737	2794	2838	2882	2926	2967	2999	3031
11.0	2940	2987	3023	3058	3094	3127	3150	3174
11.5	3095	3133	3160	3186	3213	3237	3253	3269
12.0	3207	3236	3254	3273	3291	3307	3314	3322
12.5	3283	3303	3312	3322	3331	3339	3339	3339
13.0	3326	3336	3338	3339	3340	3340	3340	3340
13.5	3339	3340	3340	3340	3340	3340	3340	3340
14.0	3340	3340	3340	3340	3340	3340	3340	3340
14.5	3340	3340	3340	3340	3340	3340	3340	3340
15.0	3340	3340	3340	3340	3340	3340	3340	3340
15.5	3340	3340	3340	3340	3340	3340	3340	3340
16.0	3340	3340	3340	3340	3340	3340	3340	3340
16.5	3340	3340	3340	3340	3340	3340	3340	3340
17.0	3340	3340	3340	3340	3340	3340	3340	3340
17.5	3340	3340	3340	3340	3340	3340	3340	3340
18.0	3340	3340	3340	3340	3340	3340	3340	3340
18.5	3340	3340	3340	3340	3340	3340	3340	3340
19.0	3340	3340	3340	3340	3340	3340	3340	3340
19.5	3340	3340	3340	3340	3340	3340	3340	3340
20.0	3340	3340	3340	3340	3340	3340	3340	3340
20.5	3340	3340	3340	3340	3340	3340	3340	3340
21.0	3340	3340	3340	3340	3340	3340	3340	3340
21.5	3340	3340	3340	3340	3340	3340	3340	3340
22.0	3340	3340	3340	3340	3340	3340	3340	3340
22.5	3340	3340	3340	3340	3340	3340	3340	3340
23.0	3340	3340	3340	3340	3340	3340	3340	3340
23.5	3340	3340	3340	3340	3340	3340	3340	3340
24.0	3340	3340	3340	3340	3340	3340	3340	3340
24.5	3340	3340	3340	3340	3340	3340	3340	3340
25.0	3340	3340	3340	3340	3340	3340	3340	3340

Nordex N117/3600 – Power curves – Mode 4

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	291	299	307	315
5.5	349	360	370	381	392	403	413	424	435
6.0	465	479	493	507	521	534	548	562	576
6.5	601	618	636	654	671	689	706	724	742
7.0	759	781	803	825	847	869	891	912	934
7.5	939	966	993	1019	1046	1073	1100	1126	1153
8.0	1133	1165	1198	1230	1262	1294	1325	1358	1390
8.5	1335	1373	1410	1448	1485	1523	1560	1598	1635
9.0	1538	1581	1625	1668	1711	1754	1797	1840	1884
9.5	1739	1788	1837	1886	1934	1983	2032	2082	2131
10.0	1937	1991	2047	2101	2155	2210	2264	2318	2374
10.5	2130	2191	2252	2312	2371	2431	2492	2549	2609
11.0	2320	2386	2452	2518	2585	2648	2708	2764	2818
11.5	2508	2581	2654	2719	2781	2840	2888	2934	2978
12.0	2698	2765	2832	2887	2939	2988	3027	3063	3098
12.5	2861	2917	2970	3018	3061	3100	3130	3157	3183
13.0	2991	3036	3079	3117	3151	3181	3201	3219	3236
13.5	3092	3127	3159	3189	3212	3233	3245	3257	3265
14.0	3168	3194	3217	3237	3252	3264	3266	3270	3270
14.5	3223	3239	3253	3263	3268	3270	3270	3270	3270
15.0	3257	3263	3267	3270	3270	3270	3270	3270	3270
15.5	3270	3270	3267	3270	3270	3270	3270	3270	3270
16.0	3270	3270	3267	3270	3270	3270	3270	3270	3270
16.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
17.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
17.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
18.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
18.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
19.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
19.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
20.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
20.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
21.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
21.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
22.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
22.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
23.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
23.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
24.0	3270	3270	3270	3270	3270	3270	3270	3270	3270
24.5	3270	3270	3270	3270	3270	3270	3270	3270	3270
25.0	3270	3270	3270	3270	3270	3270	3270	3270	3270

Nordex N117/3600 – Power curves – Mode 4

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	143	146	150	154	158
4.5	219	224	230	236	241	247	253	259
5.0	323	331	339	347	355	363	371	379
5.5	446	456	467	478	488	499	510	521
6.0	590	604	618	632	646	659	673	687
6.5	759	777	794	812	829	847	864	882
7.0	956	978	1000	1021	1043	1065	1087	1108
7.5	1180	1206	1233	1259	1286	1312	1339	1365
8.0	1421	1453	1485	1517	1549	1581	1612	1644
8.5	1673	1710	1748	1786	1823	1861	1898	1935
9.0	1927	1971	2014	2058	2101	2144	2187	2230
9.5	2180	2229	2278	2328	2378	2427	2476	2519
10.0	2430	2485	2537	2587	2640	2692	2738	2773
10.5	2665	2722	2772	2814	2857	2900	2938	2965
11.0	2864	2911	2952	2985	3020	3054	3084	3104
11.5	3016	3053	3086	3110	3137	3162	3184	3196
12.0	3127	3156	3179	3195	3213	3231	3244	3249
12.5	3203	3223	3238	3245	3255	3264	3269	3269
13.0	3247	3258	3267	3268	3269	3270	3270	3270
13.5	3267	3269	3270	3270	3270	3270	3270	3270
14.0	3270	3270	3270	3270	3270	3270	3270	3270
14.5	3270	3270	3270	3270	3270	3270	3270	3270
15.0	3270	3270	3270	3270	3270	3270	3270	3270
15.5	3270	3270	3270	3270	3270	3270	3270	3270
16.0	3270	3270	3270	3270	3270	3270	3270	3270
16.5	3270	3270	3270	3270	3270	3270	3270	3270
17.0	3270	3270	3270	3270	3270	3270	3270	3270
17.5	3270	3270	3270	3270	3270	3270	3270	3270
18.0	3270	3270	3270	3270	3270	3270	3270	3270
18.5	3270	3270	3270	3270	3270	3270	3270	3270
19.0	3270	3270	3270	3270	3270	3270	3270	3270
19.5	3270	3270	3270	3270	3270	3270	3270	3270
20.0	3270	3270	3270	3270	3270	3270	3270	3270
20.5	3270	3270	3270	3270	3270	3270	3270	3270
21.0	3270	3270	3270	3270	3270	3270	3270	3270
21.5	3270	3270	3270	3270	3270	3270	3270	3270
22.0	3270	3270	3270	3270	3270	3270	3270	3270
22.5	3270	3270	3270	3270	3270	3270	3270	3270
23.0	3270	3270	3270	3270	3270	3270	3270	3270
23.5	3270	3270	3270	3270	3270	3270	3270	3270
24.0	3270	3270	3270	3270	3270	3270	3270	3270
24.5	3270	3270	3270	3270	3270	3270	3270	3270
25.0	3270	3270	3270	3270	3270	3270	3270	3270

Nordex N117/3600 – Power curves – Mode 5

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	290	298	307	315
5.5	349	359	370	381	392	402	413	424	435
6.0	465	479	493	507	520	534	548	562	576
6.5	601	619	637	654	672	689	707	725	742
7.0	753	775	797	819	841	862	884	906	927
7.5	912	939	965	992	1018	1044	1070	1096	1123
8.0	1073	1104	1136	1167	1198	1228	1259	1289	1320
8.5	1232	1268	1304	1340	1376	1411	1445	1481	1516
9.0	1387	1428	1469	1510	1551	1590	1630	1669	1709
9.5	1538	1584	1631	1678	1724	1767	1811	1851	1895
10.0	1687	1738	1790	1841	1893	1940	1988	2034	2082
10.5	1835	1890	1947	2003	2061	2112	2164	2213	2267
11.0	1983	2042	2104	2164	2226	2282	2338	2392	2443
11.5	2130	2194	2260	2325	2391	2446	2499	2548	2591
12.0	2277	2344	2415	2477	2538	2586	2629	2670	2705
12.5	2423	2490	2551	2605	2656	2695	2730	2765	2791
13.0	2553	2611	2662	2707	2748	2779	2806	2833	2851
13.5	2659	2708	2750	2785	2817	2840	2860	2878	2889
14.0	2743	2783	2816	2843	2865	2881	2893	2904	2907
14.5	2808	2839	2863	2881	2896	2904	2907	2910	2910
15.0	2855	2877	2893	2903	2909	2910	2910	2910	2910
15.5	2887	2900	2907	2910	2910	2910	2910	2910	2910
16.0	2904	2910	2910	2910	2910	2910	2910	2910	2910
16.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
17.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
17.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
18.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
18.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
19.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
19.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
20.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
20.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
21.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
21.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
22.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
22.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
23.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
23.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
24.0	2910	2910	2910	2910	2910	2910	2910	2910	2910
24.5	2910	2910	2910	2910	2910	2910	2910	2910	2910
25.0	2910	2910	2910	2910	2910	2910	2910	2910	2910

Nordex N117/3600 – Power curves – Mode 5

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	143	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	323	331	339	347	355	363	371	379
5.5	445	456	467	477	488	499	510	520
6.0	590	604	618	632	645	659	673	687
6.5	760	777	795	812	830	847	865	882
7.0	949	971	992	1014	1036	1058	1079	1101
7.5	1149	1175	1201	1227	1253	1279	1305	1331
8.0	1351	1381	1412	1443	1474	1504	1535	1566
8.5	1551	1586	1621	1657	1693	1728	1763	1798
9.0	1748	1788	1825	1865	1906	1945	1985	2025
9.5	1939	1983	2024	2069	2114	2158	2203	2248
10.0	2130	2178	2222	2272	2322	2367	2414	2460
10.5	2319	2369	2413	2463	2510	2547	2585	2623
11.0	2495	2539	2574	2615	2653	2683	2714	2744
11.5	2634	2669	2697	2731	2760	2782	2805	2828
12.0	2740	2767	2790	2815	2836	2852	2867	2882
12.5	2819	2838	2853	2871	2885	2893	2900	2908
13.0	2871	2883	2892	2901	2908	2909	2910	2910
13.5	2901	2906	2908	2910	2910	2910	2910	2910
14.0	2910	2910	2910	2910	2910	2910	2910	2910
14.5	2910	2910	2910	2910	2910	2910	2910	2910
15.0	2910	2910	2910	2910	2910	2910	2910	2910
15.5	2910	2910	2910	2910	2910	2910	2910	2910
16.0	2910	2910	2910	2910	2910	2910	2910	2910
16.5	2910	2910	2910	2910	2910	2910	2910	2910
17.0	2910	2910	2910	2910	2910	2910	2910	2910
17.5	2910	2910	2910	2910	2910	2910	2910	2910
18.0	2910	2910	2910	2910	2910	2910	2910	2910
18.5	2910	2910	2910	2910	2910	2910	2910	2910
19.0	2910	2910	2910	2910	2910	2910	2910	2910
19.5	2910	2910	2910	2910	2910	2910	2910	2910
20.0	2910	2910	2910	2910	2910	2910	2910	2910
20.5	2910	2910	2910	2910	2910	2910	2910	2910
21.0	2910	2910	2910	2910	2910	2910	2910	2910
21.5	2910	2910	2910	2910	2910	2910	2910	2910
22.0	2910	2910	2910	2910	2910	2910	2910	2910
22.5	2910	2910	2910	2910	2910	2910	2910	2910
23.0	2910	2910	2910	2910	2910	2910	2910	2910
23.5	2910	2910	2910	2910	2910	2910	2910	2910
24.0	2910	2910	2910	2910	2910	2910	2910	2910
24.5	2910	2910	2910	2910	2910	2910	2910	2910
25.0	2910	2910	2910	2910	2910	2910	2910	2910

Nordex N117/3600 – Power curves – Mode 6

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	290	298	306	315
5.5	349	359	370	381	392	402	413	424	435
6.0	465	479	493	507	520	534	548	562	576
6.5	600	618	636	653	671	689	706	724	741
7.0	748	770	792	814	836	857	879	901	922
7.5	902	928	954	981	1007	1033	1059	1085	1111
8.0	1055	1086	1117	1147	1178	1208	1239	1269	1300
8.5	1205	1240	1276	1311	1347	1381	1416	1451	1485
9.0	1352	1390	1430	1470	1510	1549	1588	1627	1666
9.5	1497	1539	1583	1626	1670	1713	1756	1800	1844
10.0	1638	1685	1733	1782	1829	1877	1924	1972	2020
10.5	1778	1830	1883	1936	1989	2040	2091	2143	2195
11.0	1918	1974	2032	2090	2146	2201	2257	2314	2366
11.5	2058	2119	2181	2242	2304	2363	2415	2468	2513
12.0	2196	2263	2330	2395	2450	2504	2547	2591	2627
12.5	2335	2405	2466	2524	2571	2615	2650	2686	2714
13.0	2465	2526	2578	2626	2665	2701	2728	2755	2776
13.5	2572	2624	2666	2705	2736	2764	2783	2803	2816
14.0	2658	2701	2734	2764	2786	2806	2818	2831	2836
14.5	2725	2759	2784	2806	2820	2832	2836	2840	2840
15.0	2775	2800	2817	2831	2836	2840	2840	2840	2840
15.5	2810	2827	2834	2840	2840	2840	2840	2840	2840
16.0	2831	2839	2840	2840	2840	2840	2840	2840	2840
16.5	2839	2840	2840	2840	2840	2840	2840	2840	2840
17.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
17.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
18.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
18.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
19.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
19.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
20.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
20.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
21.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
21.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
22.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
22.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
23.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
23.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
24.0	2840	2840	2840	2840	2840	2840	2840	2840	2840
24.5	2840	2840	2840	2840	2840	2840	2840	2840	2840
25.0	2840	2840	2840	2840	2840	2840	2840	2840	2840

Nordex N117/3600 – Power curves – Mode 6

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	142	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	323	331	339	347	355	363	371	379
5.5	445	456	467	477	488	499	510	520
6.0	590	604	618	632	645	659	673	687
6.5	759	776	794	811	829	847	864	881
7.0	944	966	987	1009	1031	1052	1074	1095
7.5	1137	1163	1189	1215	1241	1266	1292	1318
8.0	1330	1361	1391	1421	1452	1481	1511	1541
8.5	1521	1556	1590	1625	1660	1693	1727	1761
9.0	1707	1746	1785	1824	1864	1901	1939	1977
9.5	1888	1932	1975	2018	2062	2103	2146	2188
10.0	2068	2116	2164	2212	2261	2303	2347	2391
10.5	2248	2301	2349	2397	2444	2479	2515	2550
11.0	2417	2467	2506	2546	2584	2612	2641	2669
11.5	2554	2595	2627	2658	2689	2711	2732	2753
12.0	2661	2693	2717	2741	2764	2779	2793	2807
12.5	2740	2764	2781	2798	2813	2821	2828	2835
13.0	2794	2811	2820	2829	2837	2838	2839	2840
13.5	2826	2836	2837	2839	2840	2840	2840	2840
14.0	2838	2840	2840	2840	2840	2840	2840	2840
14.5	2840	2840	2840	2840	2840	2840	2840	2840
15.0	2840	2840	2840	2840	2840	2840	2840	2840
15.5	2840	2840	2840	2840	2840	2840	2840	2840
16.0	2840	2840	2840	2840	2840	2840	2840	2840
16.5	2840	2840	2840	2840	2840	2840	2840	2840
17.0	2840	2840	2840	2840	2840	2840	2840	2840
17.5	2840	2840	2840	2840	2840	2840	2840	2840
18.0	2840	2840	2840	2840	2840	2840	2840	2840
18.5	2840	2840	2840	2840	2840	2840	2840	2840
19.0	2840	2840	2840	2840	2840	2840	2840	2840
19.5	2840	2840	2840	2840	2840	2840	2840	2840
20.0	2840	2840	2840	2840	2840	2840	2840	2840
20.5	2840	2840	2840	2840	2840	2840	2840	2840
21.0	2840	2840	2840	2840	2840	2840	2840	2840
21.5	2840	2840	2840	2840	2840	2840	2840	2840
22.0	2840	2840	2840	2840	2840	2840	2840	2840
22.5	2840	2840	2840	2840	2840	2840	2840	2840
23.0	2840	2840	2840	2840	2840	2840	2840	2840
23.5	2840	2840	2840	2840	2840	2840	2840	2840
24.0	2840	2840	2840	2840	2840	2840	2840	2840
24.5	2840	2840	2840	2840	2840	2840	2840	2840
25.0	2840	2840	2840	2840	2840	2840	2840	2840

Nordex N117/3600 – Power curves – Mode 7

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	290	298	306	314
5.5	349	359	370	381	392	402	413	424	435
6.0	465	479	493	507	521	535	549	562	576
6.5	599	617	634	652	670	687	705	722	740
7.0	743	765	787	808	830	852	873	895	916
7.5	890	916	942	968	994	1020	1046	1072	1098
8.0	1035	1065	1096	1127	1157	1187	1218	1248	1278
8.5	1177	1212	1247	1282	1316	1351	1386	1420	1455
9.0	1315	1354	1394	1433	1472	1512	1551	1591	1630
9.5	1450	1495	1538	1581	1625	1668	1713	1756	1799
10.0	1585	1635	1683	1729	1777	1825	1873	1921	1968
10.5	1719	1773	1826	1876	1928	1980	2033	2085	2137
11.0	1852	1910	1968	2022	2079	2135	2194	2251	2304
11.5	1985	2048	2110	2169	2231	2293	2349	2402	2449
12.0	2120	2188	2256	2319	2377	2433	2480	2523	2562
12.5	2256	2327	2392	2448	2498	2544	2583	2619	2649
13.0	2387	2448	2504	2553	2593	2631	2662	2689	2712
13.5	2496	2547	2594	2634	2666	2696	2719	2738	2753
14.0	2584	2626	2664	2696	2720	2742	2756	2768	2775
14.5	2654	2688	2717	2740	2756	2770	2775	2779	2780
15.0	2707	2732	2752	2767	2774	2780	2780	2780	2780
15.5	2745	2761	2773	2779	2780	2780	2780	2780	2780
16.0	2769	2776	2780	2780	2780	2780	2780	2780	2780
16.5	2779	2780	2780	2780	2780	2780	2780	2780	2780
17.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
17.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
18.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
18.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
19.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
19.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
20.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
20.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
21.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
21.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
22.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
22.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
23.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
23.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
24.0	2780	2780	2780	2780	2780	2780	2780	2780	2780
24.5	2780	2780	2780	2780	2780	2780	2780	2780	2780
25.0	2780	2780	2780	2780	2780	2780	2780	2780	2780

Nordex N117/3600 – Power curves – Mode 7

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	142	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	323	331	339	347	355	363	371	379
5.5	445	456	467	477	488	499	510	520
6.0	590	604	618	632	646	660	673	687
6.5	757	775	792	810	827	845	862	880
7.0	938	959	981	1002	1024	1045	1067	1088
7.5	1123	1149	1174	1200	1225	1251	1277	1302
8.0	1308	1338	1367	1397	1426	1456	1486	1515
8.5	1489	1523	1557	1591	1625	1658	1692	1726
9.0	1668	1707	1744	1782	1820	1858	1891	1929
9.5	1842	1886	1927	1969	2011	2053	2091	2131
10.0	2015	2063	2109	2155	2201	2246	2285	2327
10.5	2189	2242	2288	2335	2381	2419	2450	2485
11.0	2355	2406	2444	2482	2520	2550	2574	2602
11.5	2491	2533	2564	2594	2624	2648	2666	2687
12.0	2596	2629	2653	2676	2699	2715	2730	2744
12.5	2675	2701	2717	2733	2749	2758	2765	2773
13.0	2730	2748	2758	2767	2775	2778	2778	2780
13.5	2764	2775	2777	2779	2780	2780	2780	2780
14.0	2778	2780	2780	2780	2780	2780	2780	2780
14.5	2780	2780	2780	2780	2780	2780	2780	2780
15.0	2780	2780	2780	2780	2780	2780	2780	2780
15.5	2780	2780	2780	2780	2780	2780	2780	2780
16.0	2780	2780	2780	2780	2780	2780	2780	2780
16.5	2780	2780	2780	2780	2780	2780	2780	2780
17.0	2780	2780	2780	2780	2780	2780	2780	2780
17.5	2780	2780	2780	2780	2780	2780	2780	2780
18.0	2780	2780	2780	2780	2780	2780	2780	2780
18.5	2780	2780	2780	2780	2780	2780	2780	2780
19.0	2780	2780	2780	2780	2780	2780	2780	2780
19.5	2780	2780	2780	2780	2780	2780	2780	2780
20.0	2780	2780	2780	2780	2780	2780	2780	2780
20.5	2780	2780	2780	2780	2780	2780	2780	2780
21.0	2780	2780	2780	2780	2780	2780	2780	2780
21.5	2780	2780	2780	2780	2780	2780	2780	2780
22.0	2780	2780	2780	2780	2780	2780	2780	2780
22.5	2780	2780	2780	2780	2780	2780	2780	2780
23.0	2780	2780	2780	2780	2780	2780	2780	2780
23.5	2780	2780	2780	2780	2780	2780	2780	2780
24.0	2780	2780	2780	2780	2780	2780	2780	2780
24.5	2780	2780	2780	2780	2780	2780	2780	2780
25.0	2780	2780	2780	2780	2780	2780	2780	2780

Nordex N117/3600 – Power curves – Mode 8

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	290	298	306	314
5.5	349	359	370	381	392	402	413	424	435
6.0	465	479	493	507	521	535	549	563	577
6.5	597	615	632	650	667	685	702	720	738
7.0	736	757	779	801	822	844	865	887	908
7.5	875	901	927	953	978	1004	1030	1055	1081
8.0	1012	1042	1073	1103	1132	1162	1192	1222	1252
8.5	1146	1181	1216	1249	1283	1317	1352	1386	1417
9.0	1276	1315	1355	1392	1431	1470	1509	1543	1579
9.5	1404	1447	1491	1533	1575	1619	1661	1701	1741
10.0	1532	1580	1627	1672	1719	1767	1813	1857	1902
10.5	1658	1711	1762	1811	1862	1913	1964	2012	2061
11.0	1784	1841	1897	1950	2005	2060	2114	2166	2220
11.5	1910	1971	2031	2089	2147	2205	2264	2314	2367
12.0	2037	2102	2166	2227	2289	2342	2396	2440	2483
12.5	2163	2232	2300	2357	2412	2457	2501	2537	2571
13.0	2288	2355	2416	2464	2510	2547	2583	2610	2637
13.5	2399	2457	2509	2549	2587	2615	2643	2663	2682
14.0	2491	2540	2582	2614	2644	2665	2685	2698	2709
14.5	2565	2605	2639	2662	2684	2698	2711	2716	2719
15.0	2623	2654	2679	2695	2709	2715	2720	2720	2720
15.5	2665	2688	2705	2713	2720	2720	2720	2720	2720
16.0	2695	2709	2718	2720	2720	2720	2720	2720	2720
16.5	2712	2719	2720	2720	2720	2720	2720	2720	2720
17.0	2719	2720	2720	2720	2720	2720	2720	2720	2720
17.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
18.0	2720	2720	2720	2720	2720	2720	2720	2720	2720
18.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
19.0	2720	2720	2720	2720	2720	2720	2720	2720	2720
19.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
20.0	2720	2720	2720	2720	2720	2720	2720	2720	2720
20.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
21.0	2720	2720	2720	2720	2720	2720	2720	2720	2720
21.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
22.0	2720	2720	2720	2720	2720	2720	2720	2720	2720
22.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
23.0	2720	2720	2720	2720	2720	2720	2720	2720	2720
23.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
24.0	2720	2720	2720	2720	2720	2720	2720	2720	2720
24.5	2720	2720	2720	2720	2720	2720	2720	2720	2720
25.0	2720	2720	2720	2720	2720	2720	2720	2720	2720

Nordex N117/3600 – Power curves – Mode 8

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	142	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	322	331	339	347	355	363	371	379
5.5	445	456	467	477	488	499	510	520
6.0	591	604	618	632	646	660	674	688
6.5	755	773	790	808	825	842	860	877
7.0	930	951	973	994	1015	1037	1058	1079
7.5	1107	1133	1158	1183	1208	1234	1259	1285
8.0	1282	1312	1341	1370	1399	1429	1458	1488
8.5	1452	1486	1519	1552	1585	1618	1652	1687
9.0	1617	1657	1693	1729	1766	1803	1842	1880
9.5	1782	1826	1866	1906	1946	1988	2030	2073
10.0	1947	1994	2037	2081	2125	2172	2215	2260
10.5	2110	2162	2209	2253	2297	2343	2379	2415
11.0	2271	2321	2366	2402	2437	2475	2504	2533
11.5	2410	2451	2488	2517	2545	2576	2597	2619
12.0	2518	2551	2581	2603	2624	2647	2662	2677
12.5	2600	2625	2648	2663	2678	2693	2701	2709
13.0	2658	2676	2692	2700	2708	2717	2718	2719
13.5	2696	2707	2716	2717	2719	2720	2720	2720
14.0	2716	2718	2720	2720	2720	2720	2720	2720
14.5	2720	2720	2720	2720	2720	2720	2720	2720
15.0	2720	2720	2720	2720	2720	2720	2720	2720
15.5	2720	2720	2720	2720	2720	2720	2720	2720
16.0	2720	2720	2720	2720	2720	2720	2720	2720
16.5	2720	2720	2720	2720	2720	2720	2720	2720
17.0	2720	2720	2720	2720	2720	2720	2720	2720
17.5	2720	2720	2720	2720	2720	2720	2720	2720
18.0	2720	2720	2720	2720	2720	2720	2720	2720
18.5	2720	2720	2720	2720	2720	2720	2720	2720
19.0	2720	2720	2720	2720	2720	2720	2720	2720
19.5	2720	2720	2720	2720	2720	2720	2720	2720
20.0	2720	2720	2720	2720	2720	2720	2720	2720
20.5	2720	2720	2720	2720	2720	2720	2720	2720
21.0	2720	2720	2720	2720	2720	2720	2720	2720
21.5	2720	2720	2720	2720	2720	2720	2720	2720
22.0	2720	2720	2720	2720	2720	2720	2720	2720
22.5	2720	2720	2720	2720	2720	2720	2720	2720
23.0	2720	2720	2720	2720	2720	2720	2720	2720
23.5	2720	2720	2720	2720	2720	2720	2720	2720
24.0	2720	2720	2720	2720	2720	2720	2720	2720
24.5	2720	2720	2720	2720	2720	2720	2720	2720
25.0	2720	2720	2720	2720	2720	2720	2720	2720

Nordex N117/3600 – Power curves – Mode 9

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	290	298	306	314
5.5	349	359	370	381	392	402	413	424	435
6.0	465	479	493	507	521	534	548	562	576
6.5	593	611	628	646	663	681	698	716	733
7.0	726	747	769	790	812	833	855	876	898
7.5	858	883	909	934	960	985	1010	1036	1062
8.0	987	1016	1045	1075	1105	1134	1163	1193	1223
8.5	1113	1146	1179	1212	1245	1278	1311	1345	1379
9.0	1236	1273	1311	1348	1383	1419	1456	1493	1532
9.5	1358	1398	1438	1480	1519	1559	1600	1643	1684
10.0	1479	1522	1566	1611	1655	1699	1744	1791	1836
10.5	1599	1645	1694	1742	1789	1837	1886	1937	1987
11.0	1718	1768	1820	1873	1925	1976	2028	2084	2138
11.5	1837	1891	1947	2004	2061	2115	2172	2231	2282
12.0	1957	2015	2074	2135	2196	2253	2304	2358	2400
12.5	2077	2138	2201	2265	2320	2371	2413	2457	2492
13.0	2195	2260	2319	2375	2422	2464	2498	2534	2561
13.5	2309	2366	2417	2464	2502	2537	2563	2591	2610
14.0	2404	2452	2495	2534	2564	2591	2610	2630	2642
14.5	2482	2522	2556	2587	2609	2629	2641	2653	2657
15.0	2543	2575	2601	2624	2639	2651	2656	2660	2660
15.5	2590	2614	2633	2648	2655	2660	2660	2660	2660
16.0	2624	2640	2652	2659	2660	2660	2660	2660	2660
16.5	2646	2655	2659	2660	2660	2660	2660	2660	2660
17.0	2658	2660	2660	2660	2660	2660	2660	2660	2660
17.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
18.0	2660	2660	2660	2660	2660	2660	2660	2660	2660
18.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
19.0	2660	2660	2660	2660	2660	2660	2660	2660	2660
19.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
20.0	2660	2660	2660	2660	2660	2660	2660	2660	2660
20.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
21.0	2660	2660	2660	2660	2660	2660	2660	2660	2660
21.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
22.0	2660	2660	2660	2660	2660	2660	2660	2660	2660
22.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
23.0	2660	2660	2660	2660	2660	2660	2660	2660	2660
23.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
24.0	2660	2660	2660	2660	2660	2660	2660	2660	2660
24.5	2660	2660	2660	2660	2660	2660	2660	2660	2660
25.0	2660	2660	2660	2660	2660	2660	2660	2660	2660

Nordex N117/3600 – Power curves – Mode 9

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	142	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	322	331	339	347	355	363	371	379
5.5	445	456	467	477	488	499	510	520
6.0	590	604	618	632	646	659	673	687
6.5	751	768	786	803	821	838	856	873
7.0	919	940	962	983	1004	1026	1047	1068
7.5	1087	1112	1138	1163	1188	1214	1239	1264
8.0	1252	1281	1311	1340	1369	1398	1427	1457
8.5	1412	1446	1479	1512	1545	1579	1614	1647
9.0	1569	1607	1644	1680	1717	1756	1795	1834
9.5	1725	1767	1808	1848	1889	1932	1975	2018
10.0	1880	1925	1970	2015	2060	2107	2153	2197
10.5	2035	2084	2133	2181	2226	2272	2316	2352
11.0	2190	2238	2285	2329	2367	2404	2439	2468
11.5	2330	2370	2409	2445	2475	2505	2532	2553
12.0	2440	2473	2504	2533	2555	2578	2597	2611
12.5	2525	2550	2573	2595	2610	2626	2638	2645
13.0	2587	2604	2621	2635	2644	2652	2658	2659
13.5	2628	2639	2649	2656	2658	2660	2660	2660
14.0	2653	2656	2659	2660	2660	2660	2660	2660
14.5	2660	2660	2660	2660	2660	2660	2660	2660
15.0	2660	2660	2660	2660	2660	2660	2660	2660
15.5	2660	2660	2660	2660	2660	2660	2660	2660
16.0	2660	2660	2660	2660	2660	2660	2660	2660
16.5	2660	2660	2660	2660	2660	2660	2660	2660
17.0	2660	2660	2660	2660	2660	2660	2660	2660
17.5	2660	2660	2660	2660	2660	2660	2660	2660
18.0	2660	2660	2660	2660	2660	2660	2660	2660
18.5	2660	2660	2660	2660	2660	2660	2660	2660
19.0	2660	2660	2660	2660	2660	2660	2660	2660
19.5	2660	2660	2660	2660	2660	2660	2660	2660
20.0	2660	2660	2660	2660	2660	2660	2660	2660
20.5	2660	2660	2660	2660	2660	2660	2660	2660
21.0	2660	2660	2660	2660	2660	2660	2660	2660
21.5	2660	2660	2660	2660	2660	2660	2660	2660
22.0	2660	2660	2660	2660	2660	2660	2660	2660
22.5	2660	2660	2660	2660	2660	2660	2660	2660
23.0	2660	2660	2660	2660	2660	2660	2660	2660
23.5	2660	2660	2660	2660	2660	2660	2660	2660
24.0	2660	2660	2660	2660	2660	2660	2660	2660
24.5	2660	2660	2660	2660	2660	2660	2660	2660
25.0	2660	2660	2660	2660	2660	2660	2660	2660

Nordex N117/3600 – Power curves – Mode 10

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m³]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	9
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	290	298	306	314
5.5	349	360	370	381	392	402	413	424	435
6.0	464	478	492	506	519	533	547	561	575
6.5	588	606	623	640	658	675	693	710	728
7.0	716	736	757	779	800	821	842	863	885
7.5	841	865	889	914	940	964	989	1015	1040
8.0	963	990	1018	1047	1076	1105	1133	1163	1193
8.5	1081	1112	1143	1176	1208	1241	1273	1307	1342
9.0	1198	1232	1266	1302	1339	1375	1411	1448	1487
9.5	1313	1350	1388	1428	1469	1509	1549	1588	1631
10.0	1428	1468	1509	1552	1598	1641	1685	1728	1774
10.5	1542	1586	1630	1676	1726	1773	1820	1867	1918
11.0	1657	1704	1751	1801	1854	1905	1956	2007	2063
11.5	1772	1822	1872	1926	1984	2038	2095	2151	2204
12.0	1887	1940	1995	2054	2115	2174	2226	2278	2322
12.5	2003	2061	2120	2181	2238	2290	2334	2378	2414
13.0	2121	2181	2238	2292	2341	2384	2420	2457	2485
13.5	2233	2287	2336	2382	2422	2458	2487	2515	2536
14.0	2328	2374	2415	2453	2486	2514	2536	2556	2569
14.5	2406	2444	2478	2509	2534	2554	2569	2582	2586
15.0	2468	2499	2526	2549	2566	2579	2585	2590	2590
15.5	2516	2540	2560	2575	2584	2590	2590	2590	2590
16.0	2552	2569	2581	2588	2590	2590	2590	2590	2590
16.5	2575	2584	2589	2590	2590	2590	2590	2590	2590
17.0	2587	2589	2590	2590	2590	2590	2590	2590	2590
17.5	2590	2590	2590	2590	2590	2590	2590	2590	2590
18.0	2590	2590	2590	2590	2590	2590	2590	2590	2590
18.5	2590	2590	2590	2590	2590	2590	2590	2590	2590
19.0	2590	2590	2590	2590	2590	2590	2590	2590	2590
19.5	2590	2590	2590	2590	2590	2590	2590	2590	2590
20.0	2590	2590	2590	2590	2590	2590	2590	2590	2590
20.5	2590	2590	2590	2590	2590	2590	2590	2590	2590
21.0	2590	2590	2590	2590	2590	2590	2590	2590	2590
21.5	2590	2590	2590	2590	2590	2590	2590	2590	2590
22.0	2590	2590	2590	2590	2590	2590	2590	2590	2590

Nordex N117/3600 – Power curves – Mode 10

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	142	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	322	330	338	347	355	363	371	379
5.5	445	456	467	477	488	499	510	520
6.0	589	603	617	631	644	658	672	686
6.5	745	763	780	797	815	832	850	867
7.0	906	927	948	970	991	1012	1033	1054
7.5	1065	1090	1115	1140	1166	1191	1216	1240
8.0	1221	1249	1278	1309	1339	1367	1396	1424
8.5	1373	1405	1439	1471	1505	1537	1569	1602
9.0	1522	1557	1595	1632	1669	1705	1741	1777
9.5	1670	1709	1751	1793	1833	1872	1911	1951
10.0	1817	1859	1905	1952	1997	2040	2083	2124
10.5	1963	2010	2062	2112	2158	2201	2241	2275
11.0	2113	2161	2210	2259	2296	2331	2364	2391
11.5	2251	2292	2332	2373	2403	2432	2458	2478
12.0	2361	2394	2428	2460	2483	2505	2524	2538
12.5	2446	2473	2498	2522	2539	2554	2567	2574
13.0	2510	2529	2547	2564	2573	2581	2588	2589
13.5	2554	2567	2577	2586	2588	2590	2590	2590
14.0	2580	2586	2589	2590	2590	2590	2590	2590
14.5	2590	2590	2590	2590	2590	2590	2590	2590
15.0	2590	2590	2590	2590	2590	2590	2590	2590
15.5	2590	2590	2590	2590	2590	2590	2590	2590
16.0	2590	2590	2590	2590	2590	2590	2590	2590
16.5	2590	2590	2590	2590	2590	2590	2590	2590
17.0	2590	2590	2590	2590	2590	2590	2590	2590
17.5	2590	2590	2590	2590	2590	2590	2590	2590
18.0	2590	2590	2590	2590	2590	2590	2590	2590
18.5	2590	2590	2590	2590	2590	2590	2590	2590
19.0	2590	2590	2590	2590	2590	2590	2590	2590
19.5	2590	2590	2590	2590	2590	2590	2590	2590
20.0	2590	2590	2590	2590	2590	2590	2590	2590
20.5	2590	2590	2590	2590	2590	2590	2590	2590
21.0	2590	2590	2590	2590	2590	2590	2590	2590
21.5	2590	2590	2590	2590	2590	2590	2590	2590
22.0	2590	2590	2590	2590	2590	2590	2590	2590

Nordex N117/3600 – Power curves – Mode 11

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	10
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	196	201	207	213
5.0	250	258	266	274	282	290	298	306	314
5.5	349	360	371	382	392	403	414	425	435
6.0	462	476	490	504	518	532	546	560	574
6.5	582	599	617	634	651	669	686	704	721
7.0	702	723	744	765	786	807	828	849	870
7.5	820	844	868	893	917	942	967	991	1016
8.0	935	962	990	1018	1045	1074	1102	1131	1159
8.5	1046	1077	1108	1139	1170	1203	1235	1268	1299
9.0	1156	1190	1225	1259	1294	1329	1365	1402	1436
9.5	1265	1303	1340	1377	1416	1454	1494	1535	1572
10.0	1374	1414	1455	1496	1538	1579	1623	1666	1708
10.5	1481	1525	1569	1613	1659	1704	1751	1798	1844
11.0	1590	1637	1684	1732	1781	1829	1880	1930	1980
11.5	1699	1749	1800	1850	1902	1955	2008	2062	2116
12.0	1808	1861	1915	1969	2024	2080	2138	2187	2237
12.5	1916	1973	2030	2087	2145	2198	2249	2291	2332
13.0	2025	2085	2145	2199	2250	2295	2338	2372	2406
13.5	2133	2194	2245	2292	2335	2372	2407	2434	2460
14.0	2232	2284	2328	2367	2402	2432	2460	2479	2498
14.5	2313	2357	2394	2426	2454	2476	2497	2509	2521
15.0	2379	2416	2445	2470	2491	2506	2520	2525	2530
15.5	2431	2461	2483	2501	2515	2524	2529	2530	2530
16.0	2472	2494	2509	2521	2528	2530	2530	2530	2530
16.5	2500	2516	2524	2529	2530	2530	2530	2530	2530
17.0	2519	2528	2530	2530	2530	2530	2530	2530	2530
17.5	2528	2530	2530	2530	2530	2530	2530	2530	2530
18.0	2530	2530	2530	2530	2530	2530	2530	2530	2530
18.5	2530	2530	2530	2530	2530	2530	2530	2530	2530
19.0	2530	2530	2530	2530	2530	2530	2530	2530	2530
19.5	2530	2530	2530	2530	2530	2530	2530	2530	2530
20.0	2530	2530	2530	2530	2530	2530	2530	2530	2530
20.5	2530	2530	2530	2530	2530	2530	2530	2530	2530
21.0	2530	2530	2530	2530	2530	2530	2530	2530	2530
21.5	2530	2530	2530	2530	2530	2530	2530	2530	2530
22.0	2530	2530	2530	2530	2530	2530	2530	2530	2530

Nordex N117/3600 – Power curves – Mode 11

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	142	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	322	330	338	346	354	363	371	379
5.5	446	457	467	478	489	500	510	521
6.0	587	601	615	629	643	657	670	684
6.5	738	755	773	790	807	825	842	859
7.0	891	911	932	953	974	995	1016	1037
7.5	1040	1065	1089	1114	1139	1163	1188	1212
8.0	1187	1213	1242	1270	1299	1326	1354	1382
8.5	1330	1359	1391	1422	1454	1485	1517	1548
9.0	1470	1504	1541	1575	1609	1644	1679	1714
9.5	1610	1648	1688	1726	1763	1801	1839	1877
10.0	1749	1791	1834	1876	1916	1958	2000	2042
10.5	1888	1934	1981	2026	2071	2112	2154	2195
11.0	2028	2077	2125	2170	2213	2246	2280	2314
11.5	2162	2208	2250	2287	2322	2349	2376	2403
12.0	2275	2312	2346	2376	2405	2426	2446	2466
12.5	2363	2393	2420	2443	2465	2479	2494	2507
13.0	2430	2453	2473	2489	2505	2512	2520	2528
13.5	2478	2495	2508	2517	2526	2528	2529	2530
14.0	2509	2520	2526	2528	2530	2530	2530	2530
14.5	2526	2529	2530	2530	2530	2530	2530	2530
15.0	2530	2530	2530	2530	2530	2530	2530	2530
15.5	2530	2530	2530	2530	2530	2530	2530	2530
16.0	2530	2530	2530	2530	2530	2530	2530	2530
16.5	2530	2530	2530	2530	2530	2530	2530	2530
17.0	2530	2530	2530	2530	2530	2530	2530	2530
17.5	2530	2530	2530	2530	2530	2530	2530	2530
18.0	2530	2530	2530	2530	2530	2530	2530	2530
18.5	2530	2530	2530	2530	2530	2530	2530	2530
19.0	2530	2530	2530	2530	2530	2530	2530	2530
19.5	2530	2530	2530	2530	2530	2530	2530	2530
20.0	2530	2530	2530	2530	2530	2530	2530	2530
20.5	2530	2530	2530	2530	2530	2530	2530	2530
21.0	2530	2530	2530	2530	2530	2530	2530	2530
21.5	2530	2530	2530	2530	2530	2530	2530	2530
22.0	2530	2530	2530	2530	2530	2530	2530	2530

Nordex N117/3600 – Power curves – Mode 12

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	2	3	4	5	6	7	8	10
3.5	41	43	46	48	50	52	54	57	59
4.0	97	101	105	108	112	116	120	124	127
4.5	167	173	178	184	190	195	201	207	213
5.0	250	258	266	274	282	290	298	306	314
5.5	349	360	371	381	392	403	414	424	435
6.0	460	473	487	501	515	529	543	557	570
6.5	574	591	609	626	643	660	677	695	712
7.0	688	708	729	749	770	790	811	832	852
7.5	798	822	846	869	893	918	942	966	990
8.0	907	933	960	987	1014	1041	1068	1096	1124
8.5	1012	1042	1072	1103	1134	1162	1193	1224	1255
9.0	1117	1150	1182	1216	1250	1281	1316	1351	1386
9.5	1221	1257	1293	1328	1366	1400	1438	1477	1516
10.0	1324	1363	1402	1440	1481	1519	1560	1602	1645
10.5	1426	1468	1511	1552	1596	1638	1683	1728	1774
11.0	1529	1574	1619	1664	1711	1757	1805	1854	1903
11.5	1632	1680	1729	1777	1826	1877	1928	1979	2032
12.0	1735	1786	1838	1889	1942	1996	2050	2103	2151
12.5	1838	1892	1947	2002	2058	2114	2162	2209	2248
13.0	1941	1998	2056	2113	2164	2214	2254	2293	2325
13.5	2045	2103	2159	2208	2252	2294	2327	2359	2384
14.0	2145	2196	2244	2286	2322	2357	2383	2408	2425
14.5	2229	2273	2313	2348	2377	2405	2424	2442	2453
15.0	2298	2335	2368	2396	2418	2438	2451	2462	2467
15.5	2354	2384	2410	2431	2446	2460	2465	2470	2470
16.0	2397	2420	2440	2454	2463	2470	2470	2470	2470
16.5	2430	2446	2459	2467	2469	2470	2470	2470	2470
17.0	2452	2462	2469	2470	2470	2470	2470	2470	2470
17.5	2465	2469	2470	2470	2470	2470	2470	2470	2470
18.0	2470	2470	2470	2470	2470	2470	2470	2470	2470
18.5	2470	2470	2470	2470	2470	2470	2470	2470	2470
19.0	2470	2470	2470	2470	2470	2470	2470	2470	2470
19.5	2470	2470	2470	2470	2470	2470	2470	2470	2470
20.0	2470	2470	2470	2470	2470	2470	2470	2470	2470

Nordex N117/3600 – Power curves – Mode 12

wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m³] for hub heights 91 m, 106 m, 120 m and 141 m							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	11	12	13	14	15	16	17	18
3.5	61	63	66	68	70	72	74	77
4.0	131	135	139	142	146	150	154	158
4.5	218	224	230	236	241	247	253	258
5.0	322	330	338	346	354	362	370	378
5.5	446	457	467	478	489	500	510	521
6.0	584	598	612	626	639	653	667	681
6.5	729	746	763	780	797	815	832	849
7.0	873	893	914	934	955	976	996	1017
7.5	1014	1038	1061	1086	1110	1134	1157	1182
8.0	1150	1177	1205	1233	1260	1288	1315	1343
8.5	1285	1315	1346	1376	1406	1438	1469	1500
9.0	1419	1453	1487	1518	1553	1587	1621	1656
9.5	1552	1589	1626	1660	1698	1736	1773	1811
10.0	1684	1724	1764	1802	1842	1883	1924	1966
10.5	1816	1859	1902	1943	1988	2032	2072	2113
11.0	1948	1994	2042	2083	2126	2167	2200	2234
11.5	2080	2123	2167	2204	2239	2272	2299	2326
12.0	2194	2230	2266	2297	2325	2352	2372	2392
12.5	2285	2313	2343	2367	2389	2409	2423	2437
13.0	2355	2377	2400	2417	2432	2446	2454	2462
13.5	2407	2422	2438	2450	2459	2467	2468	2469
14.0	2442	2452	2462	2466	2469	2470	2470	2470
14.5	2463	2466	2470	2470	2470	2470	2470	2470
15.0	2470	2470	2470	2470	2470	2470	2470	2470
15.5	2470	2470	2470	2470	2470	2470	2470	2470
16.0	2470	2470	2470	2470	2470	2470	2470	2470
16.5	2470	2470	2470	2470	2470	2470	2470	2470
17.0	2470	2470	2470	2470	2470	2470	2470	2470
17.5	2470	2470	2470	2470	2470	2470	2470	2470
18.0	2470	2470	2470	2470	2470	2470	2470	2470
18.5	2470	2470	2470	2470	2470	2470	2470	2470
19.0	2470	2470	2470	2470	2470	2470	2470	2470
19.5	2470	2470	2470	2470	2470	2470	2470	2470
20.0	2470	2470	2470	2470	2470	2470	2470	2470

Nordex N117/3600 – General remarks thrust curves

Basis:	The represented thrust coefficients are based on aerodynamical calculations by the Nordex Energy GmbH. The thrust curves are only for information and will not be warranted.

Nordex N117/3600 – Thrust curves – PM1

for hub heights 91 m, 106 m, 120 m and 141 m (mode on request for 91 m, 106 m, 120 m and 141 m)									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.863	0.864	0.865	0.866	0.867	0.868	0.869	0.870	0.871
4.0	0.870	0.871	0.872	0.872	0.872	0.873	0.873	0.874	0.874
4.5	0.874	0.874	0.873	0.873	0.873	0.873	0.873	0.873	0.873
5.0	0.873	0.872	0.872	0.871	0.871	0.870	0.870	0.870	0.870
5.5	0.866	0.866	0.865	0.865	0.864	0.864	0.863	0.863	0.862
6.0	0.861	0.861	0.860	0.860	0.860	0.859	0.859	0.858	0.858
6.5	0.858	0.857	0.857	0.856	0.856	0.856	0.856	0.855	0.855
7.0	0.855	0.854	0.854	0.854	0.854	0.853	0.853	0.853	0.852
7.5	0.852	0.852	0.852	0.852	0.851	0.851	0.851	0.851	0.850
8.0	0.850	0.850	0.850	0.850	0.849	0.849	0.849	0.849	0.849
8.5	0.839	0.839	0.839	0.839	0.840	0.840	0.840	0.840	0.840
9.0	0.785	0.786	0.787	0.788	0.789	0.790	0.790	0.791	0.792
9.5	0.735	0.737	0.739	0.740	0.741	0.742	0.744	0.745	0.746
10.0	0.689	0.691	0.693	0.695	0.697	0.698	0.700	0.701	0.703
10.5	0.646	0.648	0.651	0.653	0.656	0.657	0.659	0.661	0.663
11.0	0.607	0.610	0.613	0.615	0.618	0.619	0.621	0.624	0.626
11.5	0.571	0.574	0.578	0.580	0.583	0.585	0.587	0.589	0.592
12.0	0.538	0.542	0.546	0.548	0.543	0.545	0.547	0.549	0.531
12.5	0.507	0.511	0.508	0.511	0.513	0.497	0.475	0.457	0.442
13.0	0.474	0.477	0.476	0.454	0.434	0.418	0.405	0.393	0.382
13.5	0.439	0.419	0.402	0.388	0.375	0.364	0.353	0.343	0.334
14.0	0.378	0.363	0.351	0.340	0.330	0.320	0.312	0.304	0.296
14.5	0.332	0.321	0.311	0.302	0.293	0.285	0.278	0.270	0.264
15.0	0.295	0.286	0.278	0.270	0.262	0.255	0.249	0.243	0.237
15.5	0.265	0.257	0.250	0.243	0.236	0.230	0.224	0.219	0.214
16.0	0.239	0.232	0.226	0.220	0.214	0.209	0.204	0.199	0.194
16.5	0.217	0.211	0.205	0.200	0.195	0.190	0.185	0.181	0.177
17.0	0.198	0.192	0.187	0.182	0.178	0.173	0.169	0.165	0.162
17.5	0.181	0.176	0.172	0.167	0.163	0.159	0.155	0.152	0.148
18.0	0.166	0.162	0.158	0.154	0.150	0.146	0.143	0.140	0.137
18.5	0.153	0.149	0.145	0.142	0.138	0.135	0.132	0.129	0.126
19.0	0.142	0.138	0.134	0.131	0.128	0.125	0.122	0.119	0.117
19.5	0.131	0.128	0.124	0.122	0.119	0.116	0.113	0.111	0.108
20.0	0.122	0.119	0.116	0.113	0.110	0.108	0.105	0.103	0.101
20.5	0.114	0.111	0.108	0.105	0.103	0.100	0.098	0.096	0.094
21.0	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088
21.5	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082
22.0	0.093	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.077
22.5	0.087	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073
23.0	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068
23.5	0.077	0.075	0.074	0.072	0.070	0.069	0.067	0.066	0.065
24.0	0.073	0.071	0.069	0.068	0.066	0.065	0.064	0.062	0.061
24.5	0.069	0.067	0.066	0.064	0.063	0.061	0.060	0.059	0.058
25.0	0.065	0.064	0.062	0.061	0.059	0.058	0.057	0.056	0.055

Nordex N117/3600 – Thrust curves – PM1

for hub heights 91 m, 106 m, 120 m and 141 m (mode on request for 91 m, 106 m, 120 m and 141 m)								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.866	0.867	0.868	0.870	0.871	0.872	0.873	0.874
3.5	0.872	0.872	0.873	0.874	0.874	0.875	0.875	0.876
4.0	0.874	0.874	0.875	0.875	0.875	0.876	0.876	0.876
4.5	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873
5.0	0.869	0.869	0.869	0.868	0.868	0.868	0.868	0.867
5.5	0.862	0.862	0.861	0.861	0.860	0.860	0.860	0.860
6.0	0.858	0.858	0.857	0.857	0.857	0.856	0.856	0.856
6.5	0.855	0.854	0.854	0.854	0.854	0.854	0.853	0.853
7.0	0.852	0.852	0.852	0.852	0.851	0.851	0.851	0.851
7.5	0.850	0.850	0.850	0.850	0.849	0.849	0.849	0.849
8.0	0.848	0.848	0.848	0.848	0.848	0.847	0.847	0.847
8.5	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840
9.0	0.792	0.792	0.792	0.792	0.792	0.792	0.792	0.792
9.5	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.742
10.0	0.703	0.703	0.703	0.703	0.703	0.699	0.685	0.672
10.5	0.663	0.663	0.663	0.660	0.647	0.634	0.621	0.609
11.0	0.626	0.626	0.614	0.602	0.589	0.578	0.566	0.555
11.5	0.586	0.574	0.562	0.550	0.536	0.518	0.502	0.488
12.0	0.508	0.490	0.474	0.460	0.448	0.436	0.425	0.415
12.5	0.429	0.416	0.405	0.394	0.385	0.376	0.367	0.359
13.0	0.371	0.361	0.352	0.344	0.336	0.328	0.321	0.314
13.5	0.326	0.318	0.310	0.303	0.296	0.290	0.284	0.278
14.0	0.289	0.282	0.275	0.269	0.264	0.258	0.253	0.248
14.5	0.258	0.252	0.246	0.241	0.236	0.231	0.226	0.222
15.0	0.232	0.226	0.222	0.217	0.212	0.208	0.204	0.200
15.5	0.209	0.205	0.200	0.196	0.192	0.188	0.185	0.181
16.0	0.190	0.186	0.182	0.178	0.174	0.171	0.168	0.165
16.5	0.173	0.169	0.166	0.162	0.159	0.156	0.153	0.150
17.0	0.158	0.155	0.152	0.149	0.146	0.143	0.140	0.138
17.5	0.145	0.142	0.139	0.136	0.134	0.131	0.129	0.127
18.0	0.134	0.131	0.128	0.126	0.123	0.121	0.119	0.117
18.5	0.124	0.121	0.118	0.116	0.114	0.112	0.110	0.108
19.0	0.114	0.112	0.110	0.108	0.106	0.104	0.102	0.100
19.5	0.106	0.104	0.102	0.100	0.098	0.096	0.095	0.093
20.0	0.099	0.097	0.095	0.093	0.092	0.090	0.088	0.087
20.5	0.092	0.090	0.089	0.087	0.085	0.084	0.082	0.081
21.0	0.086	0.084	0.083	0.081	0.080	0.078	0.077	0.076
21.5	0.081	0.079	0.078	0.076	0.075	0.074	0.072	0.071
22.0	0.076	0.074	0.073	0.072	0.070	0.069	0.068	0.067
22.5	0.071	0.070	0.069	0.067	0.066	0.065	0.064	0.063
23.0	0.067	0.066	0.065	0.064	0.062	0.061	0.060	0.059
23.5	0.063	0.062	0.061	0.060	0.059	0.058	0.057	0.056
24.0	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.053
24.5	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050
25.0	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.048

Nordex N117/3600 – Thrust curves – Mode 0

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.863	0.864	0.865	0.866	0.867	0.868	0.869	0.870	0.871
4.0	0.871	0.871	0.872	0.872	0.872	0.873	0.873	0.874	0.874
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.873	0.873
5.0	0.873	0.872	0.872	0.872	0.871	0.871	0.870	0.870	0.870
5.5	0.866	0.866	0.865	0.865	0.864	0.864	0.864	0.863	0.863
6.0	0.862	0.861	0.861	0.860	0.860	0.860	0.859	0.859	0.858
6.5	0.858	0.858	0.857	0.857	0.856	0.856	0.856	0.856	0.855
7.0	0.855	0.855	0.854	0.854	0.854	0.854	0.853	0.853	0.853
7.5	0.853	0.852	0.852	0.852	0.852	0.851	0.851	0.851	0.851
8.0	0.851	0.850	0.850	0.850	0.850	0.850	0.849	0.849	0.849
8.5	0.839	0.839	0.839	0.839	0.840	0.840	0.840	0.840	0.840
9.0	0.785	0.786	0.787	0.788	0.789	0.790	0.790	0.791	0.792
9.5	0.735	0.736	0.738	0.740	0.741	0.742	0.743	0.745	0.746
10.0	0.688	0.690	0.693	0.694	0.696	0.698	0.699	0.701	0.703
10.5	0.645	0.648	0.651	0.653	0.655	0.657	0.659	0.661	0.663
11.0	0.606	0.609	0.612	0.615	0.617	0.619	0.621	0.624	0.626
11.5	0.570	0.574	0.577	0.580	0.582	0.584	0.582	0.589	0.592
12.0	0.537	0.541	0.545	0.548	0.542	0.545	0.547	0.532	0.509
12.5	0.506	0.510	0.508	0.510	0.500	0.477	0.458	0.443	0.429
13.0	0.473	0.476	0.458	0.436	0.420	0.406	0.394	0.382	0.372
13.5	0.423	0.405	0.390	0.377	0.365	0.354	0.344	0.335	0.326
14.0	0.366	0.354	0.342	0.331	0.322	0.313	0.304	0.296	0.289
14.5	0.323	0.313	0.303	0.294	0.286	0.278	0.271	0.264	0.258
15.0	0.288	0.279	0.271	0.263	0.256	0.250	0.243	0.237	0.232
15.5	0.259	0.251	0.244	0.237	0.231	0.225	0.220	0.214	0.209
16.0	0.234	0.227	0.221	0.215	0.209	0.204	0.199	0.194	0.190
16.5	0.212	0.206	0.201	0.195	0.190	0.186	0.181	0.177	0.173
17.0	0.194	0.188	0.183	0.178	0.174	0.170	0.166	0.162	0.158
17.5	0.177	0.172	0.168	0.164	0.160	0.156	0.152	0.149	0.145
18.0	0.163	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134
18.5	0.150	0.146	0.142	0.139	0.135	0.132	0.129	0.126	0.124
19.0	0.139	0.135	0.132	0.128	0.125	0.122	0.120	0.117	0.114
19.5	0.128	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.106
20.0	0.119	0.116	0.113	0.111	0.108	0.106	0.103	0.101	0.099
20.5	0.111	0.108	0.106	0.103	0.101	0.098	0.096	0.094	0.092
21.0	0.104	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086
21.5	0.097	0.095	0.092	0.090	0.088	0.086	0.084	0.082	0.081
22.0	0.091	0.089	0.086	0.084	0.083	0.081	0.079	0.077	0.076
22.5	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.071
23.0	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.068	0.067
23.5	0.076	0.074	0.072	0.070	0.069	0.067	0.066	0.065	0.063
24.0	0.071	0.070	0.068	0.066	0.065	0.064	0.062	0.061	0.060
24.5	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057
25.0	0.064	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054

Nordex N117/3600 – Thrust curves – Mode 0

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.866	0.867	0.869	0.870	0.871	0.872	0.873	0.874
3.5	0.872	0.872	0.873	0.874	0.874	0.875	0.875	0.876
4.0	0.874	0.874	0.875	0.875	0.875	0.876	0.876	0.876
4.5	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873
5.0	0.870	0.869	0.869	0.869	0.868	0.868	0.868	0.868
5.5	0.862	0.862	0.862	0.861	0.861	0.860	0.860	0.860
6.0	0.858	0.858	0.858	0.857	0.857	0.857	0.856	0.856
6.5	0.855	0.855	0.854	0.854	0.854	0.854	0.854	0.853
7.0	0.852	0.852	0.852	0.852	0.852	0.851	0.851	0.851
7.5	0.850	0.850	0.850	0.850	0.850	0.850	0.849	0.849
8.0	0.849	0.848	0.848	0.848	0.848	0.848	0.848	0.847
8.5	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.840
9.0	0.792	0.792	0.792	0.792	0.792	0.792	0.792	0.792
9.5	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.742
10.0	0.703	0.703	0.703	0.702	0.702	0.699	0.685	0.672
10.5	0.663	0.663	0.663	0.660	0.647	0.634	0.621	0.609
11.0	0.626	0.626	0.614	0.602	0.589	0.578	0.566	0.555
11.5	0.586	0.574	0.557	0.535	0.517	0.501	0.487	0.474
12.0	0.490	0.474	0.460	0.447	0.435	0.424	0.414	0.404
12.5	0.417	0.405	0.394	0.384	0.375	0.366	0.358	0.350
13.0	0.362	0.352	0.344	0.336	0.328	0.320	0.314	0.307
13.5	0.318	0.310	0.303	0.296	0.289	0.283	0.278	0.272
14.0	0.282	0.275	0.269	0.263	0.258	0.252	0.247	0.242
14.5	0.252	0.246	0.241	0.236	0.231	0.226	0.222	0.217
15.0	0.226	0.221	0.217	0.212	0.208	0.204	0.200	0.196
15.5	0.205	0.200	0.196	0.192	0.188	0.184	0.181	0.177
16.0	0.186	0.182	0.178	0.174	0.171	0.168	0.164	0.161
16.5	0.169	0.166	0.162	0.159	0.156	0.153	0.150	0.147
17.0	0.155	0.152	0.148	0.146	0.143	0.140	0.138	0.135
17.5	0.142	0.139	0.136	0.134	0.131	0.129	0.126	0.124
18.0	0.131	0.128	0.126	0.123	0.121	0.119	0.116	0.114
18.5	0.121	0.118	0.116	0.114	0.112	0.110	0.108	0.106
19.0	0.112	0.110	0.108	0.106	0.104	0.102	0.100	0.098
19.5	0.104	0.102	0.100	0.098	0.096	0.095	0.093	0.091
20.0	0.097	0.095	0.093	0.091	0.090	0.088	0.087	0.085
20.5	0.090	0.089	0.087	0.085	0.084	0.082	0.081	0.080
21.0	0.084	0.083	0.081	0.080	0.078	0.077	0.076	0.074
21.5	0.079	0.078	0.076	0.075	0.074	0.072	0.071	0.070
22.0	0.074	0.073	0.072	0.070	0.069	0.068	0.067	0.066
22.5	0.070	0.069	0.067	0.066	0.065	0.064	0.063	0.062
23.0	0.066	0.065	0.064	0.062	0.061	0.060	0.059	0.058
23.5	0.062	0.061	0.060	0.059	0.058	0.057	0.056	0.055
24.0	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052
24.5	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049
25.0	0.053	0.052	0.051	0.050	0.049	0.048	0.048	0.047

Nordex N117/3600 – Thrust curves – Mode 1

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.863	0.864	0.865	0.866	0.867	0.868	0.869	0.870	0.871
4.0	0.871	0.871	0.872	0.872	0.873	0.873	0.874	0.874	0.874
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.873	0.873	0.872	0.872	0.872	0.871	0.871	0.870	0.870
5.5	0.867	0.866	0.866	0.865	0.865	0.864	0.864	0.863	0.863
6.0	0.862	0.862	0.861	0.861	0.860	0.860	0.860	0.859	0.859
6.5	0.858	0.858	0.858	0.857	0.857	0.856	0.856	0.856	0.856
7.0	0.855	0.855	0.855	0.854	0.854	0.854	0.854	0.853	0.853
7.5	0.853	0.853	0.853	0.852	0.852	0.852	0.852	0.851	0.851
8.0	0.851	0.851	0.851	0.850	0.850	0.850	0.850	0.850	0.849
8.5	0.814	0.814	0.815	0.815	0.815	0.816	0.816	0.816	0.816
9.0	0.760	0.761	0.762	0.763	0.763	0.764	0.765	0.765	0.766
9.5	0.710	0.712	0.713	0.714	0.715	0.716	0.717	0.718	0.719
10.0	0.664	0.666	0.668	0.669	0.670	0.671	0.673	0.674	0.675
10.5	0.622	0.624	0.627	0.628	0.629	0.630	0.632	0.633	0.634
11.0	0.584	0.586	0.589	0.590	0.593	0.595	0.597	0.598	0.600
11.5	0.546	0.549	0.552	0.558	0.560	0.563	0.565	0.566	0.567
12.0	0.519	0.524	0.527	0.528	0.530	0.525	0.527	0.515	0.491
12.5	0.488	0.490	0.493	0.494	0.486	0.463	0.443	0.428	0.415
13.0	0.464	0.465	0.443	0.424	0.407	0.393	0.381	0.370	0.359
13.5	0.411	0.393	0.378	0.365	0.354	0.343	0.333	0.324	0.316
14.0	0.357	0.342	0.331	0.321	0.312	0.303	0.295	0.287	0.280
14.5	0.313	0.303	0.294	0.285	0.277	0.270	0.263	0.256	0.250
15.0	0.279	0.271	0.263	0.255	0.248	0.242	0.236	0.230	0.225
15.5	0.251	0.244	0.237	0.230	0.224	0.218	0.213	0.208	0.203
16.0	0.227	0.220	0.214	0.208	0.203	0.198	0.193	0.189	0.184
16.5	0.206	0.200	0.195	0.190	0.185	0.180	0.176	0.172	0.168
17.0	0.188	0.183	0.178	0.173	0.169	0.165	0.161	0.157	0.154
17.5	0.172	0.167	0.163	0.159	0.155	0.151	0.148	0.144	0.141
18.0	0.158	0.154	0.150	0.146	0.142	0.139	0.136	0.133	0.130
18.5	0.146	0.142	0.138	0.135	0.131	0.128	0.125	0.123	0.120
19.0	0.135	0.131	0.128	0.125	0.122	0.119	0.116	0.114	0.111
19.5	0.125	0.122	0.118	0.116	0.113	0.110	0.108	0.106	0.103
20.0	0.116	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096
20.5	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.090
21.0	0.101	0.098	0.096	0.094	0.091	0.089	0.087	0.086	0.084
21.5	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.080	0.078
22.0	0.088	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.074
22.5	0.083	0.081	0.079	0.077	0.076	0.074	0.072	0.071	0.069
23.0	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.065
23.5	0.074	0.072	0.070	0.068	0.067	0.066	0.064	0.063	0.062
24.0	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.059	0.058
24.5	0.066	0.064	0.063	0.061	0.060	0.059	0.057	0.056	0.055
25.0	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052

Nordex N117/3600 – Thrust curves – Mode 1

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.866	0.867	0.868	0.869	0.871	0.872	0.873	0.874
3.5	0.872	0.872	0.873	0.874	0.874	0.875	0.876	0.876
4.0	0.874	0.875	0.875	0.875	0.876	0.876	0.876	0.876
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.870	0.870	0.869	0.869	0.869	0.868	0.868	0.868
5.5	0.863	0.862	0.862	0.862	0.861	0.861	0.860	0.860
6.0	0.858	0.858	0.858	0.858	0.857	0.857	0.857	0.857
6.5	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.854
7.0	0.853	0.853	0.852	0.852	0.852	0.852	0.852	0.852
7.5	0.851	0.851	0.850	0.850	0.850	0.850	0.850	0.850
8.0	0.849	0.849	0.849	0.849	0.848	0.848	0.848	0.848
8.5	0.817	0.817	0.818	0.818	0.819	0.819	0.819	0.819
9.0	0.767	0.768	0.769	0.770	0.771	0.771	0.771	0.771
9.5	0.720	0.722	0.723	0.725	0.726	0.726	0.726	0.726
10.0	0.676	0.678	0.680	0.682	0.684	0.684	0.684	0.672
10.5	0.637	0.639	0.641	0.643	0.645	0.634	0.621	0.609
11.0	0.602	0.604	0.606	0.602	0.589	0.578	0.566	0.553
11.5	0.569	0.560	0.535	0.515	0.498	0.483	0.469	0.457
12.0	0.473	0.458	0.444	0.432	0.420	0.409	0.399	0.390
12.5	0.403	0.392	0.381	0.372	0.363	0.354	0.346	0.338
13.0	0.350	0.341	0.332	0.325	0.317	0.310	0.304	0.297
13.5	0.308	0.300	0.293	0.286	0.280	0.274	0.269	0.263
14.0	0.273	0.267	0.261	0.255	0.250	0.244	0.239	0.235
14.5	0.244	0.239	0.233	0.228	0.224	0.219	0.215	0.210
15.0	0.220	0.215	0.210	0.206	0.201	0.197	0.194	0.190
15.5	0.198	0.194	0.190	0.186	0.182	0.179	0.175	0.172
16.0	0.180	0.176	0.173	0.169	0.166	0.162	0.159	0.156
16.5	0.164	0.161	0.158	0.154	0.151	0.148	0.146	0.143
17.0	0.150	0.147	0.144	0.141	0.138	0.136	0.133	0.131
17.5	0.138	0.135	0.132	0.130	0.127	0.125	0.123	0.120
18.0	0.127	0.125	0.122	0.120	0.117	0.115	0.113	0.111
18.5	0.118	0.115	0.113	0.111	0.108	0.106	0.105	0.103
19.0	0.109	0.107	0.105	0.102	0.101	0.099	0.097	0.095
19.5	0.101	0.099	0.097	0.095	0.094	0.092	0.090	0.089
20.0	0.094	0.092	0.090	0.089	0.087	0.086	0.084	0.083
20.5	0.088	0.086	0.084	0.083	0.081	0.080	0.078	0.077
21.0	0.082	0.080	0.079	0.078	0.076	0.075	0.074	0.072
21.5	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.068
22.0	0.072	0.071	0.070	0.068	0.067	0.066	0.065	0.064
22.5	0.068	0.067	0.065	0.064	0.063	0.062	0.061	0.060
23.0	0.064	0.063	0.062	0.061	0.060	0.058	0.058	0.057
23.5	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.054
24.0	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.051
24.5	0.054	0.053	0.052	0.051	0.050	0.050	0.049	0.048
25.0	0.051	0.050	0.050	0.049	0.048	0.047	0.046	0.046

Nordex N117/3600 – Thrust curves – Mode 2

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.864
3.5	0.863	0.864	0.865	0.866	0.868	0.868	0.869	0.870	0.871
4.0	0.871	0.872	0.872	0.872	0.873	0.873	0.874	0.874	0.874
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.873	0.873	0.872	0.872	0.872	0.871	0.871	0.871	0.870
5.5	0.867	0.867	0.866	0.866	0.865	0.865	0.864	0.864	0.863
6.0	0.862	0.862	0.861	0.861	0.860	0.860	0.860	0.860	0.859
6.5	0.859	0.858	0.858	0.858	0.857	0.857	0.857	0.856	0.856
7.0	0.856	0.855	0.855	0.855	0.854	0.854	0.854	0.854	0.854
7.5	0.854	0.853	0.853	0.853	0.852	0.852	0.852	0.852	0.852
8.0	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
8.5	0.792	0.792	0.793	0.793	0.793	0.794	0.795	0.795	0.795
9.0	0.738	0.739	0.740	0.740	0.741	0.742	0.743	0.744	0.744
9.5	0.688	0.690	0.691	0.692	0.692	0.693	0.695	0.696	0.696
10.0	0.643	0.644	0.646	0.647	0.647	0.649	0.651	0.652	0.652
10.5	0.602	0.604	0.606	0.606	0.607	0.608	0.611	0.612	0.612
11.0	0.564	0.566	0.568	0.569	0.570	0.572	0.574	0.576	0.577
11.5	0.530	0.532	0.535	0.537	0.533	0.541	0.536	0.537	0.538
12.0	0.500	0.503	0.499	0.500	0.502	0.504	0.506	0.503	0.478
12.5	0.468	0.471	0.474	0.475	0.472	0.449	0.431	0.417	0.404
13.0	0.443	0.445	0.430	0.415	0.396	0.383	0.371	0.360	0.350
13.5	0.400	0.384	0.369	0.356	0.344	0.334	0.325	0.316	0.308
14.0	0.347	0.333	0.323	0.313	0.304	0.295	0.287	0.280	0.273
14.5	0.306	0.296	0.287	0.278	0.270	0.263	0.256	0.250	0.244
15.0	0.273	0.264	0.256	0.249	0.242	0.236	0.230	0.224	0.219
15.5	0.245	0.238	0.231	0.224	0.218	0.213	0.208	0.203	0.198
16.0	0.221	0.215	0.209	0.203	0.198	0.193	0.188	0.184	0.180
16.5	0.201	0.195	0.190	0.185	0.180	0.176	0.172	0.168	0.164
17.0	0.183	0.178	0.174	0.169	0.165	0.161	0.157	0.153	0.150
17.5	0.168	0.163	0.159	0.155	0.151	0.148	0.144	0.141	0.138
18.0	0.154	0.150	0.146	0.143	0.139	0.136	0.133	0.130	0.127
18.5	0.142	0.138	0.135	0.132	0.128	0.125	0.122	0.120	0.117
19.0	0.132	0.128	0.125	0.122	0.119	0.116	0.113	0.111	0.108
19.5	0.122	0.119	0.116	0.113	0.110	0.108	0.105	0.103	0.101
20.0	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094
20.5	0.106	0.103	0.100	0.098	0.096	0.093	0.091	0.089	0.088
21.0	0.098	0.096	0.094	0.091	0.089	0.087	0.085	0.084	0.082
21.5	0.092	0.090	0.088	0.086	0.084	0.082	0.080	0.078	0.077
22.0	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.074	0.072
22.5	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068
23.0	0.076	0.074	0.073	0.071	0.069	0.068	0.066	0.065	0.064
23.5	0.072	0.070	0.068	0.067	0.066	0.064	0.063	0.061	0.060
24.0	0.068	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057
24.5	0.064	0.063	0.061	0.060	0.058	0.057	0.056	0.055	0.054
25.0	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051

Nordex N117/3600 – Thrust curves – Mode 2

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.866	0.867	0.868	0.870	0.871	0.872	0.873	0.874
3.5	0.872	0.872	0.873	0.874	0.874	0.875	0.876	0.876
4.0	0.875	0.875	0.875	0.876	0.876	0.876	0.876	0.876
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.870	0.870	0.870	0.869	0.869	0.869	0.868	0.868
5.5	0.863	0.862	0.862	0.862	0.862	0.861	0.861	0.860
6.0	0.859	0.858	0.858	0.858	0.858	0.857	0.857	0.857
6.5	0.856	0.856	0.855	0.855	0.855	0.854	0.854	0.854
7.0	0.853	0.853	0.853	0.853	0.852	0.852	0.852	0.852
7.5	0.851	0.851	0.851	0.851	0.850	0.850	0.850	0.850
8.0	0.850	0.849	0.849	0.849	0.849	0.849	0.848	0.848
8.5	0.796	0.797	0.797	0.798	0.798	0.799	0.799	0.800
9.0	0.745	0.746	0.747	0.748	0.750	0.750	0.751	0.752
9.5	0.698	0.699	0.700	0.702	0.704	0.705	0.705	0.706
10.0	0.654	0.656	0.658	0.660	0.661	0.662	0.663	0.664
10.5	0.614	0.616	0.618	0.621	0.623	0.624	0.621	0.609
11.0	0.580	0.582	0.584	0.586	0.588	0.578	0.556	0.536
11.5	0.540	0.542	0.519	0.500	0.483	0.469	0.456	0.444
12.0	0.460	0.445	0.432	0.420	0.408	0.398	0.388	0.379
12.5	0.392	0.381	0.371	0.362	0.353	0.345	0.337	0.330
13.0	0.341	0.332	0.324	0.316	0.309	0.302	0.296	0.289
13.5	0.300	0.292	0.286	0.279	0.273	0.267	0.262	0.256
14.0	0.266	0.260	0.254	0.248	0.243	0.238	0.233	0.229
14.5	0.238	0.233	0.228	0.223	0.218	0.214	0.209	0.205
15.0	0.214	0.209	0.205	0.200	0.196	0.192	0.189	0.185
15.5	0.194	0.189	0.185	0.181	0.178	0.174	0.171	0.168
16.0	0.176	0.172	0.168	0.165	0.162	0.158	0.156	0.153
16.5	0.160	0.157	0.154	0.150	0.148	0.145	0.142	0.139
17.0	0.147	0.144	0.141	0.138	0.135	0.133	0.130	0.128
17.5	0.135	0.132	0.129	0.127	0.124	0.122	0.120	0.118
18.0	0.124	0.122	0.119	0.117	0.115	0.112	0.110	0.108
18.5	0.115	0.112	0.110	0.108	0.106	0.104	0.102	0.100
19.0	0.106	0.104	0.102	0.100	0.098	0.096	0.095	0.093
19.5	0.099	0.097	0.095	0.093	0.091	0.090	0.088	0.087
20.0	0.092	0.090	0.088	0.087	0.085	0.084	0.082	0.081
20.5	0.086	0.084	0.082	0.081	0.080	0.078	0.077	0.075
21.0	0.080	0.079	0.077	0.076	0.074	0.073	0.072	0.071
21.5	0.075	0.074	0.072	0.071	0.070	0.068	0.067	0.066
22.0	0.071	0.069	0.068	0.067	0.066	0.064	0.063	0.062
22.5	0.066	0.065	0.064	0.063	0.062	0.061	0.060	0.059
23.0	0.063	0.061	0.060	0.059	0.058	0.057	0.056	0.055
23.5	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052
24.0	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.050
24.5	0.053	0.052	0.051	0.050	0.049	0.048	0.048	0.047
25.0	0.050	0.049	0.048	0.048	0.047	0.046	0.045	0.044

Nordex N117/3600 – Thrust curves – Mode 3

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.864
3.5	0.863	0.864	0.865	0.866	0.868	0.868	0.869	0.870	0.871
4.0	0.871	0.872	0.872	0.873	0.873	0.873	0.874	0.874	0.874
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.874	0.873	0.873	0.872	0.872	0.872	0.871	0.871	0.871
5.5	0.868	0.867	0.866	0.866	0.865	0.865	0.864	0.864	0.864
6.0	0.863	0.862	0.862	0.861	0.861	0.860	0.860	0.860	0.860
6.5	0.859	0.858	0.858	0.858	0.858	0.857	0.857	0.857	0.856
7.0	0.856	0.856	0.856	0.855	0.855	0.855	0.854	0.854	0.854
7.5	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.852	0.852
8.0	0.827	0.828	0.828	0.828	0.828	0.828	0.828	0.829	0.829
8.5	0.770	0.770	0.770	0.770	0.771	0.771	0.772	0.773	0.774
9.0	0.716	0.717	0.717	0.717	0.718	0.718	0.719	0.721	0.722
9.5	0.667	0.668	0.668	0.668	0.669	0.670	0.670	0.673	0.675
10.0	0.623	0.623	0.624	0.624	0.624	0.626	0.627	0.629	0.632
10.5	0.582	0.583	0.584	0.584	0.584	0.586	0.587	0.589	0.592
11.0	0.546	0.545	0.547	0.543	0.548	0.544	0.550	0.548	0.551
11.5	0.508	0.508	0.510	0.510	0.511	0.513	0.516	0.521	0.525
12.0	0.475	0.476	0.477	0.478	0.480	0.482	0.484	0.487	0.465
12.5	0.449	0.451	0.453	0.454	0.455	0.439	0.421	0.405	0.393
13.0	0.425	0.427	0.420	0.403	0.387	0.373	0.361	0.351	0.341
13.5	0.391	0.374	0.360	0.347	0.336	0.326	0.316	0.308	0.300
14.0	0.338	0.326	0.315	0.305	0.296	0.288	0.280	0.273	0.266
14.5	0.298	0.288	0.279	0.271	0.264	0.256	0.250	0.243	0.238
15.0	0.266	0.258	0.250	0.243	0.236	0.230	0.224	0.219	0.214
15.5	0.239	0.232	0.225	0.219	0.213	0.208	0.203	0.198	0.193
16.0	0.216	0.210	0.204	0.198	0.193	0.188	0.184	0.180	0.175
16.5	0.196	0.191	0.185	0.180	0.176	0.172	0.168	0.164	0.160
17.0	0.179	0.174	0.169	0.165	0.161	0.157	0.153	0.150	0.146
17.5	0.164	0.159	0.155	0.151	0.148	0.144	0.141	0.137	0.134
18.0	0.151	0.146	0.143	0.139	0.136	0.132	0.129	0.126	0.124
18.5	0.139	0.135	0.132	0.128	0.125	0.122	0.120	0.117	0.114
19.0	0.128	0.125	0.122	0.119	0.116	0.113	0.111	0.108	0.106
19.5	0.119	0.116	0.113	0.110	0.108	0.105	0.103	0.100	0.098
20.0	0.111	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092
20.5	0.103	0.100	0.098	0.096	0.093	0.091	0.089	0.087	0.086
21.0	0.096	0.094	0.092	0.089	0.087	0.085	0.083	0.082	0.080
21.5	0.090	0.088	0.086	0.084	0.082	0.080	0.078	0.076	0.075
22.0	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.072	0.070
22.5	0.079	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066
23.0	0.075	0.073	0.071	0.069	0.068	0.066	0.065	0.064	0.062
23.5	0.070	0.069	0.067	0.065	0.064	0.063	0.061	0.060	0.059
24.0	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056
24.5	0.063	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053
25.0	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050

Nordex N117/3600 – Thrust curves – Mode 3

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m³]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.866	0.867	0.868	0.870	0.871	0.872	0.873	0.874
3.5	0.872	0.873	0.873	0.874	0.875	0.875	0.876	0.876
4.0	0.875	0.875	0.875	0.876	0.876	0.876	0.876	0.877
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.870	0.870	0.870	0.870	0.869	0.869	0.869	0.869
5.5	0.863	0.863	0.862	0.862	0.862	0.862	0.861	0.861
6.0	0.859	0.859	0.858	0.858	0.858	0.858	0.858	0.857
6.5	0.856	0.856	0.856	0.855	0.855	0.855	0.855	0.854
7.0	0.854	0.853	0.853	0.853	0.853	0.853	0.852	0.852
7.5	0.852	0.852	0.851	0.851	0.851	0.851	0.851	0.850
8.0	0.829	0.829	0.830	0.830	0.830	0.830	0.830	0.831
8.5	0.774	0.775	0.775	0.776	0.777	0.778	0.778	0.779
9.0	0.723	0.724	0.725	0.726	0.727	0.728	0.729	0.730
9.5	0.676	0.676	0.678	0.679	0.681	0.682	0.683	0.685
10.0	0.633	0.634	0.635	0.637	0.638	0.640	0.641	0.643
10.5	0.593	0.594	0.596	0.598	0.600	0.602	0.603	0.605
11.0	0.557	0.559	0.562	0.564	0.566	0.562	0.538	0.519
11.5	0.526	0.526	0.503	0.485	0.469	0.455	0.442	0.431
12.0	0.447	0.432	0.420	0.408	0.397	0.387	0.378	0.369
12.5	0.381	0.371	0.361	0.352	0.343	0.335	0.328	0.321
13.0	0.332	0.323	0.315	0.308	0.301	0.294	0.288	0.282
13.5	0.292	0.285	0.278	0.272	0.266	0.260	0.255	0.250
14.0	0.259	0.253	0.248	0.242	0.237	0.232	0.227	0.223
14.5	0.232	0.227	0.222	0.217	0.212	0.208	0.204	0.200
15.0	0.209	0.204	0.200	0.195	0.191	0.188	0.184	0.180
15.5	0.189	0.185	0.181	0.177	0.173	0.170	0.167	0.164
16.0	0.171	0.168	0.164	0.161	0.158	0.155	0.152	0.149
16.5	0.156	0.153	0.150	0.147	0.144	0.141	0.138	0.136
17.0	0.143	0.140	0.137	0.134	0.132	0.129	0.127	0.125
17.5	0.132	0.129	0.126	0.124	0.121	0.119	0.117	0.115
18.0	0.121	0.119	0.116	0.114	0.112	0.110	0.108	0.106
18.5	0.112	0.110	0.108	0.105	0.103	0.102	0.100	0.098
19.0	0.104	0.102	0.100	0.098	0.096	0.094	0.092	0.091
19.5	0.096	0.094	0.093	0.091	0.089	0.088	0.086	0.084
20.0	0.090	0.088	0.086	0.085	0.083	0.082	0.080	0.079
20.5	0.084	0.082	0.080	0.079	0.078	0.076	0.075	0.074
21.0	0.078	0.077	0.075	0.074	0.073	0.071	0.070	0.069
21.5	0.073	0.072	0.071	0.069	0.068	0.067	0.066	0.065
22.0	0.069	0.068	0.066	0.065	0.064	0.063	0.062	0.061
22.5	0.065	0.064	0.062	0.061	0.060	0.059	0.058	0.057
23.0	0.061	0.060	0.059	0.058	0.057	0.056	0.055	0.054
23.5	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051
24.0	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048
24.5	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.046
25.0	0.049	0.048	0.047	0.046	0.046	0.045	0.044	0.044

Nordex N117/3600 – Thrust curves – Mode 4

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.863	0.864	0.866	0.867	0.868	0.869	0.870	0.870	0.871
4.0	0.871	0.872	0.872	0.873	0.873	0.874	0.874	0.874	0.875
4.5	0.875	0.875	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.874	0.874	0.873	0.873	0.872	0.872	0.872	0.871	0.871
5.5	0.868	0.867	0.867	0.866	0.866	0.865	0.865	0.864	0.864
6.0	0.863	0.862	0.862	0.862	0.861	0.861	0.860	0.860	0.860
6.5	0.859	0.859	0.858	0.858	0.858	0.858	0.857	0.857	0.857
7.0	0.856	0.856	0.856	0.856	0.855	0.855	0.855	0.854	0.854
7.5	0.854	0.854	0.854	0.853	0.853	0.853	0.853	0.852	0.852
8.0	0.804	0.804	0.804	0.805	0.805	0.805	0.806	0.806	0.806
8.5	0.746	0.746	0.747	0.747	0.748	0.748	0.749	0.750	0.751
9.0	0.692	0.693	0.694	0.694	0.695	0.696	0.696	0.697	0.699
9.5	0.644	0.644	0.645	0.646	0.647	0.647	0.648	0.650	0.651
10.0	0.600	0.601	0.602	0.602	0.603	0.604	0.605	0.607	0.608
10.5	0.560	0.561	0.562	0.563	0.564	0.565	0.566	0.568	0.570
11.0	0.523	0.524	0.526	0.527	0.528	0.529	0.530	0.532	0.534
11.5	0.489	0.492	0.493	0.494	0.495	0.496	0.497	0.493	0.495
12.0	0.456	0.457	0.458	0.458	0.460	0.461	0.463	0.466	0.457
12.5	0.429	0.430	0.432	0.434	0.435	0.430	0.413	0.398	0.384
13.0	0.404	0.406	0.408	0.394	0.378	0.366	0.353	0.343	0.333
13.5	0.383	0.366	0.352	0.339	0.328	0.318	0.309	0.301	0.293
14.0	0.332	0.318	0.305	0.298	0.290	0.281	0.274	0.266	0.260
14.5	0.292	0.282	0.273	0.265	0.258	0.251	0.244	0.238	0.232
15.0	0.260	0.252	0.245	0.238	0.231	0.225	0.219	0.214	0.209
15.5	0.234	0.227	0.220	0.214	0.208	0.203	0.198	0.193	0.189
16.0	0.211	0.205	0.199	0.194	0.189	0.184	0.180	0.176	0.172
16.5	0.192	0.186	0.181	0.177	0.172	0.168	0.164	0.160	0.156
17.0	0.175	0.170	0.166	0.161	0.157	0.154	0.150	0.146	0.143
17.5	0.160	0.156	0.152	0.148	0.144	0.141	0.138	0.134	0.132
18.0	0.147	0.143	0.140	0.136	0.133	0.130	0.127	0.124	0.121
18.5	0.136	0.132	0.129	0.126	0.123	0.120	0.117	0.114	0.112
19.0	0.126	0.122	0.119	0.116	0.114	0.111	0.108	0.106	0.104
19.5	0.116	0.114	0.111	0.108	0.105	0.103	0.101	0.098	0.096
20.0	0.108	0.106	0.103	0.100	0.098	0.096	0.094	0.092	0.090
20.5	0.101	0.098	0.096	0.094	0.091	0.089	0.087	0.086	0.084
21.0	0.094	0.092	0.090	0.087	0.085	0.084	0.082	0.080	0.078
21.5	0.088	0.086	0.084	0.082	0.080	0.078	0.076	0.075	0.073
22.0	0.083	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069
22.5	0.078	0.076	0.074	0.072	0.070	0.069	0.068	0.066	0.065
23.0	0.073	0.071	0.070	0.068	0.066	0.065	0.064	0.062	0.061
23.5	0.069	0.067	0.066	0.064	0.063	0.061	0.060	0.059	0.058
24.0	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.054
24.5	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052
25.0	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049

Nordex N117/3600 – Thrust curves – Mode 4

for hub heights 91 m, 106 m and 141 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.866	0.867	0.868	0.870	0.871	0.872	0.873	0.874
3.5	0.872	0.873	0.873	0.874	0.875	0.875	0.876	0.876
4.0	0.875	0.875	0.876	0.876	0.876	0.876	0.876	0.877
4.5	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.0	0.871	0.870	0.870	0.870	0.870	0.869	0.869	0.869
5.5	0.864	0.863	0.863	0.862	0.862	0.862	0.862	0.861
6.0	0.859	0.859	0.859	0.859	0.858	0.858	0.858	0.858
6.5	0.856	0.856	0.856	0.856	0.855	0.855	0.855	0.855
7.0	0.854	0.854	0.854	0.853	0.853	0.853	0.853	0.853
7.5	0.852	0.852	0.852	0.851	0.851	0.851	0.851	0.851
8.0	0.807	0.807	0.808	0.808	0.809	0.809	0.810	0.810
8.5	0.751	0.752	0.753	0.754	0.755	0.756	0.756	0.757
9.0	0.700	0.701	0.702	0.704	0.705	0.706	0.707	0.708
9.5	0.652	0.654	0.656	0.657	0.659	0.660	0.661	0.663
10.0	0.610	0.611	0.613	0.615	0.617	0.618	0.620	0.621
10.5	0.571	0.573	0.575	0.577	0.579	0.580	0.582	0.578
11.0	0.536	0.538	0.535	0.534	0.537	0.539	0.525	0.506
11.5	0.497	0.499	0.496	0.474	0.458	0.444	0.432	0.420
12.0	0.439	0.422	0.410	0.398	0.388	0.378	0.368	0.360
12.5	0.372	0.362	0.352	0.344	0.335	0.327	0.320	0.313
13.0	0.324	0.316	0.308	0.301	0.294	0.287	0.281	0.275
13.5	0.285	0.278	0.272	0.266	0.260	0.254	0.249	0.244
14.0	0.253	0.248	0.242	0.236	0.231	0.227	0.222	0.218
14.5	0.227	0.222	0.217	0.212	0.208	0.203	0.199	0.195
15.0	0.204	0.200	0.195	0.191	0.187	0.183	0.180	0.176
15.5	0.185	0.180	0.177	0.173	0.169	0.166	0.163	0.160
16.0	0.168	0.164	0.161	0.157	0.154	0.151	0.148	0.146
16.5	0.153	0.150	0.146	0.144	0.141	0.138	0.135	0.133
17.0	0.140	0.137	0.134	0.132	0.129	0.126	0.124	0.122
17.5	0.129	0.126	0.123	0.121	0.119	0.116	0.114	0.112
18.0	0.118	0.116	0.114	0.112	0.109	0.107	0.105	0.104
18.5	0.110	0.107	0.105	0.103	0.101	0.099	0.098	0.096
19.0	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.089
19.5	0.094	0.092	0.091	0.089	0.087	0.086	0.084	0.083
20.0	0.088	0.086	0.084	0.083	0.081	0.080	0.078	0.077
20.5	0.082	0.080	0.079	0.077	0.076	0.075	0.073	0.072
21.0	0.077	0.075	0.074	0.072	0.071	0.070	0.069	0.068
21.5	0.072	0.070	0.069	0.068	0.067	0.066	0.064	0.063
22.0	0.068	0.066	0.065	0.064	0.063	0.062	0.060	0.060
22.5	0.064	0.062	0.061	0.060	0.059	0.058	0.057	0.056
23.0	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.053
23.5	0.056	0.055	0.054	0.054	0.052	0.052	0.051	0.050
24.0	0.053	0.052	0.052	0.051	0.050	0.049	0.048	0.047
24.5	0.051	0.050	0.049	0.048	0.047	0.046	0.046	0.045
25.0	0.048	0.047	0.046	0.046	0.045	0.044	0.043	0.043

Nordex N117/3600 – Thrust curves – Mode 5

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.864	0.865	0.866	0.867	0.868	0.869	0.870	0.871	0.872
4.0	0.872	0.873	0.873	0.874	0.874	0.875	0.875	0.875	0.876
4.5	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.0	0.876	0.875	0.875	0.874	0.874	0.873	0.873	0.873	0.872
5.5	0.869	0.869	0.868	0.868	0.867	0.867	0.866	0.866	0.866
6.0	0.865	0.864	0.864	0.863	0.863	0.863	0.862	0.862	0.862
6.5	0.861	0.861	0.860	0.860	0.860	0.859	0.859	0.859	0.859
7.0	0.818	0.818	0.819	0.819	0.820	0.820	0.820	0.820	0.820
7.5	0.749	0.750	0.750	0.751	0.752	0.752	0.753	0.753	0.754
8.0	0.686	0.687	0.688	0.690	0.691	0.691	0.691	0.692	0.693
8.5	0.630	0.631	0.633	0.634	0.636	0.636	0.636	0.637	0.638
9.0	0.580	0.582	0.584	0.586	0.587	0.588	0.588	0.589	0.590
9.5	0.536	0.538	0.540	0.542	0.544	0.544	0.544	0.545	0.546
10.0	0.496	0.499	0.500	0.503	0.505	0.505	0.505	0.506	0.507
10.5	0.458	0.460	0.465	0.467	0.469	0.469	0.470	0.465	0.466
11.0	0.425	0.426	0.428	0.430	0.434	0.434	0.435	0.436	0.437
11.5	0.397	0.399	0.401	0.402	0.405	0.405	0.405	0.406	0.406
12.0	0.371	0.372	0.374	0.376	0.378	0.378	0.378	0.379	0.380
12.5	0.348	0.349	0.351	0.352	0.354	0.354	0.354	0.353	0.340
13.0	0.326	0.328	0.330	0.331	0.333	0.325	0.313	0.304	0.294
13.5	0.307	0.309	0.310	0.302	0.292	0.282	0.274	0.266	0.259
14.0	0.290	0.285	0.274	0.265	0.257	0.249	0.242	0.236	0.230
14.5	0.260	0.251	0.243	0.235	0.228	0.222	0.216	0.211	0.206
15.0	0.231	0.224	0.217	0.211	0.205	0.200	0.194	0.190	0.185
15.5	0.208	0.201	0.196	0.190	0.185	0.180	0.176	0.171	0.167
16.0	0.188	0.182	0.177	0.172	0.168	0.164	0.160	0.156	0.152
16.5	0.170	0.166	0.161	0.157	0.153	0.149	0.146	0.142	0.139
17.0	0.156	0.151	0.147	0.143	0.140	0.136	0.133	0.130	0.127
17.5	0.143	0.139	0.135	0.132	0.128	0.125	0.122	0.120	0.117
18.0	0.131	0.128	0.124	0.121	0.118	0.115	0.113	0.110	0.108
18.5	0.121	0.118	0.115	0.112	0.109	0.106	0.104	0.102	0.100
19.0	0.112	0.109	0.106	0.104	0.101	0.099	0.096	0.094	0.092
19.5	0.104	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.086
20.0	0.096	0.094	0.092	0.089	0.087	0.085	0.083	0.082	0.080
20.5	0.090	0.088	0.086	0.083	0.082	0.080	0.078	0.076	0.075
21.0	0.084	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070
21.5	0.079	0.077	0.075	0.073	0.071	0.070	0.068	0.067	0.065
22.0	0.074	0.072	0.070	0.068	0.067	0.066	0.064	0.063	0.062
22.5	0.069	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058
23.0	0.065	0.064	0.062	0.061	0.059	0.058	0.057	0.056	0.054
23.5	0.062	0.060	0.058	0.057	0.056	0.055	0.054	0.052	0.052
24.0	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049
24.5	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.046
25.0	0.052	0.051	0.050	0.048	0.047	0.046	0.045	0.044	0.044

Nordex N117/3600 – Thrust curves – Mode 5

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m³]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.866	0.867	0.869	0.870	0.870	0.872	0.873	0.874
3.5	0.872	0.873	0.874	0.875	0.875	0.876	0.876	0.877
4.0	0.876	0.876	0.876	0.877	0.877	0.877	0.878	0.878
4.5	0.876	0.876	0.876	0.876	0.875	0.875	0.875	0.876
5.0	0.872	0.872	0.872	0.871	0.871	0.871	0.870	0.870
5.5	0.865	0.865	0.864	0.864	0.864	0.864	0.863	0.863
6.0	0.861	0.861	0.861	0.860	0.860	0.860	0.860	0.859
6.5	0.858	0.858	0.858	0.858	0.857	0.857	0.857	0.857
7.0	0.821	0.821	0.821	0.821	0.822	0.822	0.822	0.822
7.5	0.754	0.754	0.755	0.756	0.756	0.757	0.757	0.758
8.0	0.693	0.694	0.694	0.695	0.696	0.697	0.698	0.698
8.5	0.638	0.639	0.640	0.641	0.642	0.643	0.644	0.645
9.0	0.590	0.591	0.592	0.593	0.594	0.595	0.596	0.597
9.5	0.547	0.547	0.549	0.550	0.552	0.552	0.553	0.554
10.0	0.508	0.509	0.505	0.507	0.508	0.509	0.511	0.512
10.5	0.466	0.467	0.468	0.470	0.471	0.472	0.473	0.474
11.0	0.438	0.439	0.437	0.439	0.440	0.441	0.442	0.443
11.5	0.407	0.407	0.408	0.409	0.404	0.391	0.379	0.369
12.0	0.381	0.375	0.362	0.351	0.341	0.332	0.324	0.316
12.5	0.331	0.320	0.311	0.303	0.295	0.288	0.282	0.275
13.0	0.286	0.279	0.272	0.265	0.259	0.253	0.248	0.242
13.5	0.252	0.246	0.240	0.234	0.229	0.224	0.220	0.215
14.0	0.224	0.219	0.214	0.209	0.204	0.200	0.196	0.192
14.5	0.201	0.196	0.192	0.188	0.184	0.180	0.176	0.173
15.0	0.181	0.177	0.173	0.169	0.166	0.162	0.159	0.156
15.5	0.164	0.160	0.157	0.153	0.150	0.147	0.144	0.142
16.0	0.149	0.146	0.142	0.140	0.137	0.134	0.131	0.129
16.5	0.136	0.133	0.130	0.127	0.125	0.122	0.120	0.118
17.0	0.124	0.122	0.119	0.117	0.114	0.112	0.110	0.108
17.5	0.114	0.112	0.110	0.108	0.105	0.103	0.102	0.100
18.0	0.105	0.103	0.101	0.099	0.097	0.095	0.094	0.092
18.5	0.098	0.096	0.094	0.092	0.090	0.088	0.087	0.085
19.0	0.090	0.088	0.087	0.085	0.084	0.082	0.080	0.079
19.5	0.084	0.082	0.081	0.079	0.078	0.076	0.075	0.074
20.0	0.078	0.077	0.075	0.074	0.072	0.071	0.070	0.069
20.5	0.073	0.072	0.070	0.069	0.068	0.066	0.065	0.064
21.0	0.068	0.067	0.066	0.064	0.063	0.062	0.061	0.060
21.5	0.064	0.063	0.062	0.061	0.060	0.058	0.057	0.056
22.0	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.053
22.5	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050
23.0	0.053	0.052	0.052	0.050	0.050	0.049	0.048	0.047
23.5	0.050	0.050	0.049	0.048	0.047	0.046	0.045	0.045
24.0	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042
24.5	0.045	0.044	0.044	0.043	0.042	0.041	0.041	0.040
25.0	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038

Nordex N117/3600 – Thrust curves – Mode 6

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m³]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.864	0.865	0.866	0.867	0.868	0.870	0.870	0.871	0.872
4.0	0.873	0.873	0.874	0.874	0.874	0.875	0.875	0.876	0.876
4.5	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.0	0.876	0.876	0.875	0.875	0.874	0.874	0.873	0.873	0.873
5.5	0.870	0.869	0.869	0.868	0.868	0.867	0.867	0.866	0.866
6.0	0.865	0.865	0.864	0.864	0.863	0.863	0.863	0.862	0.862
6.5	0.862	0.861	0.861	0.860	0.860	0.860	0.860	0.859	0.859
7.0	0.794	0.795	0.796	0.796	0.797	0.797	0.798	0.798	0.798
7.5	0.725	0.726	0.727	0.728	0.729	0.730	0.730	0.731	0.732
8.0	0.662	0.664	0.666	0.667	0.668	0.669	0.670	0.670	0.671
8.5	0.607	0.609	0.611	0.612	0.614	0.614	0.615	0.616	0.617
9.0	0.559	0.561	0.563	0.564	0.566	0.566	0.568	0.569	0.570
9.5	0.516	0.518	0.520	0.521	0.523	0.524	0.525	0.526	0.526
10.0	0.478	0.475	0.477	0.479	0.480	0.481	0.482	0.484	0.485
10.5	0.441	0.444	0.444	0.443	0.444	0.445	0.446	0.448	0.449
11.0	0.407	0.409	0.411	0.414	0.414	0.415	0.416	0.418	0.419
11.5	0.380	0.382	0.384	0.386	0.387	0.388	0.388	0.389	0.390
12.0	0.355	0.356	0.358	0.360	0.362	0.362	0.363	0.364	0.365
12.5	0.332	0.334	0.336	0.337	0.338	0.339	0.340	0.341	0.332
13.0	0.312	0.314	0.315	0.317	0.318	0.318	0.306	0.296	0.287
13.5	0.294	0.295	0.297	0.296	0.284	0.275	0.267	0.259	0.252
14.0	0.277	0.278	0.268	0.258	0.250	0.243	0.236	0.230	0.224
14.5	0.254	0.245	0.237	0.230	0.223	0.217	0.211	0.206	0.201
15.0	0.226	0.218	0.212	0.206	0.200	0.195	0.190	0.185	0.180
15.5	0.202	0.196	0.191	0.185	0.180	0.176	0.171	0.167	0.163
16.0	0.183	0.178	0.173	0.168	0.164	0.160	0.156	0.152	0.148
16.5	0.166	0.162	0.157	0.153	0.149	0.145	0.142	0.139	0.136
17.0	0.152	0.148	0.144	0.140	0.136	0.133	0.130	0.127	0.124
17.5	0.139	0.135	0.132	0.128	0.125	0.122	0.119	0.117	0.114
18.0	0.128	0.125	0.121	0.118	0.115	0.113	0.110	0.108	0.105
18.5	0.118	0.115	0.112	0.109	0.106	0.104	0.102	0.099	0.097
19.0	0.109	0.106	0.104	0.101	0.099	0.096	0.094	0.092	0.090
19.5	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084
20.0	0.094	0.092	0.090	0.087	0.085	0.083	0.082	0.080	0.078
20.5	0.088	0.086	0.084	0.082	0.080	0.078	0.076	0.074	0.073
21.0	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068
21.5	0.077	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064
22.0	0.072	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060
22.5	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.056
23.0	0.064	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053
23.5	0.060	0.059	0.057	0.056	0.055	0.054	0.052	0.051	0.050
24.0	0.057	0.055	0.054	0.053	0.052	0.050	0.050	0.048	0.048
24.5	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045
25.0	0.051	0.050	0.048	0.047	0.046	0.045	0.044	0.044	0.043

Nordex N117/3600 – Thrust curves – Mode 6

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.866	0.867	0.868	0.870	0.871	0.872	0.873	0.874
3.5	0.873	0.873	0.874	0.875	0.875	0.876	0.876	0.877
4.0	0.876	0.876	0.877	0.877	0.877	0.878	0.878	0.878
4.5	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.0	0.872	0.872	0.872	0.872	0.871	0.871	0.871	0.871
5.5	0.866	0.865	0.865	0.865	0.864	0.864	0.864	0.863
6.0	0.862	0.861	0.861	0.861	0.861	0.860	0.860	0.860
6.5	0.859	0.858	0.858	0.858	0.858	0.858	0.857	0.857
7.0	0.799	0.799	0.799	0.800	0.800	0.800	0.800	0.800
7.5	0.732	0.733	0.733	0.734	0.734	0.734	0.735	0.735
8.0	0.672	0.673	0.673	0.674	0.675	0.675	0.675	0.676
8.5	0.618	0.619	0.620	0.621	0.621	0.622	0.622	0.622
9.0	0.571	0.572	0.572	0.573	0.574	0.574	0.575	0.575
9.5	0.528	0.529	0.530	0.531	0.532	0.531	0.531	0.531
10.0	0.487	0.488	0.489	0.490	0.491	0.492	0.492	0.493
10.5	0.450	0.451	0.452	0.453	0.454	0.454	0.454	0.455
11.0	0.420	0.421	0.422	0.423	0.424	0.424	0.424	0.425
11.5	0.391	0.392	0.393	0.394	0.394	0.381	0.370	0.359
12.0	0.366	0.365	0.353	0.342	0.332	0.323	0.315	0.308
12.5	0.321	0.312	0.303	0.295	0.288	0.281	0.274	0.268
13.0	0.279	0.272	0.265	0.259	0.252	0.247	0.241	0.236
13.5	0.246	0.240	0.234	0.229	0.224	0.219	0.214	0.210
14.0	0.219	0.213	0.208	0.204	0.199	0.195	0.191	0.188
14.5	0.196	0.191	0.187	0.183	0.179	0.175	0.172	0.168
15.0	0.176	0.172	0.169	0.165	0.162	0.158	0.155	0.152
15.5	0.160	0.156	0.153	0.150	0.146	0.144	0.141	0.138
16.0	0.145	0.142	0.139	0.136	0.133	0.131	0.128	0.126
16.5	0.132	0.130	0.127	0.124	0.122	0.120	0.117	0.115
17.0	0.121	0.119	0.116	0.114	0.112	0.110	0.108	0.106
17.5	0.112	0.109	0.107	0.105	0.103	0.101	0.099	0.097
18.0	0.103	0.101	0.099	0.097	0.095	0.093	0.092	0.090
18.5	0.095	0.093	0.091	0.090	0.088	0.086	0.085	0.083
19.0	0.088	0.086	0.085	0.083	0.082	0.080	0.079	0.077
19.5	0.082	0.080	0.079	0.077	0.076	0.074	0.073	0.072
20.0	0.076	0.075	0.074	0.072	0.071	0.070	0.068	0.067
20.5	0.071	0.070	0.069	0.067	0.066	0.065	0.064	0.063
21.0	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059
21.5	0.063	0.061	0.060	0.059	0.058	0.057	0.056	0.055
22.0	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052
22.5	0.055	0.054	0.053	0.052	0.051	0.050	0.050	0.049
23.0	0.052	0.051	0.050	0.049	0.048	0.048	0.047	0.046
23.5	0.049	0.048	0.048	0.047	0.046	0.045	0.044	0.044
24.0	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041
24.5	0.044	0.043	0.043	0.042	0.041	0.040	0.040	0.039
25.0	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037

Nordex N117/3600 – Thrust curves – Mode 7

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.864	0.865	0.866	0.868	0.868	0.869	0.870	0.871	0.872
4.0	0.873	0.873	0.874	0.874	0.875	0.875	0.875	0.876	0.876
4.5	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.0	0.876	0.876	0.875	0.875	0.874	0.874	0.874	0.873	0.873
5.5	0.870	0.870	0.869	0.869	0.868	0.868	0.867	0.867	0.866
6.0	0.865	0.865	0.864	0.864	0.864	0.863	0.863	0.863	0.862
6.5	0.848	0.849	0.849	0.849	0.849	0.850	0.850	0.850	0.850
7.0	0.771	0.772	0.773	0.773	0.774	0.775	0.776	0.776	0.777
7.5	0.701	0.703	0.704	0.705	0.706	0.708	0.709	0.709	0.710
8.0	0.640	0.642	0.644	0.645	0.646	0.648	0.649	0.650	0.651
8.5	0.586	0.588	0.590	0.591	0.593	0.594	0.596	0.597	0.598
9.0	0.538	0.540	0.543	0.544	0.546	0.548	0.549	0.550	0.552
9.5	0.496	0.498	0.501	0.502	0.503	0.504	0.506	0.507	0.508
10.0	0.455	0.457	0.460	0.462	0.464	0.466	0.468	0.471	0.472
10.5	0.422	0.424	0.424	0.426	0.428	0.430	0.431	0.432	0.434
11.0	0.391	0.395	0.397	0.397	0.399	0.400	0.402	0.403	0.405
11.5	0.365	0.367	0.369	0.370	0.371	0.373	0.374	0.376	0.377
12.0	0.340	0.342	0.344	0.346	0.347	0.349	0.351	0.353	0.355
12.5	0.319	0.320	0.322	0.324	0.327	0.330	0.332	0.334	0.326
13.0	0.299	0.301	0.305	0.307	0.310	0.312	0.300	0.290	0.281
13.5	0.284	0.286	0.290	0.292	0.280	0.270	0.261	0.254	0.247
14.0	0.270	0.272	0.263	0.253	0.245	0.238	0.231	0.225	0.219
14.5	0.251	0.240	0.232	0.225	0.218	0.212	0.206	0.201	0.196
15.0	0.221	0.214	0.207	0.201	0.196	0.190	0.186	0.181	0.177
15.5	0.198	0.192	0.187	0.182	0.177	0.172	0.168	0.164	0.160
16.0	0.179	0.174	0.169	0.165	0.160	0.156	0.152	0.149	0.145
16.5	0.163	0.158	0.154	0.150	0.146	0.142	0.139	0.136	0.133
17.0	0.149	0.145	0.141	0.137	0.134	0.130	0.127	0.124	0.122
17.5	0.136	0.133	0.129	0.126	0.123	0.120	0.117	0.114	0.112
18.0	0.125	0.122	0.119	0.116	0.113	0.110	0.108	0.105	0.103
18.5	0.116	0.113	0.110	0.107	0.104	0.102	0.100	0.097	0.095
19.0	0.107	0.104	0.102	0.099	0.097	0.094	0.092	0.090	0.088
19.5	0.099	0.097	0.094	0.092	0.090	0.088	0.086	0.084	0.082
20.0	0.092	0.090	0.088	0.086	0.084	0.082	0.080	0.078	0.076
20.5	0.086	0.084	0.082	0.080	0.078	0.076	0.074	0.073	0.071
21.0	0.080	0.078	0.076	0.075	0.073	0.071	0.070	0.068	0.067
21.5	0.075	0.073	0.072	0.070	0.068	0.067	0.065	0.064	0.063
22.0	0.071	0.069	0.067	0.066	0.064	0.063	0.061	0.060	0.059
22.5	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.056	0.055
23.0	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052
23.5	0.059	0.057	0.056	0.055	0.054	0.052	0.051	0.050	0.049
24.0	0.056	0.054	0.053	0.052	0.051	0.050	0.048	0.048	0.047
24.5	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
25.0	0.050	0.049	0.047	0.046	0.045	0.044	0.044	0.043	0.042

Nordex N117/3600 – Thrust curves – Mode 7

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.866	0.867	0.869	0.870	0.871	0.872	0.873	0.874
3.5	0.873	0.874	0.874	0.875	0.876	0.876	0.877	0.877
4.0	0.876	0.877	0.877	0.877	0.877	0.878	0.878	0.878
4.5	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.0	0.873	0.872	0.872	0.872	0.872	0.871	0.871	0.871
5.5	0.866	0.866	0.865	0.865	0.865	0.864	0.864	0.864
6.0	0.862	0.862	0.862	0.861	0.861	0.861	0.860	0.860
6.5	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.851
7.0	0.777	0.777	0.778	0.778	0.778	0.778	0.778	0.779
7.5	0.711	0.711	0.712	0.712	0.712	0.712	0.713	0.713
8.0	0.651	0.652	0.652	0.653	0.653	0.654	0.654	0.654
8.5	0.599	0.600	0.600	0.600	0.601	0.601	0.602	0.602
9.0	0.552	0.553	0.554	0.554	0.554	0.555	0.556	0.556
9.5	0.509	0.511	0.512	0.512	0.513	0.514	0.514	0.515
10.0	0.473	0.474	0.474	0.475	0.475	0.476	0.470	0.471
10.5	0.435	0.437	0.438	0.438	0.439	0.440	0.441	0.440
11.0	0.405	0.406	0.407	0.408	0.408	0.409	0.411	0.412
11.5	0.379	0.381	0.382	0.383	0.384	0.373	0.362	0.351
12.0	0.357	0.359	0.346	0.335	0.326	0.317	0.308	0.301
12.5	0.315	0.305	0.297	0.289	0.282	0.275	0.269	0.262
13.0	0.273	0.266	0.259	0.253	0.247	0.241	0.236	0.231
13.5	0.241	0.235	0.229	0.224	0.219	0.214	0.210	0.205
14.0	0.214	0.209	0.204	0.200	0.195	0.191	0.187	0.183
14.5	0.192	0.187	0.183	0.179	0.175	0.172	0.168	0.165
15.0	0.173	0.169	0.165	0.162	0.158	0.155	0.152	0.149
15.5	0.156	0.153	0.150	0.146	0.143	0.140	0.138	0.135
16.0	0.142	0.139	0.136	0.133	0.130	0.128	0.126	0.123
16.5	0.130	0.127	0.124	0.122	0.119	0.117	0.115	0.113
17.0	0.119	0.116	0.114	0.112	0.109	0.107	0.105	0.103
17.5	0.109	0.107	0.105	0.103	0.101	0.099	0.097	0.095
18.0	0.101	0.099	0.097	0.095	0.093	0.091	0.090	0.088
18.5	0.093	0.091	0.090	0.088	0.086	0.084	0.083	0.081
19.0	0.086	0.085	0.083	0.081	0.080	0.078	0.077	0.076
19.5	0.080	0.079	0.077	0.076	0.074	0.073	0.072	0.070
20.0	0.075	0.073	0.072	0.071	0.069	0.068	0.067	0.066
20.5	0.070	0.068	0.067	0.066	0.065	0.064	0.062	0.061
21.0	0.065	0.064	0.063	0.062	0.061	0.060	0.058	0.058
21.5	0.061	0.060	0.059	0.058	0.057	0.056	0.055	0.054
22.0	0.058	0.056	0.056	0.054	0.054	0.053	0.052	0.051
22.5	0.054	0.053	0.052	0.051	0.050	0.050	0.049	0.048
23.0	0.051	0.050	0.049	0.048	0.048	0.047	0.046	0.045
23.5	0.048	0.047	0.046	0.046	0.045	0.044	0.043	0.043
24.0	0.046	0.045	0.044	0.043	0.042	0.042	0.041	0.040
24.5	0.043	0.042	0.042	0.041	0.040	0.040	0.039	0.038
25.0	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036

Nordex N117/3600 – Thrust curves – Mode 8

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.864	0.865	0.867	0.868	0.868	0.870	0.870	0.871	0.872
4.0	0.873	0.873	0.874	0.874	0.875	0.875	0.876	0.876	0.876
4.5	0.877	0.877	0.877	0.877	0.877	0.877	0.876	0.876	0.876
5.0	0.877	0.876	0.876	0.875	0.875	0.874	0.874	0.874	0.873
5.5	0.870	0.870	0.870	0.869	0.868	0.868	0.868	0.867	0.867
6.0	0.866	0.865	0.865	0.864	0.864	0.864	0.863	0.863	0.863
6.5	0.823	0.824	0.824	0.825	0.825	0.826	0.826	0.826	0.826
7.0	0.745	0.747	0.748	0.749	0.750	0.750	0.751	0.752	0.753
7.5	0.676	0.678	0.680	0.681	0.682	0.683	0.684	0.685	0.686
8.0	0.616	0.618	0.620	0.621	0.623	0.624	0.625	0.626	0.627
8.5	0.563	0.565	0.568	0.569	0.570	0.572	0.573	0.574	0.576
9.0	0.517	0.519	0.522	0.523	0.524	0.526	0.527	0.528	0.530
9.5	0.476	0.478	0.481	0.481	0.482	0.485	0.487	0.488	0.485
10.0	0.436	0.438	0.442	0.443	0.446	0.448	0.449	0.445	0.447
10.5	0.404	0.404	0.407	0.408	0.410	0.411	0.412	0.415	0.417
11.0	0.374	0.378	0.378	0.380	0.381	0.383	0.384	0.386	0.387
11.5	0.348	0.350	0.353	0.354	0.354	0.356	0.358	0.359	0.360
12.0	0.324	0.326	0.329	0.330	0.332	0.333	0.334	0.335	0.336
12.5	0.304	0.306	0.308	0.309	0.310	0.312	0.313	0.314	0.315
13.0	0.285	0.287	0.289	0.290	0.292	0.293	0.294	0.284	0.275
13.5	0.268	0.270	0.272	0.273	0.274	0.265	0.256	0.248	0.242
14.0	0.253	0.254	0.257	0.249	0.240	0.233	0.226	0.220	0.215
14.5	0.239	0.236	0.227	0.220	0.214	0.208	0.202	0.197	0.192
15.0	0.217	0.209	0.203	0.197	0.192	0.186	0.182	0.177	0.173
15.5	0.194	0.188	0.183	0.178	0.173	0.168	0.164	0.160	0.156
16.0	0.176	0.170	0.166	0.161	0.157	0.153	0.149	0.146	0.142
16.5	0.160	0.155	0.151	0.147	0.143	0.139	0.136	0.133	0.130
17.0	0.146	0.142	0.138	0.134	0.131	0.128	0.124	0.122	0.119
17.5	0.134	0.130	0.126	0.123	0.120	0.117	0.114	0.112	0.109
18.0	0.123	0.120	0.116	0.113	0.111	0.108	0.105	0.103	0.101
18.5	0.113	0.110	0.107	0.105	0.102	0.100	0.097	0.095	0.093
19.0	0.105	0.102	0.099	0.097	0.095	0.092	0.090	0.088	0.086
19.5	0.097	0.095	0.092	0.090	0.088	0.086	0.084	0.082	0.080
20.0	0.090	0.088	0.086	0.084	0.082	0.080	0.078	0.076	0.075
20.5	0.084	0.082	0.080	0.078	0.076	0.075	0.073	0.071	0.070
21.0	0.079	0.077	0.075	0.073	0.071	0.070	0.068	0.067	0.065
21.5	0.074	0.072	0.070	0.068	0.067	0.065	0.064	0.063	0.061
22.0	0.069	0.067	0.066	0.064	0.063	0.061	0.060	0.059	0.058
22.5	0.065	0.063	0.062	0.060	0.059	0.058	0.056	0.055	0.054
23.0	0.061	0.060	0.058	0.057	0.056	0.054	0.053	0.052	0.051
23.5	0.058	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048
24.0	0.054	0.053	0.052	0.051	0.050	0.048	0.048	0.046	0.046
24.5	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
25.0	0.049	0.048	0.046	0.045	0.044	0.044	0.043	0.042	0.041

Nordex N117/3600 – Thrust curves – Mode 8

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.866	0.867	0.869	0.870	0.871	0.872	0.873	0.874
3.5	0.873	0.874	0.874	0.875	0.876	0.876	0.877	0.877
4.0	0.877	0.877	0.877	0.877	0.878	0.878	0.878	0.878
4.5	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.0	0.873	0.873	0.873	0.872	0.872	0.872	0.872	0.871
5.5	0.866	0.866	0.866	0.865	0.865	0.865	0.864	0.864
6.0	0.862	0.862	0.862	0.862	0.861	0.861	0.861	0.861
6.5	0.827	0.827	0.827	0.828	0.828	0.828	0.828	0.828
7.0	0.754	0.755	0.755	0.755	0.755	0.756	0.756	0.757
7.5	0.688	0.689	0.689	0.690	0.690	0.690	0.691	0.692
8.0	0.629	0.631	0.631	0.631	0.631	0.632	0.633	0.634
8.5	0.577	0.579	0.580	0.580	0.580	0.581	0.582	0.584
9.0	0.532	0.534	0.534	0.534	0.535	0.536	0.537	0.538
9.5	0.487	0.489	0.489	0.490	0.490	0.491	0.493	0.494
10.0	0.449	0.451	0.451	0.452	0.452	0.453	0.454	0.456
10.5	0.417	0.419	0.420	0.420	0.420	0.421	0.423	0.424
11.0	0.388	0.390	0.390	0.390	0.390	0.392	0.393	0.394
11.5	0.362	0.364	0.364	0.364	0.364	0.365	0.354	0.344
12.0	0.338	0.340	0.340	0.328	0.318	0.310	0.302	0.295
12.5	0.309	0.299	0.290	0.283	0.275	0.269	0.262	0.257
13.0	0.267	0.260	0.254	0.247	0.242	0.236	0.231	0.226
13.5	0.235	0.230	0.224	0.219	0.214	0.209	0.205	0.201
14.0	0.209	0.204	0.200	0.195	0.191	0.187	0.183	0.179
14.5	0.187	0.183	0.179	0.175	0.171	0.168	0.164	0.161
15.0	0.169	0.165	0.161	0.158	0.155	0.152	0.149	0.146
15.5	0.153	0.150	0.146	0.143	0.140	0.138	0.135	0.132
16.0	0.139	0.136	0.133	0.130	0.128	0.125	0.123	0.120
16.5	0.127	0.124	0.122	0.119	0.117	0.114	0.112	0.110
17.0	0.116	0.114	0.112	0.109	0.107	0.105	0.103	0.101
17.5	0.107	0.105	0.103	0.100	0.099	0.097	0.095	0.093
18.0	0.099	0.097	0.095	0.093	0.091	0.089	0.088	0.086
18.5	0.091	0.089	0.088	0.086	0.084	0.083	0.081	0.080
19.0	0.085	0.083	0.081	0.080	0.078	0.077	0.075	0.074
19.5	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069
20.0	0.073	0.072	0.070	0.069	0.068	0.067	0.065	0.064
20.5	0.068	0.067	0.066	0.065	0.063	0.062	0.061	0.060
21.0	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056
21.5	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.053
22.0	0.056	0.055	0.054	0.053	0.052	0.052	0.051	0.050
22.5	0.053	0.052	0.051	0.050	0.049	0.048	0.048	0.047
23.0	0.050	0.049	0.048	0.047	0.046	0.046	0.045	0.044
23.5	0.047	0.046	0.046	0.045	0.044	0.043	0.042	0.042
24.0	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.040
24.5	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.038
25.0	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.036

Nordex N117/3600 – Thrust curves – Mode 9

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.864	0.865	0.866	0.868	0.869	0.870	0.870	0.871	0.872
4.0	0.873	0.874	0.874	0.875	0.875	0.875	0.876	0.876	0.876
4.5	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877
5.0	0.877	0.876	0.876	0.876	0.875	0.875	0.874	0.874	0.874
5.5	0.871	0.870	0.870	0.869	0.869	0.868	0.868	0.868	0.867
6.0	0.866	0.866	0.865	0.865	0.864	0.864	0.864	0.864	0.863
6.5	0.797	0.798	0.798	0.799	0.800	0.800	0.800	0.801	0.802
7.0	0.720	0.721	0.722	0.723	0.724	0.725	0.725	0.727	0.728
7.5	0.652	0.653	0.654	0.655	0.657	0.658	0.659	0.660	0.662
8.0	0.592	0.593	0.595	0.596	0.598	0.599	0.600	0.602	0.604
8.5	0.540	0.542	0.543	0.545	0.547	0.548	0.549	0.551	0.554
9.0	0.495	0.497	0.498	0.500	0.502	0.503	0.504	0.506	0.509
9.5	0.455	0.456	0.458	0.459	0.458	0.459	0.461	0.463	0.465
10.0	0.417	0.419	0.421	0.424	0.423	0.425	0.426	0.426	0.428
10.5	0.386	0.387	0.387	0.389	0.390	0.392	0.393	0.397	0.397
11.0	0.359	0.358	0.360	0.361	0.363	0.364	0.366	0.368	0.370
11.5	0.332	0.334	0.335	0.336	0.338	0.339	0.340	0.342	0.344
12.0	0.309	0.311	0.312	0.314	0.316	0.316	0.318	0.319	0.321
12.5	0.290	0.291	0.292	0.294	0.295	0.296	0.297	0.299	0.301
13.0	0.272	0.273	0.274	0.276	0.277	0.278	0.279	0.280	0.270
13.5	0.255	0.257	0.258	0.259	0.261	0.260	0.251	0.243	0.236
14.0	0.241	0.242	0.243	0.244	0.236	0.228	0.221	0.216	0.210
14.5	0.227	0.228	0.223	0.215	0.209	0.203	0.198	0.193	0.188
15.0	0.214	0.205	0.199	0.193	0.187	0.182	0.178	0.173	0.169
15.5	0.190	0.184	0.179	0.174	0.169	0.165	0.161	0.157	0.153
16.0	0.172	0.167	0.162	0.158	0.153	0.150	0.146	0.142	0.139
16.5	0.156	0.152	0.148	0.144	0.140	0.136	0.133	0.130	0.127
17.0	0.142	0.138	0.135	0.131	0.128	0.125	0.122	0.119	0.116
17.5	0.131	0.127	0.124	0.120	0.118	0.115	0.112	0.109	0.107
18.0	0.120	0.117	0.114	0.111	0.108	0.106	0.103	0.101	0.099
18.5	0.111	0.108	0.105	0.102	0.100	0.098	0.095	0.093	0.091
19.0	0.103	0.100	0.097	0.095	0.093	0.090	0.088	0.086	0.085
19.5	0.095	0.093	0.090	0.088	0.086	0.084	0.082	0.080	0.079
20.0	0.088	0.086	0.084	0.082	0.080	0.078	0.076	0.075	0.073
20.5	0.082	0.080	0.078	0.076	0.075	0.073	0.071	0.070	0.068
21.0	0.077	0.075	0.073	0.072	0.070	0.068	0.067	0.065	0.064
21.5	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.061	0.060
22.0	0.068	0.066	0.064	0.063	0.061	0.060	0.059	0.058	0.056
22.5	0.064	0.062	0.060	0.059	0.058	0.056	0.055	0.054	0.053
23.0	0.060	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050
23.5	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047
24.0	0.053	0.052	0.051	0.050	0.048	0.048	0.046	0.046	0.045
24.5	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042
25.0	0.048	0.047	0.046	0.044	0.044	0.043	0.042	0.041	0.040

Nordex N117/3600 – Thrust curves – Mode 9

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.866	0.867	0.868	0.870	0.871	0.872	0.873	0.874
3.5	0.873	0.874	0.874	0.875	0.876	0.876	0.877	0.878
4.0	0.877	0.877	0.877	0.878	0.878	0.878	0.878	0.879
4.5	0.877	0.877	0.877	0.877	0.877	0.877	0.876	0.876
5.0	0.874	0.873	0.873	0.873	0.872	0.872	0.872	0.872
5.5	0.867	0.866	0.866	0.866	0.865	0.865	0.865	0.864
6.0	0.863	0.863	0.862	0.862	0.862	0.862	0.861	0.861
6.5	0.802	0.803	0.803	0.804	0.804	0.804	0.805	0.805
7.0	0.729	0.730	0.730	0.731	0.732	0.733	0.734	0.734
7.5	0.663	0.664	0.665	0.666	0.667	0.668	0.669	0.670
8.0	0.605	0.606	0.608	0.609	0.610	0.611	0.612	0.614
8.5	0.555	0.556	0.557	0.558	0.560	0.561	0.563	0.564
9.0	0.510	0.511	0.513	0.514	0.514	0.515	0.517	0.518
9.5	0.466	0.468	0.470	0.470	0.472	0.475	0.478	0.480
10.0	0.430	0.431	0.432	0.434	0.435	0.436	0.438	0.441
10.5	0.399	0.400	0.402	0.403	0.404	0.406	0.407	0.408
11.0	0.370	0.371	0.372	0.374	0.375	0.377	0.378	0.379
11.5	0.345	0.346	0.347	0.348	0.350	0.351	0.347	0.337
12.0	0.322	0.324	0.325	0.322	0.312	0.303	0.295	0.288
12.5	0.302	0.293	0.284	0.276	0.270	0.263	0.257	0.251
13.0	0.262	0.254	0.248	0.242	0.236	0.231	0.226	0.221
13.5	0.230	0.224	0.219	0.214	0.209	0.205	0.200	0.196
14.0	0.205	0.200	0.195	0.191	0.187	0.183	0.179	0.175
14.5	0.183	0.179	0.175	0.171	0.168	0.164	0.161	0.158
15.0	0.165	0.162	0.158	0.154	0.151	0.148	0.145	0.142
15.5	0.150	0.146	0.143	0.140	0.137	0.134	0.132	0.129
16.0	0.136	0.133	0.130	0.128	0.125	0.122	0.120	0.118
16.5	0.124	0.122	0.119	0.117	0.114	0.112	0.110	0.108
17.0	0.114	0.111	0.109	0.107	0.105	0.103	0.101	0.099
17.5	0.105	0.102	0.100	0.098	0.096	0.095	0.093	0.091
18.0	0.096	0.094	0.093	0.091	0.089	0.087	0.086	0.084
18.5	0.089	0.088	0.086	0.084	0.082	0.081	0.079	0.078
19.0	0.083	0.081	0.080	0.078	0.076	0.075	0.074	0.072
19.5	0.077	0.075	0.074	0.072	0.071	0.070	0.069	0.067
20.0	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.063
20.5	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059
21.0	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055
21.5	0.059	0.058	0.057	0.056	0.054	0.054	0.053	0.052
22.0	0.055	0.054	0.053	0.052	0.051	0.050	0.050	0.049
22.5	0.052	0.051	0.050	0.049	0.048	0.048	0.047	0.046
23.0	0.049	0.048	0.047	0.046	0.046	0.045	0.044	0.043
23.5	0.046	0.045	0.045	0.044	0.043	0.042	0.042	0.041
24.0	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039
24.5	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037
25.0	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.035

Nordex N117/3600 – Thrust curves – Mode 10

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.864	0.866	0.867	0.868	0.869	0.870	0.871	0.872	0.872
4.0	0.874	0.874	0.874	0.875	0.875	0.876	0.876	0.876	0.877
4.5	0.878	0.877	0.877	0.878	0.877	0.877	0.877	0.877	0.877
5.0	0.877	0.877	0.876	0.876	0.876	0.875	0.875	0.874	0.874
5.5	0.871	0.871	0.870	0.870	0.869	0.869	0.868	0.868	0.868
6.0	0.858	0.859	0.859	0.859	0.859	0.859	0.860	0.860	0.860
6.5	0.772	0.772	0.772	0.773	0.774	0.774	0.775	0.776	0.777
7.0	0.695	0.696	0.696	0.697	0.698	0.699	0.700	0.702	0.703
7.5	0.629	0.629	0.630	0.631	0.632	0.634	0.635	0.636	0.639
8.0	0.571	0.572	0.572	0.574	0.575	0.576	0.577	0.580	0.582
8.5	0.521	0.522	0.522	0.524	0.525	0.526	0.528	0.530	0.532
9.0	0.477	0.478	0.478	0.480	0.481	0.483	0.484	0.486	0.489
9.5	0.435	0.436	0.436	0.437	0.439	0.440	0.442	0.445	0.448
10.0	0.402	0.402	0.402	0.404	0.405	0.407	0.408	0.408	0.411
10.5	0.370	0.370	0.371	0.372	0.375	0.377	0.378	0.378	0.381
11.0	0.343	0.344	0.344	0.346	0.347	0.348	0.350	0.351	0.353
11.5	0.319	0.320	0.320	0.321	0.322	0.324	0.325	0.327	0.329
12.0	0.298	0.298	0.299	0.300	0.301	0.302	0.303	0.305	0.309
12.5	0.278	0.279	0.279	0.280	0.282	0.283	0.286	0.289	0.292
13.0	0.261	0.262	0.262	0.264	0.267	0.269	0.271	0.274	0.263
13.5	0.246	0.246	0.248	0.251	0.254	0.255	0.245	0.237	0.230
14.0	0.234	0.235	0.237	0.239	0.230	0.222	0.216	0.210	0.204
14.5	0.223	0.224	0.218	0.210	0.204	0.198	0.192	0.188	0.183
15.0	0.212	0.200	0.194	0.188	0.182	0.178	0.173	0.169	0.165
15.5	0.186	0.180	0.174	0.169	0.165	0.160	0.156	0.153	0.149
16.0	0.167	0.162	0.158	0.154	0.150	0.146	0.142	0.139	0.136
16.5	0.152	0.148	0.144	0.140	0.136	0.133	0.130	0.127	0.124
17.0	0.139	0.135	0.131	0.128	0.125	0.122	0.119	0.116	0.113
17.5	0.127	0.124	0.120	0.117	0.114	0.112	0.109	0.107	0.104
18.0	0.117	0.114	0.111	0.108	0.106	0.103	0.101	0.098	0.096
18.5	0.108	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089
19.0	0.100	0.097	0.095	0.092	0.090	0.088	0.086	0.084	0.082
19.5	0.093	0.090	0.088	0.086	0.084	0.082	0.080	0.078	0.077
20.0	0.086	0.084	0.082	0.080	0.078	0.076	0.075	0.073	0.071
20.5	0.080	0.078	0.076	0.075	0.073	0.071	0.070	0.068	0.067
21.0	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.062
21.5	0.070	0.069	0.067	0.065	0.064	0.062	0.061	0.060	0.058
22.0	0.066	0.064	0.063	0.061	0.060	0.059	0.057	0.056	0.055

Nordex N117/3600 – Thrust curves – Mode 10

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m³]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.866	0.868	0.869	0.870	0.871	0.872	0.873	0.874
3.5	0.873	0.874	0.875	0.875	0.876	0.876	0.877	0.878
4.0	0.877	0.877	0.878	0.878	0.878	0.878	0.879	0.879
4.5	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877
5.0	0.874	0.874	0.873	0.873	0.873	0.872	0.872	0.872
5.5	0.867	0.867	0.866	0.866	0.866	0.866	0.865	0.865
6.0	0.860	0.860	0.860	0.860	0.860	0.860	0.860	0.860
6.5	0.777	0.778	0.778	0.780	0.780	0.781	0.781	0.782
7.0	0.704	0.704	0.706	0.707	0.709	0.710	0.710	0.711
7.5	0.639	0.640	0.642	0.643	0.645	0.646	0.647	0.648
8.0	0.582	0.583	0.585	0.587	0.590	0.590	0.591	0.592
8.5	0.533	0.534	0.536	0.538	0.541	0.542	0.542	0.543
9.0	0.490	0.490	0.491	0.495	0.498	0.498	0.499	0.501
9.5	0.449	0.450	0.452	0.450	0.453	0.454	0.455	0.456
10.0	0.411	0.412	0.414	0.419	0.419	0.420	0.421	0.422
10.5	0.382	0.382	0.385	0.387	0.389	0.389	0.390	0.391
11.0	0.354	0.355	0.357	0.359	0.362	0.363	0.365	0.366
11.5	0.330	0.331	0.334	0.337	0.340	0.341	0.339	0.328
12.0	0.311	0.312	0.315	0.315	0.304	0.295	0.287	0.280
12.5	0.294	0.286	0.277	0.269	0.262	0.256	0.250	0.244
13.0	0.255	0.248	0.241	0.236	0.230	0.225	0.220	0.215
13.5	0.224	0.219	0.213	0.208	0.204	0.199	0.195	0.191
14.0	0.199	0.194	0.190	0.186	0.182	0.178	0.174	0.171
14.5	0.178	0.174	0.170	0.167	0.163	0.160	0.157	0.154
15.0	0.161	0.157	0.154	0.150	0.147	0.144	0.142	0.139
15.5	0.146	0.142	0.139	0.136	0.134	0.131	0.128	0.126
16.0	0.132	0.130	0.127	0.124	0.122	0.119	0.117	0.115
16.5	0.121	0.118	0.116	0.114	0.111	0.109	0.107	0.105
17.0	0.111	0.108	0.106	0.104	0.102	0.100	0.098	0.096
17.5	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.089
18.0	0.094	0.092	0.090	0.088	0.087	0.085	0.084	0.082
18.5	0.087	0.085	0.084	0.082	0.080	0.079	0.077	0.076
19.0	0.081	0.079	0.078	0.076	0.075	0.073	0.072	0.071
19.5	0.075	0.074	0.072	0.071	0.069	0.068	0.067	0.066
20.0	0.070	0.068	0.067	0.066	0.065	0.064	0.062	0.061
20.5	0.065	0.064	0.063	0.062	0.060	0.059	0.058	0.057
21.0	0.061	0.060	0.059	0.058	0.057	0.056	0.055	0.054
21.5	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050
22.0	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.048

Nordex N117/3600 – Thrust curves – Mode 11

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.862	0.863	0.865
3.5	0.864	0.866	0.867	0.868	0.869	0.870	0.871	0.872	0.872
4.0	0.874	0.874	0.875	0.875	0.876	0.876	0.876	0.877	0.877
4.5	0.878	0.878	0.878	0.878	0.878	0.878	0.878	0.877	0.877
5.0	0.878	0.877	0.877	0.876	0.876	0.876	0.875	0.875	0.875
5.5	0.872	0.871	0.871	0.870	0.870	0.869	0.869	0.868	0.868
6.0	0.831	0.831	0.831	0.832	0.832	0.832	0.833	0.833	0.834
6.5	0.744	0.745	0.746	0.746	0.747	0.748	0.749	0.750	0.751
7.0	0.669	0.670	0.671	0.672	0.672	0.674	0.675	0.676	0.678
7.5	0.604	0.605	0.606	0.607	0.608	0.609	0.611	0.612	0.614
8.0	0.548	0.549	0.550	0.551	0.552	0.554	0.555	0.557	0.559
8.5	0.499	0.500	0.501	0.502	0.504	0.505	0.507	0.509	0.510
9.0	0.457	0.458	0.459	0.459	0.460	0.462	0.463	0.466	0.467
9.5	0.416	0.417	0.418	0.419	0.421	0.423	0.425	0.427	0.427
10.0	0.383	0.384	0.386	0.386	0.388	0.387	0.389	0.391	0.392
10.5	0.354	0.355	0.355	0.355	0.357	0.359	0.360	0.362	0.364
11.0	0.327	0.328	0.330	0.330	0.332	0.333	0.334	0.335	0.337
11.5	0.304	0.305	0.306	0.307	0.308	0.310	0.311	0.312	0.314
12.0	0.284	0.285	0.286	0.286	0.287	0.289	0.290	0.292	0.293
12.5	0.265	0.266	0.267	0.268	0.269	0.270	0.272	0.273	0.274
13.0	0.249	0.250	0.250	0.251	0.252	0.254	0.255	0.256	0.258
13.5	0.234	0.235	0.235	0.236	0.237	0.238	0.240	0.232	0.225
14.0	0.220	0.221	0.222	0.223	0.224	0.218	0.211	0.205	0.200
14.5	0.208	0.209	0.210	0.206	0.199	0.193	0.188	0.183	0.179
15.0	0.197	0.198	0.190	0.184	0.178	0.174	0.169	0.165	0.161
15.5	0.182	0.176	0.170	0.166	0.161	0.157	0.153	0.149	0.146
16.0	0.164	0.159	0.154	0.150	0.146	0.142	0.139	0.136	0.132
16.5	0.149	0.144	0.140	0.137	0.133	0.130	0.127	0.124	0.121
17.0	0.136	0.132	0.128	0.125	0.122	0.119	0.116	0.113	0.111
17.5	0.124	0.121	0.118	0.115	0.112	0.109	0.107	0.104	0.102
18.0	0.114	0.111	0.108	0.106	0.103	0.101	0.098	0.096	0.094
18.5	0.106	0.103	0.100	0.098	0.095	0.093	0.091	0.089	0.087
19.0	0.098	0.095	0.093	0.090	0.088	0.086	0.084	0.082	0.081
19.5	0.091	0.088	0.086	0.084	0.082	0.080	0.078	0.077	0.075
20.0	0.084	0.082	0.080	0.078	0.076	0.075	0.073	0.071	0.070
20.5	0.079	0.077	0.075	0.073	0.071	0.070	0.068	0.067	0.065
21.0	0.074	0.072	0.070	0.068	0.067	0.065	0.064	0.062	0.061
21.5	0.069	0.067	0.066	0.064	0.062	0.061	0.060	0.058	0.057
22.0	0.065	0.063	0.061	0.060	0.059	0.057	0.056	0.055	0.054

Nordex N117/3600 – Thrust curves – Mode 11

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.866	0.868	0.869	0.870	0.871	0.872	0.873	0.874
3.5	0.873	0.874	0.875	0.875	0.876	0.877	0.877	0.878
4.0	0.877	0.878	0.878	0.878	0.878	0.879	0.879	0.879
4.5	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877
5.0	0.874	0.874	0.874	0.874	0.873	0.873	0.873	0.872
5.5	0.868	0.867	0.867	0.867	0.866	0.866	0.866	0.866
6.0	0.834	0.834	0.834	0.835	0.835	0.835	0.835	0.836
6.5	0.751	0.752	0.753	0.754	0.754	0.755	0.755	0.756
7.0	0.678	0.679	0.680	0.681	0.682	0.683	0.684	0.685
7.5	0.615	0.616	0.617	0.618	0.619	0.620	0.621	0.622
8.0	0.560	0.560	0.562	0.563	0.565	0.566	0.566	0.568
8.5	0.511	0.512	0.514	0.515	0.517	0.518	0.519	0.520
9.0	0.468	0.466	0.467	0.469	0.470	0.471	0.472	0.474
9.5	0.428	0.429	0.430	0.430	0.431	0.432	0.433	0.434
10.0	0.393	0.396	0.398	0.400	0.399	0.400	0.401	0.402
10.5	0.365	0.366	0.367	0.368	0.369	0.370	0.371	0.372
11.0	0.338	0.339	0.340	0.342	0.343	0.344	0.345	0.346
11.5	0.315	0.316	0.317	0.318	0.319	0.320	0.321	0.321
12.0	0.294	0.295	0.296	0.297	0.298	0.289	0.281	0.274
12.5	0.275	0.276	0.271	0.263	0.256	0.250	0.244	0.238
13.0	0.250	0.242	0.236	0.230	0.225	0.219	0.215	0.210
13.5	0.219	0.214	0.208	0.204	0.199	0.195	0.190	0.186
14.0	0.195	0.190	0.186	0.182	0.178	0.174	0.170	0.167
14.5	0.174	0.170	0.167	0.163	0.160	0.156	0.153	0.150
15.0	0.157	0.154	0.150	0.147	0.144	0.141	0.138	0.136
15.5	0.142	0.139	0.136	0.133	0.131	0.128	0.126	0.123
16.0	0.130	0.127	0.124	0.121	0.119	0.117	0.114	0.112
16.5	0.118	0.116	0.113	0.111	0.109	0.107	0.105	0.103
17.0	0.108	0.106	0.104	0.102	0.100	0.098	0.096	0.094
17.5	0.100	0.098	0.096	0.094	0.092	0.090	0.088	0.087
18.0	0.092	0.090	0.088	0.086	0.085	0.083	0.082	0.080
18.5	0.085	0.083	0.082	0.080	0.078	0.077	0.076	0.074
19.0	0.079	0.077	0.076	0.074	0.073	0.072	0.070	0.069
19.5	0.073	0.072	0.070	0.069	0.068	0.067	0.065	0.064
20.0	0.068	0.067	0.066	0.064	0.063	0.062	0.061	0.060
20.5	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.056
21.0	0.060	0.059	0.058	0.056	0.055	0.054	0.054	0.053
21.5	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049
22.0	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046

Nordex N117/3600 – Thrust curves – Mode 12

for hub heights 91 m, 106 m, 120 m and 141 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.860	0.860	0.860	0.860	0.860	0.860	0.861	0.863	0.865
3.5	0.864	0.866	0.867	0.868	0.869	0.870	0.871	0.872	0.873
4.0	0.874	0.874	0.875	0.875	0.876	0.876	0.877	0.877	0.877
4.5	0.878	0.878	0.878	0.878	0.878	0.878	0.878	0.878	0.878
5.0	0.878	0.878	0.877	0.877	0.876	0.876	0.876	0.875	0.875
5.5	0.872	0.872	0.871	0.871	0.870	0.870	0.869	0.869	0.869
6.0	0.802	0.803	0.803	0.804	0.804	0.805	0.805	0.806	0.806
6.5	0.718	0.718	0.719	0.719	0.720	0.721	0.722	0.723	0.724
7.0	0.644	0.644	0.645	0.646	0.647	0.648	0.650	0.651	0.652
7.5	0.580	0.581	0.582	0.583	0.584	0.586	0.587	0.588	0.590
8.0	0.526	0.527	0.528	0.529	0.530	0.532	0.533	0.534	0.536
8.5	0.479	0.480	0.481	0.482	0.483	0.484	0.486	0.488	0.489
9.0	0.437	0.437	0.438	0.439	0.441	0.440	0.441	0.443	0.444
9.5	0.399	0.400	0.402	0.403	0.405	0.404	0.406	0.407	0.408
10.0	0.367	0.368	0.368	0.369	0.370	0.371	0.372	0.375	0.377
10.5	0.340	0.340	0.341	0.340	0.342	0.343	0.345	0.346	0.348
11.0	0.313	0.314	0.315	0.316	0.317	0.318	0.319	0.320	0.322
11.5	0.291	0.291	0.292	0.293	0.294	0.296	0.297	0.298	0.300
12.0	0.271	0.272	0.273	0.274	0.274	0.276	0.277	0.278	0.280
12.5	0.253	0.254	0.255	0.256	0.257	0.258	0.259	0.260	0.262
13.0	0.238	0.238	0.239	0.240	0.241	0.242	0.243	0.244	0.246
13.5	0.223	0.224	0.225	0.226	0.226	0.228	0.229	0.229	0.221
14.0	0.210	0.211	0.212	0.213	0.214	0.215	0.207	0.201	0.195
14.5	0.199	0.200	0.200	0.201	0.196	0.189	0.184	0.179	0.174
15.0	0.188	0.189	0.186	0.180	0.174	0.170	0.165	0.161	0.157
15.5	0.178	0.172	0.167	0.162	0.157	0.153	0.149	0.146	0.142
16.0	0.160	0.155	0.151	0.147	0.143	0.139	0.136	0.132	0.129
16.5	0.146	0.141	0.137	0.134	0.130	0.127	0.124	0.121	0.118
17.0	0.133	0.129	0.125	0.122	0.119	0.116	0.113	0.111	0.108
17.5	0.122	0.118	0.115	0.112	0.109	0.107	0.104	0.102	0.100
18.0	0.112	0.109	0.106	0.103	0.101	0.098	0.096	0.094	0.092
18.5	0.103	0.100	0.098	0.095	0.093	0.091	0.089	0.087	0.085
19.0	0.096	0.093	0.091	0.088	0.086	0.084	0.082	0.080	0.079
19.5	0.089	0.086	0.084	0.082	0.080	0.078	0.076	0.075	0.073
20.0	0.082	0.080	0.078	0.076	0.075	0.073	0.071	0.070	0.068

Nordex N117/3600 – Thrust curves – Mode 12

for hub heights 91 m, 106 m, 120 m and 141 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.866	0.868	0.869	0.870	0.871	0.872	0.873	0.874
3.5	0.873	0.874	0.875	0.876	0.876	0.877	0.877	0.878
4.0	0.878	0.878	0.878	0.878	0.879	0.879	0.879	0.879
4.5	0.878	0.878	0.878	0.878	0.878	0.878	0.878	0.878
5.0	0.875	0.874	0.874	0.874	0.874	0.873	0.873	0.873
5.5	0.868	0.868	0.868	0.867	0.867	0.866	0.866	0.866
6.0	0.807	0.807	0.807	0.808	0.808	0.809	0.809	0.809
6.5	0.725	0.725	0.726	0.727	0.728	0.728	0.729	0.730
7.0	0.653	0.653	0.654	0.655	0.656	0.657	0.658	0.659
7.5	0.590	0.591	0.592	0.593	0.594	0.595	0.596	0.597
8.0	0.536	0.538	0.539	0.540	0.541	0.542	0.543	0.544
8.5	0.490	0.490	0.492	0.493	0.494	0.495	0.496	0.498
9.0	0.445	0.446	0.447	0.448	0.449	0.451	0.453	0.454
9.5	0.409	0.410	0.411	0.410	0.412	0.413	0.414	0.415
10.0	0.378	0.379	0.380	0.379	0.380	0.381	0.382	0.384
10.5	0.348	0.349	0.350	0.350	0.351	0.352	0.353	0.354
11.0	0.322	0.323	0.324	0.325	0.326	0.327	0.328	0.329
11.5	0.300	0.301	0.302	0.303	0.304	0.305	0.306	0.307
12.0	0.280	0.281	0.282	0.283	0.284	0.284	0.275	0.268
12.5	0.262	0.263	0.264	0.258	0.250	0.244	0.238	0.233
13.0	0.246	0.238	0.231	0.225	0.219	0.214	0.210	0.205
13.5	0.214	0.209	0.204	0.199	0.194	0.190	0.186	0.182
14.0	0.190	0.186	0.181	0.177	0.173	0.170	0.166	0.163
14.5	0.170	0.166	0.163	0.159	0.156	0.153	0.150	0.146
15.0	0.154	0.150	0.147	0.144	0.141	0.138	0.135	0.132
15.5	0.139	0.136	0.133	0.130	0.128	0.125	0.123	0.120
16.0	0.126	0.124	0.121	0.119	0.116	0.114	0.112	0.110
16.5	0.116	0.113	0.111	0.108	0.106	0.104	0.102	0.100
17.0	0.106	0.104	0.102	0.100	0.098	0.096	0.094	0.092
17.5	0.097	0.095	0.093	0.092	0.090	0.088	0.086	0.085
18.0	0.090	0.088	0.086	0.084	0.083	0.081	0.080	0.078
18.5	0.083	0.082	0.080	0.078	0.077	0.075	0.074	0.073
19.0	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.068
19.5	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.063
20.0	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059

NORDEX N131

General documentation

Technical description

Wind turbine class K08 delta

N131/3900 IEC S

E0003806613

Revision 05 / 2018-06-07

- Translation of the original document (E0003696129, rev. 08) -

This is a translation from German. In case of doubt, the German text shall prevail.

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1. Structure

The Nordex N131/3900 wind turbine (WT) is a speed-variable wind turbine with a rotor diameter of 131.0 m and a nominal power of 3900 kW. The wind turbine is designed for 50 Hz or 60 Hz. The wind turbine is designed for class IIIS in accordance with IEC 61400-1.

The wind turbine Nordex N131/3900 consists of the following main components:

- Rotor, with rotor hub, three rotor blades and the pitch system
- Nacelle with drive train, generator and yaw system
- Tubular tower with foundation or hybrid tower with foundation
- Medium-voltage transformer (MV transformer) and medium-voltage switchgear (MV switchgear)

1.1 Tower

The Nordex N131/3900 is erected on a tubular steel tower or hybrid towers with various hub heights. The cylindrical steel tower has a conical head section and consists of 2 to 6 sections. Corrosion protection is guaranteed by a coating system of the surface acc. to ISO 12944. A service lift, the vertical ladder with fall protection system as well as resting and working platforms inside the tower allow for a weather-protected ascent to the nacelle. The lower part of the hybrid tower consists of a concrete part on which the two steel sections are mounted.

The size and design of the foundation depend on the ground conditions at the intended site. The tubular steel tower is bolted to the anchor cage embedded in the foundation.

Switch cabinets are integrated in the tower base, which contain important components of the electronic controls, the turbine PC, frequency converter, low-voltage main switch, fuses, the transformer for auxiliary power in the tower base and outputs to the transformer and to the generator. The frequency converter is equipped with a water cooling system. The water heated in the frequency converter is cooled in a water/air heat exchanger. It is located on the outer tower wall.

The MV transformer and MV switchgear may be located in a separate transformer substation near the wind turbine. For the transformer in the tower (TIT) variant, the MV transformer and MV switchgear can also be located in the tower base.
In this case, the components in the tower base of the tubular steel tower are arranged on three different levels:

- The MV transformer on the foundation
- The MV switchgear on the first tower platform
- The switch cabinet with frequency converter on the second tower platform

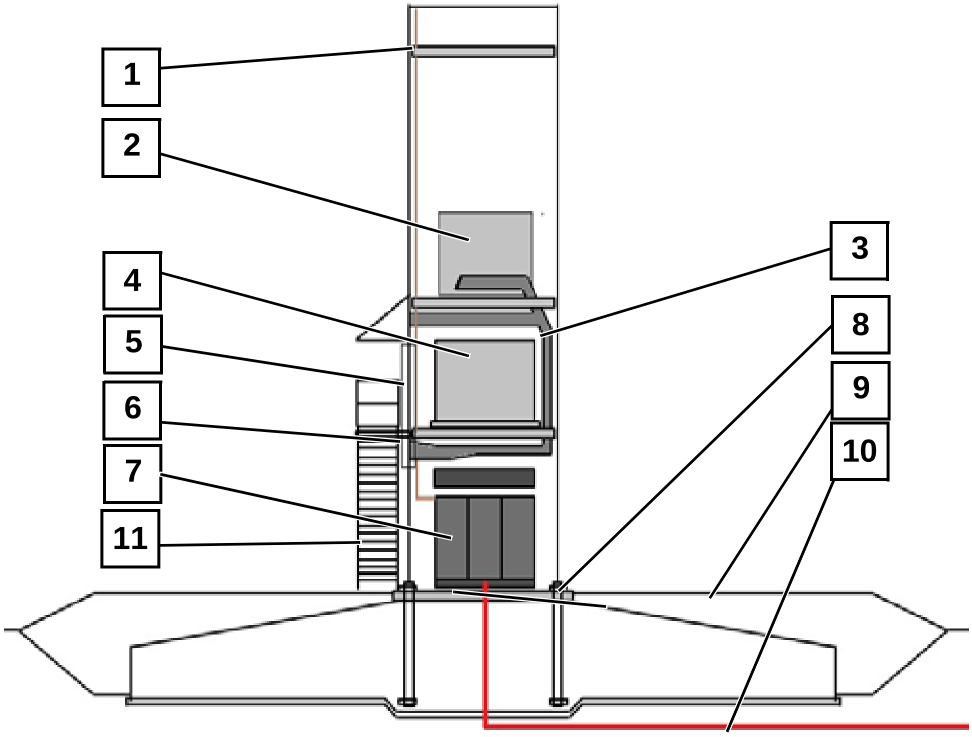

Fig. 1 Section through the tower base, transformer inside tower (TIT) variant

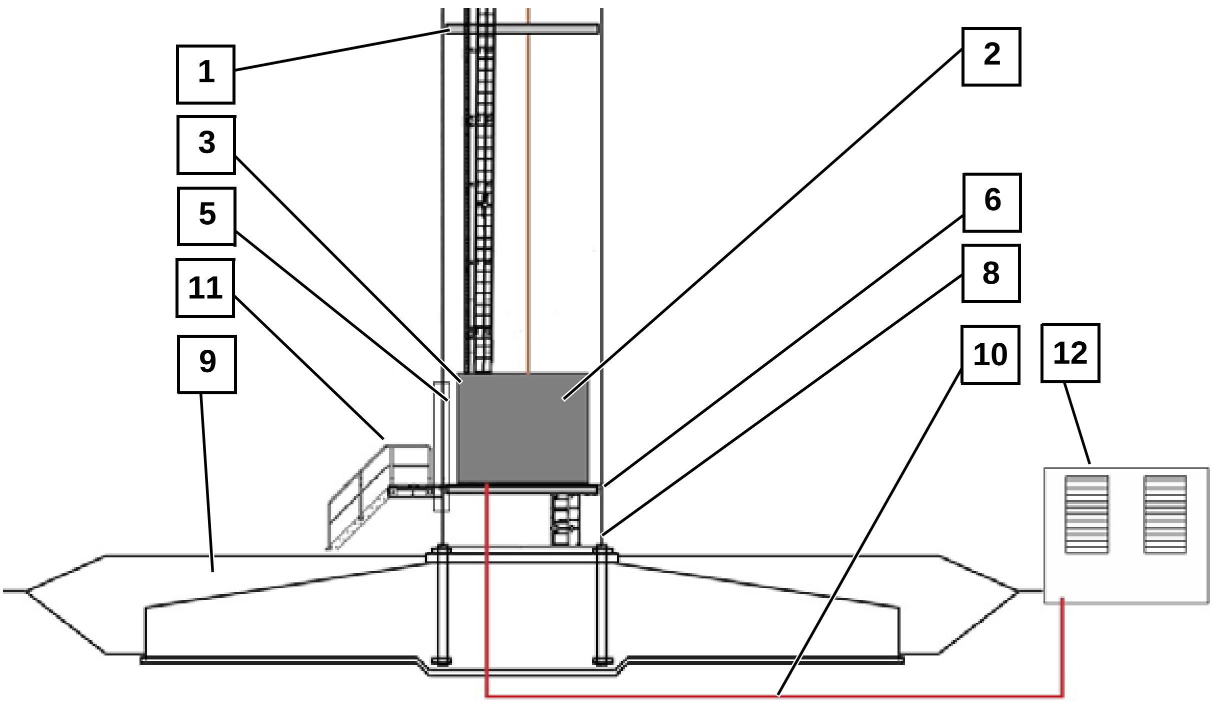

Fig. 2 Section through the tower base, transformer outside tower (TAT) variant

1	Flange tower platform	2	Switch cabinet/converter	3	Ventilation/cooling
4	MV switchgear (TIT)	5	Tower door	6	First tower platform
7	Transformer (TIT)	8	Anchor bolts	9	Soil backfill
10	Power cables in conduits	11	Tower stairs	12	Transformer station with switchgear (TAT)

The hybrid tower is only available in the transformer in the tower variant. All tower base interiors are installed on one level.

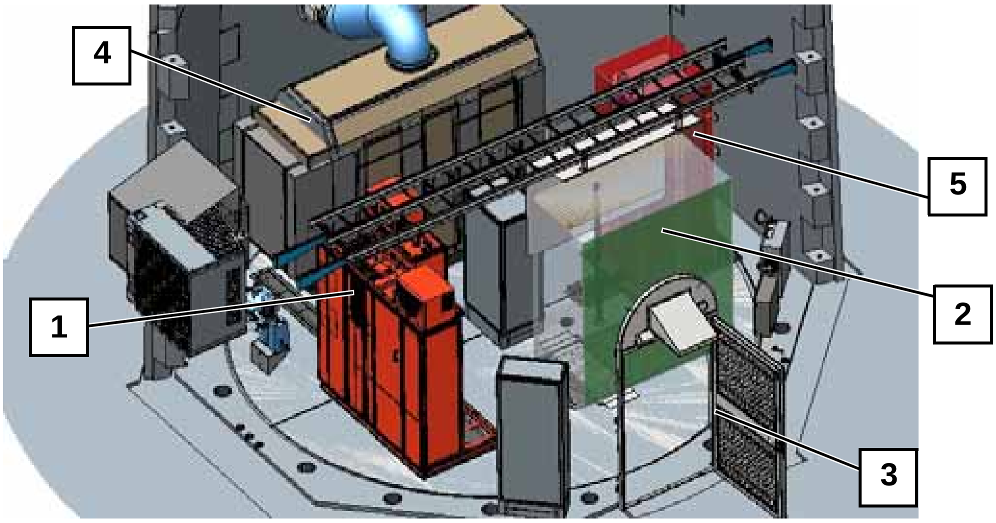

Fig. 3 Hybrid tower base

1	Main converter	2	MV switchgear	3	Tower access
4	MV transformer	5	Service lift		

1.2 Rotor

The rotor consists of the rotor hub with three pitch bearings and three pitch drives for blade adjustment as well as three rotor blades.

The **rotor hub** consists of the base element, support structure and spinner. The base element consists of a stiff cast structure, on which the pitch bearings and the rotor blades are assembled. The rotor hub is covered with the spinner which enables the direct access from the nacelle into the rotor hub.

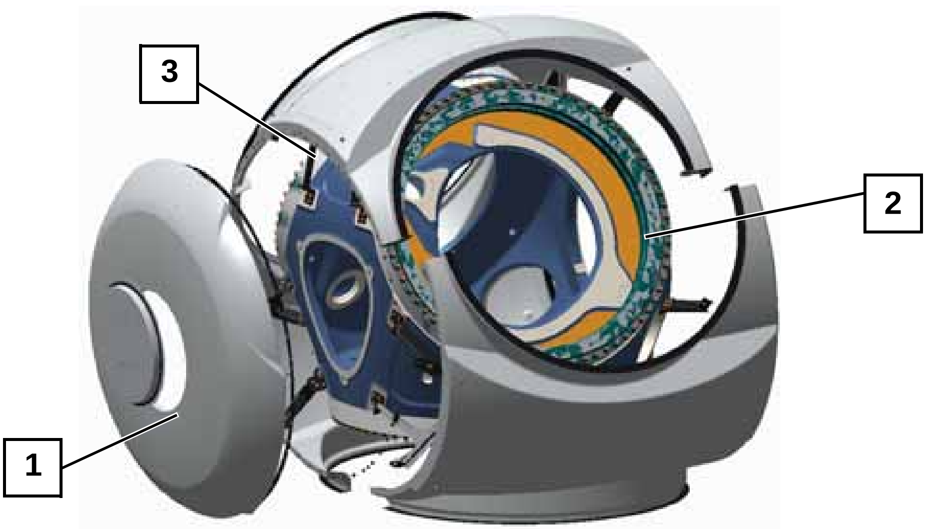

Fig. 4 Rotor hub and spinner of Nordex delta generation wind turbines

1	Spinner segment	2	Rotor hub	3	Spinner support structure

The **rotor blades** are made of high-quality glass fiber-reinforced and carbon-fiber reinforced plastics. The rotor blade is statically and dynamically tested in accordance with the guidelines IEC 61400-23 and GL IV-1 (2010). If requested by the customer, the rotor blades can be equipped with serrations, which optimize the sound power level.

The **pitch system** serves to adjust the pitch angle of the rotor blades set by the control system. For each individual rotor blade the pitch system comprises an electromechanical drive with 3-phase motor, planetary gear and drive pinion, as well as a control unit with frequency converter and emergency power supply. Power supply and signal transfer are realized through a slip ring in the nacelle.

1.3 Nacelle

The nacelle contains essential mechanical and electrical components of the wind turbine. The nacelle can be pivoted on the tower.

The **rotor shaft** is supported in the rotor bearing inside the nacelle. A rotor lock is integrated in the rotor bearing, with which the rotor can be reliably locked in place mechanically.

The **gearbox** increases the rotor speed until it reaches the speed required for the generator.

The bearings and gearings are continuously lubricated with oil. A 2-stage pump enables the oil circulation. A combination filter element with coarse, fine and ultrafine filter retains solid particles. The control system monitors the contamination of the filter element.

The gear oil used for lubrication also cools the gearbox. The temperatures of the gearbox bearings and the oil are continuously monitored. If the optimum operating temperature is not yet reached, a thermal bypass directs the gear oil directly back to the gearbox. If the operating temperature of the gear oil is exceeded it is cooled down.

The gearbox cooling is realized with an oil/water cooler that is installed directly at the gearbox. The heated cooling water is cooled together with the cooling water of the generator in a passive cooler on the roof of the nacelle.

The **generator** is a 6-pole doubly-fed induction machine. An air/water heat exchanger is mounted on the generator. The cooling water is recooled together with the cooling water of the gearbox heat exchanger in a passive cooler on the nacelle roof.

The mechanical **rotor brake** supports the aerodynamic braking effect of the rotor blades as soon as the rotor speed falls below a defined value and finally stops the rotor. The aerodynamic braking effect of the rotor is achieved by adjusting the rotor blades perpendicular to the rotation direction. The rotor brake consists of a brake caliper, which acts on the brake disk assembled behind the gearbox.

The **yaw drives** optimally rotate the nacelle into the wind. The four yaw drives are located on the machine frame in the nacelle. A yaw drive consists of an electric motor, multi-stage planetary gear, and a drive pinion. The drive pinions mesh with the external teeth of the yaw bearing.

Being positioned properly, the nacelle is locked by means of a hydraulic and an electric brake system. It consists of several brake calipers which are fastened to the machine frame and act on a brake disk. In addition, the electric motors of the yaw drives are equipped with an electrically actuated holding brake.

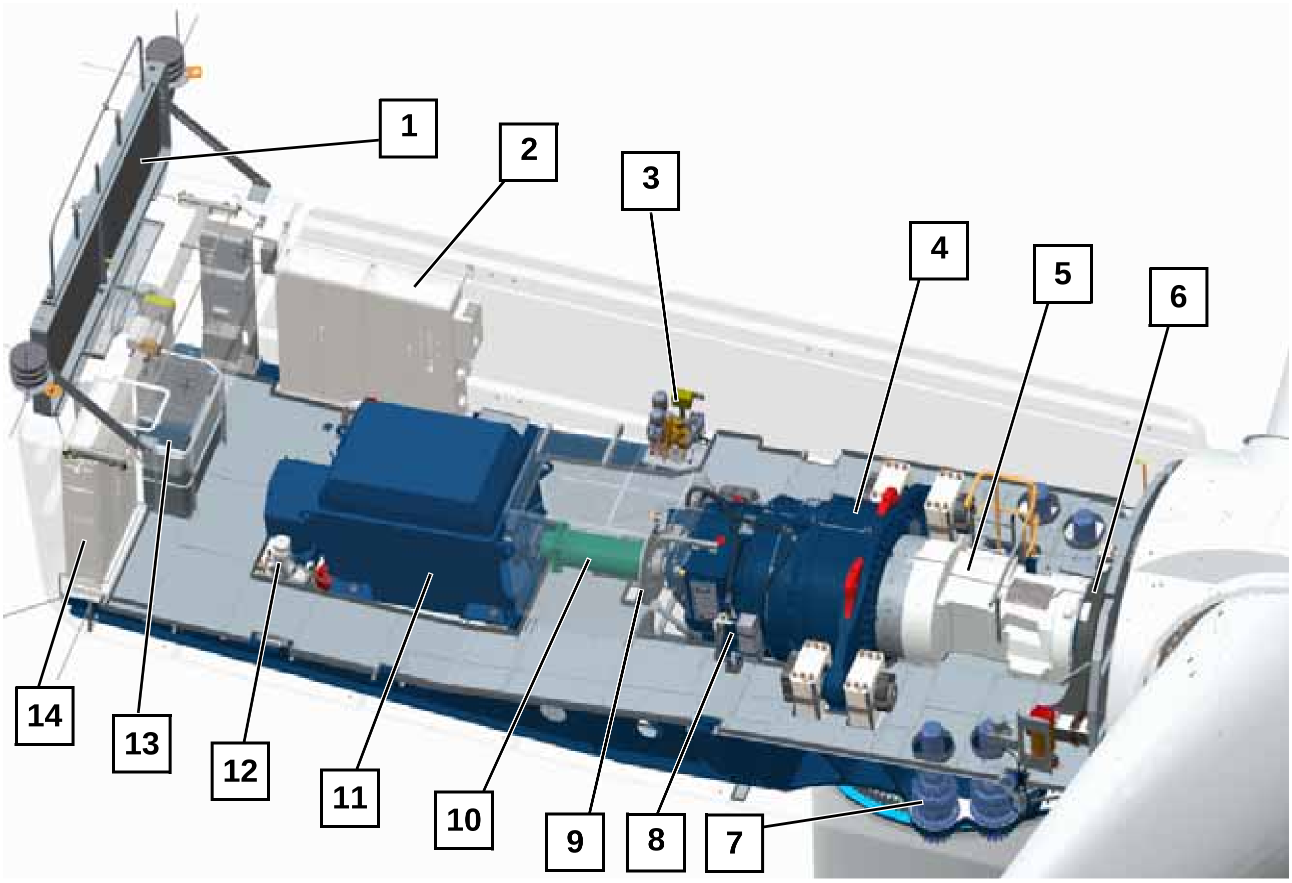

Fig. 5 Nacelle layout drawing

1	Heat exchanger	2	Topbox
3	Hydraulic unit	4	Gearbox
5	Rotor shaft	6	Rotor bearing
7	Yaw drives	8	Gear oil cooler
9	Rotor brake	10	Coupling
11	Generator	12	Cooling water pump
13	Hatch for on-board crane	14	Transformer box

Fig. 6 Components of the yaw system

1	Machine frame	2	Yaw drives
3	Yaw bearing	4	Brake calipers

The **hydraulic unit** provides the oil pressure required for the operation of the rotor brake and the yaw brakes.

1.4 Auxiliary systems

Rotor bearing, generator bearing, gearing of the pitch bearings and gearing of the yaw bearing are each equipped with an **automatic lubrication system**. An automatic raceway lubrication of the pitch bearings can be offered as an option.

The switch cabinets in the nacelle and the tower base of the wind turbine are in part equipped with **air conditioning units**.

Gearbox, generator, hydraulic unit and all switch cabinets are equipped with **heaters**.

An electric **chain hoist** is installed in the nacelle which is used for lifting tools, components and other work materials from the ground into the nacelle. A second, movable **overhead crane** is used for carrying the materials within the nacelle.

Various options of additional equipment are available for the wind turbine.

Cooling system

Gearbox and generator are cooled by a coupled oil/water circulation. At startup the lightly heated gear oil is directly fed back into the gearbox via a thermal bypass and only directed into the plate-type heat exchanger after reaching operating temperature.

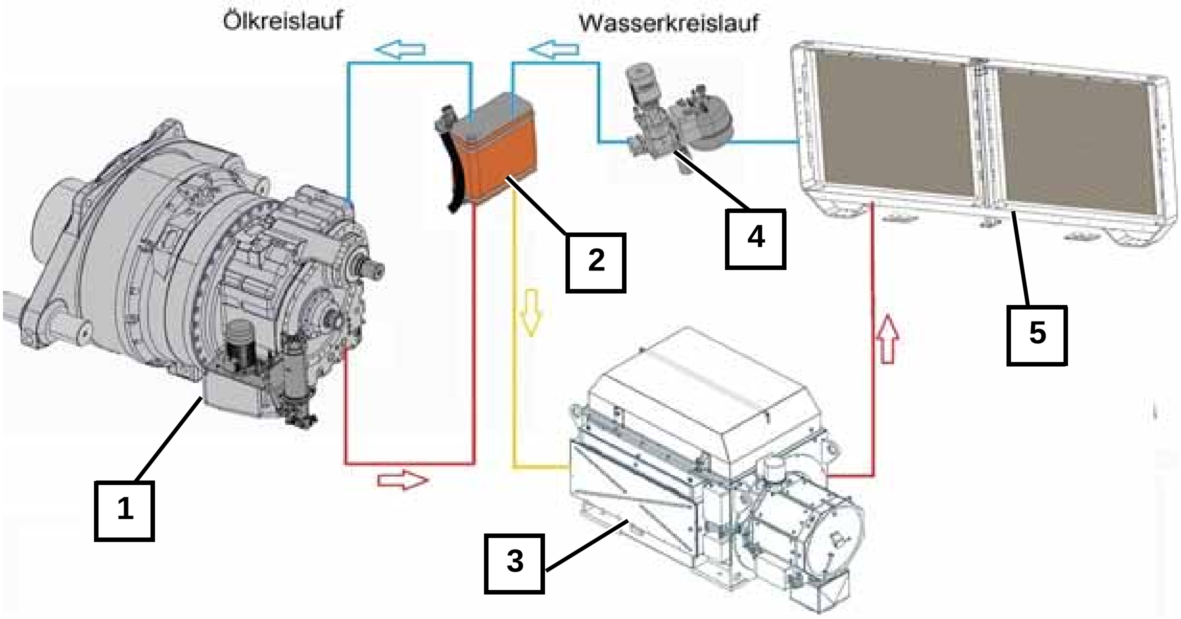

Fig. 7 Schematic diagram of gearbox cooling and generator cooling

1 - Gearbox with oil pump
2 - Plate-type heat exchanger
3 - Generator
4 - Water pump
5 - Passive coolers

The converter in the tower base is cooled by a water/glycol mixture. A pump conveys the mixture through main converter and heat exchanger. The heat exchanger is equipped with a 2-stage fan that is operated depending on the water temperature.

2. Functional principle

The turbine operates automatically. A programmable logic controller (PLC) continuously monitors the operating parameters using various sensors, compares the actual values with the corresponding setpoints and issues the required control signals to the WT components. The operating parameters are specified by Nordex and are adapted to the individual location.

When there is no wind the WT remains in idle mode. Only various auxiliary systems are operational or activated as required: e.g., heaters, gear lubrication or PLC, which monitors the data from the wind measuring system. All other systems are switched off and do not use any energy. The rotor idles. When the cut-in wind speed is reached, the wind turbine will change to the mode 'Ready for operation'. Now all systems are tested, the nacelle turns into the wind and the rotor blades turn into the wind. When a certain speed is reached, the generator is connected to the grid and the WT produces energy.

At low wind speeds the WT operates at part load. During this the rotor blades remain fully turned into the wind (pitch angle 0°). The power produced by the WT depends on the wind speed.

When the nominal wind speed is reached, the WT switches over to the nominal load range. If the wind speed continues to increase, the speed control changes the rotor blade angle so that the rotor speed and thus the power output of the WT remain constant.

The yaw system is used to always optimally align the nacelle with the wind. To this end, two separate wind measuring systems located at the height of the hub measure the wind direction. Only one wind measuring system is used for the control system, while the second system monitors the first and takes over in case the first system fails. If the measured wind direction deviates too greatly from the alignment of the nacelle, the nacelle is yawed into the wind.

The wind energy absorbed from the rotor is converted into electrical energy using a doubly-fed induction machine with slip ring rotor. Its stator is directly connected to the MV transformer, and its rotor via a specially controlled frequency converter. This offers a significant advantage enabling the generator to be operated in a defined speed range near its synchronous speed.

Safety systems

Nordex wind turbines are equipped with extensive equipment and accessories to provide for personal and turbine safety and ensure continuous operation. The entire turbine is designed in accordance with the Machinery Directive 2006/42/EC and certified as per IEC 61400. For details on the safety devices refer to the current safety manual.

If certain parameters concerning turbine safety are exceeded, the WT will cut out immediately and is put into a safe state. Depending on the cut-out cause, different brake programs are triggered. In case of external causes, such as excessive wind speeds or if the operating temperature is not met, the wind turbine is softly braked by means of rotor blade adjustment.

Lightning protection/surge protection and electromagnetic compatibility (EMC)

The lightning/surge protection of the wind turbine is based on the EMC-compliant lightning protection zone concept, which comprises the implementation of internal and external lightning/surge protection measures under consideration of the standard IEC 61400-24.

The wind turbine falls into lightning protection level I. All components of the internal and external lightning/surge protection are designed in accordance with lightning protection level I.

The wind turbine with the electrical equipment, consumers, the measurement, control, protection, information and telecommunication technology meets the EMC requirements according to IEC 61400-1, item 10.11.

Low-voltage network types

The **660 V low voltage network** as an IT network configuration and three phase rotary current network is insulated against ground and is the primary low voltage energy system of the wind turbine. The bodies of the electrical equipment and measuring instruments of this network are grounded directly or by means of separate protective bonding conductors. As a further protection measure for personal and turbine protection in the 660 V IT network a central insulation monitor has been installed.

The **400 V/230 V low-voltage network** has its neutral point grounded directly at the supplying network transformers as TN system and three-phase system. The equipment grounding conductor PE and the neutral conductor are available separately. The bodies of the electrical equipment and consumers are connected directly and straight to the neutral points of the supplying network transformers via equipment grounding conductors, including the protective equipotential bonding. The 400 V/230 V low voltage network is the auxiliary low voltage system of the wind turbine.

Auxiliary power of the wind turbine

The auxiliary low voltage required by the wind turbine in stand-by mode and feed-in mode is requested by the following consumers:

- Wind turbine control including main converter control
- 400 V/230 V auxiliary power of the main converter
- 230 V AC UPS supply including 24 V DC supply
- Yaw system
- Pitch system
- Hydraulic unit
- Auxiliary drives such as pumps, fans and lubrication units
- Heaters, AC units, lighting

- Auxiliary systems such as service lift, obstacle lights
- Optional systems

Based on measurements, simulations and existing operating experience, a coincidence factor of 0.6 can be estimated for the installed low voltage auxiliary power for the worst load case of the auxiliary low voltage system as well as the feed-in operation mode of the WT. In the worst load case as well as in stand-by mode of the WT, a coincidence factor of 0.2 is estimated. In addition, measurements and simulations show that the average power factor (cos phi) at the supply points of the auxiliary low voltage system does not permanently fall below approx. 0.97 in any WT operating point/load case.

Long-term measurements show that the average base load (average active power) of the auxiliary low voltage system during WT feed-in operation mode is approx. 15 kW, based on one year.

For locations with an average annual speed of 6.5 m/s approx. 10,000 kWh auxiliary consumption arise, however, this value is greatly dependent on location. Auxiliary consumption is defined as the energy consumption of the WT from the grid for a period during which the WT does not supply current to the grid.

3. Technical data

Design	
Design temperature	Default: -20 °C to +45 °C CCV: -40 °C to +45 °C
Operating temperature range	-20 °C to +40 °C*
Operating temperature range CCV	-30 °C to +40 °C*
Stop	Default: -20 °C, restart at-18 °C CCV: -30 °C, restart at-28 °C
Max. height above MSL	2000 m**
Certificate	according to IEC 61400-1
Type	3-blade rotor with horizontal axis Up-wind turbine
Output control	Active single blade adjustment
Nominal power	3900 kW*/**
Nominal power starting at wind speeds of (at air density of 1.225 kg/m^3)	Approx. 12.0 m/s
Operating speed range of the rotor	7.9 to 14.4 min^{-1}
Nominal speed	12.6 min^{-1}
Cut-in wind speed	3.0 m/s
Cut-out wind speed	25.0 m/s***
Cut-back-in wind speed	22.0 m/s***
Calculated service life	At least 20 years

* Nominal power is reached up to defined temperature ranges. Limited project-specific operating ranges are possible and must be agreed to with Nordex.

** At installation altitudes above 1000 m, the nominal power is reached up to defined temperature ranges.

*** The cut-off wind speed can be set to 20 m/s (cut-in-wind speed: 19.5 m/s) on a project-specific basis.

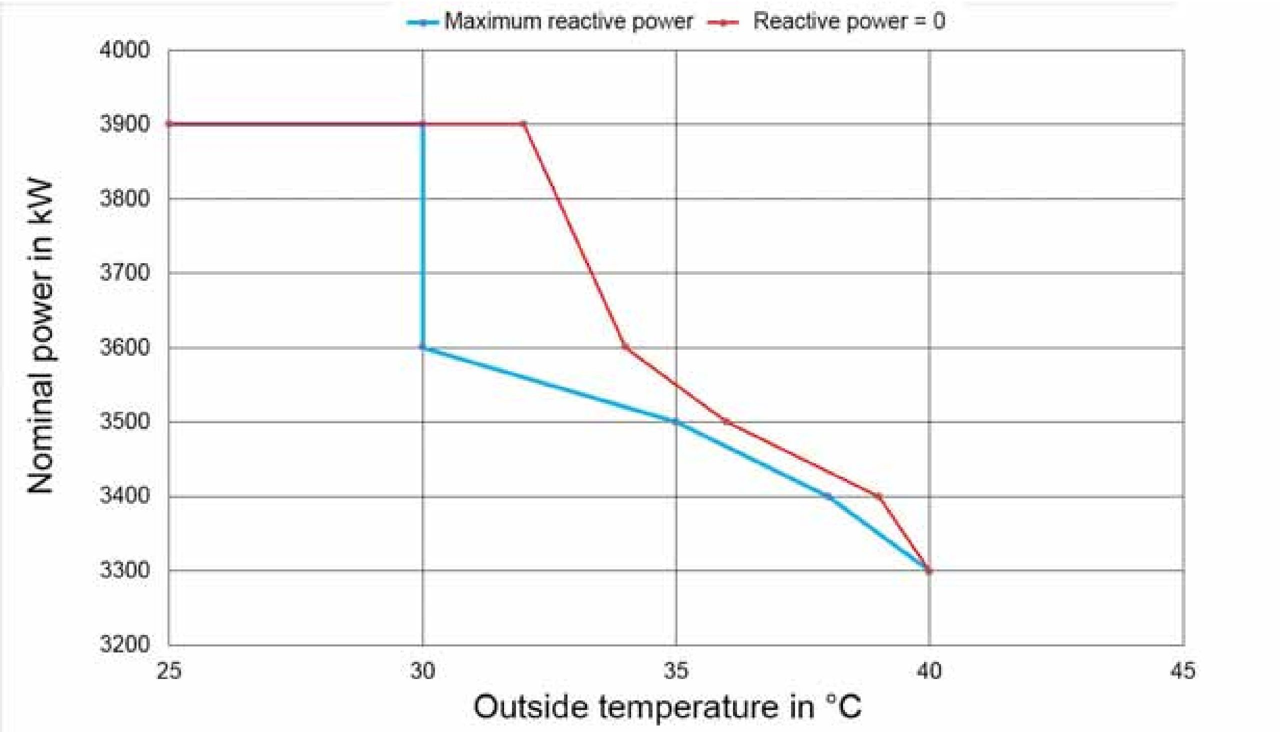

Fig. 8 *Power adjustment depending on reactive power and temperature (up to height ≤1000 m above MSL)*

Towers	**TS84**	**TS114**	**TS120**	**TS134**	**TCS134**	**TCS164**
Hub height	84 m	114 m	120 m	134 m	134 m	164 m
Wind class	DIBt S IEC IIIS	IEC S	DIBt S IEC IIIS	DIBt S IEC IIIS	DIBt S	DIBt S
Number of tower sections	3	5	5	6	Concrete part + 2 steel sections	

Rotor	
Rotor diameter	131.0 m
Swept area	13478 m^2
Nominal power/area	289.4 W/m^2
Rotor shaft inclination angle	5 °
Blade cone angle	4.5 °

Rotor blade	
Material	glass-fiber and carbon-fiber reinforced plastic
Total length	64.4 m
Total weight per blade	Max. 15.7 t

Rotor shaft/rotor bearing	
Type	Forged hollow shaft
Material	42CrMo4 or 34CrNiMo6
Bearing type	Spherical roller bearing
Lubrication	Continuous and automatic with lubricating grease
Rotor bearing housing material	EN-GJS-400-18-LT

Mechanical brake	
Type	Actively actuated disk brake
Location	On the high-speed shaft
Disk diameter	920 mm
Number of brake calipers	1
Brake pad material	Sintered metal

Gearbox	
Type	Multi-stage planetary gear + spur gear stage
Gear ratio	50 Hz: i = 92.3 60 Hz: i = 110.75
Lubrication	Forced-feed lubrication
Oil type	VG 320
Max. oil temperature	75 °C
Oil change	Change, if required

Electrical system	
Nominal power P_{nG}	3900 kW*
Nominal voltage	3 x AC 660 V ± 10 % (specific to grid code)
Rated current I_{nG} at S_{nG}	3795 A*
Rated apparent power S_{nG} at P_{nG}	4338 kVA*
Power factor at P_{nG}	1.00 as default setting 0.899 underexcited (inductive) up to 0.899 overexcited (capacitive) possible
Frequency	50 and 60 Hz

* All values are maximum values; values may vary depending on temperature and reactive power, see Fig. 8

Generator	
Degree of protection	IP 54 (slip ring box IP 23)
Nominal voltage	660 V
Frequency	50 and 60 Hz
Speed range	50 Hz: 730 to 1325 rpm 60 Hz: 876 to 1590 rpm
Poles	6
Weight	Approx. 10.6 t

Gearbox cooling and filtration	
Type	1st cooling circuit: Oil circuit with oil/water heat exchanger and thermal bypass 2nd cooling circuit: Water/air together with generator cooling
Filter	Coarse filter 50 µm / fine filter 10 µm / ultrafine filter <5 µm
Flow rate	Stage 1: approx. 75 l/min Stage 2: approx. 150 l/min

Generator cooling	
Type	Water circuit with water/air heat exchanger
Flow rate	Approx. 160 l/min
Coolant	Water/glycol-based coolant

Converter cooling system	
Type	Water circuit with water/air heat exchanger and thermal bypass
Coolant	Water/glycol-based coolant

Pitch system	
Pitch bearing	Double-row four-point contact bearing
Lubrication of gearing and race	Regular lubrication with grease Optional: Automatic lubrication unit with grease
Drive	3-phase motor incl. spring-actuated brake and multi-stage planetary gear
Emergency power supply	VRLA batteries

Hydraulic system	
Hydraulic oil	VG 32
Oil quantity	Approx. 25 L
Thermal protection	Integrated PT100

Yaw drive	
Motor	Asynchronous motor
Gearbox	4-stage planetary gear
Number of drives	4
Lubrication	Oil, ISO VG 150
Yaw speed	Approx. 0.5 °/s

Yaw brake	
1st type	Disk brake with hydraulic brake calipers
Brake pad material	Organic
Number of brake calipers	18
2nd type	Electric spring-applied brake on every driving motor

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Noise level, Power curves, Thrust curves

Nordex N131/3900 IEC S

Nordex N131/3900 IEC S – Noise level measurement requirements

<u>Basis:</u>	The specified sound power levels are expected values in terms of statistics. Results of single measurements will be within the confidence interval according to IEC 61400-14 [4].
<u>Remarks:</u>	
Verification according to:	Measurements are to be carried out by a measuring institute accredited for noise emission measurements at wind turbines according to ISO/IEC 17025 [3] at the reference position as defined in IEC 61400-11 [1]. The data analysis must be carried out according to the preferred method 1 of IEC 61400-11 [1]. The tonal penalties in the vicinity of wind turbines K_{TN} based on these measurements are to be determined according to „Technische Richtlinien für Windenergieanlagen" [2].
Tonality:	The noise can be tonal in the vicinity of wind turbines. The specified sound power level includes potential tonal penalties according to „Technische Richtlinien für Windenergieanlagen" [2], without taking into account any tonality $K_{TN} \leq 2$ dB.

[1] IEC 61400-11 ed. 2: Wind Turbine Generator Systems - Part 11: Acoustic Noise Measurement Techniques; 2002-12

[2] Technische Richtlinie für Windenergieanlagen - Teil 1: Bestimmung der Schallemissionswerte, Revision 18; FGW 2008-02

[3] ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories; 2017-11

[4] IEC 61400-14, Wind turbines - Part 14: Declaration of apparent sound power level and tonality values, first edition, 2005-03

<u>Abbreviations</u>

L_{WA} … A-weighted sound power level

STE … Serrated Trailing Edge

Nordex N131/3900 IEC S – Noise level, rated power and available hub heights

operating mode	rated power [kW]	Maximum sound power level over the complete operating range of the wind turbine		available hub heights [m]				
		L_{WA} [dB(A)]	L_{WA} (STE) [dB(A)]	84	114	120	134	164
Mode 0	3900	107.7	106.2	●	●	●	●	●
Mode 1	3810	107.2	105.7	●	●	●	●	●
Mode 2	3710	106.7	105.2	●	●	●	●	●
Mode 3	3600	106.4	104.9	●	●	●	●	●
Mode 4	3500	106.0	104.5	●	○	●	●	●
Mode 5	3400	105.6	104.1	●	–	●	●	●
Mode 6	3130	103.0	101.5	●	●	–	●	●
Mode 7	3060	102.5	101.0	●	●	–	●	●
Mode 8	2920	102.0	100.5	●	●	●	○	●
Mode 9	2860	101.5	100.0	●	●	●	○	●
Mode 10	2800	101.0	99.5	●	●	●	○	●
Mode 11	2730	100.5	99.0	●	●	●	○	●
Mode 12	2670	100.0	98.5	●	●	●	○	●
Mode 13	2610	99.5	98.0	●	●	●	●	●

● mode available
○ mode on request
– mode not available

Nordex N131/3900 IEC S – Verification conditions power curve

Basis:	These power curve values according to IEC 61400-12-1 are based on aerodynamic calculations by Nordex Energy GmbH.

Determinations for the power curve verification:

Verification according to:	IEC 61400-12-1
Type of anemometer:	Thies First Class (Advanced) or Vector A100
Type of LiDAR:	Windcube V2 or ZephIR V300
Measurement of power:	low voltage side, 660 VAC
Air density:	normalization to the nearest air density shown in the table
Filter of turbulence intesity:	$9\,\% \leq \mathrm{TI} \leq 20\,\%$
Filter of wind shear:	$0 \leq \alpha \leq 0.3$ Wind shear measurement and determination according to the requirements of MEASNET power performance measurement procedure, Version 5, December - 2009, chapter 3.3 and 3.8
Filter of inflow angle:	$-2^\circ \leq \psi \leq +2^\circ$
Filter of temperature:	$\theta \leq 25\,^\circ\mathrm{C}$
Ice / snow on the blades:	No (determined with ice detectors)
Filter of grid voltage U:	$93\,\%\,U_N < U < 110\,\%\,U_N$ (of nominal voltage U_N)
Filter of grid reactive power:	Power factor = 1.0
Status signal:	Ready for unlimited operation in the corresponding operational mode without consideration of the cut-out hysteresis

Abbreviations

TI ...	turbulence intesity
α ...	Hellmann exponent
ψ ...	vertical inflow angle
v_H ...	hub height wind speed

Nordex N131/3900 IEC S – Power curves – Mode 0

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	61	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	218	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	510	523	537	550
6.0	589	607	624	642	659	677	694	712	729
6.5	760	783	805	827	849	871	893	915	937
7.0	958	986	1013	1041	1068	1096	1123	1151	1178
7.5	1186	1219	1253	1287	1320	1354	1387	1420	1454
8.0	1444	1485	1525	1565	1606	1646	1686	1727	1767
8.5	1731	1779	1827	1875	1922	1970	2018	2065	2113
9.0	2039	2095	2151	2207	2262	2317	2373	2428	2482
9.5	2363	2426	2490	2553	2616	2679	2741	2803	2866
10.0	2695	2766	2837	2907	2977	3046	3115	3174	3228
10.5	3030	3107	3183	3243	3302	3360	3418	3465	3506
11.0	3329	3392	3456	3503	3548	3593	3638	3673	3701
11.5	3556	3606	3656	3690	3722	3754	3786	3809	3826
12.0	3720	3756	3792	3813	3833	3853	3873	3883	3887
12.5	3827	3850	3873	3881	3887	3894	3900	3900	3900
13.0	3884	3893	3900	3900	3900	3900	3900	3900	3900
13.5	3900	3900	3900	3900	3900	3900	3900	3900	3900
14.0	3900	3900	3900	3900	3900	3900	3900	3900	3900
14.5	3900	3900	3900	3900	3900	3900	3900	3900	3900
15.0	3900	3900	3900	3900	3900	3900	3900	3900	3900
15.5	3900	3900	3900	3900	3900	3900	3900	3900	3900
16.0	3900	3900	3900	3900	3900	3900	3900	3900	3900
16.5	3900	3900	3900	3900	3900	3900	3900	3900	3900
17.0	3900	3900	3900	3900	3900	3900	3900	3900	3900
17.5	3900	3900	3900	3900	3900	3900	3900	3900	3900
18.0	3900	3900	3900	3900	3900	3900	3900	3900	3900
18.5	3900	3900	3900	3900	3900	3900	3900	3900	3900
19.0	3900	3900	3900	3900	3900	3900	3900	3900	3900
19.5	3900	3900	3900	3900	3900	3900	3900	3900	3900
20.0	3900	3900	3900	3900	3900	3900	3900	3900	3900
20.5*	3861	3861	3861	3861	3861	3861	3861	3861	3861
21.0*	3771	3771	3771	3771	3771	3771	3771	3771	3771
21.5*	3592	3592	3592	3592	3592	3592	3592	3592	3592
22.0*	3327	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 0

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	467	477
5.5	564	577	590	604	617	631	644	657
6.0	746	764	781	799	816	833	851	868
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1205	1233	1260	1287	1314	1342	1369	1396
7.5	1487	1520	1554	1587	1620	1653	1687	1720
8.0	1807	1847	1887	1927	1967	2007	2046	2086
8.5	2160	2208	2255	2302	2349	2396	2442	2489
9.0	2537	2591	2645	2700	2754	2809	2863	2917
9.5	2927	2989	3050	3105	3153	3201	3249	3297
10.0	3281	3333	3386	3431	3468	3504	3540	3576
10.5	3547	3587	3627	3661	3686	3712	3737	3761
11.0	3730	3758	3786	3808	3823	3837	3851	3864
11.5	3843	3859	3876	3886	3889	3892	3895	3897
12.0	3892	3896	3900	3900	3900	3900	3900	3900
12.5	3900	3900	3900	3900	3900	3900	3900	3900
13.0	3900	3900	3900	3900	3900	3900	3900	3900
13.5	3900	3900	3900	3900	3900	3900	3900	3900
14.0	3900	3900	3900	3900	3900	3900	3900	3900
14.5	3900	3900	3900	3900	3900	3900	3900	3900
15.0	3900	3900	3900	3900	3900	3900	3900	3900
15.5	3900	3900	3900	3900	3900	3900	3900	3900
16.0	3900	3900	3900	3900	3900	3900	3900	3900
16.5	3900	3900	3900	3900	3900	3900	3900	3900
17.0	3900	3900	3900	3900	3900	3900	3900	3900
17.5	3900	3900	3900	3900	3900	3900	3900	3900
18.0	3900	3900	3900	3900	3900	3900	3900	3900
18.5	3900	3900	3900	3900	3900	3900	3900	3900
19.0	3900	3900	3900	3900	3900	3900	3900	3900
19.5	3900	3900	3900	3900	3900	3900	3900	3900
20.0	3900	3900	3900	3900	3900	3900	3900	3900
20.5*	3861	3861	3861	3861	3861	3861	3861	3861
21.0*	3771	3771	3771	3771	3771	3771	3771	3771
21.5*	3592	3592	3592	3592	3592	3592	3592	3592
22.0*	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 1

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m³]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	61	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	218	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	510	523	537	550
6.0	589	607	624	642	659	677	694	711	729
6.5	760	783	805	827	849	871	893	915	937
7.0	958	986	1013	1041	1068	1096	1123	1151	1178
7.5	1186	1219	1253	1287	1320	1353	1387	1420	1454
8.0	1444	1485	1525	1565	1606	1646	1686	1727	1767
8.5	1730	1778	1826	1874	1922	1969	2017	2064	2112
9.0	2037	2093	2148	2204	2259	2314	2369	2424	2479
9.5	2357	2421	2484	2547	2609	2672	2734	2797	2859
10.0	2685	2756	2826	2896	2966	3035	3096	3150	3203
10.5	3014	3091	3156	3215	3273	3331	3381	3422	3463
11.0	3296	3359	3411	3457	3502	3547	3584	3613	3642
11.5	3508	3558	3597	3629	3662	3694	3719	3736	3753
12.0	3658	3695	3720	3740	3760	3780	3792	3797	3802
12.5	3754	3777	3789	3796	3803	3809	3810	3810	3810
13.0	3800	3809	3810	3810	3810	3810	3810	3810	3810
13.5	3810	3810	3810	3810	3810	3810	3810	3810	3810
14.0	3810	3810	3810	3810	3810	3810	3810	3810	3810
14.5	3810	3810	3810	3810	3810	3810	3810	3810	3810
15.0	3810	3810	3810	3810	3810	3810	3810	3810	3810
15.5	3810	3810	3810	3810	3810	3810	3810	3810	3810
16.0	3810	3810	3810	3810	3810	3810	3810	3810	3810
16.5	3810	3810	3810	3810	3810	3810	3810	3810	3810
17.0	3810	3810	3810	3810	3810	3810	3810	3810	3810
17.5	3810	3810	3810	3810	3810	3810	3810	3810	3810
18.0	3810	3810	3810	3810	3810	3810	3810	3810	3810
18.5	3810	3810	3810	3810	3810	3810	3810	3810	3810
19.0	3810	3810	3810	3810	3810	3810	3810	3810	3810
19.5	3810	3810	3810	3810	3810	3810	3810	3810	3810
20.0	3810	3810	3810	3810	3810	3810	3810	3810	3810
20.5*	3810	3810	3810	3810	3810	3810	3810	3810	3810
21.0*	3743	3743	3743	3743	3743	3743	3743	3743	3743
21.5*	3592	3592	3592	3592	3592	3592	3592	3592	3592
22.0*	3327	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 1

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	467	477
5.5	563	577	590	604	617	631	644	657
6.0	746	764	781	799	816	833	851	868
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1205	1233	1260	1287	1314	1342	1369	1396
7.5	1487	1520	1554	1587	1620	1653	1686	1719
8.0	1807	1847	1887	1927	1967	2007	2047	2086
8.5	2159	2207	2254	2301	2347	2394	2441	2487
9.0	2533	2587	2641	2696	2751	2805	2859	2912
9.5	2920	2981	3036	3085	3133	3181	3228	3276
10.0	3256	3309	3353	3390	3427	3463	3499	3535
10.5	3503	3543	3577	3602	3628	3653	3678	3702
11.0	3671	3699	3721	3735	3749	3763	3777	3791
11.5	3770	3786	3796	3799	3802	3805	3808	3810
12.0	3806	3810	3810	3810	3810	3810	3810	3810
12.5	3810	3810	3810	3810	3810	3810	3810	3810
13.0	3810	3810	3810	3810	3810	3810	3810	3810
13.5	3810	3810	3810	3810	3810	3810	3810	3810
14.0	3810	3810	3810	3810	3810	3810	3810	3810
14.5	3810	3810	3810	3810	3810	3810	3810	3810
15.0	3810	3810	3810	3810	3810	3810	3810	3810
15.5	3810	3810	3810	3810	3810	3810	3810	3810
16.0	3810	3810	3810	3810	3810	3810	3810	3810
16.5	3810	3810	3810	3810	3810	3810	3810	3810
17.0	3810	3810	3810	3810	3810	3810	3810	3810
17.5	3810	3810	3810	3810	3810	3810	3810	3810
18.0	3810	3810	3810	3810	3810	3810	3810	3810
18.5	3810	3810	3810	3810	3810	3810	3810	3810
19.0	3810	3810	3810	3810	3810	3810	3810	3810
19.5	3810	3810	3810	3810	3810	3810	3810	3810
20.0	3810	3810	3810	3810	3810	3810	3810	3810
20.5*	3810	3810	3810	3810	3810	3810	3810	3810
21.0*	3743	3743	3743	3743	3743	3743	3743	3743
21.5*	3592	3592	3592	3592	3592	3592	3592	3592
22.0*	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 2

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	61	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	218	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	510	523	537	550
6.0	589	607	624	642	659	677	694	711	729
6.5	760	782	805	827	849	871	893	915	937
7.0	958	986	1013	1041	1068	1096	1123	1150	1178
7.5	1186	1219	1253	1286	1320	1353	1387	1420	1454
8.0	1444	1484	1525	1565	1606	1646	1686	1726	1766
8.5	1729	1777	1825	1872	1920	1968	2015	2063	2110
9.0	2034	2089	2145	2200	2256	2311	2365	2420	2475
9.5	2351	2415	2478	2541	2604	2666	2729	2791	2853
10.0	2677	2747	2818	2888	2957	3018	3072	3126	3179
10.5	3001	3069	3128	3187	3246	3294	3336	3377	3418
11.0	3264	3318	3364	3410	3456	3492	3521	3550	3579
11.5	3459	3500	3533	3566	3598	3622	3640	3657	3674
12.0	3594	3621	3642	3662	3682	3693	3698	3703	3707
12.5	3675	3690	3696	3703	3710	3710	3710	3710	3710
13.0	3708	3710	3710	3710	3710	3710	3710	3710	3710
13.5	3710	3710	3710	3710	3710	3710	3710	3710	3710
14.0	3710	3710	3710	3710	3710	3710	3710	3710	3710
14.5	3710	3710	3710	3710	3710	3710	3710	3710	3710
15.0	3710	3710	3710	3710	3710	3710	3710	3710	3710
15.5	3710	3710	3710	3710	3710	3710	3710	3710	3710
16.0	3710	3710	3710	3710	3710	3710	3710	3710	3710
16.5	3710	3710	3710	3710	3710	3710	3710	3710	3710
17.0	3710	3710	3710	3710	3710	3710	3710	3710	3710
17.5	3710	3710	3710	3710	3710	3710	3710	3710	3710
18.0	3710	3710	3710	3710	3710	3710	3710	3710	3710
18.5	3710	3710	3710	3710	3710	3710	3710	3710	3710
19.0	3710	3710	3710	3710	3710	3710	3710	3710	3710
19.5	3710	3710	3710	3710	3710	3710	3710	3710	3710
20.0	3710	3710	3710	3710	3710	3710	3710	3710	3710
20.5*	3710	3710	3710	3710	3710	3710	3710	3710	3710
21.0*	3689	3689	3689	3689	3689	3689	3689	3689	3689
21.5*	3537	3537	3537	3537	3537	3537	3537	3537	3537
22.0*	3327	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 2

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m³]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	467	477
5.5	563	577	590	604	617	631	644	657
6.0	746	764	781	799	816	833	851	868
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1205	1232	1260	1287	1314	1341	1369	1396
7.5	1487	1520	1554	1587	1620	1653	1686	1719
8.0	1806	1846	1886	1926	1966	2006	2046	2086
8.5	2158	2205	2252	2298	2345	2392	2438	2485
9.0	2529	2584	2639	2693	2748	2802	2856	2901
9.5	2915	2967	3016	3064	3112	3160	3208	3242
10.0	3232	3273	3310	3347	3383	3420	3456	3480
10.5	3459	3488	3514	3539	3565	3590	3616	3629
11.0	3608	3626	3641	3655	3670	3684	3698	3701
11.5	3691	3697	3700	3703	3706	3709	3710	3710
12.0	3710	3710	3710	3710	3710	3710	3710	3710
12.5	3710	3710	3710	3710	3710	3710	3710	3710
13.0	3710	3710	3710	3710	3710	3710	3710	3710
13.5	3710	3710	3710	3710	3710	3710	3710	3710
14.0	3710	3710	3710	3710	3710	3710	3710	3710
14.5	3710	3710	3710	3710	3710	3710	3710	3710
15.0	3710	3710	3710	3710	3710	3710	3710	3710
15.5	3710	3710	3710	3710	3710	3710	3710	3710
16.0	3710	3710	3710	3710	3710	3710	3710	3710
16.5	3710	3710	3710	3710	3710	3710	3710	3710
17.0	3710	3710	3710	3710	3710	3710	3710	3710
17.5	3710	3710	3710	3710	3710	3710	3710	3710
18.0	3710	3710	3710	3710	3710	3710	3710	3710
18.5	3710	3710	3710	3710	3710	3710	3710	3710
19.0	3710	3710	3710	3710	3710	3710	3710	3710
19.5	3710	3710	3710	3710	3710	3710	3710	3710
20.0	3710	3710	3710	3710	3710	3710	3710	3710
20.5*	3710	3710	3710	3710	3710	3710	3710	3710
21.0*	3689	3689	3689	3689	3689	3689	3689	3689
21.5*	3537	3537	3537	3537	3537	3537	3537	3537
22.0*	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 3

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	61	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	218	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	510	523	537	550
6.0	589	607	624	642	659	676	694	711	729
6.5	760	782	805	827	849	871	893	915	937
7.0	958	986	1013	1041	1068	1096	1123	1150	1178
7.5	1186	1219	1253	1286	1320	1353	1387	1420	1454
8.0	1444	1484	1525	1565	1606	1646	1686	1726	1766
8.5	1730	1778	1825	1873	1921	1969	2016	2064	2111
9.0	2035	2091	2146	2202	2257	2312	2367	2421	2476
9.5	2353	2417	2480	2543	2606	2669	2731	2794	2852
10.0	2678	2749	2819	2889	2945	2999	3053	3107	3156
10.5	2988	3047	3107	3166	3210	3251	3293	3334	3371
11.0	3228	3274	3320	3366	3398	3427	3457	3486	3511
11.5	3402	3435	3468	3501	3520	3538	3556	3573	3586
12.0	3517	3538	3558	3579	3585	3590	3595	3599	3600
12.5	3581	3588	3595	3600	3600	3600	3600	3600	3600
13.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
13.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
14.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
14.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
15.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
15.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
16.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
16.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.5	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.0	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.5*	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.0*	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.5*	3500	3500	3500	3500	3500	3500	3500	3500	3500
22.0*	3327	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 3

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	467	477
5.5	563	577	590	604	617	630	644	657
6.0	746	764	781	798	816	833	851	868
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1205	1232	1260	1287	1314	1341	1369	1396
7.5	1487	1520	1553	1587	1620	1653	1686	1719
8.0	1806	1847	1887	1927	1967	2006	2046	2085
8.5	2158	2205	2252	2299	2345	2393	2440	2487
9.0	2531	2586	2641	2696	2750	2798	2842	2886
9.5	2901	2950	2999	3047	3096	3134	3167	3200
10.0	3193	3231	3268	3304	3341	3369	3392	3415
10.5	3397	3423	3449	3475	3500	3518	3530	3542
11.0	3526	3541	3555	3570	3584	3591	3593	3594
11.5	3589	3592	3595	3598	3600	3600	3600	3600
12.0	3600	3600	3600	3600	3600	3600	3600	3600
12.5	3600	3600	3600	3600	3600	3600	3600	3600
13.0	3600	3600	3600	3600	3600	3600	3600	3600
13.5	3600	3600	3600	3600	3600	3600	3600	3600
14.0	3600	3600	3600	3600	3600	3600	3600	3600
14.5	3600	3600	3600	3600	3600	3600	3600	3600
15.0	3600	3600	3600	3600	3600	3600	3600	3600
15.5	3600	3600	3600	3600	3600	3600	3600	3600
16.0	3600	3600	3600	3600	3600	3600	3600	3600
16.5	3600	3600	3600	3600	3600	3600	3600	3600
17.0	3600	3600	3600	3600	3600	3600	3600	3600
17.5	3600	3600	3600	3600	3600	3600	3600	3600
18.0	3600	3600	3600	3600	3600	3600	3600	3600
18.5	3600	3600	3600	3600	3600	3600	3600	3600
19.0	3600	3600	3600	3600	3600	3600	3600	3600
19.5	3600	3600	3600	3600	3600	3600	3600	3600
20.0	3600	3600	3600	3600	3600	3600	3600	3600
20.5*	3600	3600	3600	3600	3600	3600	3600	3600
21.0*	3600	3600	3600	3600	3600	3600	3600	3600
21.5*	3500	3500	3500	3500	3500	3500	3500	3500
22.0*	3327	3327	3327	3327	3327	3327	3327	3327
22.5*	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 4

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 114 m)									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	61	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	218	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	510	523	537	550
6.0	589	607	624	642	659	676	694	711	729
6.5	760	782	804	827	849	871	893	915	937
7.0	958	986	1013	1041	1068	1095	1123	1150	1178
7.5	1186	1219	1253	1286	1320	1353	1387	1420	1453
8.0	1444	1484	1525	1565	1605	1645	1686	1726	1766
8.5	1728	1775	1823	1871	1919	1966	2014	2061	2108
9.0	2030	2086	2141	2196	2251	2306	2361	2416	2471
9.5	2344	2407	2470	2534	2597	2659	2722	2780	2829
10.0	2663	2733	2804	2862	2917	2971	3025	3073	3110
10.5	2954	3013	3073	3119	3161	3203	3244	3280	3306
11.0	3176	3222	3268	3302	3332	3362	3391	3415	3430
11.5	3334	3367	3400	3422	3440	3457	3475	3487	3490
12.0	3436	3456	3477	3485	3490	3495	3500	3500	3500
12.5	3487	3494	3500	3500	3500	3500	3500	3500	3500
13.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
13.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
14.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
14.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
15.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
15.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
16.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
16.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
17.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
17.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
18.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
18.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
19.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
19.5	3500	3500	3500	3500	3500	3500	3500	3500	3500
20.0	3500	3500	3500	3500	3500	3500	3500	3500	3500
20.5*	3500	3500	3500	3500	3500	3500	3500	3500	3500
21.0*	3500	3500	3500	3500	3500	3500	3500	3500	3500
21.5*	3436	3436	3436	3436	3436	3436	3436	3436	3436
22.0*	3275	3275	3275	3275	3275	3275	3275	3275	3275
22.5*	3003	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 4

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 114 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m³]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	467	477
5.5	563	577	590	604	617	630	644	657
6.0	746	764	781	798	816	833	850	868
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1205	1232	1260	1287	1314	1341	1368	1396
7.5	1487	1520	1553	1587	1620	1653	1686	1719
8.0	1806	1846	1886	1926	1966	2005	2045	2084
8.5	2155	2202	2249	2296	2343	2391	2438	2486
9.0	2526	2581	2636	2691	2736	2780	2824	2868
9.5	2878	2927	2976	3024	3058	3091	3124	3157
10.0	3148	3185	3222	3259	3282	3305	3328	3351
10.5	3333	3359	3385	3410	3423	3436	3448	3460
11.0	3445	3460	3474	3489	3492	3493	3495	3497
11.5	3493	3496	3499	3500	3500	3500	3500	3500
12.0	3500	3500	3500	3500	3500	3500	3500	3500
12.5	3500	3500	3500	3500	3500	3500	3500	3500
13.0	3500	3500	3500	3500	3500	3500	3500	3500
13.5	3500	3500	3500	3500	3500	3500	3500	3500
14.0	3500	3500	3500	3500	3500	3500	3500	3500
14.5	3500	3500	3500	3500	3500	3500	3500	3500
15.0	3500	3500	3500	3500	3500	3500	3500	3500
15.5	3500	3500	3500	3500	3500	3500	3500	3500
16.0	3500	3500	3500	3500	3500	3500	3500	3500
16.5	3500	3500	3500	3500	3500	3500	3500	3500
17.0	3500	3500	3500	3500	3500	3500	3500	3500
17.5	3500	3500	3500	3500	3500	3500	3500	3500
18.0	3500	3500	3500	3500	3500	3500	3500	3500
18.5	3500	3500	3500	3500	3500	3500	3500	3500
19.0	3500	3500	3500	3500	3500	3500	3500	3500
19.5	3500	3500	3500	3500	3500	3500	3500	3500
20.0	3500	3500	3500	3500	3500	3500	3500	3500
20.5*	3500	3500	3500	3500	3500	3500	3500	3500
21.0*	3500	3500	3500	3500	3500	3500	3500	3500
21.5*	3436	3436	3436	3436	3436	3436	3436	3436
22.0*	3275	3275	3275	3275	3275	3275	3275	3275
22.5*	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 5

for hub heights 84 m, 120 m, 134 m and 164 m (mode not available for 114 m)									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	61	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	217	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	510	523	536	550
6.0	589	607	624	641	659	676	694	711	729
6.5	760	782	804	827	849	871	893	915	937
7.0	958	986	1013	1041	1068	1095	1123	1150	1177
7.5	1186	1219	1253	1286	1320	1353	1387	1420	1453
8.0	1444	1484	1524	1565	1605	1645	1686	1726	1766
8.5	1726	1774	1822	1870	1918	1965	2013	2060	2107
9.0	2027	2083	2138	2193	2248	2303	2359	2414	2470
9.5	2338	2402	2465	2528	2592	2655	2711	2760	2810
10.0	2653	2724	2783	2838	2893	2948	2993	3030	3068
10.5	2924	2984	3032	3074	3116	3158	3192	3218	3245
11.0	3127	3174	3209	3239	3269	3299	3321	3336	3351
11.5	3268	3302	3324	3342	3360	3378	3388	3391	3394
12.0	3355	3376	3386	3391	3396	3400	3400	3400	3400
12.5	3393	3400	3400	3400	3400	3400	3400	3400	3400
13.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
13.5	3400	3400	3400	3400	3400	3400	3400	3400	3400
14.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
14.5	3400	3400	3400	3400	3400	3400	3400	3400	3400
15.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
15.5	3400	3400	3400	3400	3400	3400	3400	3400	3400
16.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
16.5	3400	3400	3400	3400	3400	3400	3400	3400	3400
17.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
17.5	3400	3400	3400	3400	3400	3400	3400	3400	3400
18.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
18.5	3400	3400	3400	3400	3400	3400	3400	3400	3400
19.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
19.5	3400	3400	3400	3400	3400	3400	3400	3400	3400
20.0	3400	3400	3400	3400	3400	3400	3400	3400	3400
20.5*	3400	3400	3400	3400	3400	3400	3400	3400	3400
21.0*	3400	3400	3400	3400	3400	3400	3400	3400	3400
21.5*	3369	3369	3369	3369	3369	3369	3369	3369	3369
22.0*	3242	3242	3242	3242	3242	3242	3242	3242	3242
22.5*	3003	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 5

for hub heights 84 m, 120 m, 134 m and 164 m (mode not available for 114 m)								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	467	477
5.5	563	577	590	604	617	630	644	657
6.0	746	764	781	798	816	833	850	868
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1205	1232	1259	1287	1314	1341	1368	1395
7.5	1487	1520	1553	1587	1620	1653	1686	1719
8.0	1806	1846	1886	1926	1965	2005	2044	2084
8.5	2154	2201	2248	2296	2343	2391	2439	2486
9.0	2525	2581	2631	2676	2720	2764	2808	2853
9.5	2859	2909	2951	2985	3018	3051	3084	3117
10.0	3106	3143	3175	3198	3221	3244	3267	3290
10.5	3271	3298	3318	3331	3343	3355	3368	3380
11.0	3366	3381	3391	3393	3394	3396	3398	3400
11.5	3397	3400	3400	3400	3400	3400	3400	3400
12.0	3400	3400	3400	3400	3400	3400	3400	3400
12.5	3400	3400	3400	3400	3400	3400	3400	3400
13.0	3400	3400	3400	3400	3400	3400	3400	3400
13.5	3400	3400	3400	3400	3400	3400	3400	3400
14.0	3400	3400	3400	3400	3400	3400	3400	3400
14.5	3400	3400	3400	3400	3400	3400	3400	3400
15.0	3400	3400	3400	3400	3400	3400	3400	3400
15.5	3400	3400	3400	3400	3400	3400	3400	3400
16.0	3400	3400	3400	3400	3400	3400	3400	3400
16.5	3400	3400	3400	3400	3400	3400	3400	3400
17.0	3400	3400	3400	3400	3400	3400	3400	3400
17.5	3400	3400	3400	3400	3400	3400	3400	3400
18.0	3400	3400	3400	3400	3400	3400	3400	3400
18.5	3400	3400	3400	3400	3400	3400	3400	3400
19.0	3400	3400	3400	3400	3400	3400	3400	3400
19.5	3400	3400	3400	3400	3400	3400	3400	3400
20.0	3400	3400	3400	3400	3400	3400	3400	3400
20.5*	3400	3400	3400	3400	3400	3400	3400	3400
21.0*	3400	3400	3400	3400	3400	3400	3400	3400
21.5*	3369	3369	3369	3369	3369	3369	3369	3369
22.0*	3242	3242	3242	3242	3242	3242	3242	3242
22.5*	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 6

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	217	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	510	523	536	550
6.0	589	606	624	641	659	676	694	711	728
6.5	760	782	804	826	849	871	893	915	937
7.0	959	986	1014	1041	1069	1096	1124	1151	1178
7.5	1180	1214	1247	1281	1314	1348	1382	1415	1449
8.0	1414	1455	1495	1536	1576	1617	1657	1698	1739
8.5	1654	1701	1750	1798	1845	1893	1942	1990	2038
9.0	1895	1949	2006	2061	2116	2171	2227	2284	2341
9.5	2134	2195	2260	2322	2385	2449	2513	2573	2624
10.0	2370	2439	2511	2581	2642	2697	2753	2802	2841
10.5	2602	2671	2733	2791	2840	2882	2926	2963	2990
11.0	2794	2851	2898	2944	2980	3011	3041	3066	3082
11.5	2936	2980	3014	3047	3071	3089	3108	3120	3124
12.0	3035	3066	3088	3108	3119	3124	3129	3130	3130
12.5	3097	3115	3122	3129	3130	3130	3130	3130	3130
13.0	3125	3130	3130	3130	3130	3130	3130	3130	3130
13.5	3130	3130	3130	3130	3130	3130	3130	3130	3130
14.0	3130	3130	3130	3130	3130	3130	3130	3130	3130
14.5	3130	3130	3130	3130	3130	3130	3130	3130	3130
15.0	3130	3130	3130	3130	3130	3130	3130	3130	3130
15.5	3130	3130	3130	3130	3130	3130	3130	3130	3130
16.0	3130	3130	3130	3130	3130	3130	3130	3130	3130
16.5	3130	3130	3130	3130	3130	3130	3130	3130	3130
17.0	3130	3130	3130	3130	3130	3130	3130	3130	3130
17.5	3130	3130	3130	3130	3130	3130	3130	3130	3130
18.0	3130	3130	3130	3130	3130	3130	3130	3130	3130
18.5	3130	3130	3130	3130	3130	3130	3130	3130	3130
19.0	3130	3130	3130	3130	3130	3130	3130	3130	3130
19.5	3130	3130	3130	3130	3130	3130	3130	3130	3130
20.0	3130	3130	3130	3130	3130	3130	3130	3130	3130
20.5*	3130	3130	3130	3130	3130	3130	3130	3130	3130
21.0*	3130	3130	3130	3130	3130	3130	3130	3130	3130
21.5*	3130	3130	3130	3130	3130	3130	3130	3130	3130
22.0*	3086	3086	3086	3086	3086	3086	3086	3086	3086
22.5*	3003	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 6

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	467	476
5.5	563	577	590	603	617	630	644	657
6.0	746	763	781	798	815	833	850	868
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1206	1233	1260	1288	1315	1342	1369	1396
7.5	1482	1516	1549	1583	1616	1649	1682	1715
8.0	1780	1820	1861	1900	1940	1979	2018	2058
8.5	2087	2134	2183	2231	2280	2326	2373	2418
9.0	2399	2454	2508	2553	2598	2641	2683	2724
9.5	2676	2726	2770	2804	2838	2870	2902	2931
10.0	2881	2919	2952	2975	2999	3021	3043	3063
10.5	3018	3045	3066	3079	3092	3104	3115	3125
11.0	3098	3113	3123	3125	3127	3128	3130	3130
11.5	3127	3130	3130	3130	3130	3130	3130	3130
12.0	3130	3130	3130	3130	3130	3130	3130	3130
12.5	3130	3130	3130	3130	3130	3130	3130	3130
13.0	3130	3130	3130	3130	3130	3130	3130	3130
13.5	3130	3130	3130	3130	3130	3130	3130	3130
14.0	3130	3130	3130	3130	3130	3130	3130	3130
14.5	3130	3130	3130	3130	3130	3130	3130	3130
15.0	3130	3130	3130	3130	3130	3130	3130	3130
15.5	3130	3130	3130	3130	3130	3130	3130	3130
16.0	3130	3130	3130	3130	3130	3130	3130	3130
16.5	3130	3130	3130	3130	3130	3130	3130	3130
17.0	3130	3130	3130	3130	3130	3130	3130	3130
17.5	3130	3130	3130	3130	3130	3130	3130	3130
18.0	3130	3130	3130	3130	3130	3130	3130	3130
18.5	3130	3130	3130	3130	3130	3130	3130	3130
19.0	3130	3130	3130	3130	3130	3130	3130	3130
19.5	3130	3130	3130	3130	3130	3130	3130	3130
20.0	3130	3130	3130	3130	3130	3130	3130	3130
20.5*	3130	3130	3130	3130	3130	3130	3130	3130
21.0*	3130	3130	3130	3130	3130	3130	3130	3130
21.5*	3130	3130	3130	3130	3130	3130	3130	3130
22.0*	3086	3086	3086	3086	3086	3086	3086	3086
22.5*	3003	3003	3003	3003	3003	3003	3003	3003
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 7

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	146	150	155	159
4.5	210	217	225	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	509	523	536	550
6.0	589	606	624	641	659	676	694	711	728
6.5	760	782	804	826	849	871	893	915	937
7.0	958	986	1013	1041	1068	1096	1123	1151	1178
7.5	1175	1208	1242	1276	1309	1343	1377	1410	1444
8.0	1401	1441	1482	1522	1563	1603	1644	1685	1726
8.5	1628	1676	1724	1772	1821	1868	1918	1966	2015
9.0	1855	1910	1967	2023	2080	2136	2193	2249	2308
9.5	2084	2148	2212	2276	2342	2404	2470	2527	2580
10.0	2315	2386	2456	2526	2589	2643	2700	2747	2787
10.5	2539	2612	2671	2730	2781	2823	2866	2902	2930
11.0	2728	2788	2834	2880	2918	2947	2977	3001	3016
11.5	2869	2916	2948	2980	3005	3022	3040	3051	3054
12.0	2967	2999	3019	3038	3050	3055	3059	3060	3060
12.5	3026	3046	3052	3058	3060	3060	3060	3060	3060
13.0	3054	3060	3060	3060	3060	3060	3060	3060	3060
13.5	3060	3060	3060	3060	3060	3060	3060	3060	3060
14.0	3060	3060	3060	3060	3060	3060	3060	3060	3060
14.5	3060	3060	3060	3060	3060	3060	3060	3060	3060
15.0	3060	3060	3060	3060	3060	3060	3060	3060	3060
15.5	3060	3060	3060	3060	3060	3060	3060	3060	3060
16.0	3060	3060	3060	3060	3060	3060	3060	3060	3060
16.5	3060	3060	3060	3060	3060	3060	3060	3060	3060
17.0	3060	3060	3060	3060	3060	3060	3060	3060	3060
17.5	3060	3060	3060	3060	3060	3060	3060	3060	3060
18.0	3060	3060	3060	3060	3060	3060	3060	3060	3060
18.5	3060	3060	3060	3060	3060	3060	3060	3060	3060
19.0	3060	3060	3060	3060	3060	3060	3060	3060	3060
19.5	3060	3060	3060	3060	3060	3060	3060	3060	3060
20.0	3060	3060	3060	3060	3060	3060	3060	3060	3060
20.5*	3060	3060	3060	3060	3060	3060	3060	3060	3060
21.0*	3060	3060	3060	3060	3060	3060	3060	3060	3060
21.5*	3060	3060	3060	3060	3060	3060	3060	3060	3060
22.0*	3039	3039	3039	3039	3039	3039	3039	3039	3039
22.5*	2990	2990	2990	2990	2990	2990	2990	2990	2990
23.0*	2906	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 7

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	457	466	476
5.5	563	577	590	603	617	630	644	657
6.0	746	763	781	798	815	833	850	867
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1205	1233	1260	1287	1315	1342	1369	1396
7.5	1478	1512	1545	1579	1612	1646	1679	1712
8.0	1767	1808	1849	1889	1930	1969	2008	2048
8.5	2063	2112	2161	2209	2259	2307	2353	2394
9.0	2365	2422	2472	2516	2563	2607	2649	2683
9.5	2630	2680	2722	2755	2790	2823	2854	2878
10.0	2825	2864	2894	2917	2941	2964	2986	3000
10.5	2956	2983	3002	3014	3027	3039	3051	3056
11.0	3031	3046	3054	3055	3057	3059	3060	3060
11.5	3057	3060	3060	3060	3060	3060	3060	3060
12.0	3060	3060	3060	3060	3060	3060	3060	3060
12.5	3060	3060	3060	3060	3060	3060	3060	3060
13.0	3060	3060	3060	3060	3060	3060	3060	3060
13.5	3060	3060	3060	3060	3060	3060	3060	3060
14.0	3060	3060	3060	3060	3060	3060	3060	3060
14.5	3060	3060	3060	3060	3060	3060	3060	3060
15.0	3060	3060	3060	3060	3060	3060	3060	3060
15.5	3060	3060	3060	3060	3060	3060	3060	3060
16.0	3060	3060	3060	3060	3060	3060	3060	3060
16.5	3060	3060	3060	3060	3060	3060	3060	3060
17.0	3060	3060	3060	3060	3060	3060	3060	3060
17.5	3060	3060	3060	3060	3060	3060	3060	3060
18.0	3060	3060	3060	3060	3060	3060	3060	3060
18.5	3060	3060	3060	3060	3060	3060	3060	3060
19.0	3060	3060	3060	3060	3060	3060	3060	3060
19.5	3060	3060	3060	3060	3060	3060	3060	3060
20.0	3060	3060	3060	3060	3060	3060	3060	3060
20.5*	3060	3060	3060	3060	3060	3060	3060	3060
21.0*	3060	3060	3060	3060	3060	3060	3060	3060
21.5*	3060	3060	3060	3060	3060	3060	3060	3060
22.0*	3039	3039	3039	3039	3039	3039	3039	3039
22.5*	2990	2990	2990	2990	2990	2990	2990	2990
23.0*	2906	2906	2906	2906	2906	2906	2906	2906
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 8

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m
(mode on request for 134 m)

wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m³]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	145	150	155	159
4.5	210	217	224	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	483	496	509	523	536	550
6.0	589	606	624	641	659	676	693	711	728
6.5	760	782	804	827	849	871	893	915	937
7.0	956	984	1011	1039	1066	1094	1121	1149	1176
7.5	1167	1200	1234	1268	1301	1335	1369	1403	1436
8.0	1384	1423	1464	1504	1545	1586	1627	1667	1708
8.5	1601	1646	1694	1741	1789	1838	1887	1934	1981
9.0	1815	1867	1921	1976	2032	2088	2144	2199	2255
9.5	2028	2086	2147	2209	2272	2336	2400	2452	2501
10.0	2238	2302	2369	2438	2497	2553	2608	2649	2686
10.5	2442	2509	2566	2623	2671	2713	2756	2785	2811
11.0	2615	2669	2713	2757	2793	2823	2853	2871	2886
11.5	2742	2785	2816	2848	2871	2889	2907	2913	2916
12.0	2832	2862	2881	2901	2911	2916	2920	2920	2920
12.5	2888	2906	2913	2919	2920	2920	2920	2920	2920
13.0	2914	2920	2920	2920	2920	2920	2920	2920	2920
13.5	2920	2920	2920	2920	2920	2920	2920	2920	2920
14.0	2920	2920	2920	2920	2920	2920	2920	2920	2920
14.5	2920	2920	2920	2920	2920	2920	2920	2920	2920
15.0	2920	2920	2920	2920	2920	2920	2920	2920	2920
15.5	2920	2920	2920	2920	2920	2920	2920	2920	2920
16.0	2920	2920	2920	2920	2920	2920	2920	2920	2920
16.5	2920	2920	2920	2920	2920	2920	2920	2920	2920
17.0	2920	2920	2920	2920	2920	2920	2920	2920	2920
17.5	2920	2920	2920	2920	2920	2920	2920	2920	2920
18.0	2920	2920	2920	2920	2920	2920	2920	2920	2920
18.5	2920	2920	2920	2920	2920	2920	2920	2920	2920
19.0	2920	2920	2920	2920	2920	2920	2920	2920	2920
19.5	2920	2920	2920	2920	2920	2920	2920	2920	2920
20.0	2920	2920	2920	2920	2920	2920	2920	2920	2920
20.5*	2920	2920	2920	2920	2920	2920	2920	2920	2920
21.0*	2920	2920	2920	2920	2920	2920	2920	2920	2920
21.5*	2920	2920	2920	2920	2920	2920	2920	2920	2920
22.0*	2920	2920	2920	2920	2920	2920	2920	2920	2920
22.5*	2916	2916	2916	2916	2916	2916	2916	2916	2916
23.0*	2901	2901	2901	2901	2901	2901	2901	2901	2901
23.5*	2874	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 8

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	447	456	466	476
5.5	563	577	590	603	617	630	644	657
6.0	746	763	781	798	815	833	850	867
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1204	1231	1258	1286	1313	1340	1368	1395
7.5	1470	1504	1537	1571	1604	1638	1671	1705
8.0	1748	1790	1830	1870	1910	1951	1991	2034
8.5	2029	2079	2126	2176	2223	2273	2314	2356
9.0	2310	2367	2411	2457	2500	2547	2580	2611
9.5	2551	2600	2633	2667	2700	2735	2758	2780
10.0	2724	2761	2783	2807	2830	2854	2867	2878
10.5	2838	2863	2875	2888	2900	2913	2916	2917
11.0	2901	2914	2915	2917	2919	2920	2920	2920
11.5	2919	2920	2920	2920	2920	2920	2920	2920
12.0	2920	2920	2920	2920	2920	2920	2920	2920
12.5	2920	2920	2920	2920	2920	2920	2920	2920
13.0	2920	2920	2920	2920	2920	2920	2920	2920
13.5	2920	2920	2920	2920	2920	2920	2920	2920
14.0	2920	2920	2920	2920	2920	2920	2920	2920
14.5	2920	2920	2920	2920	2920	2920	2920	2920
15.0	2920	2920	2920	2920	2920	2920	2920	2920
15.5	2920	2920	2920	2920	2920	2920	2920	2920
16.0	2920	2920	2920	2920	2920	2920	2920	2920
16.5	2920	2920	2920	2920	2920	2920	2920	2920
17.0	2920	2920	2920	2920	2920	2920	2920	2920
17.5	2920	2920	2920	2920	2920	2920	2920	2920
18.0	2920	2920	2920	2920	2920	2920	2920	2920
18.5	2920	2920	2920	2920	2920	2920	2920	2920
19.0	2920	2920	2920	2920	2920	2920	2920	2920
19.5	2920	2920	2920	2920	2920	2920	2920	2920
20.0	2920	2920	2920	2920	2920	2920	2920	2920
20.5*	2920	2920	2920	2920	2920	2920	2920	2920
21.0*	2920	2920	2920	2920	2920	2920	2920	2920
21.5*	2920	2920	2920	2920	2920	2920	2920	2920
22.0*	2920	2920	2920	2920	2920	2920	2920	2920
22.5*	2916	2916	2916	2916	2916	2916	2916	2916
23.0*	2901	2901	2901	2901	2901	2901	2901	2901
23.5*	2874	2874	2874	2874	2874	2874	2874	2874
24.0*	2855	2855	2855	2855	2855	2855	2855	2855
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 9

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)									
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m³]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	145	150	155	159
4.5	210	217	224	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	482	496	509	523	536	550
6.0	589	606	624	641	659	676	693	711	728
6.5	761	783	805	827	849	871	893	915	938
7.0	953	981	1008	1036	1064	1091	1118	1146	1173
7.5	1157	1190	1224	1258	1291	1324	1358	1392	1425
8.0	1363	1402	1443	1483	1523	1563	1603	1643	1683
8.5	1567	1613	1661	1707	1755	1800	1848	1895	1941
9.0	1768	1821	1876	1930	1984	2036	2091	2143	2197
9.5	1969	2027	2090	2150	2211	2269	2332	2388	2436
10.0	2166	2231	2300	2367	2431	2480	2535	2582	2618
10.5	2360	2430	2493	2550	2602	2640	2683	2718	2743
11.0	2532	2591	2640	2684	2725	2752	2782	2805	2820
11.5	2663	2708	2745	2777	2805	2821	2839	2852	2855
12.0	2756	2789	2814	2833	2849	2854	2859	2860	2860
12.5	2817	2838	2850	2857	2860	2860	2860	2860	2860
13.0	2850	2858	2860	2860	2860	2860	2860	2860	2860
13.5	2860	2860	2860	2860	2860	2860	2860	2860	2860
14.0	2860	2860	2860	2860	2860	2860	2860	2860	2860
14.5	2860	2860	2860	2860	2860	2860	2860	2860	2860
15.0	2860	2860	2860	2860	2860	2860	2860	2860	2860
15.5	2860	2860	2860	2860	2860	2860	2860	2860	2860
16.0	2860	2860	2860	2860	2860	2860	2860	2860	2860
16.5	2860	2860	2860	2860	2860	2860	2860	2860	2860
17.0	2860	2860	2860	2860	2860	2860	2860	2860	2860
17.5	2860	2860	2860	2860	2860	2860	2860	2860	2860
18.0	2860	2860	2860	2860	2860	2860	2860	2860	2860
18.5	2860	2860	2860	2860	2860	2860	2860	2860	2860
19.0	2860	2860	2860	2860	2860	2860	2860	2860	2860
19.5	2860	2860	2860	2860	2860	2860	2860	2860	2860
20.0	2860	2860	2860	2860	2860	2860	2860	2860	2860
20.5*	2860	2860	2860	2860	2860	2860	2860	2860	2860
21.0*	2860	2860	2860	2860	2860	2860	2860	2860	2860
21.5*	2860	2860	2860	2860	2860	2860	2860	2860	2860
22.0*	2860	2860	2860	2860	2860	2860	2860	2860	2860
22.5*	2860	2860	2860	2860	2860	2860	2860	2860	2860
23.0*	2860	2860	2860	2860	2860	2860	2860	2860	2860
23.5*	2859	2859	2859	2859	2859	2859	2859	2859	2859
24.0*	2852	2852	2852	2852	2852	2852	2852	2852	2852
24.5*	2835	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 9

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	437	446	456	466	476
5.5	563	576	590	603	617	630	643	657
6.0	746	763	781	798	815	833	850	867
6.5	960	982	1004	1026	1048	1069	1091	1113
7.0	1201	1228	1256	1283	1311	1338	1366	1393
7.5	1458	1492	1526	1561	1595	1629	1662	1695
8.0	1723	1763	1805	1847	1889	1929	1970	2011
8.5	1987	2034	2085	2136	2188	2235	2280	2319
9.0	2252	2307	2357	2405	2454	2498	2534	2563
9.5	2484	2533	2573	2609	2646	2678	2704	2724
10.0	2655	2692	2720	2746	2771	2794	2809	2819
10.5	2769	2795	2812	2825	2839	2851	2856	2857
11.0	2835	2850	2855	2857	2859	2860	2860	2860
11.5	2858	2860	2860	2860	2860	2860	2860	2860
12.0	2860	2860	2860	2860	2860	2860	2860	2860
12.5	2860	2860	2860	2860	2860	2860	2860	2860
13.0	2860	2860	2860	2860	2860	2860	2860	2860
13.5	2860	2860	2860	2860	2860	2860	2860	2860
14.0	2860	2860	2860	2860	2860	2860	2860	2860
14.5	2860	2860	2860	2860	2860	2860	2860	2860
15.0	2860	2860	2860	2860	2860	2860	2860	2860
15.5	2860	2860	2860	2860	2860	2860	2860	2860
16.0	2860	2860	2860	2860	2860	2860	2860	2860
16.5	2860	2860	2860	2860	2860	2860	2860	2860
17.0	2860	2860	2860	2860	2860	2860	2860	2860
17.5	2860	2860	2860	2860	2860	2860	2860	2860
18.0	2860	2860	2860	2860	2860	2860	2860	2860
18.5	2860	2860	2860	2860	2860	2860	2860	2860
19.0	2860	2860	2860	2860	2860	2860	2860	2860
19.5	2860	2860	2860	2860	2860	2860	2860	2860
20.0	2860	2860	2860	2860	2860	2860	2860	2860
20.5*	2860	2860	2860	2860	2860	2860	2860	2860
21.0*	2860	2860	2860	2860	2860	2860	2860	2860
21.5*	2860	2860	2860	2860	2860	2860	2860	2860
22.0*	2860	2860	2860	2860	2860	2860	2860	2860
22.5*	2860	2860	2860	2860	2860	2860	2860	2860
23.0*	2860	2860	2860	2860	2860	2860	2860	2860
23.5*	2859	2859	2859	2859	2859	2859	2859	2859
24.0*	2852	2852	2852	2852	2852	2852	2852	2852
24.5*	2835	2835	2835	2835	2835	2835	2835	2835
25.0*	2820	2820	2820	2820	2820	2820	2820	2820

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 10

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	145	150	155	159
4.5	210	217	224	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	456	469	482	496	509	523	536	550
6.0	589	606	624	641	659	676	693	711	728
6.5	760	782	804	827	849	871	893	915	937
7.0	948	976	1004	1031	1058	1086	1113	1140	1168
7.5	1144	1178	1211	1244	1278	1311	1344	1377	1410
8.0	1340	1380	1420	1458	1498	1537	1577	1616	1656
8.5	1533	1579	1626	1671	1718	1763	1810	1856	1902
9.0	1726	1780	1835	1886	1941	1992	2047	2099	2153
9.5	1923	1984	2046	2103	2164	2222	2283	2338	2386
10.0	2120	2187	2254	2316	2380	2430	2482	2529	2565
10.5	2312	2383	2444	2497	2550	2588	2628	2663	2688
11.0	2483	2541	2590	2630	2670	2697	2725	2749	2762
11.5	2612	2656	2692	2721	2748	2764	2779	2792	2795
12.0	2703	2734	2757	2774	2790	2794	2798	2800	2800
12.5	2760	2779	2791	2796	2800	2800	2800	2800	2800
13.0	2791	2798	2800	2800	2800	2800	2800	2800	2800
13.5	2800	2800	2800	2800	2800	2800	2800	2800	2800
14.0	2800	2800	2800	2800	2800	2800	2800	2800	2800
14.5	2800	2800	2800	2800	2800	2800	2800	2800	2800
15.0	2800	2800	2800	2800	2800	2800	2800	2800	2800
15.5	2800	2800	2800	2800	2800	2800	2800	2800	2800
16.0	2800	2800	2800	2800	2800	2800	2800	2800	2800
16.5	2800	2800	2800	2800	2800	2800	2800	2800	2800
17.0	2800	2800	2800	2800	2800	2800	2800	2800	2800
17.5	2800	2800	2800	2800	2800	2800	2800	2800	2800
18.0	2800	2800	2800	2800	2800	2800	2800	2800	2800
18.5	2800	2800	2800	2800	2800	2800	2800	2800	2800
19.0	2800	2800	2800	2800	2800	2800	2800	2800	2800
19.5	2800	2800	2800	2800	2800	2800	2800	2800	2800
20.0	2800	2800	2800	2800	2800	2800	2800	2800	2800
20.5*	2800	2800	2800	2800	2800	2800	2800	2800	2800
21.0*	2800	2800	2800	2800	2800	2800	2800	2800	2800
21.5*	2800	2800	2800	2800	2800	2800	2800	2800	2800
22.0*	2800	2800	2800	2800	2800	2800	2800	2800	2800
22.5*	2800	2800	2800	2800	2800	2800	2800	2800	2800
23.0*	2800	2800	2800	2800	2800	2800	2800	2800	2800
23.5*	2800	2800	2800	2800	2800	2800	2800	2800	2800
24.0*	2800	2800	2800	2800	2800	2800	2800	2800	2800
24.5*	2800	2800	2800	2800	2800	2800	2800	2800	2800
25.0*	2800	2800	2800	2800	2800	2800	2800	2800	2800

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 10

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m³]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	436	446	456	466	476
5.5	563	576	590	603	617	630	643	657
6.0	746	763	780	798	815	833	850	867
6.5	959	981	1003	1025	1047	1069	1091	1113
7.0	1195	1223	1251	1278	1306	1333	1360	1388
7.5	1444	1478	1512	1546	1580	1614	1647	1681
8.0	1695	1737	1779	1819	1861	1902	1941	1983
8.5	1949	1998	2049	2097	2147	2196	2238	2278
9.0	2207	2263	2312	2357	2403	2448	2483	2513
9.5	2433	2483	2522	2555	2590	2623	2648	2668
10.0	2601	2638	2666	2689	2712	2735	2750	2760
10.5	2713	2739	2754	2767	2779	2791	2797	2797
11.0	2776	2790	2795	2797	2799	2800	2800	2800
11.5	2798	2800	2800	2800	2800	2800	2800	2800
12.0	2800	2800	2800	2800	2800	2800	2800	2800
12.5	2800	2800	2800	2800	2800	2800	2800	2800
13.0	2800	2800	2800	2800	2800	2800	2800	2800
13.5	2800	2800	2800	2800	2800	2800	2800	2800
14.0	2800	2800	2800	2800	2800	2800	2800	2800
14.5	2800	2800	2800	2800	2800	2800	2800	2800
15.0	2800	2800	2800	2800	2800	2800	2800	2800
15.5	2800	2800	2800	2800	2800	2800	2800	2800
16.0	2800	2800	2800	2800	2800	2800	2800	2800
16.5	2800	2800	2800	2800	2800	2800	2800	2800
17.0	2800	2800	2800	2800	2800	2800	2800	2800
17.5	2800	2800	2800	2800	2800	2800	2800	2800
18.0	2800	2800	2800	2800	2800	2800	2800	2800
18.5	2800	2800	2800	2800	2800	2800	2800	2800
19.0	2800	2800	2800	2800	2800	2800	2800	2800
19.5	2800	2800	2800	2800	2800	2800	2800	2800
20.0	2800	2800	2800	2800	2800	2800	2800	2800
20.5*	2800	2800	2800	2800	2800	2800	2800	2800
21.0*	2800	2800	2800	2800	2800	2800	2800	2800
21.5*	2800	2800	2800	2800	2800	2800	2800	2800
22.0*	2800	2800	2800	2800	2800	2800	2800	2800
22.5*	2800	2800	2800	2800	2800	2800	2800	2800
23.0*	2800	2800	2800	2800	2800	2800	2800	2800
23.5*	2800	2800	2800	2800	2800	2800	2800	2800
24.0*	2800	2800	2800	2800	2800	2800	2800	2800
24.5*	2800	2800	2800	2800	2800	2800	2800	2800
25.0*	2800	2800	2800	2800	2800	2800	2800	2800

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 11

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m
(mode on request for 134 m)

wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3] 0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	145	150	155	159
4.5	210	217	224	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	455	469	482	496	509	523	536	550
6.0	589	606	624	641	659	676	694	711	728
6.5	759	781	803	825	847	869	891	913	935
7.0	941	968	995	1023	1051	1078	1106	1133	1160
7.5	1128	1161	1193	1227	1261	1294	1327	1360	1393
8.0	1314	1352	1389	1430	1471	1509	1548	1587	1625
8.5	1497	1540	1583	1631	1678	1722	1768	1812	1856
9.0	1678	1727	1774	1830	1884	1933	1985	2034	2084
9.5	1857	1912	1964	2026	2086	2140	2198	2253	2306
10.0	2034	2094	2150	2219	2284	2341	2390	2437	2481
10.5	2207	2271	2331	2396	2450	2497	2535	2571	2603
11.0	2373	2429	2478	2530	2572	2608	2634	2660	2682
11.5	2504	2548	2587	2626	2655	2680	2696	2711	2723
12.0	2601	2634	2662	2688	2706	2720	2725	2728	2730
12.5	2668	2690	2707	2721	2727	2730	2730	2730	2730
13.0	2710	2720	2727	2730	2730	2730	2730	2730	2730
13.5	2728	2730	2730	2730	2730	2730	2730	2730	2730
14.0	2730	2730	2730	2730	2730	2730	2730	2730	2730
14.5	2730	2730	2730	2730	2730	2730	2730	2730	2730
15.0	2730	2730	2730	2730	2730	2730	2730	2730	2730
15.5	2730	2730	2730	2730	2730	2730	2730	2730	2730
16.0	2730	2730	2730	2730	2730	2730	2730	2730	2730
16.5	2730	2730	2730	2730	2730	2730	2730	2730	2730
17.0	2730	2730	2730	2730	2730	2730	2730	2730	2730
17.5	2730	2730	2730	2730	2730	2730	2730	2730	2730
18.0	2730	2730	2730	2730	2730	2730	2730	2730	2730
18.5	2730	2730	2730	2730	2730	2730	2730	2730	2730
19.0	2730	2730	2730	2730	2730	2730	2730	2730	2730
19.5	2730	2730	2730	2730	2730	2730	2730	2730	2730
20.0	2730	2730	2730	2730	2730	2730	2730	2730	2730
20.5*	2730	2730	2730	2730	2730	2730	2730	2730	2730
21.0*	2730	2730	2730	2730	2730	2730	2730	2730	2730
21.5*	2730	2730	2730	2730	2730	2730	2730	2730	2730
22.0*	2730	2730	2730	2730	2730	2730	2730	2730	2730
22.5*	2730	2730	2730	2730	2730	2730	2730	2730	2730
23.0*	2730	2730	2730	2730	2730	2730	2730	2730	2730
23.5*	2730	2730	2730	2730	2730	2730	2730	2730	2730
24.0*	2730	2730	2730	2730	2730	2730	2730	2730	2730
24.5*	2730	2730	2730	2730	2730	2730	2730	2730	2730
25.0*	2730	2730	2730	2730	2730	2730	2730	2730	2730

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 11

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	427	436	446	456	466	476
5.5	563	576	590	603	617	630	643	657
6.0	746	763	781	798	815	833	850	867
6.5	957	980	1002	1024	1046	1068	1090	1112
7.0	1187	1215	1243	1270	1298	1325	1353	1380
7.5	1426	1460	1494	1527	1562	1596	1628	1662
8.0	1664	1705	1746	1786	1827	1867	1905	1947
8.5	1900	1948	1996	2043	2093	2140	2185	2225
9.0	2135	2190	2246	2289	2335	2378	2419	2449
9.5	2351	2399	2448	2481	2515	2548	2578	2598
10.0	2515	2552	2589	2611	2635	2657	2678	2688
10.5	2627	2653	2678	2690	2703	2715	2726	2727
11.0	2695	2710	2724	2726	2728	2729	2730	2730
11.5	2725	2728	2730	2730	2730	2730	2730	2730
12.0	2730	2730	2730	2730	2730	2730	2730	2730
12.5	2730	2730	2730	2730	2730	2730	2730	2730
13.0	2730	2730	2730	2730	2730	2730	2730	2730
13.5	2730	2730	2730	2730	2730	2730	2730	2730
14.0	2730	2730	2730	2730	2730	2730	2730	2730
14.5	2730	2730	2730	2730	2730	2730	2730	2730
15.0	2730	2730	2730	2730	2730	2730	2730	2730
15.5	2730	2730	2730	2730	2730	2730	2730	2730
16.0	2730	2730	2730	2730	2730	2730	2730	2730
16.5	2730	2730	2730	2730	2730	2730	2730	2730
17.0	2730	2730	2730	2730	2730	2730	2730	2730
17.5	2730	2730	2730	2730	2730	2730	2730	2730
18.0	2730	2730	2730	2730	2730	2730	2730	2730
18.5	2730	2730	2730	2730	2730	2730	2730	2730
19.0	2730	2730	2730	2730	2730	2730	2730	2730
19.5	2730	2730	2730	2730	2730	2730	2730	2730
20.0	2730	2730	2730	2730	2730	2730	2730	2730
20.5*	2730	2730	2730	2730	2730	2730	2730	2730
21.0*	2730	2730	2730	2730	2730	2730	2730	2730
21.5*	2730	2730	2730	2730	2730	2730	2730	2730
22.0*	2730	2730	2730	2730	2730	2730	2730	2730
22.5*	2730	2730	2730	2730	2730	2730	2730	2730
23.0*	2730	2730	2730	2730	2730	2730	2730	2730
23.5*	2730	2730	2730	2730	2730	2730	2730	2730
24.0*	2730	2730	2730	2730	2730	2730	2730	2730
24.5*	2730	2730	2730	2730	2730	2730	2730	2730
25.0*	2730	2730	2730	2730	2730	2730	2730	2730

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 12

wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)									
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	145	150	155	159
4.5	210	217	224	232	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	455	469	482	496	509	523	536	549
6.0	590	607	625	642	659	677	694	712	729
6.5	756	778	800	823	845	867	889	911	933
7.0	932	959	987	1014	1041	1068	1095	1122	1150
7.5	1109	1142	1175	1207	1240	1272	1304	1337	1370
8.0	1284	1322	1361	1399	1437	1474	1511	1550	1589
8.5	1457	1500	1545	1588	1631	1673	1715	1760	1806
9.0	1629	1676	1727	1775	1824	1871	1918	1969	2020
9.5	1798	1851	1907	1960	2015	2066	2118	2174	2232
10.0	1965	2022	2083	2142	2201	2258	2308	2356	2406
10.5	2128	2190	2256	2317	2367	2414	2455	2492	2530
11.0	2287	2349	2403	2454	2492	2529	2558	2584	2611
11.5	2421	2470	2513	2552	2579	2606	2626	2641	2657
12.0	2521	2559	2590	2618	2635	2652	2662	2666	2670
12.5	2592	2620	2640	2657	2663	2669	2670	2670	2670
13.0	2639	2656	2664	2670	2670	2670	2670	2670	2670
13.5	2664	2670	2670	2670	2670	2670	2670	2670	2670
14.0	2670	2670	2670	2670	2670	2670	2670	2670	2670
14.5	2670	2670	2670	2670	2670	2670	2670	2670	2670
15.0	2670	2670	2670	2670	2670	2670	2670	2670	2670
15.5	2670	2670	2670	2670	2670	2670	2670	2670	2670
16.0	2670	2670	2670	2670	2670	2670	2670	2670	2670
16.5	2670	2670	2670	2670	2670	2670	2670	2670	2670
17.0	2670	2670	2670	2670	2670	2670	2670	2670	2670
17.5	2670	2670	2670	2670	2670	2670	2670	2670	2670
18.0	2670	2670	2670	2670	2670	2670	2670	2670	2670
18.5	2670	2670	2670	2670	2670	2670	2670	2670	2670
19.0	2670	2670	2670	2670	2670	2670	2670	2670	2670
19.5	2670	2670	2670	2670	2670	2670	2670	2670	2670
20.0	2670	2670	2670	2670	2670	2670	2670	2670	2670
20.5*	2670	2670	2670	2670	2670	2670	2670	2670	2670
21.0*	2670	2670	2670	2670	2670	2670	2670	2670	2670
21.5*	2670	2670	2670	2670	2670	2670	2670	2670	2670
22.0*	2670	2670	2670	2670	2670	2670	2670	2670	2670

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 12

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	**Power P_{el} [kW] at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	426	436	446	456	466	476
5.5	563	576	590	603	617	630	643	657
6.0	747	764	781	799	816	834	851	868
6.5	955	977	999	1021	1043	1065	1087	1109
7.0	1177	1205	1232	1260	1287	1315	1341	1369
7.5	1404	1437	1470	1504	1537	1570	1602	1636
8.0	1629	1669	1707	1748	1787	1826	1863	1902
8.5	1852	1898	1942	1989	2035	2081	2124	2168
9.0	2072	2125	2176	2226	2268	2310	2350	2387
9.5	2282	2329	2374	2415	2446	2477	2507	2534
10.0	2445	2480	2514	2544	2566	2587	2608	2625
10.5	2558	2583	2606	2626	2637	2649	2660	2667
11.0	2629	2643	2656	2665	2667	2668	2670	2670
11.5	2664	2667	2670	2670	2670	2670	2670	2670
12.0	2670	2670	2670	2670	2670	2670	2670	2670
12.5	2670	2670	2670	2670	2670	2670	2670	2670
13.0	2670	2670	2670	2670	2670	2670	2670	2670
13.5	2670	2670	2670	2670	2670	2670	2670	2670
14.0	2670	2670	2670	2670	2670	2670	2670	2670
14.5	2670	2670	2670	2670	2670	2670	2670	2670
15.0	2670	2670	2670	2670	2670	2670	2670	2670
15.5	2670	2670	2670	2670	2670	2670	2670	2670
16.0	2670	2670	2670	2670	2670	2670	2670	2670
16.5	2670	2670	2670	2670	2670	2670	2670	2670
17.0	2670	2670	2670	2670	2670	2670	2670	2670
17.5	2670	2670	2670	2670	2670	2670	2670	2670
18.0	2670	2670	2670	2670	2670	2670	2670	2670
18.5	2670	2670	2670	2670	2670	2670	2670	2670
19.0	2670	2670	2670	2670	2670	2670	2670	2670
19.5	2670	2670	2670	2670	2670	2670	2670	2670
20.0	2670	2670	2670	2670	2670	2670	2670	2670
20.5*	2670	2670	2670	2670	2670	2670	2670	2670
21.0*	2670	2670	2670	2670	2670	2670	2670	2670
21.5*	2670	2670	2670	2670	2670	2670	2670	2670
22.0*	2670	2670	2670	2670	2670	2670	2670	2670

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Power curves – Mode 13

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	1	3	4	5	7	8	9	10	12
3.5	52	55	58	60	63	66	69	71	74
4.0	122	127	132	136	141	145	150	155	159
4.5	210	217	224	231	239	246	253	260	267
5.0	317	327	337	347	357	367	377	387	397
5.5	442	455	469	482	496	509	523	536	549
6.0	589	607	624	642	659	677	694	711	729
6.5	752	774	796	818	840	862	884	906	928
7.0	920	947	975	1001	1028	1055	1082	1109	1136
7.5	1087	1120	1153	1184	1215	1247	1280	1312	1345
8.0	1252	1290	1329	1364	1400	1437	1475	1513	1551
8.5	1415	1458	1503	1543	1584	1627	1671	1715	1761
9.0	1577	1626	1678	1724	1771	1821	1871	1921	1972
9.5	1742	1798	1856	1907	1959	2014	2069	2124	2179
10.0	1908	1969	2032	2087	2144	2203	2257	2303	2351
10.5	2072	2137	2202	2261	2310	2359	2403	2438	2474
11.0	2231	2296	2349	2397	2435	2472	2504	2529	2553
11.5	2365	2417	2458	2495	2522	2547	2568	2583	2596
12.0	2465	2504	2533	2559	2576	2591	2602	2606	2610
12.5	2534	2562	2580	2597	2603	2608	2610	2610	2610
13.0	2580	2597	2604	2610	2610	2610	2610	2610	2610
13.5	2603	2610	2610	2610	2610	2610	2610	2610	2610
14.0	2610	2610	2610	2610	2610	2610	2610	2610	2610
14.5	2610	2610	2610	2610	2610	2610	2610	2610	2610
15.0	2610	2610	2610	2610	2610	2610	2610	2610	2610
15.5	2610	2610	2610	2610	2610	2610	2610	2610	2610
16.0	2610	2610	2610	2610	2610	2610	2610	2610	2610
16.5	2610	2610	2610	2610	2610	2610	2610	2610	2610
17.0	2610	2610	2610	2610	2610	2610	2610	2610	2610
17.5	2610	2610	2610	2610	2610	2610	2610	2610	2610
18.0	2610	2610	2610	2610	2610	2610	2610	2610	2610
18.5	2610	2610	2610	2610	2610	2610	2610	2610	2610
19.0	2610	2610	2610	2610	2610	2610	2610	2610	2610
19.5	2610	2610	2610	2610	2610	2610	2610	2610	2610
20.0	2610	2610	2610	2610	2610	2610	2610	2610	2610

Nordex N131/3900 IEC S – Power curves – Mode 13

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Power P_{el} [kW] at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	13	14	15	17	18	19	21	22
3.5	77	79	82	85	87	90	93	95
4.0	164	169	173	178	182	187	192	196
4.5	274	281	288	295	302	309	316	323
5.0	407	417	426	436	446	456	466	476
5.5	563	576	590	603	616	630	643	657
6.0	746	764	781	799	816	833	851	868
6.5	950	972	994	1016	1039	1061	1083	1105
7.0	1163	1191	1218	1245	1273	1300	1327	1355
7.5	1377	1410	1443	1475	1509	1542	1575	1609
8.0	1589	1628	1668	1706	1747	1786	1825	1865
8.5	1804	1850	1896	1940	1988	2034	2079	2122
9.0	2021	2073	2124	2172	2215	2256	2298	2335
9.5	2228	2273	2318	2358	2390	2421	2452	2479
10.0	2389	2424	2457	2487	2509	2530	2550	2567
10.5	2502	2525	2547	2567	2578	2589	2600	2607
11.0	2571	2583	2595	2605	2607	2608	2610	2610
11.5	2604	2607	2609	2610	2610	2610	2610	2610
12.0	2610	2610	2610	2610	2610	2610	2610	2610
12.5	2610	2610	2610	2610	2610	2610	2610	2610
13.0	2610	2610	2610	2610	2610	2610	2610	2610
13.5	2610	2610	2610	2610	2610	2610	2610	2610
14.0	2610	2610	2610	2610	2610	2610	2610	2610
14.5	2610	2610	2610	2610	2610	2610	2610	2610
15.0	2610	2610	2610	2610	2610	2610	2610	2610
15.5	2610	2610	2610	2610	2610	2610	2610	2610
16.0	2610	2610	2610	2610	2610	2610	2610	2610
16.5	2610	2610	2610	2610	2610	2610	2610	2610
17.0	2610	2610	2610	2610	2610	2610	2610	2610
17.5	2610	2610	2610	2610	2610	2610	2610	2610
18.0	2610	2610	2610	2610	2610	2610	2610	2610
18.5	2610	2610	2610	2610	2610	2610	2610	2610
19.0	2610	2610	2610	2610	2610	2610	2610	2610
19.5	2610	2610	2610	2610	2610	2610	2610	2610
20.0	2610	2610	2610	2610	2610	2610	2610	2610

Nordex N131/3900 IEC S – General remarks thrust curves

Basis:	The represented thrust coefficients are based on aerodynamical calculations by the Nordex Energy GmbH. The thrust curves are only for information and will not be warranted.

Nordex N131/3900 IEC S – Thrust curves – Mode 0

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.894	0.895	0.896	0.897	0.897	0.898	0.899	0.899	0.900
4.0	0.887	0.887	0.888	0.888	0.889	0.889	0.889	0.890	0.890
4.5	0.879	0.879	0.880	0.880	0.880	0.880	0.880	0.880	0.880
5.0	0.872	0.872	0.872	0.872	0.872	0.871	0.871	0.871	0.871
5.5	0.863	0.863	0.862	0.862	0.862	0.862	0.861	0.861	0.861
6.0	0.857	0.857	0.856	0.856	0.856	0.855	0.855	0.855	0.854
6.5	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.852	0.852
7.0	0.852	0.851	0.851	0.851	0.850	0.850	0.850	0.850	0.850
7.5	0.850	0.849	0.849	0.849	0.848	0.848	0.848	0.848	0.848
8.0	0.847	0.847	0.847	0.847	0.847	0.846	0.846	0.846	0.846
8.5	0.821	0.821	0.820	0.820	0.820	0.820	0.820	0.820	0.820
9.0	0.794	0.794	0.793	0.793	0.793	0.793	0.793	0.793	0.793
9.5	0.755	0.754	0.754	0.754	0.753	0.753	0.753	0.752	0.752
10.0	0.714	0.713	0.712	0.711	0.710	0.709	0.708	0.707	0.706
10.5	0.675	0.674	0.672	0.671	0.670	0.668	0.667	0.665	0.663
11.0	0.639	0.637	0.636	0.634	0.632	0.630	0.628	0.612	0.590
11.5	0.605	0.603	0.602	0.579	0.557	0.538	0.520	0.504	0.490
12.0	0.540	0.519	0.501	0.484	0.469	0.455	0.442	0.430	0.418
12.5	0.458	0.443	0.429	0.416	0.404	0.393	0.382	0.372	0.363
13.0	0.397	0.385	0.374	0.363	0.353	0.343	0.334	0.326	0.318
13.5	0.349	0.338	0.329	0.320	0.311	0.303	0.296	0.288	0.282
14.0	0.309	0.300	0.292	0.284	0.277	0.270	0.263	0.257	0.251
14.5	0.276	0.268	0.261	0.254	0.248	0.242	0.236	0.230	0.225
15.0	0.248	0.241	0.235	0.228	0.223	0.217	0.212	0.208	0.203
15.5	0.224	0.218	0.212	0.207	0.202	0.197	0.192	0.188	0.184
16.0	0.203	0.198	0.193	0.188	0.183	0.179	0.175	0.171	0.167
16.5	0.185	0.180	0.176	0.171	0.167	0.163	0.160	0.156	0.153
17.0	0.169	0.165	0.161	0.157	0.153	0.150	0.146	0.143	0.140
17.5	0.155	0.151	0.148	0.144	0.141	0.138	0.134	0.132	0.129
18.0	0.143	0.140	0.136	0.133	0.130	0.127	0.124	0.122	0.119
18.5	0.132	0.129	0.126	0.123	0.120	0.117	0.115	0.112	0.110
19.0	0.122	0.119	0.117	0.114	0.111	0.109	0.107	0.104	0.102
19.5	0.114	0.111	0.108	0.106	0.104	0.101	0.099	0.097	0.095
20.0	0.106	0.103	0.101	0.099	0.096	0.094	0.092	0.091	0.089
20.5*	0.098	0.095	0.093	0.092	0.089	0.087	0.085	0.084	0.082
21.0*	0.089	0.087	0.085	0.084	0.081	0.079	0.078	0.077	0.075
21.5*	0.080	0.078	0.076	0.075	0.072	0.071	0.069	0.069	0.067
22.0*	0.070	0.068	0.066	0.065	0.063	0.062	0.060	0.060	0.058
22.5*	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050
23.0*	0.054	0.053	0.052	0.051	0.049	0.048	0.047	0.047	0.045
23.5*	0.051	0.050	0.049	0.048	0.046	0.045	0.044	0.044	0.043
24.0*	0.048	0.047	0.046	0.045	0.043	0.043	0.042	0.041	0.040
24.5*	0.045	0.044	0.043	0.042	0.041	0.040	0.039	0.039	0.038
25.0*	0.042	0.041	0.040	0.039	0.038	0.037	0.036	0.036	0.035

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 0

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.907	0.909	0.910	0.910	0.911	0.912	0.912	0.913
3.5	0.901	0.901	0.902	0.902	0.903	0.903	0.904	0.904
4.0	0.890	0.891	0.891	0.891	0.891	0.892	0.892	0.892
4.5	0.880	0.880	0.880	0.881	0.881	0.881	0.881	0.881
5.0	0.871	0.871	0.871	0.871	0.871	0.871	0.871	0.871
5.5	0.861	0.860	0.860	0.860	0.860	0.860	0.860	0.860
6.0	0.854	0.854	0.854	0.853	0.853	0.853	0.853	0.852
6.5	0.852	0.851	0.851	0.851	0.851	0.850	0.850	0.850
7.0	0.849	0.849	0.849	0.849	0.849	0.848	0.848	0.848
7.5	0.848	0.847	0.847	0.847	0.847	0.847	0.846	0.846
8.0	0.846	0.846	0.846	0.846	0.845	0.845	0.845	0.845
8.5	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820
9.0	0.793	0.793	0.793	0.793	0.793	0.793	0.793	0.793
9.5	0.751	0.751	0.750	0.749	0.748	0.748	0.747	0.746
10.0	0.704	0.703	0.701	0.699	0.697	0.695	0.693	0.690
10.5	0.661	0.659	0.656	0.644	0.622	0.602	0.584	0.568
11.0	0.570	0.553	0.536	0.522	0.508	0.495	0.483	0.471
11.5	0.476	0.463	0.451	0.440	0.430	0.420	0.410	0.401
12.0	0.407	0.397	0.388	0.379	0.370	0.362	0.354	0.347
12.5	0.354	0.345	0.338	0.330	0.323	0.316	0.310	0.303
13.0	0.311	0.304	0.297	0.290	0.284	0.278	0.273	0.268
13.5	0.275	0.269	0.263	0.258	0.252	0.247	0.242	0.238
14.0	0.245	0.240	0.235	0.230	0.225	0.221	0.217	0.213
14.5	0.220	0.215	0.211	0.207	0.202	0.199	0.195	0.191
15.0	0.198	0.194	0.190	0.187	0.183	0.179	0.176	0.173
15.5	0.180	0.176	0.173	0.169	0.166	0.163	0.160	0.157
16.0	0.164	0.160	0.157	0.154	0.151	0.148	0.146	0.143
16.5	0.150	0.147	0.144	0.141	0.138	0.136	0.133	0.131
17.0	0.137	0.134	0.132	0.129	0.127	0.125	0.123	0.120
17.5	0.126	0.124	0.122	0.119	0.117	0.115	0.113	0.111
18.0	0.117	0.114	0.112	0.110	0.108	0.106	0.104	0.103
18.5	0.108	0.106	0.104	0.102	0.100	0.098	0.097	0.095
19.0	0.100	0.098	0.096	0.095	0.093	0.092	0.090	0.088
19.5	0.093	0.092	0.090	0.088	0.087	0.085	0.084	0.082
20.0	0.087	0.086	0.084	0.082	0.081	0.080	0.078	0.077
20.5*	0.080	0.080	0.078	0.076	0.075	0.074	0.072	0.071
21.0*	0.073	0.073	0.071	0.069	0.068	0.068	0.066	0.065
21.5*	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058
22.0*	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.051
22.5*	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043
23.0*	0.044	0.044	0.043	0.042	0.041	0.041	0.040	0.039
23.5*	0.042	0.041	0.040	0.040	0.039	0.039	0.038	0.037
24.0*	0.039	0.039	0.038	0.037	0.037	0.036	0.035	0.035
24.5*	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033
25.0*	0.034	0.034	0.033	0.032	0.032	0.032	0.031	0.030

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 1

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.894	0.895	0.896	0.897	0.897	0.898	0.899	0.900	0.900
4.0	0.887	0.887	0.888	0.888	0.889	0.889	0.889	0.890	0.890
4.5	0.879	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880
5.0	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.871
5.5	0.863	0.863	0.863	0.862	0.862	0.862	0.862	0.862	0.861
6.0	0.857	0.857	0.857	0.856	0.856	0.856	0.855	0.855	0.855
6.5	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.852
7.0	0.852	0.852	0.851	0.851	0.851	0.850	0.850	0.850	0.850
7.5	0.850	0.850	0.849	0.849	0.849	0.849	0.848	0.848	0.848
8.0	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.846	0.846
8.5	0.821	0.821	0.821	0.821	0.821	0.821	0.821	0.821	0.821
9.0	0.792	0.792	0.792	0.792	0.792	0.792	0.792	0.792	0.792
9.5	0.748	0.748	0.747	0.747	0.746	0.746	0.745	0.744	0.744
10.0	0.707	0.706	0.706	0.704	0.704	0.702	0.701	0.700	0.699
10.5	0.668	0.667	0.666	0.665	0.663	0.662	0.660	0.659	0.657
11.0	0.632	0.631	0.629	0.628	0.626	0.625	0.611	0.589	0.569
11.5	0.599	0.597	0.580	0.558	0.538	0.520	0.503	0.488	0.474
12.0	0.522	0.502	0.485	0.469	0.454	0.441	0.428	0.417	0.406
12.5	0.444	0.430	0.416	0.404	0.392	0.381	0.371	0.361	0.352
13.0	0.386	0.374	0.363	0.353	0.343	0.334	0.325	0.317	0.309
13.5	0.339	0.329	0.320	0.311	0.303	0.295	0.288	0.280	0.274
14.0	0.301	0.292	0.284	0.276	0.269	0.262	0.256	0.250	0.244
14.5	0.269	0.261	0.254	0.247	0.241	0.235	0.230	0.224	0.219
15.0	0.241	0.235	0.228	0.223	0.217	0.212	0.207	0.202	0.198
15.5	0.218	0.212	0.207	0.201	0.196	0.192	0.187	0.183	0.179
16.0	0.198	0.193	0.188	0.183	0.179	0.174	0.170	0.167	0.163
16.5	0.180	0.176	0.171	0.167	0.163	0.159	0.156	0.152	0.149
17.0	0.165	0.161	0.157	0.153	0.149	0.146	0.143	0.140	0.137
17.5	0.152	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.126
18.0	0.140	0.136	0.133	0.130	0.127	0.124	0.121	0.118	0.116
18.5	0.129	0.126	0.123	0.120	0.117	0.114	0.112	0.110	0.108
19.0	0.120	0.116	0.114	0.111	0.109	0.106	0.104	0.102	0.100
19.5	0.111	0.108	0.106	0.103	0.101	0.099	0.097	0.095	0.093
20.0	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.087
20.5*	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080
21.0*	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073
21.5*	0.078	0.076	0.074	0.072	0.071	0.069	0.068	0.066	0.066
22.0*	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057
22.5*	0.058	0.057	0.055	0.054	0.053	0.052	0.050	0.049	0.049
23.0*	0.053	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044
23.5*	0.050	0.049	0.047	0.046	0.045	0.044	0.043	0.042	0.042
24.0*	0.047	0.046	0.044	0.043	0.043	0.042	0.041	0.040	0.039
24.5*	0.044	0.043	0.042	0.041	0.040	0.039	0.038	0.037	0.037
25.0*	0.041	0.040	0.039	0.038	0.037	0.036	0.036	0.035	0.034

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 1

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.908	0.908	0.910	0.910	0.911	0.912	0.913	0.913
3.5	0.901	0.901	0.902	0.902	0.903	0.903	0.904	0.904
4.0	0.890	0.891	0.891	0.891	0.892	0.892	0.892	0.892
4.5	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881
5.0	0.871	0.871	0.871	0.871	0.871	0.871	0.871	0.871
5.5	0.861	0.861	0.861	0.860	0.860	0.860	0.860	0.860
6.0	0.854	0.854	0.854	0.854	0.854	0.853	0.853	0.853
6.5	0.852	0.852	0.851	0.851	0.851	0.851	0.851	0.850
7.0	0.850	0.850	0.849	0.849	0.849	0.849	0.849	0.848
7.5	0.848	0.848	0.848	0.847	0.847	0.847	0.847	0.847
8.0	0.846	0.846	0.846	0.846	0.846	0.846	0.845	0.845
8.5	0.821	0.820	0.820	0.820	0.820	0.820	0.820	0.820
9.0	0.792	0.792	0.792	0.793	0.793	0.793	0.793	0.793
9.5	0.743	0.742	0.741	0.740	0.739	0.738	0.737	0.735
10.0	0.698	0.696	0.694	0.693	0.691	0.688	0.686	0.684
10.5	0.655	0.653	0.640	0.618	0.597	0.579	0.563	0.548
11.0	0.550	0.534	0.518	0.504	0.491	0.479	0.467	0.456
11.5	0.461	0.449	0.438	0.427	0.417	0.407	0.398	0.389
12.0	0.395	0.386	0.376	0.368	0.360	0.352	0.344	0.337
12.5	0.344	0.336	0.328	0.321	0.314	0.307	0.301	0.295
13.0	0.302	0.295	0.289	0.282	0.276	0.271	0.266	0.260
13.5	0.268	0.262	0.256	0.251	0.246	0.241	0.236	0.232
14.0	0.239	0.234	0.229	0.224	0.220	0.215	0.211	0.207
14.5	0.214	0.210	0.205	0.201	0.197	0.194	0.190	0.186
15.0	0.193	0.189	0.186	0.182	0.178	0.175	0.172	0.168
15.5	0.175	0.172	0.168	0.165	0.162	0.159	0.156	0.153
16.0	0.160	0.156	0.153	0.150	0.147	0.145	0.142	0.140
16.5	0.146	0.143	0.140	0.138	0.135	0.132	0.130	0.128
17.0	0.134	0.131	0.129	0.126	0.124	0.122	0.120	0.118
17.5	0.123	0.121	0.118	0.116	0.114	0.112	0.110	0.108
18.0	0.114	0.112	0.109	0.107	0.106	0.104	0.102	0.100
18.5	0.105	0.103	0.101	0.100	0.098	0.096	0.094	0.093
19.0	0.098	0.096	0.094	0.092	0.091	0.089	0.088	0.086
19.5	0.091	0.089	0.088	0.086	0.085	0.083	0.082	0.080
20.0	0.085	0.083	0.082	0.080	0.079	0.078	0.076	0.075
20.5*	0.079	0.077	0.076	0.074	0.073	0.072	0.070	0.069
21.0*	0.072	0.070	0.069	0.068	0.067	0.066	0.064	0.063
21.5*	0.064	0.062	0.062	0.060	0.059	0.059	0.057	0.056
22.0*	0.056	0.054	0.054	0.052	0.052	0.051	0.050	0.049
22.5*	0.048	0.046	0.046	0.045	0.044	0.044	0.043	0.042
23.0*	0.043	0.042	0.042	0.041	0.040	0.040	0.039	0.038
23.5*	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036
24.0*	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034
24.5*	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032
25.0*	0.034	0.033	0.032	0.032	0.031	0.031	0.030	0.030

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 2

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.894	0.895	0.896	0.897	0.898	0.898	0.899	0.900	0.900
4.0	0.887	0.888	0.888	0.888	0.889	0.889	0.889	0.890	0.890
4.5	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.881
5.0	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872
5.5	0.864	0.863	0.863	0.863	0.862	0.862	0.862	0.862	0.862
6.0	0.858	0.857	0.857	0.857	0.856	0.856	0.856	0.855	0.855
6.5	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.853	0.852
7.0	0.852	0.852	0.852	0.851	0.851	0.851	0.851	0.850	0.850
7.5	0.850	0.850	0.850	0.850	0.849	0.849	0.849	0.849	0.848
8.0	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847
8.5	0.821	0.821	0.821	0.821	0.821	0.821	0.821	0.821	0.820
9.0	0.784	0.784	0.784	0.784	0.784	0.784	0.784	0.783	0.783
9.5	0.742	0.742	0.741	0.741	0.740	0.740	0.739	0.738	0.738
10.0	0.702	0.701	0.700	0.699	0.699	0.698	0.697	0.696	0.695
10.5	0.664	0.663	0.662	0.661	0.660	0.659	0.658	0.656	0.655
11.0	0.628	0.628	0.626	0.625	0.624	0.608	0.585	0.564	0.546
11.5	0.595	0.580	0.557	0.536	0.518	0.501	0.485	0.471	0.458
12.0	0.502	0.484	0.468	0.453	0.439	0.426	0.414	0.403	0.392
12.5	0.429	0.415	0.403	0.391	0.380	0.369	0.359	0.350	0.341
13.0	0.374	0.362	0.351	0.342	0.332	0.323	0.315	0.307	0.300
13.5	0.329	0.319	0.310	0.301	0.293	0.286	0.279	0.272	0.266
14.0	0.292	0.283	0.275	0.268	0.261	0.255	0.248	0.243	0.237
14.5	0.260	0.253	0.246	0.240	0.234	0.228	0.223	0.218	0.213
15.0	0.234	0.228	0.222	0.216	0.211	0.206	0.201	0.196	0.192
15.5	0.212	0.206	0.201	0.196	0.191	0.186	0.182	0.178	0.174
16.0	0.192	0.187	0.182	0.178	0.174	0.169	0.166	0.162	0.158
16.5	0.175	0.171	0.166	0.162	0.158	0.155	0.151	0.148	0.145
17.0	0.160	0.156	0.152	0.149	0.145	0.142	0.139	0.136	0.133
17.5	0.147	0.144	0.140	0.137	0.133	0.130	0.128	0.125	0.122
18.0	0.136	0.132	0.129	0.126	0.123	0.120	0.118	0.115	0.113
18.5	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.105
19.0	0.116	0.113	0.111	0.108	0.106	0.103	0.101	0.099	0.097
19.5	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.090
20.0	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.084
20.5*	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078
21.0*	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.071
21.5*	0.076	0.074	0.072	0.071	0.069	0.068	0.066	0.065	0.063
22.0*	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.056	0.055
22.5*	0.057	0.055	0.054	0.053	0.052	0.050	0.049	0.048	0.047
23.0*	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
23.5*	0.049	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040
24.0*	0.046	0.044	0.043	0.043	0.042	0.041	0.040	0.039	0.038
24.5*	0.043	0.042	0.041	0.040	0.039	0.038	0.037	0.036	0.036
25.0*	0.040	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.033

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 2

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.908	0.909	0.910	0.910	0.911	0.912	0.913	0.913
3.5	0.901	0.901	0.902	0.902	0.903	0.903	0.904	0.904
4.0	0.891	0.891	0.891	0.892	0.892	0.892	0.892	0.892
4.5	0.881	0.881	0.881	0.881	0.881	0.881	0.881	0.881
5.0	0.872	0.872	0.872	0.871	0.871	0.871	0.871	0.871
5.5	0.861	0.861	0.861	0.861	0.860	0.860	0.860	0.860
6.0	0.855	0.855	0.854	0.854	0.854	0.854	0.853	0.853
6.5	0.852	0.852	0.852	0.852	0.851	0.851	0.851	0.851
7.0	0.850	0.850	0.850	0.850	0.849	0.849	0.849	0.849
7.5	0.848	0.848	0.848	0.848	0.848	0.848	0.847	0.847
8.0	0.847	0.846	0.846	0.846	0.846	0.846	0.846	0.846
8.5	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820
9.0	0.783	0.783	0.782	0.782	0.782	0.781	0.781	0.781
9.5	0.737	0.736	0.735	0.734	0.733	0.732	0.731	0.730
10.0	0.694	0.692	0.691	0.690	0.688	0.687	0.685	0.661
10.5	0.654	0.633	0.610	0.590	0.572	0.556	0.541	0.527
11.0	0.529	0.514	0.499	0.486	0.474	0.462	0.451	0.441
11.5	0.445	0.434	0.423	0.412	0.403	0.394	0.385	0.377
12.0	0.382	0.373	0.364	0.356	0.348	0.340	0.333	0.326
12.5	0.333	0.325	0.318	0.311	0.304	0.298	0.292	0.286
13.0	0.293	0.286	0.280	0.274	0.268	0.263	0.258	0.252
13.5	0.260	0.254	0.248	0.243	0.238	0.234	0.229	0.225
14.0	0.232	0.227	0.222	0.217	0.213	0.209	0.205	0.201
14.5	0.208	0.204	0.199	0.195	0.192	0.188	0.184	0.181
15.0	0.188	0.184	0.180	0.176	0.173	0.170	0.167	0.164
15.5	0.170	0.167	0.163	0.160	0.157	0.154	0.151	0.149
16.0	0.155	0.152	0.149	0.146	0.143	0.141	0.138	0.136
16.5	0.142	0.139	0.136	0.134	0.131	0.129	0.126	0.124
17.0	0.130	0.128	0.125	0.123	0.120	0.118	0.116	0.114
17.5	0.120	0.118	0.115	0.113	0.111	0.109	0.107	0.105
18.0	0.111	0.108	0.106	0.104	0.103	0.101	0.099	0.097
18.5	0.102	0.100	0.099	0.097	0.095	0.094	0.092	0.090
19.0	0.095	0.093	0.092	0.090	0.088	0.087	0.085	0.084
19.5	0.089	0.087	0.085	0.084	0.082	0.081	0.080	0.078
20.0	0.083	0.081	0.080	0.078	0.077	0.076	0.074	0.073
20.5*	0.077	0.075	0.074	0.072	0.071	0.070	0.068	0.068
21.0*	0.070	0.068	0.068	0.066	0.065	0.064	0.062	0.062
21.5*	0.062	0.061	0.060	0.059	0.058	0.057	0.056	0.055
22.0*	0.054	0.053	0.052	0.051	0.051	0.050	0.049	0.048
22.5*	0.046	0.045	0.045	0.044	0.043	0.043	0.041	0.041
23.0*	0.042	0.041	0.041	0.040	0.039	0.039	0.038	0.037
23.5*	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035
24.0*	0.038	0.037	0.036	0.035	0.035	0.034	0.034	0.033
24.5*	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031
25.0*	0.033	0.032	0.032	0.031	0.030	0.030	0.029	0.029

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 3

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.894	0.895	0.896	0.897	0.898	0.898	0.899	0.900	0.900
4.0	0.887	0.888	0.888	0.889	0.889	0.889	0.890	0.890	0.890
4.5	0.880	0.880	0.880	0.880	0.880	0.881	0.881	0.881	0.881
5.0	0.873	0.873	0.872	0.872	0.872	0.872	0.872	0.872	0.872
5.5	0.864	0.864	0.863	0.863	0.863	0.863	0.862	0.862	0.862
6.0	0.858	0.858	0.858	0.857	0.857	0.856	0.856	0.856	0.856
6.5	0.855	0.855	0.854	0.854	0.854	0.854	0.853	0.853	0.853
7.0	0.853	0.852	0.852	0.852	0.852	0.851	0.851	0.851	0.851
7.5	0.851	0.850	0.850	0.850	0.850	0.850	0.849	0.849	0.849
8.0	0.848	0.848	0.848	0.848	0.848	0.847	0.847	0.847	0.847
8.5	0.829	0.829	0.828	0.828	0.828	0.828	0.828	0.828	0.828
9.0	0.789	0.789	0.788	0.788	0.788	0.788	0.787	0.787	0.787
9.5	0.745	0.745	0.744	0.744	0.743	0.742	0.742	0.741	0.740
10.0	0.704	0.703	0.702	0.702	0.701	0.700	0.699	0.698	0.696
10.5	0.665	0.664	0.663	0.662	0.661	0.660	0.659	0.657	0.649
11.0	0.629	0.628	0.627	0.626	0.602	0.578	0.558	0.539	0.522
11.5	0.577	0.553	0.532	0.513	0.496	0.480	0.466	0.452	0.440
12.0	0.482	0.465	0.450	0.436	0.422	0.410	0.399	0.388	0.378
12.5	0.413	0.400	0.388	0.377	0.366	0.356	0.347	0.338	0.329
13.0	0.360	0.349	0.339	0.330	0.321	0.312	0.304	0.297	0.290
13.5	0.317	0.308	0.299	0.291	0.284	0.276	0.270	0.263	0.257
14.0	0.282	0.274	0.266	0.259	0.253	0.246	0.240	0.235	0.229
14.5	0.252	0.245	0.238	0.232	0.226	0.221	0.216	0.211	0.206
15.0	0.227	0.220	0.215	0.209	0.204	0.199	0.195	0.190	0.186
15.5	0.205	0.200	0.194	0.190	0.185	0.180	0.176	0.172	0.169
16.0	0.186	0.181	0.177	0.172	0.168	0.164	0.160	0.157	0.154
16.5	0.170	0.165	0.161	0.157	0.154	0.150	0.147	0.144	0.140
17.0	0.156	0.152	0.148	0.144	0.141	0.138	0.134	0.132	0.129
17.5	0.143	0.139	0.136	0.132	0.130	0.127	0.124	0.121	0.119
18.0	0.132	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.110
18.5	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.104	0.102
19.0	0.113	0.110	0.107	0.105	0.103	0.100	0.098	0.096	0.094
19.5	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.090	0.088
20.0	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.084	0.082
20.5*	0.091	0.088	0.086	0.084	0.082	0.080	0.079	0.078	0.076
21.0*	0.083	0.080	0.078	0.077	0.075	0.073	0.072	0.071	0.069
21.5*	0.074	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062
22.0*	0.064	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054
22.5*	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
23.0*	0.050	0.049	0.048	0.047	0.045	0.044	0.043	0.043	0.042
23.5*	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040
24.0*	0.044	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037
24.5*	0.042	0.040	0.039	0.039	0.038	0.037	0.036	0.036	0.035
25.0*	0.039	0.038	0.037	0.036	0.035	0.034	0.034	0.033	0.032

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 3

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.908	0.909	0.909	0.910	0.911	0.912	0.913	0.913
3.5	0.901	0.901	0.902	0.902	0.903	0.903	0.904	0.904
4.0	0.891	0.891	0.891	0.892	0.892	0.892	0.892	0.893
4.5	0.881	0.881	0.881	0.881	0.881	0.882	0.882	0.882
5.0	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872
5.5	0.862	0.861	0.861	0.861	0.861	0.861	0.861	0.860
6.0	0.855	0.855	0.855	0.854	0.854	0.854	0.854	0.854
6.5	0.853	0.852	0.852	0.852	0.852	0.852	0.851	0.851
7.0	0.851	0.850	0.850	0.850	0.850	0.850	0.850	0.849
7.5	0.849	0.849	0.848	0.848	0.848	0.848	0.848	0.848
8.0	0.847	0.847	0.847	0.847	0.847	0.846	0.846	0.846
8.5	0.828	0.828	0.828	0.828	0.828	0.827	0.827	0.827
9.0	0.786	0.786	0.786	0.785	0.785	0.784	0.784	0.783
9.5	0.739	0.738	0.738	0.736	0.735	0.734	0.733	0.732
10.0	0.695	0.694	0.693	0.691	0.690	0.671	0.646	0.625
10.5	0.623	0.601	0.581	0.563	0.547	0.532	0.518	0.505
11.0	0.507	0.492	0.479	0.467	0.455	0.444	0.434	0.424
11.5	0.428	0.417	0.407	0.397	0.388	0.379	0.371	0.363
12.0	0.369	0.360	0.352	0.344	0.336	0.329	0.322	0.315
12.5	0.322	0.314	0.307	0.300	0.294	0.288	0.282	0.276
13.0	0.283	0.277	0.271	0.265	0.259	0.254	0.249	0.244
13.5	0.251	0.246	0.240	0.235	0.231	0.226	0.222	0.218
14.0	0.224	0.220	0.215	0.210	0.206	0.202	0.198	0.195
14.5	0.202	0.197	0.193	0.189	0.186	0.182	0.179	0.175
15.0	0.182	0.178	0.175	0.171	0.168	0.165	0.162	0.159
15.5	0.165	0.162	0.158	0.155	0.152	0.150	0.147	0.144
16.0	0.150	0.147	0.144	0.142	0.139	0.136	0.134	0.132
16.5	0.138	0.135	0.132	0.130	0.127	0.125	0.123	0.121
17.0	0.126	0.124	0.121	0.119	0.117	0.115	0.113	0.111
17.5	0.116	0.114	0.112	0.110	0.108	0.106	0.104	0.102
18.0	0.107	0.105	0.103	0.102	0.100	0.098	0.096	0.095
18.5	0.100	0.098	0.096	0.094	0.092	0.091	0.089	0.088
19.0	0.092	0.091	0.089	0.087	0.086	0.084	0.083	0.082
19.5	0.086	0.084	0.083	0.082	0.080	0.079	0.077	0.076
20.0	0.080	0.079	0.078	0.076	0.075	0.074	0.072	0.071
20.5*	0.074	0.073	0.072	0.070	0.069	0.068	0.067	0.066
21.0*	0.068	0.067	0.066	0.064	0.063	0.062	0.061	0.060
21.5*	0.060	0.059	0.059	0.057	0.056	0.056	0.054	0.053
22.0*	0.052	0.052	0.051	0.050	0.049	0.049	0.047	0.047
22.5*	0.045	0.044	0.044	0.043	0.042	0.041	0.040	0.040
23.0*	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036
23.5*	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034
24.0*	0.036	0.036	0.035	0.034	0.034	0.034	0.033	0.032
24.5*	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030
25.0*	0.032	0.031	0.031	0.030	0.030	0.029	0.028	0.028

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 4

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 114 m)									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.894	0.895	0.896	0.897	0.898	0.898	0.899	0.900	0.900
4.0	0.887	0.888	0.888	0.889	0.889	0.890	0.890	0.890	0.891
4.5	0.880	0.880	0.880	0.880	0.881	0.881	0.881	0.881	0.881
5.0	0.873	0.873	0.873	0.873	0.873	0.872	0.872	0.872	0.872
5.5	0.864	0.864	0.864	0.864	0.863	0.863	0.863	0.862	0.862
6.0	0.859	0.858	0.858	0.858	0.857	0.857	0.856	0.856	0.856
6.5	0.856	0.855	0.855	0.855	0.854	0.854	0.854	0.854	0.853
7.0	0.853	0.853	0.853	0.852	0.852	0.852	0.852	0.851	0.851
7.5	0.851	0.851	0.851	0.850	0.850	0.850	0.850	0.850	0.850
8.0	0.848	0.848	0.848	0.848	0.848	0.848	0.848	0.847	0.847
8.5	0.824	0.824	0.824	0.824	0.824	0.824	0.824	0.824	0.824
9.0	0.779	0.779	0.778	0.778	0.778	0.778	0.777	0.777	0.777
9.5	0.736	0.736	0.735	0.735	0.734	0.734	0.733	0.733	0.732
10.0	0.696	0.695	0.695	0.694	0.693	0.693	0.692	0.691	0.690
10.5	0.658	0.657	0.656	0.656	0.655	0.654	0.653	0.642	0.616
11.0	0.621	0.621	0.620	0.599	0.575	0.554	0.535	0.518	0.502
11.5	0.552	0.531	0.511	0.493	0.477	0.462	0.449	0.436	0.424
12.0	0.464	0.448	0.434	0.420	0.408	0.396	0.385	0.375	0.366
12.5	0.399	0.386	0.375	0.364	0.354	0.344	0.335	0.327	0.319
13.0	0.348	0.338	0.328	0.319	0.310	0.302	0.295	0.287	0.281
13.5	0.307	0.298	0.290	0.282	0.275	0.268	0.261	0.255	0.249
14.0	0.273	0.265	0.258	0.251	0.245	0.239	0.233	0.228	0.222
14.5	0.244	0.238	0.231	0.225	0.220	0.214	0.209	0.204	0.200
15.0	0.220	0.214	0.208	0.203	0.198	0.193	0.189	0.184	0.180
15.5	0.199	0.194	0.188	0.184	0.179	0.175	0.171	0.167	0.164
16.0	0.181	0.176	0.171	0.167	0.163	0.159	0.156	0.152	0.149
16.5	0.165	0.160	0.156	0.153	0.149	0.146	0.142	0.139	0.136
17.0	0.151	0.147	0.143	0.140	0.137	0.134	0.131	0.128	0.125
17.5	0.139	0.135	0.132	0.129	0.126	0.123	0.120	0.118	0.115
18.0	0.128	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.106
18.5	0.118	0.115	0.112	0.110	0.107	0.105	0.103	0.101	0.099
19.0	0.110	0.107	0.104	0.102	0.100	0.098	0.096	0.094	0.092
19.5	0.102	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.085
20.0	0.095	0.093	0.090	0.088	0.086	0.085	0.083	0.081	0.080
20.5*	0.088	0.086	0.083	0.081	0.080	0.079	0.077	0.075	0.074
21.0*	0.080	0.078	0.076	0.074	0.073	0.072	0.070	0.068	0.068
21.5*	0.072	0.070	0.068	0.066	0.065	0.064	0.062	0.061	0.060
22.0*	0.062	0.061	0.059	0.058	0.056	0.056	0.054	0.053	0.052
22.5*	0.053	0.052	0.050	0.049	0.048	0.048	0.046	0.045	0.045
23.0*	0.049	0.048	0.046	0.045	0.044	0.043	0.042	0.041	0.041
23.5*	0.046	0.045	0.043	0.042	0.041	0.041	0.040	0.039	0.039
24.0*	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.036
24.5*	0.040	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034
25.0*	0.038	0.037	0.036	0.035	0.034	0.034	0.033	0.032	0.032

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 4

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m
(mode on request for 114 m)

wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m³]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.908	0.909	0.909	0.910	0.911	0.912	0.912	0.913
3.5	0.901	0.902	0.902	0.902	0.903	0.903	0.904	0.904
4.0	0.891	0.891	0.892	0.892	0.892	0.892	0.893	0.893
4.5	0.881	0.881	0.882	0.882	0.882	0.882	0.882	0.882
5.0	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872
5.5	0.862	0.862	0.862	0.861	0.861	0.861	0.861	0.861
6.0	0.856	0.855	0.855	0.855	0.855	0.854	0.854	0.854
6.5	0.853	0.853	0.853	0.852	0.852	0.852	0.852	0.852
7.0	0.851	0.851	0.851	0.850	0.850	0.850	0.850	0.850
7.5	0.849	0.849	0.849	0.849	0.849	0.849	0.848	0.848
8.0	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847
8.5	0.824	0.824	0.824	0.824	0.824	0.824	0.824	0.824
9.0	0.776	0.776	0.776	0.775	0.774	0.774	0.773	0.773
9.5	0.731	0.731	0.730	0.729	0.728	0.727	0.726	0.725
10.0	0.690	0.688	0.688	0.686	0.659	0.635	0.614	0.596
10.5	0.594	0.574	0.556	0.540	0.525	0.511	0.498	0.486
11.0	0.488	0.474	0.462	0.450	0.439	0.428	0.419	0.409
11.5	0.413	0.403	0.393	0.384	0.375	0.367	0.359	0.351
12.0	0.356	0.348	0.340	0.332	0.325	0.318	0.311	0.305
12.5	0.311	0.304	0.297	0.291	0.284	0.279	0.273	0.268
13.0	0.274	0.268	0.262	0.256	0.251	0.246	0.241	0.237
13.5	0.243	0.238	0.233	0.228	0.224	0.219	0.215	0.211
14.0	0.218	0.213	0.208	0.204	0.200	0.196	0.192	0.189
14.5	0.195	0.191	0.187	0.184	0.180	0.177	0.173	0.170
15.0	0.177	0.173	0.169	0.166	0.163	0.160	0.157	0.154
15.5	0.160	0.157	0.154	0.151	0.148	0.145	0.143	0.140
16.0	0.146	0.143	0.140	0.138	0.135	0.132	0.130	0.128
16.5	0.134	0.131	0.128	0.126	0.124	0.121	0.119	0.117
17.0	0.123	0.120	0.118	0.116	0.114	0.112	0.110	0.108
17.5	0.113	0.111	0.109	0.107	0.105	0.103	0.101	0.099
18.0	0.104	0.102	0.100	0.099	0.097	0.095	0.094	0.092
18.5	0.097	0.095	0.093	0.091	0.090	0.088	0.087	0.085
19.0	0.090	0.088	0.087	0.085	0.084	0.082	0.081	0.079
19.5	0.084	0.082	0.081	0.079	0.078	0.077	0.075	0.074
20.0	0.078	0.077	0.075	0.074	0.073	0.072	0.070	0.069
20.5*	0.072	0.071	0.069	0.068	0.068	0.067	0.065	0.064
21.0*	0.066	0.065	0.063	0.062	0.062	0.061	0.059	0.058
21.5*	0.059	0.058	0.056	0.056	0.055	0.054	0.053	0.052
22.0*	0.051	0.051	0.049	0.049	0.048	0.047	0.046	0.045
22.5*	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039
23.0*	0.040	0.039	0.038	0.038	0.037	0.037	0.036	0.035
23.5*	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033
24.0*	0.035	0.035	0.034	0.034	0.033	0.033	0.032	0.031
24.5*	0.033	0.033	0.032	0.031	0.031	0.031	0.030	0.029
25.0*	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027

* These values are based on a yield and load optimized operation that is not feasible at all sites.

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Nordex N131/3900 IEC S – Thrust curves – Mode 5

for hub heights 84 m, 120 m, 134 m and 164 m (mode not available for 114 m)									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m³]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.894	0.895	0.896	0.897	0.898	0.898	0.899	0.900	0.900
4.0	0.888	0.888	0.888	0.889	0.889	0.890	0.890	0.890	0.891
4.5	0.880	0.880	0.881	0.881	0.881	0.881	0.881	0.881	0.881
5.0	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873	0.873
5.5	0.865	0.864	0.864	0.864	0.864	0.863	0.863	0.863	0.863
6.0	0.859	0.859	0.858	0.858	0.858	0.857	0.857	0.857	0.856
6.5	0.856	0.856	0.855	0.855	0.855	0.854	0.854	0.854	0.854
7.0	0.854	0.853	0.853	0.853	0.853	0.852	0.852	0.852	0.852
7.5	0.852	0.852	0.851	0.851	0.851	0.851	0.850	0.850	0.850
8.0	0.849	0.849	0.849	0.848	0.848	0.848	0.848	0.848	0.848
8.5	0.819	0.819	0.819	0.819	0.819	0.819	0.818	0.818	0.818
9.0	0.775	0.774	0.774	0.774	0.774	0.774	0.774	0.773	0.773
9.5	0.732	0.732	0.732	0.732	0.731	0.731	0.730	0.730	0.730
10.0	0.692	0.692	0.692	0.691	0.691	0.690	0.690	0.689	0.689
10.5	0.654	0.653	0.653	0.652	0.652	0.652	0.635	0.609	0.587
11.0	0.617	0.617	0.596	0.571	0.550	0.530	0.513	0.497	0.482
11.5	0.529	0.509	0.491	0.474	0.459	0.445	0.432	0.420	0.409
12.0	0.447	0.432	0.418	0.405	0.393	0.382	0.372	0.362	0.353
12.5	0.385	0.373	0.362	0.352	0.342	0.333	0.324	0.316	0.308
13.0	0.336	0.326	0.317	0.308	0.300	0.292	0.285	0.278	0.272
13.5	0.297	0.288	0.280	0.273	0.266	0.259	0.253	0.247	0.241
14.0	0.264	0.257	0.250	0.243	0.237	0.231	0.226	0.220	0.215
14.5	0.236	0.230	0.224	0.218	0.213	0.208	0.203	0.198	0.194
15.0	0.213	0.207	0.202	0.197	0.192	0.187	0.183	0.179	0.175
15.5	0.193	0.188	0.183	0.178	0.174	0.170	0.166	0.162	0.159
16.0	0.175	0.171	0.166	0.162	0.158	0.155	0.151	0.148	0.145
16.5	0.160	0.156	0.152	0.148	0.145	0.141	0.138	0.135	0.132
17.0	0.146	0.143	0.139	0.136	0.133	0.130	0.127	0.124	0.122
17.5	0.135	0.131	0.128	0.125	0.122	0.119	0.117	0.114	0.112
18.0	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.106	0.103
18.5	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096
19.0	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089
19.5	0.099	0.097	0.094	0.092	0.090	0.088	0.086	0.085	0.083
20.0	0.092	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078
20.5*	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.073	0.072
21.0*	0.078	0.076	0.074	0.073	0.071	0.069	0.068	0.067	0.066
21.5*	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.059	0.059
22.0*	0.060	0.059	0.058	0.056	0.055	0.054	0.053	0.052	0.051
22.5*	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044
23.0*	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040
23.5*	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.038
24.0*	0.042	0.041	0.040	0.039	0.038	0.037	0.037	0.036	0.035
24.5*	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.033	0.033
25.0*	0.036	0.036	0.035	0.034	0.033	0.032	0.032	0.031	0.031

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 5

for hub heights 84 m, 120 m, 134 m and 164 m (mode not available for 114 m)								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.908	0.909	0.910	0.910	0.911	0.912	0.912	0.913
3.5	0.901	0.902	0.902	0.903	0.903	0.904	0.904	0.904
4.0	0.891	0.892	0.892	0.892	0.892	0.892	0.893	0.893
4.5	0.882	0.882	0.882	0.882	0.882	0.882	0.882	0.882
5.0	0.872	0.872	0.872	0.872	0.872	0.872	0.872	0.872
5.5	0.862	0.862	0.862	0.862	0.862	0.861	0.861	0.861
6.0	0.856	0.856	0.856	0.855	0.855	0.855	0.855	0.854
6.5	0.854	0.853	0.853	0.853	0.853	0.853	0.852	0.852
7.0	0.852	0.851	0.851	0.851	0.851	0.851	0.851	0.850
7.5	0.850	0.850	0.850	0.850	0.849	0.849	0.849	0.849
8.0	0.848	0.848	0.848	0.848	0.848	0.847	0.847	0.847
8.5	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818
9.0	0.773	0.772	0.772	0.772	0.771	0.771	0.770	0.770
9.5	0.729	0.729	0.728	0.728	0.727	0.726	0.726	0.726
10.0	0.689	0.689	0.676	0.648	0.625	0.604	0.586	0.569
10.5	0.567	0.549	0.533	0.518	0.504	0.491	0.478	0.467
11.0	0.469	0.456	0.444	0.433	0.423	0.413	0.404	0.395
11.5	0.399	0.389	0.379	0.370	0.362	0.354	0.346	0.339
12.0	0.344	0.336	0.328	0.321	0.314	0.307	0.301	0.295
12.5	0.301	0.294	0.287	0.281	0.275	0.270	0.264	0.259
13.0	0.265	0.259	0.254	0.248	0.243	0.238	0.234	0.229
13.5	0.236	0.230	0.226	0.221	0.216	0.212	0.208	0.204
14.0	0.211	0.206	0.202	0.198	0.194	0.190	0.186	0.183
14.5	0.189	0.186	0.182	0.178	0.174	0.171	0.168	0.165
15.0	0.171	0.168	0.164	0.161	0.158	0.155	0.152	0.149
15.5	0.155	0.152	0.149	0.146	0.144	0.141	0.138	0.136
16.0	0.142	0.139	0.136	0.134	0.131	0.129	0.126	0.124
16.5	0.130	0.127	0.125	0.122	0.120	0.118	0.116	0.114
17.0	0.119	0.117	0.114	0.112	0.110	0.108	0.106	0.105
17.5	0.110	0.108	0.106	0.104	0.102	0.100	0.098	0.096
18.0	0.101	0.099	0.098	0.096	0.094	0.092	0.091	0.089
18.5	0.094	0.092	0.090	0.089	0.087	0.086	0.084	0.083
19.0	0.087	0.086	0.084	0.083	0.081	0.080	0.078	0.077
19.5	0.081	0.080	0.078	0.077	0.076	0.074	0.073	0.072
20.0	0.076	0.075	0.073	0.072	0.071	0.070	0.068	0.067
20.5*	0.070	0.069	0.068	0.067	0.066	0.065	0.063	0.062
21.0*	0.064	0.063	0.062	0.061	0.060	0.059	0.057	0.057
21.5*	0.057	0.056	0.055	0.054	0.053	0.053	0.051	0.050
22.0*	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044
22.5*	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.038
23.0*	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.034
23.5*	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.032
24.0*	0.034	0.034	0.033	0.033	0.032	0.032	0.031	0.030
24.5*	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.028
25.0*	0.030	0.030	0.029	0.028	0.028	0.028	0.027	0.026

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 6

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.895	0.896	0.896	0.897	0.898	0.899	0.900	0.900	0.901
4.0	0.888	0.888	0.889	0.890	0.890	0.890	0.891	0.891	0.891
4.5	0.881	0.881	0.881	0.882	0.882	0.882	0.882	0.882	0.882
5.0	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.5	0.866	0.866	0.865	0.865	0.865	0.864	0.864	0.864	0.864
6.0	0.860	0.860	0.860	0.859	0.859	0.859	0.858	0.858	0.858
6.5	0.857	0.857	0.857	0.856	0.856	0.856	0.856	0.856	0.855
7.0	0.855	0.855	0.854	0.854	0.854	0.854	0.854	0.854	0.853
7.5	0.822	0.822	0.823	0.823	0.824	0.824	0.824	0.825	0.825
8.0	0.763	0.764	0.765	0.766	0.767	0.768	0.769	0.771	0.772
8.5	0.708	0.709	0.711	0.713	0.714	0.716	0.718	0.720	0.722
9.0	0.658	0.659	0.662	0.664	0.666	0.668	0.670	0.673	0.676
9.5	0.612	0.613	0.617	0.618	0.621	0.623	0.626	0.628	0.631
10.0	0.570	0.572	0.575	0.577	0.579	0.582	0.584	0.587	0.590
10.5	0.532	0.533	0.537	0.539	0.541	0.544	0.547	0.540	0.521
11.0	0.496	0.498	0.502	0.504	0.492	0.475	0.460	0.446	0.433
11.5	0.465	0.461	0.442	0.427	0.414	0.401	0.390	0.379	0.369
12.0	0.404	0.390	0.378	0.366	0.355	0.346	0.336	0.328	0.319
12.5	0.349	0.338	0.328	0.318	0.310	0.301	0.294	0.286	0.279
13.0	0.305	0.296	0.288	0.280	0.272	0.265	0.259	0.252	0.247
13.5	0.270	0.262	0.255	0.248	0.242	0.236	0.230	0.224	0.219
14.0	0.240	0.234	0.227	0.221	0.216	0.210	0.205	0.201	0.196
14.5	0.215	0.210	0.204	0.199	0.194	0.189	0.185	0.180	0.176
15.0	0.194	0.189	0.184	0.179	0.175	0.171	0.167	0.163	0.160
15.5	0.176	0.171	0.167	0.163	0.159	0.155	0.151	0.148	0.145
16.0	0.160	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132
16.5	0.146	0.142	0.139	0.135	0.132	0.129	0.126	0.124	0.121
17.0	0.134	0.130	0.127	0.124	0.121	0.118	0.116	0.113	0.111
17.5	0.123	0.120	0.117	0.114	0.112	0.109	0.107	0.104	0.102
18.0	0.114	0.111	0.108	0.106	0.103	0.101	0.099	0.096	0.095
18.5	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.089	0.088
19.0	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082
19.5	0.091	0.088	0.086	0.084	0.082	0.081	0.079	0.077	0.076
20.0	0.084	0.082	0.080	0.079	0.077	0.075	0.074	0.072	0.071
20.5*	0.078	0.076	0.074	0.073	0.071	0.069	0.068	0.067	0.066
21.0*	0.071	0.069	0.068	0.067	0.065	0.063	0.062	0.061	0.060
21.5*	0.063	0.062	0.060	0.059	0.058	0.056	0.056	0.054	0.053
22.0*	0.055	0.054	0.052	0.052	0.051	0.049	0.049	0.047	0.047
22.5*	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040
23.0*	0.043	0.042	0.041	0.040	0.039	0.038	0.038	0.037	0.036
23.5*	0.040	0.040	0.039	0.038	0.037	0.036	0.036	0.035	0.034
24.0*	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.032
24.5*	0.036	0.035	0.034	0.033	0.033	0.032	0.031	0.031	0.030
25.0*	0.033	0.032	0.032	0.031	0.030	0.030	0.029	0.028	0.028

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 6

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.908	0.909	0.909	0.910	0.911	0.912	0.913	0.913
3.5	0.901	0.902	0.902	0.903	0.903	0.904	0.904	0.905
4.0	0.892	0.892	0.892	0.893	0.893	0.893	0.893	0.894
4.5	0.882	0.882	0.883	0.883	0.883	0.883	0.883	0.883
5.0	0.874	0.873	0.873	0.873	0.873	0.873	0.873	0.873
5.5	0.864	0.863	0.863	0.863	0.863	0.863	0.862	0.862
6.0	0.858	0.857	0.857	0.857	0.857	0.856	0.856	0.856
6.5	0.855	0.855	0.855	0.854	0.854	0.854	0.854	0.854
7.0	0.853	0.853	0.853	0.853	0.852	0.852	0.852	0.852
7.5	0.826	0.826	0.827	0.827	0.827	0.827	0.827	0.827
8.0	0.774	0.775	0.776	0.777	0.778	0.778	0.778	0.778
8.5	0.725	0.726	0.729	0.730	0.732	0.732	0.732	0.731
9.0	0.678	0.680	0.683	0.685	0.687	0.687	0.687	0.687
9.5	0.635	0.636	0.640	0.642	0.644	0.644	0.644	0.639
10.0	0.594	0.596	0.587	0.566	0.548	0.532	0.518	0.504
10.5	0.504	0.489	0.475	0.462	0.450	0.439	0.428	0.418
11.0	0.421	0.410	0.399	0.390	0.380	0.372	0.363	0.356
11.5	0.360	0.351	0.342	0.334	0.327	0.320	0.313	0.307
12.0	0.312	0.304	0.297	0.291	0.284	0.278	0.273	0.267
12.5	0.273	0.267	0.261	0.255	0.250	0.245	0.240	0.235
13.0	0.241	0.236	0.230	0.226	0.221	0.216	0.212	0.208
13.5	0.214	0.210	0.205	0.201	0.197	0.193	0.189	0.186
14.0	0.192	0.188	0.184	0.180	0.176	0.173	0.170	0.167
14.5	0.173	0.169	0.166	0.162	0.159	0.156	0.153	0.150
15.0	0.156	0.153	0.150	0.147	0.144	0.141	0.139	0.136
15.5	0.142	0.139	0.136	0.133	0.131	0.128	0.126	0.124
16.0	0.129	0.127	0.124	0.122	0.120	0.117	0.115	0.113
16.5	0.118	0.116	0.114	0.112	0.110	0.108	0.106	0.104
17.0	0.109	0.107	0.105	0.103	0.101	0.099	0.097	0.096
17.5	0.100	0.098	0.096	0.095	0.093	0.091	0.090	0.088
18.0	0.093	0.091	0.089	0.088	0.086	0.084	0.083	0.082
18.5	0.086	0.084	0.083	0.081	0.080	0.078	0.077	0.076
19.0	0.080	0.078	0.077	0.076	0.074	0.073	0.072	0.070
19.5	0.074	0.073	0.072	0.070	0.069	0.068	0.067	0.066
20.0	0.070	0.068	0.067	0.066	0.065	0.064	0.063	0.062
20.5*	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.057
21.0*	0.059	0.057	0.057	0.056	0.055	0.054	0.053	0.052
21.5*	0.053	0.051	0.050	0.050	0.049	0.048	0.047	0.047
22.0*	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.041
22.5*	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.035
23.0*	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.032
23.5*	0.034	0.033	0.032	0.032	0.031	0.031	0.030	0.030
24.0*	0.032	0.031	0.030	0.030	0.029	0.029	0.029	0.028
24.5*	0.030	0.029	0.028	0.028	0.028	0.027	0.027	0.026
25.0*	0.028	0.027	0.026	0.026	0.026	0.025	0.025	0.024

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 7

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.895	0.896	0.897	0.897	0.898	0.899	0.900	0.900	0.901
4.0	0.888	0.889	0.889	0.890	0.890	0.890	0.891	0.891	0.892
4.5	0.881	0.882	0.882	0.882	0.882	0.882	0.882	0.882	0.882
5.0	0.875	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.5	0.866	0.866	0.866	0.865	0.865	0.865	0.865	0.864	0.864
6.0	0.861	0.860	0.860	0.860	0.859	0.859	0.859	0.858	0.858
6.5	0.858	0.857	0.857	0.857	0.857	0.856	0.856	0.856	0.856
7.0	0.856	0.855	0.855	0.855	0.854	0.854	0.854	0.854	0.854
7.5	0.804	0.804	0.805	0.806	0.807	0.807	0.808	0.809	0.810
8.0	0.741	0.742	0.744	0.746	0.747	0.748	0.751	0.752	0.755
8.5	0.684	0.686	0.688	0.690	0.693	0.694	0.698	0.699	0.703
9.0	0.633	0.635	0.638	0.640	0.643	0.645	0.649	0.651	0.655
9.5	0.587	0.589	0.592	0.594	0.599	0.602	0.607	0.610	0.615
10.0	0.547	0.552	0.556	0.560	0.564	0.567	0.570	0.573	0.576
10.5	0.516	0.520	0.523	0.526	0.529	0.531	0.534	0.524	0.505
11.0	0.485	0.488	0.490	0.492	0.479	0.461	0.446	0.433	0.421
11.5	0.454	0.452	0.430	0.415	0.402	0.390	0.379	0.369	0.359
12.0	0.394	0.380	0.368	0.356	0.346	0.336	0.328	0.319	0.311
12.5	0.340	0.329	0.319	0.310	0.302	0.294	0.286	0.279	0.272
13.0	0.298	0.289	0.280	0.273	0.266	0.259	0.252	0.246	0.240
13.5	0.263	0.256	0.249	0.242	0.236	0.230	0.224	0.219	0.214
14.0	0.234	0.228	0.222	0.216	0.210	0.205	0.200	0.196	0.191
14.5	0.210	0.204	0.199	0.194	0.189	0.184	0.180	0.176	0.172
15.0	0.190	0.184	0.180	0.175	0.171	0.167	0.163	0.159	0.156
15.5	0.172	0.167	0.163	0.159	0.155	0.151	0.148	0.144	0.141
16.0	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132	0.129
16.5	0.143	0.139	0.135	0.132	0.129	0.126	0.123	0.121	0.118
17.0	0.131	0.127	0.124	0.121	0.118	0.116	0.113	0.111	0.108
17.5	0.120	0.117	0.114	0.112	0.109	0.107	0.104	0.102	0.100
18.0	0.111	0.108	0.106	0.103	0.101	0.098	0.096	0.094	0.092
18.5	0.103	0.100	0.098	0.095	0.093	0.091	0.089	0.087	0.086
19.0	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080
19.5	0.088	0.086	0.084	0.082	0.081	0.079	0.077	0.076	0.074
20.0	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069
20.5*	0.077	0.075	0.073	0.071	0.069	0.068	0.067	0.066	0.064
21.0*	0.070	0.068	0.067	0.065	0.063	0.062	0.061	0.060	0.058
21.5*	0.062	0.061	0.059	0.058	0.056	0.056	0.054	0.053	0.052
22.0*	0.054	0.053	0.052	0.051	0.049	0.049	0.047	0.047	0.045
22.5*	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039
23.0*	0.042	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.035
23.5*	0.040	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.033
24.0*	0.038	0.037	0.036	0.035	0.034	0.034	0.033	0.032	0.031
24.5*	0.035	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.029
25.0*	0.033	0.032	0.031	0.030	0.030	0.029	0.028	0.028	0.027

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 7

for hub heights 84 m, 114 m, 134 m and 164 m (mode not available for 120 m)								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.908	0.909	0.910	0.910	0.911	0.912	0.913	0.913
3.5	0.902	0.902	0.903	0.903	0.903	0.904	0.904	0.905
4.0	0.892	0.892	0.892	0.893	0.893	0.893	0.894	0.894
4.5	0.883	0.883	0.883	0.883	0.883	0.883	0.883	0.883
5.0	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.873
5.5	0.864	0.864	0.863	0.863	0.863	0.863	0.863	0.863
6.0	0.858	0.858	0.857	0.857	0.857	0.857	0.857	0.856
6.5	0.856	0.855	0.855	0.855	0.855	0.854	0.854	0.854
7.0	0.854	0.853	0.853	0.853	0.853	0.853	0.853	0.853
7.5	0.811	0.812	0.813	0.814	0.814	0.815	0.815	0.815
8.0	0.756	0.758	0.760	0.761	0.763	0.764	0.764	0.764
8.5	0.705	0.708	0.711	0.712	0.715	0.717	0.717	0.716
9.0	0.658	0.662	0.665	0.667	0.670	0.672	0.672	0.672
9.5	0.618	0.621	0.624	0.625	0.628	0.629	0.629	0.614
10.0	0.579	0.581	0.567	0.548	0.531	0.516	0.502	0.489
10.5	0.489	0.474	0.461	0.449	0.437	0.426	0.416	0.407
11.0	0.409	0.399	0.388	0.379	0.370	0.362	0.354	0.346
11.5	0.350	0.341	0.333	0.326	0.318	0.312	0.305	0.299
12.0	0.304	0.296	0.290	0.283	0.277	0.271	0.266	0.260
12.5	0.266	0.260	0.254	0.249	0.244	0.238	0.234	0.229
13.0	0.235	0.230	0.225	0.220	0.216	0.211	0.207	0.203
13.5	0.209	0.204	0.200	0.196	0.192	0.188	0.185	0.181
14.0	0.187	0.183	0.179	0.176	0.172	0.169	0.166	0.163
14.5	0.168	0.165	0.162	0.158	0.155	0.152	0.149	0.147
15.0	0.152	0.149	0.146	0.143	0.141	0.138	0.135	0.133
15.5	0.138	0.136	0.133	0.130	0.128	0.126	0.123	0.121
16.0	0.126	0.124	0.121	0.119	0.117	0.115	0.112	0.111
16.5	0.116	0.113	0.111	0.109	0.107	0.105	0.103	0.101
17.0	0.106	0.104	0.102	0.100	0.098	0.097	0.095	0.093
17.5	0.098	0.096	0.094	0.092	0.091	0.089	0.088	0.086
18.0	0.091	0.089	0.087	0.086	0.084	0.082	0.081	0.080
18.5	0.084	0.082	0.081	0.079	0.078	0.077	0.075	0.074
19.0	0.078	0.077	0.075	0.074	0.072	0.071	0.070	0.069
19.5	0.073	0.071	0.070	0.069	0.068	0.066	0.065	0.064
20.0	0.068	0.067	0.066	0.064	0.063	0.062	0.061	0.060
20.5*	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.056
21.0*	0.057	0.057	0.056	0.054	0.053	0.052	0.051	0.051
21.5*	0.051	0.050	0.050	0.048	0.047	0.047	0.046	0.045
22.0*	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039
22.5*	0.038	0.038	0.037	0.036	0.035	0.035	0.034	0.034
23.0*	0.035	0.034	0.034	0.033	0.032	0.032	0.031	0.031
23.5*	0.033	0.032	0.032	0.031	0.030	0.030	0.029	0.029
24.0*	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027
24.5*	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.025
25.0*	0.027	0.026	0.026	0.025	0.025	0.024	0.024	0.024

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 8

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m
(mode on request for 134 m)

wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.895	0.896	0.897	0.898	0.898	0.899	0.900	0.900	0.901
4.0	0.889	0.889	0.890	0.890	0.890	0.891	0.891	0.892	0.892
4.5	0.882	0.882	0.882	0.882	0.883	0.883	0.883	0.883	0.883
5.0	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.874	0.874
5.5	0.867	0.867	0.866	0.866	0.866	0.866	0.865	0.865	0.865
6.0	0.862	0.861	0.861	0.860	0.860	0.860	0.860	0.859	0.859
6.5	0.859	0.858	0.858	0.858	0.858	0.857	0.857	0.857	0.857
7.0	0.849	0.849	0.850	0.850	0.850	0.850	0.850	0.850	0.850
7.5	0.781	0.781	0.782	0.783	0.784	0.786	0.787	0.788	0.789
8.0	0.718	0.718	0.720	0.722	0.724	0.726	0.728	0.730	0.731
8.5	0.662	0.662	0.664	0.666	0.669	0.672	0.675	0.677	0.679
9.0	0.611	0.612	0.614	0.616	0.619	0.622	0.626	0.628	0.630
9.5	0.565	0.566	0.569	0.571	0.574	0.578	0.581	0.584	0.586
10.0	0.524	0.525	0.528	0.530	0.534	0.537	0.540	0.543	0.545
10.5	0.487	0.488	0.490	0.493	0.496	0.499	0.503	0.489	0.473
11.0	0.453	0.454	0.456	0.459	0.449	0.434	0.420	0.408	0.397
11.5	0.422	0.421	0.405	0.392	0.380	0.369	0.358	0.349	0.340
12.0	0.371	0.359	0.348	0.337	0.328	0.319	0.310	0.302	0.295
12.5	0.322	0.312	0.303	0.294	0.286	0.279	0.272	0.265	0.259
13.0	0.282	0.274	0.266	0.259	0.252	0.246	0.240	0.234	0.229
13.5	0.250	0.243	0.236	0.230	0.224	0.218	0.213	0.208	0.204
14.0	0.223	0.217	0.211	0.206	0.200	0.195	0.191	0.186	0.182
14.5	0.200	0.195	0.190	0.185	0.180	0.176	0.172	0.168	0.164
15.0	0.180	0.176	0.171	0.167	0.163	0.159	0.155	0.152	0.148
15.5	0.164	0.159	0.155	0.151	0.148	0.144	0.141	0.138	0.135
16.0	0.149	0.145	0.141	0.138	0.135	0.132	0.129	0.126	0.123
16.5	0.136	0.132	0.129	0.126	0.123	0.120	0.118	0.115	0.113
17.0	0.125	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.104
17.5	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096
18.0	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088
18.5	0.098	0.096	0.093	0.091	0.089	0.087	0.085	0.084	0.082
19.0	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076
19.5	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.072	0.071
20.0	0.079	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066
20.5*	0.073	0.071	0.069	0.068	0.067	0.065	0.064	0.063	0.061
21.0*	0.067	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056
21.5*	0.059	0.058	0.056	0.056	0.054	0.053	0.052	0.051	0.050
22.0*	0.052	0.051	0.049	0.049	0.047	0.046	0.045	0.045	0.043
22.5*	0.044	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037
23.0*	0.040	0.039	0.038	0.038	0.037	0.036	0.035	0.035	0.034
23.5*	0.038	0.037	0.036	0.036	0.035	0.034	0.033	0.033	0.032
24.0*	0.036	0.035	0.034	0.034	0.033	0.032	0.031	0.031	0.030
24.5*	0.033	0.033	0.032	0.031	0.031	0.030	0.029	0.029	0.028
25.0*	0.031	0.030	0.030	0.029	0.028	0.028	0.027	0.027	0.026

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 8

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.908	0.909	0.910	0.910	0.911	0.912	0.913	0.914
3.5	0.902	0.902	0.903	0.903	0.904	0.904	0.905	0.905
4.0	0.892	0.893	0.893	0.893	0.893	0.894	0.894	0.894
4.5	0.883	0.883	0.883	0.883	0.884	0.884	0.884	0.884
5.0	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
5.5	0.865	0.864	0.864	0.864	0.864	0.864	0.863	0.863
6.0	0.859	0.859	0.858	0.858	0.858	0.858	0.858	0.857
6.5	0.856	0.856	0.856	0.856	0.856	0.856	0.855	0.855
7.0	0.850	0.851	0.851	0.851	0.851	0.851	0.851	0.851
7.5	0.790	0.792	0.792	0.793	0.794	0.795	0.796	0.798
8.0	0.733	0.736	0.737	0.739	0.740	0.743	0.744	0.747
8.5	0.681	0.685	0.686	0.689	0.690	0.694	0.695	0.699
9.0	0.633	0.637	0.638	0.642	0.643	0.647	0.648	0.653
9.5	0.588	0.593	0.594	0.598	0.599	0.603	0.586	0.568
10.0	0.548	0.546	0.527	0.511	0.496	0.483	0.471	0.459
10.5	0.459	0.446	0.434	0.423	0.412	0.402	0.393	0.384
11.0	0.386	0.376	0.367	0.358	0.350	0.342	0.335	0.328
11.5	0.331	0.323	0.316	0.309	0.302	0.295	0.289	0.283
12.0	0.288	0.281	0.275	0.269	0.263	0.258	0.252	0.248
12.5	0.253	0.247	0.242	0.236	0.231	0.227	0.222	0.218
13.0	0.224	0.218	0.214	0.209	0.205	0.201	0.197	0.193
13.5	0.199	0.195	0.191	0.187	0.183	0.179	0.176	0.173
14.0	0.178	0.174	0.171	0.167	0.164	0.161	0.158	0.155
14.5	0.160	0.157	0.154	0.151	0.148	0.145	0.142	0.140
15.0	0.145	0.142	0.139	0.137	0.134	0.132	0.129	0.127
15.5	0.132	0.129	0.127	0.124	0.122	0.120	0.118	0.116
16.0	0.121	0.118	0.116	0.114	0.112	0.109	0.108	0.106
16.5	0.110	0.108	0.106	0.104	0.102	0.100	0.099	0.097
17.0	0.102	0.100	0.098	0.096	0.094	0.092	0.091	0.089
17.5	0.094	0.092	0.090	0.088	0.087	0.085	0.084	0.082
18.0	0.087	0.085	0.083	0.082	0.080	0.079	0.078	0.076
18.5	0.080	0.079	0.077	0.076	0.075	0.073	0.072	0.071
19.0	0.075	0.073	0.072	0.071	0.069	0.068	0.067	0.066
19.5	0.070	0.068	0.067	0.066	0.065	0.064	0.063	0.062
20.0	0.065	0.064	0.063	0.062	0.061	0.060	0.059	0.058
20.5*	0.060	0.059	0.058	0.057	0.056	0.056	0.055	0.054
21.0*	0.055	0.054	0.053	0.052	0.051	0.051	0.050	0.049
21.5*	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.044
22.0*	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038
22.5*	0.036	0.036	0.035	0.035	0.034	0.034	0.033	0.032
23.0*	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030
23.5*	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028
24.0*	0.029	0.029	0.029	0.028	0.028	0.027	0.027	0.026
24.5*	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025
25.0*	0.026	0.025	0.025	0.024	0.024	0.024	0.023	0.023

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 9

wind speed v_H [m/s]	for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m) Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.895	0.896	0.897	0.898	0.898	0.899	0.900	0.901	0.901
4.0	0.889	0.889	0.890	0.890	0.891	0.891	0.891	0.892	0.892
4.5	0.882	0.882	0.882	0.882	0.883	0.883	0.883	0.883	0.883
5.0	0.876	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
5.5	0.867	0.867	0.867	0.866	0.866	0.866	0.866	0.865	0.865
6.0	0.862	0.862	0.861	0.861	0.861	0.860	0.860	0.860	0.860
6.5	0.859	0.859	0.858	0.858	0.858	0.858	0.858	0.857	0.857
7.0	0.825	0.826	0.826	0.827	0.827	0.827	0.828	0.828	0.829
7.5	0.756	0.756	0.758	0.759	0.760	0.761	0.763	0.764	0.764
8.0	0.692	0.694	0.696	0.698	0.700	0.701	0.703	0.704	0.706
8.5	0.636	0.638	0.641	0.643	0.645	0.646	0.649	0.650	0.652
9.0	0.586	0.588	0.591	0.593	0.596	0.597	0.600	0.602	0.604
9.5	0.541	0.543	0.546	0.549	0.552	0.553	0.556	0.558	0.560
10.0	0.501	0.503	0.506	0.509	0.511	0.513	0.516	0.518	0.520
10.5	0.465	0.467	0.470	0.472	0.475	0.476	0.481	0.477	0.461
11.0	0.432	0.434	0.437	0.441	0.439	0.423	0.410	0.398	0.387
11.5	0.403	0.407	0.396	0.382	0.371	0.360	0.350	0.340	0.332
12.0	0.363	0.350	0.339	0.329	0.320	0.311	0.303	0.295	0.288
12.5	0.314	0.305	0.296	0.287	0.280	0.272	0.265	0.259	0.253
13.0	0.276	0.268	0.260	0.253	0.246	0.240	0.234	0.229	0.224
13.5	0.244	0.237	0.231	0.225	0.219	0.214	0.208	0.204	0.199
14.0	0.218	0.212	0.206	0.201	0.196	0.191	0.187	0.182	0.178
14.5	0.196	0.190	0.185	0.181	0.176	0.172	0.168	0.164	0.160
15.0	0.176	0.172	0.167	0.163	0.159	0.155	0.152	0.148	0.145
15.5	0.160	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132
16.0	0.146	0.142	0.138	0.135	0.132	0.129	0.126	0.123	0.120
16.5	0.133	0.130	0.126	0.123	0.120	0.118	0.115	0.113	0.110
17.0	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.101
17.5	0.112	0.110	0.107	0.104	0.102	0.100	0.098	0.096	0.094
18.0	0.104	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086
18.5	0.096	0.094	0.091	0.089	0.087	0.085	0.084	0.082	0.080
19.0	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075
19.5	0.083	0.081	0.079	0.077	0.076	0.074	0.072	0.071	0.070
20.0	0.077	0.076	0.074	0.072	0.070	0.069	0.068	0.066	0.065
20.5*	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060
21.0*	0.065	0.064	0.062	0.061	0.059	0.058	0.057	0.056	0.055
21.5*	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049
22.0*	0.051	0.050	0.049	0.047	0.046	0.045	0.045	0.043	0.043
22.5*	0.043	0.043	0.041	0.040	0.039	0.039	0.038	0.037	0.036
23.0*	0.039	0.039	0.038	0.037	0.036	0.035	0.035	0.034	0.033
23.5*	0.037	0.037	0.036	0.035	0.034	0.033	0.033	0.032	0.031
24.0*	0.035	0.034	0.034	0.033	0.032	0.031	0.031	0.030	0.029
24.5*	0.033	0.032	0.031	0.031	0.030	0.029	0.029	0.028	0.028
25.0*	0.030	0.030	0.029	0.028	0.028	0.027	0.027	0.026	0.026

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 9

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.908	0.908	0.910	0.911	0.911	0.912	0.913	0.914
3.5	0.902	0.902	0.903	0.903	0.904	0.904	0.905	0.905
4.0	0.892	0.893	0.893	0.893	0.894	0.894	0.894	0.894
4.5	0.883	0.883	0.884	0.884	0.884	0.884	0.884	0.884
5.0	0.875	0.875	0.874	0.874	0.874	0.875	0.874	0.875
5.5	0.865	0.865	0.864	0.864	0.864	0.864	0.864	0.864
6.0	0.859	0.859	0.859	0.858	0.858	0.858	0.858	0.858
6.5	0.857	0.857	0.856	0.856	0.856	0.856	0.856	0.856
7.0	0.829	0.829	0.830	0.831	0.832	0.832	0.832	0.833
7.5	0.766	0.767	0.769	0.771	0.774	0.774	0.776	0.777
8.0	0.707	0.709	0.712	0.716	0.720	0.721	0.723	0.725
8.5	0.654	0.656	0.660	0.664	0.669	0.670	0.674	0.675
9.0	0.606	0.608	0.612	0.617	0.622	0.623	0.627	0.629
9.5	0.562	0.564	0.569	0.573	0.579	0.581	0.569	0.551
10.0	0.522	0.526	0.513	0.497	0.483	0.470	0.458	0.447
10.5	0.447	0.434	0.423	0.412	0.402	0.392	0.383	0.375
11.0	0.377	0.367	0.358	0.350	0.342	0.334	0.327	0.320
11.5	0.324	0.316	0.308	0.301	0.295	0.288	0.282	0.277
12.0	0.281	0.275	0.269	0.263	0.257	0.252	0.247	0.242
12.5	0.247	0.241	0.236	0.231	0.226	0.222	0.217	0.213
13.0	0.218	0.214	0.209	0.205	0.200	0.196	0.193	0.189
13.5	0.194	0.190	0.186	0.182	0.179	0.175	0.172	0.169
14.0	0.174	0.171	0.167	0.164	0.160	0.157	0.154	0.152
14.5	0.157	0.154	0.151	0.148	0.145	0.142	0.139	0.137
15.0	0.142	0.139	0.136	0.134	0.131	0.129	0.126	0.124
15.5	0.129	0.127	0.124	0.122	0.119	0.117	0.115	0.113
16.0	0.118	0.116	0.113	0.111	0.109	0.107	0.105	0.103
16.5	0.108	0.106	0.104	0.102	0.100	0.098	0.096	0.095
17.0	0.099	0.097	0.096	0.094	0.092	0.090	0.089	0.087
17.5	0.092	0.090	0.088	0.086	0.085	0.084	0.082	0.081
18.0	0.085	0.083	0.082	0.080	0.079	0.077	0.076	0.075
18.5	0.079	0.077	0.076	0.074	0.073	0.072	0.071	0.069
19.0	0.073	0.072	0.070	0.069	0.068	0.067	0.066	0.065
19.5	0.068	0.067	0.066	0.064	0.063	0.062	0.061	0.060
20.0	0.064	0.062	0.061	0.060	0.059	0.058	0.057	0.056
20.5*	0.059	0.057	0.056	0.056	0.055	0.054	0.053	0.052
21.0*	0.054	0.052	0.051	0.051	0.050	0.049	0.048	0.047
21.5*	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042
22.0*	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037
22.5*	0.036	0.035	0.034	0.034	0.033	0.032	0.032	0.031
23.0*	0.033	0.032	0.031	0.031	0.030	0.030	0.029	0.029
23.5*	0.031	0.030	0.029	0.029	0.028	0.028	0.027	0.027
24.0*	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.025
24.5*	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024
25.0*	0.025	0.024	0.024	0.024	0.023	0.023	0.023	0.022

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 10

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.895	0.896	0.897	0.898	0.899	0.899	0.900	0.901	0.901
4.0	0.889	0.890	0.890	0.890	0.891	0.891	0.892	0.892	0.892
4.5	0.882	0.882	0.882	0.883	0.883	0.883	0.883	0.883	0.884
5.0	0.876	0.876	0.876	0.875	0.875	0.875	0.875	0.875	0.875
5.5	0.868	0.867	0.867	0.867	0.866	0.866	0.866	0.866	0.866
6.0	0.862	0.862	0.862	0.861	0.861	0.861	0.860	0.860	0.860
6.5	0.860	0.859	0.859	0.859	0.858	0.858	0.858	0.858	0.858
7.0	0.800	0.801	0.802	0.803	0.803	0.804	0.804	0.805	0.805
7.5	0.731	0.733	0.734	0.735	0.736	0.737	0.738	0.739	0.740
8.0	0.669	0.671	0.673	0.674	0.675	0.676	0.678	0.680	0.681
8.5	0.613	0.616	0.618	0.619	0.621	0.622	0.625	0.626	0.628
9.0	0.564	0.567	0.570	0.571	0.573	0.574	0.576	0.578	0.581
9.5	0.520	0.523	0.526	0.529	0.533	0.536	0.540	0.543	0.546
10.0	0.485	0.490	0.495	0.498	0.501	0.503	0.506	0.508	0.510
10.5	0.457	0.461	0.464	0.466	0.468	0.470	0.472	0.467	0.449
11.0	0.429	0.431	0.434	0.435	0.433	0.413	0.400	0.388	0.377
11.5	0.402	0.404	0.389	0.374	0.362	0.351	0.341	0.332	0.324
12.0	0.357	0.343	0.332	0.322	0.312	0.304	0.296	0.288	0.281
12.5	0.307	0.298	0.289	0.281	0.273	0.266	0.259	0.253	0.247
13.0	0.270	0.262	0.254	0.247	0.241	0.235	0.229	0.224	0.218
13.5	0.239	0.232	0.226	0.220	0.214	0.209	0.204	0.199	0.194
14.0	0.213	0.207	0.202	0.196	0.191	0.187	0.182	0.178	0.174
14.5	0.191	0.186	0.181	0.176	0.172	0.168	0.164	0.160	0.157
15.0	0.173	0.168	0.164	0.160	0.156	0.152	0.148	0.145	0.142
15.5	0.156	0.152	0.148	0.145	0.141	0.138	0.135	0.132	0.129
16.0	0.142	0.139	0.135	0.132	0.129	0.126	0.123	0.120	0.118
16.5	0.130	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108
17.0	0.119	0.116	0.114	0.111	0.108	0.106	0.104	0.101	0.099
17.5	0.110	0.107	0.104	0.102	0.100	0.098	0.095	0.093	0.092
18.0	0.102	0.099	0.097	0.094	0.092	0.090	0.088	0.086	0.085
18.5	0.094	0.092	0.089	0.087	0.085	0.084	0.082	0.080	0.078
19.0	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073
19.5	0.081	0.079	0.077	0.076	0.074	0.072	0.071	0.069	0.068
20.0	0.076	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064
20.5*	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059
21.0*	0.064	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054
21.5*	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048
22.0*	0.050	0.049	0.047	0.046	0.045	0.045	0.043	0.043	0.042
22.5*	0.043	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036
23.0*	0.039	0.038	0.037	0.036	0.035	0.035	0.034	0.033	0.033
23.5*	0.037	0.036	0.035	0.034	0.033	0.033	0.032	0.031	0.031
24.0*	0.034	0.034	0.033	0.032	0.031	0.031	0.030	0.029	0.029
24.5*	0.032	0.031	0.031	0.030	0.029	0.029	0.028	0.028	0.027
25.0*	0.030	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.025

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 10

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m
(mode on request for 134 m)

wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m³]**							
	1.125	**1.150**	**1.175**	**1.200**	**1.225**	**1.250**	**1.275**	**1.300**
3.0	0.908	0.909	0.910	0.911	0.911	0.912	0.913	0.914
3.5	0.902	0.902	0.903	0.904	0.904	0.904	0.905	0.905
4.0	0.893	0.893	0.893	0.894	0.894	0.894	0.894	0.894
4.5	0.884	0.884	0.884	0.884	0.884	0.884	0.884	0.884
5.0	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
5.5	0.865	0.865	0.865	0.865	0.864	0.864	0.864	0.864
6.0	0.860	0.859	0.859	0.859	0.859	0.859	0.858	0.858
6.5	0.857	0.857	0.857	0.857	0.857	0.856	0.856	0.856
7.0	0.806	0.807	0.808	0.809	0.810	0.811	0.811	0.812
7.5	0.741	0.743	0.745	0.747	0.750	0.751	0.752	0.754
8.0	0.682	0.685	0.688	0.690	0.694	0.696	0.697	0.700
8.5	0.629	0.632	0.636	0.638	0.643	0.646	0.648	0.651
9.0	0.584	0.589	0.594	0.597	0.601	0.604	0.606	0.608
9.5	0.548	0.552	0.556	0.558	0.561	0.564	0.552	0.535
10.0	0.512	0.515	0.499	0.484	0.470	0.458	0.446	0.435
10.5	0.436	0.423	0.412	0.401	0.392	0.382	0.374	0.365
11.0	0.367	0.358	0.349	0.341	0.333	0.326	0.319	0.312
11.5	0.316	0.308	0.301	0.294	0.288	0.282	0.276	0.270
12.0	0.275	0.268	0.262	0.256	0.251	0.246	0.241	0.236
12.5	0.241	0.236	0.231	0.226	0.221	0.216	0.212	0.208
13.0	0.213	0.209	0.204	0.200	0.196	0.192	0.188	0.185
13.5	0.190	0.186	0.182	0.178	0.175	0.171	0.168	0.165
14.0	0.170	0.167	0.163	0.160	0.157	0.154	0.151	0.148
14.5	0.154	0.150	0.147	0.144	0.142	0.139	0.136	0.134
15.0	0.139	0.136	0.133	0.131	0.128	0.126	0.124	0.121
15.5	0.126	0.124	0.121	0.119	0.117	0.115	0.113	0.111
16.0	0.115	0.113	0.111	0.109	0.107	0.105	0.103	0.101
16.5	0.106	0.104	0.102	0.100	0.098	0.096	0.094	0.093
17.0	0.097	0.095	0.094	0.092	0.090	0.088	0.087	0.085
17.5	0.090	0.088	0.086	0.085	0.083	0.082	0.080	0.079
18.0	0.083	0.081	0.080	0.078	0.077	0.076	0.074	0.073
18.5	0.077	0.076	0.074	0.073	0.072	0.070	0.069	0.068
19.0	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.063
19.5	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059
20.0	0.062	0.061	0.060	0.059	0.058	0.057	0.056	0.055
20.5*	0.057	0.056	0.056	0.055	0.054	0.053	0.052	0.051
21.0*	0.052	0.051	0.051	0.050	0.049	0.048	0.047	0.046
21.5*	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041
22.0*	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036
22.5*	0.035	0.034	0.034	0.033	0.032	0.032	0.031	0.031
23.0*	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028
23.5*	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.027
24.0*	0.028	0.028	0.027	0.027	0.026	0.026	0.025	0.025
24.5*	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.023
25.0*	0.024	0.024	0.024	0.023	0.023	0.023	0.022	0.022

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 11

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.895	0.896	0.897	0.898	0.899	0.899	0.900	0.901	0.901
4.0	0.889	0.890	0.890	0.891	0.891	0.891	0.892	0.892	0.892
4.5	0.883	0.883	0.883	0.883	0.883	0.883	0.884	0.884	0.884
5.0	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.5	0.868	0.868	0.867	0.867	0.867	0.867	0.866	0.866	0.866
6.0	0.863	0.862	0.862	0.862	0.862	0.861	0.861	0.861	0.860
6.5	0.852	0.852	0.853	0.853	0.853	0.853	0.853	0.853	0.854
7.0	0.775	0.776	0.776	0.778	0.779	0.779	0.780	0.781	0.782
7.5	0.706	0.707	0.707	0.710	0.712	0.712	0.714	0.715	0.716
8.0	0.645	0.646	0.646	0.649	0.652	0.653	0.655	0.656	0.657
8.5	0.590	0.592	0.592	0.596	0.599	0.600	0.602	0.603	0.604
9.0	0.543	0.544	0.544	0.548	0.551	0.552	0.555	0.556	0.557
9.5	0.500	0.501	0.501	0.506	0.509	0.510	0.512	0.513	0.515
10.0	0.462	0.463	0.463	0.468	0.471	0.472	0.474	0.475	0.476
10.5	0.428	0.429	0.429	0.433	0.436	0.436	0.439	0.440	0.436
11.0	0.397	0.398	0.398	0.402	0.404	0.402	0.388	0.377	0.366
11.5	0.369	0.370	0.370	0.364	0.352	0.341	0.332	0.323	0.314
12.0	0.344	0.334	0.322	0.313	0.304	0.295	0.288	0.280	0.273
12.5	0.299	0.290	0.281	0.273	0.266	0.259	0.252	0.246	0.240
13.0	0.262	0.255	0.247	0.241	0.234	0.228	0.223	0.218	0.212
13.5	0.232	0.226	0.220	0.214	0.208	0.203	0.198	0.194	0.189
14.0	0.208	0.202	0.196	0.191	0.186	0.182	0.178	0.174	0.170
14.5	0.186	0.181	0.176	0.172	0.168	0.164	0.160	0.156	0.153
15.0	0.168	0.164	0.159	0.155	0.152	0.148	0.145	0.141	0.138
15.5	0.152	0.148	0.145	0.141	0.138	0.134	0.131	0.128	0.126
16.0	0.139	0.135	0.132	0.129	0.126	0.123	0.120	0.117	0.115
16.5	0.127	0.124	0.121	0.118	0.115	0.112	0.110	0.107	0.105
17.0	0.116	0.114	0.111	0.108	0.106	0.103	0.101	0.099	0.097
17.5	0.107	0.104	0.102	0.100	0.097	0.095	0.093	0.091	0.089
18.0	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082
18.5	0.092	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.076
19.0	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071
19.5	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.066
20.0	0.074	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062
20.5*	0.068	0.067	0.065	0.064	0.062	0.061	0.059	0.058	0.057
21.0*	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052
21.5*	0.056	0.054	0.053	0.052	0.050	0.050	0.048	0.047	0.047
22.0*	0.049	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041
22.5*	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.035	0.035
23.0*	0.038	0.037	0.036	0.035	0.034	0.034	0.033	0.032	0.032
23.5*	0.036	0.035	0.034	0.033	0.032	0.032	0.031	0.030	0.030
24.0*	0.034	0.033	0.032	0.031	0.030	0.030	0.029	0.029	0.028
24.5*	0.031	0.031	0.030	0.029	0.028	0.028	0.027	0.027	0.026
25.0*	0.029	0.028	0.028	0.027	0.026	0.026	0.025	0.025	0.024

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 11

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.908	0.909	0.910	0.910	0.911	0.912	0.913	0.913
3.5	0.902	0.903	0.903	0.904	0.904	0.905	0.905	0.906
4.0	0.893	0.893	0.894	0.894	0.894	0.894	0.894	0.895
4.5	0.884	0.884	0.884	0.884	0.884	0.884	0.884	0.885
5.0	0.875	0.875	0.875	0.875	0.875	0.875	0.875	0.875
5.5	0.866	0.866	0.865	0.865	0.865	0.865	0.865	0.864
6.0	0.860	0.860	0.860	0.860	0.859	0.859	0.859	0.859
6.5	0.854	0.854	0.854	0.854	0.854	0.854	0.854	0.854
7.0	0.782	0.783	0.785	0.786	0.787	0.788	0.789	0.790
7.5	0.717	0.719	0.721	0.723	0.725	0.727	0.728	0.730
8.0	0.658	0.661	0.664	0.666	0.669	0.672	0.672	0.675
8.5	0.606	0.609	0.612	0.614	0.618	0.621	0.621	0.624
9.0	0.559	0.562	0.565	0.568	0.572	0.574	0.575	0.578
9.5	0.516	0.520	0.523	0.525	0.529	0.531	0.532	0.516
10.0	0.478	0.481	0.484	0.468	0.455	0.443	0.432	0.422
10.5	0.422	0.410	0.399	0.389	0.380	0.371	0.362	0.354
11.0	0.357	0.348	0.339	0.331	0.324	0.316	0.310	0.303
11.5	0.307	0.299	0.292	0.286	0.280	0.274	0.268	0.263
12.0	0.267	0.261	0.255	0.249	0.244	0.239	0.234	0.230
12.5	0.234	0.229	0.224	0.220	0.215	0.211	0.206	0.202
13.0	0.208	0.203	0.199	0.195	0.191	0.187	0.183	0.180
13.5	0.185	0.181	0.177	0.174	0.170	0.167	0.164	0.161
14.0	0.166	0.162	0.159	0.156	0.153	0.150	0.147	0.144
14.5	0.150	0.146	0.143	0.141	0.138	0.135	0.133	0.130
15.0	0.135	0.133	0.130	0.127	0.125	0.123	0.120	0.118
15.5	0.123	0.121	0.118	0.116	0.114	0.112	0.110	0.108
16.0	0.112	0.110	0.108	0.106	0.104	0.102	0.100	0.099
16.5	0.103	0.101	0.099	0.097	0.095	0.094	0.092	0.090
17.0	0.095	0.093	0.091	0.089	0.088	0.086	0.085	0.083
17.5	0.087	0.086	0.084	0.083	0.081	0.080	0.078	0.077
18.0	0.081	0.079	0.078	0.076	0.075	0.074	0.072	0.071
18.5	0.075	0.074	0.072	0.071	0.070	0.068	0.067	0.066
19.0	0.070	0.068	0.067	0.066	0.065	0.064	0.063	0.062
19.5	0.065	0.064	0.063	0.062	0.061	0.060	0.059	0.058
20.0	0.061	0.060	0.059	0.058	0.057	0.056	0.055	0.054
20.5*	0.056	0.056	0.055	0.054	0.053	0.052	0.051	0.050
21.0*	0.051	0.051	0.050	0.049	0.048	0.047	0.046	0.046
21.5*	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.041
22.0*	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035
22.5*	0.034	0.034	0.033	0.032	0.032	0.031	0.031	0.030
23.0*	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028
23.5*	0.029	0.029	0.028	0.028	0.027	0.027	0.027	0.026
24.0*	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.024
24.5*	0.026	0.025	0.025	0.025	0.024	0.024	0.023	0.023
25.0*	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.021

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 12

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m (mode on request for 134 m)									
wind speed v_H [m/s]	**Thrust coefficients c_T at air density ρ [kg/m^3]**								
	0.900	**0.925**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.895	0.896	0.897	0.898	0.899	0.900	0.900	0.901	0.902
4.0	0.889	0.890	0.890	0.891	0.891	0.892	0.892	0.892	0.893
4.5	0.883	0.883	0.883	0.883	0.884	0.884	0.884	0.884	0.884
5.0	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.5	0.869	0.868	0.868	0.868	0.867	0.867	0.867	0.866	0.866
6.0	0.863	0.863	0.863	0.862	0.862	0.862	0.861	0.861	0.861
6.5	0.826	0.826	0.826	0.827	0.827	0.827	0.828	0.828	0.828
7.0	0.749	0.750	0.751	0.752	0.752	0.753	0.753	0.754	0.755
7.5	0.681	0.681	0.683	0.684	0.685	0.686	0.686	0.688	0.689
8.0	0.620	0.621	0.623	0.624	0.626	0.626	0.627	0.629	0.631
8.5	0.567	0.568	0.570	0.572	0.573	0.574	0.575	0.577	0.579
9.0	0.521	0.522	0.524	0.525	0.527	0.528	0.528	0.530	0.533
9.5	0.479	0.480	0.482	0.484	0.486	0.486	0.487	0.489	0.491
10.0	0.442	0.443	0.446	0.447	0.448	0.449	0.450	0.452	0.454
10.5	0.409	0.410	0.412	0.413	0.415	0.415	0.416	0.418	0.422
11.0	0.379	0.380	0.382	0.383	0.385	0.387	0.380	0.368	0.357
11.5	0.352	0.353	0.357	0.358	0.344	0.333	0.324	0.315	0.307
12.0	0.330	0.328	0.316	0.305	0.296	0.288	0.281	0.274	0.267
12.5	0.293	0.283	0.274	0.266	0.259	0.252	0.246	0.240	0.234
13.0	0.256	0.249	0.242	0.235	0.229	0.223	0.218	0.212	0.207
13.5	0.227	0.221	0.214	0.209	0.204	0.198	0.194	0.189	0.185
14.0	0.203	0.197	0.192	0.187	0.182	0.178	0.173	0.169	0.166
14.5	0.182	0.177	0.172	0.168	0.164	0.160	0.156	0.153	0.149
15.0	0.164	0.160	0.156	0.152	0.148	0.145	0.141	0.138	0.135
15.5	0.149	0.145	0.141	0.138	0.134	0.131	0.128	0.126	0.123
16.0	0.136	0.132	0.129	0.126	0.123	0.120	0.117	0.115	0.112
16.5	0.124	0.121	0.118	0.115	0.112	0.110	0.107	0.105	0.103
17.0	0.114	0.111	0.108	0.106	0.103	0.101	0.099	0.097	0.095
17.5	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087
18.0	0.097	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.081
18.5	0.090	0.087	0.085	0.083	0.082	0.080	0.078	0.076	0.075
19.0	0.083	0.081	0.079	0.077	0.076	0.074	0.072	0.071	0.070
19.5	0.077	0.076	0.074	0.072	0.070	0.069	0.068	0.066	0.065
20.0	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061
20.5*	0.067	0.065	0.064	0.062	0.061	0.059	0.058	0.057	0.056
21.0*	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051
21.5*	0.054	0.053	0.052	0.050	0.050	0.048	0.047	0.047	0.046
22.0*	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 12

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m
(mode on request for 134 m)

wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.908	0.909	0.910	0.911	0.911	0.912	0.913	0.913
3.5	0.902	0.903	0.903	0.904	0.904	0.905	0.905	0.906
4.0	0.893	0.893	0.894	0.894	0.894	0.894	0.895	0.895
4.5	0.884	0.884	0.884	0.884	0.885	0.885	0.885	0.885
5.0	0.876	0.876	0.876	0.876	0.876	0.876	0.875	0.875
5.5	0.866	0.866	0.866	0.866	0.865	0.865	0.865	0.865
6.0	0.861	0.860	0.860	0.860	0.860	0.860	0.859	0.859
6.5	0.829	0.829	0.830	0.830	0.831	0.831	0.831	0.831
7.0	0.757	0.758	0.759	0.760	0.762	0.762	0.763	0.764
7.5	0.691	0.694	0.695	0.697	0.698	0.700	0.700	0.702
8.0	0.633	0.636	0.637	0.640	0.642	0.644	0.644	0.647
8.5	0.582	0.584	0.586	0.589	0.591	0.593	0.594	0.596
9.0	0.535	0.538	0.540	0.543	0.545	0.547	0.548	0.550
9.5	0.494	0.497	0.498	0.501	0.503	0.506	0.507	0.502
10.0	0.456	0.459	0.462	0.456	0.443	0.431	0.420	0.410
10.5	0.412	0.400	0.389	0.379	0.370	0.361	0.353	0.345
11.0	0.348	0.339	0.331	0.323	0.316	0.308	0.302	0.296
11.5	0.299	0.292	0.285	0.279	0.273	0.267	0.262	0.256
12.0	0.260	0.254	0.249	0.243	0.238	0.233	0.229	0.224
12.5	0.229	0.224	0.219	0.214	0.210	0.206	0.202	0.198
13.0	0.203	0.198	0.194	0.190	0.186	0.182	0.179	0.176
13.5	0.181	0.177	0.173	0.170	0.166	0.163	0.160	0.157
14.0	0.162	0.159	0.155	0.152	0.149	0.146	0.144	0.141
14.5	0.146	0.143	0.140	0.137	0.135	0.132	0.130	0.127
15.0	0.132	0.130	0.127	0.124	0.122	0.120	0.118	0.116
15.5	0.120	0.118	0.116	0.113	0.111	0.109	0.107	0.105
16.0	0.110	0.108	0.106	0.104	0.102	0.100	0.098	0.096
16.5	0.101	0.099	0.097	0.095	0.093	0.092	0.090	0.088
17.0	0.093	0.091	0.089	0.087	0.086	0.084	0.083	0.082
17.5	0.086	0.084	0.082	0.081	0.079	0.078	0.076	0.075
18.0	0.079	0.078	0.076	0.075	0.073	0.072	0.071	0.070
18.5	0.073	0.072	0.071	0.069	0.068	0.067	0.066	0.065
19.0	0.068	0.067	0.066	0.065	0.064	0.062	0.061	0.060
19.5	0.064	0.062	0.061	0.060	0.059	0.058	0.057	0.056
20.0	0.060	0.058	0.057	0.056	0.055	0.054	0.054	0.053
20.5*	0.056	0.054	0.053	0.052	0.051	0.050	0.050	0.049
21.0*	0.051	0.049	0.048	0.047	0.046	0.046	0.046	0.045
21.5*	0.045	0.044	0.043	0.042	0.041	0.041	0.041	0.040
22.0*	0.039	0.038	0.037	0.037	0.036	0.035	0.035	0.035

* These values are based on a yield and load optimized operation that is not feasible at all sites.

Nordex N131/3900 IEC S – Thrust curves – Mode 13

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m									
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]								
	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100
3.0	0.902	0.902	0.902	0.902	0.903	0.904	0.905	0.906	0.907
3.5	0.896	0.896	0.897	0.898	0.899	0.900	0.900	0.901	0.902
4.0	0.890	0.890	0.891	0.891	0.891	0.892	0.892	0.893	0.893
4.5	0.883	0.883	0.884	0.884	0.884	0.884	0.884	0.884	0.884
5.0	0.877	0.877	0.877	0.876	0.876	0.876	0.876	0.876	0.876
5.5	0.869	0.868	0.868	0.868	0.868	0.867	0.867	0.867	0.867
6.0	0.864	0.863	0.863	0.863	0.862	0.862	0.862	0.862	0.861
6.5	0.798	0.799	0.800	0.800	0.800	0.801	0.801	0.802	0.802
7.0	0.722	0.723	0.725	0.725	0.725	0.726	0.727	0.728	0.729
7.5	0.654	0.656	0.658	0.658	0.658	0.660	0.661	0.662	0.664
8.0	0.595	0.597	0.600	0.600	0.600	0.601	0.603	0.605	0.606
8.5	0.544	0.546	0.548	0.549	0.549	0.550	0.552	0.554	0.556
9.0	0.498	0.500	0.503	0.503	0.503	0.505	0.506	0.508	0.512
9.5	0.458	0.460	0.463	0.463	0.466	0.470	0.473	0.477	0.480
10.0	0.424	0.428	0.433	0.435	0.437	0.440	0.442	0.445	0.447
10.5	0.399	0.402	0.406	0.407	0.409	0.411	0.413	0.414	0.416
11.0	0.374	0.377	0.380	0.381	0.382	0.383	0.374	0.359	0.348
11.5	0.351	0.353	0.355	0.356	0.338	0.326	0.316	0.307	0.299
12.0	0.330	0.327	0.310	0.299	0.290	0.281	0.274	0.267	0.260
12.5	0.288	0.277	0.268	0.260	0.253	0.246	0.240	0.234	0.229
13.0	0.251	0.243	0.236	0.229	0.223	0.218	0.212	0.207	0.202
13.5	0.222	0.216	0.210	0.204	0.199	0.194	0.189	0.185	0.180
14.0	0.198	0.192	0.187	0.182	0.178	0.173	0.169	0.165	0.162
14.5	0.178	0.173	0.168	0.164	0.160	0.156	0.152	0.149	0.146
15.0	0.160	0.156	0.152	0.148	0.145	0.141	0.138	0.135	0.132
15.5	0.146	0.142	0.138	0.135	0.131	0.128	0.126	0.123	0.120
16.0	0.133	0.129	0.126	0.123	0.120	0.117	0.114	0.112	0.110
16.5	0.121	0.118	0.115	0.112	0.110	0.107	0.105	0.103	0.100
17.0	0.111	0.108	0.106	0.103	0.101	0.099	0.096	0.094	0.092
17.5	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.085
18.0	0.095	0.092	0.090	0.088	0.086	0.084	0.082	0.080	0.079
18.5	0.088	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073
19.0	0.081	0.079	0.078	0.076	0.074	0.072	0.071	0.069	0.068
19.5	0.076	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064
20.0	0.071	0.069	0.067	0.066	0.064	0.063	0.062	0.060	0.059

Nordex N131/3900 IEC S – Thrust curves – Mode 13

for hub heights 84 m, 114 m, 120 m, 134 m and 164 m								
wind speed v_H [m/s]	Thrust coefficients c_T at air density ρ [kg/m^3]							
	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	0.908	0.909	0.910	0.911	0.911	0.912	0.913	0.914
3.5	0.902	0.903	0.903	0.904	0.904	0.905	0.905	0.906
4.0	0.893	0.894	0.894	0.894	0.894	0.895	0.895	0.895
4.5	0.884	0.885	0.885	0.885	0.885	0.885	0.885	0.885
5.0	0.876	0.876	0.876	0.876	0.876	0.876	0.876	0.876
5.5	0.866	0.866	0.866	0.866	0.866	0.866	0.865	0.865
6.0	0.861	0.861	0.861	0.860	0.860	0.860	0.860	0.860
6.5	0.803	0.804	0.804	0.805	0.806	0.806	0.807	0.808
7.0	0.730	0.731	0.733	0.734	0.736	0.737	0.738	0.739
7.5	0.665	0.667	0.669	0.670	0.673	0.674	0.676	0.677
8.0	0.607	0.610	0.612	0.614	0.616	0.618	0.620	0.622
8.5	0.556	0.559	0.562	0.563	0.567	0.570	0.573	0.576
9.0	0.515	0.519	0.523	0.526	0.530	0.532	0.535	0.537
9.5	0.482	0.485	0.488	0.490	0.493	0.494	0.496	0.490
10.0	0.449	0.451	0.453	0.448	0.432	0.420	0.409	0.399
10.5	0.404	0.390	0.379	0.369	0.360	0.352	0.344	0.336
11.0	0.339	0.330	0.322	0.315	0.307	0.301	0.294	0.288
11.5	0.292	0.285	0.278	0.272	0.266	0.260	0.255	0.250
12.0	0.254	0.248	0.243	0.237	0.232	0.228	0.223	0.219
12.5	0.223	0.218	0.214	0.209	0.205	0.201	0.197	0.193
13.0	0.198	0.194	0.189	0.186	0.182	0.178	0.175	0.171
13.5	0.176	0.173	0.169	0.166	0.162	0.159	0.156	0.153
14.0	0.158	0.155	0.152	0.149	0.146	0.143	0.140	0.138
14.5	0.143	0.140	0.137	0.134	0.132	0.129	0.127	0.124
15.0	0.129	0.127	0.124	0.122	0.119	0.117	0.115	0.113
15.5	0.118	0.115	0.113	0.111	0.109	0.107	0.105	0.103
16.0	0.107	0.105	0.103	0.101	0.099	0.098	0.096	0.094
16.5	0.098	0.096	0.095	0.093	0.091	0.090	0.088	0.086
17.0	0.091	0.089	0.087	0.086	0.084	0.082	0.081	0.080
17.5	0.084	0.082	0.080	0.079	0.078	0.076	0.075	0.074
18.0	0.077	0.076	0.074	0.073	0.072	0.070	0.069	0.068
18.5	0.072	0.070	0.069	0.068	0.067	0.066	0.064	0.063
19.0	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059
19.5	0.062	0.061	0.060	0.059	0.058	0.057	0.056	0.055
20.0	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.052

SIEMENS-GAMESA SG145

Developer Package SG 4.5-145

Application of the Developer Package
The Developer Package serves the purpose of informing customers about the latest planned product development from Siemens Gamesa Renewable Energy (SGRE). By sharing information about coming developments, SGRE can ensure that customers are provided with necessary information to make decisions.

Furthermore, the Developer Package can assist in guiding prospective customers with the indicated technical footprint of the SG 4.5-145 in cases where financial institutes, governing bodies, or permitting entities require product specific information in their decision processes.

All technical data contained in the Developer Package is subject to change owing to ongoing technical developments. Information contained within the Developer Package may not be treated separately or out of the context of the Developer Package.

The information contained in the Developer Package may not be used as legally binding documentation and cannot be used in contracts between SGRE and any other parties. This Developer Package contains preliminary technical data on SGRE turbines currently under development and can be used in an indicative capacity only.

All technical data is subject to change according to the technical development of the wind turbine.

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Developer Package
SG 4.5-145

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Introduction

The SG 4.5-145 is the first wind turbine of the new Siemens Gamesa 4.X Platform, the next generation Siemens Gamesa Onshore Geared product series, which builds on the Siemens & Gamesa design and operational experience in the wind energy market.

With a brand new 71m blade, a 4.5 MW generator and a tower portfolio with hub heights ranging from 107.5m to 157.5m, the SG 4.5-145 aims at becoming a new benchmark in the market for efficiency and profitability.

This Developer Package describes the turbine technical specifications and provides preliminary information for the main components and subsystems.

For further information, please contact your regional SGRE Sales Manager.

Technical Description

Rotor-Nacelle
The rotor is a three-bladed construction, mounted upwind of the tower. The power output is controlled by pitch and torque demand regulation. The rotor speed is variable and is designed to maximize the power output while maintaining loads and noise level.

The nacelle has been designed for safe access to all service points during scheduled service. In addition the nacelle has been designed for safe presence of service technicians in the nacelle during Service Test Runs with the wind turbine in full operation. This allows a high quality service of the wind turbine and provides optimum troubleshooting conditions.

Blades
The SG 4.5–145 Siemens Gamesa blade is made up of fiberglass infusion-molded components. The blade structure uses aerodynamic shells containing embedded spar-caps, bonded to two main epoxy-fiberglass-balsa/foam-core shear webs. The SG 4.5–145 SGRE blade uses a blade design based on SGRE proprietary airfoils.

Rotor Hub
The rotor hub is cast in nodular cast iron and is fitted to the drive train low speed shaft with a flange connection. The hub is sufficiently large to provide room for service technicians during maintenance of blade roots and pitch bearings from inside the structure.

Drive train
The drive train is a 4-points suspension concept: main shaft with two main bearings and the gearbox with two torque arms assembled to the main frame.
The gearbox is in cantilever position; the gearbox planet carrier is assembled to the main shaft by means of a flange bolted joint and supports the gearbox.

Main Shaft
A forged main shaft ensures a comfortable access from the nacelle cover to the hub.

Main Bearings
The low speed shaft of the wind turbine is supported by two spherical roller bearings. The bearings are grease lubricated.

Gearbox
The gearbox is 3 stages high speed type (2 planetary + 1 parallel).

Generator
The generator is Asynchronous type, functioning as a Double Feed machine. It is Liquid/Air cooled, positioned in nacelle, and linked mechanically with a gearbox.
Rotor: The rotor winding is a standard nerved type, connected by a Frequency converter PWM.
Stator: The Stator winding is a classic stacked type, directly connected to the grid.

Mechanical Brake
The mechanical brake is fitted to the non-drive end of the gearbox.

Yaw System
A cast bed frame connects the drive train to the tower. The yaw bearing is an externally geared ring with a friction and sliding plain bearing. A series of electric planetary gear motors drives the yawing.

Nacelle Cover
The weather screen and housing around the machinery in the nacelle is made of fiberglass-reinforced laminated panels.

Tower
The wind turbine is as standard mounted on a tapered tubular steel tower. Other tower technologies will be available for higher hub heights. The tower has internal ascent and direct access to the yaw system and nacelle. It is equipped with platforms and internal electric lighting.

Controller
The wind turbine controller is a microprocessor-based industrial controller. The controller is complete with switchgear and protection devices. It is self-diagnosing and has a touch panel and display for easy readout of status and for adjustment of settings.

Converter
Connected directly with the Rotor, the Frequency Converter is a back to back 4Q conversion system with 2 VSC in a common DC-link.The Frequency Converter allows generator operation at variable speed and voltage, while supplying power at constant frequency and voltage to the MV transformer. The power conversion system is water cooled and has a modular arrangement for easy maintenance.

SCADA
The wind turbine provides connection to the SGRE SCADA system. This system offers remote control and a variety of status views and useful reports from a standard internet web browser. The status views present information including electrical and mechanical data, operation and fault status, meteorological data and grid station data.

Turbine Condition Monitoring
In addition to the SGRE SCADA system, the wind turbine is equipped with the unique SGRE condition monitoring setup. This system monitors the vibration level of the main components and compares the actual vibration spectra with a set of established reference spectra. Review of results, detailed analysis and reprogramming can all be carried out using a standard web browser.

Operation Systems
The wind turbine operates automatically. It is self-starting when the aerodynamic torque is enough. Below rated wind speed, the wind turbine controller fixes the pitch and torque references for operating in the optimum aerodynamic point (maximum production) taking into account the generator capability. Once rated wind speed is surpassed, the pitch position demand is adjusted to keep a stable power production equal to the nominal value. If high wind derated mode is enabled, the power production is limited once the wind speed exceeds a threshold value defined by design, until cut-out wind speed is reached and the wind turbine stops producing power. If the average wind speed exceeds the maximum operational limit, the wind turbine is shut down by pitching of the blades. When the average wind speed drops back below the restart average wind speed, the systems reset automatically.

Technical Specifications

Rotor
Type ....3-bladed, horizontal axis
Position ....Upwind
Diameter..........................145 m
Swept area ....16.506 m²
Power regulation ....Pitch & torque regulation with variable speed
Rotor tilt...........................6 degrees

Blade
Type ....Self-supporting
Blade length ....71.0 m
Root chord.......................2.856 m
Aerodynamic profile ....Siemens Gamesa proprietary airfoils
Material ....GRE (Glassfiber Reinforced Epoxy)
Surface gloss ....Semi-gloss, < 30 / ISO2813
Surface color .... Light grey, RAL 7035 or White, RAL 9018

Aerodynamic Brake
Type ....Full span pitching
Activation.........................Active, hydraulic

Load-Supporting Parts
Hub.................................Nodular cast iron
Main shaft........................Forged steel
Nacelle bed frame.......... Nodular cast iron

Mechanical Brake
Type ....Hydraulic disc brake
Position ....Gearbox rear end

Nacelle Cover
Type ....Totally enclosed
Surface gloss ....Semi-gloss, <30 / ISO2813
Color................................Papyrus White, RAL 9018 (other colours under request)

Generator
Type................................Asynchronous, DFIG

Grid Terminals (LV)
Baseline nominal power ..4.5 MW
Voltage ....690 V
Frequency........................50 Hz or 60 Hz

Yaw System
Type................................Active
Yaw bearing.....................Externally geared
Yaw drive ....7 electric gear motors
Yaw brake........................Active friction brake

Controller
Type ....SGRE Wind Turbine Control architecture
SCADA system ....SGRE SCADA System

Tower
Type ....Tubular steel
Hub height ....Steel: 107 - 157 m, site-specific

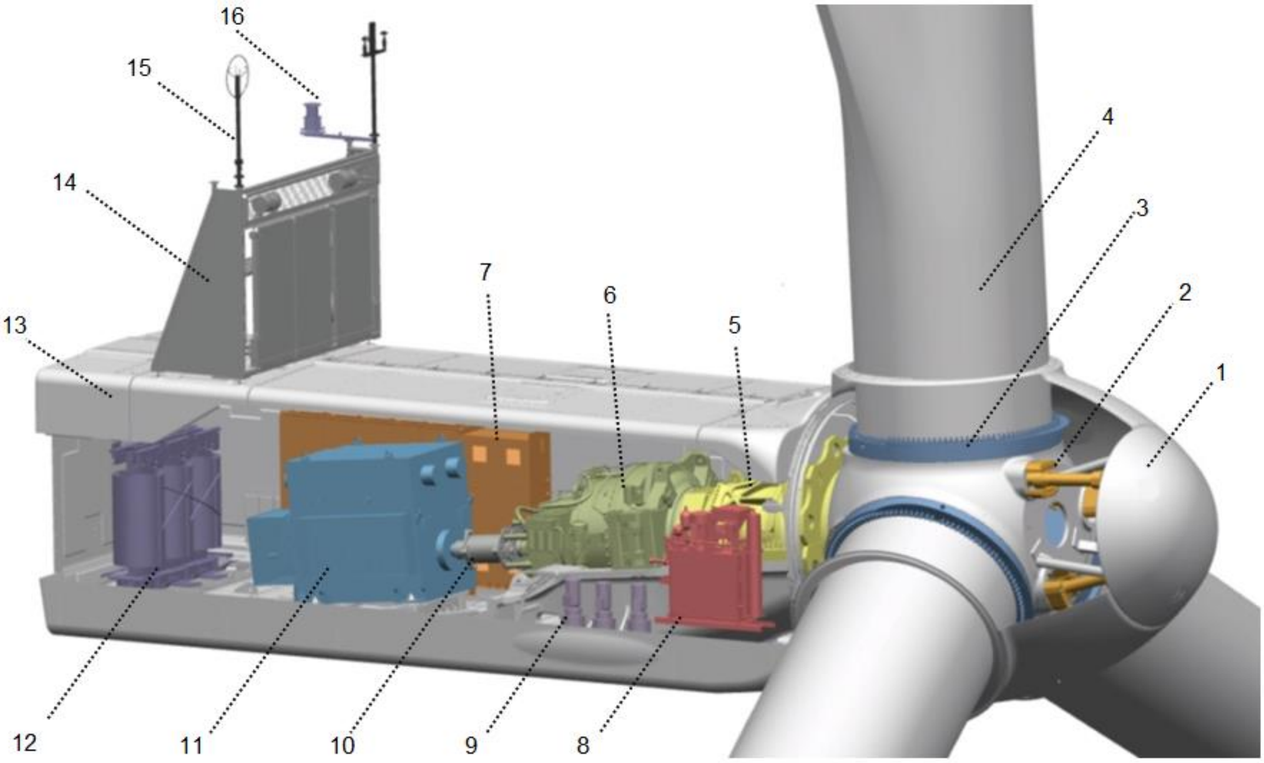
Corrosion protection ....Painted
Surface gloss ....Semi-gloss, <30 / ISO-2813
Color ....Light grey, RAL 9018 (other colours under request)

Operational Data
Cut-in wind speed ....3–5 m/s
Nominal power at ....11 m/s
Cut-out wind speed ....27 m/s
Maximum 3 s gust ....59.5 m/s

Weight
Modular approach All modules weight lower than 100 t for transport

Nacelle Arrangement

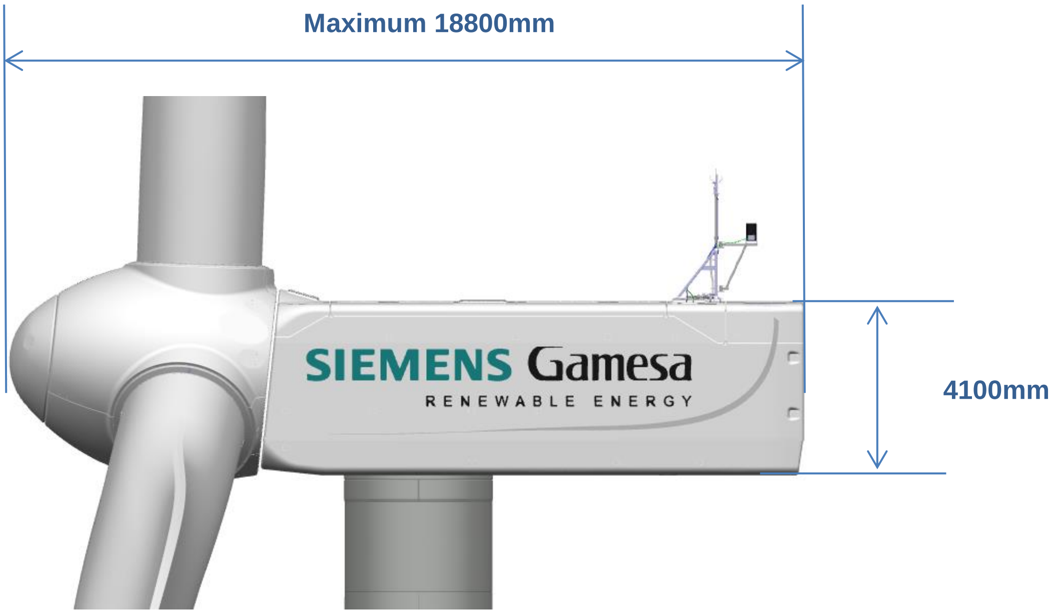
The design and layout of the nacelle are preliminary and may be subject to changes during the development of the product.

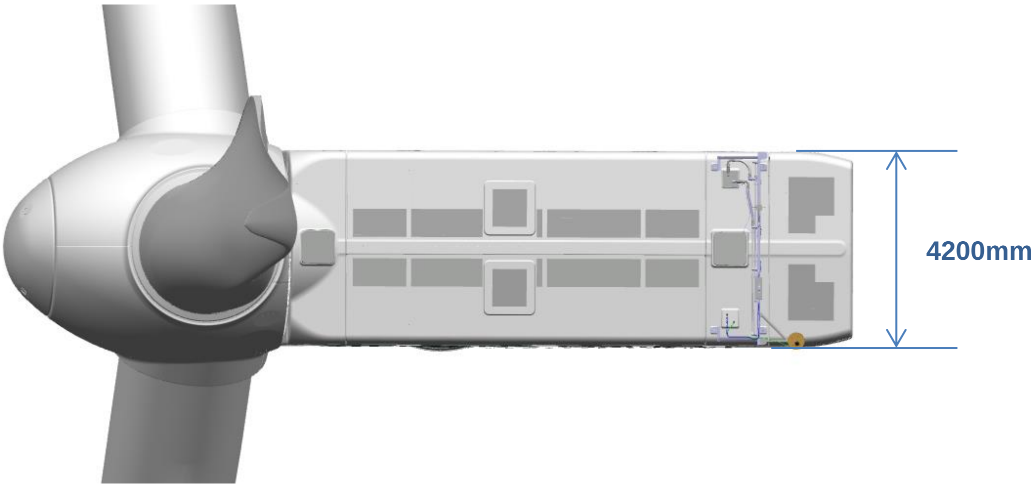


1	Rotor cover	**9**	Yaw system
2	Pitch system	**10**	High speed shaft
3	Blade bearings	**11**	Generator
4	Blades	**12**	Transformer
5	Low speed shaft	**13**	Nacelle cover
6	Gearbox	**14**	Cooling system
7	Electrical cabinets	**15**	Wind sensors
8	Hydraulic group	**16**	Beacon system

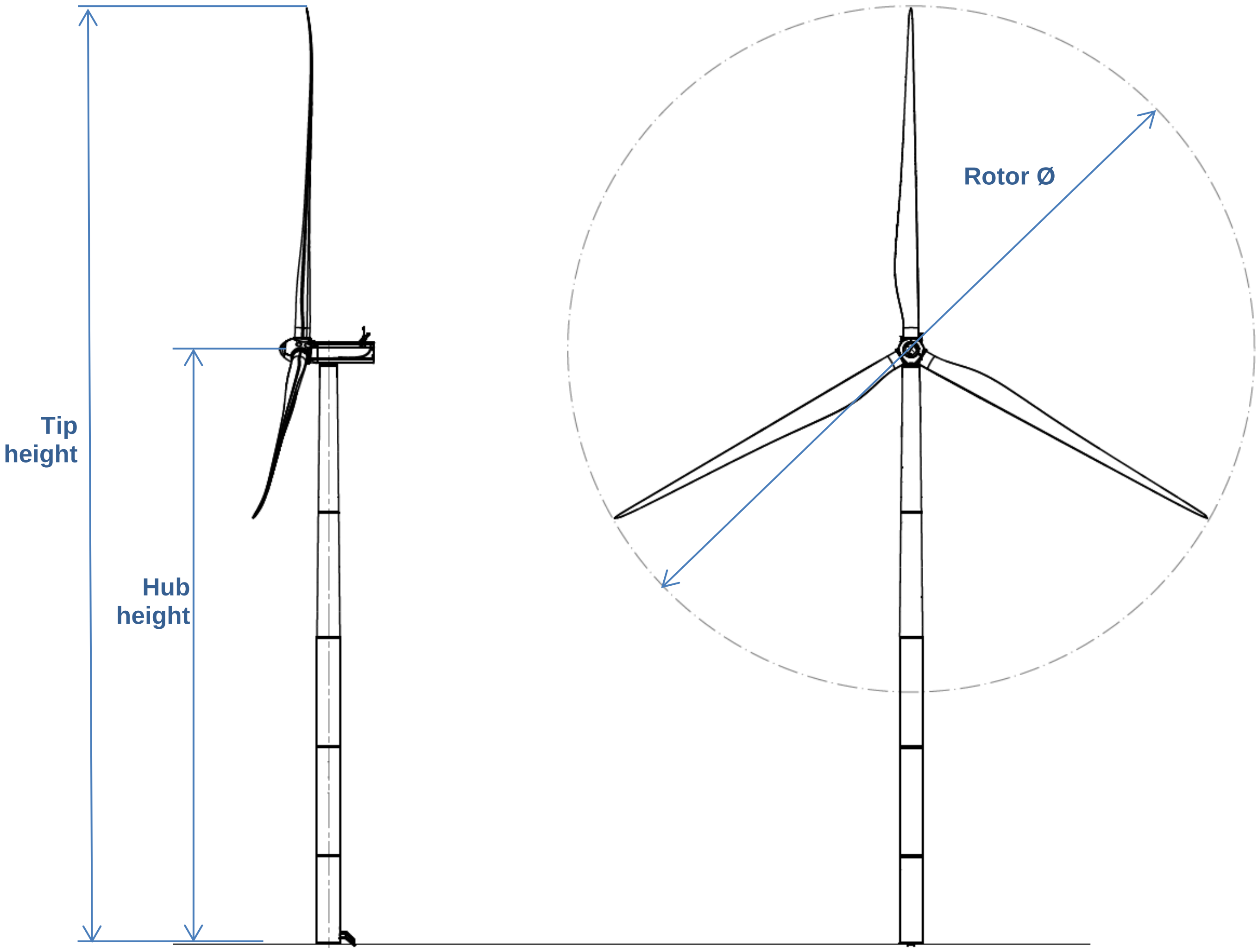
Nacelle Dimensions

The design and dimensions of the nacelle are preliminary and may be subject to changes during the development phases of the product.



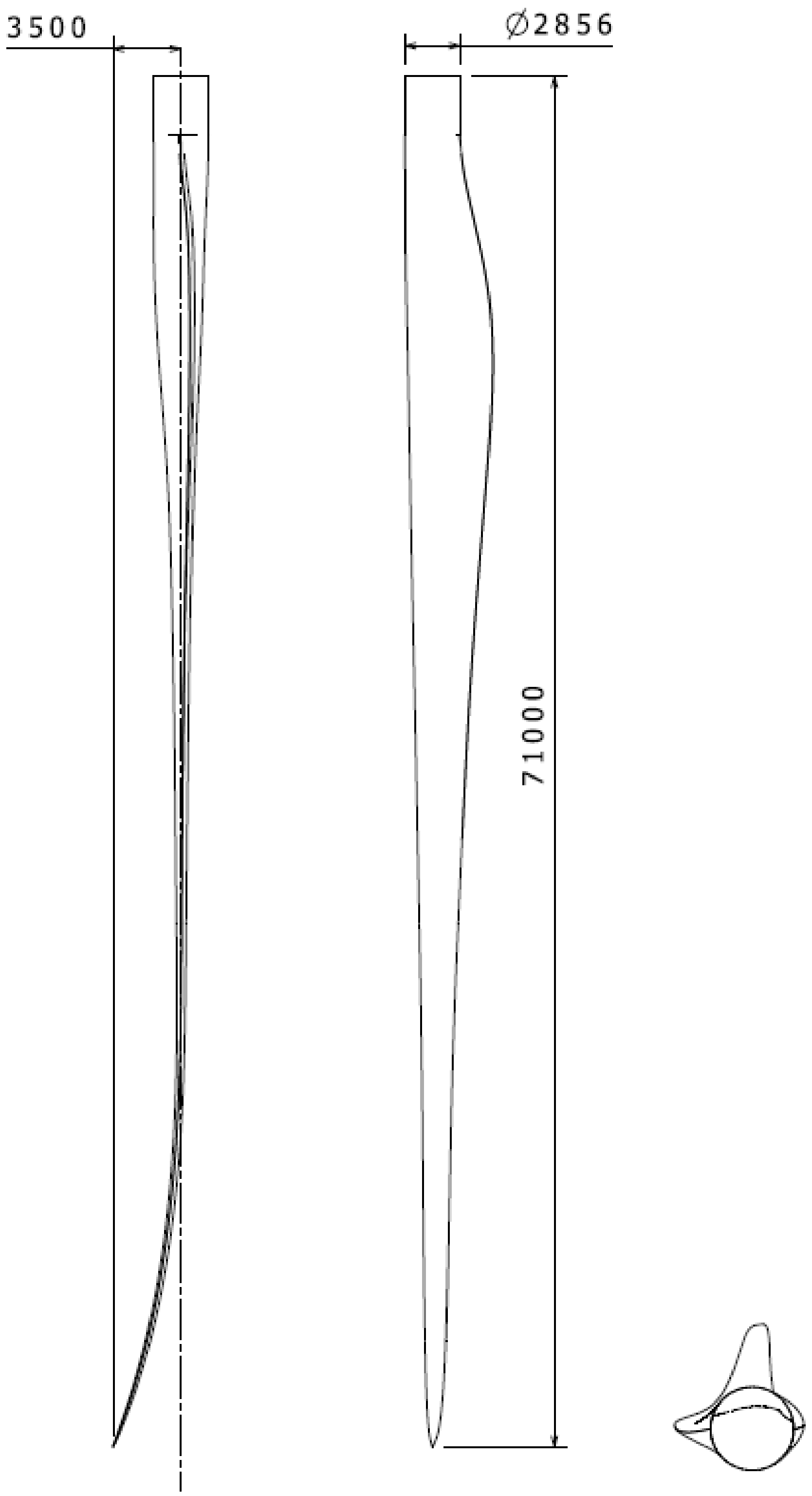


Elevation Drawing



Tip height	180m, 200m, 230m
Hub height	107.5m, 127.5m, 157,5m
Rotor diameter	145m

Blade Drawing



Dimensions in millimeters.

Design Climatic Conditions

The design climatic conditions are the boundary conditions at which the turbine can be applied without supplementary design review. Applications of the wind turbine in more severe conditions may be possible, depending upon the overall circumstances. A project site-specific review requires the completion by the Client of the “Project Climatic Conditions” form.

Subject	ID	Issue	Unit	Value
Wind, operation	1.1	Wind definitions	-	IEC 61400-1[1]
	1.2	IEC class	-	IIB
	1.3	Mean air density, ρ	kg/m^3	1.225
	1.4	Mean wind speed, V_{ave}	m/s	8.5
	1.5	Weibull scale parameter, A	m/s	9.59
	1.6	Weibull shape parameter, k	-	2
	1.7	Wind shear exponent, α	-	0.20
	1.8	Reference turbulence intensity at 15 m/s, I_{ref}	-	0.14
	1.9	Standard deviation of wind direction	Deg	8
	1.10	Maximum flow inclination	Deg	8
	1.11	Minimum turbine spacing, in rows	D	3
	1.12	Minimum turbine spacing, between rows	D	5
Wind, extreme	2.1	Wind definitions		IEC 61400-1
	2.2	Air density, ρ	kg/m^3	1.225
	2.3	Reference wind speed average over 10 min at hub height, V_{ref}	m/s	42.5
	2.4	Maximum 3 s gust in hub height, V_{e50}	m/s	59.5
	2.5	Maximum hub height power law index, α	-	0.11
Temperature	3.1	Temperature definitions	-	IEC 61400-1
	3.2	Minimum temperature at 2 m, stand-still, $T_{min, s}$	Deg.C	-30
	3.3	Minimum temperature at 2 m, operation, $T_{min, o}$	Deg.C	-20
	3.4	Maximum temperature at 2 m, nominal operation, $T_{max, o}$	Deg.C	35
	3.5	Maximum temperature at 2 m, stand-still, $T_{max, s}$	Deg.C	50
Corrosion	4.1	Atmospheric-corrosivity category definitions	-	ISO 12944-2
	4.2	Internal nacelle environment (corrosivity category)	-	C3
	4.3	Exterior environment (corrosivity category)	-	C5-M
Lightning	5.1	Lightning definitions	-	IEC61400-24:2010
	5.2	Lightning protection level (LPL)	-	LPL 1
Dust	6.1	Dust definitions	-	IEC 60721-3-4:1995
	6.2	Working environmental conditions	mg/m^3	Average Dust Concentration (95% time) → 0.05 mg/m3
	6.3	Concentration of particles	mg/m^3	Peak Dust Concentration (95% time) → 0.5 mg/m3
Hail	7.1	Maximum hail diameter	mm	20
	7.2	Maximum hail falling speed	m/s	20
Ice	8.1	Ice definitions	-	-
	8.2	Ice conditions	Days/yr	7
9. Solar radiation	9.1	Solar radiation definitions	-	IEC 61400-1
	9.2	Solar radiation intensity	W/m^2	1000

[1] All mentioning of IEC 61400-1 refers to IEC 61400-1 Ed3.0 2005/A1:2010.

Subject	ID	Issue	Unit	Value
10. Humidity	10.1	Humidity definition	-	IEC 61400-1
	10.2	Relative humidity	%	Up to 95
11. Obstacles	11.1	If the height of obstacles within 500m of any turbine location height exceeds 1/3 of (H – D/2) where H is the hub height and D is the rotor diameter then restrictions may apply. Please contact Siemens Gamesa Renewable Energy for information on the maximum allowable obstacle height with respect to the site and the turbine type.		

Standard Power Curve, Standard power operational mode

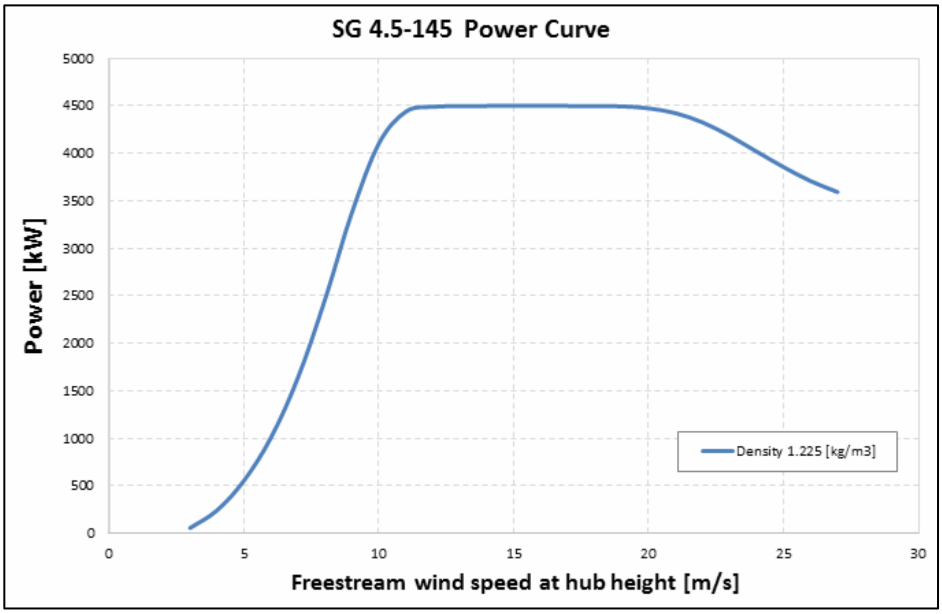
Air density 1.225 kg/m3
Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\%\dfrac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\%\dfrac{(0.75v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [º]	-2º ≤ β ≤ +2º
Grid frequency [Hz]	± 0.5 Hz

Other considerations: Clean rotor blades, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

Next table shows the electrical power [kW] as a function of the wind speed [m/s] horizontal referred to the hub height, averaged in ten minutes, for air density = 1.225 kg/m^3. The power curve does not include losses in the transformer and high voltage cables. The power curve is for the standard version of the turbine.

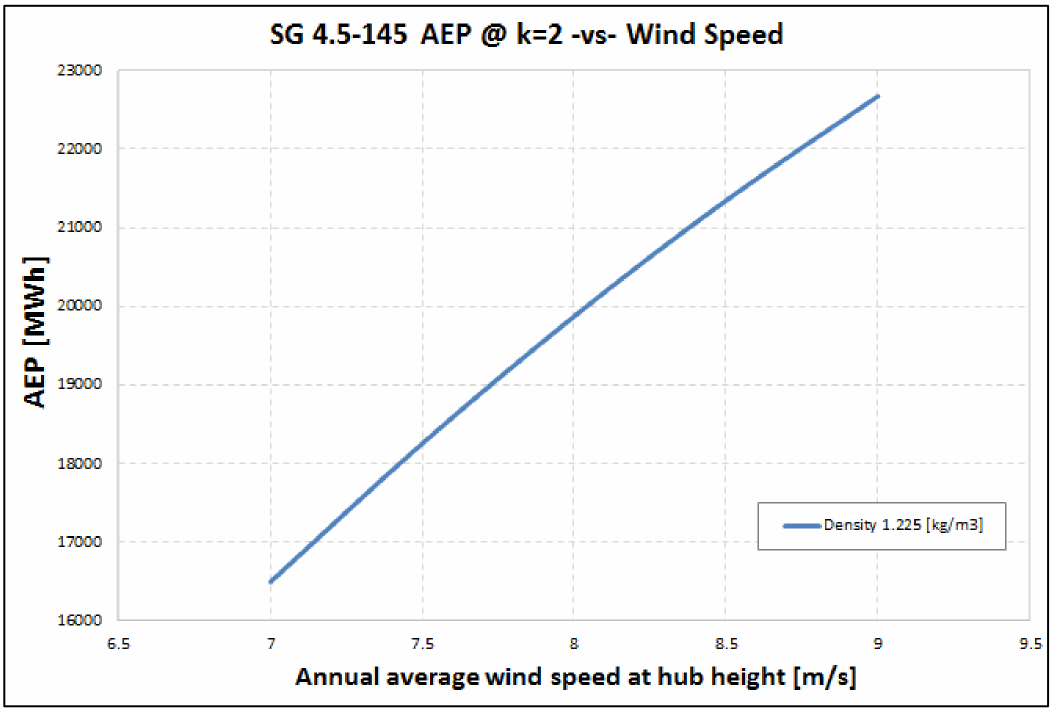
SG 4.5-145	
Wind Speed [m/s]	**Power [kW]**
3	57
4	243
5	556
6	1010
7	1640
8	2459
9	3376
10	4105
11	4440
12	4491
13	4498
14	4500
15	4500
16	4500
17	4500
18	4499
19	4495
20	4475
21	4423
22	4326
23	4185
24	4020
25	3856
26	3709
27	3593



The annual energy production data for different annual mean wind speeds in hub height are calculated from the above power curve assuming a Weibull wind speed distribution, 100 percent availability, and no reductions due to array losses, grid losses, or other external factors affecting the production.

AEP [MWh]		**Annual Average Wind Speed [m/s] at Hub Height**										
		5	***5.5***	***6***	***6.5***	***7***	***7.5***	***8***	***8.5***	***9***	***9.5***	***10***
Weibull K	***1.5***	9251	10993	12659	14222	15667	16985	18171	19225	20149	20948	21628
	2	8447	10533	12605	14605	16496	18256	19874	21346	22672	23854	24894
	2.5	7611	9861	12196	14518	16752	18849	20783	22544	24131	25551	26813

Annual Production [MWh] SG 4.5-145 wind turbine for the standard version, as a function of the annual mean wind speed at hub height, and for different Weibull parameters. Air density 1.225 kg/m3.



Standard Ct Curve, Standard power operational mode

Air density 1.225 kg/m3
Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\% \frac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\% \frac{(0.75v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [º]	$-2^o \leq \beta \leq +2^o$
Grid frequency [Hz]	± 0.5 Hz

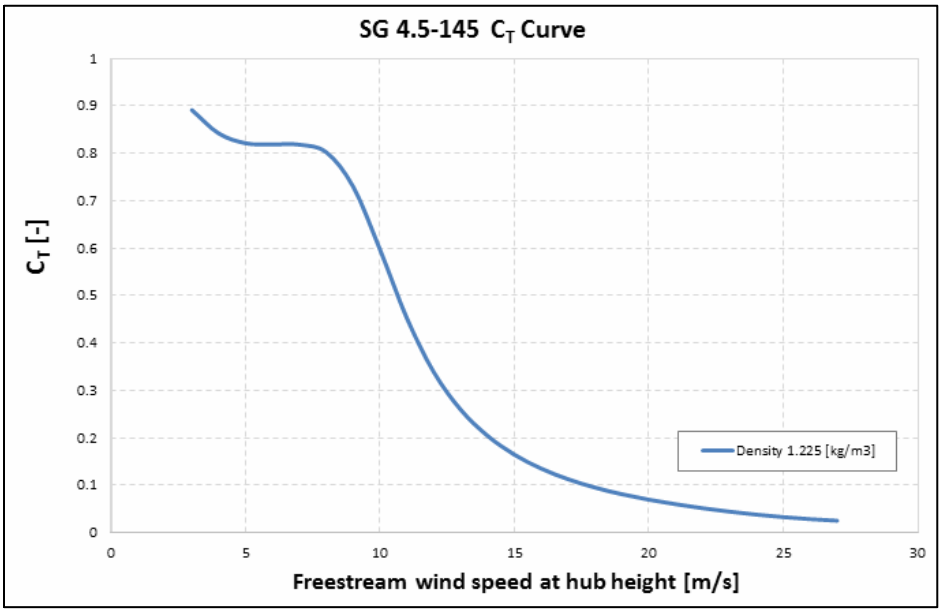
Other considerations: Clean rotor blades, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

The thrust coefficient Ct is used for the calculation of the wind speed deficit in the wake of a wind turbine.

Ct is defined by the following expression:
Ct = F / (0.5*ad*w^2*A)

where
F = Rotor force [N]
ad = Air density [kg/m3]
w = Wind speed [m/s]
A = Swept area of rotor [m2]

SG 4.5-145	
Wind Speed [m/s]	**C_T [-]**
3	0.8914
4	0.8422
5	0.8214
6	0.8191
7	0.8184
8	0.8023
9	0.7299
10	0.5966
11	0.4521
12	0.3386
13	0.2595
14	0.2044
15	0.1647
16	0.1353
17	0.1128
18	0.0953
19	0.0813
20	0.0699
21	0.0603
22	0.0519
23	0.0446
24	0.0383
25	0.0331
26	0.0289
27	0.0255



Power Curve, Air density, Standard power operational mode

Air density 1.225 kg/m3
Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\% \frac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\% \frac{(0.75v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [º]	-2º ≤ β ≤ +2º
Grid frequency [Hz]	± 0.5 Hz

Other considerations: Clean rotor blades, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

Next table shows the electrical power [kW] as a function of the wind speed [m/s] horizontal referred to the hub height, averaged in ten minutes, for different air densities [kg/m^3]. The power curve does not include losses in the transformer and high voltage cables. The power curve is for the standard version of the turbine.

P [kW]	***Air Density [kg/m3]***								
Wind Speed [m/s]	**1.225**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
3	57	42	45	48	50	53	56	58	61
4	243	202	209	217	224	232	239	247	254
5	556	472	488	503	518	533	549	564	579
6	1010	865	891	918	944	970	997	1023	1049
7	1640	1410	1452	1494	1535	1577	1619	1661	1702
8	2459	2121	2182	2244	2306	2367	2429	2490	2551
9	3376	2938	3021	3103	3183	3262	3338	3413	3484
10	4105	3714	3798	3877	3949	4016	4076	4131	4181
11	4440	4251	4304	4348	4383	4412	4432	4448	4459
12	4491	4465	4474	4480	4484	4488	4490	4492	4493
13	4498	4493	4494	4495	4496	4497	4498	4498	4499
14	4500	4498	4499	4499	4499	4499	4499	4500	4500
15	4500	4500	4500	4500	4500	4500	4500	4500	4500
16	4500	4500	4500	4500	4500	4500	4500	4500	4500
17	4500	4500	4500	4500	4500	4500	4500	4500	4500
18	4499	4499	4499	4499	4499	4499	4499	4499	4499
19	4495	4495	4495	4495	4495	4495	4495	4495	4495
20	4475	4475	4475	4475	4475	4475	4475	4475	4475
21	4423	4423	4423	4423	4423	4423	4423	4423	4423
22	4326	4326	4326	4326	4326	4326	4326	4326	4326
23	4185	4185	4185	4185	4185	4185	4185	4185	4185
24	4020	4020	4020	4020	4020	4020	4020	4020	4020
25	3856	3856	3856	3856	3856	3856	3856	3856	3856
26	3709	3709	3709	3709	3709	3709	3709	3709	3709
27	3593	3593	3593	3593	3593	3593	3593	3593	3593

The annual energy production data for different annual mean wind speeds in hub height are calculated from the above power curve assuming a Rayleigh wind speed distribution, 100 percent availability, and no reductions due to array losses, grid losses, or other external factors affecting the production.

AEP [MWh] @ k=2		**Annual Average Wind Speed [m/s] at Hub Height**										
		5	***5.5***	***6***	***6.5***	***7***	***7.5***	***8***	***8.5***	***9***	***9.5***	***10***
Density [kg/m3]	***1.06***	7441	9384	11353	13286	15143	16894	18524	20023	21386	22611	23698
	1.09	7631	9604	11594	13543	15408	17163	18792	20287	21644	22861	23939
	1.12	7818	9818	11830	13792	15665	17422	19049	20540	21890	23100	24169
	1.15	8002	10028	12059	14033	15912	17671	19296	20782	22126	23327	24388
	1.18	8182	10233	12282	14267	16152	17911	19534	21014	22351	23545	24597
	1.21	8359	10434	12499	14494	16383	18143	19763	21238	22568	23753	24797
	1.225	8447	10533	12605	14605	16496	18256	19874	21346	22672	23854	24894
	1.24	8534	10630	12710	14715	16607	18367	19983	21452	22775	23953	24988
	1.27	8705	10822	12916	14929	16824	18583	20195	21659	22975	24145	25172

Annual Production [MWh] SG 4.5-145 wind turbine for the standard version, as a function of the annual mean wind speed at hub height and for different air densities considering a Rayleigh wind speed distribution.

Ct Curve, Air Density, Standard power operational mode

Air density 1.225 kg/m3
Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\% \frac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\% \frac{(0.75v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [º]	-2º ≤ β ≤ +2º
Grid frequency [Hz]	± 0.5 Hz

Other considerations: Clean rotor blades, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

The calculated Ct curve data are valid for air densities as stated below, clean rotor blades, substantially horizontal, undisturbed air flow, normal turbulence intensity and normal wind shear.

C_T [kW]	***Air Density [kg/m3]***								
Wind Speed [m/s]	**1.225**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
3	0.8914	0.8914	0.8914	0.8914	0.8914	0.8914	0.8914	0.8914	0.8914
4	0.8422	0.8422	0.8422	0.8422	0.8422	0.8422	0.8422	0.8422	0.8422
5	0.8214	0.8214	0.8214	0.8214	0.8214	0.8214	0.8214	0.8214	0.8214
6	0.8191	0.8191	0.8191	0.8191	0.8191	0.8191	0.8191	0.8191	0.8191
7	0.8184	0.8184	0.8184	0.8184	0.8184	0.8184	0.8184	0.8184	0.8184
8	0.8023	0.8026	0.8026	0.8026	0.8025	0.8025	0.8024	0.8022	0.8019
9	0.7299	0.7388	0.7381	0.7370	0.7356	0.7338	0.7313	0.7283	0.7247
10	0.5966	0.6338	0.6288	0.6231	0.6164	0.6091	0.6009	0.5921	0.5829
11	0.4521	0.5088	0.4991	0.4890	0.4785	0.4680	0.4574	0.4468	0.4364
12	0.3386	0.3924	0.3819	0.3718	0.3618	0.3523	0.3431	0.3342	0.3258
13	0.2595	0.3023	0.2936	0.2853	0.2774	0.2700	0.2629	0.2562	0.2498
14	0.2044	0.2374	0.2306	0.2242	0.2181	0.2124	0.2070	0.2018	0.1970
15	0.1647	0.1906	0.1853	0.1802	0.1755	0.1710	0.1668	0.1627	0.1589
16	0.1353	0.1560	0.1517	0.1477	0.1439	0.1403	0.1369	0.1337	0.1306
17	0.1128	0.1297	0.1262	0.1229	0.1198	0.1169	0.1141	0.1115	0.1090
18	0.0953	0.1093	0.1064	0.1037	0.1011	0.0987	0.0964	0.0942	0.0921
19	0.0813	0.0931	0.0907	0.0884	0.0862	0.0842	0.0823	0.0804	0.0787
20	0.0699	0.0799	0.0779	0.0759	0.0741	0.0724	0.0707	0.0692	0.0677
21	0.0603	0.0688	0.0670	0.0654	0.0638	0.0624	0.0610	0.0597	0.0584
22	0.0519	0.0591	0.0576	0.0562	0.0549	0.0537	0.0525	0.0514	0.0503
23	0.0446	0.0506	0.0494	0.0482	0.0471	0.0461	0.0451	0.0441	0.0432
24	0.0383	0.0434	0.0424	0.0414	0.0404	0.0396	0.0387	0.0379	0.0372
25	0.0331	0.0374	0.0365	0.0357	0.0349	0.0342	0.0334	0.0328	0.0321
26	0.0289	0.0326	0.0318	0.0311	0.0304	0.0298	0.0292	0.0286	0.0280
27	0.0255	0.0288	0.0281	0.0275	0.0269	0.0263	0.0258	0.0253	0.0248

Standard Acoustic Emission

Noise Level (LW): Values reported correspond to the average estimated Sound Power Level emitted by the WTG at hub height, called LW in TS IEC-61400-14. LW values are expressed in dB(A). To obtain LWd value, as defined in IEC-61400-14, it must be applied a 2 dB increase to LW.

dB(A): LW is expressed in decibels applying the “A” filter as required by IEC.

Noise generated at standard power operation mode LW is **107.8 dB(A).**

Noise values included in the present document correspond to the wind turbine configuration equipped with noise reduction add-ons attached to the blade.

SG 4.5-145	
Wind Speed [m/s]	**LW [dB(A)]**
3	95.1
3.5	95.1
4	95.1
4.5	95.1
5	95.5
5.5	97.6
6	99.7
6.5	101.5
7	103.2
7.5	104.7
8	106.2
8.5	107.6
9	107.8
9.5	107.8
10	107.8
10.5	107.8
11	107.8
11.5	107.8
12	107.8
12.5	107.8
13	107.8
13.5	107.8
14	107.8
14.5	107.8
15	107.8

Noise values included in the present document correspond to the wind turbine configuration equipped with noise reduction add-ons attached to the blade.

Noise Reduction System (NRS) operational modes

The Noise Reduction System NRS is an optional module available with the basic SCADA configuration and it therefore requires the presence of a SGRE SCADA system to work.

The purpose of this system is to limit the noise emitted by any of the functioning turbines and thereby comply with local regulations regarding noise emissions. This allows wind farms to be located close to urban areas, limiting the environmental impact that they imply.

Noise control is achieved through reducing the active power and rotational speed of the wind turbine. This reduction is dependent on the wind speed:

The task of the Noise Reduction System is to control the noise settings of each turbine to the most appropriate level at all times, in order to keep the noise emissions within the limits allowed.

In order to do this, the SCADA control has to consider the wind speed of each turbine, its direction, and a configured schedule/calendar.

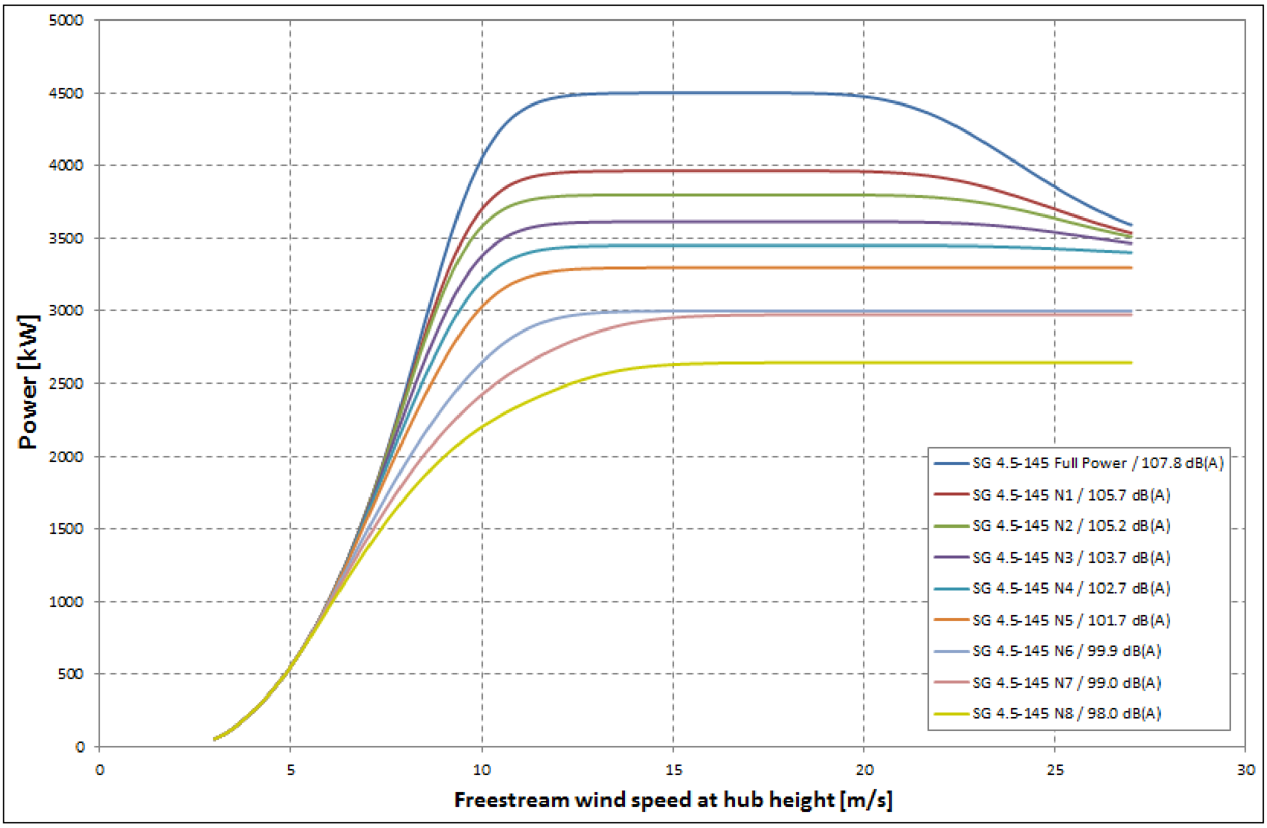
There can be up to 8 low noise modes, besides the full operation one. Noise levels corresponding to each mode are the following:

Mode:	FP	N1	N2	N3	N4	N5	N6	N7	N8
Noise Level [dB(A)]	107.8	105.7	105.2	103.7	102.7	101.7	99.9	99	98

Noise values included in the present document correspond to the wind turbine configuration equipped with noise reduction add-ons attached to the blade.

Next table presents the power production as a function of the horizontal wind speed measured at hub height for different noise reduction mode settings.

P [kW]	***Low Noise Operation Mode***							
Wind Speed [m/s]	**N1 105.7 dB(A)**	**N2 105.2 dB(A)**	**N3 103.7 dB(A)**	**N4 102.7 dB(A)**	**N5 101.7 dB(A)**	**N6 99.9 dB(A)**	**N7 99.0 dB(A)**	**N8 98.0 dB(A)**
3	57	57	57	57	57	57	57	57
4	243	243	243	243	243	243	243	243
5	556	556	556	556	556	556	556	555
6	1010	1010	1010	1009	1007	995	981	961
7	1638	1636	1623	1604	1574	1490	1432	1366
8	2422	2404	2320	2240	2147	1951	1837	1717
9	3198	3134	2958	2814	2658	2341	2168	1994
10	3700	3581	3378	3207	3029	2647	2424	2202
11	3897	3747	3552	3382	3214	2851	2612	2350
12	3950	3790	3602	3435	3276	2951	2751	2466
13	3961	3798	3612	3447	3292	2987	2854	2554
14	3963	3800	3615	3449	3295	2997	2920	2607
15	3964	3800	3615	3450	3296	2999	2953	2631
16	3964	3800	3615	3450	3296	3000	2967	2641
17	3964	3800	3615	3450	3296	3000	2972	2644
18	3964	3800	3615	3450	3296	3000	2973	2645
19	3963	3800	3615	3450	3296	3000	2974	2645
20	3960	3799	3615	3450	3296	3000	2974	2645
21	3948	3794	3614	3450	3296	3000	2974	2645
22	3919	3779	3609	3449	3296	3000	2974	2645
23	3865	3748	3597	3446	3296	3000	2974	2645
24	3789	3700	3574	3439	3296	3000	2974	2645
25	3702	3638	3542	3429	3296	3000	2974	2645
26	3613	3571	3503	3416	3296	3000	2974	2645
27	3537	3511	3466	3402	3296	3000	2974	2645


Power [kW]
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
Freestream wind speed at hub height [m/s]
SG 4.5-145 Full Power / 107.8 dB(A)
SG 4.5-145 N1 / 105.7 dB(A)
SG 4.5-145 N2 / 105.2 dB(A)
SG 4.5-145 N3 / 103.7 dB(A)
SG 4.5-145 N4 / 102.7 dB(A)
SG 4.5-145 N5 / 101.7 dB(A)
SG 4.5-145 N6 / 99.9 dB(A)
SG 4.5-145 N7 / 99.0 dB(A)
SG 4.5-145 N8 / 98.0 dB(A)

The table below contains the noise levels as a function of the horizontal wind speed measured at hub height for different noise reduction mode settings.

Noise [dB(A)]	***Low Noise Operation Mode***							
Wind Speed [m/s]	**N1 105.7 dB(A)**	**N2 105.2 dB(A)**	**N3 103.7 dB(A)**	**N4 102.7 dB(A)**	**N5 101.7 dB(A)**	**N6 99.9 dB(A)**	**N7 99.0 dB(A)**	**N8 98.0 dB(A)**
3	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
3.5	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
4	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
4.5	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5
5.5	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6
6	99.7	99.7	99.7	99.7	99.7	99.7	99.0	98.0
6.5	101.5	101.5	101.5	101.5	101.5	99.9	99.0	98.0
7	103.2	103.2	103.2	102.7	101.7	99.9	99.0	98.0
7.5	104.7	104.7	103.7	102.7	101.7	99.9	99.0	98.0
8	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
8.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
9	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
9.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
10	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
10.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
11	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
11.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
12	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
12.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
13	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
13.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
14	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
14.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
15	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0

Noise values included in the present document correspond to the wind turbine configuration equipped with noise reduction add-ons attached to the blade.

Electrical Specifications

Nominal output and grid conditions

Nominal power	4500 kW
Nominal voltage	690 V
Power factor correction	Frequency converter control
Power factor range	0.9 capacitive to 0.9 inductive at nominal balanced voltage

Generator

Type	DFIG Asynchronous
Maximum power	4650 kW
Nominal speed	1120 rpm-6p (50Hz) 1344 rpm-6p (60Hz)

Generator Protection

Insulation class	Stator F/H Rotor F/H
Winding temperatures	6 Pt 100 sensors
Bearing temperatures	2 Pt 100
Slip Rings	1 Pt 100
Grounding brush	On side no coupling

Generator Cooling

Cooling system	Liquid cooling.
Internal ventilation	Air
Control parameter	Winding, Liquid, Bearings temperature.

Frequency Converter

Operation	4Q B2B Partial Load
Switching	PWM
Switching freq., grid side	2.5 kHz
Cooling	Liquid/Air

Main Circuit Protection

Short circuit protection	Circuit breaker
Surge arrester	varistors

Peak Power Levels

10 min average	Limited to nominal

Grid Requirements

Nominal grid frequency	50 or 60 Hz
Minimum voltage	90 % of nominal
Maximum voltage	112 % of nominal
Minimum frequency	94 % of nominal
Maximum frequency	106 % of nominal
Maximum voltage imbalance (negative sequence of component voltage).	≤5 %
Max short circuit level at controller's grid Terminals (690 V)	67 kA

Power Consumption from Grid (approximately)

At stand-by,No yawing	10 kW
At stand-by, yawing	15 kW

Controller back-up

UPS Controller system	Online UPS, Li battery
Back-up time	1 min.
Back-up time Scada	24 h

Transformer Requirements

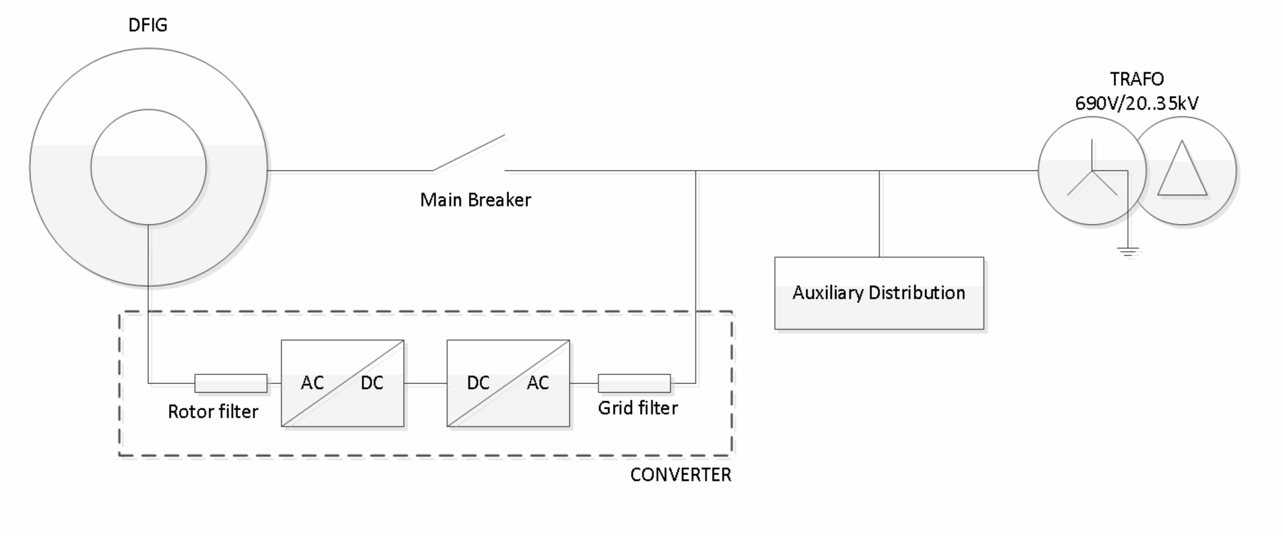
Transformer impedance requirement	8.0 % -9.5%
Secondary voltage	690 V
Vector group	Dyn 11 or Dyn 1 (star point earthed)

Earthing Requirements

Earthing system	Acc. to IEC62305-3 ED 1.0:2006
Foundation reinforcement	Must be connected to earth electrodes
Foundation terminals	Acc. to SGRE Standard
HV connection	HV cable shield shall be connected to earthing system

All data are subject to tolerances in accordance with IEC.

Simplified Single Line Diagram



Transformer Specifications ECO 30 kV*

Transformer

Type	Dry type
Nominal power	5350 kVA @nominal voltage +/- 10 %
Nominal voltage	30/0.69 kV
Frequency	50 Hz
Transformer impedance	10.7%
Loss (P_0 /$P_{n120°C}$)	4.8/39 kW
Vector group	Dyn11
Offload tap changer	+/- 2.5% / +/- 5 %
Standard…………………...	IEC 60076 ECO Design Directive

Transformer Cooling

Cooling system……………	AF
Ventilation …………………	Forced ventilation of the transformer room
Control parameter.............	Winding & Magnetic core temperature

Transformer Monitoring

WindingTemperature………	PT100 sensor
Mag. Core temperature…	PT100 sensor

Transformer Earthing

Star point	The star point of the transformer must be connected to earth

All data are subject to tolerances in accordance with IEC.
***Example for an ECO 30V transformer. For other MV transformers, consult with SGRE**

Switchgear Specifications

The Switchgear it is not within the scope of WTG. The minimum requirements that must be compliance, from the point of view of electrical protection, are :

Switchgear Specification (36 kV)

Technical Data for Switchgear

Switchgear	
Type	CGM.3
Rated voltage	36 kV
Operating voltage	30 - 36 kV
Rated current	630 A
Short time withstand current	20 kA/1s
Peak withstand current	50 kA
Power frequency withstand voltage	70 kV
Lightning withstand voltage	170 kV
Insulating medium	SF_6
Switching medium	vacuum
Consist of	1, 2 or 3 panels
Grid cable feeder	Load break switch or direct
Circuit breaker feeder	Circuit breaker
Degree of protection, vessel	IPX8
Degree of protection, front cover	IP2XD
Degree of protection, LV Comp.	IP2XD
Internal arc classification IAC:	A FL 20 kA 1s
Pressure relief	Down
Standard	IEC 62271
Temperature range	-30°C to +40°C

Grid Cable feeder	
Rated current , cubicle	630 A
Rated current , load breaker	630 A
Short time withstand current	20 kA/1s
Short circuit making current	50 kA/1s
Three position switch	Closed, open, earthed
Switch mechanism	Spring operated
Control	Local
Voltage detection system	Capacitive

Circuit breaker feeder	
Rated current , Cubicle	630 A
Rated current , circuit breaker	630 A
Short time withstand current	20 kA/1s
Short circuit making current	50 kA/1s
Short circuit breaking current	20 kA/1s
Three position CB switch	Closed, open, earthed
Switch mechanism	Spring operated
Tripping mechanism	Stored energy
Motor voltage	Under request
Control	Local
Coil for external trip	230 V AC
Voltage detection system	Capacitive

Protection	
Over-current relay	Ekor.wtp
Functions	50/51 50N/51N
Power supply	Dual (Self & Aux. powered)
Current transformer	300/1A; 0.18VA, Cl. 5P20

Interface- MV Cables	
Grid cable feeder	630A bushings type C M16 Max 2 feeder cables
Cable entry	From bottom
Cable clamp size (cable outer diameter)	up to 48mm
Circuit breaker feeder	630 A bushings type C M16
Cable entry	From bottom

Interface to turbine control	
Breaker status	1 NO + 1 NC contacts
Insulation supervision	Under request
External trip	230 V AC

All data are subject to tolerances in accordance with IEC.
Example for 36kV Switchgear. For other MV or differents grounding system MV, contact SGRE.

Preliminary Foundation Loads

Detailed information about foundation loads will be available upon request.

Tower Dimensions

SG 4.5-145 presents a tower portfolio with hub heights ranging from 107.5m to 157.5m. Information for the baseline towers is included below:

- Tower hub height 107.5m. Baseline design.

TOWER HH 107.5 SG 4.5-145					
	Section 1 (bottom)	Section 2	Section 3	Section 4	Section 5 (top)
External diameter upper flange (m)	4.435	4.429	4.422	4.419	3.503
External diameter lower flange (m)	4.4678	4.435	4.429	4.422	4.190
Section´s height (m)	13.305	18.2	21.120	23.875	29.000
Section structural weigth (kgs)	72702.1	70632.3	58339.0	51154.2	56214.7
Section total weight (kgs)	74642.2	71451.3	59289.4	52228.6	57519.7
Total tower height (m)	**105.510**				
Total tower weight (kg)	**315131.1**				

- Tower hub height 127.5m. Baseline design.

TOWER HH 127.5 SG 4.5-145						
	Section 1 (bottom)	Section 2	Section 3	Section 4	Section 5	Section 6 (top)
External diameter upper flange (m)	4.670	4.436	4.232	4.226	3.772	3.503
External diameter lower flange (m)	4.680	4.467	4.436	4.232	4.226	3.772
Section´s height (m)	13.380	16.825	20.625	23.400	23.270	28.000
Section structural weigth (kgs)	76680.7	74835.7	75207.2	70598.7	52979.1	52629.9
Section total weight (kgs)	78624.1	75592.8	76135.3	71651.7	54026.3	53889.9
Total tower height (m)	**125.510**					
Total tower weight (kg)	**409920.2**					

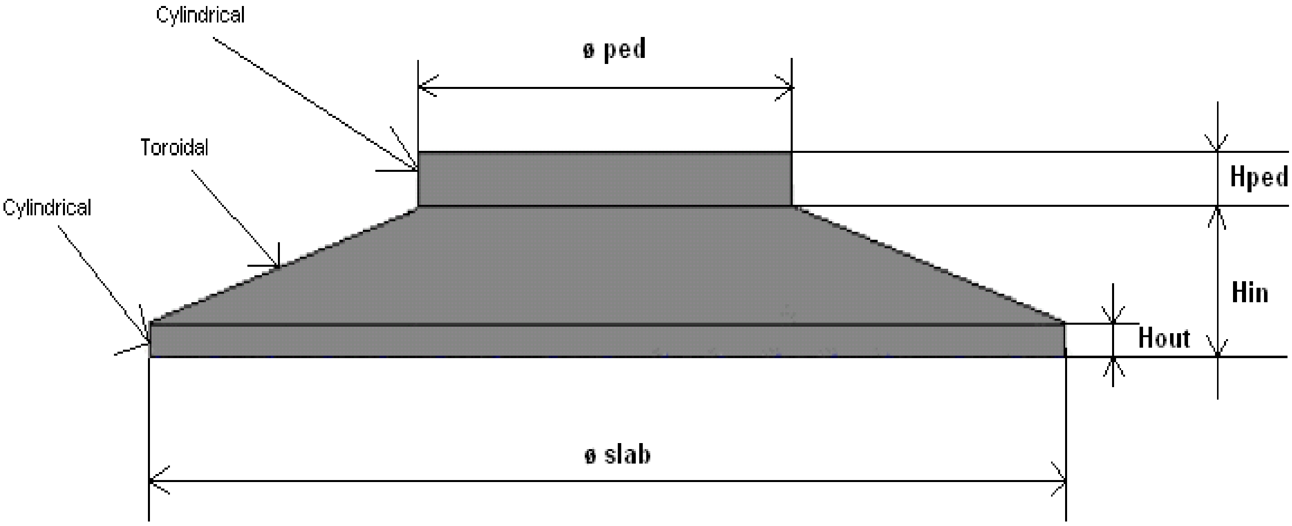
Information about other tower heights will be available upon request.

Estimated Foundation Design

Hub height: 107.5 m

Volumes

Concrete volume	~529.18 m³, C35/45 – C40/50 MPa
Reinforcement steel	~55410 kg, B 500 S



FOUNDATION GEOMTERY	
øslab= Slab diameter [m]	21.50
Hout= Outter egde height [m]	0.50
Hin= Inner edge height [m]	2.60
øped= Pedestal diameter [m]	5.50
Hped= Pedestal height [m]	0.50

The estimated foundation design is based on the following assumptions:

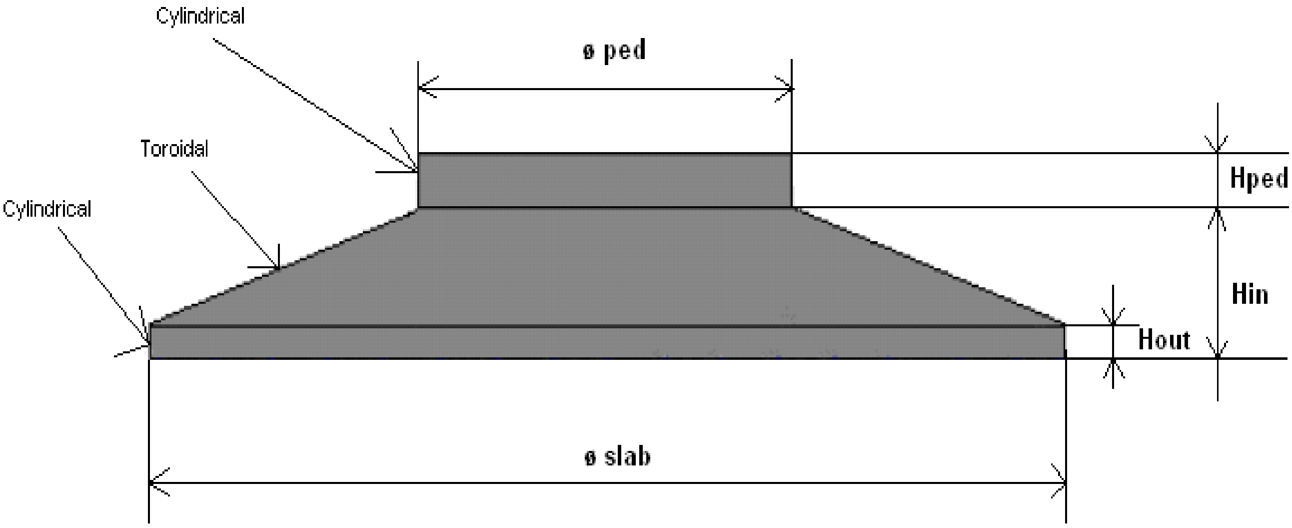
- Gravity based flat foundation without buoyancy
- Specific weight of backfill 18.0 kN/m³
- Friction angle 30.0°

Additional factors that may impact the foundation design:
Soil conditions, country, designer practise, national codes and standards.

Hub height: 127.5 m

Volumes

Concrete volume	~583.19 m³, C35/45 – C45/55 MPa
Reinforcement steel	~69740 kg, B 500 S



FOUNDATION GEOMTERY	
øslab= Slab diameter [m]	23.10
Hout= Outter egde height [m]	0.50
Hin= Inner edge height [m]	2.50
øped= Pedestal diameter [m]	5.50
Hped= Pedestal height [m]	0.50

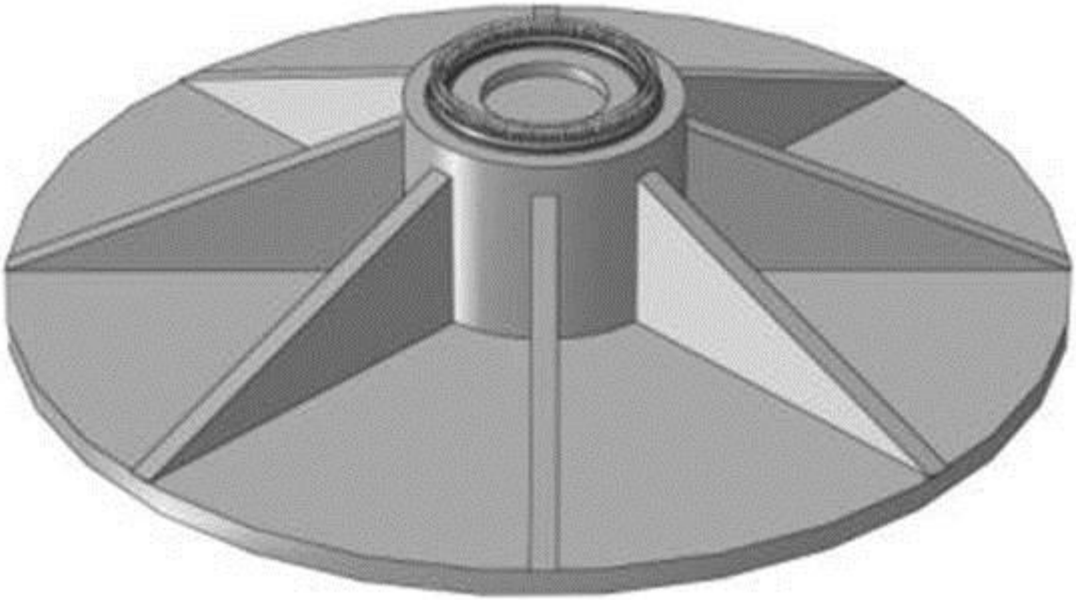
The estimated foundation design is based on the following assumptions:

- Gravity based flat foundation without buoyancy
- Specific weight of backfill 18.0 kN/m³
- Friction angle 30.0°

Additional factors that may impact the foundation design:
Soil conditions, country, designer practise, national codes and standards.

Although the standard and most common foundation concept is the previously shown circular tapered slab, it is also possible to design, based on site specific conditions, the optimized “8 Walls foundation” .

See image below:



Preliminary Grid Performance Specification, 50 Hz

General
This document describes the grid performance of the SG 4.5-145, 50 Hz wind turbine. Siemens Gamesa Renewable Energy (SGRE) will provide wind turbine technical data for the developer to use in the design of the wind power plant and the evaluation of requirements compliance. The developer will be responsible for the evaluation and ensuring that the requirements are met for the wind power plant.

The capabilities described in this document are based on the assumption that the electrical network is designed to be compatible with operation of the wind turbine. SGRE will provide a document with guidance to perform an assessment of the network's compatibility.

Fault Ride Through (FRT) Capability
The wind turbine is capable of operating when voltage transient events occur on the interconnecting transmission system above and below the standard voltage lower limits and time slot according to Figure 1 and Figure 2.

This performance assumes that the installed amount of wind turbines is in the right proportion to the strength of the grid, which means that the short circuit ratio (Sk/Sn) and the X/R ratio of the grid at the wind turbine transformer terminals must be adequate.

Evaluation of the wind turbine's fault ride through capability in a specific system must be based on simulation studies using the specific network model and a dynamic wind turbine model provided by SGRE in PSS/E. This model is a reduced order model, suitable for balanced simulations with time steps between 4-10 ms.

The standard voltage limits for the SG 4.5-145, 50 Hz wind turbine are presented in Figure 1 between 180 - 1000 seconds and in Figure 2 between 0.4 – 100 seconds.

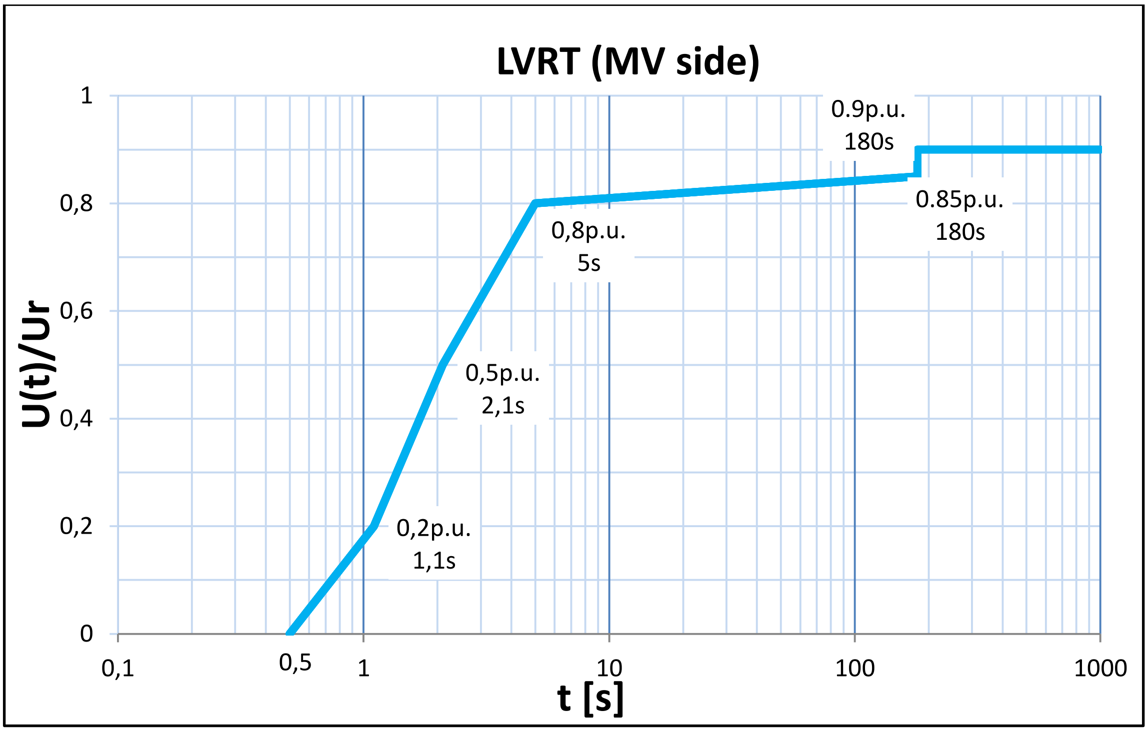


Figure 1. Lower voltage limits for SG 4.5-145, 50 Hz wind turbine in the range of 0-1000 seconds. The nominal voltage is 690 V (i.e. 1 p.u.).

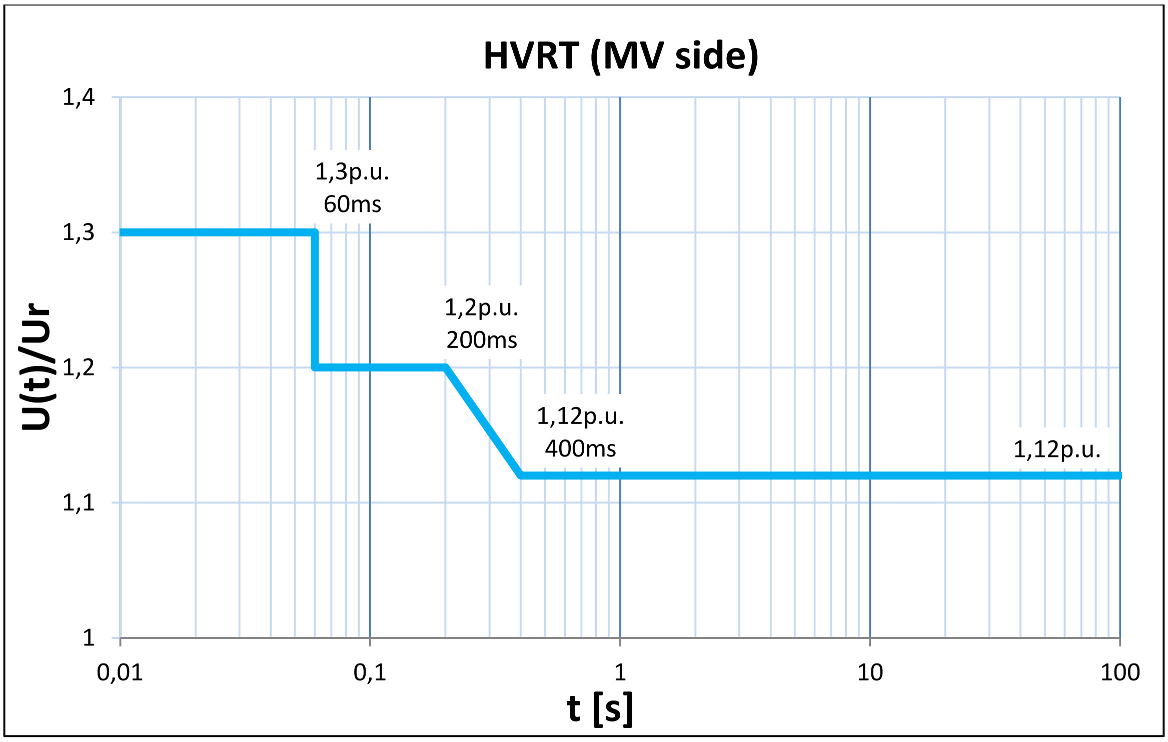


Figure 2. Upper voltage limits for SG 4.5-145, 50 Hz wind turbine in the range of 0-100 seconds. The nominal voltage is 690 V (i.e. 1 p.u.).

Power Factor (Reactive Power) Capability
The wind turbine is able to operate in a power factor range of 0.9 leading to 0.9 lagging at the low voltage side of the wind turbine transformer, at nominal balanced voltage and nominal frequency. The control mode for the wind turbine is voltage control. Power factor and reactive power regulation are not provided at the wind turbine level.

Supervisory Control and Data Acquisition (SCADA) Capability
The SGRE SCADA system has the capability to transmit and receive instructions from the transmission system provider for system reliability purposes depending on the configuration of the SCADA system. The project specific SCADA requirements must be specified in detail for design purposes.

Frequency Capability
The wind turbine is able to operate in the frequency range between 47 Hz and 53 Hz.

Voltage Capability
The voltage operation range for the wind turbine is between 90% and 112% of nominal voltage at the low voltage side of the wind turbine transformer. The voltage can be up to 130% for 60ms, see Figure 2. The wind turbine's target voltage shall stay between 95% and 105% in order to support the best possible performance by staying within the operation limits.

Flicker and Harmonics
Flicker and Harmonics values will be provided in the power quality measurement report extract in accordance with IEC 61400-21 Edition 2.

Voltage Control
The voltage control of the wind power plant is managed by two control loops. The inner loop controls the 690V system and is carried out by the wind turbine controller. The outer loop controls the HV system and is carried out by the SCADA system. The SCADA system receives feedback on the voltage level at the wind power plant connection point. This is compared to the target levels by the wind power plant's controller and voltage set-points are distributed to each individual wind turbine, to the controllers. This means that the wind turbine's controller responds to the latest reference from the SCADA system and will maintain this on the 690V system.

Frequency Control
The frequency control is managed by the SCADA system together with the wind turbine controller. The wind power plant frequency control is carried out by the SCADA system which distributes active power set-points to each individual wind turbine, to the controllers. The wind turbine controller responds to the latest reference from the SCADA system and will maintain this active power locally.

All data are subject to tolerances in accordance with IEC.

Preliminary Grid Performance Specification, 60 Hz

General
This document describes the grid performance of the SG 4.5-145, 60 Hz wind turbine. Siemens Gamesa Renewable Energy (SGRE) will provide wind turbine technical data for the developer to use in the design of the wind power plant and the evaluation of requirements compliance. The developer will be responsible for the evaluation and ensuring that the requirements are met for the wind power plant.

The capabilities described in this document are based on the assumption that the electrical network is designed to be compatible with operation of the wind turbine. SGRE will provide a document with guidance to perform an assessment of the network's compatibility.

Fault Ride Through (FRT) Capability
The wind turbine is capable of operating when voltage transient events occur on the interconnecting transmission system above and below the standard voltage lower limits and time slot according to Figure 3 and Figure 4.

This performance assumes that the installed amount of wind turbines is in the right proportion to the strength of the grid, which means that the short circuit ratio (Sk/Sn) and the X/R ratio of the grid at the wind turbine transformer terminals must be adequate.

Evaluation of the wind turbine's fault ride through capability in a specific system must be based on simulation studies using the specific network model and a dynamic wind turbine model provided by SGRE in PSS/E. This model is a reduced order model, suitable for balanced simulations with time steps between 4-10 ms.

The standard voltage limits for the SG 4.5-145, 60 Hz wind turbine are presented in Figure 3 between 180 - 1000 seconds and in Figure 4 between 0.4 – 100 seconds.

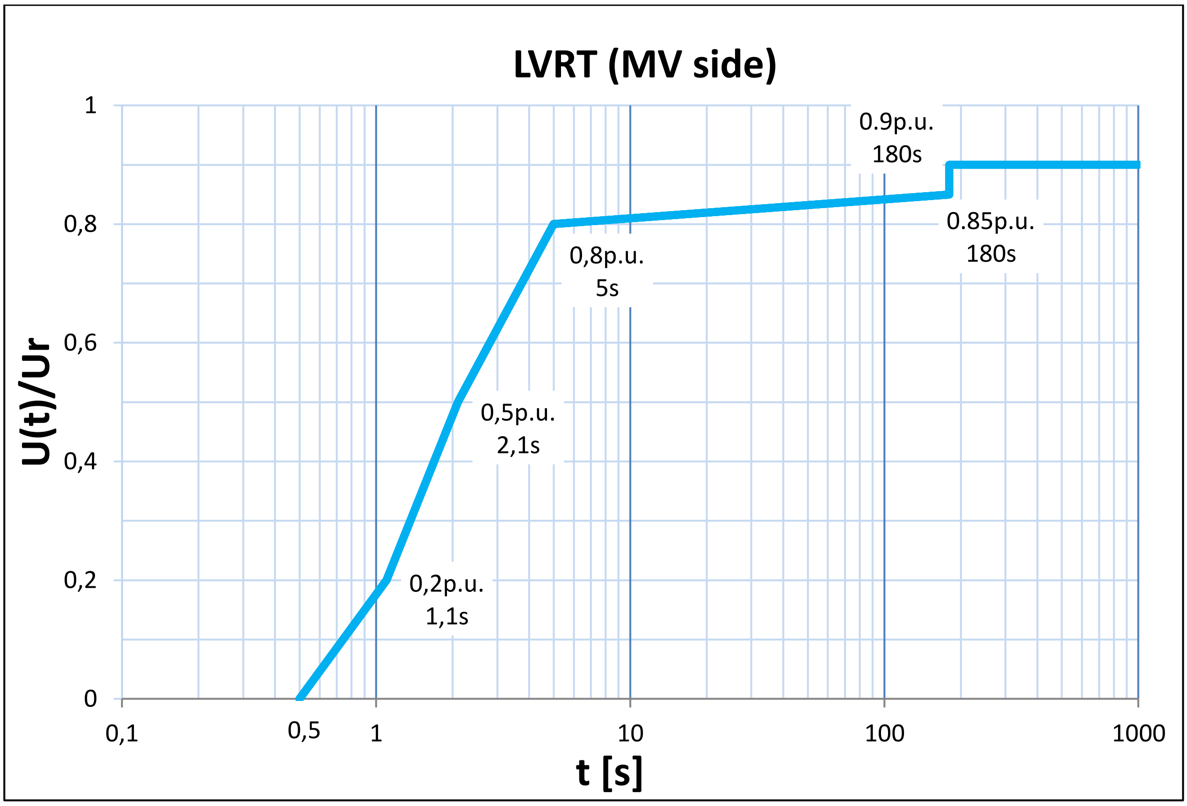


Figure 3. Lower voltage limits for SG 4.5-145, 60 Hz wind turbine in the range of 0-1000 seconds. The nominal voltage is 690 V (i.e. 1 p.u.).

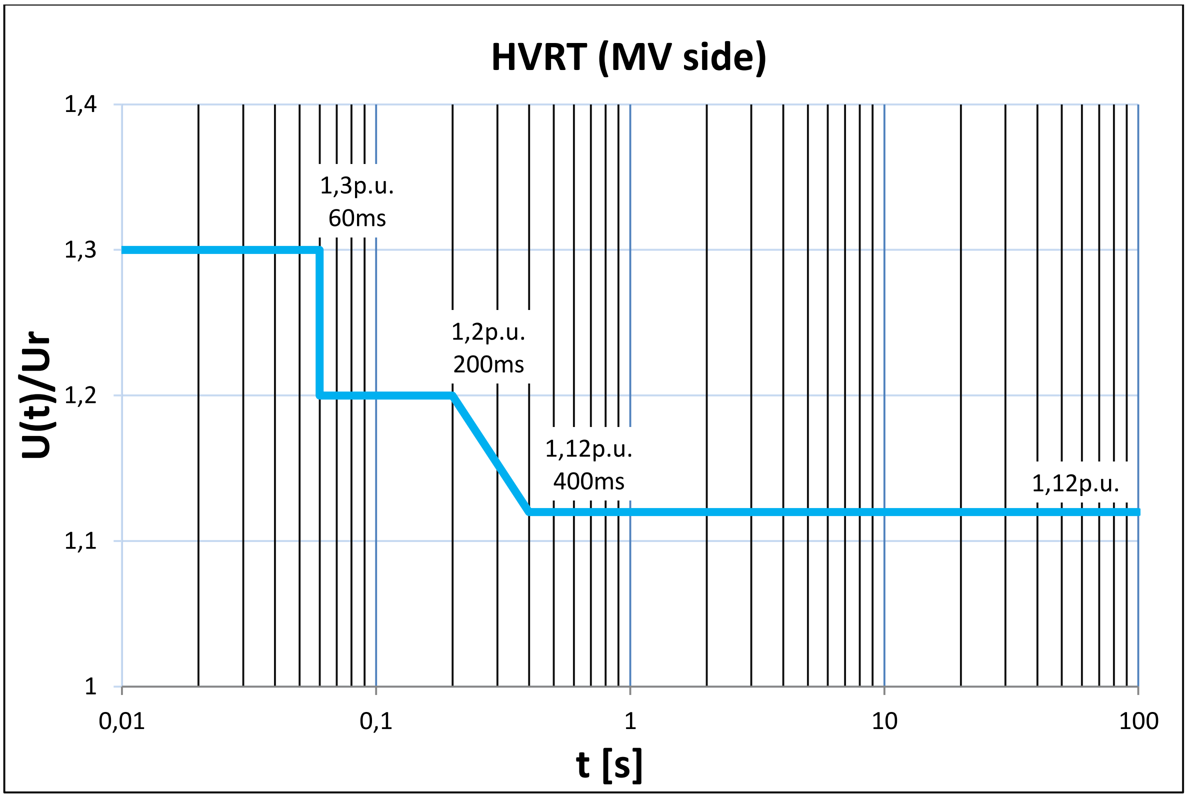


Figure 4. Upper voltage limits for SG 4.5-145, 60 Hz wind turbine in the range of 0-100 seconds. The nominal voltage is 690 V (i.e. 1 p.u.).

Power Factor (Reactive Power) Capability
The wind turbine is able to operate in a power factor range of 0.9 leading to 0.9 lagging at the low voltage side of the wind turbine transformer, at nominal balanced voltage and nominal frequency. The control mode for the wind turbine is voltage control. Power factor and reactive power regulation are not provided at the wind turbine level.

Supervisory Control and Data Acquisition (SCADA) Capability
The SGRE SCADA system has the capability to transmit and receive instructions from the transmission system provider for system reliability purposes depending on the configuration of the SCADA system. The project specific SCADA requirements must be specified in detail for design purposes.

Frequency Capability
The wind turbine is able to operate in the frequency range between 56.4 Hz and 63.6 Hz.

Voltage Capability
The voltage operation range for the wind turbine is between 90% and 112% of nominal voltage at the low voltage side of the wind turbine transformer. The voltage can be up to 130% for 60ms, see Figure 4. The wind turbine’s target voltage shall stay between 95% and 105% in order to support the best possible performance by staying within the operation limits

Flicker and Harmonics
Flicker and Harmonics values will be provided in the power quality measurement report extract in accordance with IEC 61400-21 Edition 2.

Voltage Control
The voltage control of the wind power plant is managed by two control loops. The inner loop controls the 690V system and is carried out by the wind turbine controller. The outer loop controls the HV system and is carried out by the SCADA system. The SCADA system receives feedback on the voltage level at the wind power plant connection point. This is compared to the target levels by the wind power plant’s controller and voltage set-points are distributed to each individual wind turbine, to the controllers. This means that the wind turbine’s controller responds to the latest reference from the SCADA system and will maintain this on the 690V system.

Frequency Control
The frequency control is managed by the SCADA system together with the wind turbine controller. The wind power plant frequency control is carried out by the SCADA system which distributes active power set-points to each individual wind turbine, to the controllers. The wind turbine controller responds to the latest reference from the SCADA system and will maintain this active power locally.

All data are subject to tolerances in accordance with IEC.

Reactive Power Capability, 50 Hz

General
This document describes the reactive power capability of SG 4.5-145, 50 Hz wind turbines during active power production. SG 4.5-145 wind turbines are equipped with a B2B Partial load frequency converter which allows the wind turbine to operate in a wide power factor range.

Reactive Power Capability Curves

The reactive power capability for the wind turbine at the LV side of the wind turbine transformer will be presented in the following Figures.

Figure 5 shows the reactive power capability on the LV side of the wind turbine depending on the generated power at LV terminals.

Figure 6 shows the reactive power capability on the LV side of the wind turbine transformer at various voltages between 0.90 p.u. and 1.13 p.u. at the LV terminals.

Figure 7 includes reactive power capability at no wind (QwP0).

The SCADA can send voltage references to the wind turbine in the range of 0.92 p.u. to 1.08 p.u. The wind power plant should be designed to maintain the wind turbine voltage references between 0.95 p.u. and 1.05 p.u. during steady state operation.

The tables and figures assume that the phase voltages are balanced, and that the grid operational frequency and component values are nominal. Unbalanced voltages will decrease the reactive power capability. Component tolerances were not considered in determining curve parameters. Instead, the curves and data are subject to an overall tolerance of ± 5 % of the rated power.

The reactive power capability presented in this document is the net capability and accounts for the contribution from the wind turbine auxiliary system, the reactor and the filter.

The reactive power capability described is valid while operating the wind turbine within the limits specified in the Design Climatic Conditions.

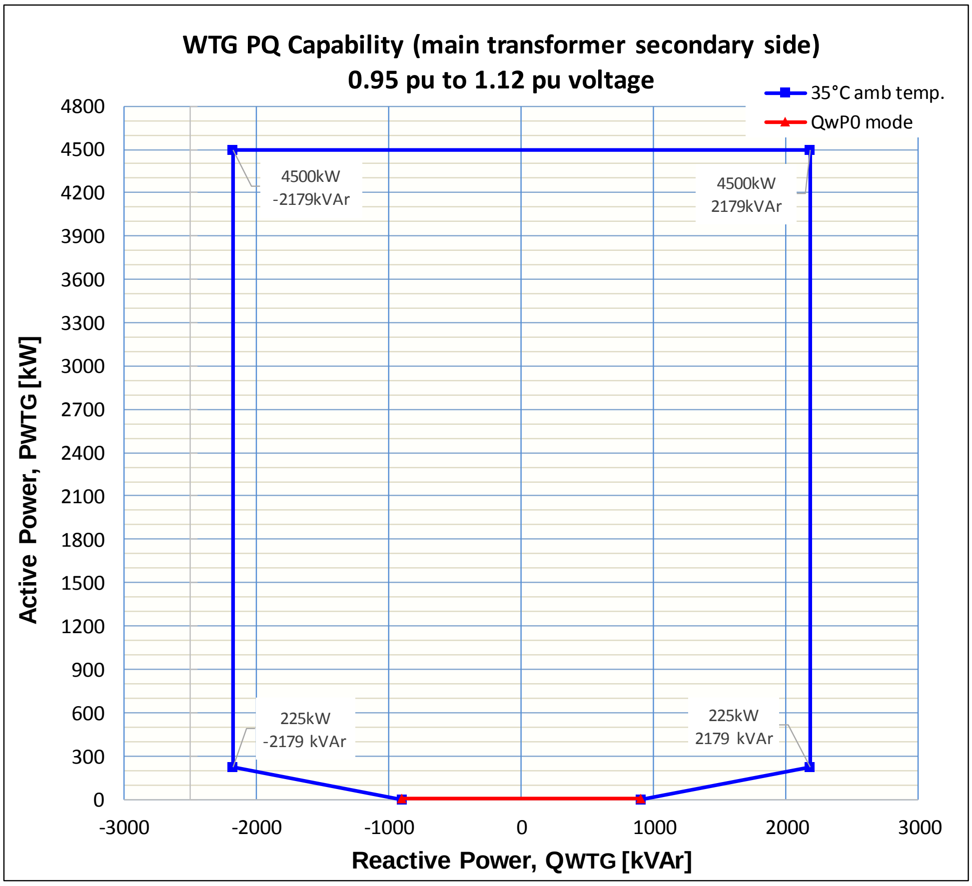


Figure 5: Reactive power capability curves for for all application modes, 50 Hz wind turbine, at LV side of wind turbine transformer.

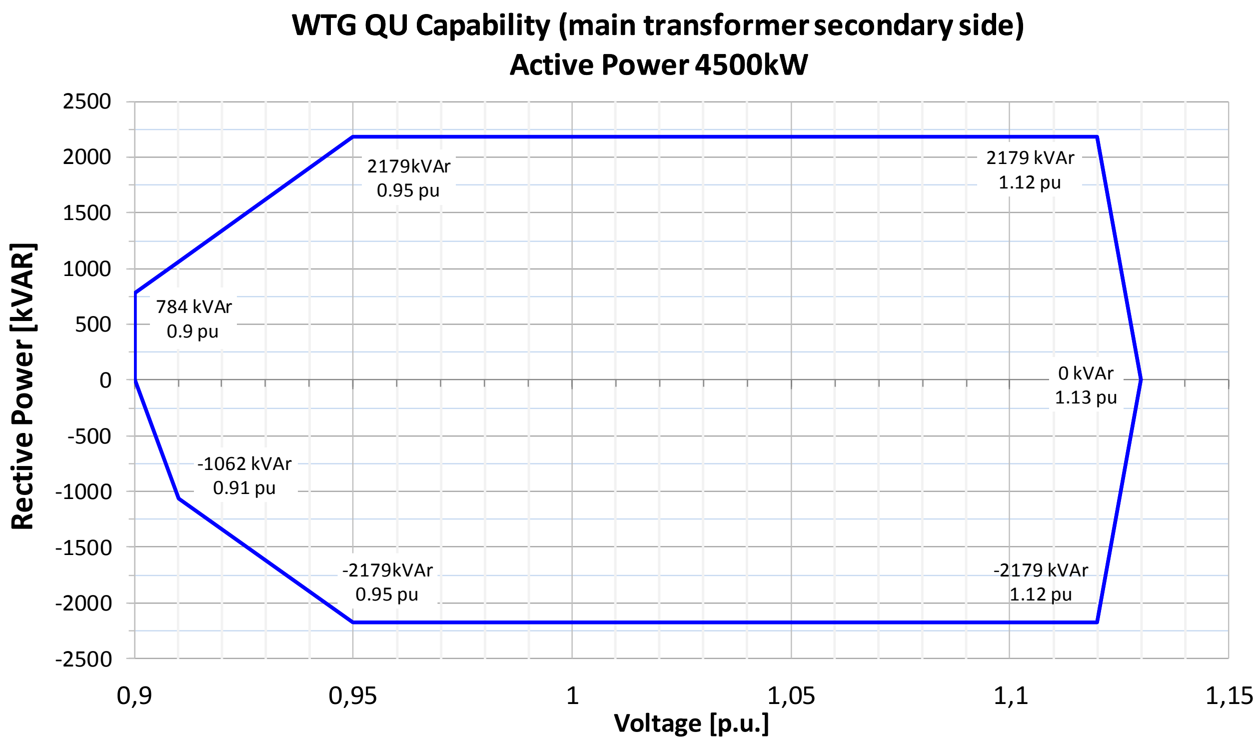


Figure 6. Reactive power capability versus LV voltage.

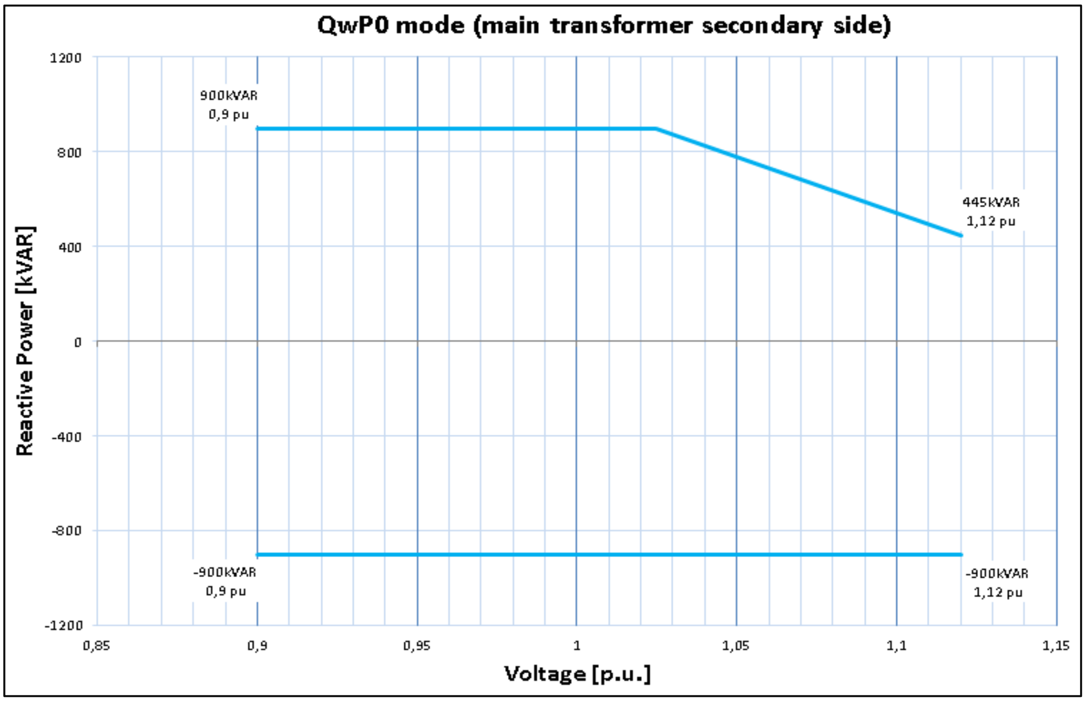


Figure 7. Reactive power capability at no wind (QwP0)

All data are subject to tolerances in accordance with IEC.

Reactive Power Capability, 60 Hz

General
This document describes the reactive power capability of SG 4.5-145, 60 Hz wind turbines during active power production. SG 4.5-145 wind turbines are equipped with a B2B Partial load frequency converter which allows the wind turbine to operate in a wide power factor range.

Reactive Power Capability Curves
The reactive power capability for the wind turbine at the LV side of the wind turbine transformer will be presented in the following Figures.

Figure 8 shows the reactive power capability on the LV side of the wind turbine depending on the generated power at LV terminals.

Figure 9 shows the reactive power capability on the LV side of the wind turbine transformer at various voltages between 0.90 p.u. and 1.13 p.u. at the LV terminals.

Figure 10 includes reactive power capability at no wind (QwP0).

The SCADA can send voltage references to the wind turbine in the range of 0.92 p.u. to 1.08 p.u. The wind power plant should be designed to maintain the wind turbine voltage references between 0.95 p.u. and 1.05 p.u. during steady state operation.

The tables and figures assume that the phase voltages are balanced, and that the grid operational frequency and component values are nominal. Unbalanced voltages will decrease the reactive power capability. Component tolerances were not considered in determining curve parameters. Instead, the curves and data are subject to an overall tolerance of ± 5 % of the rated power.

The reactive power capability presented in this document is the net capability and accounts for the contribution from the wind turbine auxiliary system, the reactor and the filter.

The reactive power capability described is valid while operating the wind turbine within the limits specified in the Design Climatic Conditions.

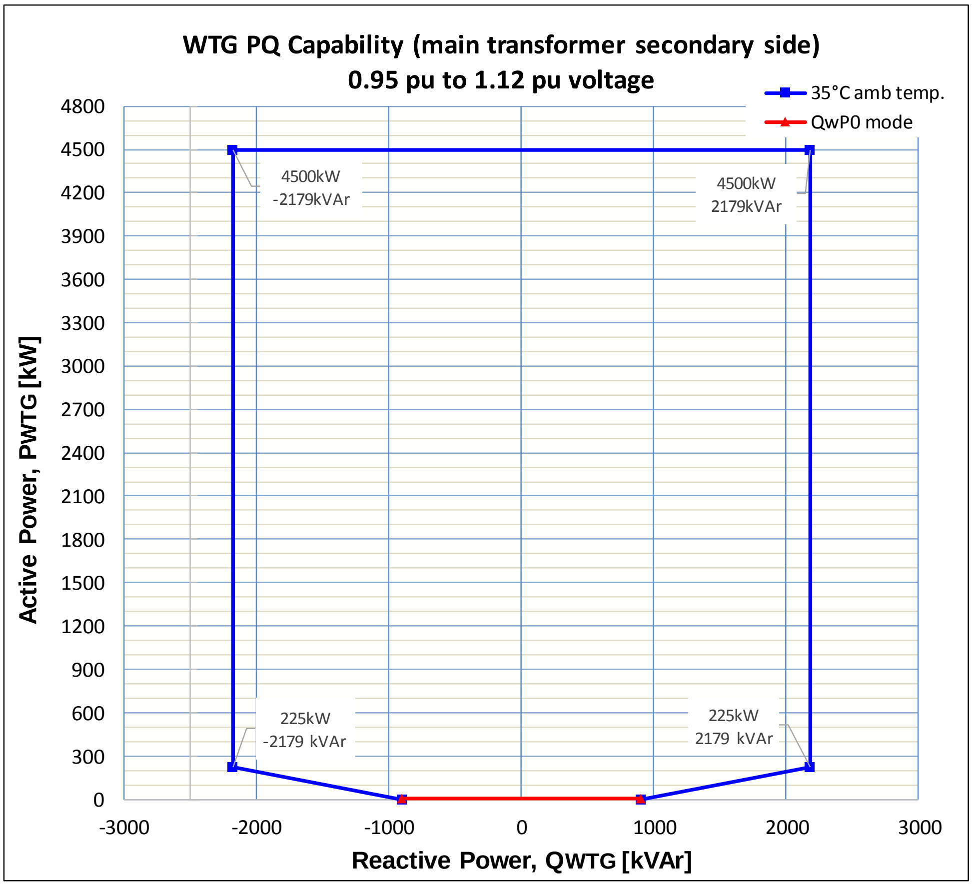


Figure 8. Reactive power capability curves for all application modes, 60 Hz wind turbine, at LV side of wind turbine transformer

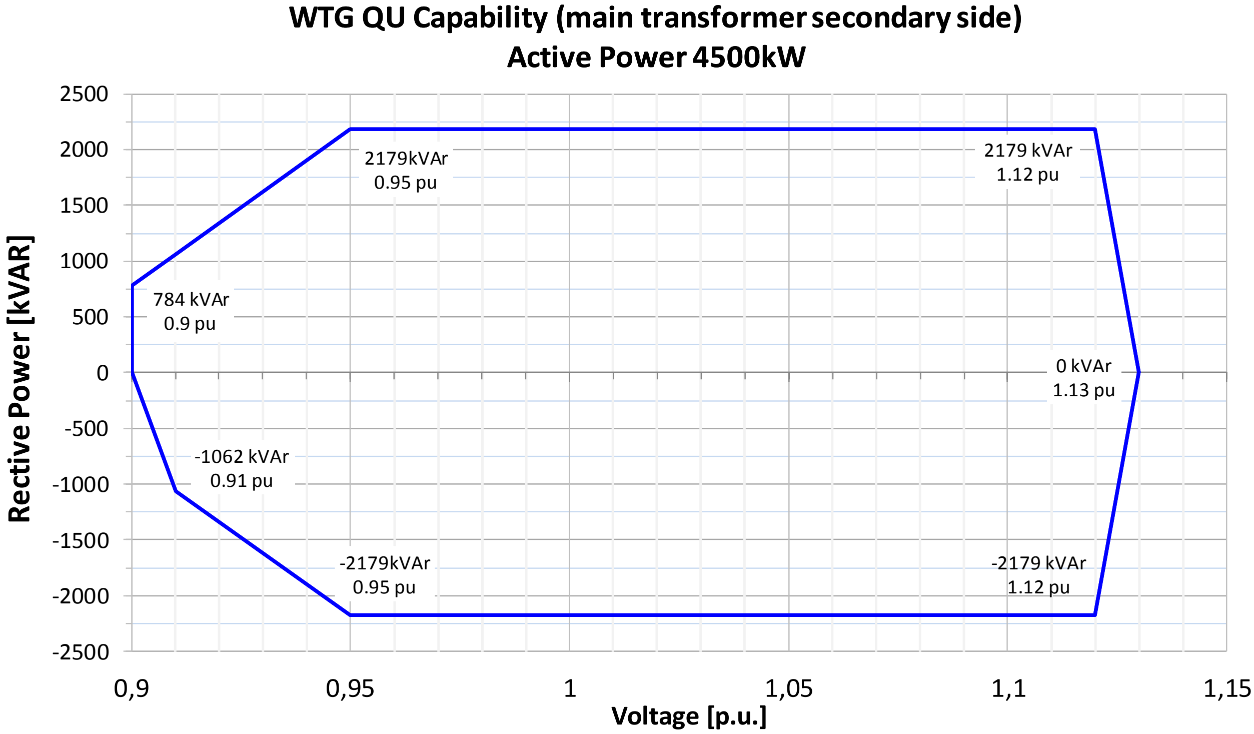


Figure 9. Reactive power capability versus LV voltage

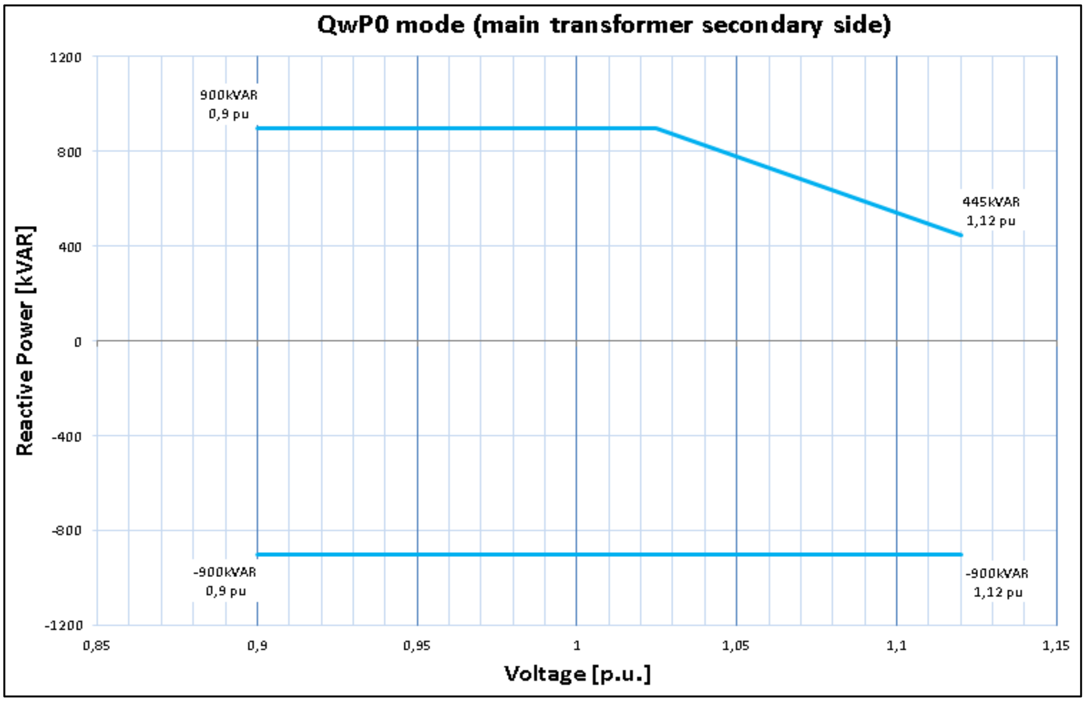


Figure 10. Reactive power capability at no wind (QwP0).

SCADA, System Description

General

This is a general description of the Siemens Gamesa Renewable Energy (SGRE) SCADA System.

WindNet® PRO SCADA is a wind farm management tool. Overall, the SCADA enables:

- Supervising, monitoring and/or controlling not only wind turbines in a given wind farm, but also other components installed in the wind farm such as meteorological masts, substations, measuring devices, etc.
- Storing and managing information, which provides an advanced capacity to generate reports.
- Connecting to control centers or higher level management systems.
- Wind farm power regulation for both active as well as reactive power.
- Wind farm electricity generation based on environmental conditions.

In short, the SCADA system is an indispensable communications gateway for incoming and outgoing wind farm data.

Main Features

The WindNet® PRO SCADA system has the following main features:

– Wind turbine supervision and control.
– Meteorological mast supervision.
– Supervision and control of the wind farm's feed-in substation.
– Alarms and notifications SGRE management.
– Reporting for technical and economic wind farm exploitation.
– Access security via user and profile management.
– Multiple-wind farm management capacity enabling various wind farms to be managed from a single SCADA installation. Optimized SQL database for data management.
– Integration with the SGRE preventive maintenance system (PMS)
– Integration with SGRE support systems for managing payment features
– Additionally, the SGRE SCADA system has the following optional features:
– Data server for access and/or integration in upper systems: OPC-DA server, OPC-HDA server, MODBUS client/server and DNP3 client/server.
– Integration of the SGRE Power Manager tool, which includes the active power/frequency regulating tools and reactive power/voltage regulation for the wind farm (up to two points of connection for each SCADA installation)
– NRS® (Noise Reduction System) to safeguard the acoustic integrity of the area based on wind direction and time
– Shadow Control System to prevent the undesired effects of shadows in residential areas near the wind farm
– Wake Cancellation System for protecting wind turbines from intense turbulence based on wind direction
– Ice Detection System for protecting the surrounding area against ice thrown from wind turbine blades
– Bat Shield System for protecting bats
– SGRE Messenger application for distributing SMS and/or email messages to operators and maintenance technicians (SIM card not included)

- Communication Manager integration with the cut-off switch feature to prevent remote wind turbine operation while maintaining continuous wind turbine monitoring, in addition to a slow buffer feature to retrieve and send data to the SCADA following an extended period of disconnected communication.
- ODBC access to the database.
- Integration of GUYS, SGRE's yawing interruption system. This system works from installed diesel generators that supply power to the auxiliary circuits in the wind turbines. It has been designed to enable the wind turbine to yaw automatically in conditions of strong gusty winds.

Main System Capabalities

WindNet® PRO has successfully undergone a certification process that enables it to guarantee the following for 5-second sampling periods:

- 99.99% data acquisition reliability.
- 99.99% reliability in the publication of information by OPC-DA (up to 100,000 variables for a single OPC client connected or 10,000 variables for 10 simultaneous clients).
- 99.99% correlation between the information displayed in real time (OPC-DA) and the recovered log (OPC-HDA, ODBC, Trends or through reporting tools).
- 100% correlation of log (historical) data recovered by any of the 4 methods (OPC-HDA, ODBC, Trends and reporting tools).

The WindNet® PRO storage system has a guaranteed 5-year storage of analog, digital, AWES and 10min variables, accessible online, and 15 additional years for recoverable data backup

Wind Farm Management System

SGRE's wind farm management system comprises the central system WindOne®, Service Operations Center (SOC), the SCADAs installed in wind farms and the wide area network (WAN) that links them all together.

During maintenance and/or the warranty period, wind farms with SGRE wind turbines must be integrated in the central system WindOne® under the control of the SOC (Service Operations Center). This system compiles data from all connected wind farms, checking and storing the retrieved data in keeping with the specified storage policy. The centralization of wind farm supervision offers excellent resources for monitoring the product, maintenance planning and reports on operating status and maintenance intended for clients. WindOne® likewise offers the Delegated Dispatch function in communication with the Network Operator with a view to keeping the electricity grid stable.

External access to the wind farm from WindOne® requires both primary and redundant communications lines to guarantee the availability of communications. Both lines and communications equipment are supplied by SGRE. Nonetheless, other communications solutions can be assessed whenever they meet the technical requirements for communications specified by SGRE.

Communication Network in Wind Farm

A wind farm's internal communications infrastructure is a network that links the SGRE SCADA system to the various wind farm devices (e.g., wind turbines, meteorological masts and substations).
Internal wind farm communications are based on a local area network (LAN) with Ethernet communications on ring-configured fiber optics. This is a "logical" round-trip ring through the same fiber optic cable so that the send path runs through two fibers and the return path runs through another two in the same cable. The wind turbines alternate where fibers connect to one another in the routing to prevent long links whenever possible.

The selection of the fiber optics for the wind farm and the overall layout of the ring network must meet SGRE specifications and will always be defined or validated by SGRE.
Likewise, the final configuration of a specific LAN network for a given wind farm will be jointly agreed between SGRE and the wind farm client.

External communication outside the wind farm through external protocols and/or SCADA clients can be based on any type of telecommunications system such as satellite links, ADSL/DSL lines, GPRS links, PSTN modems, GSM modems, etc. The primary criteria for selecting the appropriate means are the bandwidth requirements, need for continuous or on-demand connection, and the amount of data exchanged

Client Interface

Wind farm operators can view all the data in a simple and intuitive user interface based on web browser technology.
All operational aspects and access to SCADA system options are available through a standard web browser, though the latest version of Google Chrome is recommended

Data Analysis

WindNet® PRO includes 3 different wind farm data analysis tools:

- Reports: designed for exploitation reports
- Trending: designed for in-depth analysis of wind turbine variables.
- Comparatives: designed for instantaneously comparing two variables of all the wind turbines in the farm.

Codes and Standards For Design, Manufacturing, and Testing

The wind turbine is designed, manufactured, and tested to Siemens Gamesa Renewable Energy's technical drawings, procedures, and processes that are generally in compliance with the applicable sections of the codes and standards listed herein. This list of codes and standards for design, manufacturing, and testing forms a part of the design basis documentation for the certification of the wind turbine. The edition of the codes and standards is the version used for the certification process which was conducted by an external certifying body.

General

- IEC 61400-22:2010 Ed.1, Wind turbines – Part 22: Conformity testing and certification
- EN 61400-1:2006, Wind turbine generator systems, Part 1: Safety requirements, (IEC 61400-1:2005, modified).
- IEC 61400-1:2005 Ed.3, incl. Amendment. Wind turbine generator systems, Part 1: Safety requirements.
- DIBt – Richtlinie für Windenergieanlagen – Fassung September 2013.
- IEC 61400-11:2012 ed.3: Wind turbine generator systems. Part 11: Acoustic noise measurement techniques.
- IEC 61400-12:2005, Wind turbine generator systems. Part 12: Wind turbines power performance testing.
- DS/IEC/TS 61400-13 Ed.1, Wind turbine generator systems, Part 13: Measurement of mechanical loads.
- DS/IEC/TS 61400-23:2001, Wind turbine generator systems, Part 23: Full-scale structural testing of rotor blades.
- VDI 2230 Blatt 1, February 2003, Systematic calculation of high duty bolted joints – Joints with one cylindrical bolt (Bolt calculations)
- DS-EN ISO 898-1(2009-08), Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.
- EN 10029:2010, Hot rolled steel plates 3 mm thick or above – Tolerances on dimensions, shape and mass
- DS/EN 10083:2006, Quenched and tempered steels – Part 1: Technical delivery conditions for special steels (Main shaft)
- DS/EN 1563 +A1:2004, Founding – Spheroidal graphite cast irons
- DS/EN 10025-1:2004, Hot rolled products of structural steels – Part 1: General technical delivery conditions
- DS/EN 10025-2:2004, Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels
- DS/EN 10025-3:2004, Hot rolled products of structural steels – Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
- 97/23/EC Pressure Equipment Directive
- EN 1993 – Design of steel structures
- EN 1999 – Design of aluminum structures
- ISO/TS 16281:2008 Rolling bearings – Methods for calculating the modified reference rating life for universally loaded bearings
- DIN ISO 281 Rolling bearings - Dynamic load ratings and rating life
- DIN ISO 76:2006 Rolling bearings - Static load ratings
- ISO/TS 16281:2008 + Cor. 1:2009 Rolling bearings - Methods for calculating the modified reference rating life for universally loaded bearings
- DNV-DS-J102:2010, Design and Manufacture of Wind Turbine Blades, Offshore and Onshore Wind Turbines

Electrical

- EN 61000-6-2:2005 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for
- industrial environments
- EN 61000-6-4:2007 Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
- EN 60204-1:2006 Safety of machinery – Electrical equipment of machines – Part 1: General requirements
- IEC 61400-24:2010, Wind turbine generator systems – Part 24: Lightning protection
- DS/EN 60076–16:2012 - Power transformers – Part 16: Transformers for wind turbine applications
- IEC 61400-21:2008, Wind turbine generator systems – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines
- Directive 2014/35/EU on Electrical Low Voltage Equipment (LV)
- Directive 2014/30/EU on Electromagnetic Compatibility (EMC)

Quality

- ISO 9001:2015, Quality management systems – Requirements.

Personal Safety

- OSHA 2005 Requirements for clearances at doorways, hatches, and caged.
    - OSHA’s Subpart D Walking-Working Surfaces Section 1910.27v
- 2006/42/EC Machinery Directive

Corrosion

- DS/EN ISO 12944-1:2000, Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 1: General introduction (class C3 to C4).

Other Performance Features

Siemens Gamesa Renewable Energy (SGRE) offers the following optional performance features for SG 4.5-145 that can optimize your wind farm by boosting performance, enhancing environmental agility, supporting compliance with legal regulation, and supporting grid stability.

High Wind Derated operational mode
In the case of SG 4.5-145 high wind derated mode, it is enabled as it can be observed on the different power curves included in this document. The power production is limited once wind speed exceeds a threshold value defined by design, until cut-out wind speed is reached and the wind turbine stops producing power. This functionality extends the range of operation in high wind conditions limiting turbine loads dependent of maximum operational wind speed, providing more predictable energy output, minimizing production losses, and improving grid stability by reducing the risk of simultaneous power cut outs.

High Temperature Derated operational mode (also known as Power Derating due to external ambient temperature and altitude)

Ventilation and cooling systems are designed to allow the WTG operation at rated power up to a certain external nominal temperature and a certain altitude. For sites located beyond 1000m above the sea level, the air density reduction affects the turbine components ventilation capacity, reducing the maximum operational temperature at rated power. However, this maximum ambient temperature can be extended by reducing the delivered power.

Considering the individual components requirements in temperatures at different altitude levels, and their dissipated heat at different power limits, several curves power-temperature will be generated. These curves will define the envelopes inside which SG 4.5-145 could operate assuring the integrity of all components.

The control system, considering the defined turbine type and altitude above sea level, will dynamically adjust the maximum allowed power as a function of the ambient temperature.

Ice Detection System

A default IDS is included in SG 4.5-145. This system is required in order to prevent the turbine operating under non desirable ice conditions that could represent an out-of-design situation with risk for the turbine integrity or H&S.

The default IDS can be improved by application of additional features, described as follows:

- Ice on nacelle sensor (optional kit). Additional sensor is installed to detect ice on nacelle.
- Improved ice on blade detection algorithm (optional, only available when blade de-icing system is installed). It requires additional hardware. It is a more complex ice detection algorithm defined based on ice probability calculation, and it is a valuable complement for improving the blade de-icing system performance.

Noise Reduction System

The Noise Reduction System NRS is an optional module available with the basic SCADA configuration and it therefore requires the existence of a SGRE SCADA system to work.

The purpose of this system is to limit the noise emitted by any of the functioning turbines and thereby comply with local regulations regarding noise emissions. This allows wind farms to be located close to urban areas, limiting the environmental impact that they imply.

Bat Shield
Bat shield is an application for mitigating bat mortality in areas with local or migrating bat population.

SIEMENS Gamesa RENEWABLE ENERGY	GENERAL CHARACTERISTICS MANUAL	Code: GD372369-en Rev: 0
		Date: 16/04/2018 Pg. 1 of 7
Approval process: PDTD - Product	Title:	Approval process: Electronic: PDM Flow
		Prepared: JSANMARTIN / SNOVO
Deliverable: S12	SG 4.5-145 LOW NOISE MODES	Verified: JEJGUERRERO
		Approved: RRS

INDEX

RECORD OF CHANGES

Rev.	Date	Author	Description
0	16/04/2018	JSANMARTIN/SNOVO	Initial Version

1 AIM

This document presents the power curves and noise emissions associated to the low noise operating modes of the SG 4.5-145 wind turbine.

2 SCOPE

The values in the present document are applicable to all the existing configurations for the SG 4.5-145 wind turbine according to tower height. Tonality is not considered. The noise levels given in the document do not apply to high temperature versions.

3 ABBREVIATIONS, DEFINITIONS

- **WT**: Wind turbine.
- **Power (P):** Expressed in kW, this is the electric power obtained at the generator terminals without considering the losses in the transformer or high voltage cables of the wind turbine, or the occasional power consumption which may exist in the same to supply a component. Averaged every 10 minutes.
- **Wind speed (W_S):** Expressed in m/s, it is the horizontal wind component value at the height of the hub averaged every 10 minutes.
- **Power curve (CdP):** Represents the change in the P in accordance with the W_S for the different WT operating modes.
- **Annual Output / Annual Energy Production (AEP)**: Expressed in [MWh], it is the total electrical energy produced in a WT during a one-year period, in accordance with a given CdP and a given wind distribution.
- **Wind distribution:** The Weibull distribution is used for different K-distribution parameters and for annual average wind speed values (W_{ave}).
- **Wind speed W_{10} [m/s]:** The wind speed value, measured at 10m above ground level.
- **Tower height (H):** Expressed in meters, is the height of the rotor center above ground level.
- **Power coefficient:** C_P.
- **Thrust coefficient:** C_T.
- **Noise level:** The expected sound power level values, expressed in dB(A), represent the sound power that the WT emits at the height of the hub for a given wind speed. In accordance with the IEC standard, the wind speed value (W_{10}) 10 m from the ground is used.

  The noise levels shown in this document are average expected values, called Lw in IEC-61400-14. To obtain the Lwd value, as defined in IEC-61400-14, an increase of 2 dB(A) shall be considered over said Lw values.

- **dB(A):** An A type frequency filter is applied, in accordance with the IEC standard.

4 DESCRIPTION

When not specified otherwise, data in following sections is calculated using the parameters from Table 1. All power curve and annual energy production values in this document are subject to the validity ranges presented in Table 2.

Rated power	4.5 MW
Frequency	50Hz/60Hz
Rotor Diameter	145 m
Angle of blade tip	Pitch control regulation
Air density reference	1.225 kg/m3

Table 1 Calculation parameter values for the SG 4.5-145 wind turbine power curve.

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\% \frac{(0.75 v_i + 5.6)}{v_i} < TI_i < 12\% \frac{(0.75 v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [º]	-2º ≤ β ≤ +2º
Grid frequency [Hz]	± 0.5 Hz

Table 2 Validity ranges for the SG 4.5-145 wind turbine power curve.

Noise values included in the present document correspond to the wind turbine configuration equipped with noise reduction add-ons attached to the blade.

5 LOW NOISE OPERATION MODES

5.1 LOW NOISE POWER CURVES

The noise reduction modes that limit the noise at higher wind speed are indicated as N1, N2 up to N8. The noise reduction levels that correspond to the mode indication in this document are represented in **table 3** below:

Mode:	**FP**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Noise Level [dB(A)]	107.8	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0

Table 3: Wind turbine SG 4.5-145 noise reduction levels at high wind speed.

Table 4 shows the feasibility for low noise operation modes:

SG 4.5-145	N1	N2	N3	N4	N5	N6	N7	N8
H= 107.5 m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
H= 127.5 m	No	No	No	No	Yes	Yes	Yes	Yes

Table 4: Wind turbine SG 4.5-145 low noise levels

Table 5 presents the electrical power output [kW] in function of the horizontal wind speed W_S [m/s] at hub height (W_S) for different noise reduction mode settings.

Power [kW]								
W_S [m/s]	N1 105.7 [dB(A)]	N2 105.2 [dB(A)]	N3 103.7 [dB(A)]	N4 102.7 [dB(A)]	N5 101.7 [dB(A)]	N6 99.9 [dB(A)]	N7 99.0 [dB(A)]	N8 98.0 [dB(A)]
3	57	57	57	57	57	57	57	57
4	243	243	243	243	243	243	243	243
5	556	556	556	556	556	556	556	555
6	1010	1010	1010	1009	1007	995	981	961
7	1638	1636	1623	1604	1574	1490	1432	1366
8	2422	2404	2320	2240	2147	1951	1837	1717
9	3198	3134	2958	2814	2658	2341	2168	1994
10	3700	3581	3378	3207	3029	2647	2424	2202
11	3897	3747	3552	3382	3214	2851	2612	2350
12	3950	3790	3602	3435	3276	2951	2751	2466
13	3961	3798	3612	3447	3292	2987	2854	2554
14	3963	3800	3615	3449	3295	2997	2920	2607
15	3964	3800	3615	3450	3296	2999	2953	2631
16	3964	3800	3615	3450	3296	3000	2967	2641
17	3964	3800	3615	3450	3296	3000	2972	2644
18	3964	3800	3615	3450	3296	3000	2973	2645
19	3963	3800	3615	3450	3296	3000	2974	2645
20	3960	3799	3615	3450	3296	3000	2974	2645
21	3948	3794	3614	3450	3296	3000	2974	2645
22	3919	3779	3609	3449	3296	3000	2974	2645
23	3865	3748	3597	3446	3296	3000	2974	2645
24	3789	3700	3574	3439	3296	3000	2974	2645
25	3702	3638	3542	3429	3296	3000	2974	2645
26	3613	3571	3503	3416	3296	3000	2974	2645
27	3537	3511	3466	3402	3296	3000	2974	2645

Table 5: Electric power [kW] of the SG 4.5-145 wind turbine, according to W_S [m/s] and noise level [dB(A)]. (ref: *SG145AERNRS4500KW_R00_16042018*)

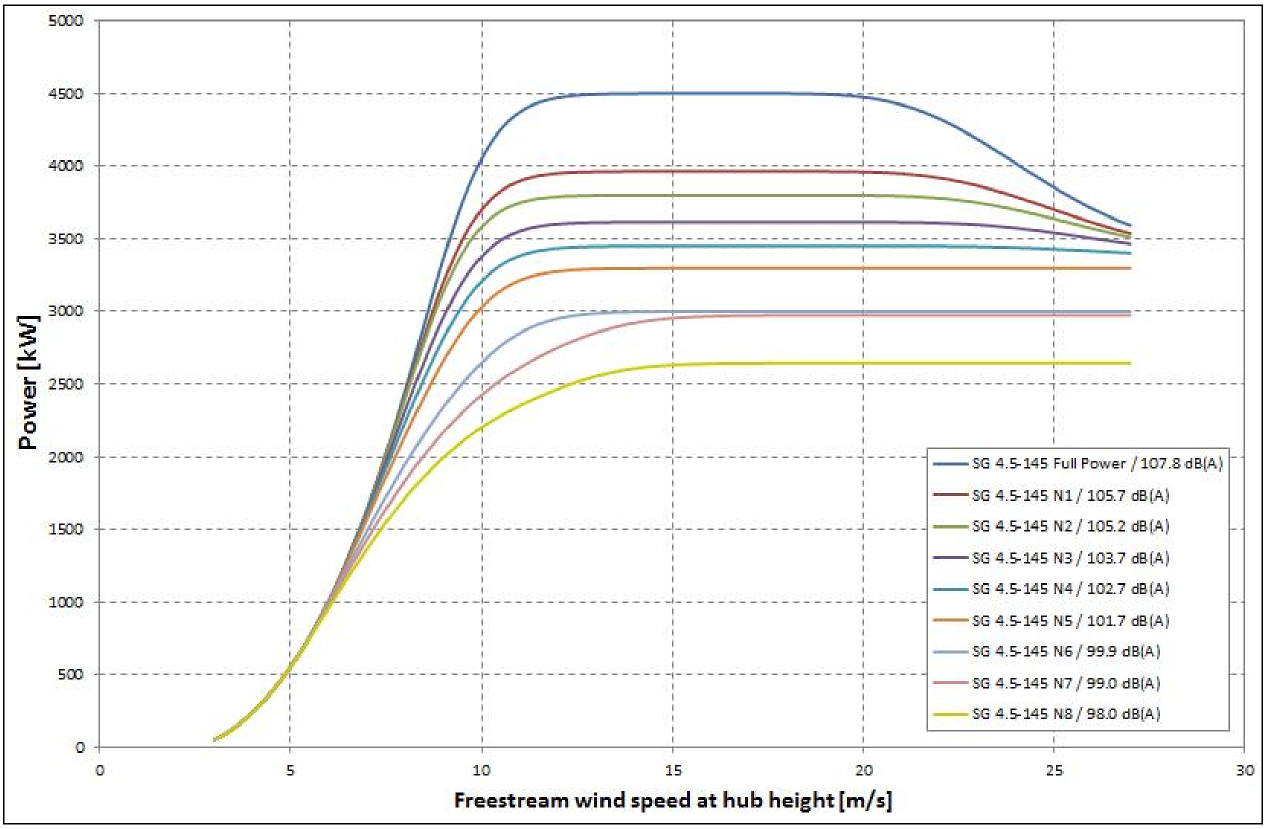


Figure 1: Power curves of the SG 4.5-145 wind turbine for different versions of low noise operating modes.

5.2 ANNUAL ENERGY PRODUCTION FOR THE LOW NOISE OPERATION MODES

Table 6 presents the annual energy output [MWh] for the SG 4.5-145 wind turbine calculated with different Weibull distribution parameters W_{ave} [m/s] and K, for different noise reduction modes.

AEP [MWh]												
W_{ave} [m/s]		5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
N1 105.7 [dB(A)]	K = 1.5	8704	10271	11758	13146	14424	15586	16629	17555	18366	19066	19661
	K = 2.0	8111	10011	11872	13648	15310	16847	18252	19526	20671	21691	22587
	K = 2.5	7435	9525	11649	13724	15691	17516	19183	20688	22038	23242	24309
N2 105.2 [dB(A)]	K = 1.5	8535	10048	11480	12815	14042	15157	16157	17043	17819	18489	19058
	K = 2.0	8004	9847	11644	13352	14946	16415	17756	18970	20060	21030	21882
	K = 2.5	7375	9415	11474	13475	15362	17106	18693	20122	21401	22539	23547
N3 103.7 [dB(A)]	K = 1.5	8239	9677	11037	12303	13467	14524	15472	16313	17050	17686	18227
	K = 2.0	7775	9526	11228	12843	14349	15736	17001	18148	19177	20094	20901
	K = 2.5	7215	9155	11105	12992	14769	16409	17901	19246	20449	21521	22471
N4 102.7 [dB(A)]	K = 1.5	7976	9348	10644	11849	12957	13962	14865	15665	16365	16970	17484
	K = 2.0	7569	9240	10860	12393	13822	15137	16336	17422	18398	19267	20032
	K = 2.5	7067	8921	10775	12564	14245	15796	17206	18476	19612	20624	21522
N5 101.7 [dB(A)]	K = 1.5	7696	9002	10235	11382	12435	13391	14249	15010	15676	16251	16741
	K = 2.0	7340	8928	10464	11918	13271	14517	15654	16684	17610	18435	19162
	K = 2.5	6894	8656	10410	12099	13687	15150	16483	17684	18760	19719	20571
N6 99.9 [dB(A)]	K = 1.5	7096	8268	9373	10401	11345	12203	12974	13658	14257	14775	15215
	K = 2.0	6836	8250	9615	10905	12108	13217	14231	15153	15983	16724	17379
	K = 2.5	6502	8068	9614	11098	12493	13782	14960	16027	16988	17848	18615
N7 99.0 [dB(A)]	K = 1.5	6762	7872	8924	9908	10817	11647	12397	13066	13655	14167	14605
	K = 2.0	6533	7852	9127	10339	11477	12536	13513	14409	15223	15957	16611
	K = 2.5	6259	7710	9137	10508	11804	13013	14130	15155	16090	16939	17707
N8 98.0 [dB(A)]	K = 1.5	6327	7327	8269	9146	9953	10687	11348	11936	12452	12898	13279
	K = 2.0	6189	7385	8531	9612	10620	11554	12411	13193	13903	14539	15105
	K = 2.5	5991	7317	8604	9829	10976	12039	13016	13907	14716	15448	16108

Table 6: Annual energy production for the SG 4.5-145 wind turbine for different Weibull parameters W_{ave} [m/s], Weibull K parameter and different noise reduction modes.
(ref: *SG145AERNRS4500KW_R00_16042018*)

5.3 NOISE CURVES

Table 7 represents the noise curves of the SG 4.5-145 wind turbine for different noise reduction modes in function of Ws [m/s].

Ws [m/s]	N1 [dB(A)]	N2 [dB(A)]	N3 [dB(A)]	N4 [dB(A)]	N5 [dB(A)]	N6 [dB(A)]	N7 [dB(A)]	N8 [dB(A)]
3	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
3.5	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
4	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
4.5	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1
5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5
5.5	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6
6	99.7	99.7	99.7	99.7	99.7	99.7	99.0	98.0
6.5	101.5	101.5	101.5	101.5	101.5	99.9	99.0	98.0
7	103.2	103.2	103.2	102.7	101.7	99.9	99.0	98.0
7.5	104.7	104.7	103.7	102.7	101.7	99.9	99.0	98.0
8	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
8.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
9	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
9.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
10	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
10.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
11	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
11.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
12	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
12.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
13	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
13.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
14	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
14.5	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0
15	105.7	105.2	103.7	102.7	101.7	99.9	99.0	98.0

Table 7: Noise curves of the SG 4.5-145 wind turbine (ref: *SG145AERNRS4500KW_R00_16042018*)

VESTAS V117

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General Description

4MW Platform

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Denmark · www.vestas.com

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See general reservations, notes and disclaimers (including, section 12, p. 37) to this general description.

1 Introduction

The 4MW Platform wind turbine configurations covered by this General Description are listed below with designations according to IEC61400-22.

DIBt 2012 wind classes are also listed where applicable.

Please refer to the Performance Specification for the relevant turbine variant for full wind class definition.

This General Description contains data and descriptions common among the platform variants.

The variant specific performance can be found in the Performance Specifications for the turbine variant and operational mode required.

Turbine Type Class	Turbine Type | Operating Mode
V117-4.0/4.2 MW Strong Wind	V117-4.0 MW IEC IB / IEC IIA 50/60 Hz | Mode 0
	V117-4.0 MW IEC IB / IEC IIA 50/60 Hz | Reactive Power Optimized Mode (QO1)
	V117-4.2 MW IEC S / IEC IIA 50/60 Hz | Power Optimized Mode (PO1)
	V117-3.8 MW IEC IB / IEC IIA 50/60 Hz | Load Optimized Mode (LO1)
	V117-3.6/3.x MW IEC IB / IEC IIA+ 50/60 Hz | Load Optimized Mode (LO2)
V117-4.0/4.2 MW Typhoon	V117-4.0 MW IEC IB-T / IEC IIA-T 50/60 Hz | Mode 0
	V117-4.0 MW IEC IB-T / IEC IIA-T 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V117-4.2 MW IEC S-T / IEC IIA-T 50/60 Hz | Power Optimized Mode (PO1)
	V117-3.8 MW IEC IB-T / IEC IIA-T 50/60 Hz | Load Optimized Mode (LO1)
	V117-3.6/3.x MW IEC IB-T / IEC IIA+-T 50/60 Hz | Load Optimized Mode (LO2)
V136-4.0/4.2 MW	V136-4.0 MW IEC IIB / IEC S 50/60 Hz | Mode 0
	V136-4.0 MW IEC IIB / IEC S 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V136-4.2 MW IEC S 50/60 Hz | Power Optimized Mode (PO1)
	V136-3.8 MW IEC IIB / IEC S 50/60 Hz | Load Optimized Mode (LO1)
	V136-3.6 MW IEC IIB / S 50/60 Hz | Load Optimized Mode (LO2)
	V136-4.0 MW DIBt S 50 Hz | Mode 0
	V136-4.0 MW DIBt S 50 Hz | Reactive Power Optimized Mode (QO1)
	V136-4.2 MW DIBt S 50 Hz | Power Optimized Mode (PO1)
	V136-3.8 MW DIBt S 50 Hz | Load Optimized Mode (LO1)
	V136-3.6 MW DIBt S 50 Hz | Load Optimized Mode (LO2)
V150-4.0/4.2 MW	V150-4.0 MW IEC IIIB / IEC S 50/60 Hz | Mode 0
	V150-4.0 MW IEC IIIB / IEC S 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V150-4.2 MW IEC S 50/60 Hz | Power Optimized Mode (PO1)
	V150-3.8 MW IEC IIIB / IEC S 50/60 Hz | Load Optimized Mode (LO1)
	V150-3.6 MW IEC IIIB / S 50/60 Hz | Load Optimized Mode (LO2)
	V150-4.0 MW DIBt S 50 Hz | Mode 0

Turbine Type Class	Turbine Type | Operating Mode
V150-4.0/4.2 MW (cont'd)	V150-4.0 MW DIBt S 50 Hz | Reactive Power Optimized Mode (QO1)
	V150-4.2 MW DIBt S 50 Hz | Power Optimized Mode (PO1)
	V150-3.8 MW DIBt S 50 Hz | Load Optimized Mode (LO1)
	V150-3.6 MW DIBt S 50 Hz | Load Optimized Mode (LO2)

Table 1-1: 4MW Platform turbine configurations covered.

2 General Description

Vestas 4MW Platform comprises a family of wind turbines sharing a common design basis.

The 4MW Platform family of wind turbines includes V105-3.45/3.6 MW, V112-3.45/3.6 MW, V117-3.45/3.6 MW, V126-3.45 MW LTq, V126-3.45/3.6 MW HTq, V136-3.45/3.6 MW, V117-4.0/4.2 MW Strong Wind, V117-4.0/4.2 MW Typhoon, V136-4.0/4.2 MW and V150-4.0/4.2 MW.

For V105-3.45/3.6 MW, V112-3.45/3.6 MW, V117-3.45/3.6 MW, V126-3.45 MW LTq, V126-3.45/3.6 MW HTq and V136-3.45/3.6 MW, please refer to General Description 0053-3707.

This General Description only applies to V117-4.0/4.2 MW Strong Wind, V117-4.0/4.2 MW Typhoon, V136-4.0/4.2 MW and V150-4.0/4.2 MW.

These turbines are pitch regulated upwind turbines with active yaw and a three-blade rotor.

The turbines covered in this General Description are equipped with rotor with diameters residing in the range 117 m to 150 m and a rated output power of 4.0 MW.

A 4.0 MW Reactive Power Optimized Mode (QO1) is available for all variants.

A 4.2 MW Power Optimized Mode (PO1) is available for all variants.

Also, a 3.8 MW Load Optimized Mode (LO1) and a 3.6 MW Load Optimized Mode (LO2) is available for all variants. However, for V117, the LO2 power rating for the high turbulence intensity IEC 2A+ design climate is not yet fixed.

The wind turbine family utilises the OptiTip® concept and a power system based on an induction generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintain the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

Operating the wind turbine in 4.0 MW Reactive Power Optimized Mode (QO1) is achieved by applying an extended ambient temperature derate strategy compared with 4.0 MW Mode 0 operation.

Operating the wind turbine in 4.2 MW Power Optimized Mode (PO1) is achieved by applying an extended ambient temperature derate strategy and reduced reactive power capability compared with 4.0 MW Mode 0 operation.

3 Mechanical Design

3.1 Rotor

The wind turbine is equipped with a rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle.

Rotor	V117	V136	V150
Diameter	117 m	136 m	150 m
Swept Area	10751 m^2	14527 m^2	17671 m^2
Speed, Dynamic Operation Range	6.7-17.5	5.6-14.0	4.9-12.0
Rotational Direction	Clockwise (front view)		
Orientation	Upwind		
Tilt	6°		
Hub Coning	4°	4°	5.5°
No. of Blades	3		
Aerodynamic Brakes	Full feathering		

Table 3-1: Rotor data

3.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam or with embedded structure.

Blades	V117	V136	V150
Type Description	Airfoil shells bonded to supporting beam	Prepreg or infused structural airfoil shell	Prepreg or infused structural airfoil shell
Blade Length	57.15 m	66.66 m	73.66 m
Material	Fibreglass reinforced epoxy, carbon fibres and Solid Metal Tip (SMT)		
Blade Connection	Steel roots inserted		
Airfoils	High-lift profile		
Maximum Chord	4.0 m	4.1 m	4.2 m
Chord at 90% blade radius	1.1 m	1.2 m	1.4 m

Table 3-2: Blades data

3.3 Blade Bearing

The blade bearings are double-row four-point contact ball bearings.

Blade Bearing	
Lubrication	Grease

Table 3-3: Blade bearing data

3.4 Pitch System

The turbine is equipped with a pitch system for each blade and a distributor block, all located in the hub. Each pitch system is connected to the distributor block with flexible hoses. The distributor block is connected to the pipes of the hydraulic rotating transfer unit in the hub by means of three hoses (pressure line, return line and drain line).

Each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade bearing via a torque arm shaft. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Pitch System	
Type	Hydraulic
Number	1 per blade
Range	-10° to 95°

Table 3-4: Pitch system data

Hydraulic System	
Main Pump	Two redundant internal-gear oil pumps
Pressure	260 bar
Filtration	3 µm (absolute)

Table 3-5: Hydraulic system data.

3.5 Hub

The hub supports the three blades and transfers the reaction loads to the main bearing and the torque to the gearbox. The hub structure also supports blade bearings and pitch cylinders.

Hub	
Type	Cast ball shell hub
Material	Cast iron

Table 3-6: Hub data

3.6 Main Shaft

The main shaft transfers the reaction forces to the main bearing and the torque to the gearbox.

Main Shaft	
Type Description	Hollow shaft
Material	Cast iron or forged steel

Table 3-7: Main shaft data

3.7 Main Bearing Housing

The main bearing housing covers the main bearing and is the first connection point for the drive train system to the bedplate.

Main Bearing Housing	
Material	Cast iron

Table 3-8: Main bearing housing data

3.8 Main Bearing

The main bearing carries all thrust loads.

Main Bearing	
Type	Double-row spherical roller bearing
Lubrication	Automatic grease lubrication

Table 3-9: Main bearing data

3.9 Gearbox

The main gear converts the low-speed rotation of the rotor to high-speed generator rotation.

The disc brake is mounted on the high-speed shaft. The gearbox lubrication system is a pressure-fed system.

Gearbox	
Type	Planetary stages + one helical stage
Gear House Material	Cast
Lubrication System	Pressure oil lubrication
Backup Lubrication System	Oil sump filled from external gravity tank
Total Gear Oil Volume	1000-1500
Oil Cleanliness Codes	ISO 4406-/15/12
Shaft Seals	Labyrinth

Table 3-10: Gearbox data

3.10 Generator Bearings

The bearings are grease lubricated and grease is supplied continuously from an automatic lubrication unit.

3.11 High-Speed Shaft Coupling

The coupling transmits the torque of the gearbox high-speed output shaft to the generator input shaft.

The coupling consists of two 4-link laminate packages and a fibreglass intermediate tube with two metal flanges.

The coupling is fitted to two-armed hubs on the brake disc and the generator hub.

3.12 Yaw System

The yaw system is an active system based on a robust pre-tensioned plain yaw-bearing concept with PETP as friction material.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed (50 Hz)	0.45°/sec.
Yawing Speed (60 Hz)	0.55°/sec.

Table 3-11: Yaw system data

Yaw Gear	
Type	Multiple stages geared
Ratio Total	944:1
Rotational Speed at Full Load	1.4 rpm at output shaft

Table 3-12: Yaw gear data

3.13 Crane

The nacelle houses the internal safe working load (SWL) service crane. The crane is a single system hoist.

Crane	
Lifting Capacity	Maximum 800 kg

Table 3-13: Crane data

3.14 Towers

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. The towers are designed with the majority of internal welded connections replaced by magnet supports to create a predominantly smooth-walled tower.

Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (that is, in the gravitational direction) by a mechanical connection. The smooth tower design reduces the required steel thickness, rendering the tower lighter compared to one with all internals welded to the tower shells.

Available hub heights are listed in the Performance Specification for each turbine variant. Designated hub heights include a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange and a distance from tower top flange to centre of the hub of 2.2 m.

Towers	
Type	Cylindrical/conical tubular

Table 3-14: Tower structure data

3.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel. The roof section is equipped with wind sensors and skylights.

The skylights can be opened from inside the nacelle to access the roof and from outside to access the nacelle. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the front nacelle bedplate.

The crane girders are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, the cooling system and transformer. The nacelle cover is installed on the nacelle bedplate.

Type Description	Material
Nacelle Cover	GRP
Bedplate Front	Cast iron
Bedplate Rear	Girder structure

Table 3-15: Nacelle bedplate and cover data

3.16 Thermal Conditioning System

The thermal conditioning system consists of a few robust components:

- The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.
- The CoolerTop® comes as standard in a “naked” form, with no side cover panels. Side cover panels are available as an option.
- The Liquid Cooling System, which serves the gearbox, hydraulic systems, generator and converter is driven by an electrical pumping system.
- The transformer forced air cooling comprised of an electrical fan.

3.16.1 Generator and Converter Cooling

The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.2 Gearbox and Hydraulic Cooling

The gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the nacelle. In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.3 Transformer Cooling

The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the converter and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

3.16.4 Nacelle Cooling

Hot air generated by mechanical and electrical equipment is dissipated from the nacelle by a fan system located in the nacelle.

3.16.5 Optional Air Intake Hatches

Specific air intakes in the nacelle can optionally be fitted with hatches which can be operated as a part of the thermal control strategy. In case of lost grid to the turbine, the hatches will automatically be closed.

4 Electrical Design

4.1 Generator

The generator is a three-phase asynchronous induction generator with cage rotor that is connected to the grid through a full-scale converter. The generator housing allows the circulation of cooling air within the stator and rotor. The air-to-water heat exchange occurs in an external heat exchanger.

Generator	
Type	Asynchronous with cage rotor
Rated Power [P_N]	4230 / 4430 kW
Frequency [f_N]	0-100 Hz
Voltage, Stator [U_{NS}]	3 x 800 V (at rated speed)
Number of Poles	4/6
Winding Type	Form with VPI (Vacuum Pressurized Impregnation)

Generator	
Winding Connection	Star or Delta
Rated rpm	1450-1550 rpm
Overspeed Limit Acc. to IEC (2 minutes)	2400 rpm
Generator Bearing	Hybrid/ceramic
Temperature Sensors, Stator	3 PT100 sensors placed at hot spots and 3 as back-up
Temperature Sensors, Bearings	1 per bearing
Insulation Class	F or H
Enclosure	IP54

Table 4-1: Generator data

4.2 Converter

The converter is a full-scale converter system controlling both the generator and the power quality delivered to the grid. The converter consists of 3 machine-side converter units and 3 line-side converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency AC power from the generator into fixed frequency AC power with desired active and reactive power levels (and other grid connection parameters) suitable for the grid.

The converter is located in the nacelle and has a grid side voltage rating of 720 V. The generator side voltage rating is up to 750 V dependent on generator speed.

Converter	
Rated Apparent Power [S_N]	5100 kVA
Rated Grid Voltage	3 x 720 V
Rated Generator Voltage	3 x 800 V
Rated Grid Current	4100 A (≤30°C ambient) / 4150 (≤20°C ambient)
Rated Generator Current	3600 A (≤30°C ambient) / 3650 (≤20°C ambient)
Enclosure	IP54

Table 4-2: Converter data

4.3 HV Transformer

The step-up HV transformer is located in a separate locked room in the back of the nacelle.

The transformer is a three-phase, two-winding, dry-type transformer that is self-extinguishing. The windings are delta-connected on the high-voltage side unless otherwise specified.

The transformer comes in different versions depending on the market where it is intended to be installed.

- For 50 and 60 Hz regions the transformer is as default designed according to IEC standards, but also complying to European Ecodesign regulation No 548/2014 set by the European Commission. Refer to Table 4-3.

4.3.1 Ecodesign - IEC 50 Hz/60 Hz version

Transformer	
Type description	Ecodesign dry-type cast resin transformer.
Basic layout	3 phase, 2 winding transformer.
Applied standards	IEC 60076-11, IEC 60076-16, IEC 61936-1, Commission Regulation No 548/2014.
Cooling method	AF
Rated power	4700 kVA
Rated voltage, turbine side	
U_m 1.1kV	0.720 kV
Rated voltage, grid side	
U_m 24.0kV	19.1-22.0 kV
U_m 36.0kV	22.1-33.0 kV
U_m 40.5kV	33.1-36.0 kV
Insulation level AC / LI / LIC	
U_m 1.1kV	3[1] / - / - kV
U_m 24.0kV	50[1] / 125 / 125 kV
U_m 36.0kV	70[1] / 170 / 170 kV
U_m 40.5kV	80[1] / 170 / 170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	50 Hz / 60 Hz
Vector group	Dyn5
Peak Efficiency Index (PEI) [2]	Ecodesign requirement
U_m 24.0kV	~ 99.348
U_m 36.0kV	~ 99.348
U_m 40.5kV	~ 99.158
No-load loss [2]	
U_m 24.0kV	~ 8.2 kW
U_m 36.0kV	~ 8.2 kW
U_m 40.5kV	~ 9.8 kW
Load loss @ power consumption HV, 120°C	**@4700kVA[2]**
U_m 24.0kV	~ 29.0 kW
U_m 36.0kV	~ 29.0 kW
U_m 40.5kV	~ 37.45 kW
No-load reactive power [3]	~20 kVAr
Full load reactive power [3]	~390 kVAr
No-load current [3]	~0.5 %
Positive sequence short-circuit impedance @ rated power, 120°C [4]	9.0 %
Positive sequence short-circuit	~0.8 %

Transformer	
resistance@ rated power, 120°C [3]	
Zero sequence short-circuit impedance@ rated power, 120°C [3]	~8.2 %
Zero sequence short-circuit resistance@ rated power, 120°C [3]	~0.7 %
Inrush peak current [3]	
Dyn5	5-8 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$
Half crest time [3]	~ 0.6 s
Sound power level	≤ 80 dB(A)
Average temperature rise at max altitude	≤90 K
Max altitude [5]	2000 m
Insulation class	155 (F)
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	≤10500 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20 mm earthing ball points

Table 4-3: Transformer data for Ecodesign IEC 50 Hz/60 Hz version.

NOTE

[1] @1000m. According to IEC 60076-11, AC test voltage is altitude dependent.
[2] For Ecodesign transformers, PEI is the legal requirement and is calculated according to the Commission Regulation based on rated power, no-load and load losses. Losses are maximum values and will not simultaneously occur in a specific design as this will be incompliant with the PEI requirement. All values are preliminary.
[3] Based on an average of calculated values across voltages and manufacturers. All values are preliminary.
[4] Subjected to standard IEC tolerances. All values are preliminary.
[5] Transformer max altitude may be adjusted to match turbine location. All values are preliminary.

4.4 HV Cables

The high-voltage cable runs from the transformer in the nacelle down the tower to the HV switchgear located at the bottom of the tower. The high-voltage cable is a four-core, rubber-insulated, halogen-free, high-voltage cable.

HV Cables	
High-Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Pre-terminated	HV termination in transformer end. T-Connector Type-C in switchgear end.
Maximum Voltage	24 kV for 19.1-22.0 kV rated voltage 42 kV for 22.1-36.0 kV rated voltage
Conductor Cross Sections	3x70 / 70 mm^2 (Single PE core) 3x70 + 3x70/3 mm^2 (Split PE core)

Table 4-4: HV cables data

4.5 HV Switchgear

A gas insulated switchgear is installed in the bottom of the tower as an integrated part of the turbine. Its controls are integrated with the turbine safety system, which monitors the condition of the switchgear and high voltage safety related devices in the turbine. This system is named 'Ready to Protect' and ensures all protection devices are operational, whenever high voltage components in the turbine are energised. To ensure that the switchgear is always ready to trip, it is equipped with redundant trip circuits consisting of an active trip coil and an undervoltage trip coil.

In case of grid outage the circuit breaker will disconnect the turbine from the grid after an adjustable time.

When grid returns, all relevant protection devices will automatically be powered up via UPS.

When all the protection devices are operational, the circuit breaker will re-close after an adjustable time. The re-close functionality can furthermore be used to implement a sequential energization of a wind park, in order to avoid simultaneous inrush currents from all turbines once grid returns after an outage.

In case the circuit breaker has tripped due to a fault detection, the circuit breaker will be blocked for re-connection until a manual reset is performed.

In order to avoid unauthorized access to the transformer room during live condition, the earthing switch of the circuit breaker, contains a trapped-key interlock system with its counterpart installed on the access door to the transformer room.

The switchgear is available in three variants with increasing features, see Table 4-5. Beside the increase in features, the switchgear can be configured depending on the number of grid cables planned to enter the individual turbine. The design of the switchgear solution is optimized such grid cables can be connected to the switchgear even before the tower is installed and still maintain its protection toward weather conditions and internal condensation due to a gas tight packing.

The switchgear is available in an IEC version and in an IEEE version. The IEEE version is however only available in the highest voltage class. The electrical parameters of the switchgear are seen in Table 4-6 for the IEC version and in Table 4-7 for the IEEE version.

HV Switchgear			
Variant	**Basic**	**Streamline**	**Standard**
IEC standards	○	⊙	⊙
IEEE standards	⊙	○	⊙
Vacuum circuit breaker panel	⊙	⊙	⊙
Overcurrent, short-circuit and earth fault protection	⊙	⊙	⊙
Disconnector / earthing switch in circuit breaker panel	⊙	⊙	⊙
Voltage Presence Indicator System for circuit breaker	⊙	⊙	⊙
Voltage Presence Indicator System for grid cables	⊙	⊙	⊙
Double grid cable connection	⊙	⊙	⊙
Triple grid cable connection	⊙	○	○
Preconfigured relay settings	⊙	⊙	⊙
Turbine safety system integration	⊙	⊙	⊙
Redundant trip coil circuits	⊙	⊙	⊙
Trip coil supervision	⊙	⊙	⊙
Pendant remote control from outside of tower	⊙	⊙	⊙
Sequential energization	⊙	⊙	⊙
Reclose blocking function	⊙	⊙	⊙
Heating elements	⊙	⊙	⊙
Trapped-key interlock system for circuit breaker panel	⊙	⊙	⊙
Motor operation of circuit breaker	⊙	⊙	⊙
Cable panel for grid cables (configurable)	○	⊙	⊙
Switch disconnector panels for grid cables – max three panels (configurable)	○	⊙	⊙
Earthing switch for grid cables	○	⊙	⊙
Internal arc classification	○	⊙	⊙
Supervision on MCB's	○	⊙	⊙
Motor operation of switch disconnector	○	○	⊙
SCADA operation and feedback of circuit breaker	○	○	⊙
SCADA operation and feedback of switch disconnector	○	○	⊙

Table 4-5: HV switchgear variants and features

4.5.1 IEC 50/60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEC 62271-103 IEC 62271-1, 62271-100, 62271-102, 62271-200, IEC 60694
Insulation medium	SF_6
Rated voltage	
U_r 24.0kV	19.1-22.0 kV
U_r 36.0kV	22.1-33.0 kV
U_r 40.5kV	33.1-36.0 kV
Rated insulation level AC // LI Common value / across isolation distance	
U_r 24.0kV	50 / 60 // 125 / 145 kV
U_r 36.0kV	70 / 80 // 170 / 195 kV
U_r 40.5kV	85 / 90 // 185 / 215 kV
Rated frequency	50 Hz / 60 Hz
Rated normal current	630 A
Rated Short-time withstand current	
U_r 24.0kV	20 kA
U_r 36.0kV	25 kA
U_r 40.5kV	25 kA
Rated peak withstand current 50 / 60 Hz	
U_r 24.0kV	50 / 52 kA
U_r 36.0kV	62.5 / 65 kA
U_r 40.5kV	62.5 / 65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	
U_r 24.0kV	IAC A FLR 20 kA, 1 s
U_r 36.0kV	IAC A FLR 25 kA, 1 s
U_r 40.5kV	IAC A FLR 25 kA, 1 s
Connection interface	Outside cone plug-in bushings, IEC interface C1.
Loss of service continuity category	LSC2
Ingress protection	
Gas tank	IP 65
Enclosure	IP 2X
LV cabinet	IP 3X
Corrosion class	C3

Table 4-6: HV switchgear data for IEC version

4.5.2 IEEE 60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEEE 37.20.3, IEEE C37.20.4, IEC 62271-200, ISO 12944.
Insulation medium	SF_6
Rated voltage	
U_r 38.0kV	22.1-36.0 kV

HV Switchgear	
Rated insulation level AC / LI	70 / 150 kV
Rated frequency	60 Hz
Rated normal current	600 A
Rated Short-time withstand current	25 kA
Rated peak withstand current	65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	IAC A FLR 25 kA, 1 s
Connection interface grid cables	Outside cone plug-in bushings, IEEE 386 interface type deadbreak, 600A.
Ingress protection	
Gas tank	NEMA 4X / IP 65
Enclosure	NEMA 2 / IP 2X
LV cabinet	NEMA 2 / IP 3X
Corrosion class	C3

Table 4-7: HV switchgear data for IEEE version

4.6 AUX System

The AUX system is supplied from a separate 650/400/230 V transformer located in the nacelle inside the converter cabinet. All motors, pumps, fans and heaters are supplied from this system.

230 V consumers are generally supplied from a 400/230 V transformer located in the tower base. Internal heating and ventilation of cabinets as well as specific option 230 V consumers are supplied from the auxiliary transformer in the converter cabinet.

Power Sockets	
Single Phase (Nacelle)	230 V (16 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Single Phase (Tower Platforms)	230 V (10 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Three Phase (Nacelle and Tower Base)	3 x 400 V (16 A)

Table 4-8: AUX system data

4.7 Wind Sensors

The turbine is either equipped with two ultrasonic wind sensors or optional one ultrasonic wind sensor and one mechanical wind vane and anemometer. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

4.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP8000 control system.

VMP8000 is a multiprocessor control system comprised of main controller, distributed control nodes, distributed IO nodes and ethernet switches and other network equipment. The main controller is placed in the tower bottom of the turbine. It runs the control algorithms of the turbine, as well as all IO communication.

The communications network is a time triggered Ethernet network (TTEthernet).

The VMP8000 control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Reactive power control and variable speed operation.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.
- Monitoring of the smoke detection system.

4.9 Uninterruptible Power Supply (UPS)

During grid outage, an UPS system will ensure power supply for specific components.

The UPS system is built by 3 subsystems:

1. 230V AC UPS for all power backup to nacelle and hub control systems
2. 24V DC UPS for power backup to tower base control systems and optional SCADA Power Plant Controller.
3. 230V AC UPS for power backup to internal lights in tower and nacelle. Internal light in the hub is fed from built-in batteries in the light armature.

UPS		
Backup Time	**Standard**	**Optional**
Control System* **(230V AC and 24V DC UPS)**	15 min	Up to 400 min**
Internal Lights **(230V AC UPS)**	30 min	60 min***
Optional SCADA Power Plant Controller **(24V DC UPS)**	N/A	48 hours****

Table 4-9: UPS data

**The control system includes: the turbine controller (VMP8000), HV switchgear functions, and remote control system.*

***Requires upgrade of the 230V UPS for control system with extra batteries.*

****Requires upgrade of the 230V UPS for internal light with extra batteries.*

*****Requires upgrade of the 24V DC UPS with extra batteries.*

NOTE For alternative backup times, consult Vestas.

5 Turbine Protection Systems

5.1 Braking Concept

The main brake on the turbine is aerodynamic. Stopping the turbine is done by full feathering the three blades (individually turning each blade). Each blade has a hydraulic accumulator to supply power for turning the blade.

In addition, there is a mechanical disc brake on the high-speed shaft of the gearbox with a dedicated hydraulic system. The mechanical brake is only used as a parking brake and when activating the emergency stop buttons.

5.2 Short Circuit Protections

Breakers	**Breaker for Aux. Power.**	**Breaker 1 for Converter Modules**	**Breaker 2 for Converter Modules**
Breaking Capacity Icu, Ics	TBD	TBD	TBD
Making Capacity Icm	TBD	TBD	TBD

Table 5-1: Short circuit protection data

5.3 Overspeed Protection

The generator rpm and the main shaft rpm are registered by inductive sensors and calculated by the wind turbine controller to protect against overspeed and rotating errors.

The safety-related partition of the VMP8000 control system monitors the rotor rpm. In case of an overspeed situation, the safety-related partition of the VMP8000 control system activates the emergency feathered position (full feathering) of the three blades independently of the non-safety related partition of VMP8000 control system.

Overspeed Protection	
Sensors Type	Inductive
Trip Level (variant dependent)	12.0-17.5 rpm / 2000 (generator rpm)

Table 5-2: Overspeed protection data

5.4 Arc Detection

The turbine is equipped with an Arc Detection system including multiple optical arc detection sensors placed in the HV transformer compartment and the converter cabinet. The Arc Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if an arc is detected.

5.5 Smoke Detection

The turbine is equipped with a Smoke Detection system including multiple smoke detection sensors placed in the nacelle (above the disc brake), in the transformer compartment, in main electrical cabinets in the nacelle and above the HV switchgear in the tower base. The Smoke Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if smoke is detected.

5.6 Lightning Protection of Blades, Nacelle, Hub and Tower

The Lightning Protection System (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS consists of five main parts:

- Lightning receptors. All lightning receptor surfaces on the blades are unpainted, excluding the Solid Metal Tips (SMT).
- Down conducting system (a system to conduct the lightning current down through the wind turbine to help avoid or minimise damage to the LPS itself or other parts of the wind turbine).
- Protection against overvoltage and overcurrent.
- Shielding against magnetic and electrical fields.
- Earthing system.

Lightning Protection Design Parameters			**Protection Level I**
Current Peak Value	i_{max}	[kA]	200
Impulse Charge	$Q_{impulse}$	[C]	100
Long Duration Charge	Q_{long}	[C]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/μs]	200

Table 5-3: Lightning protection design parameters

NOTE The Lightning Protection System is designed according to IEC standards (see section 8 Design Codes, p. 28).

5.7 EMC

The turbine and related equipment fulfils the EU Electromagnetic Compatibility (EMC) legislation:

- DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

5.8 Earthing

The Vestas Earthing System consists of a number of individual earthing electrodes interconnected as one joint earthing system.

The Vestas Earthing System includes the TN-system and the Lightning Protection System for each wind turbine. It works as an earthing system for the medium voltage distribution system within the wind farm.

The Vestas Earthing System is adapted for the different types of turbine foundations. A separate set of documents describe the earthing system in detail, depending on the type of foundation.

In terms of lightning protection of the wind turbine, Vestas has no separate requirements for a certain minimum resistance to remote earth (measured in ohms) for this system. The earthing for the lightning protection system is based on the design and construction of the Vestas Earthing System.

A primary part of the Vestas Earthing System is the main earth bonding bar placed where all cables enter the wind turbine. All earthing electrodes are connected to this main earth bonding bar. Additionally, equipotential connections are made to all cables entering or leaving the wind turbine.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

5.9 Corrosion Protection

Classification of corrosion protection is according to ISO 12944-2.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5-M	C3
Hub	C5-M	C3
Tower	C5-I	C3

Table 5-4: Corrosion protection data for nacelle, hub, and tower

6 Safety

The safety specifications in this section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, and (c) conducting all appropriate safety training and education.

6.1 Access

Access to the turbine from the outside is through a door located at the entrance platform approximately 3 meter above ground level. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is controlled with a lock. Unauthorised access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

6.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch, from the spinner by opening the nose cone, or from the roof of the nacelle. Rescue equipment is placed in the nacelle.

The hatch in the roof can be opened from both the inside and outside. Escape from the service lift is by ladder.

An emergency response plan, placed in the turbine, describes evacuation and escape routes.

6.3 Rooms/Working Areas

The tower and nacelle are equipped with power sockets for electrical tools for service and maintenance of the turbine.

6.4 Floors, Platforms, Standing, and Working Places

All floors have anti-slip surfaces.

There is one floor per tower section.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

Foot supports are placed in the turbine for maintenance and service purposes.

6.5 Service Lift

The turbine is delivered with a service lift installed as an option.

6.6 Climbing Facilities

A ladder with a fall arrest system (rigid rail) is installed through the tower.

There are anchor points in the tower, nacelle and hub, and on the roof for attaching fall arrest equipment (full-body harness). Over the crane hatch there is an anchor point for the emergency descent equipment. Anchor points are coloured yellow and are calculated and tested to 22.2 kN.

6.7 Moving Parts, Guards, and Blocking Devices

All moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and drive train.

Blocking the pitch of the cylinder can be done with mechanical tools in the hub.

6.8 Lights

The turbine is equipped with lights in the tower, nacelle and hub.

There is emergency light in case of the loss of electrical power.

6.9 Emergency Stop

There are emergency stop buttons in the nacelle, hub and bottom of the tower.

6.10 Power Disconnection

The turbine is equipped with breakers to allow for disconnection from all power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and bottom of the tower.

6.11 Fire Protection/First Aid

A handheld 5-6 kg CO_2 fire extinguisher, first aid kit and fire blanket are required to be located in the nacelle during service and maintenance.

- A handheld 5-6 kg CO_2 fire extinguisher is required only during service and maintenance activities, unless a permanently mounted fire extinguisher located in the nacelle is mandatorily required by authorities.
- First aid kits are required only during service and maintenance activities.
- Fire blankets are required only during non-electrical hot work activities.

6.12 Warning Signs

Warning signs placed inside or on the turbine must be reviewed before operating or servicing the turbine.

6.13 Manuals and Warnings

The Vestas Corporate OH&S Manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

7 Environment

7.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2004. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

8 Design Codes

8.1 Design Codes – Structural Design

The turbine design has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 3 EN 50308
Tower	IEC 61400-1 Edition 3 Eurocode 3
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2
Gearbox	ISO 81400-4
Generator	IEC 60034
Transformer	IEC 60076-11, IEC 60076-16, CENELEC HD637 S1
Lightning Protection	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006 IEC 61400-24:2010
Rotating Electrical Machines	IEC 34
Safety of Machinery, Safety-related Parts of Control Systems	IEC 13849-1
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 8-1: Design codes

9 Colours

9.1 Nacelle Colour

Colour of Vestas Nacelles	
Standard Nacelle Colour	RAL 7035 (light grey)
Standard Logo	Vestas

Table 9-1: Colour, nacelle

9.2 Tower Colour

Colour of Vestas Tower Section		
	External:	**Internal:**
Standard Tower Colour	RAL 7035 (light grey)	RAL 9001 (cream white)

Table 9-2: Colour, tower

9.3 Blade Colour

Blade Colour	
Standard Blade Colour	RAL 7035 (light grey). All lightning receptor surfaces on the blades are unpainted, excluding the Solid Metal Tips (SMT).
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% DS/EN ISO 2813

Table 9-3: Colour, blades

10 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

10.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	**All**
Ambient Temperature Interval (Standard Temperature Turbine)	-40° to +50°C

Table 10-1: Extreme design parameters

10.2 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine.

Operational Envelope – Temperature	
Ambient Temperature Interval (Standard Turbine)	-20° to +45°C
Ambient Temperature Interval (Low Temperature Turbine)	-30° to +45°C

Table 10-2: Operational envelope – temperature

NOTE The wind turbine will stop producing power at ambient temperatures above 45°C.

For the low temperature options of the wind turbine, consult Vestas.

The turbine is designed for use at altitudes up to 1000 m above sea level as standard and optional up to 2000 m above sea level.

10.3 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine. At ambient temperatures above the thresholds shown for each operating mode in Figure 10-1 below, the turbine will maintain derated production. Additional derating will take place at altitudes above 1000 m.a.s.l.

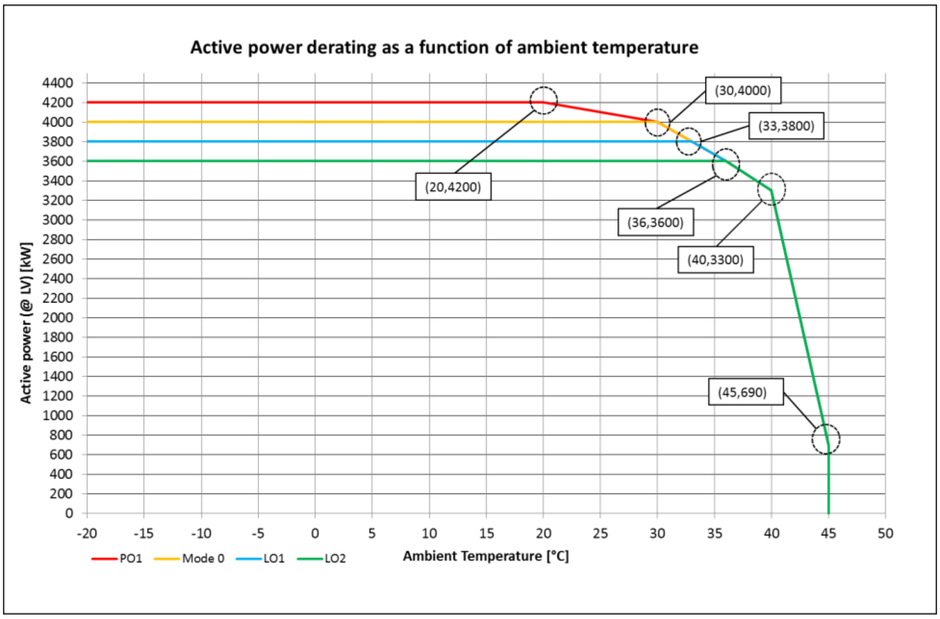

Figure 10-1: Temperature dependant derated operation.

NOTE All derating settings are preliminary and subject to change.

10.4 Operational Envelope – Grid Connection

Operational Envelope – Grid Connection		
Nominal Phase Voltage	[U_{NP}]	720 V
Nominal Frequency	[f_N]	50/60 Hz
Maximum Frequency Gradient	±4 Hz/sec.	
Maximum Negative Sequence Voltage	3% (connection) 2% (operation)	
Minimum Required Short Circuit Ratio at Turbine HV Connection	5.0 (contact Vestas for lower SCR levels)	
Maximum Short Circuit Current Contribution	1.05 p.u. (continuous) 1.45 p.u. (peak)	

Table 10-3: Operational envelope – grid connection

The generator and the converter will be disconnected if*:

Protection Settings	
Voltage Above 110% of Nominal for 1800 Seconds**	792 V
Voltage Above 116% of Nominal for 60 Seconds	835 V
Voltage Above 125% of Nominal for 2 Seconds	900 V
Voltage Above 136% of Nominal for 0.150 Seconds	979 V
Voltage Below 90% of Nominal for 180 Seconds (FRT)**	648 V
Voltage Below 85% of Nominal for 12 Seconds (FRT)	612 V
Voltage Below 80% of Nominal for 4 Seconds (FRT)	576 V
Frequency is Above 106% of Nominal for 0.2 Seconds	53/63.6 Hz
Frequency is Below 94% of Nominal for 0.2 Seconds	47/56.4 Hz

Table 10-4: Generator and converter disconnecting values

NOTE

* Over the turbine lifetime, grid drop-outs are to occur at an average of no more than 50 times a year.

** The turbine may be configured for continuous operation @ +/- 13 % voltage. Reactive power capability is limited for these widened settings to an extent that is yet to be determined.

All protection settings are preliminary and subject to change.

10.5 Operational Envelope – Reactive Power Capability in 4.0 MW Mode 0

The turbine has a reactive power capability in 4.0 MW Mode 0 on the low voltage side of the HV transformer as illustrated in Figure 10-2:

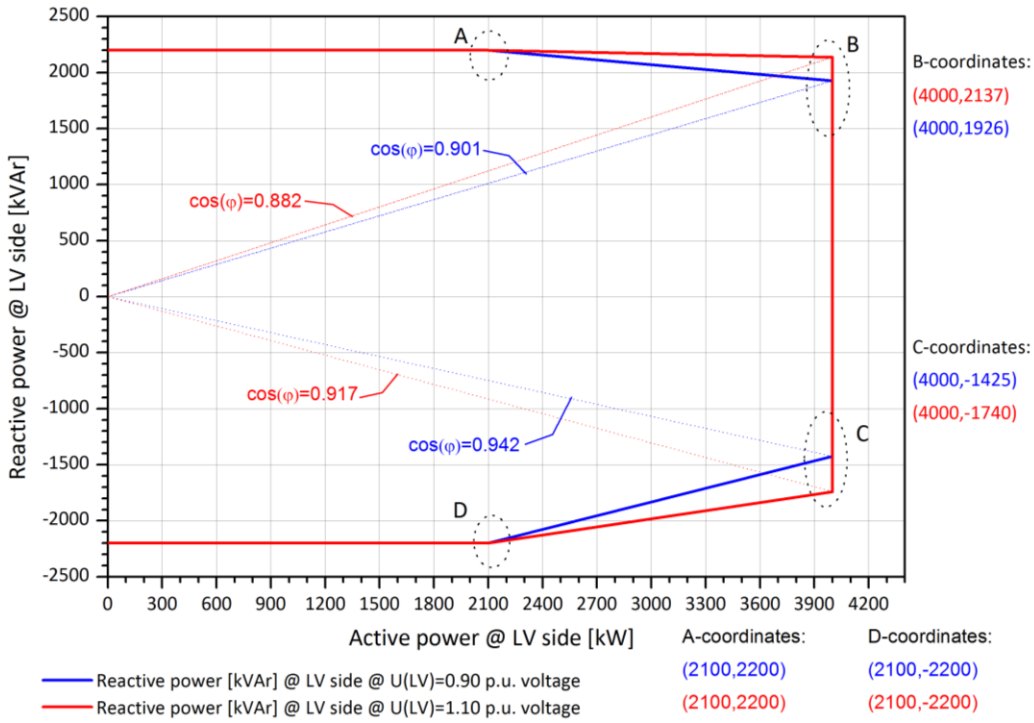

Figure 10-2: Reactive power capability for 4.0 MW Mode 0.

When operating at 4.0 MW nominal power at LV side of the HV transformer, the reactive power capability on the high voltage side of the HV transformer is approximately:

- cosφ(HV) = 0.93/0.91 capacitive/inductive @ U(HV) = 0.90 p.u. voltage
- cosφ(HV) = 0.95/0.89 capacitive/inductive @ U(HV) = 1.10 p.u. voltage

Reactive power is produced by the full-scale converter. Traditional capacitors are, therefore, not used in the turbine.

The turbine is able to maintain the reactive power capability at low wind with no active power production.

NOTE

4.0 MW Mode 0 derates above +30°C ambient temperature for ≤1000 m.a.s.l. according to Figure 10-1.

All reactive power capabilities are preliminary and subject to change.

10.6 Operational Envelope – Reactive Power Capability in 4.0 MW Reactive Power Optimized Mode (QO1)

An optional, extended reactive power capability is available with 4.0 MW Reactive Power Optimized Mode (QO1) when ambient temperature is below +20°C for ≤1000 m.a.s.l. The reactive power capability is as seen in Figure 10-3:

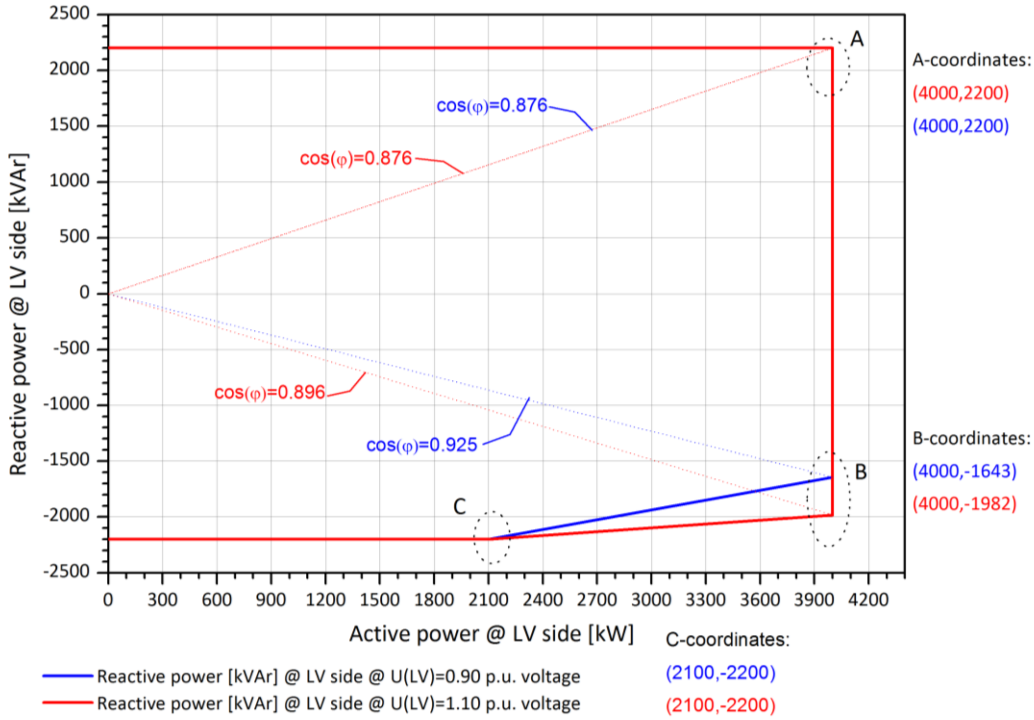

Figure 10-3: Reactive power capability for 4.0 MW Reactive Power Optimized Mode (QO1).

When operating at 4.0 MW in Reactive Power Optimized Mode (QO1) at LV side of the HV transformer, the reactive power capability on the high voltage side of the HV transformer is approximately:

- cosφ(HV) = 0.91/0.90 capacitive/inductive @ U(HV) = 0.90 p.u. voltage
- cosφ(HV) = 0.94/0.87 capacitive/inductive @ U(HV) = 1.10 p.u. voltage

The turbine is able to maintain the reactive power capability at low wind with no active power production.

NOTE

4.0 MW Reactive Power Optimized Mode (QO1) derates reactive power linearly above +20°C ambient temperature for ≤1000 m.a.s.l. to converge with the reactive power capability of 4.0 MW Mode 0 in Figure 10-2 at +30°C.

All reactive power capabilities are preliminary and subject to change.

10.7 Operational Envelope – Reactive Power Capability in 4.2 MW Power Optimized Mode (PO1)

The reactive power capability for the 4.2 MW Power Optimized Mode (PO1) is as illustrated in Figure 10-4:

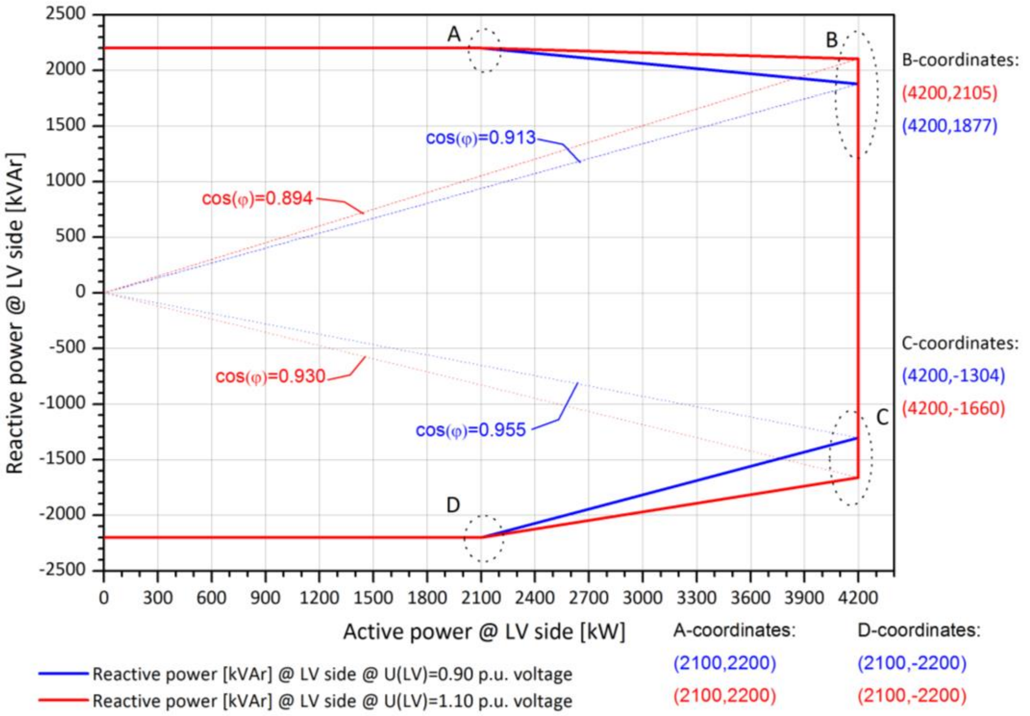

Figure 10-4: Reactive power capability for 4.2 MW Power Optimized Mode (PO1).

When operating at 4.2 MW in Power Optimized Mode (PO1) at LV side of the HV transformer, the reactive power capability on the high voltage side of the HV transformer is approximately:

- cosφ(HV) = 0.95/0.92 capacitive/inductive @ U(HV) = 0.90 p.u. voltage
- cosφ(HV) = 0.96/0.91 capacitive/inductive @ U(HV) = 1.10 p.u. voltage

The turbine is able to maintain the reactive power capability at low wind with no active power production.

NOTE

4.2 MW Power Optimized Mode (PO1) derates above +20°C ambient temperature for ≤1000 m.a.s.l. according to Figure 10-1.

4.2 MW Power Optimized Mode (PO1) is mutually exclusive with 4.0 MW Reactive Power Optimized Mode (QO1) (since Q is traded for P).

All reactive power capabilities are preliminary and subject to change.

10.8 Performance – Fault Ride Through

The turbine is equipped with a full-scale converter to gain better control of the wind turbine during grid faults. The turbine control system continues to run during grid faults.

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve as illustrated below:

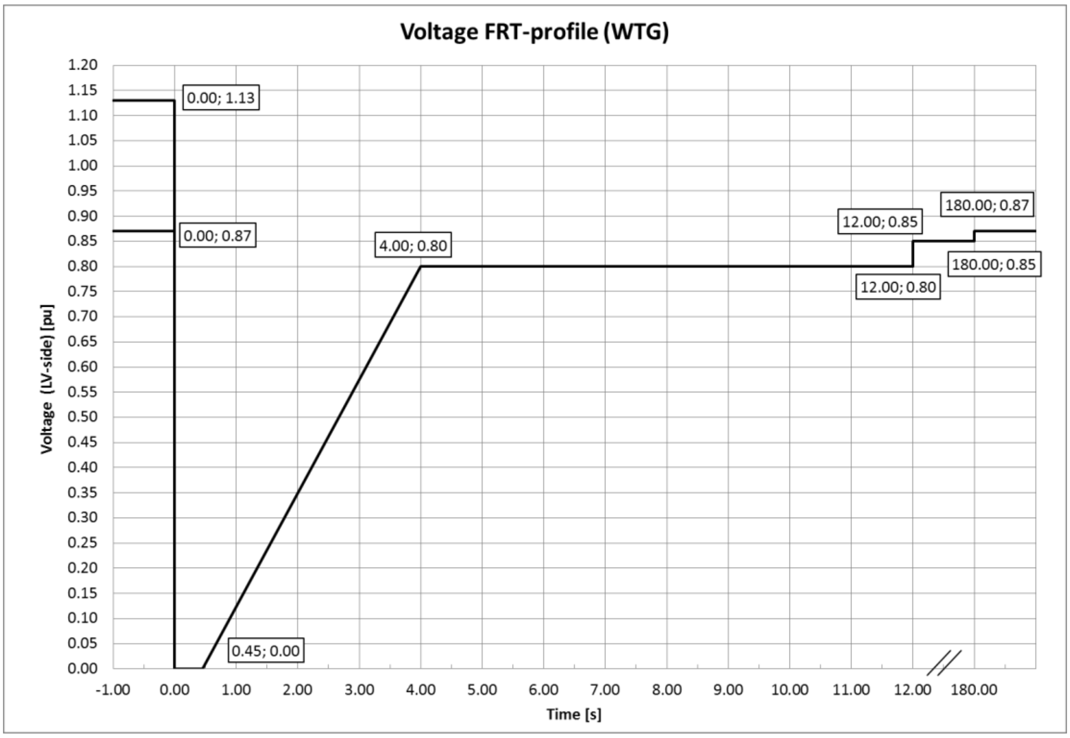

Figure 10-5: Low voltage tolerance curve for symmetrical and asymmetrical faults, where U represents voltage as measured on the grid.

For grid disturbances outside the tolerance curve in Figure 10-5, the turbine will be disconnected from the grid.

NOTE All fault ride through capability values are preliminary and subject to change.

Power Recovery Time	
Power Recovery to 90% of Pre-Fault Level	Maximum 0.1 seconds

Table 10-5: Power recovery time

10.9 Performance – Reactive Current Contribution

The reactive current contribution depends on whether the fault applied to the turbine is symmetrical or asymmetrical.

NOTE All reactive current contribution values are preliminary and subject to change.

10.9.1 Symmetrical Reactive Current Contribution

During symmetrical voltage dips, the wind farm will inject reactive current to support the grid voltage. The reactive current injected is a function of the measured grid voltage.

The default value gives a reactive current part of 1 p.u. of the rated active current at the high voltage side of the HV transformer. Figure 10-6, indicates the reactive current contribution as a function of the voltage. The reactive current contribution is independent from the actual wind conditions and pre-fault power level. As seen in Figure 10-6, the default current injection slope is 2% reactive current increase per 1% voltage decrease. The slope can be parameterized between 0 and 10 to adapt to site specific requirements.

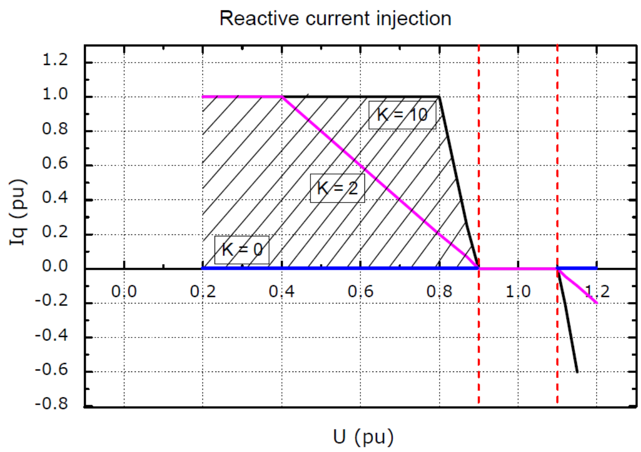

Figure 10-6: Reactive current injection

10.9.2 Asymmetrical Reactive Current Contribution

The injected current is based on the measured positive sequence voltage and the used K-factor. During asymmetrical voltage dips, the reactive current injection is limited to approximate 0.4 p.u. to limit the potential voltage increase on the healthy phases.

10.10 Performance – Multiple Voltage Dips

The turbine is designed to handle re-closure events and multiple voltage dips within a short period of time due to the fact that voltage dips are not evenly distributed during the year. For example, the turbine is designed to handle 10 voltage dips of duration of 200 ms, down to 20% voltage, within 30 minutes.

10.11 Performance – Active and Reactive Power Control

The turbine is designed for control of active and reactive power via the VestasOnline® SCADA system.

Maximum Ramp Rates for External Control	
Active Power	0.1 p.u./sec for max. power level change of 0.3 p.u. 0.3 p.u./sec for max. power level change of 0.1 p.u.
Reactive Power	20 p.u./sec

Table 10-6: Active/reactive power ramp rates (values are preliminary)

To support grid stability the turbine is capable to stay connected to the grid at active power references down to 10 % of nominal power for the turbine. For active power references below 10 % the turbine may disconnect from the grid.

10.12 Performance – Voltage Control

The turbine is designed for integration with VestasOnline® voltage control by utilising the turbine reactive power capability.

10.13 Performance – Frequency Control

The turbine can be configured to perform frequency control by decreasing the output power as a linear function of the grid frequency (over frequency). Dead band and slope for the frequency control function are configurable.

10.14 Distortion – Immunity

The turbine is able to connect with a pre-connection (background) voltage distortion level at the grid interface of 8% and operate with a post-connection voltage distortion level of 8%.

10.15 Main Contributors to Own Consumption

The consumption of electrical power by the wind turbine is defined as the power used by the wind turbine when it is not providing energy to the grid. This is defined in the control system as Production Generator 0 (zero).

The components in Table 10-7 have the largest influence on the own consumption of the wind turbine (the average own consumption depends on the actual conditions, the climate, the wind turbine output, the cut-off hours, etc.).

The VMP8000 control system has a hibernate mode that reduces own consumption when possible. Similarly, cooling pumps may be turned off when the turbine idles.

Main contributors to Own Consumption	
Hydraulic Motor	2 x 15 (V117) / 18.5 kW (V136 + V150) (master-slave)
Yaw Motors	Maximum 21 kW in total
Water Heating	10 kW
Water Pumps	2.2 + 5.5 kW
Oil Heating	7.9 kW
Oil Pump for Gearbox Lubrication	12.5 kW
Controller Including Heating Elements for the Hydraulics and all Controllers	Approximately 3 kW
HV Transformer No-load Loss	See section 4.3 HV Transformer, p. 13

Table 10-7: Main contributors to own consumption data (values are preliminary).

11 Drawings

11.1 Structural Design – Illustration of Outer Dimensions

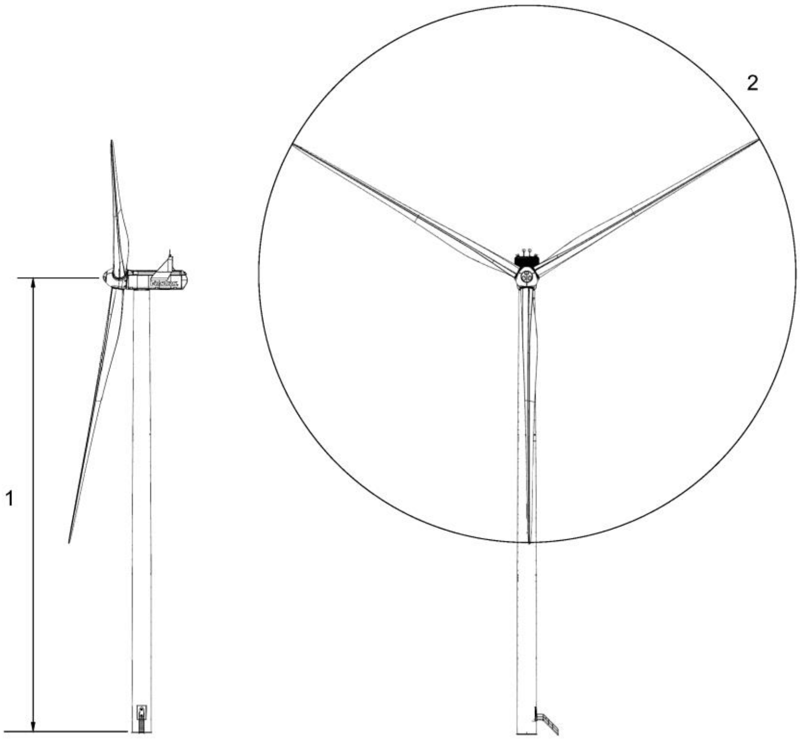

Figure 11-1: Illustration of outer dimensions – structure

1 Hub heights: See Performance Specification

2 Rotor diameter: 117-150 m

11.2 Structural Design – Side View Drawing

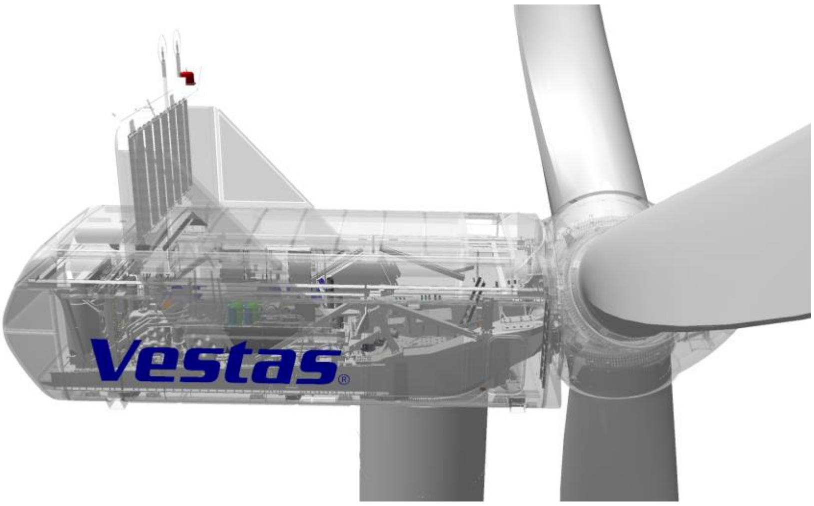

Figure 11-2: Side-view drawing

12 General Reservations, Notes and Disclaimers

-
- The general descriptions in this document apply to the current version of the 4MW Platform wind turbines. Updated versions of the 4MW Platform wind turbines, which may be manufactured in the future, may differ from this general description. In the event that Vestas supplies an updated version of a specific 4MW Platform wind turbine, Vestas will provide an updated general description applicable to the updated version.
- Vestas recommends that the grid be as close to nominal as possible with limited variation in frequency and voltage.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- All listed start/stop parameters (e. g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements and codes of standards.
- This document, General Description, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.

DMS 0067-7587 V02

V117-4.0&4.2 MW Third octave noise emission (Strong wind & Typhoon)

Original Instruction: T05 0067-7587 VER 02

T05 0067-7587 Ver 02 - Approved- Exported from DMS: 2019-08-06 by FRPIC

Abstract

This document serves as a paper behind the General Specification.

The document describes the measured/estimated third octave spectra for noise levels according to the General Specification.

The document is a living document and will be updated regularly.

When new measurements exist the document might be updated.

Contents

1. Introduction

The purpose of this document is to present the expected third octave noise spectra for the V117-4.0 MW turbine.

Results for the turbine with Serrated Trailing Edges are based upon internal measurement results obtained on a V117 turbine with STE positioned at Kappel in Denmark.

Results for the turbine without Serrated Trailing Edges are based upon internal measurement results obtained on a V117 turbine without STE positioned at Lem Kær in Denmark.

2. Method

2.1 Procedure

During measurements, a very large number of correlated values for noise emission spectra and turbine operating parameters are identified.

From these a relation between noise emission within each 1/3 octave band, wind speed and operational conditions are extracted. By combination of these extracted values and the actual turbine operation and rotor size, an estimate of the actual 1/3 octave performance is obtained.

In order to secure that measurement system limitations are not influencing the findings, the frequency content is limited to the frequency range 6.3 Hz to 10 kHz. The stated spectral values are thus representative for the expected noise emission from the turbine at each wind speed.

The method is verified as giving results corresponding to direct measured values.

The reported wind speed range cover hub height wind speeds from 3 to 20 m/s. Extrapolations outside this wind speed range is not possible due to limitations in the measured input data.

The values represent the expected turbine performance but do not in any way enable guarantees.

2.2 Physical environment

The results are valid for the downwind reference position as defined according to IEC 61400-11 Ed.3.

Applicable environmental conditions are thus corresponding to the standardized requirements as described directly and indirectly in IEC 61400-11.

These can be interpreted as air density 1.225 kg/m^3, yaw errors below +/- 15 deg. and vertical inflow angles below +/- 10 deg. Blade condition is clean and undamaged.

3. Results

3.1 Results V117 4.0 MW, Mode 0

Frequency	Hub height wind speeds [m/s]																
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	13.1	12.6	13.2	19.7	25.9	31.6	35.7	36.7	36.9	37.3	38.1	38.8	39.6	40.0	40.5	41.0	41.3	41.7
8 Hz	20.0	19.7	20.3	26.5	32.3	37.8	41.7	42.6	42.8	43.2	43.8	44.5	45.2	45.5	46.0	46.4	46.7	47.0
10 Hz	26.1	25.9	26.7	32.5	38.0	43.2	46.9	47.9	48.0	48.4	48.9	49.5	50.1	50.4	50.8	51.1	51.4	51.7
12.5 Hz	32.0	31.9	32.7	38.2	43.4	48.3	51.9	52.8	53.0	53.3	53.8	54.3	54.8	55.1	55.4	55.7	55.9	56.2
16 Hz	38.0	38.0	38.9	44.1	49.1	53.7	57.1	58.0	58.2	58.4	58.8	59.3	59.7	59.9	60.2	60.4	60.6	60.8
20 Hz	43.2	43.3	44.2	49.1	53.9	58.2	61.5	62.5	62.6	62.8	63.1	63.5	63.8	64.0	64.3	64.5	64.6	64.8
25 Hz	48.0	48.2	49.2	53.9	58.3	62.5	65.7	66.6	66.7	66.9	67.2	67.4	67.7	67.9	68.1	68.3	68.4	68.5
31.5 Hz	52.7	53.0	54.0	58.4	62.7	66.6	69.7	70.6	70.7	70.8	71.0	71.3	71.5	71.6	71.8	71.9	72.0	72.1
40 Hz	57.2	57.5	58.6	62.8	66.8	70.6	73.5	74.4	74.5	74.6	74.8	75.0	75.1	75.2	75.3	75.4	75.5	75.6
50 Hz	61.0	61.4	62.6	66.6	70.4	74.0	76.8	77.7	77.8	77.9	78.0	78.1	78.2	78.3	78.4	78.5	78.5	78.6
63 Hz	64.7	65.2	66.4	70.1	73.8	77.2	79.9	80.9	80.9	80.9	81.0	81.1	81.2	81.3	81.3	81.4	81.4	81.4
80 Hz	68.1	68.6	69.9	73.5	77.0	80.3	82.9	83.8	83.8	83.8	83.9	83.9	84.0	84.0	84.0	84.1	84.1	84.1
100 Hz	71.0	71.6	72.8	76.3	79.6	82.8	85.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3
125 Hz	73.6	74.2	75.4	78.7	82.0	85.0	87.5	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4
160 Hz	76.0	76.6	77.9	81.1	84.3	87.2	89.6	90.5	90.5	90.5	90.5	90.4	90.4	90.4	90.4	90.3	90.3	90.3
200 Hz	77.9	78.6	79.9	83.0	86.0	88.9	91.2	92.1	92.1	92.1	92.1	92.0	92.0	91.9	91.9	91.9	91.8	91.8
250 Hz	79.5	80.1	81.4	84.5	87.5	90.2	92.6	93.5	93.5	93.4	93.4	93.3	93.3	93.2	93.2	93.1	93.1	93.1
315 Hz	80.8	81.5	82.8	85.7	88.7	91.4	93.7	94.6	94.6	94.5	94.5	94.4	94.3	94.3	94.2	94.2	94.2	94.1
400 Hz	81.8	82.4	83.7	86.6	89.5	92.2	94.5	95.4	95.4	95.4	95.3	95.2	95.2	95.1	95.1	95.0	95.0	95.0
500 Hz	82.4	83.0	84.3	87.2	90.1	92.8	95.0	95.9	95.9	95.8	95.8	95.7	95.7	95.6	95.6	95.6	95.5	95.5
630 Hz	82.6	83.3	84.5	87.4	90.3	93.0	95.2	96.1	96.1	96.1	96.0	96.0	95.9	95.9	95.9	95.8	95.8	95.8
800 Hz	82.6	83.2	84.4	87.3	90.2	92.9	95.1	96.0	96.0	96.0	96.0	96.0	95.9	95.9	95.9	95.9	95.8	95.8
1 kHz	82.2	82.8	84.0	86.9	89.8	92.6	94.8	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.6	95.6	95.6	95.6
1.25 kHz	81.5	82.0	83.2	86.2	89.1	91.9	94.2	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.2	95.2	95.2
1.6 kHz	80.3	80.9	81.9	85.0	88.0	90.9	93.2	94.1	94.1	94.1	94.2	94.2	94.3	94.3	94.3	94.3	94.4	94.4
2 kHz	79.0	79.4	80.5	83.6	86.7	89.6	92.0	92.9	92.9	92.9	93.0	93.1	93.2	93.3	93.3	93.4	93.4	93.4
2.5 kHz	77.3	77.7	78.7	81.9	85.1	88.1	90.5	91.4	91.4	91.5	91.6	91.8	91.9	92.0	92.1	92.1	92.2	92.2
3.15 kHz	75.2	75.5	76.4	79.8	83.1	86.3	88.7	89.6	89.6	89.7	89.9	90.1	90.3	90.4	90.5	90.6	90.7	90.8
4 kHz	72.7	73.0	73.8	77.3	80.8	84.0	86.6	87.4	87.5	87.6	87.9	88.1	88.3	88.4	88.6	88.7	88.8	89.0
5 kHz	70.0	70.2	71.0	74.6	78.2	81.7	84.3	85.1	85.2	85.4	85.7	85.9	86.2	86.4	86.6	86.7	86.9	87.0
6.3 kHz	66.9	67.0	67.7	71.5	75.3	78.9	81.6	82.4	82.5	82.7	83.1	83.4	83.8	84.0	84.2	84.4	84.6	84.8
8 kHz	63.4	63.4	63.9	68.0	72.0	75.7	78.5	79.3	79.5	79.7	80.1	80.6	81.0	81.2	81.5	81.8	82.0	82.2
10 kHz	59.7	59.6	60.1	64.4	68.5	72.5	75.4	76.2	76.3	76.6	77.1	77.6	78.1	78.4	78.7	79.0	79.3	79.5
A-wgt	92.2	92.8	94.0	97.0	100.0	102.8	105.1	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0

Table 1: V117-4.0MW Mode 0, expected 1/3 octave band performance, (Blades with serrated trailing edge)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	29.9	28.6	27.2	30.9	34.4	38.1	40.2	40.4	40.9	41.8	43.4	45.0	46.5	47.4	48.5	49.4	50.1	51.0
8 Hz	35.3	34.3	33.2	36.8	40.3	43.8	46.0	46.2	46.6	47.5	48.9	50.3	51.6	52.4	53.3	54.2	54.8	55.5
10 Hz	40.2	39.4	38.6	42.2	45.6	48.9	51.1	51.4	51.7	52.5	53.7	54.9	56.2	56.8	57.7	58.4	59.0	59.6
12.5 Hz	44.8	44.2	43.7	47.2	50.5	53.8	55.9	56.3	56.6	57.2	58.3	59.4	60.4	61.1	61.8	62.4	62.9	63.5
16 Hz	49.6	49.2	49.0	52.5	55.7	58.8	60.9	61.4	61.7	62.2	63.1	64.0	64.9	65.5	66.1	66.6	67.0	67.5
20 Hz	53.6	53.4	53.6	56.9	60.1	63.1	65.2	65.7	65.9	66.4	67.2	68.0	68.7	69.2	69.7	70.2	70.5	70.9
25 Hz	57.4	57.4	57.8	61.1	64.2	67.1	69.2	69.8	70.0	70.4	71.0	71.7	72.3	72.7	73.1	73.5	73.8	74.1
31.5 Hz	61.1	61.3	61.9	65.1	68.2	71.0	73.1	73.7	73.9	74.2	74.7	75.3	75.8	76.1	76.4	76.8	77.0	77.3
40 Hz	64.6	64.9	65.8	69.0	72.0	74.8	76.8	77.5	77.6	77.8	78.3	78.7	79.1	79.3	79.6	79.9	80.1	80.3
50 Hz	67.7	68.1	69.1	72.3	75.3	78.0	80.0	80.7	80.8	81.0	81.3	81.7	82.0	82.2	82.4	82.6	82.7	82.9
63 Hz	70.5	71.1	72.3	75.4	78.4	81.0	83.1	83.7	83.8	84.0	84.2	84.5	84.7	84.8	85.0	85.1	85.2	85.3
80 Hz	73.2	73.9	75.2	78.3	81.3	83.8	85.9	86.6	86.7	86.8	86.9	87.1	87.2	87.3	87.4	87.5	87.6	87.7
100 Hz	75.5	76.2	77.7	80.8	83.7	86.2	88.3	89.0	89.0	89.1	89.2	89.3	89.4	89.4	89.5	89.5	89.6	89.6
125 Hz	77.5	78.3	79.9	83.0	85.8	88.3	90.4	91.1	91.2	91.2	91.2	91.3	91.3	91.3	91.3	91.3	91.4	91.4
160 Hz	79.4	80.3	82.0	85.0	87.9	90.3	92.4	93.2	93.2	93.2	93.2	93.2	93.1	93.1	93.1	93.1	93.1	93.1
200 Hz	80.9	81.8	83.6	86.6	89.5	91.9	93.9	94.8	94.7	94.7	94.7	94.6	94.6	94.5	94.5	94.5	94.4	94.4
250 Hz	82.1	83.1	84.9	87.9	90.8	93.2	95.2	96.1	96.0	96.0	95.9	95.8	95.8	95.7	95.7	95.6	95.6	95.5
315 Hz	83.1	84.1	86.0	89.0	91.8	94.2	96.3	97.1	97.1	97.0	97.0	96.9	96.8	96.7	96.6	96.6	96.5	96.4
400 Hz	83.8	84.9	86.7	89.8	92.6	95.0	97.1	97.9	97.9	97.8	97.7	97.6	97.5	97.5	97.4	97.3	97.3	97.2
500 Hz	84.3	85.3	87.2	90.2	93.1	95.5	97.6	98.4	98.4	98.3	98.2	98.1	98.0	97.9	97.9	97.8	97.7	97.7
630 Hz	84.5	85.5	87.3	90.4	93.2	95.7	97.8	98.6	98.6	98.5	98.4	98.3	98.2	98.2	98.1	98.1	98.0	97.9
800 Hz	84.4	85.3	87.2	90.2	93.1	95.6	97.7	98.5	98.5	98.4	98.4	98.3	98.2	98.2	98.1	98.1	98.1	98.0
1 kHz	84.0	85.0	86.7	89.8	92.7	95.2	97.3	98.1	98.1	98.1	98.1	98.0	98.0	98.0	97.9	97.9	97.9	97.9
1.25 kHz	83.4	84.3	86.0	89.1	92.1	94.6	96.7	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
1.6 kHz	82.5	83.3	84.8	88.0	91.0	93.6	95.7	96.5	96.5	96.6	96.6	96.7	96.7	96.8	96.8	96.8	96.8	96.9
2 kHz	81.4	82.1	83.5	86.7	89.8	92.4	94.5	95.3	95.3	95.4	95.5	95.7	95.8	95.8	95.9	96.0	96.0	96.1
2.5 kHz	80.0	80.6	81.9	85.2	88.2	91.0	93.1	93.8	93.9	94.0	94.2	94.4	94.6	94.7	94.8	94.9	95.0	95.1
3.15 kHz	78.3	78.8	80.0	83.3	86.4	89.2	91.3	92.0	92.1	92.3	92.6	92.8	93.1	93.3	93.4	93.6	93.7	93.8
4 kHz	76.3	76.6	77.6	81.0	84.2	87.0	89.2	89.9	90.0	90.2	90.6	91.0	91.3	91.5	91.8	92.0	92.1	92.3
5 kHz	74.1	74.3	75.1	78.6	81.8	84.8	87.0	87.6	87.7	88.0	88.5	89.0	89.4	89.7	90.0	90.3	90.5	90.7
6.3 kHz	71.6	71.7	72.3	75.8	79.1	82.1	84.3	84.9	85.1	85.5	86.0	86.6	87.2	87.5	87.9	88.2	88.5	88.8
8 kHz	68.7	68.6	69.0	72.5	75.9	79.1	81.3	81.9	82.1	82.5	83.2	83.9	84.6	85.0	85.5	85.9	86.2	86.6
10 kHz	65.8	65.5	65.6	69.3	72.7	76.0	78.3	78.8	79.0	79.5	80.3	81.2	82.0	82.5	83.0	83.5	83.9	84.3
A-wgt	94.5	95.4	97.1	100.2	103.1	105.6	107.7	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5

Table 2: V117-4.0MW Mode 0-0S, expected 1/3 octave band performance, (Blades without serrated trailing edge)

3.2 Results V117 4.2 MW, PO1

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	13.1	12.6	13.2	19.7	25.9	31.6	35.8	36.7	36.9	37.3	38.0	38.8	39.4	40.0	40.4	40.9	41.2	41.7
8 Hz	20.0	19.7	20.3	26.5	32.4	37.8	41.7	42.6	42.8	43.1	43.8	44.5	45.0	45.5	45.9	46.3	46.6	47.0
10 Hz	26.1	25.9	26.7	32.5	38.1	43.2	46.9	47.9	48.0	48.3	48.9	49.5	50.0	50.4	50.8	51.1	51.4	51.7
12.5 Hz	32.0	31.9	32.7	38.2	43.5	48.3	51.9	52.8	53.0	53.3	53.7	54.3	54.7	55.0	55.3	55.7	55.9	56.2
16 Hz	38.0	38.0	38.9	44.1	49.1	53.7	57.1	58.0	58.2	58.4	58.8	59.2	59.6	59.9	60.1	60.4	60.6	60.8
20 Hz	43.2	43.3	44.2	49.1	53.9	58.2	61.5	62.5	62.6	62.8	63.1	63.5	63.7	64.0	64.2	64.4	64.6	64.8
25 Hz	48.0	48.2	49.2	53.9	58.4	62.5	65.7	66.6	66.7	66.8	67.1	67.4	67.7	67.9	68.1	68.2	68.4	68.5
31.5 Hz	52.7	53.0	54.0	58.4	62.7	66.6	69.7	70.6	70.7	70.8	71.0	71.3	71.5	71.6	71.8	71.9	72.0	72.1
40 Hz	57.2	57.5	58.6	62.8	66.9	70.6	73.5	74.4	74.5	74.6	74.8	74.9	75.1	75.2	75.3	75.4	75.5	75.6
50 Hz	61.0	61.4	62.6	66.6	70.4	74.0	76.8	77.7	77.8	77.8	78.0	78.1	78.2	78.3	78.4	78.5	78.5	78.6
63 Hz	64.7	65.2	66.4	70.1	73.8	77.2	79.9	80.9	80.9	80.9	81.0	81.1	81.2	81.2	81.3	81.4	81.4	81.4
80 Hz	68.1	68.6	69.9	73.5	77.0	80.3	82.9	83.8	83.8	83.8	83.9	83.9	84.0	84.0	84.0	84.1	84.1	84.1
100 Hz	71.0	71.6	72.8	76.3	79.7	82.8	85.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3
125 Hz	73.6	74.2	75.4	78.7	82.0	85.0	87.5	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4	88.4
160 Hz	76.0	76.6	77.9	81.1	84.3	87.2	89.6	90.5	90.5	90.5	90.5	90.4	90.4	90.4	90.4	90.3	90.3	90.3
200 Hz	77.9	78.6	79.9	83.0	86.0	88.9	91.2	92.1	92.1	92.1	92.1	92.0	92.0	91.9	91.9	91.9	91.8	91.8
250 Hz	79.5	80.1	81.4	84.5	87.5	90.2	92.6	93.5	93.5	93.4	93.4	93.3	93.3	93.2	93.2	93.1	93.1	93.1
315 Hz	80.8	81.5	82.8	85.7	88.7	91.4	93.7	94.6	94.6	94.5	94.5	94.4	94.3	94.3	94.3	94.2	94.2	94.1
400 Hz	81.8	82.4	83.7	86.6	89.5	92.2	94.5	95.4	95.4	95.4	95.3	95.2	95.2	95.1	95.1	95.0	95.0	95.0
500 Hz	82.4	83.0	84.3	87.2	90.1	92.8	95.0	95.9	95.9	95.8	95.8	95.7	95.7	95.6	95.6	95.6	95.5	95.5
630 Hz	82.6	83.3	84.5	87.4	90.3	93.0	95.2	96.1	96.1	96.1	96.0	96.0	96.0	95.9	95.9	95.8	95.8	95.8
800 Hz	82.6	83.2	84.4	87.3	90.2	92.9	95.1	96.0	96.0	96.0	96.0	96.0	95.9	95.9	95.9	95.9	95.9	95.8
1 kHz	82.2	82.8	84.0	86.9	89.8	92.6	94.8	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.6	95.6	95.6	95.6
1.25 kHz	81.5	82.0	83.2	86.2	89.1	91.9	94.2	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.2	95.2	95.2
1.6 kHz	80.3	80.9	81.9	85.0	88.0	90.9	93.2	94.1	94.1	94.1	94.2	94.2	94.3	94.3	94.3	94.3	94.4	94.4
2 kHz	79.0	79.4	80.5	83.6	86.7	89.6	92.0	92.9	92.9	92.9	93.0	93.1	93.2	93.2	93.3	93.4	93.4	93.4
2.5 kHz	77.3	77.7	78.7	81.9	85.1	88.1	90.5	91.4	91.4	91.5	91.6	91.8	91.9	92.0	92.0	92.1	92.2	92.2
3.15 kHz	75.2	75.5	76.4	79.8	83.1	86.3	88.7	89.6	89.6	89.7	89.9	90.1	90.2	90.4	90.5	90.6	90.7	90.8
4 kHz	72.7	73.0	73.8	77.3	80.8	84.0	86.6	87.4	87.5	87.6	87.8	88.1	88.3	88.4	88.6	88.7	88.8	88.9
5 kHz	70.0	70.2	71.0	74.6	78.3	81.7	84.3	85.1	85.2	85.4	85.6	85.9	86.2	86.4	86.6	86.7	86.8	87.0
6.3 kHz	66.9	67.0	67.7	71.5	75.3	78.9	81.6	82.4	82.5	82.7	83.0	83.4	83.7	84.0	84.2	84.4	84.6	84.8
8 kHz	63.4	63.4	63.9	68.0	72.0	75.7	78.5	79.3	79.5	79.7	80.1	80.5	80.9	81.2	81.5	81.7	81.9	82.2
10 kHz	59.7	59.6	60.1	64.4	68.5	72.5	75.4	76.2	76.3	76.6	77.1	77.6	78.0	78.4	78.7	79.0	79.2	79.5
A-wgt	92.2	92.8	94.0	97.0	100.0	102.8	105.1	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0

Table 3: V117-4.2MW PO1 expected 1/3 octave band performance (Blades with serrated trailing edge)

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	**4 m/s**	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**	**11 m/s**	**12 m/s**	**13 m/s**	**14 m/s**	**15 m/s**	**16 m/s**	**17 m/s**	**18 m/s**	**19 m/s**	**20 m/s**
6.3 Hz	29.9	28.6	27.2	30.9	34.5	38.1	40.2	40.4	40.9	41.8	43.2	44.9	46.2	47.3	48.3	49.3	50.0	50.9
8 Hz	35.3	34.3	33.2	36.8	40.4	43.8	46.0	46.2	46.6	47.4	48.7	50.2	51.3	52.4	53.2	54.1	54.6	55.5
10 Hz	40.2	39.4	38.6	42.2	45.6	48.9	51.1	51.4	51.7	52.4	53.6	54.9	55.9	56.8	57.5	58.3	58.8	59.5
12.5 Hz	44.8	44.2	43.7	47.2	50.6	53.8	55.9	56.3	56.6	57.2	58.2	59.3	60.2	61.0	61.7	62.3	62.8	63.4
16 Hz	49.6	49.2	49.0	52.5	55.7	58.8	60.9	61.4	61.7	62.2	63.0	64.0	64.7	65.4	66.0	66.5	66.9	67.4
20 Hz	53.6	53.4	53.6	56.9	60.1	63.1	65.2	65.7	65.9	66.4	67.1	67.9	68.6	69.2	69.6	70.1	70.4	70.9
25 Hz	57.4	57.4	57.8	61.1	64.2	67.1	69.2	69.8	70.0	70.3	70.9	71.6	72.2	72.7	73.1	73.5	73.7	74.1
31.5 Hz	61.1	61.3	61.9	65.1	68.2	71.0	73.1	73.7	73.9	74.2	74.7	75.2	75.7	76.1	76.4	76.7	76.9	77.2
40 Hz	64.6	64.9	65.8	69.0	72.0	74.8	76.8	77.5	77.6	77.8	78.2	78.7	79.0	79.3	79.6	79.8	80.0	80.3
50 Hz	67.7	68.1	69.1	72.3	75.3	78.0	80.0	80.7	80.8	81.0	81.3	81.6	81.9	82.1	82.3	82.5	82.7	82.8
63 Hz	70.5	71.1	72.3	75.4	78.4	81.0	83.1	83.7	83.8	84.0	84.2	84.4	84.6	84.8	85.0	85.1	85.2	85.3
80 Hz	73.2	73.9	75.2	78.3	81.3	83.8	85.9	86.6	86.7	86.8	86.9	87.1	87.2	87.3	87.4	87.5	87.6	87.6
100 Hz	75.5	76.2	77.7	80.8	83.7	86.2	88.3	89.0	89.0	89.1	89.2	89.3	89.4	89.4	89.5	89.5	89.6	89.6
125 Hz	77.5	78.3	79.9	83.0	85.8	88.3	90.4	91.1	91.2	91.2	91.2	91.3	91.3	91.3	91.3	91.3	91.4	91.4
160 Hz	79.4	80.3	82.0	85.0	87.9	90.3	92.4	93.2	93.2	93.2	93.2	93.2	93.1	93.1	93.1	93.1	93.1	93.1
200 Hz	80.9	81.8	83.6	86.6	89.4	91.9	93.9	94.8	94.7	94.7	94.7	94.6	94.6	94.5	94.5	94.5	94.4	94.4
250 Hz	82.1	83.1	84.9	87.9	90.8	93.2	95.2	96.1	96.0	96.0	95.9	95.9	95.8	95.7	95.7	95.6	95.6	95.5
315 Hz	83.1	84.1	86.0	89.0	91.8	94.2	96.3	97.1	97.1	97.0	97.0	96.9	96.8	96.7	96.6	96.6	96.5	96.4
400 Hz	83.8	84.9	86.7	89.8	92.6	95.0	97.1	97.9	97.9	97.8	97.7	97.6	97.5	97.5	97.4	97.3	97.3	97.2
500 Hz	84.3	85.3	87.2	90.2	93.1	95.5	97.6	98.4	98.4	98.3	98.2	98.1	98.0	97.9	97.9	97.8	97.7	97.7
630 Hz	84.5	85.5	87.3	90.4	93.2	95.7	97.8	98.6	98.6	98.5	98.4	98.3	98.3	98.2	98.1	98.1	98.0	98.0
800 Hz	84.4	85.3	87.2	90.2	93.1	95.6	97.7	98.5	98.5	98.4	98.4	98.3	98.3	98.2	98.2	98.1	98.1	98.0
1 kHz	84.0	85.0	86.7	89.8	92.7	95.2	97.3	98.1	98.1	98.1	98.1	98.0	98.0	98.0	98.0	97.9	97.9	97.9
1.25 kHz	83.4	84.3	86.0	89.1	92.1	94.6	96.7	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
1.6 kHz	82.5	83.3	84.8	88.0	91.0	93.6	95.7	96.5	96.5	96.6	96.6	96.7	96.7	96.8	96.8	96.8	96.8	96.9
2 kHz	81.4	82.1	83.5	86.7	89.8	92.4	94.5	95.3	95.3	95.4	95.5	95.7	95.8	95.8	95.9	96.0	96.0	96.1
2.5 kHz	80.0	80.6	81.9	85.2	88.3	91.0	93.1	93.8	93.9	94.0	94.2	94.4	94.5	94.7	94.8	94.9	95.0	95.1
3.15 kHz	78.3	78.8	80.0	83.3	86.4	89.2	91.3	92.0	92.1	92.3	92.5	92.8	93.1	93.2	93.4	93.6	93.7	93.8
4 kHz	76.3	76.6	77.6	81.0	84.2	87.0	89.2	89.9	90.0	90.2	90.5	90.9	91.2	91.5	91.7	92.0	92.1	92.3
5 kHz	74.1	74.3	75.1	78.6	81.8	84.8	87.0	87.6	87.7	88.0	88.4	88.9	89.3	89.7	89.9	90.2	90.4	90.7
6.3 kHz	71.6	71.7	72.3	75.8	79.1	82.1	84.3	84.9	85.1	85.4	86.0	86.6	87.1	87.5	87.8	88.2	88.4	88.8
8 kHz	68.7	68.6	69.0	72.5	76.0	79.1	81.3	81.9	82.1	82.5	83.1	83.9	84.5	85.0	85.4	85.9	86.2	86.6
10 kHz	65.8	65.5	65.6	69.3	72.7	76.0	78.3	78.8	79.0	79.5	80.2	81.1	81.8	82.4	83.0	83.5	83.8	84.3
A-wgt	94.5	95.4	97.1	100.2	103.1	105.6	107.7	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5	108.5

Table 4: V117-4.2MW PO1-0S expected 1/3 octave band performance (Blades without serrated trailing edge)

3.3 Results V117 4.0 MW, SO1

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	13.1	12.7	13.2	19.7	25.9	30.6	31.9	33.5	34.4	35.9	37.1	37.8	38.6	39.0	39.5	40.0	40.3	40.7
8 Hz	20.0	19.7	20.3	26.5	32.3	36.8	38.2	39.7	40.4	41.8	42.8	43.5	44.2	44.5	45.0	45.4	45.7	46.0
10 Hz	26.1	25.9	26.7	32.5	38.0	42.4	43.7	45.1	45.8	47.0	47.9	48.5	49.1	49.4	49.8	50.1	50.4	50.7
12.5 Hz	32.0	31.9	32.7	38.2	43.4	47.6	49.0	50.3	50.9	52.0	52.8	53.3	53.8	54.1	54.4	54.7	54.9	55.2
16 Hz	38.0	38.1	38.9	44.1	49.1	53.1	54.5	55.7	56.3	57.1	57.8	58.3	58.7	58.9	59.2	59.4	59.6	59.8
20 Hz	43.2	43.3	44.2	49.1	53.9	57.7	59.1	60.3	60.8	61.5	62.1	62.5	62.8	63.0	63.3	63.5	63.6	63.8
25 Hz	48.0	48.2	49.2	53.9	58.4	62.0	63.5	64.6	65.0	65.7	66.1	66.4	66.7	66.9	67.1	67.3	67.4	67.5
31.5 Hz	52.7	53.0	54.0	58.4	62.7	66.2	67.7	68.8	69.1	69.6	70.0	70.3	70.5	70.6	70.8	70.9	71.0	71.1
40 Hz	57.2	57.5	58.6	62.8	66.9	70.3	71.8	72.8	73.0	73.5	73.8	74.0	74.1	74.2	74.3	74.4	74.5	74.6
50 Hz	61.0	61.4	62.6	66.6	70.4	73.7	75.2	76.2	76.4	76.7	77.0	77.1	77.2	77.3	77.4	77.5	77.5	77.6
63 Hz	64.7	65.2	66.4	70.1	73.8	77.0	78.5	79.5	79.6	79.9	80.0	80.1	80.2	80.3	80.3	80.4	80.4	80.4
80 Hz	68.1	68.6	69.9	73.5	77.0	80.1	81.6	82.5	82.6	82.8	82.9	82.9	83.0	83.0	83.0	83.1	83.1	83.1
100 Hz	71.0	71.6	72.8	76.3	79.7	82.6	84.2	85.0	85.1	85.2	85.3	85.3	85.3	85.3	85.3	85.3	85.3	85.3
125 Hz	73.6	74.2	75.4	78.7	82.0	84.9	86.5	87.3	87.3	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4	87.4
160 Hz	76.0	76.6	77.9	81.1	84.3	87.1	88.7	89.5	89.5	89.5	89.5	89.4	89.4	89.4	89.4	89.3	89.3	89.3
200 Hz	77.9	78.6	79.9	83.0	86.0	88.8	90.4	91.1	91.1	91.1	91.1	91.0	91.0	90.9	90.9	90.9	90.8	90.8
250 Hz	79.5	80.1	81.4	84.5	87.5	90.2	91.8	92.5	92.5	92.4	92.4	92.3	92.3	92.2	92.2	92.1	92.1	92.1
315 Hz	80.8	81.5	82.8	85.7	88.7	91.3	92.9	93.6	93.6	93.5	93.5	93.4	93.3	93.3	93.2	93.2	93.2	93.1
400 Hz	81.8	82.4	83.7	86.6	89.5	92.2	93.8	94.5	94.4	94.4	94.3	94.2	94.2	94.1	94.1	94.0	94.0	94.0
500 Hz	82.4	83.0	84.3	87.2	90.1	92.7	94.2	95.0	94.9	94.9	94.8	94.7	94.7	94.6	94.6	94.6	94.5	94.5
630 Hz	82.6	83.3	84.5	87.4	90.3	92.9	94.5	95.2	95.2	95.1	95.0	95.0	94.9	94.9	94.9	94.8	94.8	94.8
800 Hz	82.6	83.2	84.4	87.3	90.2	92.8	94.3	95.1	95.1	95.0	95.0	95.0	94.9	94.9	94.9	94.9	94.8	94.8
1 kHz	82.2	82.8	84.0	86.9	89.8	92.5	93.9	94.7	94.7	94.7	94.7	94.7	94.7	94.7	94.6	94.6	94.6	94.6
1.25 kHz	81.5	82.0	83.2	86.2	89.1	91.8	93.3	94.1	94.1	94.1	94.1	94.1	94.1	94.1	94.1	94.2	94.2	94.2
1.6 kHz	80.3	80.9	81.9	85.0	88.0	90.7	92.2	93.0	93.0	93.1	93.2	93.2	93.3	93.3	93.3	93.3	93.4	93.4
2 kHz	79.0	79.4	80.5	83.6	86.7	89.5	90.9	91.7	91.8	91.9	92.0	92.1	92.2	92.3	92.3	92.4	92.4	92.4
2.5 kHz	77.3	77.7	78.7	81.9	85.1	87.9	89.3	90.2	90.3	90.5	90.6	90.8	90.9	91.0	91.1	91.1	91.2	91.2
3.15 kHz	75.2	75.5	76.4	79.8	83.1	86.0	87.3	88.3	88.5	88.7	88.9	89.1	89.3	89.4	89.5	89.6	89.7	89.8
4 kHz	72.7	73.0	73.8	77.3	80.8	83.7	85.0	86.0	86.2	86.5	86.9	87.1	87.3	87.4	87.6	87.7	87.8	88.0
5 kHz	70.0	70.2	71.0	74.6	78.2	81.3	82.5	83.6	83.9	84.3	84.6	84.9	85.2	85.4	85.6	85.7	85.9	86.0
6.3 kHz	66.9	67.0	67.7	71.5	75.3	78.4	79.6	80.8	81.1	81.6	82.1	82.4	82.8	83.0	83.2	83.4	83.6	83.8
8 kHz	63.4	63.4	63.9	68.0	72.0	75.2	76.3	77.5	77.9	78.6	79.1	79.6	80.0	80.2	80.5	80.8	81.0	81.2
10 kHz	59.7	59.6	60.1	64.4	68.5	71.9	72.9	74.2	74.7	75.4	76.1	76.6	77.1	77.4	77.7	78.0	78.3	78.5
A-wgt	92.2	92.8	94.0	97.0	100.0	102.7	104.2	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Table 5: V117-4.0MW SO1 expected 1/3 octave band performance (Blades with serrated trailing edge)

3.4 Results V117 4.0 MW, SO2

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	13.1	12.7	13.2	19.7	25.3	27.1	29.2	28.9	29.6	31.5	33.5	34.9	35.9	36.6	37.4	37.9	38.3	38.7
8 Hz	20.0	19.7	20.3	26.5	31.8	33.6	35.6	35.3	35.9	37.7	39.4	40.7	41.5	42.2	42.8	43.3	43.7	44.0
10 Hz	26.1	25.9	26.7	32.5	37.5	39.4	41.2	41.0	41.5	43.1	44.7	45.8	46.5	47.1	47.7	48.1	48.4	48.7
12.5 Hz	32.0	31.9	32.7	38.2	43.0	44.8	46.5	46.3	46.8	48.2	49.7	50.6	51.3	51.8	52.3	52.7	52.9	53.2
16 Hz	38.0	38.1	38.9	44.1	48.7	50.5	52.1	51.9	52.3	53.6	54.9	55.7	56.3	56.7	57.1	57.4	57.6	57.8
20 Hz	43.2	43.3	44.2	49.1	53.5	55.3	56.8	56.6	57.0	58.1	59.3	60.0	60.5	60.8	61.2	61.5	61.6	61.8
25 Hz	48.0	48.2	49.2	53.9	58.0	59.9	61.2	61.1	61.4	62.4	63.4	64.0	64.4	64.7	65.0	65.2	65.4	65.5
31.5 Hz	52.7	53.0	54.0	58.4	62.4	64.2	65.4	65.4	65.7	66.5	67.4	67.9	68.2	68.5	68.7	68.9	69.0	69.1
40 Hz	57.2	57.5	58.6	62.8	66.6	68.4	69.5	69.5	69.8	70.5	71.3	71.7	71.9	72.1	72.3	72.4	72.5	72.6
50 Hz	61.0	61.4	62.6	66.6	70.2	72.0	73.0	73.0	73.3	73.9	74.6	74.9	75.1	75.2	75.4	75.5	75.5	75.6
63 Hz	64.7	65.2	66.4	70.1	73.6	75.4	76.4	76.4	76.6	77.1	77.7	77.9	78.1	78.2	78.3	78.4	78.4	78.4
80 Hz	68.1	68.6	69.9	73.5	76.8	78.6	79.5	79.5	79.7	80.2	80.6	80.8	80.9	81.0	81.0	81.1	81.1	81.1
100 Hz	71.0	71.6	72.8	76.3	79.5	81.3	82.1	82.1	82.3	82.7	83.1	83.2	83.2	83.3	83.3	83.3	83.3	83.3
125 Hz	73.6	74.2	75.4	78.7	81.9	83.7	84.4	84.5	84.6	84.9	85.3	85.3	85.4	85.4	85.4	85.4	85.4	85.4
160 Hz	76.0	76.6	77.9	81.1	84.2	86.0	86.7	86.7	86.8	87.1	87.4	87.4	87.4	87.4	87.4	87.3	87.3	87.3
200 Hz	77.9	78.6	79.9	83.0	85.9	87.7	88.4	88.4	88.5	88.8	89.0	89.0	89.0	88.9	88.9	88.9	88.8	88.8
250 Hz	79.5	80.1	81.4	84.5	87.4	89.1	89.8	89.8	89.9	90.1	90.4	90.3	90.3	90.2	90.2	90.1	90.1	90.1
315 Hz	80.8	81.5	82.8	85.7	88.6	90.3	91.0	91.0	91.1	91.3	91.5	91.4	91.4	91.3	91.3	91.2	91.2	91.1
400 Hz	81.8	82.4	83.7	86.6	89.5	91.2	91.8	91.9	91.9	92.1	92.3	92.3	92.2	92.1	92.1	92.0	92.0	92.0
500 Hz	82.4	83.0	84.3	87.2	90.0	91.7	92.3	92.4	92.4	92.7	92.9	92.8	92.7	92.7	92.6	92.6	92.5	92.5
630 Hz	82.6	83.3	84.5	87.4	90.2	91.9	92.6	92.6	92.7	92.9	93.1	93.0	93.0	92.9	92.9	92.8	92.8	92.8
800 Hz	82.6	83.2	84.4	87.3	90.1	91.8	92.5	92.5	92.6	92.8	93.1	93.0	93.0	92.9	92.9	92.9	92.8	92.8
1 kHz	82.2	82.8	84.0	86.9	89.7	91.4	92.1	92.1	92.2	92.5	92.7	92.7	92.7	92.7	92.6	92.6	92.6	92.6
1.25 kHz	81.5	82.0	83.2	86.2	89.0	90.7	91.4	91.4	91.5	91.8	92.1	92.1	92.1	92.1	92.2	92.2	92.2	92.2
1.6 kHz	80.3	80.9	81.9	85.0	87.9	89.5	90.3	90.3	90.4	90.8	91.1	91.2	91.3	91.3	91.3	91.3	91.4	91.4
2 kHz	79.0	79.4	80.5	83.6	86.6	88.2	89.0	89.0	89.1	89.5	90.0	90.1	90.2	90.2	90.3	90.4	90.4	90.4
2.5 kHz	77.3	77.7	78.7	81.9	85.0	86.6	87.4	87.4	87.5	88.0	88.5	88.7	88.8	88.9	89.0	89.1	89.2	89.2
3.15 kHz	75.2	75.5	76.4	79.8	83.0	84.5	85.5	85.4	85.6	86.2	86.8	87.0	87.2	87.3	87.5	87.6	87.7	87.8
4 kHz	72.7	73.0	73.8	77.3	80.6	82.1	83.2	83.0	83.3	83.9	84.6	85.0	85.2	85.4	85.6	85.7	85.8	86.0
5 kHz	70.0	70.2	71.0	74.6	78.0	79.5	80.7	80.5	80.8	81.6	82.3	82.8	83.1	83.3	83.5	83.7	83.9	84.0
6.3 kHz	66.9	67.0	67.7	71.5	75.0	76.5	77.8	77.6	77.9	78.8	79.7	80.2	80.6	80.9	81.2	81.4	81.6	81.8
8 kHz	63.4	63.4	63.9	68.0	71.7	73.1	74.5	74.2	74.6	75.6	76.7	77.3	77.8	78.1	78.5	78.8	79.0	79.2
10 kHz	59.7	59.6	60.1	64.4	68.2	69.6	71.1	70.8	71.2	72.4	73.5	74.3	74.8	75.3	75.7	76.0	76.3	76.5
A-wgt	92.2	92.8	94.0	97.0	99.9	101.6	102.3	102.3	102.4	102.7	103.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0

Table 6: V117-4.0MW SO2 expected 1/3 octave band performance (Blades with serrated trailing edge)

3.5 Results V117 4.0 MW, SO3

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	15 m/s	16 m/s	17 m/s	18 m/s	19 m/s	20 m/s
6.3 Hz	13.1	12.7	13.2	19.7	24.9	26.1	26.3	26.7	27.6	28.7	29.8	31.1	32.2	33.1	33.9	34.6	35.3	36.0
8 Hz	20.0	19.7	20.3	26.5	31.5	32.6	32.8	33.2	34.0	35.0	35.9	37.0	38.0	38.8	39.5	40.2	40.8	41.4
10 Hz	26.1	25.9	26.7	32.5	37.2	38.4	38.6	38.9	39.6	40.5	41.3	42.3	43.2	43.9	44.5	45.1	45.6	46.2
12.5 Hz	32.0	31.9	32.7	38.2	42.7	43.9	44.1	44.4	45.0	45.7	46.5	47.3	48.1	48.7	49.2	49.8	50.2	50.7
16 Hz	38.0	38.1	38.9	44.1	48.4	49.6	49.8	50.0	50.5	51.2	51.8	52.6	53.2	53.7	54.2	54.6	55.0	55.4
20 Hz	43.2	43.3	44.2	49.1	53.3	54.4	54.6	54.8	55.3	55.8	56.4	57.0	57.6	58.0	58.4	58.8	59.1	59.4
25 Hz	48.0	48.2	49.2	53.9	57.8	59.0	59.2	59.4	59.7	60.2	60.6	61.2	61.6	62.0	62.3	62.7	62.9	63.2
31.5 Hz	52.7	53.0	54.0	58.4	62.2	63.3	63.6	63.7	64.0	64.4	64.8	65.2	65.6	65.9	66.1	66.4	66.6	66.9
40 Hz	57.2	57.5	58.6	62.8	66.4	67.5	67.8	67.9	68.1	68.4	68.7	69.1	69.4	69.6	69.8	70.0	70.2	70.4
50 Hz	61.0	61.4	62.6	66.6	70.1	71.1	71.4	71.5	71.6	71.9	72.1	72.4	72.6	72.8	73.0	73.1	73.3	73.4
63 Hz	64.7	65.2	66.4	70.1	73.5	74.6	74.8	74.9	75.0	75.2	75.3	75.5	75.7	75.9	76.0	76.1	76.2	76.3
80 Hz	68.1	68.6	69.9	73.5	76.7	77.8	78.0	78.0	78.1	78.2	78.4	78.5	78.6	78.7	78.8	78.9	78.9	79.0
100 Hz	71.0	71.6	72.8	76.3	79.4	80.4	80.7	80.7	80.8	80.8	80.9	81.0	81.1	81.1	81.1	81.2	81.2	81.3
125 Hz	73.6	74.2	75.4	78.7	81.8	82.8	83.1	83.1	83.1	83.1	83.1	83.2	83.2	83.2	83.3	83.3	83.3	83.3
160 Hz	76.0	76.6	77.9	81.1	84.1	85.1	85.3	85.3	85.3	85.3	85.3	85.3	85.3	85.3	85.3	85.3	85.3	85.3
200 Hz	77.9	78.6	79.9	83.0	85.8	86.9	87.1	87.1	87.0	87.0	87.0	87.0	86.9	86.9	86.9	86.8	86.8	86.8
250 Hz	79.5	80.1	81.4	84.5	87.3	88.3	88.5	88.5	88.5	88.4	88.4	88.3	88.3	88.2	88.2	88.2	88.1	88.1
315 Hz	80.8	81.5	82.8	85.7	88.5	89.5	89.7	89.7	89.6	89.6	89.5	89.5	89.4	89.3	89.3	89.2	89.2	89.2
400 Hz	81.8	82.4	83.7	86.6	89.4	90.4	90.6	90.6	90.5	90.5	90.4	90.3	90.3	90.2	90.1	90.1	90.0	90.0
500 Hz	82.4	83.0	84.3	87.2	89.9	90.9	91.1	91.1	91.0	91.0	90.9	90.8	90.8	90.7	90.7	90.6	90.6	90.5
630 Hz	82.6	83.3	84.5	87.4	90.1	91.1	91.3	91.3	91.3	91.2	91.2	91.1	91.0	91.0	91.0	90.9	90.9	90.8
800 Hz	82.6	83.2	84.4	87.3	90.0	91.0	91.2	91.2	91.2	91.1	91.1	91.1	91.0	91.0	91.0	90.9	90.9	90.9
1 kHz	82.2	82.8	84.0	86.9	89.6	90.6	90.8	90.8	90.8	90.8	90.8	90.7	90.7	90.7	90.7	90.7	90.7	90.6
1.25 kHz	81.5	82.0	83.2	86.2	88.9	89.9	90.1	90.1	90.1	90.1	90.1	90.2	90.2	90.2	90.2	90.2	90.2	90.2
1.6 kHz	80.3	80.9	81.9	85.0	87.8	88.8	89.0	89.0	89.0	89.1	89.1	89.2	89.2	89.3	89.3	89.3	89.4	89.4
2 kHz	79.0	79.4	80.5	83.6	86.5	87.4	87.6	87.6	87.7	87.8	87.9	88.0	88.1	88.2	88.3	88.3	88.4	88.4
2.5 kHz	77.3	77.7	78.7	81.9	84.8	85.8	86.0	86.0	86.1	86.3	86.4	86.6	86.7	86.9	87.0	87.0	87.1	87.2
3.15 kHz	75.2	75.5	76.4	79.8	82.8	83.8	83.9	84.0	84.2	84.4	84.6	84.8	85.0	85.2	85.3	85.5	85.6	85.7
4 kHz	72.7	73.0	73.8	77.3	80.4	81.4	81.5	81.6	81.8	82.1	82.4	82.7	83.0	83.2	83.4	83.5	83.7	83.9
5 kHz	70.0	70.2	71.0	74.6	77.8	78.8	78.9	79.0	79.4	79.7	80.1	80.4	80.8	81.0	81.3	81.5	81.7	81.9
6.3 kHz	66.9	67.0	67.7	71.5	74.9	75.8	76.0	76.1	76.5	76.9	77.3	77.8	78.2	78.5	78.8	79.1	79.4	79.6
8 kHz	63.4	63.4	63.9	68.0	71.5	72.4	72.5	72.7	73.1	73.7	74.2	74.8	75.2	75.7	76.0	76.4	76.7	77.0
10 kHz	59.7	59.6	60.1	64.4	68.0	68.9	69.0	69.2	69.7	70.4	71.0	71.6	72.2	72.7	73.1	73.5	73.9	74.3
A-wgt	92.2	92.8	94.0	97.0	99.8	100.8	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0

Table 7: V117-4.0MW SO1 expected 1/3 octave band performance (Blades with serrated trailing edge)

4. Limitations

The values as stated in the present document are to be regarded as "best estimates" for the octave band performance for the turbine. The values are to be regarded as informative and cannot in any way be used as guaranteed for any projects.

The complete document can be handed out as pdf and must always be referred to using the complete document DMS number.

5. Recalculation to 10 m wind speeds

In case 10 m height wind speed references are required, recalculation of the stated values can be made using the following procedure:

1. The stated hub height wind speeds are recalculated to 10 m reference height.
2. Integer 10 m height wind speed related sound power levels are calculated using linear interpolation between the nearest non integer values.

Recalculation is made using procedures as defined in IEC 61400-11 ed.3. Appendix D.

VESTAS V136

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General Description

4MW Platform

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Denmark · www.vestas.com

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See general reservations, notes and disclaimers (including, section 12, p. 39) to this general description.

1 Introduction

The 4MW Platform wind turbine configurations covered by this General Description are listed below with designations according to IEC61400-22.

DIBt 2012 wind classes are also listed where applicable.

Please refer to the Performance Specification for the relevant turbine variant for full wind class definition.

This General Description contains data and descriptions common among the platform variants.

The variant specific performance can be found in the Performance Specifications for the turbine variant and operational mode required.

Turbine Type Class	Turbine Type | Operating Mode
V117-4.0/4.2 MW Strong Wind	V117-4.0 MW IEC IB / IEC IIA 50/60 Hz | Mode 0
	V117-4.0 MW IEC IB / IEC IIA 50/60 Hz | Reactive Power Optimized Mode (QO1)
	V117-4.2 MW IEC S / IEC IIA 50/60 Hz | Power Optimized Mode (PO1)
	V117-3.8 MW IEC IB / IEC IIA 50/60 Hz | Load Optimized Mode (LO1)
	V117-3.6 MW IEC IB / IEC IIA+ 50/60 Hz | Load Optimized Mode (LO2)
V117-4.0/4.2 MW Typhoon	V117-4.0 MW IEC IB-T / IEC IIA-T 50/60 Hz | Mode 0
	V117-4.0 MW IEC IB-T / IEC IIA-T 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V117-4.2 MW IEC S-T / IEC IIA-T 50/60 Hz | Power Optimized Mode (PO1)
	V117-3.8 MW IEC IB-T / IEC IIA-T 50/60 Hz | Load Optimized Mode (LO1)
	V117-3.6 MW IEC IB-T / IEC IIA+-T 50/60 Hz | Load Optimized Mode (LO2)
V136-4.0/4.2 MW	V136-4.0 MW IEC IIB / IEC IIIB 50/60 Hz | Mode 0
	V136-4.0 MW IEC IIB / IEC IIIB 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V136-4.2 MW IEC S / IEC IIIB 50/60 Hz | Power Optimized Mode (PO1)
	V136-3.8 MW IEC IIB / IEC IIIB 50/60 Hz | Load Optimized Mode (LO1)
	V136-3.6 MW IEC IIB / IEC IIIB 50/60 Hz | Load Optimized Mode (LO2)
	V136-4.0 MW DIBt S 50 Hz | Mode 0
	V136-4.0 MW DIBt S 50 Hz | Reactive Power Optimized Mode (QO1)
	V136-4.2 MW DIBt S 50 Hz | Power Optimized Mode (PO1)
	V136-3.8 MW DIBt S 50 Hz | Load Optimized Mode (LO1)
	V136-3.6 MW DIBt S 50 Hz | Load Optimized Mode (LO2)
V150-4.0/4.2 MW	V150-4.0 MW IEC IIIB 50/60 Hz | Mode 0
	V150-4.0 MW IEC IIIB 50/60 Hz | Reactive Power Optim. Mode (QO1)
	V150-4.2 MW IEC S 50/60 Hz | Power Optimized Mode (PO1)
	V150-3.8 MW IEC IIIB / IEC S 50/60 Hz | Load Optimized Mode (LO1)
	V150-3.6 MW IEC IIIB / S 50/60 Hz | Load Optimized Mode (LO2)
	V150-4.0 MW DIBt S 50 Hz | Mode 0

Turbine Type Class	Turbine Type | Operating Mode
V150-4.0/4.2 MW (cont'd)	V150-4.0 MW DIBt S 50 Hz | Reactive Power Optimized Mode (QO1)
	V150-4.2 MW DIBt S 50 Hz | Power Optimized Mode (PO1)
	V150-3.8 MW DIBt S 50 Hz | Load Optimized Mode (LO1)
	V150-3.6 MW DIBt S 50 Hz | Load Optimized Mode (LO2)

Table 1-1: 4MW Platform turbine configurations covered.

2 General Description

Vestas 4MW Platform comprises a family of wind turbines sharing a common design basis.

The 4MW Platform family of wind turbines includes V105-3.45/3.6 MW, V112-3.45/3.6 MW, V117-3.45/3.6 MW, V126-3.45 MW LTq, V126-3.45/3.6 MW HTq, V136-3.45/3.6 MW, V117-4.0/4.2 MW Strong Wind, V117-4.0/4.2 MW Typhoon, V136-4.0/4.2 MW and V150-4.0/4.2 MW.

For V105-3.45/3.6 MW, V112-3.45/3.6 MW, V117-3.45/3.6 MW, V126-3.45 MW LTq, V126-3.45/3.6 MW HTq and V136-3.45/3.6 MW, please refer to General Description 0053-3707.

This General Description only applies to V117-4.0/4.2 MW Strong Wind, V117-4.0/4.2 MW Typhoon, V136-4.0/4.2 MW and V150-4.0/4.2 MW.

These turbines are pitch regulated upwind turbines with active yaw and a three-blade rotor.

The turbines covered in this General Description are equipped with rotor with diameters residing in the range 117 m to 150 m and a rated output power of 4.0 MW.

A 4.0 MW Reactive Power Optimized Mode (QO1) is available for all variants.

A 4.2 MW Power Optimized Mode (PO1) is available for all variants.

Also, a 3.8 MW Load Optimized Mode (LO1) and a 3.6 MW Load Optimized Mode (LO2) is available for all variants.

The wind turbine family utilises the OptiTip® concept and a power system based on an induction generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintain the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

Operating the wind turbine in 4.0 MW Reactive Power Optimized Mode (QO1) is achieved by applying an extended ambient temperature derate strategy compared with 4.0 MW Mode 0 operation.

Operating the wind turbine in 4.2 MW Power Optimized Mode (PO1) is achieved by applying an extended ambient temperature derate strategy and reduced reactive power capability compared with 4.0 MW Mode 0 operation.

3 Mechanical Design

3.1 Rotor

The wind turbine is equipped with a rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle.

Rotor	V117	V136	V150
Diameter	117 m	136 m	150 m
Swept Area	10751 m^2	14527 m^2	17671 m^2
Speed, Dynamic Operation Range	6.7-17.5	5.6-14.0	4.9-12.0
Rotational Direction	Clockwise (front view)		
Orientation	Upwind		
Tilt	6°		
Hub Coning	4°	4°	5.5°
No. of Blades	3		
Aerodynamic Brakes	Full feathering		

Table 3-1: Rotor data

3.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam or with embedded structure.

Blades	V117	V136	V150
Type Description	Airfoil shells bonded to supporting beam	Prepreg or infused structural airfoil shell	Prepreg or infused structural airfoil shell
Blade Length	57.15 m	66.66 m	73.66 m
Material	Fibreglass reinforced epoxy, carbon fibres and Solid Metal Tip (SMT)		
Blade Connection	Steel roots inserted		
Airfoils	High-lift profile		
Maximum Chord	4.0 m	4.1 m	4.2 m
Chord at 90% blade radius	1.1 m	1.2 m	1.4 m

Table 3-2: Blades data

3.3 Blade Bearing

The blade bearings allow the blades to operate at varying pitch angles.

Blade Bearing	
Blade bearing type	Double-row four-point contact ball bearings
Lubrication	Manual grease lubrication

Table 3-3: Blade bearing data

3.4 Pitch System

The turbine is equipped with a pitch system for each blade and a distributor block, all located in the hub. Each pitch system is connected to the distributor block with flexible hoses. The distributor block is connected to the pipes of the hydraulic rotating transfer unit in the hub by means of three hoses (pressure line, return line and drain line).

Each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade bearing via a torque arm shaft. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Pitch System	
Type	Hydraulic
Number	1 per blade
Range	-10° to 95°

Table 3-4: Pitch system data

Hydraulic System	
Main Pump	Two redundant internal-gear oil pumps
Pressure	260 bar
Filtration	3 µm (absolute)

Table 3-5: Hydraulic system data.

3.5 Hub

The hub supports the three blades and transfers the reaction loads to the main bearing and the torque to the gearbox. The hub structure also supports blade bearings and pitch cylinders.

Hub	
Type	Cast ball shell hub
Material	Cast iron

Table 3-6: Hub data

3.6 Main Shaft

The main shaft transfers the reaction forces to the main bearing and the torque to the gearbox.

Main Shaft	
Type Description	Hollow shaft
Material	Cast iron or forged steel

Table 3-7: Main shaft data

3.7 Main Bearing Housing

The main bearing housing covers the main bearing and is the first connection point for the drive train system to the bedplate.

Main Bearing Housing	
Material	Cast iron

Table 3-8: Main bearing housing data

3.8 Main Bearing

The main bearing carries all thrust loads.

Main Bearing	
Type	Double-row spherical roller bearing
Lubrication	Automatic grease lubrication

Table 3-9: Main bearing data

3.9 Gearbox

The main gear converts the low-speed rotation of the rotor to high-speed generator rotation.

The disc brake is mounted on the high-speed shaft. The gearbox lubrication system is a pressure-fed system.

Gearbox	
Type	Planetary stages + one helical stage
Gear House Material	Cast
Lubrication System	Pressure oil lubrication
Backup Lubrication System	Oil sump filled from external gravity tank
Total Gear Oil Volume	1000-1500
Oil Cleanliness Codes	ISO 4406-/15/12
Shaft Seals	Labyrinth

Table 3-10: Gearbox data

3.10 Generator Bearings

The bearings are grease lubricated and grease is supplied continuously from an automatic lubrication unit.

3.11 High-Speed Shaft Coupling

The coupling transmits the torque of the gearbox high-speed output shaft to the generator input shaft.

The coupling consists of two 4-link laminate packages and a fibreglass intermediate tube with two metal flanges.

The coupling is fitted to two-armed hubs on the brake disc and the generator hub.

3.12 Yaw System

The yaw system is an active system based on a robust pre-tensioned plain yaw-bearing concept with PETP as friction material.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed (50 Hz)	0.45°/sec.
Yawing Speed (60 Hz)	0.55°/sec.

Table 3-11: Yaw system data

Yaw Gear	
Type	Multiple stages geared
Ratio Total	944:1
Rotational Speed at Full Load	1.4 rpm at output shaft

Table 3-12: Yaw gear data

3.13 Crane

The nacelle houses the internal safe working load (SWL) service crane. The crane is a single system hoist.

Crane	
Lifting Capacity	Maximum 800 kg

Table 3-13: Crane data

3.14 Towers

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. The towers are designed with the majority of internal welded connections replaced by magnet supports to create a predominantly smooth-walled tower.

Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (that is, in the gravitational direction) by a mechanical connection. The smooth tower design reduces the required steel thickness, rendering the tower lighter compared to one with all internals welded to the tower shells.

Available hub heights are listed in the Performance Specification for each turbine variant. Designated hub heights include a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange and a distance from tower top flange to centre of the hub of 2.2 m.

Towers	
Type	Cylindrical/conical tubular

Table 3-14: Tower structure data

3.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel. The roof section is equipped with wind sensors and skylights.

The skylights can be opened from inside the nacelle to access the roof and from outside to access the nacelle. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the front nacelle bedplate.

The crane girders are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, the cooling system and transformer. The nacelle cover is installed on the nacelle bedplate.

Type Description	**Material**
Nacelle Cover	GRP
Bedplate Front	Cast iron
Bedplate Rear	Girder structure

Table 3-15: Nacelle bedplate and cover data

3.16 Thermal Conditioning System

The thermal conditioning system consists of a few robust components:

- The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.

- The CoolerTop® comes as standard in a “naked” form, with no side cover panels. Side cover panels are available as an option.
- The Liquid Cooling System, which serves the gearbox, hydraulic systems, generator and converter is driven by an electrical pumping system.
- The transformer forced air cooling comprised of an electrical fan.

3.16.1 Generator and Converter Cooling

The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.2 Gearbox and Hydraulic Cooling

The gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the nacelle.

In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

3.16.3 Transformer Cooling

The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the converter and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

3.16.4 Nacelle Cooling

Hot air generated by mechanical and electrical equipment is dissipated from the nacelle by a fan system located in the nacelle.

3.16.5 Optional Air Intake Hatches

Specific air intakes in the nacelle can optionally be fitted with hatches which can be operated as a part of the thermal control strategy. In case of lost grid to the turbine, the hatches will automatically be closed.

4 Electrical Design

4.1 Generator

The generator is a three-phase asynchronous induction generator with cage rotor that is connected to the grid through a full-scale converter. The generator housing allows the circulation of cooling air within the stator and rotor.

The air-to-water heat exchange occurs in an external heat exchanger.

Generator	
Type	Asynchronous with cage rotor
Rated Power [P_N]	4250 / 4450 kW
Frequency [f_N]	0-100 Hz
Voltage, Stator [U_{NS}]	3 x 800 V (at rated speed)
Number of Poles	6
Winding Type	Form with VPI (Vacuum Pressurized Impregnation)
Winding Connection	Delta
Rated rpm	1450-1550 rpm
Overspeed Limit Acc. to IEC (2 minutes)	2400 rpm
Generator Bearing	Hybrid/ceramic
Temperature Sensors, Stator	3 PT100 sensors placed at hot spots and 3 as back-up
Temperature Sensors, Bearings	1 per bearing
Insulation Class	H
Enclosure	IP54

Table 4-1: Generator data

4.2 Converter

The converter is a full-scale converter system controlling both the generator and the power quality delivered to the grid. The converter consists of 3 machine-side converter units and 3 line-side converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency AC power from the generator into fixed frequency AC power with desired active and reactive power levels (and other grid connection parameters) suitable for the grid.

The converter is located in the nacelle and has a grid side voltage rating of 720 V. The generator side voltage rating is up to 800 V dependent on generator speed.

Converter	
Rated Apparent Power [S_N]	5100 kVA
Rated Grid Voltage	3 x 720 V
Rated Generator Voltage	3 x 800 V
Rated Grid Current	4100 A (≤30°C ambient) / 4150 (≤20°C ambient)
Rated Generator Current	3600 A (≤30°C ambient) / 3650 (≤20°C ambient)
Enclosure	IP54

Table 4-2: Converter data

4.3 HV Transformer

The step-up HV transformer is located in a separate locked room in the back of the nacelle.

The transformer is a three-phase, three limb, two-winding, dry-type transformer that is self-extinguishing. The windings are delta-connected on the high-voltage side and star connected on the low voltage side.

The transformer is designed according to IEC standards, but also complying to European Ecodesign regulation No 548/2014 set by the European Commission. Refer to Table 4-3.

4.3.1 Ecodesign - IEC 50 Hz/60 Hz version

Transformer	
Type description	Ecodesign dry-type cast resin transformer.
Basic layout	3 phase, 3 limb, 2 winding transformer.
Applied standards	IEC 60076-11, IEC 60076-16, IEC 61936-1, Commission Regulation No 548/2014.
Cooling method	AF
Rated power	5150 kVA
Rated voltage, turbine side	
U_m 1.1kV	0.720 kV
Rated voltage, grid side	
U_m 24.0kV	12.9-22.0 kV
U_m 36.0kV	22.1-33.0 kV
U_m 40.5kV	33.1-36.0 kV
Insulation level AC / LI / LIC	
U_m 1.1kV	3[1] / 3 / 3 kV
U_m 24.0kV	50[1] / 125 / 125 kV
U_m 36.0kV	70[1] / 170 / 170 kV
U_m 40.5kV	80[1] / 170 / 170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	50 Hz / 60 Hz
Vector group	Dyn5
No-load current [2]	~0.5 %
Positive sequence short-circuit impedance @ rated power, 120°C [3]	9.9 %
Positive sequence short-circuit resistance@ rated power, 120°C [2]	~0.8 %
Zero sequence short-circuit impedance@ rated power, 120°C [2]	~8.3 %
Zero sequence short-circuit resistance@ rated power, 120°C [2]	~0.7 %
No-load reactive power [2]	~20 kVAr
Full load reactive power [2]	~550 kVAr
Inrush peak current [2]	5-8 x $\hat{I}_n$ A
Half crest time [2]	~ 0.6 s
Sound power level	≤ 80 dB(A)

Transformer	
Average temperature rise at max altitude	≤ 90 K
Max altitude [4]	2000 m
Insulation class	
LV coil	155 (F)
HV coil	155 (F) or 180 (H)
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	≤11000 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø25 mm earthing ball points

Table 4-3: Transformer data for Ecodesign IEC 50 Hz/60 Hz version.

The transformer loss limits are given at rated power as combination of load loss and no-load loss which shall fulfil the Peak Efficiency Index (PEI) of the Ecodesign requirement.

The maximum losses are described by the PEI limit section of

Figure *4-1* and stretch over a range between Loss variant 1 and Loss variant 2. The Loss variant values are selected based on energy loss optimization with the turbine user profile hence the energy loss of transformers between Loss variant 1 and Loss variant 2 are comparable.

Figure 4-1 Transformer losses allowable area

The actual load losses vary depend on the operation mode of the turbine, hence in Table 4-4 the load losses are provide at different operation modes for the two loss variants. For further recalculation of load losses at different operation modes, refer to Figure 4-2.

Transformer losses			
Peak Efficiency Index (PEI)	> 99.354		
Loss variant 1			
No-load loss	7.75 kW		
Load loss @ power, 120°C	**@5150kVA**	**@4200kVA[5]**	**@4000kVA[5]**
	≤ 35.7 kW	≤ 23.8 kW	≤ 21.6 kW
Loss variant 2			
No-load loss	8.5 kW		
Load loss @ power, 120°C	**@5150kVA**	**@4200kVA[5]**	**@4000kVA[5]**
	≤ 32.55 kW	≤ 21.7 kW	≤ 19.7 kW

Table 4-4: Transformer losses for Ecodesign IEC 50 Hz/60 Hz version.

NOTE

[1] @1000m. According to IEC 60076-11, AC test voltage is altitude dependent.
[2] Based on an average of calculated values across voltages and manufacturers.
[3] Subjected to standard IEC tolerances.
[4] Transformer max altitude may be adjusted to match turbine location.
[5] Information values based on operation mode, see Figure 4-2

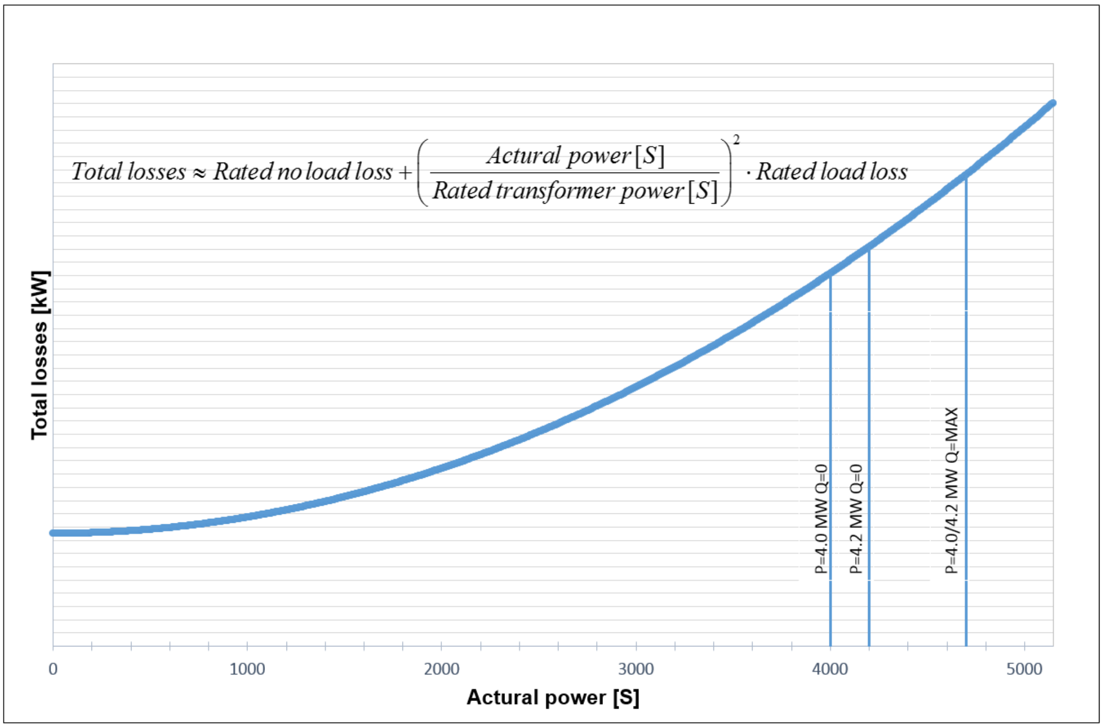


Figure 4-2: Total Losses vs. Actual Power.

4.4 HV Cables

The high-voltage cable runs from the transformer in the nacelle down the tower to the HV switchgear located at the bottom of the tower. The high-voltage cable can be of two different constructions:

- A three-core, rubber-insulated, halogen-free, high-voltage cable with a three-core split earth conductor.
- A four-core, rubber-insulated, halogen-free, high-voltage cable.

HV Cables	
High-Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Pre-terminated	HV termination in transformer end. T-Connector Type-C in switchgear end.
Maximum Voltage	24 kV for 19.1-22.0 kV rated voltage 42 kV for 22.1-36.0 kV rated voltage
Conductor Cross Sections	3x70 / 70 mm^2 (Single PE core) 3x70 + 3x70/3 mm^2 (Split PE core)

Table 4-5: HV cables data

4.5 HV Switchgear

A gas insulated switchgear is installed in the bottom of the tower as an integrated part of the turbine. Its controls are integrated with the turbine safety system, which monitors the condition of the switchgear and high voltage safety related devices in the turbine. This system is named ‘Ready to Protect’ and ensures all protection devices are operational, whenever high voltage components in the turbine are energised. To ensure that the switchgear is always ready to trip, it is equipped with redundant trip circuits consisting of an active trip coil and an undervoltage trip coil.

In case of grid outage the circuit breaker will disconnect the turbine from the grid after an adjustable time.

When grid returns, all relevant protection devices will automatically be powered up via UPS.

When all the protection devices are operational, the circuit breaker will re-close after an adjustable time. The re-close functionality can furthermore be used to implement a sequential energization of a wind park, in order to avoid simultaneous inrush currents from all turbines once grid returns after an outage.

In case the circuit breaker has tripped due to a fault detection, the circuit breaker will be blocked for re-connection until a manual reset is performed.

In order to avoid unauthorized access to the transformer room during live condition, the earthing switch of the circuit breaker, contains a trapped-key interlock system with its counterpart installed on the access door to the transformer room.

The switchgear is available in three variants with increasing features, see Table 4-6. Beside the increase in features, the switchgear can be configured depending on the number of grid cables planned to enter the individual turbine. The design of the switchgear solution is optimized such grid cables can be connected to the switchgear even before the tower is installed and still maintain its protection toward weather conditions and internal condensation due to a gas tight packing.

The switchgear is available in an IEC version and in an IEEE version. The IEEE version is however only available in the highest voltage class. The electrical parameters of the switchgear are seen in Table 4-7 for the IEC version and in Table 4-8 for the IEEE version.

HV Switchgear			
Variant	**Basic**	**Streamline**	**Standard**
IEC standards	○	⦿	⦿
IEEE standards	⦿	○	⦿
Vacuum circuit breaker panel	⦿	⦿	⦿
Overcurrent, short-circuit and earth fault protection	⦿	⦿	⦿
Disconnector / earthing switch in circuit breaker panel	⦿	⦿	⦿
Voltage Presence Indicator System for circuit breaker	⦿	⦿	⦿
Voltage Presence Indicator System for grid cables	⦿	⦿	⦿
Double grid cable connection	⦿	⦿	⦿
Triple grid cable connection	⦿	○	○
Preconfigured relay settings	⦿	⦿	⦿
Turbine safety system integration	⦿	⦿	⦿
Redundant trip coil circuits	⦿	⦿	⦿
Trip coil supervision	⦿	⦿	⦿
Pendant remote control from outside of tower	⦿	⦿	⦿
Sequential energization	⦿	⦿	⦿
Reclose blocking function	⦿	⦿	⦿
Heating elements	⦿	⦿	⦿
Trapped-key interlock system for circuit breaker panel	⦿	⦿	⦿
Motor operation of circuit breaker	⦿	⦿	⦿
Cable panel for grid cables (configurable)	○	⦿	⦿
Switch disconnector panels for grid cables – max three panels (configurable)	○	⦿	⦿
Earthing switch for grid cables	○	⦿	⦿
Internal arc classification	○	⦿	⦿
Supervision on MCB’s	○	⦿	⦿
Motor operation of switch disconnector	○	○	⦿
SCADA operation and feedback of circuit breaker	○	○	⦿

HV Switchgear			
Variant	**Basic**	**Streamline**	**Standard**
SCADA operation and feedback of switch disconnector	○	○	⊙

Table 4-6: HV switchgear variants and features

4.5.1 IEC 50/60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEC 62271-103 IEC 62271-1, 62271-100, 62271-102, 62271-200, IEC 60694
Insulation medium	SF_6
Rated voltage	
U_r 24.0kV	15.7-22.0 kV
U_r 36.0kV	22.1-33.0 kV
U_r 40.5kV	33.1-36.0 kV
Rated insulation level AC // LI Common value / across isolation distance	
U_r 24.0kV	50 / 60 // 125 / 145 kV
U_r 36.0kV	70 / 80 // 170 / 195 kV
U_r 40.5kV	85 / 90 // 185 / 215 kV
Rated frequency	50 Hz / 60 Hz
Rated normal current	630 A
Rated Short-time withstand current	
U_r 24.0kV	20 kA
U_r 36.0kV	25 kA
U_r 40.5kV	25 kA
Rated peak withstand current 50 / 60 Hz	
U_r 24.0kV	50 / 52 kA
U_r 36.0kV	62.5 / 65 kA
U_r 40.5kV	62.5 / 65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	
U_r 24.0kV	IAC A FLR 20 kA, 1 s
U_r 36.0kV	IAC A FLR 25 kA, 1 s
U_r 40.5kV	IAC A FLR 25 kA, 1 s
Connection interface	Outside cone plug-in bushings, IEC interface C1.
Loss of service continuity category	LSC2
Ingress protection	
Gas tank	IP 65
Enclosure	IP 2X
LV cabinet	IP 3X
Corrosion class	C3

Table 4-7: HV switchgear data for IEC version

4.5.2 IEEE 60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEEE 37.20.3, IEEE C37.20.4, IEC 62271-200, ISO 12944.
Insulation medium	SF_6
Rated voltage	
U_r 38.0kV	22.1-36.0 kV
Rated insulation level AC / LI	70 / 150 kV
Rated frequency	60 Hz
Rated normal current	600 A
Rated Short-time withstand current	25 kA
Rated peak withstand current	65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	IAC A FLR 25 kA, 1 s
Connection interface grid cables	Outside cone plug-in bushings, IEEE 386 interface type deadbreak, 600A.
Ingress protection	
Gas tank	NEMA 4X / IP 65
Enclosure	NEMA 2 / IP 2X
LV cabinet	NEMA 2 / IP 3X
Corrosion class	C3

Table 4-8: HV switchgear data for IEEE version

4.6 AUX System

The AUX system is supplied from a separate 650/400/230 V transformer located in the nacelle inside the converter cabinet. All motors, pumps, fans and heaters are supplied from this system.

230 V consumers are generally supplied from a 400/230 V transformer located in the tower base. Internal heating and ventilation of cabinets as well as specific option 230 V consumers are supplied from the auxiliary transformer in the converter cabinet.

Power Sockets	
Single Phase (Nacelle)	230 V (16 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Single Phase (Tower Platforms)	230 V (10 A) (standard) 110 V (16 A) (option) 2 x 55 V (16 A) (option)
Three Phase (Nacelle and Tower Base)	3 x 400 V (16 A)

Table 4-9: AUX system data

4.7 Wind Sensors

The turbine is equipped with two ultrasonic wind sensors. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

4.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP8000 control system.

VMP8000 is a multiprocessor control system comprised of main controller, distributed control nodes, distributed IO nodes and ethernet switches and other network equipment. The main controller is placed in the tower bottom of the turbine. It runs the control algorithms of the turbine, as well as all IO communication.

The communications network is a time triggered Ethernet network (TTEthernet).

The VMP8000 control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Reactive power control and variable speed operation.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.
- Monitoring of the smoke detection system.

4.9 Uninterruptible Power Supply (UPS)

During grid outage, an UPS system will ensure power supply for specific components.

The UPS system is built by 3 subsystems:

1. 230V AC UPS for all power backup to nacelle and hub control systems
2. 24V DC UPS for power backup to tower base control systems and optional SCADA Power Plant Controller.
3. 230V AC UPS for power backup to internal lights in tower and nacelle. Internal light in the hub is fed from built-in batteries in the light armature.

UPS		
Backup Time	**Standard**	**Optional**
Control System* **(230V AC and 24V DC UPS)**	15 min	Up to 400 min**

UPS		
Internal Lights **(230V AC UPS)**	30 min	60 min***
Optional SCADA Power Plant Controller **(24V DC UPS)**	N/A	48 hours****

Table 4-10: UPS data

**The control system includes: the turbine controller (VMP8000), HV switchgear functions, and remote control system.*

***Requires upgrade of the 230V UPS for control system with extra batteries.*

****Requires upgrade of the 230V UPS for internal light with extra batteries.*

*****Requires upgrade of the 24V DC UPS with extra batteries.*

NOTE For alternative backup times, consult Vestas.

5 Turbine Protection Systems

5.1 Braking Concept

The main brake on the turbine is aerodynamic. Stopping the turbine is done by full feathering the three blades (individually turning each blade). Each blade has a hydraulic accumulator to supply power for turning the blade.

In addition, there is a mechanical disc brake on the high-speed shaft of the gearbox with a dedicated hydraulic system. The mechanical brake is only used as a parking brake and when activating the emergency stop buttons.

5.2 Short Circuit Protections

Breakers	Breaker for Aux. Power. Back-up CB (T5V-HA 400A TMA 800V) and aux. power CB (T4V-HA 125A TMA 800V) tested in coordination	Breaker 1 for Converter Modules MTZ2 1600A 1000 V	Breaker 2 for Converter Modules MTZ2 3200A 1000 V
Breaking Capacity Icu, Ics	75 kA rms @ max 840 V Ics = 100%	66 kA rms @ max 1000 V Ics = 100%	66 kA rms @ max 1000 V Ics = 100%
Making Capacity Icm	166 kA peak @ max 840 V	145 kA peak @ max 1000 V	145 kA peak @ max 1000 V

Table 5-1: Short circuit protection data

5.3 Overspeed Protection

The generator rpm and the main shaft rpm are registered by inductive sensors and calculated by the wind turbine controller to protect against overspeed and rotating errors.

The safety-related partition of the VMP8000 control system monitors the rotor rpm. In case of an overspeed situation, the safety-related partition of the VMP8000 control system activates the emergency feathered position (full feathering) of the three blades independently of the non-safety related partition of VMP8000 control system.

Overspeed Protection	
Sensors Type	Inductive
Trip Level (variant dependent)	12.0-17.5 rpm / 2000 (generator rpm)

Table 5-2: Overspeed protection data

5.4 Arc Detection

The turbine is equipped with an Arc Detection system including multiple optical arc detection sensors placed in the HV transformer compartment and the converter cabinet. The Arc Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if an arc is detected.

5.5 Smoke Detection

The turbine is equipped with a Smoke Detection system including multiple smoke detection sensors placed in the nacelle (above the disc brake), in the transformer compartment, in main electrical cabinets in the nacelle and above the HV switchgear in the tower base. The Smoke Detection system is connected to the turbine safety system ensuring immediate opening of the HV switchgear if smoke is detected.

5.6 Lightning Protection of Blades, Nacelle, Hub and Tower

The Lightning Protection System (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS consists of five main parts:

- Lightning receptors. All lightning receptor surfaces on the blades are unpainted, excluding the Solid Metal Tips (SMT).
- Down conducting system (a system to conduct the lightning current down through the wind turbine to help avoid or minimise damage to the LPS itself or other parts of the wind turbine).
- Protection against overvoltage and overcurrent.
- Shielding against magnetic and electrical fields.
- Earthing system.

V136 blades and V150 blades:

Lightning Protection Design Parameters			Protection Level I
Current Peak Value	i_{max}	[kA]	200
Impulse Charge	$Q_{impulse}$	[C]	100
Long Duration Charge	Q_{long}	[C]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/µs]	200

Table 5-3: Lightning protection design parameters (IEC)

Hub/Nacelle/Tower/Foundation and V117 blades:

Lightning Protection Design Parameters			Protection Level I
Current Peak Value	i_{max}	[kA]	200
Impulse Charge	$Q_{impulse}$	[C]	200
Long Duration Charge	Q_{long}	[C]	600
Total Charge	Q_{total}	[C]	800
Specific Energy	W/R	[MJ/Ω]	20
Average Steepness	di/dt	[kA/µs]	200

Table 5-4: Lightning protection design parameters (IEC & JIS)

NOTE The Lightning Protection System is designed according to IEC and JIS standards (see section 8 Design Codes, p. 28).

5.7 EMC

The turbine and related equipment fulfils the EU Electromagnetic Compatibility (EMC) legislation:

- DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

5.8 Earthing

The Vestas Earthing System consists of a number of individual earthing electrodes interconnected as one joint earthing system.

The Vestas Earthing System includes the TN-system and the Lightning Protection System for each wind turbine. It works as an earthing system for the medium voltage distribution system within the wind farm.

The Vestas Earthing System is adapted for the different types of turbine foundations. A separate set of documents describe the earthing system in detail, depending on the type of foundation.

In terms of lightning protection of the wind turbine, Vestas has no separate requirements for a certain minimum resistance to remote earth (measured in ohms) for this system. The earthing for the lightning protection system is based on the design and construction of the Vestas Earthing System.

A primary part of the Vestas Earthing System is the main earth bonding bar placed where all cables enter the wind turbine. All earthing electrodes are connected to this main earth bonding bar. Additionally, equipotential connections are made to all cables entering or leaving the wind turbine.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

5.9 Corrosion Protection

Classification of corrosion protection is according to ISO 12944-2.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5-M	C3
Hub	C5-M	C3
Tower	C5-I	C3

Table 5-5: Corrosion protection data for nacelle, hub, and tower

6 Safety

The safety specifications in this section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, and (c) conducting all appropriate safety training and education.

6.1 Access

Access to the turbine from the outside is through a door located at the entrance platform approximately 3 meter above ground level. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is controlled with a lock. Unauthorised access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

6.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch, from the spinner by opening the nose cone, or from the roof of the nacelle. Rescue equipment is placed in the nacelle.

The hatch in the roof can be opened from both the inside and outside. Escape from the service lift is by ladder.

An emergency response plan, placed in the turbine, describes evacuation and escape routes.

6.3 Rooms/Working Areas

The tower and nacelle are equipped with power sockets for electrical tools for service and maintenance of the turbine.

6.4 Floors, Platforms, Standing, and Working Places

All floors have anti-slip surfaces.

There is one floor per tower section.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

Foot supports are placed in the turbine for maintenance and service purposes.

6.5 Service Lift

The turbine is delivered with a service lift installed as an option.

6.6 Climbing Facilities

A ladder with a fall arrest system (rigid rail) is installed through the tower.

There are anchor points in the tower, nacelle and hub, and on the roof for attaching fall arrest equipment (full-body harness). Over the crane hatch there is an anchor point for the emergency descent equipment. Anchor points are coloured yellow and are calculated and tested to 22.2 kN.

6.7 Moving Parts, Guards, and Blocking Devices

All moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and drive train.

Blocking the pitch of the cylinder can be done with mechanical tools in the hub.

6.8 Lights

The turbine is equipped with lights in the tower, nacelle and hub.

There is emergency light in case of the loss of electrical power.

6.9 Emergency Stop

There are emergency stop buttons in the nacelle, hub and bottom of the tower.

6.10 Power Disconnection

The turbine is equipped with breakers to allow for disconnection from all power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and bottom of the tower.

6.11 Fire Protection/First Aid

A handheld 5-6 kg CO_2 fire extinguisher, first aid kit and fire blanket are required to be located in the nacelle during service and maintenance.

- A handheld 5-6 kg CO_2 fire extinguisher is required only during service and maintenance activities, unless a permanently mounted fire extinguisher located in the nacelle is mandatorily required by authorities.
- First aid kits are required only during service and maintenance activities.
- Fire blankets are required only during non-electrical hot work activities.

6.12 Warning Signs

Warning signs placed inside or on the turbine must be reviewed before operating or servicing the turbine.

6.13 Manuals and Warnings

The Vestas Corporate OH&S Manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

7 Environment

7.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2015. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

8 Design Codes

8.1 Design Codes – Structural Design

The turbine design has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 3 EN 50308
Tower	IEC 61400-1 Edition 3 Eurocode 3
Blades	DNV-OS-J102 IEC 1024-1

Design Codes	
	IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2
Gearbox	ISO 81400-4
Generator	IEC 60034
Transformer	IEC 60076-11, IEC 60076-16, CENELEC HD637 S1
Lightning Protection	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006 IEC 61400-24:2010 JIS C 1400-24 2014
Rotating Electrical Machines	IEC 34
Safety of Machinery, Safety-related Parts of Control Systems	IEC 13849-1
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 8-1: Design codes

9 Colours

9.1 Nacelle Colour

Colour of Vestas Nacelles	
Standard Nacelle Colour	RAL 7035 (light grey)
Standard Logo	Vestas

Table 9-1: Colour, nacelle

9.2 Tower Colour

Colour of Vestas Tower Section		
	External:	**Internal:**
Standard Tower Colour	RAL 7035 (light grey)	RAL 9001 (cream white)

Table 9-2: Colour, tower

9.3 Blade Colour

Blade Colour	
Standard Blade Colour	RAL 7035 (light grey). All lightning receptor surfaces on the blades are unpainted, excluding the Solid Metal Tips (SMT).
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% DS/EN ISO 2813

Table 9-3: Colour, blades

10 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

10.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	**All**
Ambient Temperature Interval (Standard Temperature Turbine)	-40° to +50°C

Table 10-1: Extreme design parameters

10.2 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine.

Operational Envelope – Temperature	
Ambient Temperature Interval (V117 and V136 Standard Turbine)	-20° to +45°C
Ambient Temperature Interval (V117 and V136 Low Temperature Turbine)	-30° to +45°C
Ambient Temperature Interval (V150 Standard Turbine)	-30° to +45°C

Table 10-2: Operational envelope – temperature

NOTE The wind turbine will stop producing power at ambient temperatures above 45°C.

For the low temperature options of the wind turbine, consult Vestas.

The turbine is designed for use at altitudes up to 1000 m above sea level as standard and optional up to 2000 m above sea level.

10.3 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine. At ambient temperatures above the thresholds shown for

each operating mode in Figure 10-1 below, the turbine will maintain derated production. Additional derating will take place at altitudes above 1000 m.a.s.l.

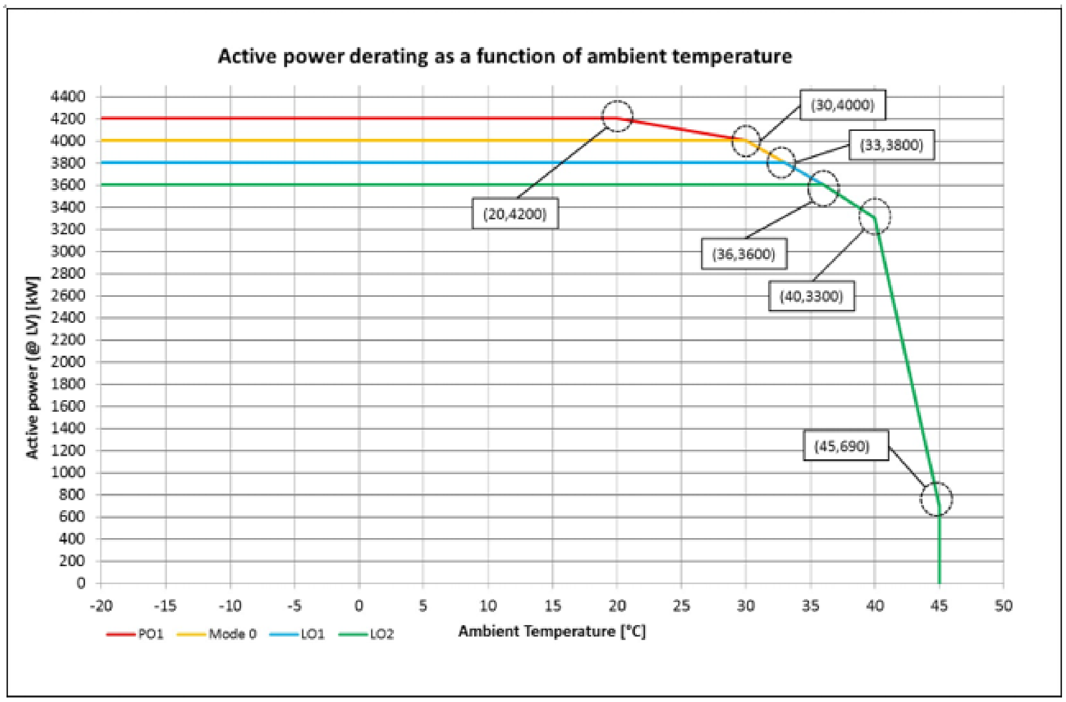


Figure 10-1: Temperature dependant derated operation.

NOTE All derating settings are preliminary and subject to change.

10.4 Operational Envelope – Grid Connection

Operational Envelope – Grid Connection		
Nominal Phase Voltage	$[U_{NP}]$	720 V
Nominal Frequency	$[f_N]$	50/60 Hz
Maximum Frequency Gradient	±4 Hz/sec.	
Maximum Negative Sequence Voltage	3% (connection) 2% (operation)	
Minimum Required Short Circuit Ratio at Turbine HV Connection	5.0 (contact Vestas for lower SCR levels)	
Maximum Short Circuit Current Contribution	1.05 p.u. (continuous) 1.45 p.u. (peak)	

Table 10-3: Operational envelope – grid connection

The generator and the converter will be disconnected if*:

Protection Settings	
Voltage Above 110% of Nominal for 1800 Seconds**	792 V
Voltage Above 116% of Nominal for 60 Seconds	835 V
Voltage Above 125% of Nominal for 2 Seconds	900 V
Voltage Above 136% of Nominal for 0.150 Seconds	979 V
Voltage Below 90% of Nominal for 180 Seconds (FRT)**	648 V
Voltage Below 85% of Nominal for 12 Seconds (FRT)	612 V
Voltage Below 80% of Nominal for 4 Seconds (FRT)	576 V
Frequency is Above 106% of Nominal for 0.2 Seconds	53/63.6 Hz
Frequency is Below 94% of Nominal for 0.2 Seconds	47/56.4 Hz

Table 10-4: Generator and converter disconnecting values

NOTE

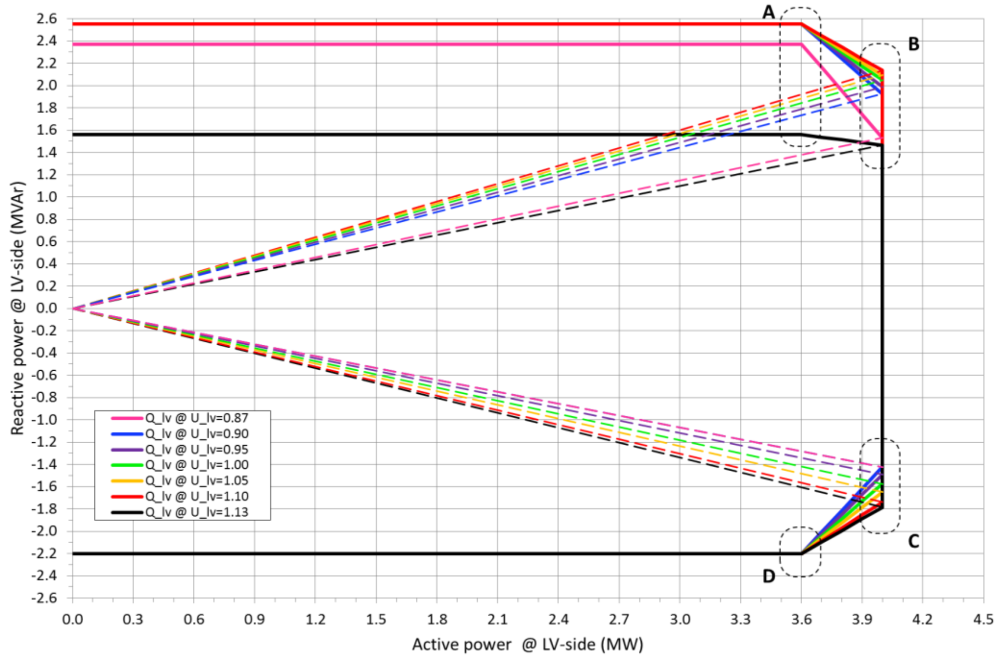
* Over the turbine lifetime, grid drop-outs are to occur at an average of no more than 50 times a year.

** The turbine may be configured for continuous operation @ +/- 13 % voltage. Reactive power capability is limited for these widened settings to an extent that is yet to be determined.

All protection settings are preliminary and subject to change.

10.5 Operational Envelope – Reactive Power Capability in 4.0 MW Mode 0

The turbine has a reactive power capability in 4.0 MW Mode 0 on the low voltage side of the HV transformer as illustrated in Figure 10-2:



		Coordinates								Power factor	
	Point:	A		B		C		D		B (Capacitive)	C (Inductive)
	Coordinate:	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)		
	Reactive power [kVAr] @ LV side @ U_lv = 0.87 p.u. voltage	3.600	2.370	4.000	1.530	4.000	-1.425	3.600	-2.200	0.934	0.942
	Reactive power [kVAr] @ LV side @ U_lv = 0.90 p.u. voltage	3.600	2.550	4.000	1.926	4.000	-1.425	3.600	-2.200	0.901	0.942
	Reactive power [kVAr] @ LV side @ U_lv = 0.95 p.u. voltage	3.600	2.550	4.000	1.988	4.000	-1.491	3.600	-2.200	0.895	0.937
	Reactive power [kVAr] @ LV side @ U_lv = 1.00 p.u. voltage	3.600	2.550	4.000	2.049	4.000	-1.575	3.600	-2.200	0.890	0.930
	Reactive power [kVAr] @ LV side @ U_lv = 1.05 p.u. voltage	3.600	2.550	4.000	2.093	4.000	-1.648	3.600	-2.200	0.886	0.925
	Reactive power [kVAr] @ LV side @ U_lv = 1.10 p.u. voltage	3.600	2.550	4.000	2.137	4.000	-1.740	3.600	-2.200	0.882	0.917
	Reactive power [kVAr] @ LV side @ U_lv = 1.13 p.u. voltage	3.600	1.560	4.000	1.465	4.000	-1.787	3.600	-2.200	0.939	0.913

Figure 10-2: Reactive power capability for 4.0 MW Mode 0.

When operating at 4.0 MW nominal power at LV side of the HV transformer, the reactive power capability on the high voltage side of the HV transformer is approximately:

- cosφ(HV) = 0.93/0.91 capacitive/inductive @ U(HV) = 0.90 p.u. voltage
- cosφ(HV) = 0.95/0.89 capacitive/inductive @ U(HV) = 1.10 p.u. voltage

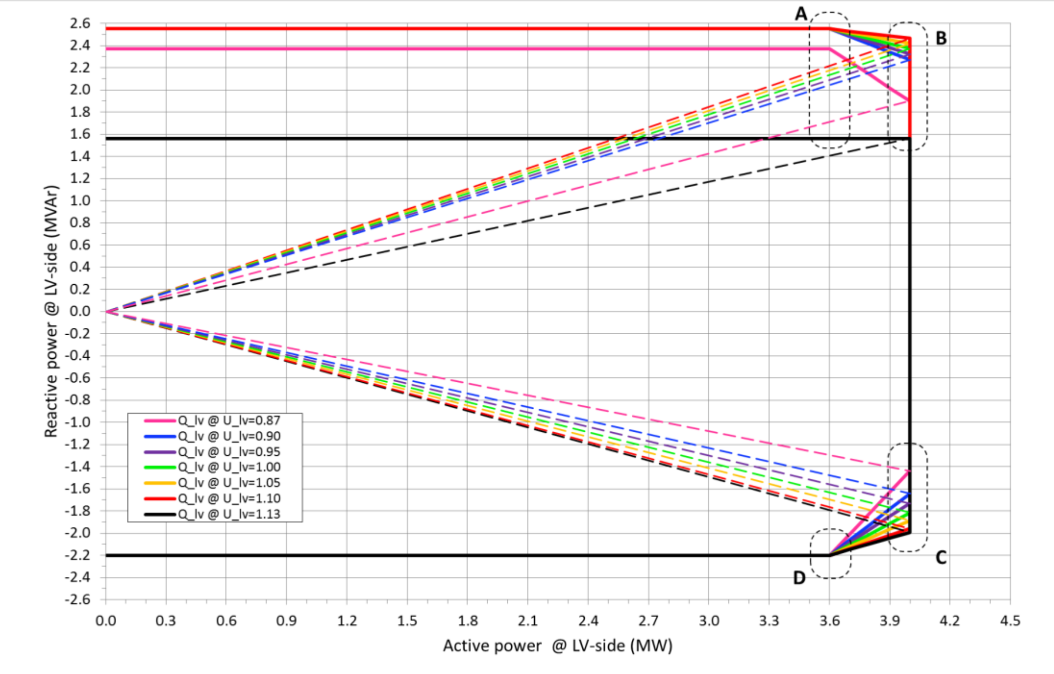
Reactive power is produced by the full-scale converter. Traditional capacitors are, therefore, not used in the turbine.

The turbine is able to maintain the reactive power capability at low wind with no active power production.

NOTE 4.0 MW Mode 0 derates above +30°C ambient temperature for ≤1000 m.a.s.l. according to Figure 10-1.

10.6 Operational Envelope – Reactive Power Capability in 4.0 MW Reactive Power Optimized Mode (QO1)

An optional, extended reactive power capability is available with 4.0 MW Reactive Power Optimized Mode (QO1) when ambient temperature is below +20°C for ≤1000 m.a.s.l. The reactive power capability is as seen in Figure 10-3:



	Coordinates								Power factor	
Point:	A		B		C		D		B (Capacitive)	C (Inductive)
Coordinate:	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)		
Reactive power [kVAr] @ LV side @ U_lv = 0.87 p.u. voltage	3.600	2.370	4.000	1.900	4.000	-1.438	3.600	-2.200	0.903	0.941
Reactive power [kVAr] @ LV side @ U_lv = 0.90 p.u. voltage	3.600	2.550	4.000	2.272	4.000	-1.643	3.600	-2.200	0.870	0.925
Reactive power [kVAr] @ LV side @ U_lv = 0.95 p.u. voltage	3.600	2.550	4.000	2.323	4.000	-1.733	3.600	-2.200	0.865	0.918
Reactive power [kVAr] @ LV side @ U_lv = 1.00 p.u. voltage	3.600	2.550	4.000	2.373	4.000	-1.815	3.600	-2.200	0.860	0.911
Reactive power [kVAr] @ LV side @ U_lv = 1.05 p.u. voltage	3.600	2.550	4.000	2.419	4.000	-1.888	3.600	-2.200	0.856	0.904
Reactive power [kVAr] @ LV side @ U_lv = 1.10 p.u. voltage	3.600	2.550	4.000	2.464	4.000	-1.960	3.600	-2.200	0.851	0.898
Reactive power [kVAr] @ LV side @ U_lv = 1.13 p.u. voltage	3.600	1.560	4.000	1.560	4.000	-1.994	3.600	-2.200	0.932	0.895

Figure 10-3: Reactive power capability for 4.0 MW Reactive Power Optimized Mode (QO1).

When operating at 4.0 MW in Reactive Power Optimized Mode (QO1) at LV side of the HV transformer, the reactive power capability on the high voltage side of the HV transformer is approximately:

- cosφ(HV) = 0.91/0.90 capacitive/inductive @ U(HV) = 0.90 p.u. voltage
- cosφ(HV) = 0.94/0.87 capacitive/inductive @ U(HV) = 1.10 p.u. voltage

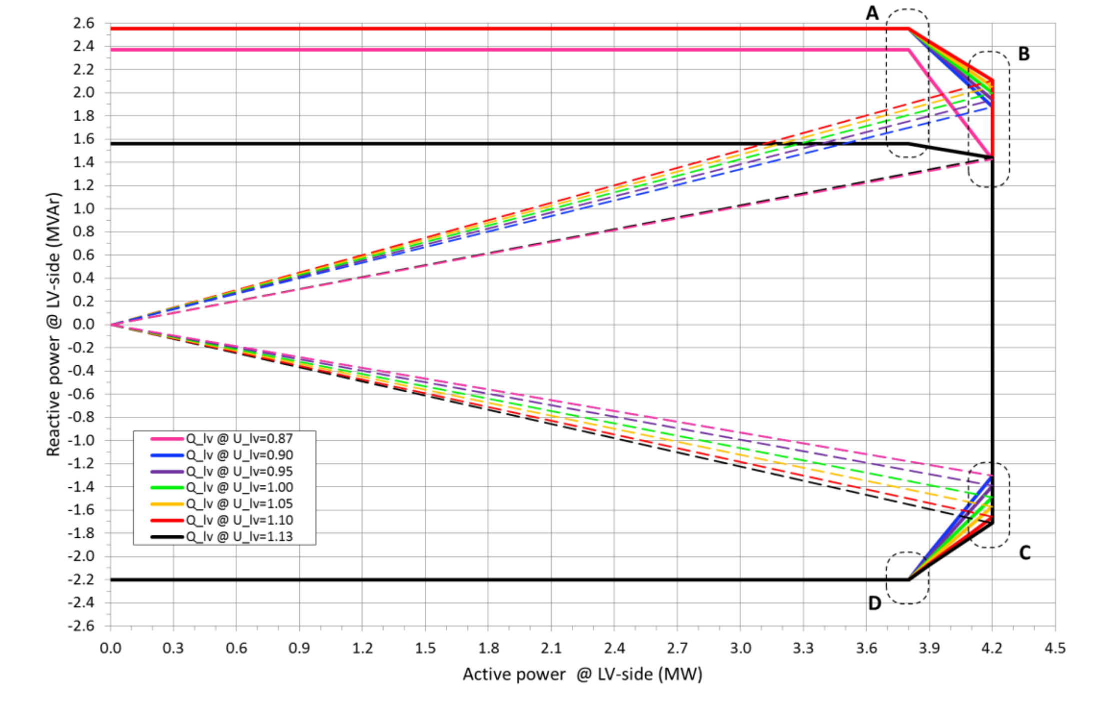
The turbine is able to maintain the reactive power capability at low wind with no active power production.

NOTE

4.0 MW Reactive Power Optimized Mode (QO1) derates reactive power linearly above +20°C ambient temperature for ≤1000 m.a.s.l. to converge with the reactive power capability of 4.0 MW Mode 0 in Figure 10-2 at +30°C.

10.7 Operational Envelope – Reactive Power Capability in 4.2 MW Power Optimized Mode (PO1)

The reactive power capability for the 4.2 MW Power Optimized Mode (PO1) is as illustrated in Figure 10-4:



	Coordinates								Power factor	
Point:	A		B		C		D		B (Capacitive)	C (Inductive)
Coordinate:	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)		
Reactive power [kVAr] @ LV side @ U_lv = 0.87 p.u. voltage	3.800	2.370	4.200	1.425	4.200	-1.304	3.800	-2.200	0.947	0.955
Reactive power [kVAr] @ LV side @ U_lv = 0.90 p.u. voltage	3.800	2.550	4.200	1.877	4.200	-1.304	3.800	-2.200	0.913	0.955
Reactive power [kVAr] @ LV side @ U_lv = 0.95 p.u. voltage	3.800	2.550	4.200	1.938	4.200	-1.392	3.800	-2.200	0.908	0.949
Reactive power [kVAr] @ LV side @ U_lv = 1.00 p.u. voltage	3.800	2.550	4.200	1.998	4.200	-1.490	3.800	-2.200	0.903	0.942
Reactive power [kVAr] @ LV side @ U_lv = 1.05 p.u. voltage	3.800	2.550	4.200	2.052	4.200	-1.570	3.800	-2.200	0.898	0.937
Reactive power [kVAr] @ LV side @ U_lv = 1.10 p.u. voltage	3.800	2.550	4.200	2.105	4.200	-1.660	3.800	-2.200	0.894	0.930
Reactive power [kVAr] @ LV side @ U_lv = 1.13 p.u. voltage	3.800	1.560	4.200	1.439	4.200	-1.712	3.800	-2.200	0.946	0.926

Figure 10-4: Reactive power capability for 4.2 MW Power Optimized Mode (PO1).

When operating at 4.2 MW in Power Optimized Mode (PO1) at LV side of the HV transformer, the reactive power capability on the high voltage side of the HV transformer is approximately:

- cosφ(HV) = 0.95/0.92 capacitive/inductive @ U(HV) = 0.90 p.u. voltage
- cosφ(HV) = 0.96/0.91 capacitive/inductive @ U(HV) = 1.10 p.u. voltage

The turbine is able to maintain the reactive power capability at low wind with no active power production.

NOTE

4.2 MW Power Optimized Mode (PO1) derates above +20°C ambient temperature for ≤1000 m.a.s.l. according to Figure 10-1.

4.2 MW Power Optimized Mode (PO1) is mutually exclusive with 4.0 MW Reactive Power Optimized Mode (QO1) (since Q is traded for P).

10.8 Performance – Fault Ride Through

The turbine is equipped with a full-scale converter to gain better control of the wind turbine during grid faults. The turbine control system continues to run during grid faults.

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve as illustrated below:

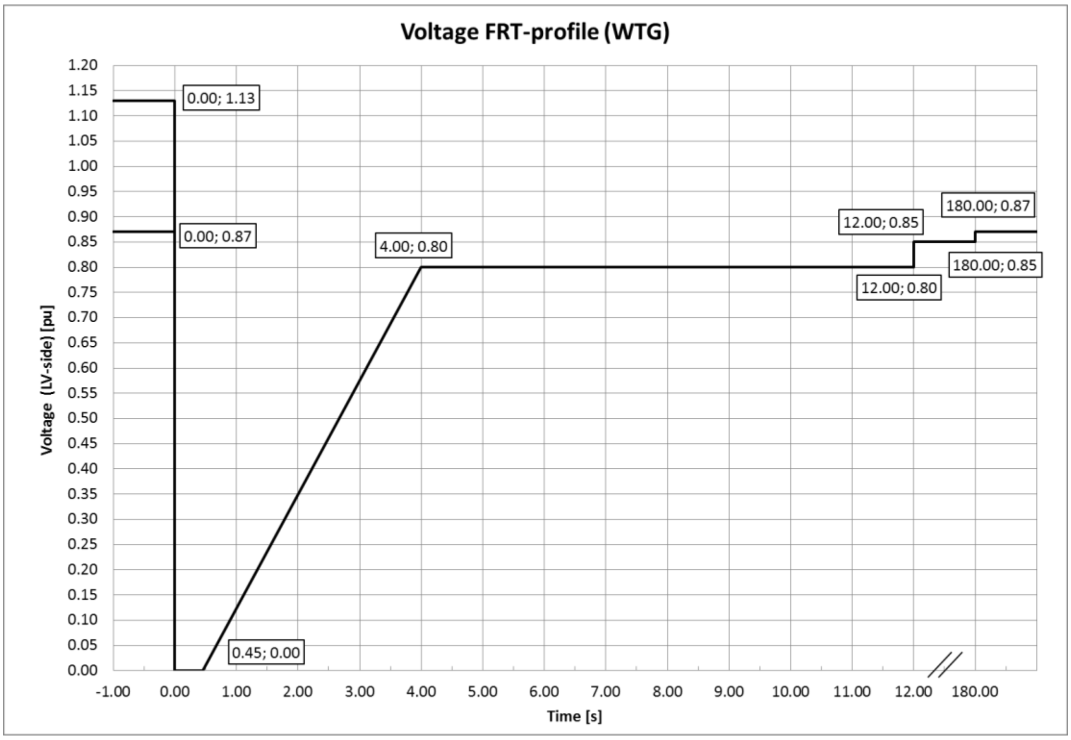


Figure 10-5: Low voltage tolerance curve for symmetrical and asymmetrical faults, where U represents voltage as measured on the grid.

For grid disturbances outside the tolerance curve in Figure 10-5, the turbine will be disconnected from the grid.

NOTE All fault ride through capability values are preliminary and subject to change.

Power Recovery Time	
Power Recovery to 90% of Pre-Fault Level	Maximum 0.1 seconds

Table 10-5: Power recovery time

10.9 Performance – Reactive Current Contribution

The reactive current contribution depends on whether the fault applied to the turbine is symmetrical or asymmetrical.

NOTE All reactive current contribution values are preliminary and subject to change.

10.9.1 Symmetrical Reactive Current Contribution

During symmetrical voltage dips, the wind farm will inject reactive current to support the grid voltage. The reactive current injected is a function of the measured grid voltage.

The default value gives a reactive current part of 1 p.u. of the rated active current at the high voltage side of the HV transformer. Figure 10-6, indicates the reactive current contribution as a function of the voltage. The reactive current contribution is independent from the actual wind conditions and pre-fault power level. As seen in Figure 10-6, the default current injection slope is 2% reactive current increase per 1% voltage decrease. The slope can be parameterized between 0 and 10 to adapt to site specific requirements.

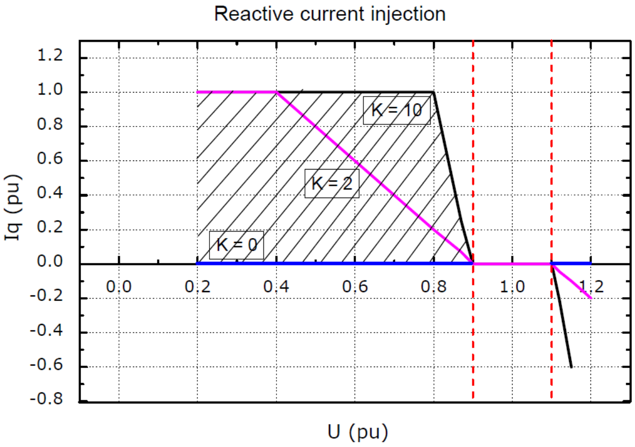


Figure 10-6: Reactive current injection

10.9.2 Asymmetrical Reactive Current Contribution

The injected current is based on the measured positive sequence voltage and the used K-factor. During asymmetrical voltage dips, the reactive current injection is limited to approximate 0.4 p.u. to limit the potential voltage increase on the healthy phases.

10.10 Performance – Multiple Voltage Dips

The turbine is designed to handle re-closure events and multiple voltage dips within a short period of time due to the fact that voltage dips are not evenly distributed during the year. For example, the turbine is designed to handle 10 voltage dips of duration of 200 ms, down to 20% voltage, within 30 minutes.

10.11 Performance – Active and Reactive Power Control

The turbine is designed for control of active and reactive power via the VestasOnline® SCADA system.

Maximum Ramp Rates for External Control	
Active Power	0.1 p.u./sec for max. power level change of 0.3 p.u. 0.3 p.u./sec for max. power level change of 0.1 p.u.
Reactive Power	20 p.u./sec

Table 10-6: Active/reactive power ramp rates (values are preliminary)

To support grid stability the turbine is capable to stay connected to the grid at active power references down to 10 % of nominal power for the turbine. For active power references below 10 % the turbine may disconnect from the grid.

10.12 Performance – Voltage Control

The turbine is designed for integration with VestasOnline® voltage control by utilising the turbine reactive power capability.

10.13 Performance – Frequency Control

The turbine can be configured to perform frequency control by decreasing the output power as a linear function of the grid frequency (over frequency). Dead band and slope for the frequency control function are configurable.

10.14 Distortion – Immunity

The turbine is able to connect with a pre-connection (background) voltage distortion level at the grid interface of 8% and operate with a post-connection voltage distortion level of 8%.

10.15 Main Contributors to Own Consumption

The consumption of electrical power by the wind turbine is defined as the power used by the wind turbine when it is not providing energy to the grid. This is defined in the control system as Production Generator 0 (zero).

The components in Table 10-7 have the largest influence on the own consumption of the wind turbine (the average own consumption depends on the actual conditions, the climate, the wind turbine output, the cut-off hours, etc.).

The VMP8000 control system has a hibernate mode that reduces own consumption when possible. Similarly, cooling pumps may be turned off when the turbine idles.

Main contributors to Own Consumption	
Hydraulic Motor	2 x 15 (V117) / 18.5 kW (V136 + V150) (master-slave)
Yaw Motors	Maximum 21 kW in total
Water Heating	10 kW
Water Pumps	2.2 + 5.5 kW
Oil Heating	7.9 kW
Oil Pump for Gearbox Lubrication	12.5 kW
Controller Including Heating Elements for the Hydraulics and all Controllers	Approximately 3 kW
HV Transformer No-load Loss	See section 4.3 HV Transformer, p. 14

Table 10-7: Main contributors to own consumption data (values are preliminary).

11 Drawings

11.1 Structural Design – Illustration of Outer Dimensions

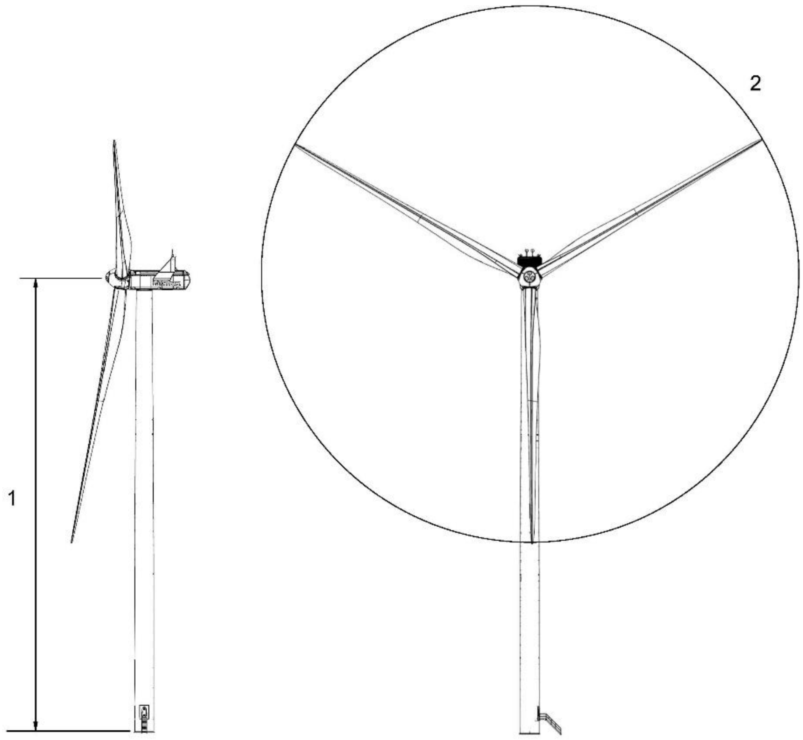


Figure 11-1: Illustration of outer dimensions – structure

1 Hub heights: See Performance Specification

2 Rotor diameter: 117-150 m

11.2 Structural Design – Side View Drawing

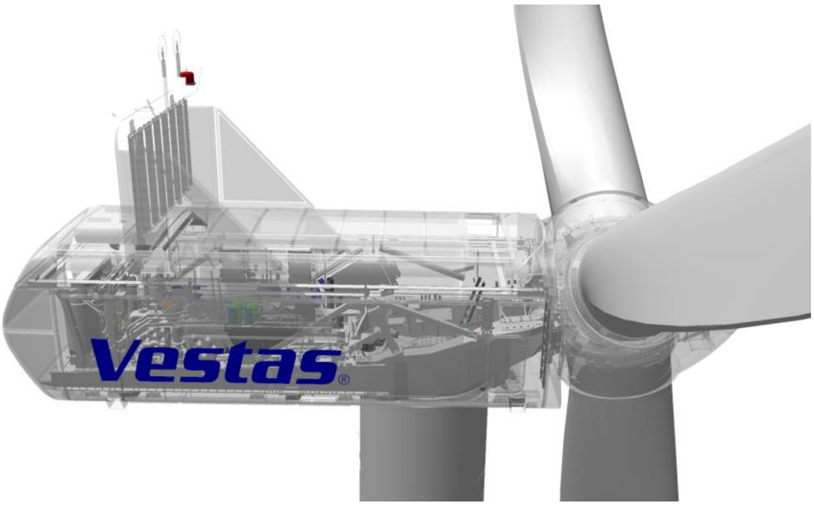


Figure 11-2: Side-view drawing

12 General Reservations, Notes and Disclaimers

-
- The general descriptions in this document apply to the current version of the 4MW Platform wind turbines. Updated versions of the 4MW Platform wind turbines, which may be manufactured in the future, may differ from this general description. In the event that Vestas supplies an updated version of a specific 4MW Platform wind turbine, Vestas will provide an updated general description applicable to the updated version.
- Vestas recommends that the grid be as close to nominal as possible with limited variation in frequency and voltage.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- All listed start/stop parameters (e. g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements and codes of standards.
- This document, General Description, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.

Restricted
Document no.: 0067-7065 V08
2018-08-10

Performance Specification

V136-4.0/4.2 MW 50/60 Hz

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Denmark · www.vestas.com

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See general reservations, notes and disclaimers (including, Section 5, p. 12) to this Performance Specification.

1 General Description

The Vestas V136-4.0/4.2 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V136-4.0/4.2 MW turbine has a rotor diameter of 136 m and a rated power of 4.0 MW.

Vestas offers an optional Power Optimized (PO) mode at 4.2 MW for the V136-4.0 MW variant.

2 Type Approvals and Available Hub Heights

The standard turbine is type certified according to the certification standards and available hub heights listed below:

Certification	Wind Class	Hub Height		
Tower type		**Standard**	**Large diameter (non-split) (1)**	**Large diameter (split)**
IEC61400-22	IEC IIB	105 m(2) / 112 m / 114 m(2)		
	IEC IIIB		162 m	
DIBt 2012	WZ4(S), GK2	112 m		
	WZ2(S), GK2			149 m / 166 m

Table 2-1: Type approval data and available hub heights

(1): These towers require special transport conditions as the bottom diameter is above 5 m and are not available as standard to the US/Canadian market, but can be evaluated on a case-by-case basis.

(2): Special transport optimized tower for US/Canada.

The hub height can be increased by up to 3 m by use of raised foundation. Use of raised foundation is subject to site-specific evaluation and is not available for all soil conditions.

3 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section does not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

3.1 Climate and Site Conditions

The standard turbine is designed for the wind climate conditions listed below. Values refer to hub height.

Wind Climate	IEC IIB	IEC IIB S	IEC IIIB
Hub Height	**105/112/114 m**	**105/112/114 m**	**162 m**
Power Rating	**4.0MW**	**4.2MW**	**4.0/4.2MW**
Extr Wind Speed (10 min average), V_{50}	42.5 m/s	42.5 m/s	37.5 m/s
Survival Wind Speed (3 s gust), V_{e50}	59.5 m/s	59.5 m/s	52.5 m/s
Turbulence Intensity, I_{V50}	11%	11%	11%

Table 3-1: Extreme design parameters – IEC

Wind Climate	IEC IIB	IEC IIB S	IEC IIIB
Hub Height	**105/112/114 m**	**105/112/114 m**	**162 m**
Power Rating	**4.0MW**	**4.2MW**	**4.0/4.2MW**
Wind Speed (10 min average), V_{ave}	8.5 m/s	8.0 m/s	7.5 m/s
Weibull Scale Factor, *C*	9.6 m/s	8.9 m/s	8.5 m/s
Weibull Shape Factor, *k*	2.0	2.0	2.0
I_{ref} acc. to IEC 61400-1	0.14	0.14	0.14
Turbulence Intensity acc. to IEC 61400-1, Including Wind Farm Turbulence (@15 m/s) I_{90} (90% quantile)	15.7%	15.7%	15.7%
Wind Shear, α	0.20	0.20	0.20
Inflow Angle (vertical)	8°	8°	8°

Table 3-2: Average design parameters – IEC

Wind Climate / Terrain Category	WZ4(S), GK2	WZ2(S), GK2	WZ2(S), GK2
Hub Height	**112 m**	**149 m**	**166 m**
Power Rating	**4.0/4.2MW**	**4.0/4.2MW**	**4.0/4.2MW**
Extr Wind Speed (10 min average), V_{50}	42.5 m/s	38.5 m/s	39.2 m/s
Survival Wind Speed (3 s gust), V_{e50}	59.5 m/s	53.9 m/s	54.9 m/s
Turbulence intensity, $I_{v(z)}$	12.9%	12.3%	12.1%

Table 3-3: Extreme design parameters – DIBt

Wind Climate / Terrain Category	WZ4(S), GK2	WZ2(S), GK2	WZ2(S), GK2
Hub Height	**112 m**	**149 m**	**166 m**
Power Rating	**4.0/4.2MW**	**4.0/4.2MW**	**4.0/4.2MW**
Wind Speed (10 min average), V_{ave}	7.95 m/s	7.63 m/s	7.05 m/s
I_{ref} acc. to IEC 61400-1	0.14	0.14	0.14
Turbulence Intensity acc. to IEC 61400-1, Including Wind Farm Turbulence (@15 m/s) I_{90} (90% quantile)	15.7%	15.7%	15.7%

Table 3-4: Average design parameters – DIBt

3.1.1 Complex Terrain

Classification of complex terrain according to IEC 61400-1:2005 Chapter 11.2. For sites classified as complex, appropriate measures are to be included in site assessment. Positioning of each turbine must be verified via Vestas Site Check.

3.1.2 Altitude

The turbine is designed for use at altitudes up to 1000 m above sea level as standard and optional up to 2000 m above sea level.

3.1.3 Wind Power Plant Layout

Turbine spacing is to be evaluated site-specifically. Spacing below two rotor diameters (2D) may require sector-wise curtailment.

NOTE As evaluation of climate and site conditions is complex, consult Vestas for every project. If conditions exceed the above parameters, Vestas must be consulted.

3.2 Operational Envelope – Wind

Values refer to hub height and are determined by the sensors and control system of the turbine.

Wind climate	IEC IIB / IEC IIB S	IEC IIIB
Hub height	**105 / 112 / 114 m**	**162**
Cut-In, V_{in}	3 m/s	3 m/s
Cut-Out (10 min exponential avg.), V_{out}	27.0 m/s	27.0 m/s
Re-Cut In (10 min exponential avg.)	25.0 m/s	25.0 m/s

Table 3-5: Operational envelope – wind – IEC

Wind climate	WZ4(S)	WZ2(S)
Hub height	**112 m**	**149 / 166 m**
Cut-In, V_{in}	3 m/s	3 m/s
Cut-Out (10 min exponential avg.), V_{out}	27.0 m/s	27.0 m/s
Re-Cut In (10 min exponential avg.)	25.0 m/s	25.0 m/s

Table 3-6: Operational envelope – wind – DIBt

3.3 Operational Envelope – Wind (HWO)

Optionally, the turbine can be offered with the High Wind Operation (HWO) control feature. The HWO control feature allows the turbine to operate up to the extended cut-out wind speeds listed in Table 3-7, p. 8 and Table 3-8, p. 8, with a controlled derating of power and speed. The power curves associated with optional HWO control are found in Sections 7, 9, 11, 13, 15, 17 and 19. Values refer to hub height and are determined by the sensors and control system of the turbine.

Wind climate	IEC IIB / IEC IIB S	IEC IIIB
Hub height	**105 / 112 / 114 m**	**162**
Cut-In, V_{in}	3 m/s	3 m/s
Cut-Out (10 min exponential avg.), V_{out}	32.0 m/s	32.0 m/s
Re-Cut In (10 min exponential avg.)	30.0 m/s	30.0 m/s

Table 3-7: Operational envelope – wind – IEC (High Wind Operation)

Wind climate	WZ4(S)	WZ2(S)
Hub height	**112 m**	**149 / 166 m**
Cut-In, V_{in}	3 m/s	3 m/s
Cut-Out (10 min exponential avg.), V_{out}	32.0 m/s	32.0 m/s
Re-Cut In (10 min exponential avg.)	30.0 m/s	30.0 m/s

Table 3-8: Operational envelope – wind – DIBt (High Wind Operation)

3.4 Operational Envelope – Conditions for Power Curve and Ct Values (at Hub Height)

Consult Section 6 and following sections for power curves and C_t values.

Conditions for Power Curve and C_t Values (at Hub Height)	
Wind Shear, *α*	0.00-0.30 (10 minute average)
Turbulence Intensity, *I*	6-12% (10 minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ±2°
Grid Voltage	Nominal Voltage ±2.5%
Grid Frequency	Nominal Frequency ±0.5 Hz
Grid Active Power (at LV-side of turbine transformer)	As per tabulated values from Section 6 and onwards
Grid Reactive Power (at LV-side of turbine transformer)	Power Factor 1.0

Table 3-9: Conditions for power curve and Ct values

3.5 Sound Modes

The sound modes listed below are available for the turbine.

Sound modes			
Mode No.	**Maximum Sound Level**	**Serrated trailing edges**	**Available hub heights**
0	103.9 dBA	Yes (standard)	105 112 / 114 / 149 / 162 / 166 m
0-0S	106.9 dBA	No (option)	105 112 / 114 / 149 / 162 / 166 m
PO1	103.9 dBA	Yes (standard)	105 112 / 114 / 149 / 162 / 166 m
PO1-0S	106.9 dBA	No (option)	105 112 / 114 / 149 / 162 / 166 m

Table 3-10: Available sound performance

NOTE The turbine is as standard equipped with serrated trailing edges on the blades. Optionally, Mode 0-0S can be offered without serrated trailing edges mounted on the blades.

In addition, Sound Optimized (SO) modes as listed below are available as options for the turbine.

Sound Optimized (SO) modes			
Mode No.	**Maximum Sound Level**	**Serrated trailing edges**	**Available hub heights**
SO1	102.0 dBA	Yes	105 / 112 / 114 / 149 / 162 / 166 m
SO2	99.5 dBA	Yes	105 / 112 / 114 / 149 / 162 / 166 m
SO11	99.2 dBA	Yes	112 m(1)
SO12	99.9 dBA	Yes	112 m(1)
SO13	97.0 dBA	Yes	112 m(1)

Table 3-11: Available Sound Optimized modes

(1): SO11, SO12, SO13 is not applicable for DIBt towers

NOTE Sound Optimized (SO) modes are only available with serrated trailing edges on the blades. For further details on sound performance and in case of specific requests for sound modes per tower, please contact Vestas Wind Systems A/S.

3.6 Load Modes

The Load Optimized (LO) modes listed below are available for the turbine.

Load Optimized (LO) modes				
Mode No.	**Power**	**Maximum Sound Level**	**Serrated trailing edges**	**Available hub heights**
LO1	3.8 MW	103.9 dBA	Yes	105 / 112 / 114 / 149 / 162 / 166 m
LO2	3.6 MW	103.9 dBA	Yes	105 / 112 / 114 / 149 m

Table 3-12: Available Load Optimized modes

NOTE Load Optimized (LO) modes are only available with serrated trailing edges mounted on the blades.

4 Drawings

4.1 Structural Design – Illustration of Outer Dimensions

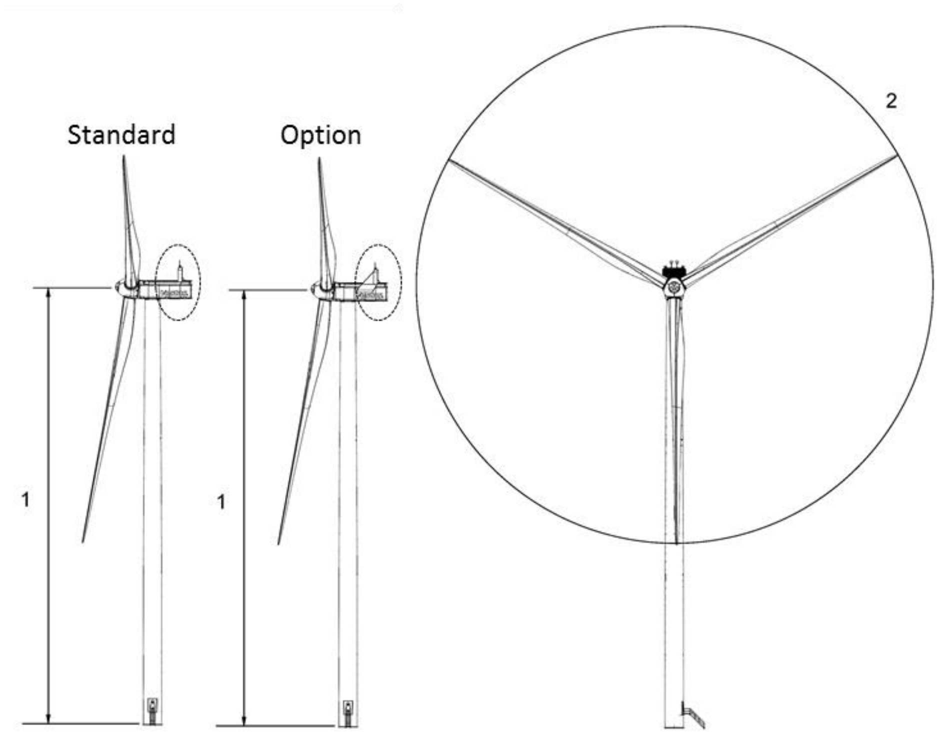

Figure 4-1: Illustration of outer dimensions – structure

1 Hub height: 105/112/114/149/162/166 m

2 Diameter: 136 m

NOTE The turbine to the right is shown with side panels on the cooler top (Option).

5 General Reservations, Notes and Disclaimers

-
- The performance specifications described in this document apply to the current version of the V136-4.0/4.2 MW wind turbine. Updated versions of the V136-4.0/4.2 MW wind turbine, which may be manufactured in the future, may differ from these performance specifications. In the event that Vestas supplies an updated version of the V136-4.0/4.2 MW wind, Vestas will provide an updated performance specification applicable to the updated version.
- All listed start/stop parameters (e.g. wind speeds) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- This document, Performance Specification, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and sound (including, without limitation, the power curve and sound verification method). Any guarantee, warranty and/or verification of the power curve and sound (including, without limitation, the power curve and sound verification method) must be agreed to separately in writing.

6 Power Curves, Ct Values and Sound Curves, Mode 0/0-0S

NOTE The power curves and Ct values presented in Section 6 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

6.1 Power Curves, Mode 0/0-0S

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1095**	837	861	884	908	931	955	978	1002	1025	1049	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1703**	1311	1347	1382	1418	1454	1490	1526	1561	1597	1632	1668	1738	1773
8.0	**2069**	1599	1642	1685	1729	1772	1815	1857	1900	1943	1985	2027	2111	2153
8.5	**2471**	1923	1974	2025	2076	2127	2177	2227	2277	2327	2375	2423	2518	2566
9.0	**2870**	2272	2329	2387	2445	2502	2556	2610	2665	2719	2769	2820	2919	2967
9.5	**3232**	2619	2679	2739	2800	2860	2915	2970	3025	3080	3131	3182	3280	3328
10.0	**3562**	2945	3007	3068	3129	3190	3246	3302	3357	3413	3462	3512	3606	3650
10.5	**3818**	3246	3308	3370	3433	3495	3547	3600	3652	3705	3743	3780	3846	3874
11.0	**3954**	3521	3577	3634	3690	3746	3784	3822	3859	3897	3916	3935	3963	3972
11.5	**3992**	3754	3795	3836	3876	3917	3932	3947	3962	3978	3982	3987	3994	3996
12.0	**3999**	3911	3928	3946	3964	3981	3985	3989	3993	3997	3998	3998	3999	3999
12.5	**4000**	3975	3980	3986	3991	3996	3997	3998	3999	3999	4000	4000	4000	4000
13.0	**4000**	3993	3995	3996	3997	3999	3999	3999	4000	4000	4000	4000	4000	4000
13.5	**4000**	3995	3996	3997	3998	3999	4000	4000	4000	4000	4000	4000	4000	4000
14.0	**4000**	3998	3999	3999	3999	4000	4000	4000	4000	4000	4000	4000	4000	4000
14.5	**4000**	3999	3999	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
15.0	**4000**	3999	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
15.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
16.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
16.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
17.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
17.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
18.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
18.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
19.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
19.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
26.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
26.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
27.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

Table 6-1: Power curve, Mode 0/0-0S

6.2 Ct Values, Mode 0/0-0S

Wind speed [m/s]	Air density kg/m³ 1.225	0.950	0.975	1.000	1.025	1.050	1.075	1.100	1.125	1.150	1.175	1.200	1.250	1.275
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.828**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.831	0.830	0.829	0.827	0.826
7.5	**0.821**	0.832	0.831	0.830	0.829	0.828	0.827	0.826	0.825	0.824	0.823	0.822	0.820	0.818
8.0	**0.823**	0.837	0.836	0.835	0.834	0.833	0.831	0.830	0.829	0.827	0.826	0.824	0.821	0.819
8.5	**0.802**	0.838	0.836	0.833	0.831	0.829	0.825	0.822	0.818	0.815	0.810	0.806	0.797	0.793
9.0	**0.743**	0.811	0.805	0.800	0.795	0.789	0.783	0.777	0.770	0.764	0.757	0.750	0.736	0.730
9.5	**0.670**	0.752	0.745	0.737	0.730	0.723	0.715	0.707	0.700	0.692	0.685	0.678	0.663	0.656
10.0	**0.604**	0.685	0.677	0.669	0.661	0.653	0.646	0.639	0.632	0.625	0.618	0.611	0.597	0.590
10.5	**0.540**	0.623	0.615	0.608	0.601	0.594	0.587	0.579	0.572	0.565	0.557	0.548	0.531	0.522
11.0	**0.471**	0.568	0.560	0.552	0.544	0.537	0.528	0.519	0.510	0.501	0.491	0.481	0.461	0.451
11.5	**0.404**	0.516	0.507	0.497	0.488	0.478	0.467	0.456	0.446	0.435	0.425	0.414	0.395	0.386
12.0	**0.348**	0.463	0.451	0.440	0.428	0.416	0.406	0.395	0.385	0.374	0.365	0.357	0.340	0.332
12.5	**0.302**	0.406	0.395	0.383	0.372	0.361	0.352	0.343	0.334	0.324	0.317	0.310	0.296	0.289
13.0	**0.265**	0.354	0.344	0.334	0.324	0.315	0.307	0.299	0.292	0.284	0.278	0.271	0.260	0.254
13.5	**0.236**	0.312	0.304	0.295	0.287	0.279	0.272	0.265	0.259	0.252	0.247	0.241	0.231	0.226
14.0	**0.210**	0.276	0.269	0.261	0.254	0.247	0.241	0.236	0.230	0.224	0.220	0.215	0.206	0.202
14.5	**0.188**	0.246	0.239	0.233	0.227	0.221	0.216	0.211	0.206	0.201	0.197	0.192	0.185	0.181
15.0	**0.169**	0.219	0.214	0.208	0.203	0.197	0.193	0.189	0.184	0.180	0.176	0.173	0.166	0.162
15.5	**0.153**	0.198	0.193	0.188	0.183	0.178	0.174	0.170	0.167	0.163	0.159	0.156	0.150	0.147
16.0	**0.139**	0.179	0.175	0.170	0.166	0.162	0.158	0.155	0.151	0.148	0.145	0.142	0.136	0.134
16.5	**0.127**	0.163	0.159	0.155	0.151	0.147	0.144	0.141	0.138	0.135	0.132	0.129	0.125	0.122
17.0	**0.116**	0.149	0.145	0.142	0.138	0.135	0.132	0.129	0.126	0.123	0.121	0.119	0.114	0.112
17.5	**0.107**	0.136	0.133	0.130	0.127	0.123	0.121	0.118	0.116	0.113	0.111	0.109	0.105	0.103
18.0	**0.098**	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.104	0.102	0.100	0.097	0.095
18.5	**0.091**	0.115	0.113	0.110	0.107	0.105	0.103	0.101	0.098	0.096	0.095	0.093	0.089	0.088
19.0	**0.084**	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.082	0.081
19.5	**0.078**	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.083	0.081	0.080	0.077	0.075
20.0	**0.073**	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.075	0.074	0.071	0.070
20.5	**0.068**	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
21.0	**0.064**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.069	0.067	0.066	0.065	0.063	0.061
21.5	**0.060**	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
22.0	**0.057**	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.058	0.056	0.055
22.5	**0.053**	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052
23.0	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
23.5	**0.047**	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.046
24.0	**0.045**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
24.5	**0.042**	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041
25.0	**0.040**	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039
25.5	**0.038**	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037
26.0	**0.037**	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036
26.5	**0.035**	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035	0.034	0.034
27.0	**0.033**	0.041	0.040	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.032

Table 6-2: C_t values, Mode 0/0-0S

6.3 Sound Curves, Mode 0/0-0S

Sound Power Level at Hub Height		
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**	
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Mode 0 (Blades with serrated trailing edge)**	**Sound Power Level at Hub Height [dBA]** **Mode 0-0S (Blades without serrated trailing edge)**
3	90.9	93.2
4	91.1	93.6
5	92.9	96.5
6	96.0	100.0
7	99.6	103.2
8	102.9	106.0
9	103.9	106.9
10	103.9	106.9
11	103.9	106.9
12	103.9	106.9
13	103.9	106.9
14	103.9	106.9
15	103.9	106.9
16	103.9	106.9
17	103.9	106.9
18	103.9	106.9
19	103.9	106.9
20	103.9	106.9

Table 6-3: Sound curves, Mode 0/0-0S

7 Power Curves, Ct Values and Sound Curves, Mode 0/0-0S (HWO)

NOTE The power curves and Ct values presented in Section 7 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

7.1 Power Curves, Mode 0/0-0S (HWO)

	Air density [kg/m³]												
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1095**	837	861	884	908	931	955	978	1002	1025	1049	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1703**	1311	1347	1382	1418	1454	1490	1526	1561	1597	1632	1668	1738	1773
8.0	**2069**	1599	1642	1685	1729	1772	1815	1857	1900	1943	1985	2027	2111	2153
8.5	**2471**	1923	1974	2025	2076	2127	2177	2227	2277	2327	2375	2423	2518	2566
9.0	**2870**	2272	2329	2387	2445	2502	2556	2610	2665	2719	2769	2820	2919	2967
9.5	**3232**	2619	2679	2739	2800	2860	2915	2970	3025	3080	3131	3182	3280	3328
10.0	**3562**	2945	3007	3068	3129	3190	3246	3302	3357	3413	3462	3512	3606	3650
10.5	**3818**	3246	3308	3370	3433	3495	3547	3600	3652	3705	3743	3780	3846	3874
11.0	**3954**	3521	3577	3634	3690	3746	3784	3822	3859	3897	3916	3935	3963	3972
11.5	**3992**	3754	3795	3836	3876	3917	3932	3947	3962	3978	3982	3987	3994	3996
12.0	**3999**	3911	3928	3946	3964	3981	3985	3989	3993	3997	3998	3998	3999	3999
12.5	**4000**	3975	3980	3986	3991	3996	3997	3998	3999	3999	4000	4000	4000	4000
13.0	**4000**	3993	3995	3996	3997	3999	3999	3999	4000	4000	4000	4000	4000	4000
13.5	**4000**	3995	3996	3997	3998	3999	4000	4000	4000	4000	4000	4000	4000	4000
14.0	**4000**	3998	3999	3999	3999	4000	4000	4000	4000	4000	4000	4000	4000	4000
14.5	**4000**	3999	3999	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
15.0	**4000**	3999	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
15.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
16.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
16.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
17.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
17.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
18.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
18.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
19.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
19.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.5	**3999**	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999
26.0	**3987**	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987
26.5	**3946**	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946
27.0	**3882**	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882
27.5	**3731**	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
28.0	**3515**	3516	3515	3515	3515	3515	3515	3515	3515	3515	3515	3515	3515	3515
28.5	**3279**	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279
29.0	**3037**	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037
29.5	**2791**	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791
30.0	**2549**	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549
30.5	**2309**	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309
31.0	**2074**	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074
31.5	**1869**	1870	1870	1870	1870	1870	1869	1869	1869	1869	1869	1869	1869	1869
32.0	**1722**	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722

Table 7-1: Power curve, Mode 0/0-0S (HWO)

7.2 Ct Values, Mode 0/0-0S (HWO)

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.828**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.831	0.830	0.829	0.827	0.826
7.5	**0.821**	0.832	0.831	0.830	0.829	0.828	0.827	0.826	0.825	0.824	0.823	0.822	0.820	0.818
8.0	**0.823**	0.837	0.836	0.835	0.834	0.833	0.831	0.830	0.829	0.827	0.826	0.824	0.821	0.819
8.5	**0.802**	0.838	0.836	0.833	0.831	0.829	0.825	0.822	0.818	0.815	0.810	0.806	0.797	0.793
9.0	**0.743**	0.811	0.805	0.800	0.795	0.789	0.783	0.777	0.770	0.764	0.757	0.750	0.736	0.730
9.5	**0.670**	0.752	0.745	0.737	0.730	0.723	0.715	0.707	0.700	0.692	0.685	0.678	0.663	0.656
10.0	**0.604**	0.685	0.677	0.669	0.661	0.653	0.646	0.639	0.632	0.625	0.618	0.611	0.597	0.590
10.5	**0.540**	0.623	0.615	0.608	0.601	0.594	0.587	0.579	0.572	0.565	0.557	0.548	0.531	0.522
11.0	**0.471**	0.568	0.560	0.552	0.544	0.537	0.528	0.519	0.510	0.501	0.491	0.481	0.461	0.451
11.5	**0.404**	0.516	0.507	0.497	0.488	0.478	0.467	0.456	0.446	0.435	0.425	0.414	0.395	0.386
12.0	**0.348**	0.463	0.451	0.440	0.428	0.416	0.406	0.395	0.385	0.374	0.365	0.357	0.340	0.332
12.5	**0.302**	0.406	0.395	0.383	0.372	0.361	0.352	0.343	0.334	0.324	0.317	0.310	0.296	0.289
13.0	**0.265**	0.354	0.344	0.334	0.324	0.315	0.307	0.299	0.292	0.284	0.278	0.271	0.260	0.254
13.5	**0.236**	0.312	0.304	0.295	0.287	0.279	0.272	0.265	0.259	0.252	0.247	0.241	0.231	0.226
14.0	**0.210**	0.276	0.269	0.261	0.254	0.247	0.241	0.236	0.230	0.224	0.220	0.215	0.206	0.202
14.5	**0.188**	0.246	0.239	0.233	0.227	0.221	0.216	0.211	0.206	0.201	0.197	0.192	0.185	0.181
15.0	**0.169**	0.219	0.214	0.208	0.203	0.197	0.193	0.189	0.184	0.180	0.176	0.173	0.166	0.162
15.5	**0.153**	0.198	0.193	0.188	0.183	0.178	0.174	0.170	0.167	0.163	0.159	0.156	0.150	0.147
16.0	**0.139**	0.179	0.175	0.170	0.166	0.162	0.158	0.155	0.151	0.148	0.145	0.142	0.136	0.134
16.5	**0.127**	0.163	0.159	0.155	0.151	0.147	0.144	0.141	0.138	0.135	0.132	0.129	0.125	0.122
17.0	**0.116**	0.149	0.145	0.142	0.138	0.135	0.132	0.129	0.126	0.123	0.121	0.119	0.114	0.112
17.5	**0.107**	0.136	0.133	0.130	0.127	0.123	0.121	0.118	0.116	0.113	0.111	0.109	0.105	0.103
18.0	**0.098**	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.104	0.102	0.100	0.097	0.095
18.5	**0.091**	0.115	0.113	0.110	0.107	0.105	0.103	0.101	0.098	0.096	0.095	0.093	0.089	0.088
19.0	**0.084**	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.082	0.081
19.5	**0.078**	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.083	0.081	0.080	0.077	0.075
20.0	**0.073**	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.075	0.074	0.071	0.070
20.5	**0.068**	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
21.0	**0.064**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.069	0.067	0.066	0.065	0.063	0.061
21.5	**0.060**	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
22.0	**0.057**	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.058	0.056	0.055
22.5	**0.053**	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052
23.0	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
23.5	**0.047**	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.046
24.0	**0.045**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
24.5	**0.042**	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041
25.0	**0.040**	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039
25.5	**0.038**	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037
26.0	**0.037**	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036	0.035
26.5	**0.035**	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.034	0.034
27.0	**0.032**	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032
27.5	**0.030**	0.036	0.036	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.029	0.029
28.0	**0.027**	0.033	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026
28.5	**0.024**	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024
29.0	**0.022**	0.026	0.026	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.021	0.021
29.5	**0.019**	0.023	0.023	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019	0.019
30.0	**0.017**	0.020	0.020	0.020	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.016
30.5	**0.015**	0.018	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.014
31.0	**0.013**	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
31.5	**0.011**	0.013	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011
32.0	**0.010**	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010

Table 7-2: C_t values, Mode 0/0-0S (HWO)

7.3 Sound Curves, Mode 0/0-0S (HWO)

Sound Power Level at Hub Height		
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m³**	
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Mode 0 (HWO) (Blades with serrated trailing edge)**	**Sound Power Level at Hub Height [dBA]** **Mode 0-0S (HWO) (Blades without serrated trailing edge)**
3	90.9	93.2
4	91.1	93.6
5	92.9	96.5
6	96.0	100.0
7	99.6	103.2
8	102.8	105.9
9	103.9	106.9
10	103.9	106.9
11	103.9	106.9
12	103.9	106.9
13	103.9	106.9
14	103.9	106.9
15	103.9	106.9
16	103.9	106.9
17	103.9	106.9
18	103.9	106.9
19	103.9	106.9
20	103.9	106.9

Table 7-3: Sound curves, Mode 0/0-0S (HWO)

8 Power Curves, Ct Values and Sound Curves, Power Optimized Mode PO1/PO1-0S

NOTE The power curves and Ct values presented in Section 8 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

8.1 Power Curves, Power Optimized Mode PO1/PO1-0S

	Air density [kg/m³]												
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	174	179	185	190	196	201	207	213	218	229	235
4.5	**337**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	401	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	548	562	576	591	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1095**	837	861	884	908	931	955	978	1002	1025	1048	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1703**	1311	1347	1382	1418	1454	1490	1526	1561	1597	1632	1668	1738	1773
8.0	**2069**	1599	1642	1685	1729	1772	1815	1857	1900	1943	1985	2027	2111	2153
8.5	**2471**	1923	1974	2025	2076	2127	2177	2227	2277	2326	2375	2423	2518	2565
9.0	**2871**	2272	2329	2387	2445	2502	2557	2611	2665	2719	2769	2820	2919	2967
9.5	**3232**	2619	2679	2739	2800	2860	2915	2970	3025	3080	3131	3182	3280	3328
10.0	**3562**	2945	3006	3068	3129	3190	3246	3301	3357	3412	3462	3512	3608	3654
10.5	**3845**	3245	3308	3370	3433	3495	3549	3603	3657	3711	3756	3801	3881	3916
11.0	**4035**	3521	3580	3638	3697	3756	3801	3846	3891	3936	3969	4002	4058	4082
11.5	**4145**	3763	3814	3864	3914	3965	3997	4029	4061	4093	4110	4128	4154	4163
12.0	**4187**	3953	3990	4027	4064	4102	4118	4134	4151	4167	4174	4180	4190	4193
12.5	**4197**	4081	4102	4123	4145	4166	4172	4179	4186	4192	4194	4196	4198	4198
13.0	**4199**	4149	4159	4169	4179	4189	4191	4193	4195	4198	4198	4199	4200	4200
13.5	**4200**	4163	4170	4178	4185	4192	4194	4196	4197	4199	4199	4200	4200	4200
14.0	**4200**	4183	4187	4190	4194	4198	4198	4199	4199	4200	4200	4200	4200	4200
14.5	**4200**	4192	4193	4195	4197	4199	4199	4200	4200	4200	4200	4200	4200	4200
15.0	**4200**	4193	4194	4196	4197	4198	4199	4199	4200	4200	4200	4200	4200	4200
15.5	**4200**	4196	4196	4197	4198	4199	4199	4200	4200	4200	4200	4200	4200	4200
16.0	**4200**	4197	4198	4198	4199	4200	4200	4200	4200	4200	4200	4200	4200	4200
16.5	**4200**	4198	4199	4199	4199	4200	4200	4200	4200	4200	4200	4200	4200	4200
17.0	**4200**	4199	4199	4199	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
17.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
18.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
18.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
19.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
19.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
20.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
20.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
21.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
21.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
22.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
22.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
23.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
23.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
24.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
24.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
25.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
25.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
26.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
26.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
27.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200

Table 8-1: Power curve, Power Optimized Mode PO1/PO1-0S

8.2 Ct Values, Power Optimized Mode PO1/PO1-0S

Wind speed [m/s]	Air density kg/m³												
	1.225	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.879**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.858	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.855	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.828**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.831	0.830	0.829	0.827	0.826
7.5	**0.821**	0.832	0.831	0.830	0.829	0.828	0.827	0.826	0.825	0.824	0.823	0.822	0.820	0.818
8.0	**0.823**	0.837	0.836	0.835	0.834	0.833	0.831	0.830	0.829	0.827	0.826	0.824	0.821	0.819
8.5	**0.802**	0.838	0.836	0.833	0.831	0.829	0.825	0.822	0.818	0.815	0.810	0.806	0.797	0.793
9.0	**0.743**	0.811	0.805	0.800	0.795	0.790	0.783	0.777	0.770	0.764	0.757	0.750	0.736	0.730
9.5	**0.670**	0.752	0.745	0.737	0.730	0.722	0.715	0.707	0.700	0.692	0.685	0.677	0.663	0.656
10.0	**0.604**	0.685	0.677	0.669	0.661	0.653	0.646	0.639	0.632	0.625	0.618	0.611	0.598	0.591
10.5	**0.545**	0.623	0.615	0.608	0.601	0.594	0.587	0.580	0.573	0.566	0.559	0.552	0.537	0.529
11.0	**0.483**	0.568	0.560	0.553	0.546	0.538	0.530	0.523	0.515	0.507	0.499	0.491	0.474	0.466
11.5	**0.423**	0.518	0.510	0.501	0.493	0.485	0.476	0.467	0.459	0.450	0.441	0.432	0.414	0.405
12.0	**0.367**	0.469	0.459	0.450	0.441	0.432	0.422	0.413	0.403	0.394	0.385	0.376	0.359	0.351
12.5	**0.319**	0.420	0.410	0.400	0.390	0.379	0.370	0.361	0.352	0.343	0.335	0.327	0.312	0.305
13.0	**0.280**	0.371	0.362	0.352	0.342	0.332	0.324	0.316	0.308	0.300	0.293	0.286	0.274	0.268
13.5	**0.249**	0.328	0.319	0.311	0.302	0.294	0.287	0.280	0.273	0.266	0.260	0.254	0.243	0.238
14.0	**0.221**	0.291	0.283	0.276	0.268	0.261	0.255	0.248	0.242	0.236	0.231	0.226	0.217	0.212
14.5	**0.198**	0.259	0.252	0.246	0.239	0.232	0.227	0.222	0.217	0.211	0.207	0.202	0.194	0.190
15.0	**0.177**	0.231	0.225	0.219	0.213	0.208	0.203	0.198	0.194	0.189	0.185	0.181	0.174	0.171
15.5	**0.160**	0.208	0.203	0.198	0.192	0.187	0.183	0.179	0.175	0.171	0.167	0.164	0.157	0.154
16.0	**0.146**	0.188	0.184	0.179	0.174	0.170	0.166	0.162	0.159	0.155	0.152	0.149	0.143	0.140
16.5	**0.133**	0.171	0.167	0.163	0.159	0.155	0.151	0.148	0.145	0.141	0.139	0.136	0.131	0.128
17.0	**0.122**	0.156	0.152	0.149	0.145	0.141	0.138	0.135	0.132	0.129	0.127	0.124	0.120	0.117
17.5	**0.112**	0.143	0.140	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
18.0	**0.103**	0.131	0.128	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.099
18.5	**0.095**	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.101	0.099	0.097	0.094	0.092
19.0	**0.088**	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.090	0.086	0.085
19.5	**0.082**	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.085	0.083	0.080	0.079
20.0	**0.076**	0.096	0.094	0.092	0.089	0.087	0.086	0.084	0.082	0.080	0.079	0.077	0.075	0.073
20.5	**0.071**	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.077	0.075	0.074	0.072	0.070	0.069
21.0	**0.066**	0.083	0.081	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.068	0.065	0.064
21.5	**0.063**	0.079	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.062	0.061
22.0	**0.059**	0.074	0.072	0.071	0.069	0.067	0.066	0.065	0.064	0.062	0.061	0.060	0.058	0.057
22.5	**0.056**	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.0	**0.052**	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.051	0.050
23.5	**0.049**	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.048
24.0	**0.047**	0.058	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045
24.5	**0.044**	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.046	0.045	0.043	0.043
25.0	**0.042**	0.052	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.043	0.043	0.041	0.041
25.5	**0.040**	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.041	0.039	0.039
26.0	**0.038**	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038	0.037
26.5	**0.036**	0.044	0.043	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035
27.0	**0.035**	0.042	0.041	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034	0.034

Table 8-2: C_t values, Power Optimized Mode PO1/PO1-0S

8.3 Sound Curves, Power Optimized Mode PO1/PO1-0S

Sound Power Level at Hub Height		
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**	
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Power Optimized Mode PO1** **(Blades with serrated trailing edge)**	**Sound Power Level at Hub Height [dBA]** **Power Optimized Mode PO1-0S** **(Blades without serrated trailing edge)**
3	90.9	93.2
4	91.1	93.6
5	92.9	96.5
6	96.0	100.0
7	99.6	103.2
8	102.9	106.0
9	103.9	106.9
10	103.9	106.9
11	103.9	106.9
12	103.9	106.9
13	103.9	106.9
14	103.9	106.9
15	103.9	106.9
16	103.9	106.9
17	103.9	106.9
18	103.9	106.9
19	103.9	106.9
20	103.9	106.9

Table 8-3: Sound curves, Power Optimized Mode PO1/PO1-0S

9 Power Curves, Ct Values and Sound Curves, Power Optimized Mode PO1/PO1-0S (HWO)

NOTE The power curves and Ct values presented in Section 9 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

9.1 Power Curves, Power Optimized Mode PO1/PO1-0S (HWO)

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	174	179	185	190	196	201	207	213	218	229	235
4.5	**337**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	401	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	548	562	576	591	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1095**	837	861	884	908	931	955	978	1002	1025	1048	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1703**	1311	1347	1382	1418	1454	1490	1526	1561	1597	1632	1668	1738	1773
8.0	**2069**	1599	1642	1685	1729	1772	1815	1857	1900	1943	1985	2027	2111	2153
8.5	**2471**	1923	1974	2025	2076	2127	2177	2227	2277	2326	2375	2423	2518	2565
9.0	**2871**	2272	2329	2387	2445	2502	2557	2611	2665	2719	2769	2820	2919	2967
9.5	**3232**	2619	2679	2739	2800	2860	2915	2970	3025	3080	3131	3182	3280	3328
10.0	**3562**	2945	3006	3068	3129	3190	3246	3301	3357	3412	3462	3512	3608	3654
10.5	**3845**	3245	3308	3370	3433	3495	3549	3603	3657	3711	3756	3801	3881	3916
11.0	**4035**	3521	3580	3638	3697	3756	3801	3846	3891	3936	3969	4002	4058	4082
11.5	**4145**	3763	3814	3864	3914	3965	3997	4029	4061	4093	4110	4128	4154	4163
12.0	**4187**	3953	3990	4027	4064	4102	4118	4134	4151	4167	4174	4180	4190	4193
12.5	**4197**	4081	4102	4123	4145	4166	4172	4179	4186	4192	4194	4196	4198	4198
13.0	**4199**	4149	4159	4169	4179	4189	4191	4193	4195	4198	4198	4199	4200	4200
13.5	**4200**	4163	4170	4178	4185	4192	4194	4196	4197	4199	4199	4200	4200	4200
14.0	**4200**	4183	4187	4190	4194	4198	4198	4199	4199	4200	4200	4200	4200	4200
14.5	**4200**	4192	4193	4195	4197	4199	4199	4200	4200	4200	4200	4200	4200	4200
15.0	**4200**	4193	4194	4196	4197	4198	4199	4199	4200	4200	4200	4200	4200	4200
15.5	**4200**	4196	4196	4197	4198	4199	4199	4200	4200	4200	4200	4200	4200	4200
16.0	**4200**	4197	4198	4198	4199	4200	4200	4200	4200	4200	4200	4200	4200	4200
16.5	**4200**	4198	4199	4199	4199	4200	4200	4200	4200	4200	4200	4200	4200	4200
17.0	**4200**	4199	4199	4199	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
17.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
18.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
18.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
19.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
19.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
20.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
20.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
21.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
21.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
22.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
22.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
23.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
23.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
24.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
24.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
25.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
25.5	**4198**	4198	4198	4198	4198	4198	4198	4198	4198	4198	4198	4198	4198	4198
26.0	**4182**	4182	4182	4182	4182	4182	4182	4182	4182	4182	4182	4182	4182	4182
26.5	**4124**	4124	4124	4124	4124	4124	4124	4124	4124	4124	4124	4124	4124	4124

Air density [kg/m³]														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
27.0	**4034**	4034	4034	4034	4034	4034	4034	4034	4034	4034	4034	4034	4034	4034
27.5	**3835**	3835	3835	3835	3835	3835	3835	3835	3835	3835	3835	3835	3835	3835
28.0	**3565**	3565	3565	3565	3565	3565	3565	3565	3565	3565	3565	3565	3565	3565
28.5	**3292**	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292	3292
29.0	**3039**	3039	3039	3039	3039	3039	3039	3039	3039	3039	3039	3039	3039	3039
29.5	**2792**	2791	2791	2791	2791	2791	2791	2791	2791	2792	2792	2792	2792	2792
30.0	**2549**	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549
30.5	**2309**	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309
31.0	**2075**	2074	2074	2074	2074	2075	2075	2075	2075	2075	2075	2075	2075	2075
31.5	**1869**	1869	1869	1869	1869	1869	1869	1869	1869	1869	1869	1869	1869	1869
32.0	**1722**	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722

Table 9-1: Power curve, Power Optimized Mode PO1/PO1-0S (HWO)

9.2 Ct Values, Power Optimized Mode PO1/PO1-0S (HWO)

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.879**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.858	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.855	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.828**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.831	0.830	0.829	0.827	0.826
7.5	**0.821**	0.832	0.831	0.830	0.829	0.828	0.827	0.826	0.825	0.824	0.823	0.822	0.820	0.818
8.0	**0.823**	0.837	0.836	0.835	0.834	0.833	0.831	0.830	0.829	0.827	0.826	0.824	0.821	0.819
8.5	**0.802**	0.838	0.836	0.833	0.831	0.829	0.825	0.822	0.818	0.815	0.810	0.806	0.797	0.793
9.0	**0.743**	0.811	0.805	0.800	0.795	0.790	0.783	0.777	0.770	0.764	0.757	0.750	0.736	0.730
9.5	**0.670**	0.752	0.745	0.737	0.730	0.722	0.715	0.707	0.700	0.692	0.685	0.677	0.663	0.656
10.0	**0.604**	0.685	0.677	0.669	0.661	0.653	0.646	0.639	0.632	0.625	0.618	0.611	0.598	0.591
10.5	**0.545**	0.623	0.615	0.608	0.601	0.594	0.587	0.580	0.573	0.566	0.559	0.552	0.537	0.529
11.0	**0.483**	0.568	0.560	0.553	0.546	0.538	0.530	0.523	0.515	0.507	0.499	0.491	0.474	0.466
11.5	**0.423**	0.518	0.510	0.501	0.493	0.485	0.476	0.467	0.459	0.450	0.441	0.432	0.414	0.405
12.0	**0.367**	0.469	0.459	0.450	0.441	0.432	0.422	0.413	0.403	0.394	0.385	0.376	0.359	0.351
12.5	**0.319**	0.420	0.410	0.400	0.390	0.379	0.370	0.361	0.352	0.343	0.335	0.327	0.312	0.305
13.0	**0.280**	0.371	0.362	0.352	0.342	0.332	0.324	0.316	0.308	0.300	0.293	0.286	0.274	0.268
13.5	**0.249**	0.328	0.319	0.311	0.302	0.294	0.287	0.280	0.273	0.266	0.260	0.254	0.243	0.238
14.0	**0.221**	0.291	0.283	0.276	0.268	0.261	0.255	0.248	0.242	0.236	0.231	0.226	0.217	0.212
14.5	**0.198**	0.259	0.252	0.246	0.239	0.232	0.227	0.222	0.217	0.211	0.207	0.202	0.194	0.190
15.0	**0.177**	0.231	0.225	0.219	0.213	0.208	0.203	0.198	0.194	0.189	0.185	0.181	0.174	0.171
15.5	**0.160**	0.208	0.203	0.198	0.192	0.187	0.183	0.179	0.175	0.171	0.167	0.164	0.157	0.154
16.0	**0.146**	0.188	0.184	0.179	0.174	0.170	0.166	0.162	0.159	0.155	0.152	0.149	0.143	0.140
16.5	**0.133**	0.171	0.167	0.163	0.159	0.155	0.151	0.148	0.145	0.141	0.139	0.136	0.131	0.128
17.0	**0.122**	0.156	0.152	0.149	0.145	0.141	0.138	0.135	0.132	0.129	0.127	0.124	0.120	0.117
17.5	**0.112**	0.143	0.140	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
18.0	**0.103**	0.131	0.128	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.099
18.5	**0.095**	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.101	0.099	0.097	0.094	0.092
19.0	**0.088**	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.090	0.086	0.085
19.5	**0.082**	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.085	0.083	0.080	0.079
20.0	**0.076**	0.096	0.094	0.092	0.089	0.087	0.086	0.084	0.082	0.080	0.079	0.077	0.075	0.073
20.5	**0.071**	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.077	0.075	0.074	0.072	0.070	0.069
21.0	**0.066**	0.083	0.081	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.068	0.065	0.064
21.5	**0.063**	0.079	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.062	0.061
22.0	**0.059**	0.074	0.072	0.071	0.069	0.067	0.066	0.065	0.064	0.062	0.061	0.060	0.058	0.057
22.5	**0.056**	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.0	**0.052**	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.051	0.050
23.5	**0.049**	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.048
24.0	**0.047**	0.058	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045
24.5	**0.044**	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.046	0.045	0.043	0.043
25.0	**0.042**	0.052	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.043	0.043	0.041	0.041
25.5	**0.040**	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.041	0.039	0.039
26.0	**0.038**	0.046	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.037	0.037
26.5	**0.036**	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037	0.036	0.035	0.035
27.0	**0.033**	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033	0.032
27.5	**0.031**	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030
28.0	**0.027**	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027
28.5	**0.024**	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024
29.0	**0.022**	0.026	0.026	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.021	0.021
29.5	**0.019**	0.023	0.023	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019	0.019
30.0	**0.017**	0.020	0.020	0.020	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.016
30.5	**0.015**	0.018	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.014
31.0	**0.013**	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
31.5	**0.011**	0.013	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011
32.0	**0.010**	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010

Table 9-2: C_t values, Power Optimized Mode PO1/PO1-0S (HWO)

9.3 Sound Curves, Power Optimized Mode PO1/PO1-0S (HWO)

Sound Power Level at Hub Height		
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m³**	
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Power Optimized Mode PO1 (HWO) (Blades with serrated trailing edge)**	**Sound Power Level at Hub Height [dBA]** **Power Optimized Mode PO1-0S (HWO) (Blades without serrated trailing edge)**
3	90.9	93.2
4	91.1	93.6
5	92.9	96.5
6	96.0	100.0
7	99.6	103.2
8	102.8	105.9
9	103.9	106.9
10	103.9	106.9
11	103.9	106.9
12	103.9	106.9
13	103.9	106.9
14	103.9	106.9
15	103.9	106.9
16	103.9	106.9
17	103.9	106.9
18	103.9	106.9
19	103.9	106.9
20	103.9	106.9

Table 9-3: Sound curves, Power Optimized Mode PO1/PO1-0S (HWO)

10 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO1

NOTE The power curves and Ct values presented in Section 10 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

10.1 Power Curves, Sound Optimized Mode SO1

Wind speed [m/s]	Air density [kg/m³] 1.225	0.950	0.975	1.000	1.025	1.050	1.075	1.100	1.125	1.150	1.175	1.200	1.250	1.275
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1096**	837	861	884	908	932	955	978	1002	1025	1049	1072	1119	1142
7.0	**1381**	1059	1088	1118	1147	1176	1206	1235	1265	1294	1323	1352	1411	1440
7.5	**1707**	1312	1348	1384	1421	1457	1493	1529	1565	1600	1636	1672	1742	1778
8.0	**2070**	1598	1641	1684	1728	1771	1814	1857	1900	1943	1985	2027	2112	2154
8.5	**2455**	1904	1955	2006	2056	2107	2157	2207	2257	2307	2356	2406	2503	2551
9.0	**2827**	2206	2264	2321	2379	2436	2493	2550	2606	2663	2718	2773	2880	2932
9.5	**3149**	2485	2549	2612	2676	2740	2801	2862	2923	2984	3039	3094	3198	3248
10.0	**3410**	2759	2827	2895	2963	3030	3090	3150	3210	3270	3317	3363	3447	3484
10.5	**3604**	3051	3118	3185	3252	3319	3367	3416	3464	3513	3543	3574	3625	3646
11.0	**3727**	3313	3371	3428	3486	3544	3577	3610	3644	3677	3694	3711	3737	3746
11.5	**3792**	3524	3567	3611	3655	3698	3716	3734	3752	3769	3777	3784	3795	3799
12.0	**3823**	3676	3703	3729	3756	3782	3791	3799	3807	3816	3818	3820	3824	3825
12.5	**3842**	3772	3785	3799	3812	3826	3829	3832	3836	3840	3840	3841	3843	3844
13.0	**3861**	3827	3834	3840	3847	3853	3855	3856	3858	3860	3860	3861	3862	3862
13.5	**3883**	3859	3864	3869	3874	3879	3880	3881	3882	3883	3883	3883	3883	3883
14.0	**3902**	3891	3893	3896	3898	3900	3901	3902	3902	3903	3902	3902	3902	3902
14.5	**3919**	3914	3915	3916	3918	3919	3919	3919	3919	3920	3920	3919	3919	3919
15.0	**3934**	3930	3931	3932	3933	3934	3934	3934	3934	3934	3934	3934	3934	3934
15.5	**3946**	3945	3945	3946	3946	3946	3947	3947	3947	3947	3947	3946	3946	3946
16.0	**3958**	3958	3958	3959	3959	3959	3959	3959	3959	3959	3959	3958	3958	3958
16.5	**3970**	3971	3972	3972	3972	3972	3972	3972	3971	3971	3971	3971	3970	3970
17.0	**3983**	3984	3984	3984	3984	3984	3984	3984	3983	3983	3983	3983	3982	3982
17.5	**3992**	3994	3994	3994	3993	3993	3993	3993	3993	3993	3993	3992	3992	3992
18.0	**3998**	3998	3998	3998	3998	3998	3998	3998	3998	3998	3998	3998	3998	3997
18.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	3999	3999
19.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
19.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
26.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
26.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
27.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

Table 10-1: Power curve, Sound Optimized Mode SO1

10.2 Ct Values, Sound Optimized Mode SO1

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.852	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.845	0.845	0.844	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.837**	0.845	0.844	0.844	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.836	0.835
7.0	**0.840**	0.850	0.849	0.848	0.847	0.846	0.845	0.844	0.843	0.843	0.842	0.841	0.839	0.838
7.5	**0.843**	0.854	0.853	0.852	0.852	0.851	0.850	0.849	0.848	0.847	0.846	0.844	0.842	0.841
8.0	**0.833**	0.845	0.844	0.843	0.842	0.841	0.840	0.839	0.838	0.837	0.835	0.834	0.831	0.830
8.5	**0.790**	0.805	0.804	0.803	0.802	0.801	0.799	0.798	0.797	0.796	0.794	0.792	0.787	0.785
9.0	**0.721**	0.737	0.736	0.735	0.734	0.734	0.732	0.731	0.729	0.728	0.726	0.723	0.717	0.714
9.5	**0.643**	0.662	0.662	0.661	0.660	0.660	0.658	0.657	0.655	0.654	0.650	0.647	0.638	0.634
10.0	**0.570**	0.607	0.605	0.604	0.603	0.602	0.598	0.595	0.592	0.588	0.582	0.576	0.563	0.556
10.5	**0.503**	0.573	0.569	0.565	0.561	0.557	0.550	0.543	0.536	0.529	0.521	0.512	0.493	0.484
11.0	**0.439**	0.536	0.529	0.522	0.514	0.507	0.498	0.488	0.479	0.470	0.460	0.449	0.430	0.420
11.5	**0.380**	0.489	0.480	0.470	0.460	0.451	0.440	0.430	0.419	0.409	0.399	0.390	0.372	0.363
12.0	**0.330**	0.436	0.426	0.415	0.404	0.394	0.384	0.374	0.364	0.355	0.346	0.338	0.322	0.315
12.5	**0.289**	0.384	0.374	0.364	0.354	0.343	0.335	0.326	0.318	0.310	0.303	0.296	0.282	0.276
13.0	**0.255**	0.338	0.329	0.320	0.311	0.302	0.294	0.287	0.280	0.273	0.267	0.261	0.250	0.244
13.5	**0.228**	0.300	0.292	0.285	0.277	0.269	0.263	0.257	0.250	0.244	0.239	0.233	0.224	0.219
14.0	**0.204**	0.268	0.261	0.254	0.247	0.240	0.235	0.229	0.224	0.218	0.214	0.209	0.200	0.196
14.5	**0.184**	0.240	0.234	0.228	0.222	0.216	0.211	0.206	0.201	0.196	0.192	0.188	0.181	0.177
15.0	**0.166**	0.215	0.210	0.204	0.199	0.194	0.189	0.185	0.181	0.177	0.173	0.169	0.163	0.159
15.5	**0.151**	0.195	0.190	0.185	0.180	0.176	0.172	0.168	0.164	0.160	0.157	0.154	0.148	0.145
16.0	**0.137**	0.177	0.173	0.168	0.164	0.160	0.156	0.153	0.150	0.146	0.143	0.140	0.135	0.132
16.5	**0.126**	0.161	0.158	0.154	0.150	0.146	0.143	0.140	0.137	0.134	0.131	0.128	0.123	0.121
17.0	**0.116**	0.148	0.144	0.141	0.138	0.134	0.131	0.128	0.126	0.123	0.120	0.118	0.114	0.111
17.5	**0.106**	0.136	0.133	0.129	0.126	0.123	0.121	0.118	0.115	0.113	0.111	0.109	0.105	0.103
18.0	**0.098**	0.125	0.122	0.119	0.116	0.113	0.111	0.109	0.107	0.104	0.102	0.100	0.097	0.095
18.5	**0.091**	0.115	0.113	0.110	0.107	0.105	0.103	0.101	0.098	0.096	0.095	0.093	0.089	0.088
19.0	**0.084**	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.082	0.081
19.5	**0.078**	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.083	0.081	0.080	0.077	0.075
20.0	**0.073**	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.075	0.074	0.071	0.070
20.5	**0.068**	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
21.0	**0.064**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.069	0.067	0.066	0.065	0.063	0.061
21.5	**0.060**	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
22.0	**0.057**	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.058	0.056	0.055
22.5	**0.053**	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052
23.0	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
23.5	**0.047**	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.046
24.0	**0.045**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
24.5	**0.042**	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041
25.0	**0.040**	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039
25.5	**0.038**	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037
26.0	**0.037**	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036
26.5	**0.035**	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035	0.034	0.034
27.0	**0.033**	0.041	0.040	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.032

Table 10-2: C_t values, Sound Optimized Mode SO1

10.3 Sound Curves, Sound Optimized Mode SO1

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3 Maximum turbulence at hub height: 30% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA] Sound Optimized Mode SO1 (Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.5
8	101.6
9	101.9
10	101.8
11	102.0
12	102.0
13	102.0
14	102.0
15	102.0
16	102.0
17	102.0
18	102.0
19	102.0
20	102.0

Table 10-3: Sound curves, Sound Optimized Mode SO1

11 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO1 (HWO)

NOTE The power curves and Ct values presented in Section 11 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

11.1 Power Curves, Sound Optimized Mode SO1 (HWO)

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1096**	837	861	884	908	932	955	978	1002	1025	1049	1072	1119	1142
7.0	**1381**	1059	1088	1118	1147	1176	1206	1235	1265	1294	1323	1352	1411	1440
7.5	**1707**	1312	1348	1384	1421	1457	1493	1529	1565	1600	1636	1672	1742	1778
8.0	**2070**	1598	1641	1684	1728	1771	1814	1857	1900	1943	1985	2027	2112	2154
8.5	**2455**	1904	1955	2006	2056	2107	2157	2207	2257	2307	2356	2406	2503	2551
9.0	**2827**	2206	2264	2321	2379	2436	2493	2550	2606	2663	2718	2773	2880	2932
9.5	**3149**	2485	2549	2612	2676	2740	2801	2862	2923	2984	3039	3094	3198	3248
10.0	**3410**	2759	2827	2895	2963	3030	3090	3150	3210	3270	3317	3363	3447	3484
10.5	**3604**	3051	3118	3185	3252	3319	3367	3416	3464	3513	3543	3574	3625	3646
11.0	**3727**	3313	3371	3428	3486	3544	3577	3610	3644	3677	3694	3711	3737	3746
11.5	**3791**	3524	3567	3611	3655	3698	3716	3734	3752	3769	3777	3784	3795	3799
12.0	**3823**	3676	3703	3729	3756	3782	3791	3799	3807	3816	3818	3820	3824	3825
12.5	**3842**	3772	3785	3799	3812	3826	3829	3832	3836	3840	3840	3841	3843	3844
13.0	**3861**	3827	3834	3840	3847	3853	3855	3856	3858	3860	3860	3861	3862	3862
13.5	**3883**	3859	3864	3869	3874	3879	3880	3881	3882	3883	3883	3883	3883	3883
14.0	**3902**	3891	3893	3896	3898	3900	3901	3902	3902	3903	3902	3902	3902	3902
14.5	**3919**	3914	3915	3916	3918	3919	3919	3919	3919	3920	3920	3919	3919	3919
15.0	**3934**	3930	3931	3932	3933	3934	3934	3934	3934	3934	3934	3934	3934	3934
15.5	**3946**	3945	3945	3946	3946	3946	3947	3947	3947	3947	3947	3946	3946	3946
16.0	**3958**	3958	3958	3959	3959	3959	3959	3959	3959	3959	3959	3958	3958	3958
16.5	**3970**	3971	3972	3972	3972	3972	3972	3972	3971	3971	3971	3971	3970	3970
17.0	**3983**	3984	3984	3984	3984	3984	3984	3984	3983	3983	3983	3983	3982	3982
17.5	**3992**	3994	3994	3994	3993	3993	3993	3993	3993	3993	3993	3992	3992	3992
18.0	**3998**	3998	3998	3998	3998	3998	3998	3998	3998	3998	3998	3998	3998	3997
18.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	3999	3999
19.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
19.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
20.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
21.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
22.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
23.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
24.5	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.0	**4000**	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
25.5	**3999**	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999	3999
26.0	**3987**	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987	3987
26.5	**3946**	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946	3946
27.0	**3882**	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882	3882
27.5	**3731**	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
28.0	**3516**	3516	3516	3516	3516	3516	3516	3516	3516	3516	3516	3516	3516	3516
28.5	**3279**	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279
29.0	**3037**	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037
29.5	**2791**	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791
30.0	**2549**	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549
30.5	**2309**	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309
31.0	**2074**	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074
31.5	**1870**	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870	1870
32.0	**1722**	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1723

Table 11-1: Power curve, Sound Optimized Mode SO1 (HWO)

11.2 Ct Values, Sound Optimized Mode SO1 (HWO)

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.852	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.845	0.845	0.844	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.837**	0.845	0.844	0.844	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.836	0.835
7.0	**0.840**	0.850	0.849	0.848	0.847	0.846	0.845	0.844	0.843	0.843	0.842	0.841	0.839	0.838
7.5	**0.843**	0.854	0.853	0.852	0.852	0.851	0.850	0.849	0.848	0.847	0.846	0.844	0.842	0.841
8.0	**0.833**	0.845	0.844	0.843	0.842	0.841	0.840	0.839	0.838	0.837	0.835	0.834	0.831	0.830
8.5	**0.790**	0.805	0.804	0.803	0.802	0.801	0.799	0.798	0.797	0.796	0.794	0.792	0.787	0.785
9.0	**0.721**	0.737	0.736	0.735	0.734	0.734	0.732	0.731	0.729	0.728	0.726	0.723	0.717	0.714
9.5	**0.643**	0.662	0.662	0.661	0.660	0.660	0.658	0.657	0.655	0.654	0.650	0.647	0.638	0.634
10.0	**0.570**	0.607	0.605	0.604	0.603	0.602	0.598	0.595	0.592	0.588	0.582	0.576	0.563	0.556
10.5	**0.503**	0.573	0.569	0.565	0.561	0.557	0.550	0.543	0.536	0.529	0.521	0.512	0.493	0.484
11.0	**0.439**	0.536	0.529	0.522	0.514	0.507	0.498	0.488	0.479	0.470	0.460	0.449	0.430	0.420
11.5	**0.380**	0.489	0.480	0.470	0.460	0.451	0.440	0.430	0.419	0.409	0.399	0.390	0.372	0.363
12.0	**0.330**	0.436	0.426	0.415	0.404	0.394	0.384	0.374	0.364	0.355	0.346	0.338	0.322	0.315
12.5	**0.289**	0.384	0.374	0.364	0.354	0.343	0.335	0.326	0.318	0.310	0.303	0.296	0.282	0.276
13.0	**0.255**	0.338	0.329	0.320	0.311	0.302	0.294	0.287	0.280	0.273	0.267	0.261	0.250	0.244
13.5	**0.228**	0.300	0.292	0.285	0.277	0.269	0.263	0.257	0.250	0.244	0.239	0.233	0.224	0.219
14.0	**0.204**	0.268	0.261	0.254	0.247	0.240	0.235	0.229	0.224	0.218	0.214	0.209	0.200	0.196
14.5	**0.184**	0.240	0.234	0.228	0.222	0.216	0.211	0.206	0.201	0.196	0.192	0.188	0.181	0.177
15.0	**0.166**	0.215	0.210	0.204	0.199	0.194	0.189	0.185	0.181	0.177	0.173	0.169	0.163	0.159
15.5	**0.151**	0.195	0.190	0.185	0.180	0.176	0.172	0.168	0.164	0.160	0.157	0.154	0.148	0.145
16.0	**0.137**	0.177	0.173	0.168	0.164	0.160	0.156	0.153	0.150	0.146	0.143	0.140	0.135	0.132
16.5	**0.126**	0.161	0.158	0.154	0.150	0.146	0.143	0.140	0.137	0.134	0.131	0.128	0.123	0.121
17.0	**0.116**	0.148	0.144	0.141	0.138	0.134	0.131	0.128	0.126	0.123	0.120	0.118	0.114	0.111
17.5	**0.106**	0.136	0.133	0.129	0.126	0.123	0.121	0.118	0.115	0.113	0.111	0.109	0.105	0.103
18.0	**0.098**	0.125	0.122	0.119	0.116	0.113	0.111	0.109	0.107	0.104	0.102	0.100	0.097	0.095
18.5	**0.091**	0.115	0.113	0.110	0.107	0.105	0.103	0.101	0.098	0.096	0.095	0.093	0.089	0.088
19.0	**0.084**	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.082	0.081
19.5	**0.078**	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.083	0.081	0.080	0.077	0.075
20.0	**0.073**	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.075	0.074	0.071	0.070
20.5	**0.068**	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
21.0	**0.064**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.069	0.067	0.066	0.065	0.063	0.061
21.5	**0.060**	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
22.0	**0.057**	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.058	0.056	0.055
22.5	**0.053**	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052
23.0	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
23.5	**0.047**	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.046
24.0	**0.045**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
24.5	**0.042**	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041
25.0	**0.040**	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039
25.5	**0.038**	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037
26.0	**0.037**	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036	0.035
26.5	**0.035**	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.034	0.034
27.0	**0.032**	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032
27.5	**0.030**	0.036	0.036	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.029	0.029
28.0	**0.027**	0.033	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026
28.5	**0.024**	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024
29.0	**0.022**	0.026	0.026	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.021	0.021
29.5	**0.019**	0.023	0.023	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019	0.019
30.0	**0.017**	0.020	0.020	0.020	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.016
30.5	**0.015**	0.018	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.014
31.0	**0.013**	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
31.5	**0.011**	0.013	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011
32.0	**0.010**	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010

Table 11-2: C_t values, Sound Optimized Mode SO1 (HWO)

11.3 Sound Curves, Sound Optimized Mode SO1 (HWO)

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO1 (HWO)** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.5
8	101.6
9	101.9
10	101.8
11	102.0
12	102.0
13	102.0
14	102.0
15	102.0
16	102.0
17	102.0
18	102.0
19	102.0
20	102.0

Table 11-3: Sound curves, Sound Optimized Mode SO1 (HWO)

12 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO2

NOTE The power curves and Ct values presented in Section 12 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

12.1 Power Curves, Sound Optimized Mode SO2

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1096**	837	861	885	908	932	955	979	1002	1026	1049	1072	1120	1143
7.0	**1381**	1058	1088	1117	1147	1176	1206	1235	1264	1294	1323	1352	1410	1438
7.5	**1675**	1304	1340	1376	1412	1448	1483	1518	1552	1587	1616	1646	1700	1724
8.0	**1870**	1560	1599	1637	1675	1714	1740	1767	1794	1820	1837	1853	1880	1890
8.5	**1967**	1790	1818	1845	1873	1901	1914	1926	1939	1952	1957	1962	1970	1974
9.0	**2030**	1955	1968	1981	1994	2007	2011	2015	2020	2024	2026	2028	2031	2031
9.5	**2075**	2049	2054	2059	2064	2069	2070	2071	2072	2073	2074	2074	2075	2076
10.0	**2114**	2108	2108	2109	2110	2111	2111	2112	2113	2113	2114	2114	2114	2114
10.5	**2148**	2159	2157	2155	2153	2151	2151	2150	2149	2149	2148	2148	2147	2147
11.0	**2195**	2230	2226	2221	2216	2212	2209	2206	2203	2200	2199	2197	2194	2192
11.5	**2238**	2284	2279	2274	2268	2263	2259	2255	2251	2247	2244	2241	2236	2233
12.0	**2295**	2344	2338	2333	2328	2322	2318	2314	2310	2306	2302	2299	2292	2288
12.5	**2361**	2414	2409	2403	2397	2391	2386	2382	2377	2372	2368	2365	2357	2354
13.0	**2420**	2475	2469	2462	2456	2450	2446	2441	2436	2432	2428	2424	2417	2414
13.5	**2473**	2523	2517	2511	2505	2498	2494	2490	2486	2482	2479	2476	2470	2467
14.0	**2516**	2565	2559	2553	2547	2542	2537	2533	2529	2525	2522	2519	2513	2510
14.5	**2566**	2618	2612	2606	2600	2594	2590	2586	2581	2577	2573	2570	2563	2560
15.0	**2673**	2716	2711	2707	2702	2698	2694	2691	2687	2684	2680	2677	2670	2666
15.5	**2760**	2795	2791	2788	2785	2781	2778	2775	2772	2769	2766	2763	2757	2754
16.0	**2852**	2880	2877	2874	2872	2869	2867	2864	2862	2860	2857	2854	2849	2847
16.5	**2927**	2943	2942	2940	2939	2937	2936	2934	2933	2932	2930	2929	2925	2923
17.0	**2976**	2979	2979	2979	2979	2979	2979	2978	2978	2978	2977	2976	2975	2974
17.5	**2997**	2996	2996	2997	2997	2998	2998	2998	2998	2998	2997	2997	2997	2996
18.0	**3006**	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006
18.5	**3020**	3020	3020	3020	3021	3021	3021	3020	3020	3020	3020	3020	3019	3019
19.0	**3046**	3058	3057	3056	3055	3054	3053	3052	3050	3049	3048	3047	3045	3044
19.5	**3091**	3104	3103	3102	3101	3100	3099	3098	3096	3095	3094	3093	3090	3089
20.0	**3154**	3162	3162	3161	3161	3161	3160	3159	3158	3157	3156	3155	3153	3152
20.5	**3222**	3217	3218	3219	3220	3220	3221	3221	3222	3222	3222	3222	3222	3222
21.0	**3276**	3260	3262	3264	3266	3267	3269	3270	3272	3273	3274	3275	3277	3277
21.5	**3314**	3299	3301	3302	3304	3306	3307	3309	3310	3312	3312	3313	3315	3316
22.0	**3341**	3324	3327	3329	3331	3333	3334	3336	3337	3339	3339	3340	3341	3342
22.5	**3368**	3352	3354	3356	3358	3360	3361	3363	3364	3365	3366	3367	3368	3369
23.0	**3393**	3373	3375	3377	3380	3382	3384	3386	3387	3389	3390	3392	3394	3395
23.5	**3407**	3389	3391	3393	3395	3398	3399	3401	3402	3404	3405	3406	3408	3410
24.0	**3415**	3397	3399	3401	3403	3406	3407	3409	3410	3412	3413	3414	3416	3417
24.5	**3419**	3401	3403	3405	3407	3409	3410	3412	3413	3415	3416	3417	3420	3421
25.0	**3418**	3401	3403	3405	3407	3410	3411	3412	3413	3415	3416	3417	3420	3421
25.5	**3405**	3381	3383	3386	3389	3392	3394	3396	3398	3400	3402	3404	3407	3408
26.0	**3402**	3380	3383	3385	3387	3389	3391	3393	3395	3397	3399	3401	3404	3405
26.5	**3400**	3380	3382	3384	3386	3388	3390	3391	3393	3395	3397	3399	3401	3403
27.0	**3384**	3367	3368	3370	3372	3374	3375	3377	3378	3380	3381	3382	3385	3386

Table 12-1: Power curve, Sound Optimized Mode SO2

12.2 Ct Values, Sound Optimized Mode SO2

Wind speed [m/s]	Air density kg/m³												
	1.225	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.847**	0.853	0.853	0.852	0.852	0.851	0.851	0.850	0.850	0.849	0.848	0.848	0.846	0.846
6.5	**0.844**	0.852	0.852	0.851	0.850	0.850	0.849	0.848	0.848	0.847	0.846	0.845	0.843	0.842
7.0	**0.844**	0.855	0.855	0.854	0.853	0.852	0.851	0.850	0.849	0.849	0.847	0.845	0.840	0.837
7.5	**0.790**	0.843	0.842	0.841	0.840	0.839	0.834	0.830	0.826	0.821	0.811	0.801	0.779	0.768
8.0	**0.655**	0.800	0.791	0.781	0.772	0.763	0.749	0.735	0.721	0.706	0.689	0.672	0.638	0.621
8.5	**0.526**	0.709	0.693	0.677	0.661	0.645	0.627	0.608	0.590	0.572	0.557	0.541	0.513	0.499
9.0	**0.433**	0.601	0.583	0.564	0.545	0.527	0.512	0.498	0.483	0.469	0.457	0.445	0.423	0.412
9.5	**0.365**	0.498	0.483	0.468	0.453	0.438	0.427	0.415	0.404	0.392	0.383	0.374	0.357	0.349
10.0	**0.313**	0.419	0.407	0.395	0.383	0.371	0.362	0.353	0.344	0.335	0.327	0.320	0.306	0.299
10.5	**0.271**	0.361	0.350	0.340	0.330	0.320	0.313	0.305	0.297	0.290	0.283	0.277	0.265	0.260
11.0	**0.238**	0.318	0.309	0.300	0.291	0.282	0.276	0.269	0.262	0.255	0.250	0.244	0.234	0.229
11.5	**0.211**	0.281	0.274	0.266	0.258	0.250	0.244	0.238	0.232	0.226	0.221	0.216	0.207	0.203
12.0	**0.190**	0.252	0.245	0.238	0.231	0.224	0.219	0.214	0.208	0.203	0.199	0.194	0.186	0.182
12.5	**0.172**	0.228	0.222	0.216	0.209	0.203	0.199	0.194	0.189	0.184	0.180	0.176	0.169	0.165
13.0	**0.157**	0.206	0.201	0.196	0.190	0.185	0.180	0.176	0.172	0.167	0.164	0.160	0.154	0.150
13.5	**0.144**	0.188	0.183	0.178	0.173	0.169	0.165	0.161	0.157	0.153	0.150	0.147	0.141	0.138
14.0	**0.131**	0.171	0.167	0.162	0.158	0.153	0.150	0.147	0.143	0.140	0.137	0.134	0.128	0.126
14.5	**0.120**	0.157	0.153	0.149	0.145	0.141	0.138	0.135	0.131	0.128	0.126	0.123	0.118	0.116
15.0	**0.113**	0.146	0.143	0.139	0.135	0.132	0.129	0.126	0.123	0.120	0.118	0.115	0.111	0.108
15.5	**0.106**	0.136	0.133	0.130	0.126	0.123	0.120	0.118	0.115	0.112	0.110	0.108	0.104	0.102
16.0	**0.099**	0.128	0.125	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.102	0.098	0.096
16.5	**0.093**	0.119	0.116	0.114	0.111	0.108	0.106	0.104	0.101	0.099	0.097	0.095	0.092	0.090
17.0	**0.087**	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.090	0.089	0.085	0.084
17.5	**0.081**	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.084	0.082	0.079	0.078
18.0	**0.075**	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078	0.076	0.073	0.072
18.5	**0.069**	0.087	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.072	0.071	0.068	0.067
19.0	**0.065**	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.063
19.5	**0.061**	0.077	0.075	0.074	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.060	0.059
20.0	**0.058**	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
20.5	**0.055**	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054
21.0	**0.053**	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
21.5	**0.050**	0.063	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049
22.0	**0.048**	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.049	0.047	0.046
22.5	**0.045**	0.056	0.055	0.054	0.053	0.051	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
23.0	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.042
23.5	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.040	0.039
24.0	**0.039**	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038
24.5	**0.037**	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036
25.0	**0.035**	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035	0.034	0.034
25.5	**0.033**	0.040	0.040	0.039	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.032
26.0	**0.032**	0.038	0.038	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031
26.5	**0.030**	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.029
27.0	**0.029**	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.028	0.028

Table 12-2: C_t values, Sound Optimized Mode SO2

12.3 Sound Curves, Sound Optimized Mode SO2

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO2** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.0
8	99.4
9	99.4
10	99.5
11	99.5
12	99.5
13	99.5
14	99.5
15	99.5
16	99.5
17	99.5
18	99.5
19	99.5
20	99.5

Table 12-3: Sound curves, Sound Optimized Mode SO2

13 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO2 (HWO)

NOTE The power curves and Ct values presented in Section 13 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

13.1 Power Curves, Sound Optimized Mode SO2 (HWO)

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1096**	837	861	885	908	932	955	979	1002	1026	1049	1072	1120	1143
7.0	**1381**	1058	1088	1117	1147	1176	1206	1235	1264	1294	1323	1352	1410	1438
7.5	**1675**	1304	1340	1376	1412	1448	1483	1518	1552	1587	1616	1646	1700	1724
8.0	**1870**	1560	1599	1637	1675	1714	1740	1767	1794	1820	1837	1853	1880	1890
8.5	**1967**	1790	1818	1845	1873	1901	1914	1926	1939	1952	1957	1962	1970	1974
9.0	**2030**	1955	1968	1981	1994	2007	2011	2015	2020	2024	2026	2028	2031	2031
9.5	**2075**	2049	2054	2059	2064	2069	2070	2071	2072	2073	2074	2074	2075	2076
10.0	**2114**	2108	2108	2109	2110	2111	2111	2112	2113	2113	2114	2114	2114	2114
10.5	**2148**	2159	2157	2155	2153	2151	2151	2150	2149	2149	2148	2148	2147	2147
11.0	**2195**	2230	2226	2221	2216	2212	2209	2206	2203	2200	2199	2197	2194	2192
11.5	**2238**	2284	2279	2274	2268	2263	2259	2255	2251	2247	2244	2241	2236	2233
12.0	**2295**	2344	2338	2333	2328	2322	2318	2314	2310	2306	2302	2299	2292	2288
12.5	**2361**	2414	2409	2403	2397	2391	2386	2382	2377	2372	2368	2365	2357	2354
13.0	**2420**	2475	2469	2462	2456	2450	2446	2441	2436	2432	2428	2424	2417	2414
13.5	**2473**	2523	2517	2511	2505	2498	2494	2490	2486	2482	2479	2476	2470	2467
14.0	**2516**	2565	2559	2553	2547	2542	2537	2533	2529	2525	2522	2519	2513	2510
14.5	**2566**	2618	2612	2606	2600	2594	2590	2586	2581	2577	2573	2570	2563	2560
15.0	**2673**	2716	2711	2707	2702	2698	2694	2691	2687	2684	2680	2677	2670	2666
15.5	**2760**	2795	2791	2788	2785	2781	2778	2775	2772	2769	2766	2763	2757	2754
16.0	**2852**	2880	2877	2874	2872	2869	2867	2864	2862	2860	2857	2854	2849	2847
16.5	**2927**	2943	2942	2940	2939	2937	2936	2934	2933	2932	2930	2929	2925	2923
17.0	**2976**	2979	2979	2979	2979	2979	2979	2978	2978	2978	2977	2976	2975	2974
17.5	**2997**	2996	2996	2997	2997	2998	2998	2998	2998	2998	2997	2997	2997	2996
18.0	**3006**	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006	3006
18.5	**3020**	3020	3020	3020	3021	3021	3021	3020	3020	3020	3020	3020	3019	3019
19.0	**3046**	3058	3057	3056	3055	3054	3053	3052	3050	3049	3048	3047	3045	3044
19.5	**3091**	3104	3103	3102	3101	3100	3099	3098	3096	3095	3094	3093	3090	3089
20.0	**3154**	3162	3162	3161	3161	3161	3160	3159	3158	3157	3156	3155	3153	3152
20.5	**3222**	3217	3218	3219	3220	3220	3221	3221	3222	3222	3222	3222	3222	3222
21.0	**3276**	3260	3262	3264	3266	3267	3269	3270	3272	3273	3274	3275	3277	3277
21.5	**3314**	3299	3301	3302	3304	3306	3307	3309	3310	3312	3312	3313	3315	3316
22.0	**3341**	3324	3327	3329	3331	3333	3334	3336	3337	3339	3339	3340	3341	3342
22.5	**3368**	3352	3354	3356	3358	3360	3361	3363	3364	3365	3366	3367	3368	3369
23.0	**3393**	3373	3375	3377	3380	3382	3384	3386	3387	3389	3390	3392	3394	3395
23.5	**3407**	3389	3391	3393	3395	3398	3399	3401	3402	3404	3405	3406	3408	3410
24.0	**3415**	3397	3399	3401	3403	3406	3407	3409	3410	3412	3413	3414	3416	3417
24.5	**3419**	3401	3403	3405	3407	3409	3410	3412	3413	3415	3416	3417	3420	3421
25.0	**3418**	3401	3403	3405	3407	3410	3411	3412	3413	3415	3416	3417	3420	3421
25.5	**3405**	3381	3383	3386	3389	3392	3394	3396	3398	3400	3402	3404	3407	3408
26.0	**3402**	3380	3382	3384	3386	3389	3391	3393	3395	3397	3398	3400	3403	3405
26.5	**3388**	3369	3371	3373	3375	3377	3379	3380	3382	3384	3385	3387	3389	3391
27.0	**3337**	3322	3323	3325	3327	3328	3330	3331	3333	3334	3335	3336	3338	3339
27.5	**3142**	3137	3137	3138	3138	3139	3140	3140	3141	3141	3141	3142	3143	3143

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
28.0	**2825**	2822	2822	2823	2823	2823	2824	2824	2824	2824	2824	2824	2825	2825
28.5	**2364**	2366	2366	2366	2365	2365	2365	2365	2365	2364	2364	2364	2364	2364
29.0	**1893**	1895	1895	1895	1894	1894	1894	1894	1893	1893	1893	1893	1893	1892
29.5	**1570**	1571	1571	1571	1571	1571	1571	1571	1570	1570	1570	1570	1570	1570
30.0	**1364**	1364	1364	1364	1364	1364	1364	1364	1364	1364	1364	1364	1363	1363
30.5	**1225**	1226	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225	1225
31.0	**1150**	1150	1150	1150	1150	1150	1150	1150	1150	1150	1150	1150	1150	1150
31.5	**1098**	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098
32.0	**1074**	1074	1074	1074	1074	1074	1074	1074	1074	1074	1074	1074	1074	1075

Table 13-1: Power curve, Sound Optimized Mode SO2 (HWO)

13.2 Ct Values, Sound Optimized Mode SO2 (HWO)

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.847**	0.853	0.853	0.852	0.852	0.851	0.851	0.850	0.850	0.849	0.848	0.848	0.846	0.846
6.5	**0.844**	0.852	0.852	0.851	0.850	0.850	0.849	0.848	0.848	0.847	0.846	0.845	0.843	0.842
7.0	**0.844**	0.855	0.855	0.854	0.853	0.852	0.851	0.850	0.849	0.849	0.847	0.845	0.840	0.837
7.5	**0.790**	0.843	0.842	0.841	0.840	0.839	0.834	0.830	0.826	0.821	0.811	0.801	0.779	0.768
8.0	**0.655**	0.800	0.791	0.781	0.772	0.763	0.749	0.735	0.721	0.706	0.689	0.672	0.638	0.621
8.5	**0.526**	0.709	0.693	0.677	0.661	0.645	0.627	0.608	0.590	0.572	0.557	0.541	0.513	0.499
9.0	**0.433**	0.601	0.583	0.564	0.545	0.527	0.512	0.498	0.483	0.469	0.457	0.445	0.423	0.412
9.5	**0.365**	0.498	0.483	0.468	0.453	0.438	0.427	0.415	0.404	0.392	0.383	0.374	0.357	0.349
10.0	**0.313**	0.419	0.407	0.395	0.383	0.371	0.362	0.353	0.344	0.335	0.327	0.320	0.306	0.299
10.5	**0.271**	0.361	0.350	0.340	0.330	0.320	0.313	0.305	0.297	0.290	0.283	0.277	0.265	0.260
11.0	**0.238**	0.318	0.309	0.300	0.291	0.282	0.276	0.269	0.262	0.255	0.250	0.244	0.234	0.229
11.5	**0.211**	0.281	0.274	0.266	0.258	0.250	0.244	0.238	0.232	0.226	0.221	0.216	0.207	0.203
12.0	**0.190**	0.252	0.245	0.238	0.231	0.224	0.219	0.214	0.208	0.203	0.199	0.194	0.186	0.182
12.5	**0.172**	0.228	0.222	0.216	0.209	0.203	0.199	0.194	0.189	0.184	0.180	0.176	0.169	0.165
13.0	**0.157**	0.206	0.201	0.196	0.190	0.185	0.180	0.176	0.172	0.167	0.164	0.160	0.154	0.150
13.5	**0.144**	0.188	0.183	0.178	0.173	0.169	0.165	0.161	0.157	0.153	0.150	0.147	0.141	0.138
14.0	**0.131**	0.171	0.167	0.162	0.158	0.153	0.150	0.147	0.143	0.140	0.137	0.134	0.128	0.126
14.5	**0.120**	0.157	0.153	0.149	0.145	0.141	0.138	0.135	0.131	0.128	0.126	0.123	0.118	0.116
15.0	**0.113**	0.146	0.143	0.139	0.135	0.132	0.129	0.126	0.123	0.120	0.118	0.115	0.111	0.108
15.5	**0.106**	0.136	0.133	0.130	0.126	0.123	0.120	0.118	0.115	0.112	0.110	0.108	0.104	0.102
16.0	**0.099**	0.128	0.125	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.102	0.098	0.096
16.5	**0.093**	0.119	0.116	0.114	0.111	0.108	0.106	0.104	0.101	0.099	0.097	0.095	0.092	0.090
17.0	**0.087**	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.090	0.089	0.085	0.084
17.5	**0.081**	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.084	0.082	0.079	0.078
18.0	**0.075**	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078	0.076	0.073	0.072
18.5	**0.069**	0.087	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.072	0.071	0.068	0.067
19.0	**0.065**	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.063
19.5	**0.061**	0.077	0.075	0.074	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.060	0.059
20.0	**0.058**	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
20.5	**0.055**	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054
21.0	**0.053**	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
21.5	**0.050**	0.063	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049
22.0	**0.048**	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.049	0.047	0.046
22.5	**0.045**	0.056	0.055	0.054	0.053	0.051	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
23.0	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.042
23.5	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.040	0.039
24.0	**0.039**	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038
24.5	**0.037**	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036
25.0	**0.035**	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035	0.034	0.034
25.5	**0.033**	0.040	0.040	0.039	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.032
26.0	**0.032**	0.038	0.038	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031
26.5	**0.030**	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.029
27.0	**0.028**	0.034	0.034	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028
27.5	**0.026**	0.031	0.031	0.030	0.029	0.029	0.028	0.028	0.028	0.027	0.027	0.026	0.026	0.025
28.0	**0.023**	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022
28.5	**0.019**	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019	0.019
29.0	**0.016**	0.018	0.018	0.018	0.017	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015
29.5	**0.013**	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013
30.0	**0.011**	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011
30.5	**0.010**	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010
31.0	**0.009**	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.009	0.009	0.009	0.009	0.009	0.009
31.5	**0.008**	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.008	0.008	0.008	0.008
32.0	**0.008**	0.009	0.009	0.009	0.009	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008

Table 13-2: C_t values, Sound Optimized Mode SO2 (HWO)

13.3 Sound Curves, Sound Optimized Mode SO2 (HWO)

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO2 (HWO)** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.0
8	99.4
9	99.4
10	99.5
11	99.5
12	99.5
13	99.5
14	99.5
15	99.5
16	99.5
17	99.5
18	99.5
19	99.5
20	99.5

Table 13-3: Sound curves, Sound Optimized Mode SO2 (HWO)

14 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO11

NOTE

The power curves and Ct values presented in Section 14 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

14.1 Power Curves, Sound Optimized Mode SO11

	Air density [kg/m^3]													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	401	412	423	434	445	456	466	488	499
5.5	**642**	486	501	515	529	543	557	572	586	600	614	628	656	670
6.0	**820**	627	644	662	680	697	715	732	750	768	785	803	838	855
6.5	**1001**	768	790	811	832	853	875	896	917	938	959	980	1022	1043
7.0	**1185**	912	937	962	987	1012	1036	1061	1086	1111	1136	1160	1209	1234
7.5	**1362**	1052	1080	1109	1137	1166	1194	1222	1250	1278	1306	1334	1390	1417
8.0	**1535**	1193	1225	1257	1289	1321	1352	1384	1416	1447	1476	1506	1561	1588
8.5	**1715**	1412	1444	1476	1508	1540	1568	1595	1623	1651	1672	1694	1734	1752
9.0	**1907**	1722	1745	1768	1790	1812	1828	1844	1859	1874	1885	1896	1915	1923
9.5	**2058**	1980	1991	2002	2013	2024	2030	2036	2042	2048	2051	2055	2061	2063
10.0	**2157**	2131	2135	2139	2143	2147	2149	2150	2152	2154	2155	2156	2157	2158
10.5	**2218**	2206	2208	2210	2212	2214	2214	2215	2216	2217	2217	2218	2218	2218
11.0	**2267**	2260	2261	2262	2264	2265	2265	2266	2266	2266	2266	2267	2267	2266
11.5	**2309**	2307	2307	2308	2308	2309	2309	2310	2310	2310	2310	2310	2309	2309
12.0	**2344**	2343	2344	2344	2344	2344	2344	2344	2344	2344	2344	2344	2343	2343
12.5	**2372**	2373	2373	2373	2373	2373	2373	2373	2373	2372	2372	2372	2371	2371
13.0	**2398**	2400	2400	2400	2400	2400	2400	2399	2399	2399	2399	2398	2398	2398
13.5	**2420**	2421	2421	2421	2421	2421	2421	2421	2420	2420	2420	2420	2420	2419
14.0	**2435**	2436	2436	2436	2436	2436	2436	2436	2436	2436	2435	2435	2435	2435
14.5	**2449**	2451	2451	2451	2451	2451	2450	2450	2450	2450	2450	2449	2449	2449
15.0	**2464**	2466	2466	2466	2466	2466	2465	2465	2465	2465	2465	2464	2464	2464
15.5	**2480**	2482	2482	2482	2482	2482	2482	2481	2481	2481	2481	2480	2480	2480
16.0	**2498**	2500	2500	2500	2500	2500	2499	2499	2499	2498	2498	2498	2497	2497
16.5	**2517**	2521	2521	2520	2520	2520	2519	2519	2519	2518	2518	2518	2517	2516
17.0	**2540**	2544	2544	2544	2544	2543	2543	2542	2542	2541	2541	2540	2539	2538
17.5	**2566**	2572	2571	2571	2570	2570	2569	2569	2568	2568	2567	2566	2565	2564
18.0	**2598**	2606	2605	2605	2604	2604	2603	2602	2602	2601	2600	2599	2597	2596
18.5	**2636**	2646	2645	2644	2644	2643	2642	2641	2640	2639	2638	2637	2635	2634
19.0	**2676**	2685	2684	2684	2683	2682	2681	2680	2679	2678	2678	2676	2674	2674
19.5	**2715**	2724	2724	2723	2722	2722	2721	2720	2719	2718	2717	2716	2714	2713
20.0	**2748**	2756	2755	2755	2754	2754	2753	2752	2752	2751	2750	2749	2748	2747
20.5	**2773**	2778	2778	2777	2777	2776	2776	2776	2775	2775	2774	2774	2773	2772
21.0	**2789**	2793	2793	2793	2792	2792	2791	2791	2791	2790	2790	2790	2789	2788
21.5	**2804**	2812	2811	2810	2810	2809	2808	2808	2807	2806	2805	2805	2803	2803
22.0	**2833**	2847	2846	2844	2843	2842	2841	2840	2839	2837	2836	2835	2832	2831
22.5	**2878**	2893	2891	2890	2889	2888	2886	2885	2884	2882	2881	2879	2876	2875
23.0	**2914**	2923	2922	2922	2921	2920	2919	2918	2918	2917	2916	2915	2913	2912
23.5	**2942**	2951	2950	2949	2948	2948	2947	2946	2945	2945	2944	2943	2941	2940
24.0	**2965**	2970	2970	2969	2969	2969	2968	2968	2967	2967	2966	2965	2964	2964

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
24.5	**2978**	2981	2980	2980	2980	2980	2979	2979	2979	2979	2979	2978	2978	2977
25.0	**2984**	2984	2984	2984	2984	2984	2984	2984	2984	2984	2984	2984	2983	2983
25.5	**2986**	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2985	2985
26.0	**2986**	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986
26.5	**2986**	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986
27.0	**2986**	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986

Table 14-1: Power curve, Sound Optimized Mode SO11

14.2 Ct Values, Sound Optimized Mode SO11

Wind speed [m/s]	Air density kg/m³													
	1.225	**0.950**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.841**	0.845	0.845	0.845	0.845	0.844	0.844	0.843	0.843	0.843	0.842	0.842	0.841	0.840
5.5	**0.785**	0.791	0.790	0.790	0.789	0.789	0.788	0.788	0.787	0.787	0.786	0.786	0.785	0.784
6.0	**0.708**	0.713	0.713	0.712	0.712	0.711	0.711	0.710	0.710	0.709	0.709	0.708	0.707	0.707
6.5	**0.637**	0.642	0.642	0.641	0.641	0.640	0.640	0.639	0.639	0.639	0.638	0.638	0.637	0.636
7.0	**0.575**	0.579	0.578	0.578	0.578	0.577	0.577	0.577	0.576	0.576	0.576	0.575	0.574	0.574
7.5	**0.518**	0.522	0.522	0.522	0.521	0.521	0.521	0.520	0.520	0.520	0.519	0.519	0.518	0.517
8.0	**0.468**	0.474	0.474	0.473	0.473	0.473	0.472	0.472	0.471	0.471	0.470	0.469	0.466	0.464
8.5	**0.427**	0.461	0.459	0.457	0.454	0.452	0.449	0.446	0.443	0.439	0.435	0.431	0.422	0.418
9.0	**0.394**	0.477	0.469	0.462	0.454	0.446	0.439	0.431	0.424	0.416	0.409	0.402	0.387	0.381
9.5	**0.358**	0.468	0.456	0.445	0.433	0.422	0.412	0.402	0.393	0.383	0.375	0.367	0.351	0.344
10.0	**0.318**	0.424	0.412	0.400	0.389	0.377	0.368	0.359	0.350	0.341	0.333	0.325	0.311	0.304
10.5	**0.279**	0.369	0.359	0.349	0.340	0.330	0.322	0.314	0.306	0.298	0.292	0.286	0.273	0.268
11.0	**0.246**	0.323	0.314	0.306	0.298	0.289	0.283	0.276	0.269	0.263	0.257	0.251	0.241	0.236
11.5	**0.218**	0.284	0.277	0.270	0.263	0.255	0.250	0.244	0.238	0.232	0.227	0.223	0.213	0.209
12.0	**0.194**	0.252	0.245	0.239	0.233	0.227	0.221	0.216	0.211	0.206	0.202	0.198	0.190	0.186
12.5	**0.173**	0.224	0.218	0.213	0.207	0.202	0.197	0.193	0.188	0.184	0.180	0.177	0.170	0.166
13.0	**0.155**	0.200	0.195	0.190	0.186	0.181	0.177	0.173	0.169	0.165	0.162	0.159	0.152	0.149
13.5	**0.141**	0.181	0.176	0.172	0.168	0.163	0.160	0.156	0.153	0.149	0.146	0.144	0.138	0.135
14.0	**0.127**	0.163	0.159	0.155	0.151	0.147	0.144	0.141	0.138	0.135	0.132	0.130	0.125	0.122
14.5	**0.115**	0.147	0.144	0.140	0.137	0.133	0.131	0.128	0.125	0.122	0.120	0.118	0.113	0.111
15.0	**0.105**	0.133	0.130	0.127	0.124	0.121	0.118	0.116	0.113	0.111	0.109	0.107	0.103	0.101
15.5	**0.096**	0.121	0.119	0.116	0.113	0.110	0.108	0.106	0.104	0.101	0.099	0.098	0.094	0.092
16.0	**0.088**	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.090	0.086	0.085
16.5	**0.081**	0.103	0.100	0.098	0.096	0.093	0.092	0.090	0.088	0.086	0.084	0.083	0.080	0.078
17.0	**0.075**	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.077	0.074	0.073
17.5	**0.070**	0.088	0.086	0.084	0.082	0.080	0.079	0.077	0.076	0.074	0.073	0.071	0.069	0.068
18.0	**0.066**	0.082	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.067	0.064	0.063
18.5	**0.062**	0.077	0.076	0.074	0.072	0.071	0.069	0.068	0.066	0.065	0.064	0.063	0.061	0.060
19.0	**0.058**	0.072	0.071	0.069	0.068	0.066	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056
19.5	**0.055**	0.068	0.067	0.065	0.064	0.062	0.061	0.060	0.059	0.058	0.057	0.056	0.054	0.053
20.0	**0.052**	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054	0.053	0.053	0.051	0.050
20.5	**0.049**	0.060	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.050	0.048	0.047
21.0	**0.046**	0.057	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.048	0.047	0.045	0.045
21.5	**0.044**	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.043	0.042
22.0	**0.042**	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.040
22.5	**0.040**	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.039	0.039
23.0	**0.038**	0.046	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037
23.5	**0.036**	0.044	0.043	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035
24.0	**0.034**	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034	0.033
24.5	**0.033**	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.032	0.032
25.0	**0.031**	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.030
25.5	**0.030**	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.029
26.0	**0.029**	0.035	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.028	0.028
26.5	**0.027**	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027
27.0	**0.026**	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.027	0.026	0.025

Table 14-2: C_t values, Sound Optimized Mode SO11

14.3 Sound Curves, Sound Optimized Mode SO11

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO11 (Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	94.5
7	95.6
8	96.9
9	98.0
10	98.8
11	99.1
12	99.2
13	99.2
14	99.2
15	99.2
16	99.2
17	99.2
18	99.2
19	99.2
20	99.2

Table 14-3: Sound curves, Sound Optimized Mode SO11

15 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO11 (HWO)

NOTE The power curves and Ct values presented in Section 15 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

15.1 Power Curves, Sound Optimized Mode SO11 (HWO)

	Air density [kg/m^3]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	401	412	423	434	445	456	466	488	499
5.5	**642**	486	501	515	529	543	557	572	586	600	614	628	656	670
6.0	**820**	627	644	662	680	697	715	732	750	768	785	803	838	855
6.5	**1001**	768	790	811	832	853	875	896	917	938	959	980	1022	1043
7.0	**1185**	912	937	962	987	1012	1036	1061	1086	1111	1136	1160	1209	1234
7.5	**1362**	1052	1080	1109	1137	1166	1194	1222	1250	1278	1306	1334	1390	1417
8.0	**1535**	1193	1225	1257	1289	1321	1352	1384	1416	1447	1476	1506	1561	1588
8.5	**1715**	1412	1444	1476	1508	1540	1568	1595	1623	1651	1672	1694	1734	1752
9.0	**1907**	1722	1745	1768	1790	1812	1828	1844	1859	1874	1885	1896	1915	1923
9.5	**2058**	1980	1991	2002	2013	2024	2030	2036	2042	2048	2051	2055	2061	2063
10.0	**2157**	2131	2135	2139	2143	2147	2149	2150	2152	2154	2155	2156	2157	2158
10.5	**2218**	2206	2208	2210	2212	2214	2214	2215	2216	2217	2217	2218	2218	2218
11.0	**2267**	2260	2261	2262	2264	2265	2265	2266	2266	2266	2266	2267	2267	2266
11.5	**2309**	2307	2307	2308	2308	2309	2309	2310	2310	2310	2310	2310	2309	2309
12.0	**2344**	2343	2344	2344	2344	2344	2344	2344	2344	2344	2344	2344	2343	2343
12.5	**2372**	2373	2373	2373	2373	2373	2373	2373	2373	2372	2372	2372	2371	2371
13.0	**2398**	2400	2400	2400	2400	2400	2400	2399	2399	2399	2399	2398	2398	2398
13.5	**2420**	2421	2421	2421	2421	2421	2421	2421	2420	2420	2420	2420	2420	2419
14.0	**2435**	2436	2436	2436	2436	2436	2436	2436	2436	2436	2435	2435	2435	2435
14.5	**2449**	2451	2451	2451	2451	2451	2450	2450	2450	2450	2450	2449	2449	2449
15.0	**2464**	2466	2466	2466	2466	2466	2465	2465	2465	2465	2465	2464	2464	2464
15.5	**2480**	2482	2482	2482	2482	2482	2482	2481	2481	2481	2481	2480	2480	2480
16.0	**2498**	2500	2500	2500	2500	2500	2499	2499	2499	2498	2498	2498	2497	2497
16.5	**2517**	2521	2521	2520	2520	2520	2519	2519	2519	2518	2518	2518	2517	2516
17.0	**2540**	2544	2544	2544	2544	2543	2543	2542	2542	2541	2541	2540	2539	2538
17.5	**2566**	2572	2571	2571	2570	2570	2569	2569	2568	2568	2567	2566	2565	2564
18.0	**2598**	2606	2605	2605	2604	2604	2603	2602	2602	2601	2600	2599	2597	2596
18.5	**2636**	2646	2645	2644	2644	2643	2642	2641	2640	2639	2638	2637	2635	2634
19.0	**2676**	2685	2684	2684	2683	2682	2681	2680	2679	2678	2678	2676	2674	2674
19.5	**2715**	2724	2724	2723	2722	2722	2721	2720	2719	2718	2717	2716	2714	2713
20.0	**2749**	2756	2755	2755	2754	2754	2753	2752	2752	2751	2750	2749	2748	2747
20.5	**2773**	2778	2778	2777	2777	2776	2776	2776	2775	2775	2774	2774	2773	2772
21.0	**2789**	2793	2793	2793	2792	2792	2791	2791	2791	2790	2790	2790	2789	2788
21.5	**2804**	2812	2811	2810	2810	2809	2808	2808	2807	2806	2805	2805	2803	2803
22.0	**2833**	2847	2846	2844	2843	2842	2841	2840	2839	2837	2836	2835	2832	2831
22.5	**2878**	2893	2891	2890	2889	2888	2886	2885	2884	2882	2881	2879	2876	2875
23.0	**2914**	2923	2922	2922	2921	2920	2919	2918	2918	2917	2916	2915	2913	2912
23.5	**2942**	2951	2950	2949	2948	2948	2947	2946	2945	2945	2944	2943	2941	2940
24.0	**2965**	2970	2970	2969	2969	2969	2968	2968	2967	2967	2966	2965	2964	2964
24.5	**2978**	2981	2980	2980	2980	2980	2979	2979	2979	2979	2979	2978	2978	2977
25.0	**2984**	2984	2984	2984	2984	2984	2984	2984	2984	2984	2984	2984	2983	2983
25.5	**2986**	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2985	2985
26.0	**2986**	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986	2986
26.5	**2979**	2979	2979	2979	2979	2979	2979	2979	2979	2979	2979	2979	2979	2979
27.0	**2955**	2955	2955	2955	2955	2955	2955	2955	2955	2955	2955	2955	2955	2955
27.5	**2834**	2834	2834	2834	2834	2834	2834	2834	2834	2834	2834	2834	2834	2834

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
28.0	**2635**	2635	2635	2635	2635	2635	2635	2635	2635	2635	2635	2635	2635	2635
28.5	**2333**	2333	2333	2333	2333	2333	2333	2333	2333	2333	2333	2333	2333	2333
29.0	**2052**	2052	2052	2052	2052	2052	2052	2052	2052	2052	2052	2052	2052	2052
29.5	**1846**	1846	1845	1845	1845	1845	1845	1845	1845	1846	1846	1846	1845	1845
30.0	**1703**	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703
30.5	**1599**	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599
31.0	**1524**	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524
31.5	**1471**	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471
32.0	**1443**	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443

Table 15-1: Power curve, Sound Optimized Mode SO11 (HWO)

15.2 Ct Values, Sound Optimized Mode SO11 (HWO)

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.841**	0.845	0.845	0.845	0.845	0.844	0.844	0.843	0.843	0.843	0.842	0.842	0.841	0.840
5.5	**0.785**	0.791	0.790	0.790	0.789	0.789	0.788	0.788	0.787	0.787	0.786	0.786	0.785	0.784
6.0	**0.708**	0.713	0.713	0.712	0.712	0.711	0.711	0.710	0.710	0.709	0.709	0.708	0.707	0.707
6.5	**0.637**	0.642	0.642	0.641	0.641	0.640	0.640	0.639	0.639	0.639	0.638	0.638	0.637	0.636
7.0	**0.575**	0.579	0.578	0.578	0.578	0.577	0.577	0.577	0.576	0.576	0.576	0.575	0.574	0.574
7.5	**0.518**	0.522	0.522	0.522	0.521	0.521	0.521	0.520	0.520	0.520	0.519	0.519	0.518	0.517
8.0	**0.468**	0.474	0.474	0.473	0.473	0.473	0.472	0.472	0.471	0.471	0.470	0.469	0.466	0.464
8.5	**0.427**	0.461	0.459	0.457	0.454	0.452	0.449	0.446	0.443	0.439	0.435	0.431	0.422	0.418
9.0	**0.394**	0.477	0.469	0.462	0.454	0.446	0.439	0.431	0.424	0.416	0.409	0.402	0.387	0.381
9.5	**0.358**	0.468	0.456	0.445	0.433	0.422	0.412	0.402	0.393	0.383	0.375	0.367	0.351	0.344
10.0	**0.318**	0.424	0.412	0.400	0.389	0.377	0.368	0.359	0.350	0.341	0.333	0.325	0.311	0.304
10.5	**0.279**	0.369	0.359	0.349	0.340	0.330	0.322	0.314	0.306	0.298	0.292	0.286	0.273	0.268
11.0	**0.246**	0.323	0.314	0.306	0.298	0.289	0.283	0.276	0.269	0.263	0.257	0.251	0.241	0.236
11.5	**0.218**	0.284	0.277	0.270	0.263	0.255	0.250	0.244	0.238	0.232	0.227	0.223	0.213	0.209
12.0	**0.194**	0.252	0.245	0.239	0.233	0.227	0.221	0.216	0.211	0.206	0.202	0.198	0.190	0.186
12.5	**0.173**	0.224	0.218	0.213	0.207	0.202	0.197	0.193	0.188	0.184	0.180	0.177	0.170	0.166
13.0	**0.155**	0.200	0.195	0.190	0.186	0.181	0.177	0.173	0.169	0.165	0.162	0.159	0.152	0.149
13.5	**0.141**	0.181	0.176	0.172	0.168	0.163	0.160	0.156	0.153	0.149	0.146	0.144	0.138	0.135
14.0	**0.127**	0.163	0.159	0.155	0.151	0.147	0.144	0.141	0.138	0.135	0.132	0.130	0.125	0.122
14.5	**0.115**	0.147	0.144	0.140	0.137	0.133	0.131	0.128	0.125	0.122	0.120	0.118	0.113	0.111
15.0	**0.105**	0.133	0.130	0.127	0.124	0.121	0.118	0.116	0.113	0.111	0.109	0.107	0.103	0.101
15.5	**0.096**	0.121	0.119	0.116	0.113	0.110	0.108	0.106	0.104	0.101	0.099	0.098	0.094	0.092
16.0	**0.088**	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.090	0.086	0.085
16.5	**0.081**	0.103	0.100	0.098	0.096	0.093	0.092	0.090	0.088	0.086	0.084	0.083	0.080	0.078
17.0	**0.075**	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.077	0.074	0.073
17.5	**0.070**	0.088	0.086	0.084	0.082	0.080	0.079	0.077	0.076	0.074	0.073	0.071	0.069	0.068
18.0	**0.066**	0.082	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.067	0.064	0.063
18.5	**0.062**	0.077	0.076	0.074	0.072	0.071	0.069	0.068	0.066	0.065	0.064	0.063	0.061	0.060
19.0	**0.058**	0.072	0.071	0.069	0.068	0.066	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056
19.5	**0.055**	0.068	0.067	0.065	0.064	0.062	0.061	0.060	0.059	0.058	0.057	0.056	0.054	0.053
20.0	**0.052**	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054	0.053	0.053	0.051	0.050
20.5	**0.049**	0.060	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.050	0.048	0.047
21.0	**0.046**	0.057	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.048	0.047	0.045	0.045
21.5	**0.044**	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.043	0.042
22.0	**0.042**	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.040
22.5	**0.040**	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.039	0.039
23.0	**0.038**	0.046	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037
23.5	**0.036**	0.044	0.043	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035
24.0	**0.034**	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034	0.033
24.5	**0.033**	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.032	0.032
25.0	**0.031**	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.030
25.5	**0.030**	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.029
26.0	**0.029**	0.035	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.028	0.028
26.5	**0.027**	0.033	0.032	0.032	0.031	0.030	0.030	0.029	0.029	0.029	0.028	0.028	0.027	0.027
27.0	**0.026**	0.031	0.031	0.030	0.029	0.029	0.028	0.028	0.028	0.027	0.027	0.026	0.026	0.025
27.5	**0.024**	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.024	0.024	0.023
28.0	**0.022**	0.026	0.025	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021
28.5	**0.019**	0.022	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.020	0.019	0.019	0.019
29.0	**0.016**	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.017	0.016	0.016
29.5	**0.014**	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.015	0.014	0.014
30.0	**0.013**	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
30.5	**0.012**	0.014	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.012	0.011	0.011
31.0	**0.011**	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010
31.5	**0.010**	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.009
32.0	**0.009**	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.009	0.009	0.009	0.009	0.009

Table 15-2: C_t values, Sound Optimized Mode SO11 (HWO)

15.3 Sound Curves, Sound Optimized Mode SO11 (HWO)

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO11 (HWO)** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	94.5
7	95.6
8	96.9
9	98.0
10	98.8
11	99.1
12	99.2
13	99.2
14	99.2
15	99.2
16	99.2
17	99.2
18	99.2
19	99.2
20	99.2

Table 15-3: Sound curves, Sound Optimized Mode SO11 (HWO)

16 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO12

NOTE

The power curves and Ct values presented in Section 16 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

16.1 Power Curves, Sound Optimized Mode SO12

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	467	488	499
5.5	**646**	489	504	518	532	547	561	575	589	604	618	632	660	674
6.0	**840**	641	659	677	696	714	732	750	768	786	804	822	858	876
6.5	**1048**	804	827	849	871	893	916	938	960	982	1004	1026	1070	1092
7.0	**1253**	965	992	1018	1044	1071	1097	1123	1149	1176	1202	1228	1279	1305
7.5	**1422**	1098	1127	1157	1187	1217	1246	1276	1305	1334	1364	1393	1451	1480
8.0	**1581**	1224	1257	1290	1322	1355	1387	1420	1452	1485	1517	1549	1613	1645
8.5	**1823**	1452	1488	1524	1560	1596	1629	1663	1696	1730	1761	1792	1852	1882
9.0	**2118**	1842	1872	1903	1933	1964	1988	2012	2036	2060	2079	2098	2135	2151
9.5	**2310**	2166	2187	2207	2228	2248	2259	2269	2279	2290	2296	2303	2315	2320
10.0	**2385**	2343	2350	2358	2366	2374	2376	2378	2380	2382	2383	2384	2385	2386
10.5	**2425**	2409	2412	2414	2417	2420	2420	2421	2422	2423	2424	2424	2425	2425
11.0	**2460**	2452	2453	2454	2456	2458	2458	2459	2459	2460	2460	2460	2460	2460
11.5	**2487**	2484	2485	2485	2486	2486	2487	2487	2487	2487	2487	2487	2487	2487
12.0	**2511**	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511
12.5	**2536**	2538	2538	2538	2538	2538	2538	2537	2537	2537	2537	2537	2536	2536
13.0	**2572**	2575	2575	2575	2575	2574	2574	2574	2574	2573	2573	2572	2571	2571
13.5	**2626**	2630	2630	2630	2630	2629	2629	2628	2628	2628	2627	2626	2625	2624
14.0	**2684**	2690	2689	2689	2689	2688	2688	2687	2686	2686	2685	2684	2683	2682
14.5	**2744**	2751	2751	2750	2750	2750	2749	2748	2747	2747	2746	2745	2743	2742
15.0	**2808**	2816	2815	2814	2814	2814	2813	2812	2811	2810	2810	2808	2806	2806
15.5	**2868**	2876	2876	2875	2875	2874	2874	2873	2872	2871	2870	2869	2867	2866
16.0	**2928**	2936	2936	2935	2935	2934	2933	2932	2931	2930	2930	2928	2926	2925
16.5	**2983**	2992	2991	2990	2990	2989	2988	2988	2987	2986	2985	2984	2982	2981
17.0	**3035**	3044	3044	3043	3042	3042	3041	3040	3039	3038	3037	3036	3034	3033
17.5	**3085**	3095	3094	3094	3093	3092	3091	3090	3089	3088	3087	3086	3084	3083
18.0	**3136**	3146	3145	3145	3144	3143	3142	3141	3140	3139	3138	3137	3134	3133
18.5	**3188**	3200	3199	3198	3197	3196	3195	3194	3193	3192	3190	3189	3186	3185
19.0	**3242**	3255	3254	3253	3252	3251	3250	3249	3247	3246	3245	3244	3241	3239
19.5	**3296**	3308	3307	3306	3305	3304	3303	3302	3301	3300	3298	3297	3294	3293
20.0	**3345**	3357	3356	3355	3354	3353	3352	3351	3350	3349	3347	3346	3343	3342
20.5	**3390**	3401	3400	3399	3399	3398	3397	3396	3394	3393	3392	3391	3388	3387
21.0	**3433**	3444	3443	3443	3442	3441	3440	3439	3437	3436	3435	3434	3432	3430
21.5	**3474**	3485	3484	3484	3483	3482	3481	3480	3479	3478	3476	3475	3472	3471
22.0	**3514**	3525	3524	3523	3522	3522	3520	3519	3518	3517	3516	3515	3513	3511
22.5	**3550**	3559	3559	3558	3557	3556	3555	3554	3553	3553	3552	3551	3548	3547
23.0	**3577**	3585	3584	3584	3583	3583	3582	3581	3580	3580	3579	3578	3576	3576
23.5	**3600**	3605	3605	3604	3604	3603	3603	3602	3601	3601	3600	3600	3599	3598
24.0	**3615**	3619	3618	3618	3618	3617	3617	3617	3616	3616	3616	3615	3615	3614

	Air density [kg/m^3]													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
24.5	**3625**	3627	3627	3627	3627	3626	3626	3626	3626	3626	3625	3625	3625	3624
25.0	**3631**	3632	3632	3632	3632	3632	3631	3631	3631	3631	3631	3631	3631	3631
25.5	**3634**	3635	3635	3635	3635	3635	3635	3635	3635	3635	3634	3634	3634	3634
26.0	**3635**	3635	3635	3635	3635	3635	3635	3635	3635	3635	3635	3635	3635	3635
26.5	**3636**	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636
27.0	**3636**	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636	3636

Table 16-1: Power curve, Sound Optimized Mode SO12

16.2 Ct Values, Sound Optimized Mode SO12

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.845**	0.850	0.849	0.849	0.849	0.848	0.848	0.848	0.847	0.847	0.846	0.846	0.845	0.844
5.5	**0.808**	0.814	0.813	0.813	0.812	0.812	0.811	0.811	0.810	0.810	0.809	0.809	0.808	0.807
6.0	**0.752**	0.758	0.758	0.757	0.757	0.756	0.756	0.755	0.755	0.754	0.754	0.753	0.752	0.751
6.5	**0.697**	0.703	0.702	0.702	0.701	0.701	0.700	0.700	0.699	0.698	0.698	0.697	0.696	0.696
7.0	**0.633**	0.638	0.638	0.637	0.637	0.636	0.636	0.635	0.635	0.634	0.634	0.633	0.632	0.632
7.5	**0.557**	0.562	0.561	0.561	0.560	0.560	0.559	0.559	0.559	0.558	0.558	0.557	0.556	0.556
8.0	**0.491**	0.496	0.496	0.495	0.495	0.494	0.494	0.494	0.493	0.493	0.492	0.492	0.491	0.490
8.5	**0.462**	0.483	0.481	0.480	0.478	0.476	0.475	0.473	0.471	0.469	0.467	0.464	0.460	0.457
9.0	**0.449**	0.528	0.520	0.512	0.505	0.497	0.490	0.483	0.476	0.469	0.462	0.455	0.442	0.436
9.5	**0.412**	0.533	0.521	0.509	0.497	0.485	0.474	0.463	0.452	0.441	0.431	0.422	0.404	0.395
10.0	**0.358**	0.483	0.469	0.456	0.442	0.428	0.417	0.407	0.396	0.385	0.376	0.367	0.350	0.342
10.5	**0.308**	0.413	0.401	0.390	0.378	0.366	0.357	0.348	0.340	0.331	0.323	0.316	0.302	0.295
11.0	**0.269**	0.356	0.346	0.337	0.327	0.318	0.310	0.303	0.295	0.288	0.281	0.275	0.263	0.258
11.5	**0.236**	0.309	0.301	0.293	0.285	0.277	0.271	0.265	0.258	0.252	0.246	0.241	0.231	0.226
12.0	**0.208**	0.271	0.265	0.258	0.251	0.244	0.238	0.233	0.227	0.222	0.217	0.213	0.204	0.200
12.5	**0.185**	0.240	0.234	0.228	0.223	0.217	0.212	0.207	0.202	0.197	0.193	0.189	0.182	0.178
13.0	**0.167**	0.215	0.210	0.205	0.200	0.194	0.190	0.186	0.182	0.177	0.174	0.170	0.163	0.160
13.5	**0.152**	0.197	0.192	0.187	0.182	0.178	0.174	0.170	0.166	0.162	0.159	0.156	0.149	0.147
14.0	**0.140**	0.180	0.175	0.171	0.167	0.162	0.159	0.155	0.152	0.148	0.145	0.142	0.137	0.134
14.5	**0.128**	0.165	0.161	0.157	0.153	0.149	0.146	0.143	0.140	0.137	0.134	0.131	0.126	0.124
15.0	**0.118**	0.152	0.148	0.144	0.141	0.137	0.134	0.132	0.129	0.126	0.123	0.121	0.116	0.114
15.5	**0.110**	0.140	0.137	0.134	0.130	0.127	0.125	0.122	0.119	0.117	0.114	0.112	0.108	0.106
16.0	**0.102**	0.130	0.127	0.124	0.121	0.118	0.116	0.113	0.111	0.108	0.106	0.104	0.100	0.098
16.5	**0.095**	0.121	0.118	0.116	0.113	0.110	0.108	0.105	0.103	0.101	0.099	0.097	0.093	0.092
17.0	**0.089**	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
17.5	**0.083**	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.085	0.081	0.080
18.0	**0.078**	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.076	0.075
18.5	**0.073**	0.093	0.090	0.088	0.086	0.084	0.083	0.081	0.079	0.077	0.076	0.075	0.072	0.071
19.0	**0.069**	0.087	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.067	0.066
19.5	**0.065**	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.064	0.063
20.0	**0.061**	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.063	0.060	0.059
20.5	**0.058**	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
21.0	**0.055**	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053
21.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
22.0	**0.050**	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
22.5	**0.048**	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
23.0	**0.045**	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.044	0.044
23.5	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041
24.0	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.040	0.039
24.5	**0.039**	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.037
25.0	**0.037**	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036
25.5	**0.035**	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034
26.0	**0.034**	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033	0.033
26.5	**0.032**	0.039	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.032	0.032	0.031
27.0	**0.031**	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.032	0.031	0.030	0.030

Table 16-2: C_t values, Sound Optimized Mode SO12

16.3 Sound Curves, Sound Optimized Mode SO12

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO12 (Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	95.0
7	97.1
8	98.8
9	99.7
10	99.9
11	99.9
12	99.9
13	99.9
14	99.9
15	99.9
16	99.9
17	99.9
18	99.9
19	99.9
20	99.9

Table 16-3: Sound curves, Sound Optimized Mode SO12

17 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO12 (HWO)

NOTE The power curves and Ct values presented in Section 17 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

17.1 Power Curves, Sound Optimized Mode SO12 (HWO)

	Air density [kg/m^3]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	467	488	499
5.5	**646**	489	504	518	532	547	561	575	589	604	618	632	660	674
6.0	**840**	641	659	677	696	714	732	750	768	786	804	822	858	876
6.5	**1048**	804	827	849	871	893	916	938	960	982	1004	1026	1070	1092
7.0	**1253**	965	992	1018	1044	1071	1097	1123	1149	1176	1202	1228	1279	1305
7.5	**1422**	1098	1127	1157	1187	1217	1246	1276	1305	1334	1364	1393	1451	1480
8.0	**1581**	1224	1257	1290	1322	1355	1387	1420	1452	1485	1517	1549	1613	1645
8.5	**1823**	1452	1488	1524	1560	1596	1629	1663	1696	1730	1761	1792	1852	1882
9.0	**2118**	1842	1872	1903	1933	1964	1988	2012	2036	2060	2079	2098	2135	2151
9.5	**2310**	2166	2187	2207	2228	2248	2259	2269	2279	2290	2296	2303	2315	2320
10.0	**2385**	2343	2350	2358	2366	2374	2376	2378	2380	2382	2383	2384	2385	2386
10.5	**2425**	2409	2412	2414	2417	2420	2420	2421	2422	2423	2424	2424	2425	2425
11.0	**2460**	2452	2453	2454	2456	2458	2458	2459	2459	2460	2460	2460	2460	2460
11.5	**2487**	2484	2485	2485	2486	2486	2487	2487	2487	2487	2487	2487	2487	2487
12.0	**2511**	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511	2511
12.5	**2536**	2538	2538	2538	2538	2538	2538	2537	2537	2537	2537	2537	2536	2536
13.0	**2572**	2575	2575	2575	2575	2574	2574	2574	2574	2573	2573	2572	2571	2571
13.5	**2626**	2630	2630	2630	2630	2629	2629	2628	2628	2628	2627	2626	2625	2624
14.0	**2684**	2690	2689	2689	2689	2688	2688	2687	2686	2686	2685	2684	2683	2682
14.5	**2744**	2751	2751	2750	2750	2750	2749	2748	2747	2747	2746	2745	2743	2742
15.0	**2808**	2816	2815	2814	2814	2814	2813	2812	2811	2810	2810	2808	2806	2806
15.5	**2868**	2876	2876	2875	2875	2874	2874	2873	2872	2871	2870	2869	2867	2866
16.0	**2928**	2936	2936	2935	2935	2934	2933	2932	2931	2930	2930	2928	2926	2925
16.5	**2983**	2992	2991	2990	2990	2989	2988	2988	2987	2986	2985	2984	2982	2981
17.0	**3035**	3044	3044	3043	3042	3042	3041	3040	3039	3038	3037	3036	3034	3033
17.5	**3085**	3095	3094	3094	3093	3092	3091	3090	3089	3088	3087	3086	3084	3083
18.0	**3136**	3146	3145	3145	3144	3143	3142	3141	3140	3139	3138	3137	3134	3133
18.5	**3188**	3200	3199	3198	3197	3196	3195	3194	3193	3192	3190	3189	3186	3185
19.0	**3242**	3255	3254	3253	3252	3251	3250	3249	3247	3246	3245	3244	3241	3239
19.5	**3296**	3308	3307	3306	3305	3304	3303	3302	3301	3300	3298	3297	3294	3293
20.0	**3345**	3356	3356	3355	3354	3353	3352	3351	3350	3349	3347	3346	3343	3342
20.5	**3390**	3401	3400	3399	3399	3398	3397	3396	3394	3393	3392	3391	3388	3387
21.0	**3433**	3444	3443	3443	3442	3441	3440	3439	3437	3436	3435	3434	3432	3430
21.5	**3474**	3485	3484	3484	3483	3482	3481	3480	3479	3478	3476	3475	3472	3471
22.0	**3514**	3525	3524	3523	3522	3522	3520	3519	3518	3517	3516	3515	3513	3511
22.5	**3550**	3559	3559	3558	3557	3556	3555	3554	3553	3553	3552	3551	3548	3547
23.0	**3577**	3585	3584	3584	3583	3583	3582	3581	3580	3580	3579	3578	3576	3576
23.5	**3600**	3605	3605	3604	3604	3603	3603	3602	3601	3601	3600	3600	3599	3598
24.0	**3615**	3619	3618	3618	3618	3617	3617	3617	3616	3616	3616	3615	3615	3614
24.5	**3625**	3627	3627	3627	3627	3626	3626	3626	3626	3626	3625	3625	3625	3624
25.0	**3631**	3632	3632	3632	3632	3632	3631	3631	3631	3631	3631	3631	3631	3631
25.5	**3634**	3635	3635	3635	3635	3635	3635	3635	3635	3635	3634	3634	3634	3634
26.0	**3634**	3635	3635	3635	3635	3635	3635	3635	3634	3634	3634	3634	3634	3634
26.5	**3604**	3604	3604	3604	3604	3604	3604	3604	3604	3604	3604	3604	3604	3604
27.0	**3527**	3527	3527	3527	3527	3527	3527	3527	3527	3527	3527	3527	3527	3527
27.5	**3271**	3271	3271	3271	3271	3271	3271	3271	3271	3271	3271	3271	3271	3271

Air density [kg/m³]														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
28.0	**2895**	2895	2895	2895	2895	2895	2895	2895	2895	2895	2895	2895	2895	2895
28.5	**2404**	2404	2404	2404	2404	2404	2404	2404	2404	2404	2404	2404	2404	2404
29.0	**2064**	2064	2064	2064	2064	2064	2064	2064	2064	2064	2064	2064	2064	2064
29.5	**1849**	1849	1849	1849	1849	1849	1849	1849	1849	1849	1849	1849	1849	1849
30.0	**1703**	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703	1703
30.5	**1599**	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599	1599
31.0	**1524**	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524	1524
31.5	**1471**	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471	1471
32.0	**1443**	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443	1443

Table 17-1: Power curve, Sound Optimized Mode SO12 (HWO)

17.2 Ct Values, Sound Optimized Mode SO12 (HWO)

Wind speed [m/s]	Air density kg/m³													
	1.225	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.857**	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.857	0.857	0.856	0.856
5.0	**0.845**	0.850	0.849	0.849	0.849	0.848	0.848	0.848	0.847	0.847	0.846	0.846	0.845	0.844
5.5	**0.808**	0.814	0.813	0.813	0.812	0.812	0.811	0.811	0.810	0.810	0.809	0.809	0.808	0.807
6.0	**0.752**	0.758	0.758	0.757	0.757	0.756	0.756	0.755	0.755	0.754	0.754	0.753	0.752	0.751
6.5	**0.697**	0.703	0.702	0.702	0.701	0.701	0.700	0.700	0.699	0.698	0.698	0.697	0.696	0.696
7.0	**0.633**	0.638	0.638	0.637	0.637	0.636	0.636	0.635	0.635	0.634	0.634	0.633	0.632	0.632
7.5	**0.557**	0.562	0.561	0.561	0.560	0.560	0.559	0.559	0.559	0.558	0.558	0.557	0.556	0.556
8.0	**0.491**	0.496	0.496	0.495	0.495	0.494	0.494	0.494	0.493	0.493	0.492	0.492	0.491	0.490
8.5	**0.462**	0.483	0.481	0.480	0.478	0.476	0.475	0.473	0.471	0.469	0.467	0.464	0.460	0.457
9.0	**0.449**	0.528	0.520	0.512	0.505	0.497	0.490	0.483	0.476	0.469	0.462	0.455	0.442	0.436
9.5	**0.412**	0.533	0.521	0.509	0.497	0.485	0.474	0.463	0.452	0.441	0.431	0.422	0.404	0.395
10.0	**0.358**	0.483	0.469	0.456	0.442	0.428	0.417	0.407	0.396	0.385	0.376	0.367	0.350	0.342
10.5	**0.308**	0.413	0.401	0.390	0.378	0.366	0.357	0.348	0.340	0.331	0.323	0.316	0.302	0.295
11.0	**0.269**	0.356	0.346	0.337	0.327	0.318	0.310	0.303	0.295	0.288	0.281	0.275	0.263	0.258
11.5	**0.236**	0.309	0.301	0.293	0.285	0.277	0.271	0.265	0.258	0.252	0.246	0.241	0.231	0.226
12.0	**0.208**	0.271	0.265	0.258	0.251	0.244	0.238	0.233	0.227	0.222	0.217	0.213	0.204	0.200
12.5	**0.185**	0.240	0.234	0.228	0.223	0.217	0.212	0.207	0.202	0.197	0.193	0.189	0.182	0.178
13.0	**0.167**	0.215	0.210	0.205	0.200	0.194	0.190	0.186	0.182	0.177	0.174	0.170	0.163	0.160
13.5	**0.152**	0.197	0.192	0.187	0.182	0.178	0.174	0.170	0.166	0.162	0.159	0.156	0.149	0.147
14.0	**0.140**	0.180	0.175	0.171	0.167	0.162	0.159	0.155	0.152	0.148	0.145	0.142	0.137	0.134
14.5	**0.128**	0.165	0.161	0.157	0.153	0.149	0.146	0.143	0.140	0.137	0.134	0.131	0.126	0.124
15.0	**0.118**	0.152	0.148	0.144	0.141	0.137	0.134	0.132	0.129	0.126	0.123	0.121	0.116	0.114
15.5	**0.110**	0.140	0.137	0.134	0.130	0.127	0.125	0.122	0.119	0.117	0.114	0.112	0.108	0.106
16.0	**0.102**	0.130	0.127	0.124	0.121	0.118	0.116	0.113	0.111	0.108	0.106	0.104	0.100	0.098
16.5	**0.095**	0.121	0.118	0.116	0.113	0.110	0.108	0.105	0.103	0.101	0.099	0.097	0.093	0.092
17.0	**0.089**	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
17.5	**0.083**	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.085	0.081	0.080
18.0	**0.078**	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.076	0.075
18.5	**0.073**	0.093	0.090	0.088	0.086	0.084	0.083	0.081	0.079	0.077	0.076	0.075	0.072	0.071
19.0	**0.069**	0.087	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.067	0.066
19.5	**0.065**	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.064	0.063
20.0	**0.061**	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.063	0.060	0.059
20.5	**0.058**	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
21.0	**0.055**	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053
21.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
22.0	**0.050**	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
22.5	**0.048**	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
23.0	**0.045**	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.044	0.044
23.5	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041
24.0	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.040	0.039
24.5	**0.039**	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.037
25.0	**0.037**	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036
25.5	**0.035**	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034
26.0	**0.034**	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033	0.033
26.5	**0.032**	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031
27.0	**0.030**	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.029	0.029
27.5	**0.027**	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026
28.0	**0.023**	0.028	0.027	0.027	0.027	0.026	0.026	0.025	0.025	0.024	0.024	0.024	0.023	0.023
28.5	**0.019**	0.023	0.023	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019
29.0	**0.017**	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.017	0.016	0.016
29.5	**0.014**	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.015	0.014	0.014
30.0	**0.013**	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
30.5	**0.012**	0.014	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.012	0.011	0.011
31.0	**0.011**	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010
31.5	**0.010**	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.009
32.0	**0.009**	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.009	0.009	0.009	0.009	0.009

Table 17-2: C_t values, Sound Optimized Mode SO12 (HWO)

17.3 Sound Curves, Sound Optimized Mode SO12 (HWO)

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO12 (HWO)** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	95.0
7	97.1
8	98.8
9	99.7
10	99.9
11	99.9
12	99.9
13	99.9
14	99.9
15	99.9
16	99.9
17	99.9
18	99.9
19	99.9
20	99.9

Table 17-3: Sound curves, Sound Optimized Mode SO12 (HWO)

18 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO13

NOTE

The power curves and Ct values presented in Section 18 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

18.1 Power Curves, Sound Optimized Mode SO13

	Air density [kg/m^3]													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**218**	158	164	169	175	180	186	191	197	202	208	213	224	229
4.5	**321**	239	246	254	261	269	276	283	291	298	306	313	328	336
5.0	**429**	323	333	343	352	362	372	381	391	401	410	420	439	449
5.5	**531**	402	414	426	437	449	461	473	484	496	508	520	543	555
6.0	**643**	490	504	518	532	546	560	574	588	602	615	629	657	671
6.5	**773**	592	608	625	642	658	674	691	707	724	740	757	789	806
7.0	**906**	696	715	734	753	772	792	811	830	849	868	887	925	944
7.5	**1038**	799	821	843	864	886	908	930	951	973	994	1016	1059	1080
8.0	**1200**	929	954	979	1003	1028	1053	1078	1103	1128	1152	1176	1222	1245
8.5	**1361**	1063	1091	1120	1148	1177	1205	1232	1260	1288	1312	1337	1382	1403
9.0	**1463**	1157	1188	1219	1250	1281	1309	1338	1366	1395	1418	1440	1482	1501
9.5	**1538**	1270	1301	1331	1361	1392	1415	1439	1463	1487	1504	1521	1551	1564
10.0	**1643**	1449	1474	1498	1523	1548	1564	1580	1596	1612	1622	1632	1650	1657
10.5	**1746**	1647	1661	1675	1689	1703	1710	1718	1725	1733	1737	1741	1749	1752
11.0	**1812**	1785	1789	1794	1799	1803	1805	1807	1808	1810	1811	1811	1812	1812
11.5	**1842**	1841	1841	1842	1842	1842	1842	1842	1842	1842	1842	1842	1842	1842
12.0	**1864**	1865	1865	1865	1865	1865	1865	1864	1864	1864	1864	1864	1864	1864
12.5	**1883**	1884	1884	1884	1884	1884	1884	1884	1883	1883	1883	1883	1883	1883
13.0	**1902**	1903	1903	1903	1903	1903	1902	1902	1902	1902	1902	1902	1902	1901
13.5	**1919**	1920	1920	1920	1920	1920	1920	1920	1919	1919	1919	1919	1919	1918
14.0	**1935**	1936	1936	1936	1936	1936	1936	1936	1936	1936	1935	1935	1935	1935
14.5	**1951**	1953	1953	1952	1952	1952	1952	1952	1952	1952	1952	1951	1951	1951
15.0	**1968**	1969	1969	1969	1969	1969	1969	1968	1968	1968	1968	1968	1967	1967
15.5	**1983**	1985	1985	1985	1984	1984	1984	1984	1984	1984	1984	1983	1983	1983
16.0	**1997**	1999	1999	1999	1999	1998	1998	1998	1998	1998	1998	1998	1997	1997
16.5	**2010**	2012	2012	2012	2011	2011	2011	2011	2011	2011	2011	2010	2010	2010
17.0	**2022**	2023	2023	2023	2023	2023	2023	2023	2022	2022	2022	2022	2022	2021
17.5	**2032**	2034	2034	2034	2034	2034	2034	2033	2033	2033	2033	2033	2032	2032
18.0	**2042**	2044	2044	2044	2044	2044	2043	2043	2043	2043	2043	2042	2042	2042
18.5	**2052**	2053	2053	2053	2053	2052	2052	2052	2052	2052	2052	2052	2051	2051
19.0	**2060**	2061	2061	2061	2061	2061	2061	2061	2060	2060	2060	2060	2060	2060
19.5	**2067**	2068	2068	2068	2068	2068	2068	2068	2068	2068	2068	2067	2067	2067
20.0	**2073**	2074	2074	2074	2074	2074	2074	2074	2073	2073	2073	2073	2073	2073
20.5	**2078**	2079	2079	2079	2079	2079	2079	2078	2078	2078	2078	2078	2078	2078
21.0	**2084**	2085	2085	2085	2085	2085	2084	2084	2084	2084	2084	2084	2083	2083
21.5	**2090**	2093	2093	2092	2092	2092	2092	2092	2091	2091	2091	2091	2090	2090
22.0	**2100**	2103	2102	2102	2102	2102	2102	2101	2101	2101	2101	2100	2100	2099
22.5	**2111**	2114	2113	2113	2113	2113	2112	2112	2112	2112	2111	2111	2110	2110
23.0	**2123**	2126	2125	2125	2125	2125	2124	2124	2124	2124	2123	2123	2122	2122
23.5	**2133**	2135	2135	2135	2135	2135	2134	2134	2134	2134	2133	2133	2133	2132
24.0	**2141**	2143	2142	2142	2142	2142	2142	2142	2141	2141	2141	2141	2140	2140

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
24.5	**2147**	2148	2148	2148	2148	2148	2148	2148	2147	2147	2147	2147	2147	2146
25.0	**2151**	2152	2152	2152	2152	2152	2151	2151	2151	2151	2151	2151	2151	2151
25.5	**2154**	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2153	2153
26.0	**2154**	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154
26.5	**2155**	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155
27.0	**2155**	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155

Table 18-1: Power curve, Sound Optimized Mode SO13

18.2 Ct Values, Sound Optimized Mode SO13

Wind speed [m/s]	Air density kg/m³													
	1.225	**0.950**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.785**	0.789	0.789	0.789	0.788	0.788	0.788	0.787	0.787	0.786	0.786	0.785	0.785	0.784
4.5	**0.693**	0.698	0.698	0.697	0.696	0.696	0.695	0.695	0.694	0.694	0.693	0.693	0.692	0.692
5.0	**0.622**	0.625	0.624	0.624	0.624	0.623	0.623	0.623	0.623	0.622	0.622	0.622	0.622	0.621
5.5	**0.546**	0.548	0.548	0.548	0.548	0.547	0.547	0.547	0.547	0.547	0.547	0.547	0.546	0.546
6.0	**0.487**	0.489	0.489	0.489	0.489	0.489	0.489	0.488	0.488	0.488	0.488	0.487	0.487	0.486
6.5	**0.446**	0.449	0.449	0.448	0.448	0.448	0.448	0.447	0.447	0.447	0.447	0.446	0.446	0.445
7.0	**0.407**	0.410	0.409	0.409	0.409	0.409	0.408	0.408	0.408	0.408	0.407	0.407	0.407	0.407
7.5	**0.371**	0.374	0.373	0.373	0.373	0.373	0.373	0.372	0.372	0.372	0.372	0.371	0.371	0.371
8.0	**0.349**	0.352	0.352	0.352	0.351	0.351	0.351	0.351	0.350	0.350	0.350	0.349	0.348	0.347
8.5	**0.327**	0.332	0.332	0.332	0.332	0.332	0.331	0.331	0.330	0.330	0.329	0.328	0.325	0.323
9.0	**0.293**	0.301	0.301	0.301	0.301	0.301	0.300	0.299	0.299	0.298	0.296	0.295	0.291	0.289
9.5	**0.259**	0.278	0.277	0.276	0.275	0.274	0.272	0.271	0.269	0.267	0.264	0.262	0.256	0.253
10.0	**0.236**	0.269	0.267	0.264	0.262	0.260	0.256	0.253	0.250	0.246	0.243	0.239	0.232	0.228
10.5	**0.216**	0.264	0.259	0.255	0.250	0.246	0.242	0.237	0.233	0.228	0.224	0.220	0.212	0.208
11.0	**0.194**	0.248	0.243	0.237	0.232	0.226	0.221	0.217	0.212	0.207	0.203	0.198	0.190	0.187
11.5	**0.172**	0.223	0.218	0.212	0.207	0.201	0.197	0.192	0.188	0.184	0.180	0.176	0.169	0.166
12.0	**0.153**	0.198	0.193	0.188	0.183	0.179	0.175	0.171	0.167	0.163	0.160	0.157	0.150	0.148
12.5	**0.137**	0.176	0.172	0.168	0.164	0.159	0.156	0.153	0.149	0.146	0.143	0.140	0.135	0.132
13.0	**0.123**	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.131	0.128	0.126	0.121	0.119
13.5	**0.112**	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
14.0	**0.101**	0.129	0.126	0.123	0.120	0.117	0.115	0.112	0.110	0.107	0.105	0.103	0.100	0.098
14.5	**0.092**	0.117	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096	0.094	0.091	0.089
15.0	**0.084**	0.107	0.104	0.102	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.083	0.081
15.5	**0.077**	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.084	0.082	0.080	0.079	0.076	0.075
16.0	**0.071**	0.090	0.088	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.074	0.073	0.070	0.069
16.5	**0.066**	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.067	0.065	0.064
17.0	**0.061**	0.076	0.075	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.063	0.062	0.060	0.059
17.5	**0.056**	0.071	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.056	0.055
18.0	**0.053**	0.066	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054	0.054	0.052	0.051
18.5	**0.049**	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.048
19.0	**0.046**	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.045	0.044
19.5	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.042
20.0	**0.040**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039
20.5	**0.038**	0.046	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.037	0.037
21.0	**0.036**	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037	0.036	0.035	0.035
21.5	**0.034**	0.042	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033
22.0	**0.032**	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031
22.5	**0.031**	0.037	0.037	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.032	0.031	0.030	0.030
23.0	**0.029**	0.035	0.035	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.028
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.030	0.030	0.029	0.029	0.029	0.028	0.027	0.027
24.0	**0.026**	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026
24.5	**0.025**	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025
25.0	**0.024**	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.024	0.024	0.023
25.5	**0.023**	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.023	0.023	0.023
26.0	**0.022**	0.026	0.026	0.025	0.025	0.024	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.022
26.5	**0.021**	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021
27.0	**0.020**	0.024	0.024	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020

Table 18-2: C_t values, Sound Optimized Mode SO13

18.3 Sound Curves, Sound Optimized Mode SO13

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO13 (Blades with serrated trailing edge)**
3	90.9
4	91.0
5	91.4
6	92.4
7	93.1
8	94.3
9	95.8
10	96.5
11	96.9
12	97.0
13	97.0
14	97.0
15	97.0
16	97.0
17	97.0
18	97.0
19	97.0
20	97.0

Table 18-3: Sound curves, Sound Optimized Mode SO13

19 Power Curves, Ct Values and Sound Curves, Sound Optimized Mode SO13 (HWO)

NOTE The power curves and Ct values presented in Section 19 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

19.1 Power Curves, Sound Optimized Mode SO13 (HWO)

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**218**	158	164	169	175	180	186	191	197	202	208	213	224	229
4.5	**321**	239	246	254	261	269	276	283	291	298	306	313	328	336
5.0	**429**	323	333	343	352	362	372	381	391	401	410	420	439	449
5.5	**531**	402	414	426	437	449	461	473	484	496	508	520	543	555
6.0	**643**	490	504	518	532	546	560	574	588	602	615	629	657	671
6.5	**773**	592	608	625	642	658	674	691	707	724	740	757	789	806
7.0	**906**	696	715	734	753	772	792	811	830	849	868	887	925	944
7.5	**1038**	799	821	843	864	886	908	930	951	973	994	1016	1059	1080
8.0	**1200**	929	954	979	1003	1028	1053	1078	1103	1128	1152	1176	1222	1245
8.5	**1361**	1063	1091	1120	1148	1177	1205	1232	1260	1288	1312	1337	1382	1403
9.0	**1463**	1157	1188	1219	1250	1281	1309	1338	1366	1395	1418	1440	1482	1501
9.5	**1538**	1270	1301	1331	1361	1392	1415	1439	1463	1487	1504	1521	1551	1564
10.0	**1643**	1449	1474	1498	1523	1548	1564	1580	1596	1612	1622	1632	1650	1657
10.5	**1746**	1647	1661	1675	1689	1703	1710	1718	1725	1733	1737	1741	1749	1752
11.0	**1812**	1785	1789	1794	1799	1803	1805	1807	1808	1810	1811	1811	1812	1812
11.5	**1842**	1841	1841	1842	1842	1842	1842	1842	1842	1842	1842	1842	1842	1842
12.0	**1864**	1865	1865	1865	1865	1865	1865	1864	1864	1864	1864	1864	1864	1864
12.5	**1883**	1884	1884	1884	1884	1884	1884	1884	1883	1883	1883	1883	1883	1883
13.0	**1902**	1903	1903	1903	1903	1903	1902	1902	1902	1902	1902	1902	1902	1901
13.5	**1919**	1920	1920	1920	1920	1920	1920	1920	1919	1919	1919	1919	1919	1918
14.0	**1935**	1936	1936	1936	1936	1936	1936	1936	1936	1936	1935	1935	1935	1935
14.5	**1951**	1953	1953	1952	1952	1952	1952	1952	1952	1952	1952	1951	1951	1951
15.0	**1968**	1969	1969	1969	1969	1969	1969	1968	1968	1968	1968	1968	1967	1967
15.5	**1983**	1985	1985	1985	1984	1984	1984	1984	1984	1984	1984	1983	1983	1983
16.0	**1997**	1999	1999	1999	1999	1998	1998	1998	1998	1998	1998	1997	1997	1997
16.5	**2010**	2012	2012	2012	2011	2011	2011	2011	2011	2011	2011	2010	2010	2010
17.0	**2022**	2023	2023	2023	2023	2023	2023	2023	2022	2022	2022	2022	2022	2021
17.5	**2032**	2034	2034	2034	2034	2034	2034	2033	2033	2033	2033	2033	2032	2032
18.0	**2042**	2044	2044	2044	2044	2044	2043	2043	2043	2043	2043	2042	2042	2042
18.5	**2052**	2053	2053	2053	2053	2052	2052	2052	2052	2052	2052	2052	2051	2051
19.0	**2060**	2061	2061	2061	2061	2061	2061	2061	2060	2060	2060	2060	2060	2060
19.5	**2067**	2068	2068	2068	2068	2068	2068	2068	2068	2068	2068	2067	2067	2067
20.0	**2073**	2074	2074	2074	2074	2074	2074	2074	2073	2073	2073	2073	2073	2073
20.5	**2078**	2079	2079	2079	2079	2079	2079	2078	2078	2078	2078	2078	2078	2078
21.0	**2084**	2085	2085	2085	2085	2085	2084	2084	2084	2084	2084	2084	2083	2083
21.5	**2090**	2093	2093	2092	2092	2092	2092	2092	2091	2091	2091	2091	2090	2090
22.0	**2100**	2103	2102	2102	2102	2102	2102	2101	2101	2101	2101	2100	2100	2099
22.5	**2111**	2114	2113	2113	2113	2113	2112	2112	2112	2112	2111	2111	2110	2110
23.0	**2123**	2126	2125	2125	2125	2125	2124	2124	2124	2124	2123	2123	2122	2122
23.5	**2133**	2135	2135	2135	2135	2135	2134	2134	2134	2134	2133	2133	2133	2132
24.0	**2141**	2143	2142	2142	2142	2142	2142	2142	2141	2141	2141	2141	2140	2140
24.5	**2147**	2148	2148	2148	2148	2148	2148	2148	2147	2147	2147	2147	2147	2146
25.0	**2151**	2152	2152	2152	2152	2152	2151	2151	2151	2151	2151	2151	2151	2151
25.5	**2154**	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2153	2153
26.0	**2154**	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154
26.5	**2155**	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155
27.0	**2155**	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155	2155
27.5	**2153**	2153	2153	2153	2153	2153	2153	2153	2153	2153	2153	2153	2153	2153

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
28.0	**2127**	2127	2127	2127	2127	2127	2127	2127	2127	2127	2127	2127	2127	2127
28.5	**2050**	2050	2050	2050	2050	2050	2050	2050	2050	2050	2050	2050	2050	2050
29.0	**1929**	1929	1929	1929	1929	1929	1929	1929	1929	1929	1929	1929	1929	1929
29.5	**1750**	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
30.0	**1600**	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600
30.5	**1488**	1488	1488	1488	1488	1488	1488	1488	1488	1488	1488	1488	1488	1488
31.0	**1413**	1413	1413	1413	1413	1413	1413	1413	1413	1413	1413	1413	1413	1413
31.5	**1364**	1363	1363	1363	1363	1363	1363	1363	1363	1364	1364	1364	1364	1364
32.0	**1338**	1338	1338	1338	1338	1338	1338	1338	1338	1338	1338	1338	1338	1338

Table 19-1: Power curve, Sound Optimized Mode SO13 (HWO)

19.2 Ct Values, Sound Optimized Mode SO13 (HWO)

	Air density kg/m^3												
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.785**	0.789	0.789	0.789	0.788	0.788	0.788	0.787	0.787	0.786	0.786	0.785	0.785	0.784
4.5	**0.693**	0.698	0.698	0.697	0.696	0.696	0.695	0.695	0.694	0.694	0.693	0.693	0.692	0.692
5.0	**0.622**	0.625	0.624	0.624	0.624	0.623	0.623	0.623	0.623	0.622	0.622	0.622	0.622	0.621
5.5	**0.546**	0.548	0.548	0.548	0.548	0.547	0.547	0.547	0.547	0.547	0.547	0.547	0.546	0.546
6.0	**0.487**	0.489	0.489	0.489	0.489	0.489	0.489	0.488	0.488	0.488	0.488	0.487	0.487	0.486
6.5	**0.446**	0.449	0.449	0.448	0.448	0.448	0.448	0.447	0.447	0.447	0.447	0.446	0.446	0.445
7.0	**0.407**	0.410	0.409	0.409	0.409	0.409	0.408	0.408	0.408	0.408	0.407	0.407	0.407	0.407
7.5	**0.371**	0.374	0.373	0.373	0.373	0.373	0.373	0.372	0.372	0.372	0.372	0.371	0.371	0.371
8.0	**0.349**	0.352	0.352	0.352	0.351	0.351	0.351	0.351	0.350	0.350	0.350	0.349	0.348	0.347
8.5	**0.327**	0.332	0.332	0.332	0.332	0.332	0.331	0.331	0.330	0.330	0.329	0.328	0.325	0.323
9.0	**0.293**	0.301	0.301	0.301	0.301	0.301	0.300	0.299	0.299	0.298	0.296	0.295	0.291	0.289
9.5	**0.259**	0.278	0.277	0.276	0.275	0.274	0.272	0.271	0.269	0.267	0.264	0.262	0.256	0.253
10.0	**0.236**	0.269	0.267	0.264	0.262	0.260	0.256	0.253	0.250	0.246	0.243	0.239	0.232	0.228
10.5	**0.216**	0.264	0.259	0.255	0.250	0.246	0.242	0.237	0.233	0.228	0.224	0.220	0.212	0.208
11.0	**0.194**	0.248	0.243	0.237	0.232	0.226	0.221	0.217	0.212	0.207	0.203	0.198	0.190	0.187
11.5	**0.172**	0.223	0.218	0.212	0.207	0.201	0.197	0.192	0.188	0.184	0.180	0.176	0.169	0.166
12.0	**0.153**	0.198	0.193	0.188	0.183	0.179	0.175	0.171	0.167	0.163	0.160	0.157	0.150	0.148
12.5	**0.137**	0.176	0.172	0.168	0.164	0.159	0.156	0.153	0.149	0.146	0.143	0.140	0.135	0.132
13.0	**0.123**	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.131	0.128	0.126	0.121	0.119
13.5	**0.112**	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
14.0	**0.101**	0.129	0.126	0.123	0.120	0.117	0.115	0.112	0.110	0.107	0.105	0.103	0.100	0.098
14.5	**0.092**	0.117	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096	0.094	0.091	0.089
15.0	**0.084**	0.107	0.104	0.102	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.083	0.081
15.5	**0.077**	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.084	0.082	0.080	0.079	0.076	0.075
16.0	**0.071**	0.090	0.088	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.074	0.073	0.070	0.069
16.5	**0.066**	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.067	0.065	0.064
17.0	**0.061**	0.076	0.075	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.063	0.062	0.060	0.059
17.5	**0.056**	0.071	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.056	0.055
18.0	**0.053**	0.066	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054	0.054	0.052	0.051
18.5	**0.049**	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.048
19.0	**0.046**	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.045	0.044
19.5	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.042
20.0	**0.040**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039
20.5	**0.038**	0.046	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.037	0.037
21.0	**0.036**	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037	0.036	0.035	0.035
21.5	**0.034**	0.042	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033
22.0	**0.032**	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031
22.5	**0.031**	0.037	0.037	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.032	0.031	0.030	0.030
23.0	**0.029**	0.035	0.035	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.028
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.030	0.030	0.029	0.029	0.029	0.028	0.027	0.027
24.0	**0.026**	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026
24.5	**0.025**	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025
25.0	**0.024**	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.024	0.024	0.023
25.5	**0.023**	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.023	0.023	0.023
26.0	**0.022**	0.026	0.026	0.025	0.025	0.024	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.022
26.5	**0.021**	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021
27.0	**0.020**	0.024	0.024	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
27.5	**0.019**	0.023	0.023	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019
28.0	**0.018**	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018
28.5	**0.017**	0.020	0.020	0.020	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017
29.0	**0.016**	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.015
29.5	**0.014**	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.014
30.0	**0.012**	0.014	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013	0.013	0.012	0.012
30.5	**0.011**	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011
31.0	**0.010**	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010	0.010
31.5	**0.009**	0.011	0.011	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.009	0.009	0.009
32.0	**0.009**	0.010	0.010	0.010	0.010	0.010	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009

Table 19-2: C_t values, Sound Optimized Mode SO13 (HWO)

19.3 Sound Curves, Sound Optimized Mode SO13 (HWO)

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO13 (HWO)** **(Blades with serrated trailing edge)**
3	90.9
4	91.0
5	91.4
6	92.4
7	93.1
8	94.3
9	95.8
10	96.5
11	96.9
12	97.0
13	97.0
14	97.0
15	97.0
16	97.0
17	97.0
18	97.0
19	97.0
20	97.0

Table 19-3: Sound curves, Sound Optimized Mode SO13 (HWO)

20 Power Curves, Ct Values and Sound Curves, Load Optimized Mode LO1

NOTE The power curves and Ct values presented in Section 20 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

20.1 Power Curves, Load Optimized Mode LO1

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1095**	837	861	884	908	931	955	978	1002	1025	1049	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1703**	1311	1347	1382	1418	1454	1490	1526	1561	1597	1632	1668	1738	1773
8.0	**2069**	1599	1642	1685	1729	1772	1815	1857	1900	1943	1985	2027	2111	2153
8.5	**2471**	1923	1974	2025	2076	2127	2177	2227	2277	2327	2375	2423	2518	2566
9.0	**2870**	2272	2329	2387	2445	2502	2556	2610	2665	2719	2769	2820	2919	2967
9.5	**3224**	2619	2679	2739	2800	2860	2915	2969	3024	3079	3127	3176	3268	3312
10.0	**3506**	2945	3005	3065	3125	3185	3236	3286	3337	3387	3427	3466	3537	3569
10.5	**3683**	3237	3292	3347	3402	3456	3495	3533	3571	3610	3634	3659	3700	3716
11.0	**3766**	3468	3510	3552	3594	3636	3660	3684	3708	3732	3743	3754	3772	3779
11.5	**3794**	3638	3664	3691	3717	3743	3753	3763	3773	3783	3787	3790	3795	3797
12.0	**3799**	3736	3748	3760	3773	3785	3788	3791	3794	3797	3798	3798	3799	3800
12.5	**3800**	3777	3782	3786	3791	3796	3797	3798	3798	3799	3799	3800	3800	3800
13.0	**3800**	3792	3793	3795	3796	3798	3799	3799	3800	3800	3800	3800	3800	3800
13.5	**3800**	3794	3795	3797	3798	3799	3800	3800	3800	3800	3800	3800	3800	3800
14.0	**3800**	3798	3798	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800
14.5	**3800**	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
15.0	**3800**	3798	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
15.5	**3800**	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
16.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
16.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
17.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
17.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
18.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
18.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
19.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
19.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
20.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
20.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
21.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
21.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
22.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
22.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
23.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
23.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
24.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
24.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
25.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
25.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
26.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
26.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
27.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800

Table 20-1: Power curve, Load Optimized Mode LO1

20.2 Ct Values, Load Optimized Mode LO1

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.855**	0.854	0.854	0.854	0.855	0.855	0.855	0.855	0.856	0.856	0.856	0.855	0.855	0.855
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.828**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.831	0.830	0.829	0.827	0.826
7.5	**0.821**	0.832	0.831	0.830	0.829	0.828	0.827	0.826	0.825	0.824	0.823	0.822	0.820	0.818
8.0	**0.823**	0.837	0.836	0.835	0.834	0.833	0.831	0.830	0.829	0.827	0.826	0.824	0.821	0.819
8.5	**0.802**	0.838	0.836	0.833	0.831	0.829	0.825	0.822	0.818	0.815	0.810	0.806	0.797	0.793
9.0	**0.743**	0.811	0.805	0.800	0.795	0.789	0.783	0.777	0.770	0.764	0.757	0.750	0.736	0.730
9.5	**0.668**	0.752	0.745	0.737	0.730	0.723	0.715	0.707	0.699	0.692	0.684	0.676	0.660	0.652
10.0	**0.592**	0.685	0.676	0.668	0.660	0.652	0.644	0.636	0.627	0.619	0.610	0.601	0.583	0.574
10.5	**0.516**	0.621	0.612	0.603	0.595	0.586	0.576	0.566	0.557	0.547	0.537	0.526	0.506	0.496
11.0	**0.444**	0.558	0.547	0.537	0.527	0.517	0.507	0.496	0.486	0.475	0.465	0.454	0.434	0.424
11.5	**0.380**	0.497	0.485	0.474	0.463	0.452	0.441	0.430	0.419	0.409	0.399	0.390	0.371	0.363
12.0	**0.328**	0.437	0.425	0.414	0.402	0.391	0.381	0.371	0.362	0.352	0.344	0.336	0.320	0.313
12.5	**0.285**	0.380	0.370	0.360	0.349	0.339	0.331	0.322	0.314	0.306	0.299	0.292	0.279	0.273
13.0	**0.251**	0.332	0.323	0.314	0.305	0.296	0.289	0.282	0.275	0.268	0.263	0.257	0.246	0.241
13.5	**0.224**	0.294	0.286	0.278	0.271	0.263	0.257	0.251	0.245	0.239	0.234	0.229	0.219	0.215
14.0	**0.199**	0.260	0.254	0.247	0.240	0.234	0.228	0.223	0.218	0.213	0.208	0.204	0.195	0.191
14.5	**0.179**	0.232	0.226	0.221	0.215	0.209	0.204	0.200	0.195	0.190	0.187	0.183	0.175	0.172
15.0	**0.160**	0.207	0.202	0.197	0.192	0.187	0.183	0.179	0.175	0.171	0.167	0.164	0.157	0.154
15.5	**0.145**	0.187	0.183	0.178	0.174	0.169	0.165	0.162	0.158	0.155	0.151	0.148	0.143	0.140
16.0	**0.132**	0.170	0.166	0.162	0.158	0.153	0.150	0.147	0.144	0.140	0.138	0.135	0.130	0.127
16.5	**0.121**	0.154	0.151	0.147	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.119	0.116
17.0	**0.111**	0.141	0.138	0.135	0.131	0.128	0.125	0.123	0.120	0.117	0.115	0.113	0.109	0.107
17.5	**0.102**	0.129	0.126	0.123	0.120	0.117	0.115	0.113	0.110	0.108	0.106	0.104	0.100	0.098
18.0	**0.094**	0.119	0.116	0.114	0.111	0.108	0.106	0.104	0.102	0.099	0.097	0.096	0.092	0.090
18.5	**0.087**	0.110	0.107	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.088	0.085	0.084
19.0	**0.080**	0.101	0.099	0.097	0.094	0.092	0.090	0.088	0.087	0.085	0.083	0.082	0.079	0.077
19.5	**0.074**	0.094	0.092	0.090	0.088	0.085	0.084	0.082	0.080	0.079	0.077	0.076	0.073	0.072
20.0	**0.069**	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.073	0.072	0.071	0.068	0.067
20.5	**0.065**	0.081	0.079	0.078	0.076	0.074	0.073	0.071	0.070	0.069	0.067	0.066	0.064	0.063
21.0	**0.061**	0.076	0.074	0.073	0.071	0.069	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.059
21.5	**0.058**	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.057	0.056
22.0	**0.054**	0.067	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.053	0.052
22.5	**0.051**	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.049
23.0	**0.048**	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.050	0.049	0.047	0.046
23.5	**0.045**	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.049	0.048	0.047	0.046	0.045	0.044
24.0	**0.043**	0.053	0.052	0.051	0.050	0.048	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.042
24.5	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.040	0.039
25.0	**0.039**	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038
25.5	**0.037**	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.038	0.036	0.036
26.0	**0.035**	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034
26.5	**0.034**	0.041	0.040	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033	0.033
27.0	**0.032**	0.039	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.033	0.032	0.031

Table 20-2: C_t values, Load Optimized Mode LO1

20.3 Sound Curves, Load Optimized Mode LO1

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Load Optimized Mode LO1** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.6
8	102.8
9	103.9
10	103.9
11	103.9
12	103.9
13	103.9
14	103.9
15	103.9
16	103.9
17	103.9
18	103.9
19	103.9
20	103.9

Table 20-3: Sound curves, Load Optimized Mode LO1

21 Power Curves, Ct Values and Sound Curves, Load Optimized Mode LO1 (HWO)

NOTE The power curves and Ct values presented in Section 21 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

21.1 Power Curves, Load Optimized Mode LO1 (HWO)

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1095**	837	861	884	908	931	955	978	1002	1025	1049	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1703**	1311	1347	1382	1418	1454	1490	1526	1561	1597	1632	1668	1738	1773
8.0	**2069**	1599	1642	1685	1729	1772	1815	1857	1900	1943	1985	2027	2111	2153
8.5	**2471**	1923	1974	2025	2076	2127	2177	2227	2277	2327	2375	2423	2518	2566
9.0	**2870**	2272	2329	2387	2445	2502	2556	2610	2665	2719	2769	2820	2919	2967
9.5	**3224**	2619	2679	2739	2800	2860	2915	2969	3024	3079	3127	3176	3268	3312
10.0	**3506**	2945	3005	3065	3125	3185	3236	3286	3337	3387	3427	3466	3537	3569
10.5	**3683**	3237	3292	3347	3402	3456	3495	3533	3571	3610	3634	3659	3700	3716
11.0	**3766**	3468	3510	3552	3594	3636	3660	3684	3708	3732	3743	3754	3772	3779
11.5	**3794**	3638	3664	3691	3717	3743	3753	3763	3773	3783	3787	3790	3795	3797
12.0	**3799**	3736	3748	3760	3773	3785	3788	3791	3794	3797	3798	3798	3799	3800
12.5	**3800**	3777	3782	3786	3791	3796	3797	3798	3798	3799	3799	3800	3800	3800
13.0	**3800**	3792	3793	3795	3796	3798	3799	3799	3800	3800	3800	3800	3800	3800
13.5	**3800**	3794	3795	3797	3798	3799	3800	3800	3800	3800	3800	3800	3800	3800
14.0	**3800**	3798	3798	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800
14.5	**3800**	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
15.0	**3800**	3798	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
15.5	**3800**	3799	3799	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
16.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
16.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
17.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
17.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
18.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
18.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
19.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
19.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
20.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
20.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
21.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
21.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
22.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
22.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
23.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
23.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
24.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
24.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
25.0	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
25.5	**3800**	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800
26.0	**3797**	3797	3797	3797	3797	3797	3797	3797	3797	3797	3797	3797	3797	3797
26.5	**3783**	3783	3783	3783	3783	3783	3783	3783	3783	3783	3783	3783	3783	3783
27.0	**3755**	3754	3754	3754	3754	3754	3754	3754	3754	3755	3755	3755	3755	3755

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
27.5	**3660**	3660	3659	3659	3659	3659	3659	3659	3659	3659	3659	3659	3660	3660
28.0	**3497**	3497	3497	3497	3497	3497	3497	3497	3497	3497	3497	3497	3497	3497
28.5	**3275**	3276	3276	3276	3276	3276	3275	3275	3275	3275	3275	3275	3275	3275
29.0	**3037**	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037	3037
29.5	**2791**	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791
30.0	**2549**	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549
30.5	**2309**	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309
31.0	**2074**	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074
31.5	**1869**	1870	1870	1870	1870	1870	1869	1869	1869	1869	1869	1869	1869	1869
32.0	**1722**	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722

Table 21-1: Power curve, Load Optimized Mode LO1 (HWO)

21.2 Ct Values, Load Optimized Mode LO1 (HWO)

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.855**	0.854	0.854	0.854	0.855	0.855	0.855	0.855	0.856	0.856	0.856	0.855	0.855	0.855
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.828**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.831	0.830	0.829	0.827	0.826
7.5	**0.821**	0.832	0.831	0.830	0.829	0.828	0.827	0.826	0.825	0.824	0.823	0.822	0.820	0.818
8.0	**0.823**	0.837	0.836	0.835	0.834	0.833	0.831	0.830	0.829	0.827	0.826	0.824	0.821	0.819
8.5	**0.802**	0.838	0.836	0.833	0.831	0.829	0.825	0.822	0.818	0.815	0.810	0.806	0.797	0.793
9.0	**0.743**	0.811	0.805	0.800	0.795	0.789	0.783	0.777	0.770	0.764	0.757	0.750	0.736	0.730
9.5	**0.668**	0.752	0.745	0.737	0.730	0.723	0.715	0.707	0.699	0.692	0.684	0.676	0.660	0.652
10.0	**0.592**	0.685	0.676	0.668	0.660	0.652	0.644	0.636	0.627	0.619	0.610	0.601	0.583	0.574
10.5	**0.516**	0.621	0.612	0.603	0.595	0.586	0.576	0.566	0.557	0.547	0.537	0.526	0.506	0.496
11.0	**0.444**	0.558	0.547	0.537	0.527	0.517	0.507	0.496	0.486	0.475	0.465	0.454	0.434	0.424
11.5	**0.380**	0.497	0.485	0.474	0.463	0.452	0.441	0.430	0.419	0.409	0.399	0.390	0.371	0.363
12.0	**0.328**	0.437	0.425	0.414	0.402	0.391	0.381	0.371	0.362	0.352	0.344	0.336	0.320	0.313
12.5	**0.285**	0.380	0.370	0.360	0.349	0.339	0.331	0.322	0.314	0.306	0.299	0.292	0.279	0.273
13.0	**0.251**	0.332	0.323	0.314	0.305	0.296	0.289	0.282	0.275	0.268	0.263	0.257	0.246	0.241
13.5	**0.224**	0.294	0.286	0.278	0.271	0.263	0.257	0.251	0.245	0.239	0.234	0.229	0.219	0.215
14.0	**0.199**	0.260	0.254	0.247	0.240	0.234	0.228	0.223	0.218	0.213	0.208	0.204	0.195	0.191
14.5	**0.179**	0.232	0.226	0.221	0.215	0.209	0.204	0.200	0.195	0.190	0.187	0.183	0.175	0.172
15.0	**0.160**	0.207	0.202	0.197	0.192	0.187	0.183	0.179	0.175	0.171	0.167	0.164	0.157	0.154
15.5	**0.145**	0.187	0.183	0.178	0.174	0.169	0.165	0.162	0.158	0.155	0.151	0.148	0.143	0.140
16.0	**0.132**	0.170	0.166	0.162	0.158	0.153	0.150	0.147	0.144	0.140	0.138	0.135	0.130	0.127
16.5	**0.121**	0.154	0.151	0.147	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.119	0.116
17.0	**0.111**	0.141	0.138	0.135	0.131	0.128	0.125	0.123	0.120	0.117	0.115	0.113	0.109	0.107
17.5	**0.102**	0.129	0.126	0.123	0.120	0.117	0.115	0.113	0.110	0.108	0.106	0.104	0.100	0.098
18.0	**0.094**	0.119	0.116	0.114	0.111	0.108	0.106	0.104	0.102	0.099	0.097	0.096	0.092	0.090
18.5	**0.087**	0.110	0.107	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.088	0.085	0.084
19.0	**0.080**	0.101	0.099	0.097	0.094	0.092	0.090	0.088	0.087	0.085	0.083	0.082	0.079	0.077
19.5	**0.074**	0.094	0.092	0.090	0.088	0.085	0.084	0.082	0.080	0.079	0.077	0.076	0.073	0.072
20.0	**0.069**	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.073	0.072	0.071	0.068	0.067
20.5	**0.065**	0.081	0.079	0.078	0.076	0.074	0.073	0.071	0.070	0.069	0.067	0.066	0.064	0.063
21.0	**0.061**	0.076	0.074	0.073	0.071	0.069	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.059
21.5	**0.058**	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.057	0.056
22.0	**0.054**	0.067	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.053	0.052
22.5	**0.051**	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.049
23.0	**0.048**	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.050	0.049	0.047	0.046
23.5	**0.045**	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.049	0.048	0.047	0.046	0.045	0.044
24.0	**0.043**	0.053	0.052	0.051	0.050	0.048	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.042
24.5	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.040	0.039
25.0	**0.039**	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.038
25.5	**0.037**	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.039	0.039	0.038	0.038	0.036	0.036
26.0	**0.035**	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034
26.5	**0.033**	0.041	0.040	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.032
27.0	**0.032**	0.038	0.038	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031
27.5	**0.029**	0.036	0.035	0.034	0.034	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029
28.0	**0.027**	0.033	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026
28.5	**0.024**	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024
29.0	**0.022**	0.026	0.026	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.021	0.021
29.5	**0.019**	0.023	0.023	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019	0.019
30.0	**0.017**	0.020	0.020	0.020	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.016
30.5	**0.015**	0.018	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.014
31.0	**0.013**	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
31.5	**0.011**	0.013	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011
32.0	**0.010**	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010

Table 21-2: C_t values, Load Optimized Mode LO1 (HWO)

21.3 Sound Curves, Load Optimized Mode LO1 (HWO)

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3 Maximum turbulence at hub height: 30% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA] Load Optimized Mode LO1 (HWO) (Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.6
8	102.9
9	103.9
10	103.9
11	103.9
12	103.9
13	103.9
14	103.9
15	103.9
16	103.9
17	103.9
18	103.9
19	103.9
20	103.9

Table 21-3: Sound curves, Load Optimized Mode LO1 (HWO)

22 Power Curves, Ct Values and Sound Curves, Load Optimized Mode LO2

NOTE The power curves and Ct values presented in Section 22 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

22.1 Power Curves, Load Optimized Mode LO2

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	467	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1096**	837	861	884	908	931	955	978	1002	1025	1049	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1705**	1312	1348	1384	1420	1456	1492	1527	1563	1599	1634	1670	1741	1776
8.0	**2071**	1600	1643	1686	1729	1773	1815	1858	1901	1944	1987	2029	2113	2155
8.5	**2465**	1912	1963	2014	2065	2117	2167	2217	2268	2318	2367	2416	2513	2561
9.0	**2854**	2229	2289	2349	2409	2469	2525	2582	2639	2696	2748	2801	2904	2953
9.5	**3185**	2535	2597	2660	2722	2785	2848	2912	2975	3039	3088	3137	3226	3267
10.0	**3418**	2830	2899	2969	3039	3109	3160	3211	3262	3313	3348	3383	3443	3467
10.5	**3536**	3051	3122	3194	3266	3337	3373	3409	3445	3481	3500	3518	3547	3558
11.0	**3583**	3277	3326	3375	3423	3472	3494	3515	3537	3558	3567	3575	3587	3592
11.5	**3596**	3425	3456	3487	3518	3549	3559	3568	3578	3587	3590	3593	3597	3598
12.0	**3599**	3519	3535	3550	3566	3581	3585	3589	3592	3596	3597	3598	3599	3599
12.5	**3600**	3551	3561	3572	3582	3593	3594	3596	3597	3598	3599	3599	3600	3600
13.0	**3600**	3583	3586	3590	3593	3597	3597	3598	3599	3600	3600	3600	3600	3600
13.5	**3600**	3587	3590	3592	3595	3598	3599	3599	3599	3600	3600	3600	3600	3600
14.0	**3600**	3593	3595	3596	3598	3599	3599	3600	3600	3600	3600	3600	3600	3600
14.5	**3600**	3597	3597	3598	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600
15.0	**3600**	3596	3597	3598	3598	3599	3599	3599	3599	3600	3600	3600	3600	3600
15.5	**3600**	3598	3598	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600	3600
16.0	**3600**	3599	3599	3599	3599	3599	3599	3600	3600	3600	3600	3600	3600	3600
16.5	**3600**	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.0	**3600**	3599	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
22.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
22.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
23.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
23.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
24.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
24.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
25.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
25.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
26.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
26.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
27.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600

Table 22-1: Power curve, Load Optimized Mode LO2

22.2 Ct Values, Load Optimized Mode LO2

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.855**	0.854	0.854	0.854	0.855	0.855	0.855	0.855	0.856	0.856	0.856	0.855	0.855	0.855
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.834**	0.843	0.842	0.842	0.841	0.840	0.839	0.838	0.837	0.837	0.836	0.835	0.833	0.832
7.5	**0.837**	0.848	0.847	0.846	0.846	0.845	0.844	0.843	0.842	0.841	0.840	0.839	0.836	0.835
8.0	**0.827**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.830	0.829	0.828	0.825	0.824
8.5	**0.786**	0.801	0.800	0.799	0.798	0.798	0.796	0.795	0.794	0.792	0.790	0.788	0.783	0.780
9.0	**0.723**	0.746	0.745	0.744	0.743	0.742	0.740	0.738	0.736	0.733	0.730	0.727	0.719	0.714
9.5	**0.650**	0.684	0.683	0.682	0.681	0.679	0.676	0.673	0.669	0.666	0.661	0.655	0.643	0.636
10.0	**0.572**	0.625	0.623	0.621	0.619	0.617	0.612	0.606	0.601	0.596	0.588	0.580	0.562	0.553
10.5	**0.491**	0.571	0.567	0.562	0.558	0.553	0.545	0.537	0.529	0.521	0.511	0.501	0.480	0.470
11.0	**0.418**	0.519	0.510	0.502	0.493	0.485	0.476	0.466	0.457	0.448	0.438	0.428	0.408	0.399
11.5	**0.357**	0.459	0.450	0.441	0.432	0.423	0.413	0.404	0.394	0.384	0.375	0.366	0.349	0.341
12.0	**0.308**	0.402	0.393	0.384	0.375	0.367	0.358	0.349	0.340	0.331	0.323	0.316	0.301	0.294
12.5	**0.269**	0.354	0.345	0.336	0.328	0.319	0.311	0.304	0.296	0.288	0.282	0.275	0.263	0.257
13.0	**0.236**	0.311	0.303	0.295	0.287	0.280	0.273	0.266	0.260	0.253	0.247	0.242	0.231	0.227
13.5	**0.211**	0.275	0.269	0.262	0.255	0.248	0.242	0.237	0.231	0.225	0.220	0.216	0.206	0.202
14.0	**0.188**	0.245	0.239	0.233	0.227	0.221	0.216	0.211	0.206	0.201	0.196	0.192	0.184	0.180
14.5	**0.169**	0.219	0.214	0.209	0.203	0.198	0.193	0.189	0.184	0.180	0.176	0.172	0.165	0.162
15.0	**0.151**	0.196	0.192	0.187	0.182	0.177	0.173	0.169	0.165	0.161	0.158	0.155	0.148	0.145
15.5	**0.137**	0.177	0.173	0.169	0.164	0.160	0.156	0.153	0.149	0.146	0.143	0.140	0.134	0.132
16.0	**0.125**	0.161	0.157	0.153	0.149	0.145	0.142	0.139	0.136	0.133	0.130	0.127	0.122	0.120
16.5	**0.114**	0.146	0.143	0.139	0.136	0.132	0.130	0.127	0.124	0.121	0.119	0.116	0.112	0.110
17.0	**0.104**	0.134	0.131	0.128	0.124	0.121	0.119	0.116	0.113	0.111	0.109	0.107	0.102	0.101
17.5	**0.096**	0.123	0.120	0.117	0.114	0.111	0.109	0.106	0.104	0.102	0.100	0.098	0.094	0.092
18.0	**0.088**	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
18.5	**0.082**	0.104	0.102	0.099	0.097	0.094	0.093	0.091	0.089	0.087	0.085	0.083	0.080	0.079
19.0	**0.075**	0.096	0.094	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.074	0.073
19.5	**0.070**	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.072	0.069	0.068
20.0	**0.066**	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.067	0.065	0.063
20.5	**0.061**	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.063	0.060	0.059
21.0	**0.057**	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.057	0.056
21.5	**0.054**	0.068	0.066	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053
22.0	**0.051**	0.064	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.050
22.5	**0.048**	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.047	0.047
23.0	**0.045**	0.056	0.055	0.054	0.053	0.051	0.050	0.050	0.049	0.048	0.047	0.046	0.045	0.044
23.5	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041
24.0	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.039
24.5	**0.038**	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037
25.0	**0.037**	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036	0.035
25.5	**0.035**	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035	0.034	0.034
26.0	**0.033**	0.041	0.040	0.039	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.032
26.5	**0.032**	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031
27.0	**0.030**	0.037	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.029

Table 22-2: C_t values, Load Optimized Mode LO2

22.3 Sound Curves, Load Optimized Mode LO2

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Load Optimized Mode LO2** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.6
8	102.2
9	102.5
10	102.5
11	102.5
12	102.5
13	102.5
14	102.5
15	102.5
16	102.5
17	102.5
18	102.5
19	102.5
20	102.5

Table 22-3: Sound curves, Load Optimized Mode LO2

23 Power Curves, Ct Values and Sound Curves, Load Optimized Mode LO2 (HWO)

NOTE The power curves and Ct values presented in Section 23 are not valid for hub heights ≤ 104 m. For hub heights ≤ 104 m, Vestas must be consulted for project specific evaluation.

23.1 Power Curves, Load Optimized Mode LO2 (HWO)

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**57**	32	35	37	39	41	43	46	48	50	52	55	59	61
3.5	**132**	91	95	99	102	106	110	114	117	121	125	128	136	140
4.0	**224**	162	168	173	179	185	190	196	201	207	213	218	229	235
4.5	**336**	250	257	265	273	281	289	297	305	313	321	329	344	352
5.0	**477**	358	369	380	391	402	412	423	434	445	456	466	488	499
5.5	**648**	490	504	519	533	547	562	576	590	605	619	633	662	676
6.0	**853**	649	668	686	705	724	742	761	779	798	816	835	872	890
6.5	**1095**	837	861	884	908	931	955	978	1002	1025	1049	1072	1119	1142
7.0	**1380**	1058	1088	1117	1146	1176	1205	1234	1264	1293	1322	1351	1409	1438
7.5	**1705**	1312	1348	1384	1420	1456	1492	1527	1563	1599	1634	1670	1741	1776
8.0	**2071**	1600	1643	1686	1730	1773	1816	1859	1902	1944	1987	2029	2113	2155
8.5	**2465**	1912	1963	2014	2065	2117	2167	2217	2268	2318	2367	2416	2513	2561
9.0	**2854**	2228	2288	2348	2408	2468	2525	2582	2639	2696	2748	2801	2904	2953
9.5	**3185**	2535	2603	2671	2739	2807	2865	2923	2981	3039	3088	3137	3226	3267
10.0	**3418**	2830	2899	2969	3039	3108	3160	3211	3262	3313	3348	3383	3443	3467
10.5	**3536**	3092	3153	3214	3276	3337	3373	3409	3445	3481	3500	3518	3547	3558
11.0	**3583**	3277	3326	3375	3423	3472	3494	3515	3537	3558	3566	3575	3587	3592
11.5	**3596**	3424	3456	3487	3518	3549	3559	3568	3578	3587	3590	3593	3597	3598
12.0	**3598**	3519	3535	3550	3566	3581	3585	3588	3592	3596	3597	3598	3599	3599
12.5	**3600**	3564	3571	3578	3586	3593	3594	3596	3597	3598	3599	3599	3600	3600
13.0	**3600**	3583	3586	3590	3593	3597	3597	3598	3599	3600	3600	3600	3600	3600
13.5	**3600**	3587	3590	3592	3595	3598	3599	3599	3599	3600	3600	3600	3600	3600
14.0	**3600**	3593	3594	3596	3598	3599	3599	3600	3600	3600	3600	3600	3600	3600
14.5	**3600**	3597	3597	3598	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600
15.0	**3600**	3596	3597	3598	3598	3599	3599	3600	3600	3600	3600	3600	3600	3600
15.5	**3600**	3598	3598	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600	3600
16.0	**3600**	3599	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
16.5	**3600**	3599	3599	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.0	**3600**	3599	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
17.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
18.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
19.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
20.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
21.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
22.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
22.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
23.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
23.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
24.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
24.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
25.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
25.5	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
26.0	**3600**	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
26.5	**3595**	3595	3595	3595	3595	3595	3595	3595	3595	3595	3595	3595	3595	3595
27.0	**3590**	3590	3590	3590	3590	3590	3590	3590	3590	3590	3590	3590	3590	3590
27.5	**3541**	3541	3541	3541	3541	3541	3541	3541	3541	3541	3541	3541	3541	3541

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
28.0	**3436**	3436	3436	3436	3436	3436	3436	3436	3436	3436	3436	3436	3436	3436
28.5	**3261**	3261	3261	3261	3261	3261	3261	3261	3261	3261	3261	3261	3261	3261
29.0	**3035**	3035	3035	3035	3035	3035	3035	3035	3035	3035	3035	3035	3035	3035
29.5	**2791**	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791	2791
30.0	**2549**	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549	2549
30.5	**2309**	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309	2309
31.0	**2074**	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074	2074
31.5	**1869**	1870	1870	1870	1870	1870	1869	1869	1869	1869	1869	1869	1869	1869
32.0	**1722**	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722	1722

Table 23-1: Power curve, Load Optimized Mode LO2 (HWO)

23.2 Ct Values, Load Optimized Mode LO2 (HWO)

Air density kg/m^3														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.878**	0.883	0.882	0.882	0.882	0.881	0.881	0.880	0.880	0.880	0.879	0.879	0.878	0.878
3.5	**0.852**	0.855	0.855	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.851	0.851
4.0	**0.852**	0.859	0.857	0.856	0.855	0.853	0.853	0.853	0.853	0.853	0.853	0.852	0.852	0.853
4.5	**0.855**	0.854	0.854	0.854	0.855	0.855	0.855	0.855	0.856	0.856	0.856	0.855	0.855	0.855
5.0	**0.851**	0.855	0.855	0.854	0.854	0.854	0.853	0.853	0.853	0.852	0.852	0.851	0.850	0.850
5.5	**0.846**	0.852	0.851	0.851	0.850	0.850	0.849	0.849	0.848	0.848	0.847	0.847	0.846	0.845
6.0	**0.841**	0.847	0.847	0.846	0.846	0.845	0.845	0.844	0.843	0.843	0.842	0.842	0.840	0.840
6.5	**0.835**	0.843	0.842	0.842	0.841	0.840	0.840	0.839	0.838	0.837	0.836	0.836	0.834	0.833
7.0	**0.828**	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.831	0.831	0.830	0.829	0.827	0.826
7.5	**0.831**	0.842	0.841	0.840	0.839	0.838	0.837	0.836	0.835	0.834	0.833	0.832	0.830	0.828
8.0	**0.831**	0.845	0.843	0.842	0.841	0.840	0.839	0.838	0.837	0.835	0.834	0.832	0.829	0.827
8.5	**0.802**	0.828	0.827	0.826	0.824	0.823	0.820	0.818	0.815	0.813	0.809	0.805	0.798	0.794
9.0	**0.739**	0.787	0.784	0.781	0.778	0.775	0.770	0.765	0.761	0.756	0.750	0.744	0.732	0.726
9.5	**0.660**	0.728	0.723	0.719	0.714	0.709	0.703	0.696	0.690	0.683	0.675	0.667	0.651	0.642
10.0	**0.576**	0.666	0.660	0.654	0.647	0.641	0.632	0.624	0.615	0.607	0.596	0.586	0.565	0.554
10.5	**0.492**	0.605	0.596	0.587	0.579	0.570	0.559	0.548	0.537	0.526	0.515	0.503	0.481	0.470
11.0	**0.418**	0.536	0.526	0.516	0.506	0.496	0.484	0.473	0.462	0.450	0.440	0.429	0.408	0.399
11.5	**0.357**	0.472	0.461	0.450	0.439	0.427	0.417	0.406	0.395	0.384	0.375	0.366	0.348	0.340
12.0	**0.308**	0.411	0.400	0.389	0.378	0.368	0.358	0.349	0.340	0.331	0.323	0.315	0.301	0.294
12.5	**0.268**	0.357	0.348	0.338	0.328	0.319	0.311	0.303	0.295	0.288	0.281	0.275	0.263	0.257
13.0	**0.236**	0.312	0.304	0.296	0.287	0.279	0.272	0.266	0.259	0.253	0.247	0.242	0.231	0.227
13.5	**0.211**	0.276	0.269	0.262	0.255	0.248	0.242	0.237	0.231	0.225	0.220	0.215	0.206	0.202
14.0	**0.188**	0.245	0.239	0.233	0.227	0.220	0.215	0.210	0.205	0.201	0.196	0.192	0.184	0.181
14.5	**0.169**	0.219	0.214	0.208	0.203	0.197	0.193	0.189	0.184	0.180	0.176	0.172	0.165	0.162
15.0	**0.152**	0.196	0.191	0.186	0.182	0.177	0.173	0.169	0.165	0.161	0.158	0.155	0.149	0.146
15.5	**0.137**	0.177	0.173	0.168	0.164	0.160	0.156	0.153	0.149	0.146	0.143	0.140	0.135	0.132
16.0	**0.125**	0.160	0.157	0.153	0.149	0.145	0.142	0.139	0.136	0.133	0.130	0.128	0.123	0.120
16.5	**0.114**	0.146	0.143	0.139	0.136	0.132	0.130	0.127	0.124	0.121	0.119	0.116	0.112	0.110
17.0	**0.105**	0.134	0.130	0.127	0.124	0.121	0.119	0.116	0.114	0.111	0.109	0.107	0.103	0.101
17.5	**0.096**	0.122	0.120	0.117	0.114	0.111	0.109	0.107	0.104	0.102	0.100	0.098	0.094	0.093
18.0	**0.089**	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
18.5	**0.082**	0.104	0.102	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.084	0.081	0.079
19.0	**0.076**	0.096	0.094	0.091	0.089	0.087	0.085	0.084	0.082	0.080	0.079	0.077	0.074	0.073
19.5	**0.070**	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.072	0.069	0.068
20.0	**0.066**	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.067	0.065	0.063
20.5	**0.061**	0.077	0.075	0.074	0.072	0.070	0.069	0.068	0.066	0.065	0.064	0.063	0.060	0.059
21.0	**0.057**	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.060	0.059	0.057	0.056
21.5	**0.054**	0.068	0.066	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053
22.0	**0.051**	0.064	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.050
22.5	**0.048**	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.047	0.047
23.0	**0.045**	0.056	0.055	0.054	0.053	0.051	0.050	0.050	0.049	0.048	0.047	0.046	0.045	0.044
23.5	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041
24.0	**0.041**	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.039
24.5	**0.038**	0.047	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.037
25.0	**0.037**	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039	0.038	0.038	0.037	0.036	0.035
25.5	**0.035**	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.037	0.036	0.035	0.034	0.034
26.0	**0.033**	0.041	0.040	0.039	0.038	0.037	0.037	0.036	0.035	0.035	0.034	0.034	0.033	0.032
26.5	**0.032**	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031	0.031
27.0	**0.030**	0.037	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.029
27.5	**0.028**	0.034	0.034	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028
28.0	**0.026**	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027	0.026	0.026
28.5	**0.024**	0.029	0.029	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.024	0.024	0.023
29.0	**0.022**	0.026	0.026	0.025	0.025	0.024	0.024	0.023	0.023	0.023	0.022	0.022	0.021	0.021
29.5	**0.019**	0.023	0.023	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019	0.019	0.019
30.0	**0.017**	0.020	0.020	0.020	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017	0.016
30.5	**0.015**	0.018	0.017	0.017	0.017	0.016	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.014
31.0	**0.013**	0.015	0.015	0.015	0.015	0.014	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
31.5	**0.011**	0.013	0.013	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011
32.0	**0.010**	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.010	0.010	0.010

Table 23-2: C_t values, Load Optimized Mode LO2 (HWO)

23.3 Sound Curves, Load Optimized Mode LO2 (HWO)

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Load Optimized Mode LO2 (HWO)** **(Blades with serrated trailing edge)**
3	90.9
4	91.1
5	92.9
6	96.0
7	99.6
8	102.2
9	102.5
10	102.5
11	102.5
12	102.5
13	102.5
14	102.5
15	102.5
16	102.5
17	102.5
18	102.5
19	102.5
20	102.5

Table 23-3: Sound curves, Load Optimized Mode LO2 (HWO)