RISE ABOVE

AW3000

ACCIONA Windpower has seen explosive growth of orders for its AW3000 platform. This success is due to a track record of reliability and product innovation coming from one of the most experienced wind energy companies in the world. The latest evolution is the AW132/3000 for low-wind sites, which delivers the lowest cost of energy in this segment. Partner with ACCIONA Windpower to make your projects rise above the competition.

OPTIMIZED PERFORMANCE FOR ALL SITES

- Full suite of rotor options covering all wind conditions, including the AW132/3000 for low-wind sites
- Steel and concrete tower options with hub heights from 84 to 137.5 meters
- Proven and bankable designs including double-bearing support on main shaft, glass fiber and epoxy blades and DFIG electrical generation

BUILT BY OPERATORS FOR OPERATORS

- Based on a scaled design of our successful AW1500, the AW3000 provides more energy capture per wind turbine location
- Our track record of fleet wind turbine performance includes global average availability over 98% and extremely low failure rates of major components

COMPATIBILITY & CONTROL

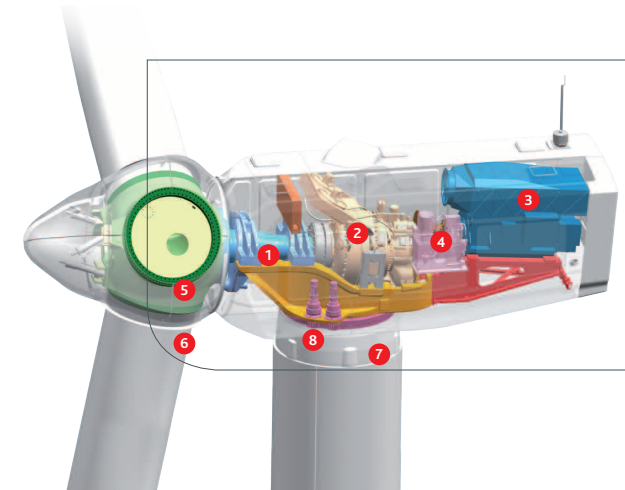
- Zero voltage ride-through beyond current regulatory requirements, in addition to grid integration and reactive power solutions to allow for maximum control for stringent grid codes
- Control software that allows intelligent automatic monitoring and operation

SAFETY

- Hydraulic pitch control for safe and reliable blade pitching in all wind environments
- Two-person lift; hub access from inside the nacelle; and spacious, ergonomic nacelle design allow for operational efficiency

12 KV VERSUS 690 V

- This configuration, proven in our wind turbines, can remove the step-up transformer from the equation and is ideal for projects that are in close proximity to the substation
- The result is significant savings over the life of the project
- Up to 50% savings in collection system costs
- Average of 1% greater energy productions due to the avoidance of transformer electrical losses
- Avoidance of maintenance and potential failures of transformers



AW3000 DESIGN ADVANTAGES

1) Double bearing-supported main shaft
2) Robust gearbox with HALT completed
3) 6 pole DFIG 12 kV generator
4) Elastic coupling
5) Cast hub with access from nacelle
6) Blades with structural shell design and proven materials including glass fiber and epoxy resin
7) Steel and concrete tower options from 84m to 137.5m hub heights
8) Yaw bearing and caliper brakes

acciona Windpower

AW3000

AW 100/3000 | AW 116/3000 | AW 125/3000 | AW 132/3000

AW3000

TECHNICAL SPECIFICATIONS

MODEL	AW 100/3000	AW 116/3000	AW 125/3000	AW 132/3000
Rotor diameter	100 m	116 m	125 m	132 m
Wind class	IEC Ia	IEC IIa	IEC IIb/IIIa	IEC IIIb
Turbine suitability	High wind sites	Medium wind sites with higher turbulence intensity	Medium wind sites with low turbulence intensity	Low wind sites with low turbulence intensity
OPERATING DATA				
Cut-in wind speed	4 m/s	3.5 m/s	3.5 m/s	3 m/s
Cut-out wind speed	25 m/s	25 m/s	25 m/s	25 m/s
Cold Weather Operational Temperature range (Optional)	-30°C to + 40°C			
Power factor range	+/- 0.93 (1,200 kVA) dynamic between +/- 5% p.u. voltage			
Zero voltage ride through	Meets or exceeds global requirements			
ROTOR				
Swept area	7,854 m²	10,568 m²	12,305 m²	13,720 m²
Power regulation	Independent pitch regulated with variable speed			
DRIVE TRAIN				
Gearbox	3 stages: 2 planetary, 1 parallel (helical)			
Bearings	Double spherical roller bearings			
Lubrication	Pressure and splash with oil cooler/oil filter			
PITCH SYSTEM				
Actuation	Hydraulic cylinders			
Failsafes	Blade-independent piston accumulators on hub			
YAW SYSTEM				
Type	Four-point ball bearing, external gear			
Slewing ring	External			
Braking system	Disk+callipers, plus electro-mechanical brake per motor drive			
GENERATOR				
Type	6 poles, double feeding			
Frequency	50/60 Hz			
Nominal voltage	12,000 V (able to eliminate step-up transformers depending on wind farm layout)			
TOWER				
Steel hub height options (m)	-	92	87.5	84
Steel tower number of sections	-	4	4	4
Concrete hub height options (m)	100	100, 120	100, 120, 137.5	120
Concrete tower number of sections	5	5, 6	5, 6, 7	6
NACELLE				
Weight (tons)	111 t (without hub)			
Dimensions	10.9 m (length) 4.09 m (width) 4.15 m (height)			
Transportability	Four options (split nacelle), and rail capable			
LIFE AND HOIST CAPACITIES				
Service lift capacity	250 kg			
Onboard crane hoist lift capacity	500 kg			

www.acciona-windpower.com
infowindpower@acciona.es

G126-2.5 MW

Benchmark in return for low-wind sites

Gamesa maintains its unwavering commitment to continue developing the best technological solutions for its clients while reducing the cost of energy of its products as much as possible. One example is Gamesa's latest technological design unveiled for its 2.5 MW product line, the new G126-2.5 MW IIIA wind turbine. Intended for low-wind sites, with this new model Gamesa will provide clients with the most competitive class III product on the market in the 2 to 3 MW power capacity segment.

The new G126-2.5 MW IIIA wind turbine, featuring a new 126-meter rotor combined with a 2.5 MW generator, is a benchmark for return in the main segment of the onshore wind power market, which is among the most competitive.

The knowledge acquired through the launching of Gamesa's latest products has been a key factor in the design of this new model. With an optimized product development methodology and new testing and validation procedures, the time to market for this new turbine has been significantly reduced.

Thanks to an extremely low power density, excellent capacity factor and reduced cost of energy, the G126-2.5 MW wind turbine has received a remarkable welcome in the sector and is destined to take its place as an industry leader alongside Gamesa's G114-2.0 MW wind turbine. As a matter of fact, the G126-2.5 MW model has recently been awarded Best Turbine Of The Year 2016 in the category of less than 3 MW by the publication Windpower Monthly.

- PROVEN TECHNOLOGY
- 20-25% MORE ENERGY PRODUCTION*
- EXCELLENT CAPACITY FACTOR AND REDUCED COST OF ENERGY
- OPTIMIZED FOR LOW-WIND SITES
- **G126-2.625 MW** ALSO AVAILABLE

WIND POWER MONTHLY
BEST ONSHORE TURBINE TO 2.9MW
2016

** Compared with G114-2.0 MW.*

GLOBAL TECHNOLOGY
EVERLASTING ENERGY

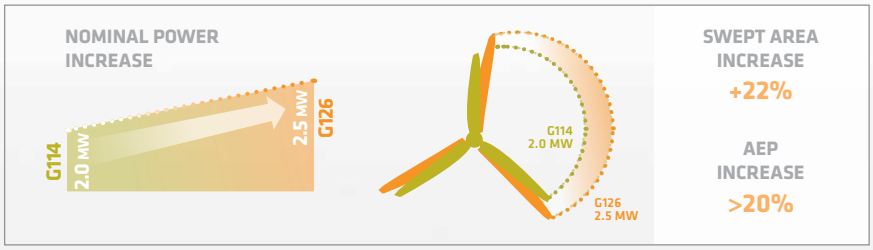
Gamesa

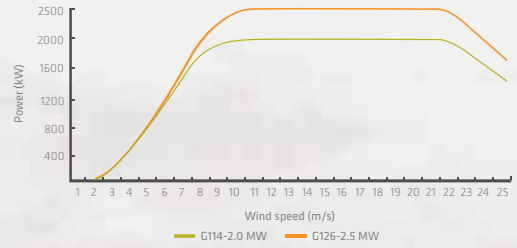
NEW MODEL G126-2.5 MW IIIA

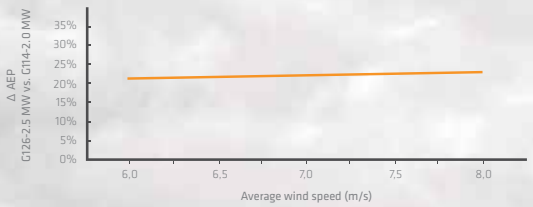
Gamesa harnessed the experience acquired through the installation of 26 GW of its high performance 2.0 MW platform to develop this new model, capable of generating even more power at low-wind sites while remaining as competitive as the existing models with smaller rotor. The company's most recently developed turbines thus emerge through this approach: G114-2.0 MW IIA/IIIA, G114-2.5 MW IIA, and now G126-2.5 MW IIIA.

Following the evolutionary model of the 2.5 platform, and minimizing the risk associated with new technologies, the G126-2.5 MW is equipped with a 62 meter blade based on the 56-meter variant already delivering maximum production at lower noise and comprehensively validated for G114 turbines. Based on the same principle, the electrical system incorporated in the G126 is common for all 2.5 MW models.

Boasting a 20% increase in power production compared to the G114-2.0 MW model, the G126-2.5 MW wind turbine rounds off Gamesa's offering for Class III sites. With this new addition, Gamesa completes its 2.5 MW product portfolio, with three different rotors, tower heights from 68 to 137 meters, and environmental options enabling installation at even the most complex sites.







SPECIFICATIONS

General Details	G126-2.5 MW	G126-2.625 MW
Rated power	2.5 MW	2.625 MW
Wind class	IIIA	IIIA
Rotor diameter	126 m	126 m
Swept area	12,469 m^2	12,469 m^2
Power density	200.50 W/m^2	210.52 W/m^2
Control	Pitch and variable speed	Pitch and variable speed
Gearbox	3 stages	3 stages
Generator	Doubly fed	Doubly fed
Frequency	50Hz / 60 Hz	50Hz / 60 Hz
Blades		
Length	62 m	62 m
Airfoil	Gamesa	Gamesa
Towers		
Height	84, 102, 129, 137 m and site specific	84, 102, 129, 137 m and site specific

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Gamesa

C/ Ciudad de la Innovación, 9-11
31621 Sarriguren (Spain)
Tel: +34 948 771 000
Fax: +34 948 165 039
info@gamesacorp.com
www.gamesacorp.com

AUSTRALIA
Level 39 , 385 Bourke Street
Melbourne VIC 3000

BRAZIL
Eldorado Business Tower
Av. das Nações Unidas, 8.501 I 5° andar
Pinheiros, São Paulo - SP
Tel: +55 11 3096 4444

CHILE
Presidente Riesco 5335 – Piso 9
Las Condes - Santiago
Tel: +56 (2) 2714 3872

CHINA
23/F, Tower 1, Beijing Prosper Center No. 5
Guanghua Road, Chaoyang District,
Beijing 100020
Tel: +86 10 5789 0899
Fax: +86 10 5761 1996

EGYPT
3, Rd 218 Degla
11431 Maadi, Cairo
Tel: +20 225 211 048
Fax: +20 225 211 282

FRANCE
97 Allée Borodine - Cedre 3
69800 Saint Priest
Tel: +33 (0) 4 72 79 49 39

GERMANY
Röntgenstraße 28
22335 Hamburg Fuhlsbüttel
Tel: +49 40 537 998 440

GREECE
9 Adrianiou str,
11525 Neo Psychiko, Athens
Tel: +30 21067 53300
Fax: +30 21067 53305

HONG KONG
Asia Pacific Oceania
Central Plaza, 35th Floor, 18, Harbour Road
Hong Kong SAR
Tel: +852 2593 1140

INDIA
The Futura IT Park, B-Block, 8th Floor
334, Rajiv Gandhi Salai
Sholinganallur, Chennai - 600 119
Tel: +91 44 3924 2424
sales.india@gamesacorp.com

ITALY
Via Ostiense 131/L
Corpo C1 – 9° piano
00154 Rome
Tel: +39 06 5750531
Fax: +39 06 5754735

JAPAN
TOC Minatomirai Bldg. 10F,
1-1-7 Sakuragi-cho, Naka-ku,
Yokohama-shi, Kanagawa 231-0062
T: +81 80 3465 6861

MEXICO
Torre Mayor
Paseo de la Reforma 505, piso 37
Col. Cuauhtémoc
C.P. 06500, Ciudad de México
Tel: +52 55 50179700

PHILIPPINES
22th Floor, The Enterprise Center Tower I
1226 Ayala Avenue
Makati City Philippines
Tel: +63 917 820 4414

POLAND
Ul. Galaktyczna 30A
80-299 Gdansk
Tel: +48 58 766 62 62
Fax: +48 58 766 62 99
poland.wind@gamesacorp.com

ROMANIA
169A Calea Floreasca Street,
Building A, 4th Floor, Office no 2069, Sector 1
014459 Bucarest
Tel: +40 318 21 24
Fax: +40 318 60 21 00

SRI LANKA
#51/1, Colombo Road,
Kurana, Katunayake
Tel: +94 31 2235890

SWEDEN, FINLAND, NORWAY
Bibilotekstorget 8
171 45 Solna (Sweden)
Tel: +46 (0) 8 510 668 10

THAILAND
Sathorn Square, 98 North Sathorn Road
37/F Sathorn Square
Silom, Bangkok
Bangkok 10500

TURKEY
Astoria, Buyukdere Cad. No. 127, Kule A, Kat 10
Esentepe, Istambul 34394
Tel: +90 212 340 76 00

UNITED KINGDOM
Braidhurst House
Finch Way, Strathclyde Business Park,
Bellshill ML4 3PE
Tel: +44 1698 572 860

UNITED STATES
1150 Northbrook Drive
Trevose, PA 19053
Tel: +1 215 710 3100
Fax: +1 267 790 0453

G132-3.3 MW

Optimum CoE for sites with medium winds

One of the keys to Gamesa's success is the constant development of new and advanced products adapted to customers' needs in any type of site and with maximum profitability.

With this purpose in mind the new Gamesa 3.3 MW platform has been launched with its first model: the G132-3.3 MW wind turbine for Class II sites. A new generation of multi-megawatt turbines that reaches the market to become the best solution in terms of Cost of Energy in the 3.0-3.6 MW segment, one of the most competitive and demanding. This new platform, together with the current Gamesa 2.0 MW, Gamesa 2.5 MW and Gamesa 5.0 MW, makes the company product portfolio one of the most complete and versatile in the market and allows Gamesa to assure the best solution for customers' projects.

Thanks to the operative experience accumulated by Gamesa throughout more than 20 years in the wind energy market, the G132-3.3 MW wind turbine enables the company to guarantee the highest levels of reliability. The use of mature and proven technology available in Gamesa's current portfolio has resulted in the first G132-3.3 MW prototype installed in 2016.

- The BEST CoE in the 3.0-3.6 MW segment
- New platform based on MATURE and PROVEN TECHNOLOGY
- 34% LARGER SWEPT AREA*
- **G132-3.465 MW** ALSO AVAILABLE

** vs. G114-2.0 MW and G114-2.5 MW.*

GLOBAL TECHNOLOGY
EVERLASTING ENERGY

Gamesa

NEW G132-3.3 MW IIA WIND TURBINE

The G132-3.3 MW IIA wind turbine is integrated in the portfolio of Gamesa with a clear objective: to complement the product offer for medium-wind sites in markets where the customers require solutions with nominal powers higher than 3 MW.

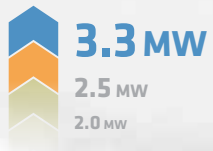
The G132-3.3 MW turbine improves on the production capacity of the models G114-2.0 MW and G114-2.5 MW, available for Class II sites, both boosting the nominal power up to 3.3 MW and increasing the rotor swept area by 34%, which makes it one of the most efficient and cost-effective solutions for medium-wind sites.

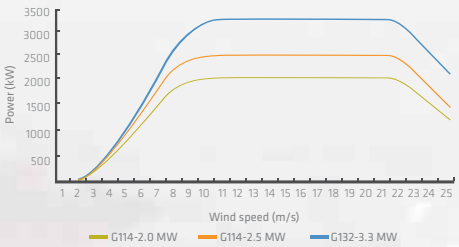
With a 64.5 m fiberglass blade, optimized for Class II sites and with airfoils that have already been thoroughly tested and validated in the G132-5.0 MW IIA wind turbine (first prototype installed in Alaiz -Spain- in the second quarter of 2015), the new model G132-3.3 MW guarantees maximum energy production and low noise emission levels, with maximum theoretical value for this turbine fixed at 105.7 dBA.

Gamesa incorporates proven technology into this model, such as the combination of a three-stage gearbox (two planetary stages and one parallel) and a doubly-fed induction generator, the same solution used in the Gamesa 2.0 MW platform, which has 26 GW installed worldwide.

The G132-3.3 MW wind turbine also has an extensive portfolio of towers with heights ranging from 84 m to 154 m, which enables it to comply with the different maximum blade tip height restrictions in certain markets.

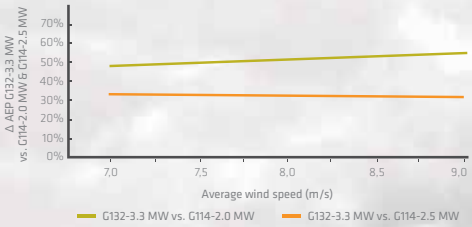
NOMINAL POWER INCREASE





SWEPT AREA INCREASE

AEP INCREASE



SPECIFICATIONS

General Details	G132-3.3 MW	G132-3.465 MW
Rated power	3.3 MW	3.465 MW
Wind class	IIA	IIA
Rotor diameter	132 m	132 m
Swept area	13,685 m²	13,685 m²
Power density	241.14 W/m²	253.20 W/m²
Control	Pitch and variable speed	Pitch and variable speed
Gearbox	3 stages	3 stages
Generator	Doubly fed	Doubly fed
Frequency	50 Hz / 60 Hz	50 Hz / 60 Hz
Blades		
Length	64.5 m	64.5 m
Airfoil	Gamesa	Gamesa
Towers		
Height	84, 97, 114, 134, 154 m and site specific	84, 97, 114, 134, 154 m and site specific

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Gamesa

C/ Ciudad de la Innovación, 9-11
31621 Sarriguren (Spain)
Tel: +34 948 771 000
Fax: +34 948 165 039
info@gamesacorp.com
www.gamesacorp.com

AUSTRALIA
Level 39 , 385 Bourke Street
Melbourne VIC 3000

BRAZIL
Eldorado Business Tower
Av. das Nações Unidas, 8.501 I 5º andar
Pinheiros, São Paulo - SP
Tel: +55 11 3096 4444

CHILE
Presidente Riesco 5335 – Piso 9
Las Condes - Santiago
Tel: +56 (2) 2714 3872

CHINA
23/F, Tower 1, Beijing Prosper Center No. 5
Guanghua Road, Chaoyang District,
Beijing 100020
Tel: +86 10 5789 0899
Fax: +86 10 5761 1996

EGYPT
3, Rd 218 Degla
11431 Maadi, Cairo
Tel: +20 225 211 048
Fax: +20 225 211 282

FRANCE
97 Allée Borodine - Cedre 3
69800 Saint Priest
Tel: +33 (0) 4 72 79 49 39

GERMANY
Röntgenstraße 28
22335 Hamburg Fuhlsbüttel
Tel: +49 40 537 998 440

GREECE
9 Adrianiou str,
11525 Neo Psychiko, Athens
Tel: +30 21067 53300
Fax: +30 21067 53305

HONG KONG
Asia Pacific Oceania
Central Plaza, 35th Floor, 18, Harbour Road
Hong Kong SAR
Tel: +852 2593 1140

INDIA
The Futura IT Park, B-Block, 8th Floor
334, Rajiv Gandhi Salai
Sholinganallur, Chennai - 600 119
Tel: +91 44 3924 2424
sales.india@gamesacorp.com

ITALY
Via Ostiense 131/L
Corpo C1 – 9° piano
00154 Rome
Tel: +39 06 5750531
Fax: +39 06 5754735

JAPAN
TOC Minatomirai Bldg. 10F,
1-1-7 Sakuragi-cho, Naka-ku,
Yokohama-shi, Kanagawa 231-0062
T: +81 80 3465 6861

MEXICO
Torre Mayor
Paseo de la Reforma 505, piso 37
Col. Cuauhtémoc
C.P. 06500, Ciudad de México
Tel: +52 55 50179700

PHILIPPINES
22th Floor, The Enterprise Center Tower I
1226 Ayala Avenue
Makati City Philippines
Tel: +63 917 820 4414

POLAND
Ul. Galaktyczna 30A
80-299 Gdansk
Tel: +48 58 766 62 62
Fax: +48 58 766 62 99
poland.wind@gamesacorp.com

ROMANIA
169A Calea Floreasca Street,
Building A, 4th Floor, Office no 2069, Sector 1
014459 Bucarest
Tel: +40 318 21 24
Fax: +40 318 60 21 00

SRI LANKA
#51/1, Colombo Road,
Kurana, Katunayake
Tel: +94 31 2235890

SWEDEN, FINLAND, NORWAY
Bibliotekstorget 8
171 45 Solna (Sweden)
Tel: +46 (0) 8 510 668 10

THAILAND
Sathorn Square, 98 North Sathorn Road
37/F Sathorn Square
Silom, Bangkok
Bangkok 10500

TURKEY
Astoria, Buyukdere Cad. No. 127, Kule A, Kat 10
Esentepe, Istambul 34394
Tel: +90 212 340 76 00

UNITED KINGDOM
Braidhurst House
Finch Way, Strathclyde Business Park,
Bellshill ML4 3PE
Tel: +44 1698 572 860

UNITED STATES
1150 Northbrook Drive
Trevose, PA 19053
Tel: +1 215 710 3100
Fax: +1 267 790 0453

GE Renewable Energy

GE's 3 MW Platform

POWERFUL AND EFFICIENT

www.ge.com/wind

GE'S **3 MW PLATFORM**

Since entering the wind industry in 2002, GE Renewable Energy has invested more than $2 billion in next-generation wind turbine technology to provide more value to customers—whether at the turbine, plant or grid level. Through the use of advanced analytics, GE Renewable Energy is redefining the future of wind power, delivering with proven performance, availability and reliability. With the integration of big data and the industrial internet, we can help customers manage the variability that comes with this resource for smooth, predictable power. Our onshore product portfolio includes wind turbines with rated capacities from 1.6-3.8 MW and flexible support services that range from basic operations and maintenance to farm- or fleet-level enhancements.

For more information visit our website:
www.ge.com/wind

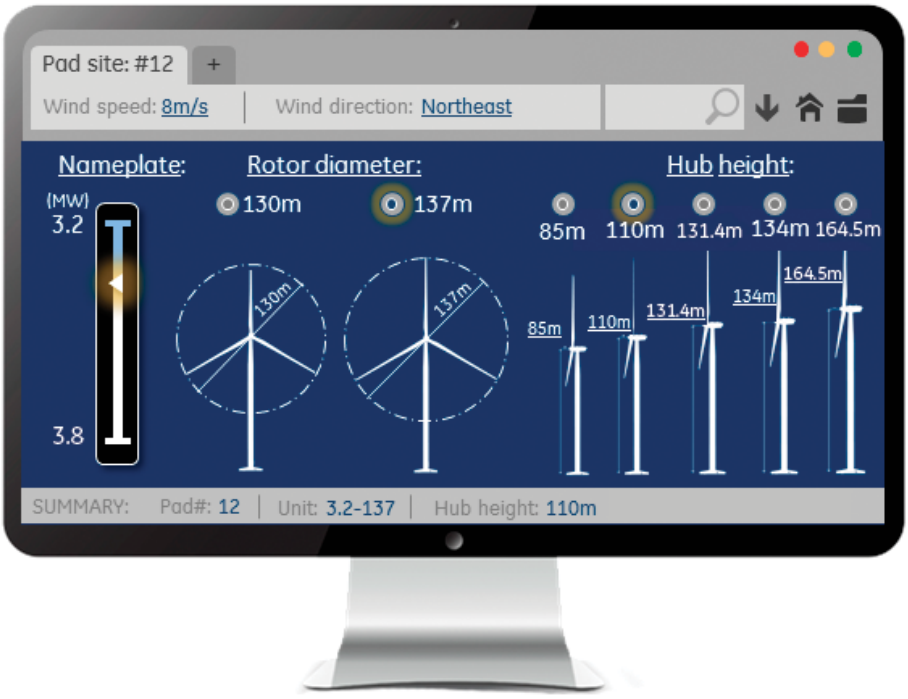
GE's 3 MW Platform

Extending the capability of the Digital Wind Farm to our 3 MW machines, GE's powerful and efficient 3.2–3.8 platform is adaptable to a full spectrum of wind regimes. The platform includes the 3.6-137, our highest performing turbine for Class III winds.

GE has employed selected legacy components with proven performance for the 3 MW platform, helping to ensure the consistent performance and reliability for which GE wind turbines are known. Turbine models within the 3 MW platform share drivetrain and electrical system architecture, with both systems scaled and upgraded for improved performance and greater energy production, as compared to previous models.

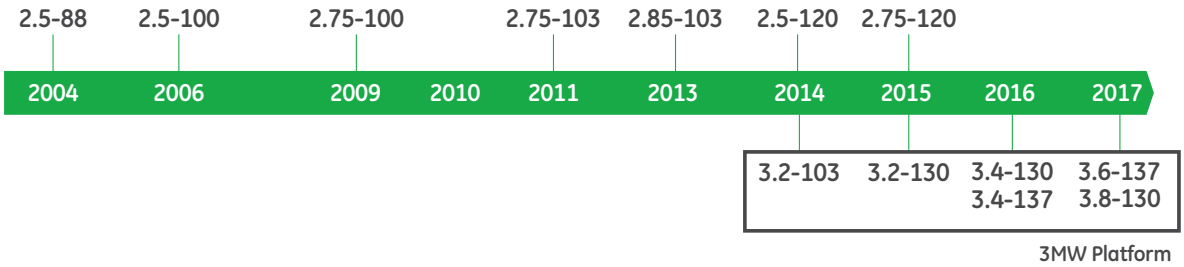
Parameters of the 3MW Platform

GE's 3MW platform can be customized based on nameplate, rotor diameter and hub height.



Building Upon Proven Technology

Model introduction
in Europe



Built from the maturity of its predecessors, the 3 MW platform increases the capacity factor, annual energy production (AEP) and application space. Component enhancements to the 2.5 MW models have resulted in a substantial performance increase, enabling the use of a 130- and 137- meter rotor on the 3 MW series and a nameplate ranging from 3.2–3.8 MW. These enhancements include gearbox and controls improvements, and a new aerodynamic structure enabling a greater blade length (130–137 meter rotor). Crafted for high reliability, GE's 3 MW platform offers excellent availability that is comparable to the 2.5 MW series units operating in the field today.

Technical Description

GE's 3 MW platform machines are three-blade, upwind, horizontal axis wind turbines with a rotor diameter ranging from 130 to 137 meters. The turbine rotor and nacelle are mounted on top of a tubular steel tower, with a range of hub height options that includes 85-, 110-, 131.4-, 134- and 164.5-meter variants. The turbines use active yaw control to keep the blades pointed into the wind. The 3 MW platform is engineered to operate at variable speeds and uses a doubly fed asynchronous generator with a partial power converter system.

Specifications

3 MW platform

- Standard and cold weather extreme options
- Standard tower corrosion protection: C2 internal and C3 external with internal and external C4/C5 options available
- Rotational direction: Clockwise viewed from an upwind location
- Speed regulation: Electric drive pitch control with battery backup
- Aerodynamic brake: Full feathering of blade pitch

GE's 3.2-130 IEC 2B/3A

- Up to 20% higher output than GE's 2.5-120
- Improved load management system and more efficient drive train technology
- Same electrical system as 3.2-103 turbine
- Sound power level of 106 db(A), reduced noise modes available
- Tip heights include 150 m, 175 m, and 199 m rotor

GE's 3.8-130 IEC2B

- Up to 30% higher output than GE's 3.2-103
- Increased electrical rating of 3.4 MW combined with 130-meter rotor
- 106.5 dB(A) normal operation sound power level, reduced noise modes available
- Tip heights include 150 m, 175 m, 199 m, and 233 m

GE's 3.6-137 IEC3B

- Up to 28% higher output than GE's 2.75-120
- New blade for more efficient production in low wind conditions
- Sound power level of 106 db(A), reduced noise modes available
- Tip heights include 178.5 m, 199 m, and 223 m

Features and Benefits

- Engineered to meet or exceed the 2.5 MW platform's historic high availability
- Available grid-friendly options:
  — Enhanced Reactive Power, Low & Zero Voltage Ride Thru, Power Factor Control, WindFreeReactive Power
- Wind Farm Control System; WindSCADA*
- Available in both 50 Hz and 60 Hz versions

Construction

Towers:

- Tubular steel sections provide a hub height of 85 m, 110 m, and 131 m
- Hybrid pre-cast concrete/tubular steel towers for multiple hub heights
- Logistic friendly tower for a hub height of 85 m, 110 m, and 131 m

Blades:

- 63.7-meter blades (130-meter rotor); 67.2-meter blades (137-meter rotor)

Drivetrain components:

- GE's 3 MW platform uses an enhanced gearbox, main shaft with double bearings, and generator with appropriate improvements to enable the 130- and 137-meter diameter rotor in medium and lower wind speeds.

Enhanced Controls Technology

The 3 MW platform uses enhanced controls features:

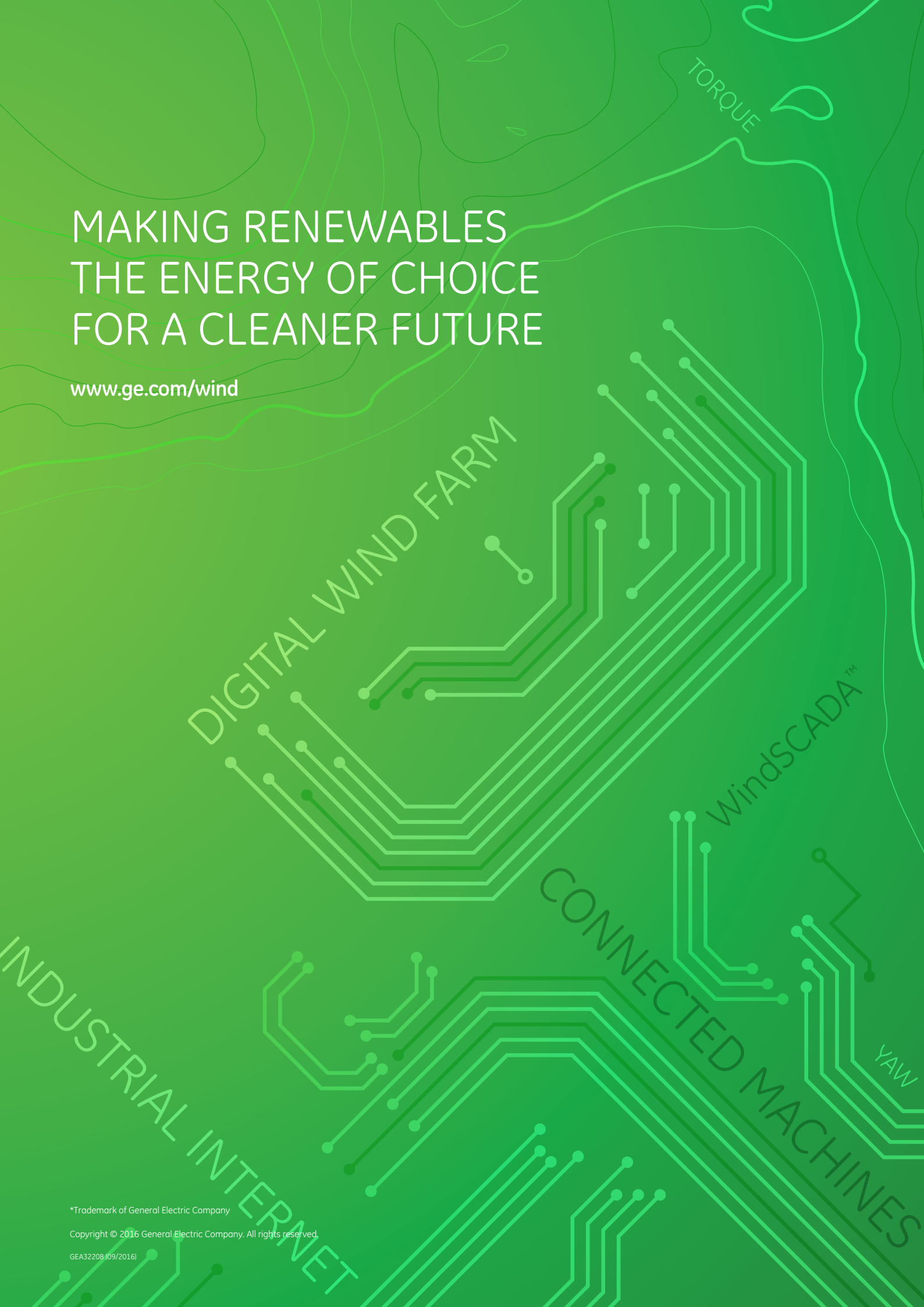
- GE's patented Advanced Loads Control reduces loads on turbine components by measuring stresses and individually adjusting blade pitch.
- Controls were developed by GE Global Research to reduce extreme loads, including those near rated wind speeds, to improve annual energy production (AEP).

Condition Monitoring System

GE's Condition Monitoring System (CMS) and SCADA Anomaly Detection Services, a complementary suite of advanced condition monitoring solutions, proactively detects impending drive train and whole-turbine issues, enabling increased availability and decreased maintenance expenses. Built upon half a century of power generation drivetrain and data anomaly monitoring experience, this service solution is now standard on GE's 3 MW platform.

MAKING RENEWABLES THE ENERGY OF CHOICE FOR A CLEANER FUTURE

www.ge.com/wind



GEA32208 (09/2016)

DELTA GENERATION

PROVEN TECHNOLOGY – AT A NEW STAGE OF EVOLUTION

N100/3300
N117/3000
N131/3000

NORDEX
We've got the power.

CONTENTS

TECHNICAL DEVELOPMENT AT NORDEX
Experience keeps us one step ahead

As one of the pioneers in the modern use of wind energy, Nordex has been developing increasingly efficient wind turbines for use onshore since 1985. Since then, we have always remained true to proven principles, using tried-and-tested series engineering and giving top priority to the reliability of all system components.

In 2000, Nordex installed the first 2.5 megawatt series turbine in the world. Since then, the company has connected more than 4,000 machines from this platform to the grid at a wide range of locations around the world. We know what we're talking about when we claim that our wind turbine generators offer quality, mature technology and dependable performance, even in extreme locations.

With Delta Generation, we are now offering the fourth turbine generation of our proven multi-megawatt platform. Thanks to its larger rotors, greater nominal capacity and optimised technical systems, Delta Generation sets new standards for economic efficiency, reliability and service- and HSE-friendliness.

MATURE TECHNOLOGY
Proven concepts ensure a secure investment

With the new Delta Generation, Nordex customers benefit from the know-how we have gathered in the multi-megawatt range over many years. Mature technical solutions that have proven their worth thousands of times form a sound basis for the new generation.

Continuity: The electrical system

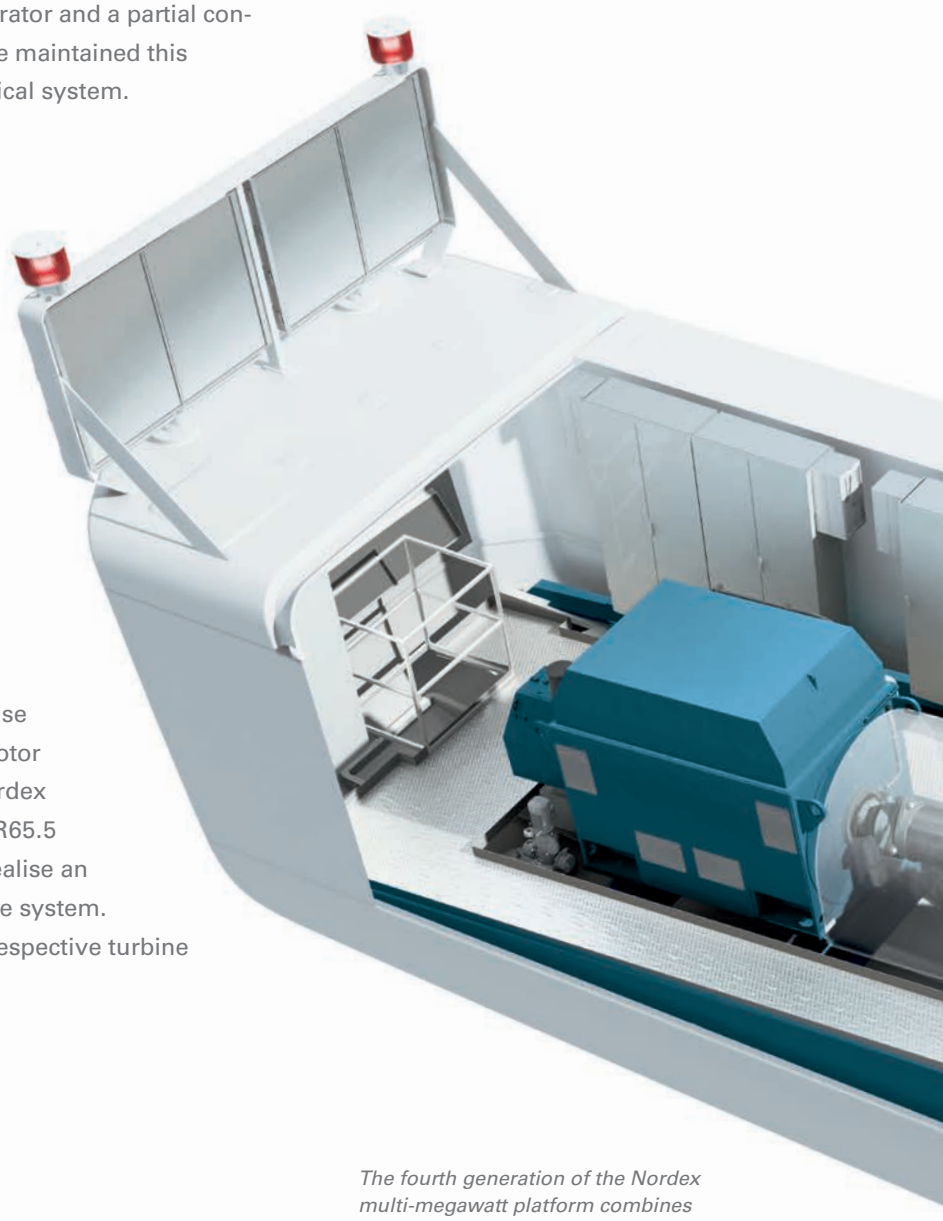
Even the first Nordex multi-megawatt turbine was equipped with a doubly fed asynchronous generator and a partial converter. With Delta Generation, we have maintained this proven and highly economical electrical system.

Tried-and-tested drive train concept

The drive train system is based on a modular drive train layout with a three-point suspension. We have used this system successfully from the outset. Together with our qualified suppliers, we work on continuously improving our drive train components. This delivers the output required while maintaining availability at a high level.

Proven rotor blade designs

The turbines of the new generation use proven aerodynamic designs for the rotor diameters of 100 and 117 metres. Nordex developed the NR50, NR58.5 and NR65.5 blades in-house. This allowed us to realise an optimal concept for the overall turbine system. The efficient rotor blades match the respective turbine technology perfectly.



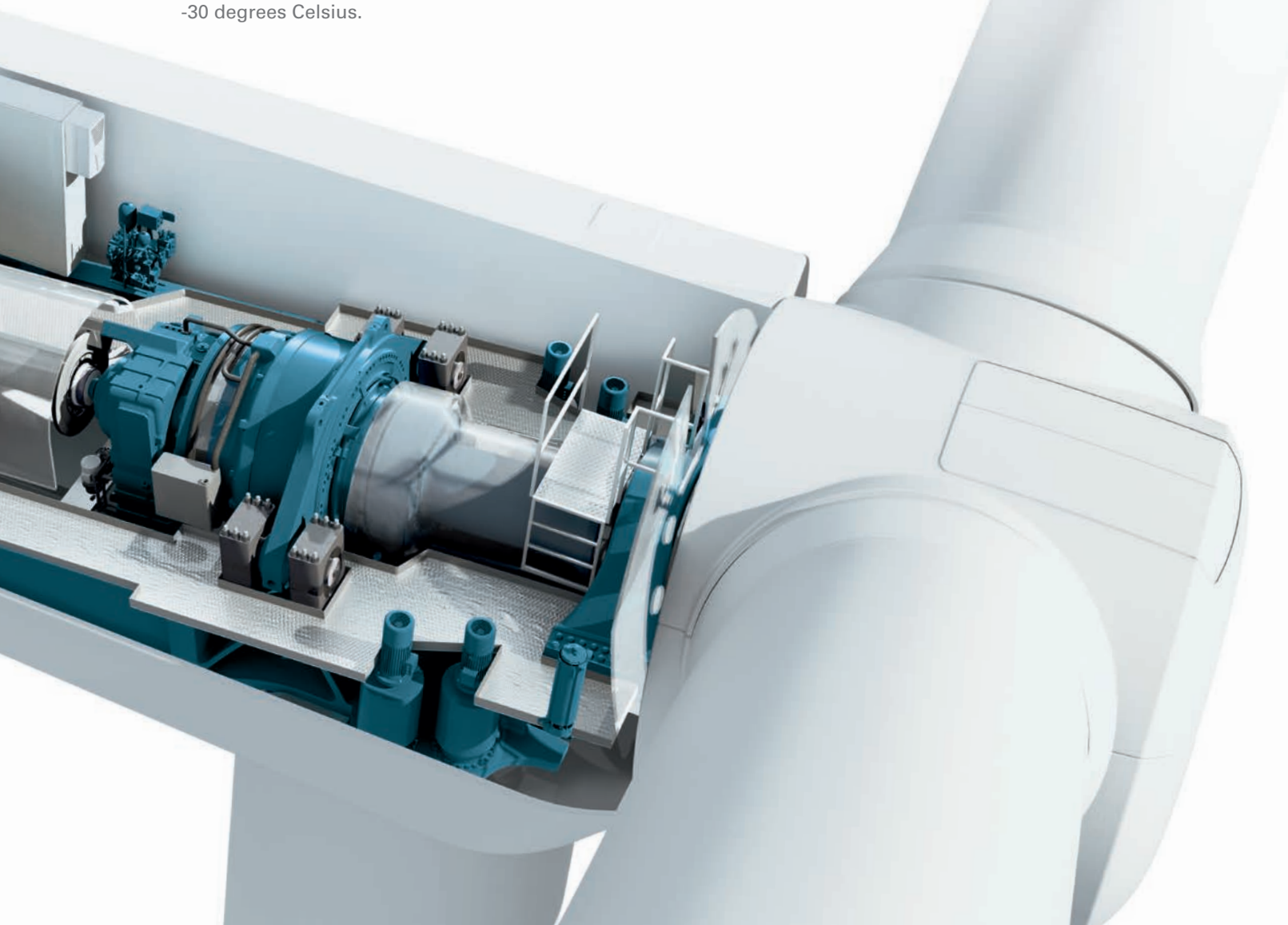
The fourth generation of the Nordex multi-megawatt platform combines proven, dependable technology with targeted improvements for enhanced performance.

Grid compatibility ensured

Like the previous generations, the turbines of Delta Generation meet the grid requirements of international markets. One of the most demanding grid connection directives in Europe is the German SDLWindV (Ordinance on System Services by Wind Energy Plants). Thanks to their fault-ride-through capability, our turbines are able to bridge voltage drops easily, thereby meeting all the requirements for the System Service Bonus (SDL Bonus). In addition, the Nordex Wind Farm Management System also allows the grid operator to directly control the active and reactive power of the wind farm in the grid.

Making the most of cold locations

During the winter, temperatures can be extreme at many sites offering a high wind yield. The tried-and-tested Nordex cold-climate package is designed to meet the challenges of these especially cold locations. Turbines in the cold-climate version (CCV) are able to operate down to an outside temperature of -30 degrees Celsius.



ECONOMIC EFFICIENCY
Higher yields reduce the cost of energy

In developing Delta Generation, we have met our main target – to cut the cost of energy. These Nordex multi-megawatt turbines deliver up to 31 per cent more yield from the sites, making Delta Generation turbines a particularly worthwhile investment.

Larger: Rotors

Nordex has designed the turbines to use a much larger rotor for each wind class. This produces higher yields. For example, the rotor diameter for machines for strong-wind locations was increased by ten metres compared to the previous model, resulting in a 23 per cent increase in swept area. The rotor for sites with moderate wind speeds is 17 metres larger: a 37 per cent increase in rotor sweep. With its 14 metre larger diameter, the rotor for light-wind sites offers a 25 per cent increase in swept area.

Stronger: Rated Output

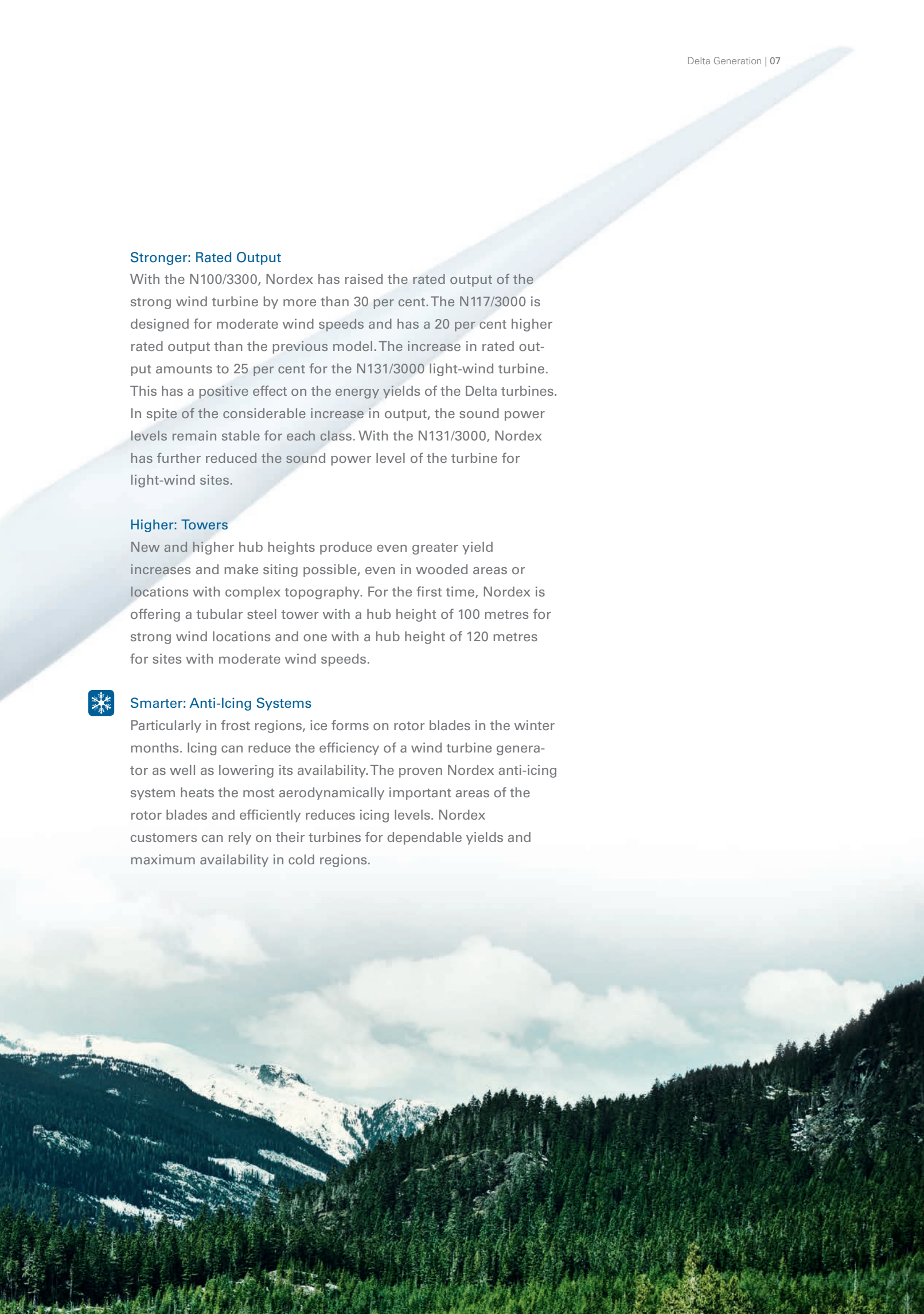
With the N100/3300, Nordex has raised the rated output of the strong wind turbine by more than 30 per cent. The N117/3000 is designed for moderate wind speeds and has a 20 per cent higher rated output than the previous model. The increase in rated output amounts to 25 per cent for the N131/3000 light-wind turbine. This has a positive effect on the energy yields of the Delta turbines. In spite of the considerable increase in output, the sound power levels remain stable for each class. With the N131/3000, Nordex has further reduced the sound power level of the turbine for light-wind sites.

Higher: Towers

New and higher hub heights produce even greater yield increases and make siting possible, even in wooded areas or locations with complex topography. For the first time, Nordex is offering a tubular steel tower with a hub height of 100 metres for strong wind locations and one with a hub height of 120 metres for sites with moderate wind speeds.

Smarter: Anti-Icing Systems

Particularly in frost regions, ice forms on rotor blades in the winter months. Icing can reduce the efficiency of a wind turbine generator as well as lowering its availability. The proven Nordex anti-icing system heats the most aerodynamically important areas of the rotor blades and efficiently reduces icing levels. Nordex customers can rely on their turbines for dependable yields and maximum availability in cold regions.



QUALITY AND RELIABILITY
A focus on high availability

To ensure that our turbines perform reliably, we conduct exhaustive tests. We certify the quality of all components and manufacture in a modern line production. The average availability of all turbines covered by Nordex Service stands at 98 per cent. We ensure this high level of availability by consistently further developing the vital important systems. This contributes to a further reduction in the cost of energy.

Extreme tests for hardware and software

In the Nordex Test Centre, engineers test the components and systems of the new turbine generation under simulated wind and weather conditions. By subjecting them to strains in excess of the usual specifications, Nordex ensures that the design meets all criteria, delivering a high-quality, mature product for serial production.

Highest industrial standards

Nordex continues to meet high industrial standards, manufacturing the nacelle and hub modules in a continuous flow process. Many of the steps needed for assembly and commissioning are performed in the protected factory hall before the equipment is shipped to the site.

In the Nordex Test Centre engineers ensure the quality of components.

Advanced control infrastructure

Nordex has equipped the new turbine generation with the Profinet communication system. Its ethernet-based fieldbus transfers turbine data rapidly, reliably and by priority. All actuators and sensors in the turbine control systems, as well as the different module options, are directly integrated into the network. This ensures improved diagnostics and the reliability of the system.

Optimised drive train

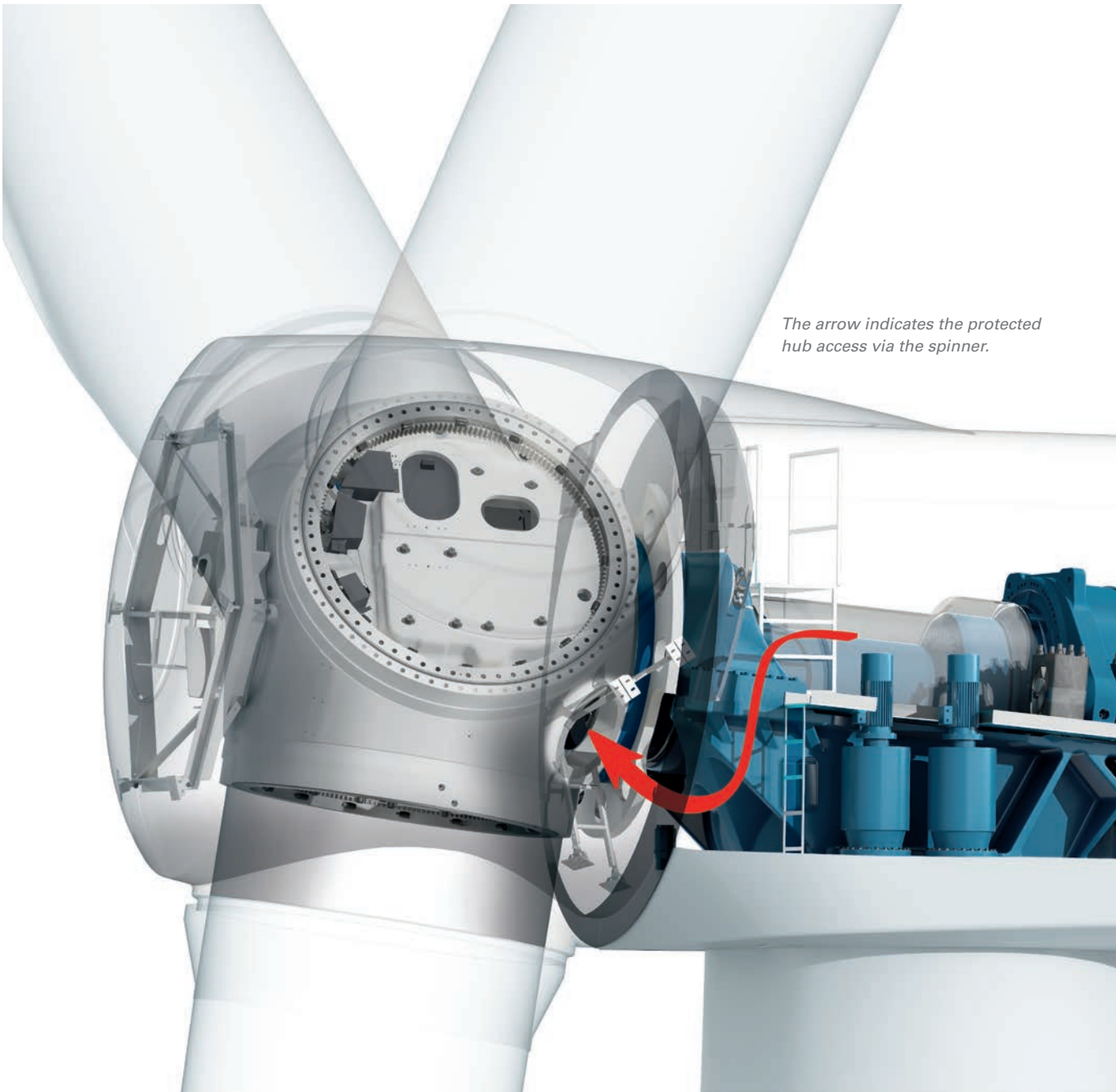
The drive train design of Delta Generation reduces the forces acting on the individual components, taking greater strain off the robust rotor bearing. Innovations in the cooling system of the drive train ensure constant temperatures over a wide operating range – with lower internal energy consumption.

SERVICE AND HSE
Fast and safe turbine O&M

Delta Generation is designed so that service operations can be conducted rapidly and safely. This reduces ongoing operational costs. We make no compromise when it comes to HSE – the turbines of the new generation meet the most stringent requirements.

Protected hub access

The new spinner, a complete housing for the rotor hub, provides rapid and protected access to the hub. This means that service work can be carried out in a wider range of wind and weather conditions. This is of particular advantage in cold regions – making it possible to reduce downtimes for service purposes.



The arrow indicates the protected hub access via the spinner.

Ergonomics and safety

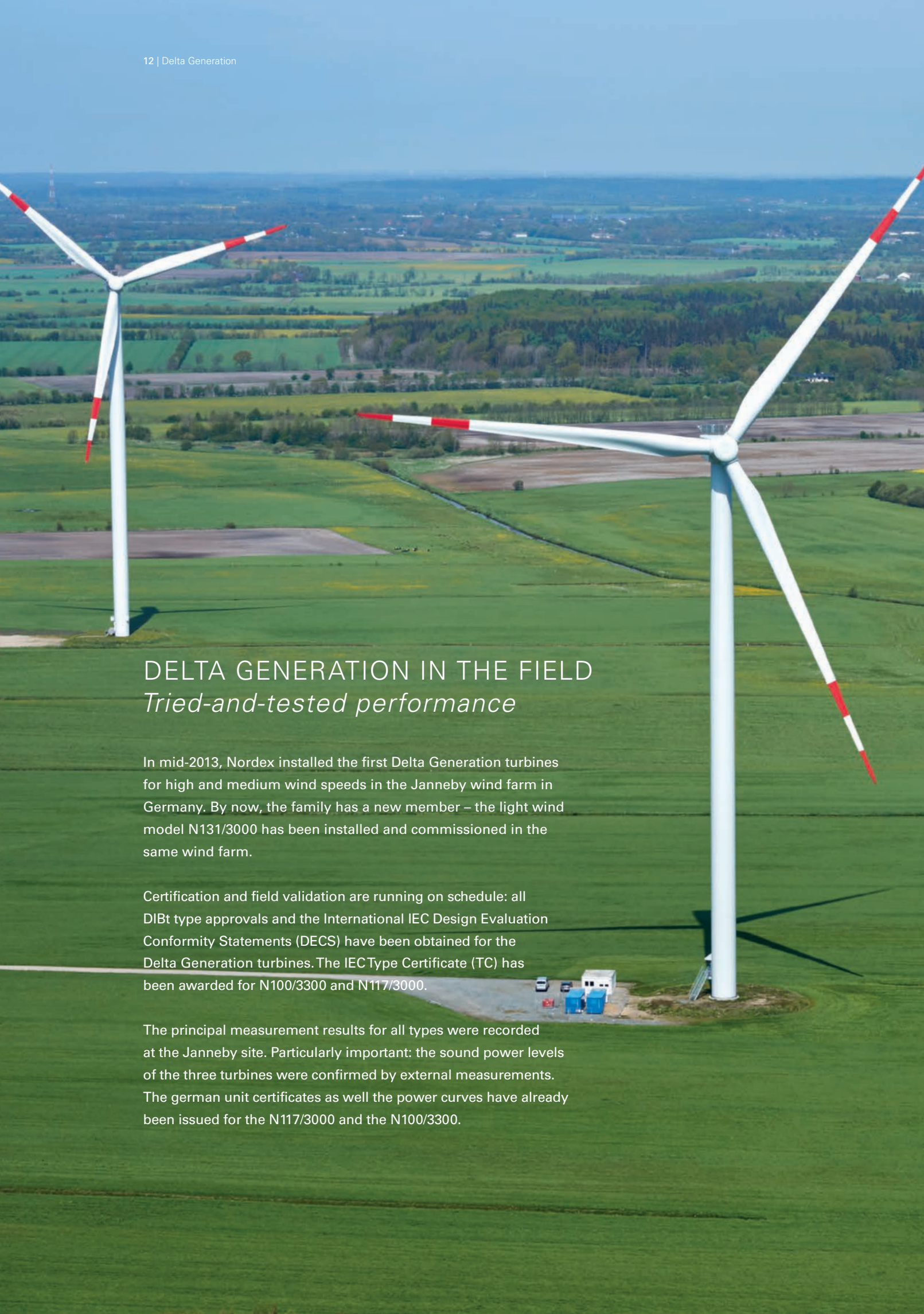
When we were developing the new multi-megawatt generation, we gave high priority to designing the turbines as a particularly safe and spacious workplace. In case of an emergency, the platform also offers extended escape and rescue routes. All systems are easily accessible for maintenance. Nacelle components weighing less than one tonne can be reached with the onboard crane and, if necessary, can be exchanged without additional equipment.

Annual service interval

The technical design of Delta Generation allows for an annual service interval. Automatic lubrication of the bearings in the pitch system replaces manual processes. These bearings, as well as the main bearing and the generator bearings, are supplied automatically with lubricant, making them less susceptible to wear. This minimises the service requirements and reduces the O&M expenses.

Yaw n-1 concept

The yaw system runs with four drives in standard operation. However, should one drive break down, the turbine can continue to run temporarily on three drives, making it possible to plan any needed service work. This concept increases turbine availability and reduces service costs.



DELTA GENERATION IN THE FIELD
Tried-and-tested performance

In mid-2013, Nordex installed the first Delta Generation turbines for high and medium wind speeds in the Janneby wind farm in Germany. By now, the family has a new member – the light wind model N131/3000 has been installed and commissioned in the same wind farm.

Certification and field validation are running on schedule: all DIBt type approvals and the International IEC Design Evaluation Conformity Statements (DECS) have been obtained for the Delta Generation turbines. The IEC Type Certificate (TC) has been awarded for N100/3300 and N117/3000.

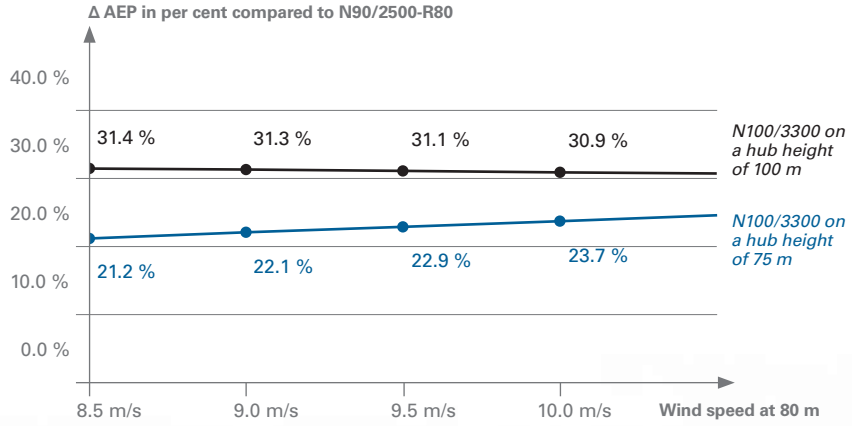
The principal measurement results for all types were recorded at the Janneby site. Particularly important: the sound power levels of the three turbines were confirmed by external measurements. The german unit certificates as well the power curves have already been issued for the N117/3000 and the N100/3300.


NORDEX

SOLUTION FOR STRONG WIND
High yields in rough climates

Wind sites with a rough environment call for mature, robust technology. With the turbines of Delta Generation, Nordex offers the proven 100-metre rotor, now also for IEC 1 locations. Thanks to the large rotor diameter and the higher rated output, the N100/3300 obtains much higher energy yields at sites with strong winds compared to the previous model. This turbine is available with hub heights of 75, 85 and 100 metres.

The N100/3300 generates between 21.2 and 31.4 per cent more AEP compared to the preceding IEC 1 model.

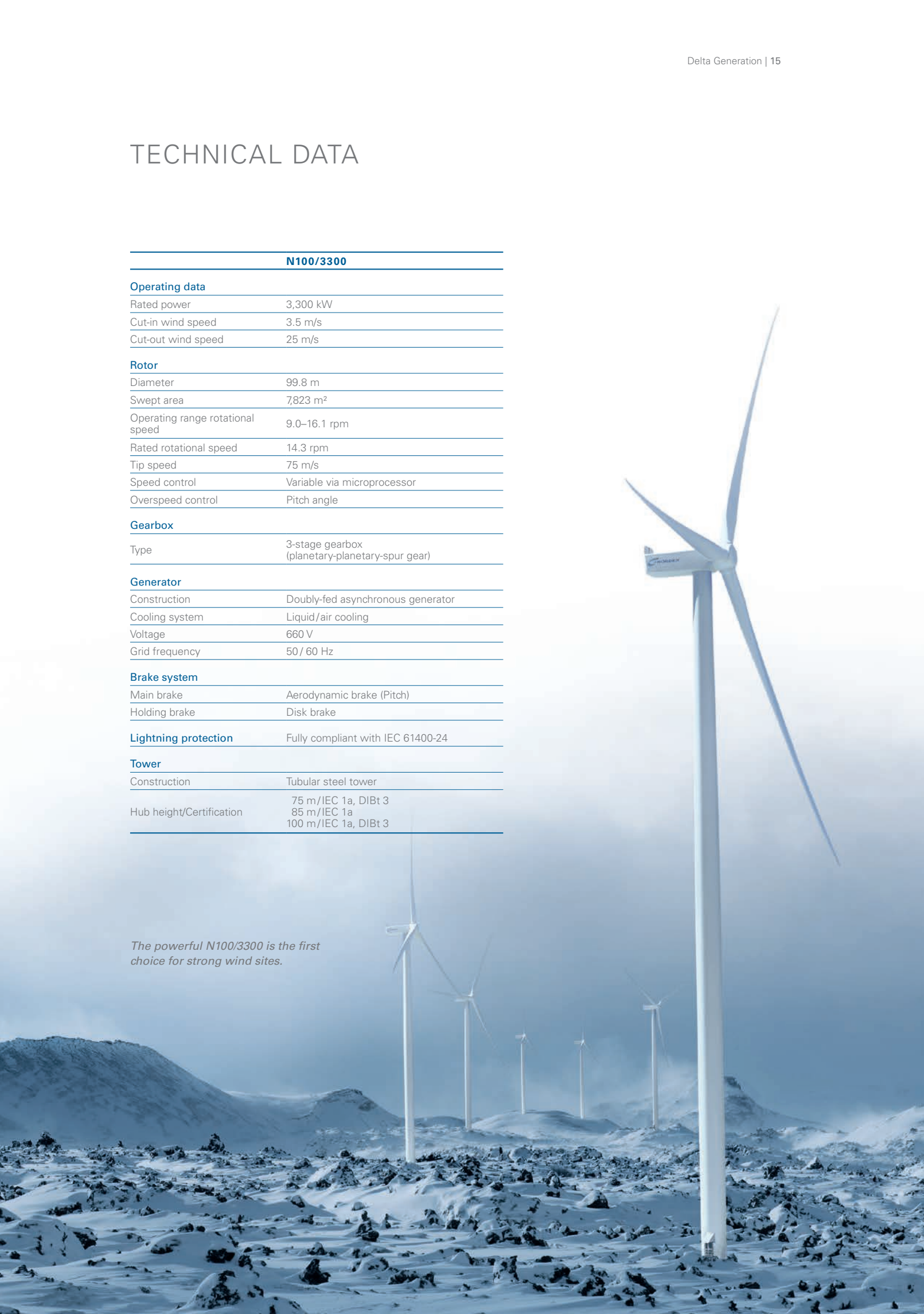


Calculation of AEP based on air density of 1.225 kg/m³, wind shear of 0.2 and Weibull shape parameter of k = 2.0

TECHNICAL DATA

	N100/3300
Operating data	
Rated power	3,300 kW
Cut-in wind speed	3.5 m/s
Cut-out wind speed	25 m/s
Rotor	
Diameter	99.8 m
Swept area	7,823 m²
Operating range rotational speed	9.0–16.1 rpm
Rated rotational speed	14.3 rpm
Tip speed	75 m/s
Speed control	Variable via microprocessor
Overspeed control	Pitch angle
Gearbox	
Type	3-stage gearbox (planetary-planetary-spur gear)
Generator	
Construction	Doubly-fed asynchronous generator
Cooling system	Liquid/air cooling
Voltage	660 V
Grid frequency	50 / 60 Hz
Brake system	
Main brake	Aerodynamic brake (Pitch)
Holding brake	Disk brake
Lightning protection	Fully compliant with IEC 61400-24
Tower	
Construction	Tubular steel tower
Hub height/Certification	75 m/IEC 1a, DIBt 3 85 m/IEC 1a 100 m/IEC 1a, DIBt 3

The powerful N100/3300 is the first choice for strong wind sites.

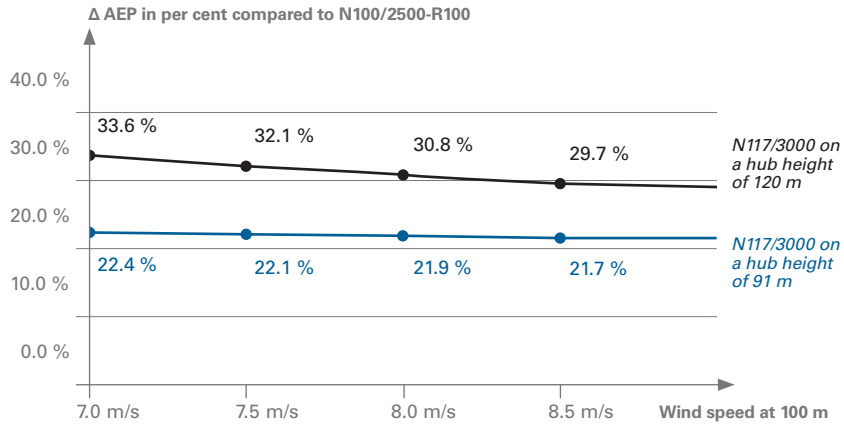


SOLUTION FOR MODERATE WIND
Economical at a wide range of sites

With the N117/3000, Nordex now offers an even more economical turbine for IEC 2 locations. The enlarged rotor sweep and higher rated output deliver much higher yields. The N117/3000 is available on tubular steel towers of 91 or 120 metres, as well as on a hybrid tower of 141 metres. Therefore, it is suitable for challenging sites as well.

To ensure high yields at sites in cold climates, Nordex equips the N117/3000 with the efficient anti-icing system as an option.

The N117/3000 generates between 21.7 and 33.6 per cent more AEP compared to the preceding IEC 2 model.

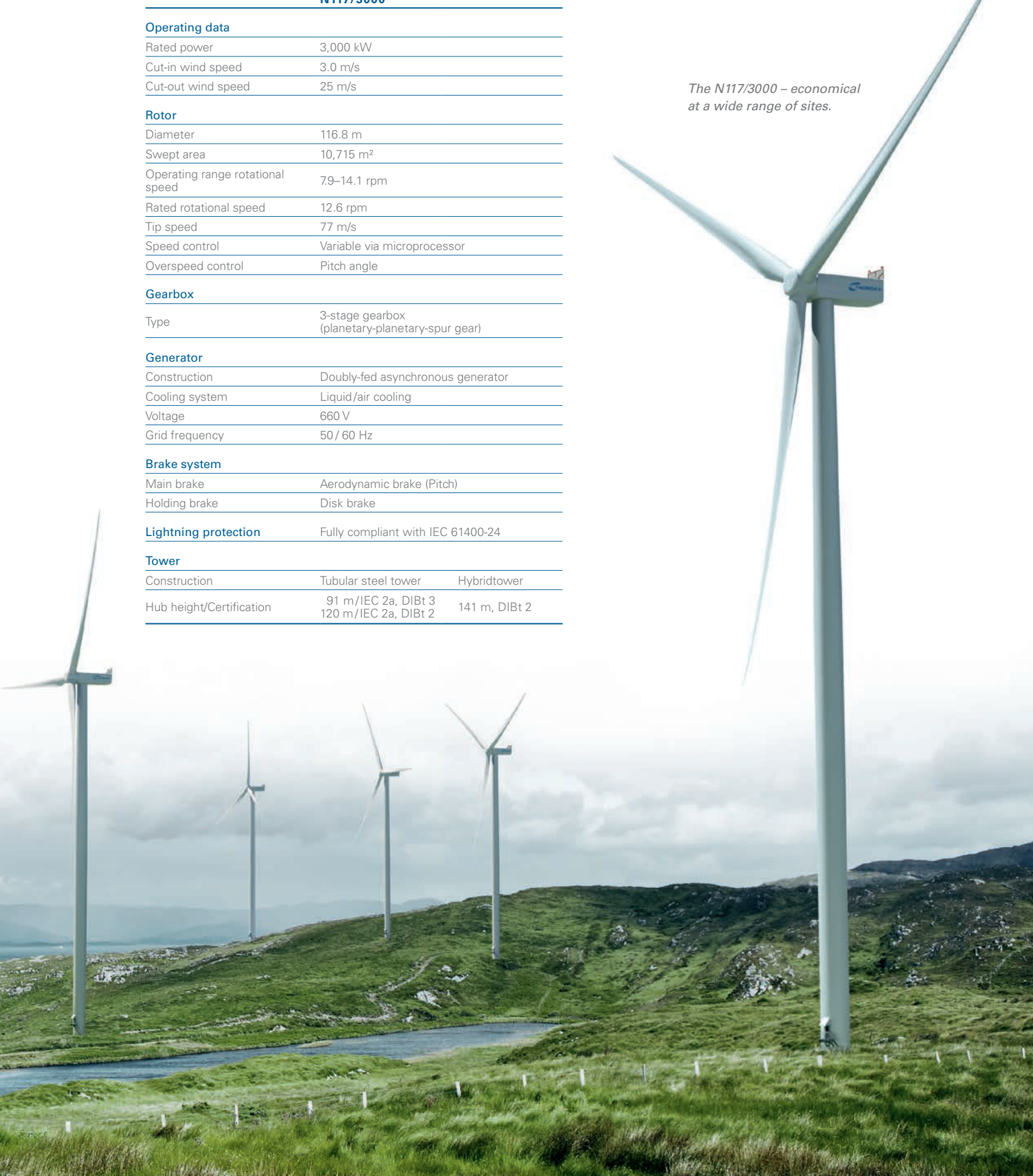


Calculation of AEP based on air density of 1.225 kg/m³, wind shear of 0.2 and Weibull shape parameter of k = 2.0

TECHNICAL DATA

	N117/3000	
Operating data		
Rated power	3,000 kW	
Cut-in wind speed	3.0 m/s	
Cut-out wind speed	25 m/s	
Rotor		
Diameter	116.8 m	
Swept area	10,715 m²	
Operating range rotational speed	7.9–14.1 rpm	
Rated rotational speed	12.6 rpm	
Tip speed	77 m/s	
Speed control	Variable via microprocessor	
Overspeed control	Pitch angle	
Gearbox		
Type	3-stage gearbox (planetary-planetary-spur gear)	
Generator		
Construction	Doubly-fed asynchronous generator	
Cooling system	Liquid/air cooling	
Voltage	660 V	
Grid frequency	50 / 60 Hz	
Brake system		
Main brake	Aerodynamic brake (Pitch)	
Holding brake	Disk brake	
Lightning protection	Fully compliant with IEC 61400-24	
Tower		
Construction	Tubular steel tower	Hybridtower
Hub height/Certification	91 m/IEC 2a, DIBt 3 120 m/IEC 2a, DIBt 2	141 m, DIBt 2

The N117/3000 – economical at a wide range of sites.



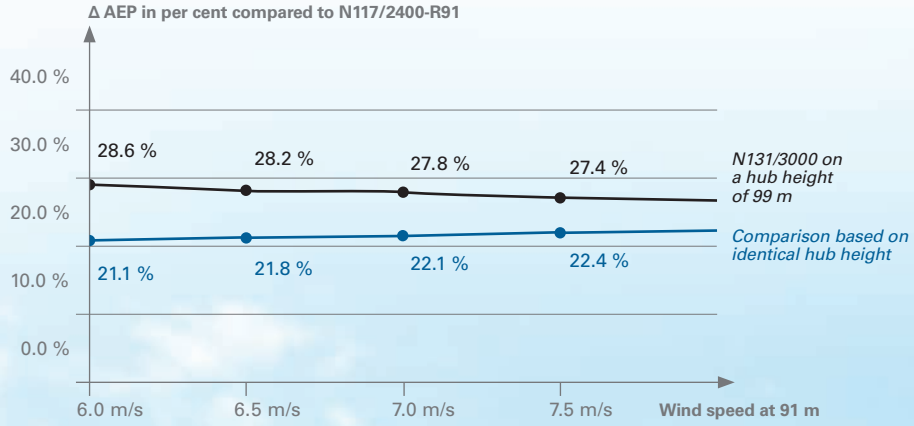
SOLUTION FOR LIGHT WIND
Maximum efficiency in the 3 MW segment

High yield even in regions with light wind: thanks to its enlarged rotor sweep and higher rated output, the N131/3000 generates a much higher yield at light-wind locations. The turbine is available on tubular steel towers with hub heights of 99 or 114 metres.

Nordex limits the sound power level of the light-wind turbine to max. 104.5 dB(A) – a crucial factor for optimising wind farms and facilitating permitting.

To ensure high yields at sites in cold climates, Nordex equips the N131/3000 with the efficient anti-icing system as an option.

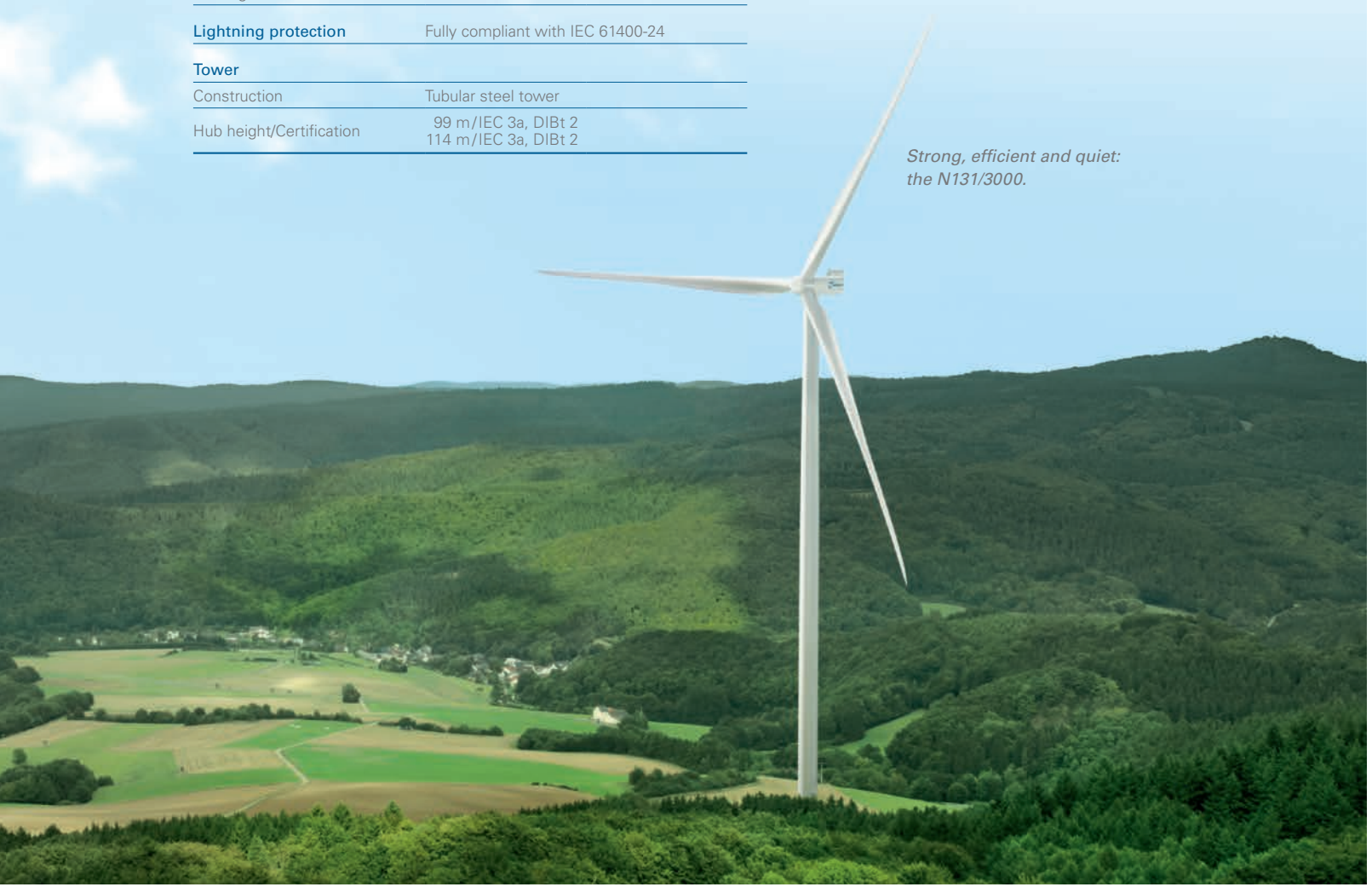
The N131/3000 generates between 27.4 and 28.6 per cent more AEP compared to the preceding IEC3 model.



Calculation of AEP based on air density of 1.225 kg/m³, wind shear of 0.2 and Weibull shape parameter of k = 2.0

TECHNICAL DATA

	N131/3000
Operating data	
Rated power	3,000 kW
Cut-in wind speed	3.0 m/s
Cut-out wind speed	20 m/s
Rotor	
Diameter	131.0 m
Swept area	13,478 m²
Operating range rotational speed	6.5–11.6 rpm
Rated rotational speed	10.3 rpm
Tip speed	70.5 m/s
Speed control	Variable via microprocessor
Overspeed control	Pitch angle
Gearbox	
Type	3-stage gearbox (planetary-planetary-spur gear)
Generator	
Construction	Doubly-fed asynchronous generator
Cooling system	Liquid/air cooling
Voltage	660 V
Grid frequency	50 / 60 Hz
Brake system	
Main brake	Aerodynamic brake (Pitch)
Holding brake	Disk brake
Lightning protection	Fully compliant with IEC 61400-24
Tower	
Construction	Tubular steel tower
Hub height/Certification	99 m/IEC 3a, DIBt 2 114 m/IEC 3a, DIBt 2



Strong, efficient and quiet: the N131/3000.

WORLDWIDE OFFICES
and subsidiaries:

Nordex SE
Langenhorner Chaussee 600
22419 Hamburg, Germany
Phone: +49 40 30030 1000
Email: info@nordex-online.com

Service Area Germany
Nordex Energy GmbH
Langenhorner Chaussee 600
22419 Hamburg, Germany
Phone: +49 40 30030 1000
Email: info@nordex-online.com

Asia
Nordex China
Room 808, First Shanghai Center, No. 39
Liangmaqiao Road, Chaoyang District
Beijing 100125, China
Phone: +86 10 84 53 51 88
Email: SalesChina@nordex-online.com

Benelux
Nordex Energy GmbH
Marconiweg 14
8501 XM Joure, the Netherlands
Phone: +31 513 41 23 54
Email: SalesBenelux@nordex-online.com

Chile
Nordex Chile SpA
Av. Presidente Riesco 5335, Piso 9,
Las Condes, Santiago, Chile
Phone: +56 2 2714 3866
Email: Saleslatam@nordex-online.com

Denmark, Baltic countries
Nordex Energy GmbH
Niels Bohrs Vej 12 b
6000 Kolding, Denmark
Phone: +45 75 73 44 00
Email: SalesDenmark@nordex-online.com

Finland
Nordex Energy GmbH
Hiilikatu 3
00180 Helsinki, Finland
Phone: +358 10 323 0060
Email: SalesFinland@nordex-online.com

France
Nordex France S.A.S.
1, Rue de la Procession
93217 La Plaine Saint-Denis, France
Phone: +33 1 55 93 43 43
Email: SalesFrance@nordex-online.com

Germany
Nordex Energy GmbH
Centroallee 263 a
46047 Oberhausen, Germany
Phone: +49 208 8241 120
Email: SalesGermany@nordex-online.com

Ireland
Nordex Energy Ireland Ltd.
Clonmel House, Forster Way
Swords, Co. Dublin, Ireland
Phone: +353 1 897 0260
Email: SalesIreland@nordex-online.com

Italy
Nordex Italia S.r.l.
Viale Città d'Europa 679
00144 Rome, Italy
Phone: +39 06 83 46 30 1
Email: SalesItaly@nordex-online.com

Norway
Nordex Energy GmbH
Regus Business Centre
Karenslyst Allé 8b, 3rd floor
0278 Oslo, Norway
Phone: +47 96 62 30 43
Email: SalesNorway@nordex-online.com

Pakistan
Nordex Pakistan Private Ltd.
187 Gomal Road, E-7
Islamabad 44000, Pakistan
Phone: +92 51 844 1101
Email: SalesPakistan@nordex-online.com

Poland
Nordex Polska Sp. z o.o.
Ul. Puławska 182, 6th floor
02-670 Warschau, Poland
Phone: +48 22 20 30 140
Email: SalesPoland@nordex-online.com

Portugal
Nordex Energy GmbH Sucursal em Portugal
Rua Eng.º Ferreira Dias, n.º 728
Edifício ANF Porto, Fracção 2.10
4100-246 Porto, Portugal
Phone: +351 229388972
Email: SalesPortugal@nordex-online.com

Romania
Nordex Energy Romania S.R.L.
Strada CA Rosetti nr 17
Etaj 7, birou 703, sector 2
020011 Bukarest, Romania
Phone: +40 21 527 0556
Email: SalesRomania@nordex-online.com

Spain
Nordex Energy Ibérica S.A.
Pso. de la Castellana, 23 2º-a
28046 Madrid, Spain
Phone: +34 91 7000356
Email: SalesSpain@nordex-online.com

South Africa
Nordex Energy South Africa (RF) (Pty) Ltd.
Wembley Square 3, 2nd Floor
80 McKenzie Street Gardens,
Cape Town 8001, South Africa
Phone: +27 21 464 0200
Email: SalesSA@nordex-online.com

Sweden
Nordex Sverige AB
Kungsängsvägen 25 b
75323 Uppsala, Sweden
Phone: +46 18 185 900
Email: SalesSweden@nordex-online.com

Turkey
Nordex Enerji A.Ş.
Havaalanı Kavşağı EGS Business Park Blokları
B1 Blok Kat: 15 No: 451-452-453
34149 Yeşilköy, Istanbul, Turkey
Phone: +90 212 468 37 37
Email: SalesTurkey@nordex-online.com

UK
Nordex UK Ltd.
Suite 4, Egerton House
The Towers Business Park, Wilmslow Road
Didsbury M20 2DX, UK
Phone: +44 161 445 99 00
Email: SalesUK@nordex-online.com

Uruguay
Nordex Energy Uruguay S.A.
Rizal 3555, Piso 2
CP 11300 Montevideo, Uruguay
Phone: +598 26245570
Email: saleslatam@nordex-online.com

USA, North America
Nordex USA, Inc.
300 South Wacker Drive, Suite 1500
Chicago, Illinois 60606, USA
Phone: +1 312 386 4100
Email: SalesUSA@nordex-online.com

Rest of the World
Nordex Energy GmbH
Langenhorner Chaussee 600
22419 Hamburg, Germany
Phone: +49 40 30030 1000
Email: info@nordex-online.com

As of: 09/2015

NORDEX
We've got the power.

Date 27.06.2017

3.4M122

Design data

Nominal power	3,400 kW (LV-side)
Cut-in wind speed	3 m/s
Nominal wind speed	12 m/s
Cut-out wind speed	22 m/s
Operating temperature range	-20 – +40 °C

Certification

Hub height	Wind class	DIBt Wind zone
86 – 89 m	IEC S (based on IEC IIA)	WZ 4, GK II
116 – 119 m	IEC S (based on IEC IIIA)	WZ 3, GK II
136 – 139 m	IEC S (based on IEC IIIA)	WZ 3, GK II

Rotor

Diameter	122 m
Rotor area	11,690 m²
Rotor speed	6.1 – 11.3 1/min (+15 %)
Power control	Electrical pitch

Rotor blade

Blade length	59.8 m
Type	Glass fibre-reinforced plastic (GFRP)
Max. chord width	3.9 m

Gear system

Type	Three-stage planetary / spur gearbox
Gear ratio	i = approx. 127
Type of suspension	Three-point contact suspension

Weight

Rotor blade	Approx. 15 t
Nacelle without drive train	Approx. 46 t
Rotor Hub	Approx. 26 t

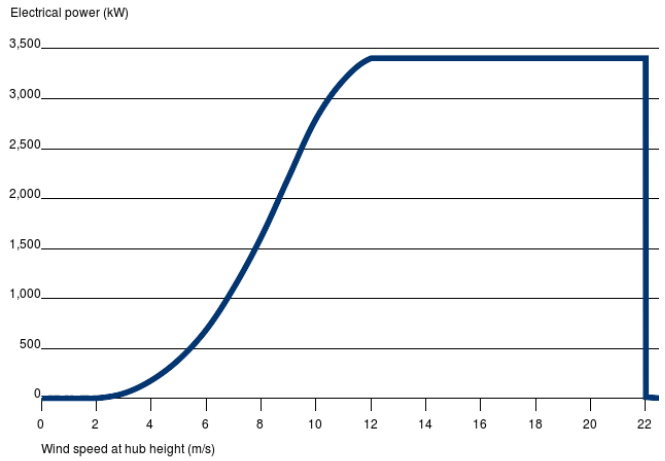
Electrical system

Nominal power	3,400 kW (LV-side)
Nominal voltage	10/20/30 kV
Nominal frequency	50 Hz
Generator	Induction generator (squirrel cage rotor)
Generator protection class	IP 54
Stator voltage	580 V
Speed range	735 – 1,356 1/min
Converter type	Full converter with DC intermediate circuit
Transformer	Internal Transformer (ITS)

Sound power level

Maximum sound power level	104.5 db (A)

Power curve



Senvion GmbH
Überseering 10
22297 Hamburg
T +49 40 5555090-0
info@senvion.com
senvion.com

SENVION
wind energy solutions

Date 27.06.2017

3.6M140 EC4

Design data

Nominal power	3,600 kW (LV-side)
Cut-in wind speed	3 m/s
Nominal wind speed	11.5 m/s
Cut-out wind speed	22 m/s
Operating temperature range	-20 – +40 °C

Certification

Hub height	Wind class	DIBt Wind zone
107 – 110 m	IEC S (based on IEC IIB)	WZ 3, GK II
127 – 130 m	IEC IIIA	WZ 2, GK II
157 – 160 m	IEC IIIA	WZ 2, GK II

Rotor

Diameter	140 m
Rotor area	15,394 m²
Rotor speed	6.3 – 9.6 1/min (+25 %)
Power control	Electrical pitch

Rotor blade

Blade length	68.5 m
Type	Glass fibre-reinforced plastic (GFRP)
Max. chord width	4 m

Gear system

Type	Three-stage planetary / spur gearbox
Type of suspension	Three-point contact suspension

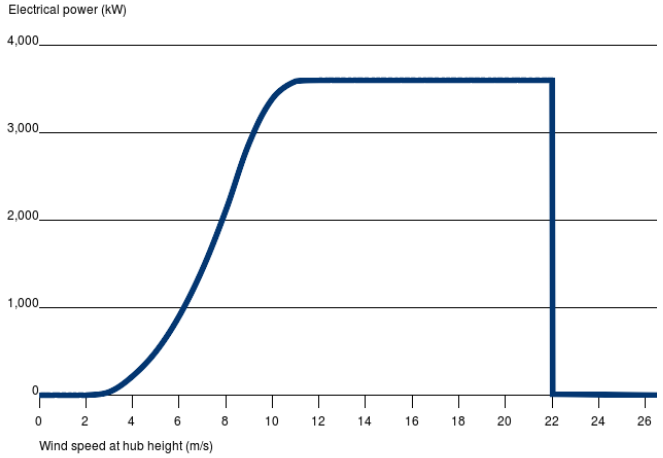
Electrical system

Nominal power	3,600 kW (LV-side)
Nominal voltage	600 V
Nominal frequency	50 Hz
Generator	Induction generator (squirrel cage rotor)
Generator protection class	IP 54
Converter type	Full converter with DC intermediate circuit
Transformer	Internal Transformer (ITS)

Sound power level

Maximum sound power level	104 db (A)

Power curve



Senvion GmbH
Überseering 10
22297 Hamburg
T +49 40 5555090-0
info@senvion.com
senvion.com

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High capacity factor for higher returns

Witness the evolution of our robust Onshore Geared platform: Designed with the high capacity factor needs of the market in mind, Siemens' powerful SWT-2.625-120 is tailored to optimize the output of medium wind sites.

The SWT-2.625-120 builds on the foundation of Siemens' proven Onshore Geared product platform, one of the most robust and successful turbine lines of all time with over 8,900 units installed globally. The turbine continues its strong heritage while scaling and streamlining innovative features to deliver an exceptional capacity factor and lower cost of energy for medium wind conditions.

The 2.625 MW rating and the 120 m rotor diameter result in a rotor to generator ratio that extracts more from the available wind. Due to the turbine's robust design, that high capacity factor can be used in medium wind sites for a dramatic improvement in the cost of energy.

Evolved technology with a proven track record

As the end-product of three decades of practical experience in the onshore wind industry, the SWT-2.625-120 stands as the pinnacle of onshore turbine technology. Design reliability is ensured through detailed component and system testing as well as complete turbine testing and certification. By incorporating extensive operational data and advanced design tools into the development process, the SWT-2.625-120 is able to deliver increased availability for medium wind sites all over the world.

The SWT-2.625-120 wind turbine employs a high-performance 120-meter rotor, with 59-meter, aeroelastically tailored blades. The turbine utilizes Siemens' IntegralBlade® technology to make intelligent use of the flexing capabilities of the blade structure. The technology allows for the SWT-2.625-120's larger rotor diameter and 23 percent greater swept area at reduced structural loads.

The nacelle is ergonomically optimized for maintenance through increased accessibility of components and enclosed by a square steel canopy.

1. Square canopy made of steel
2. Efficient electric drive yaw motors
3. Gearbox with one helical and two planetary stages for increased capacity
4. Large hatches and additional space for easy access to and service of the generator and gearbox
5. Efficient cooling system for maximum reliability

Features designed for enhanced capacity and simplified maintenance

The SWT-2.625-120 at a glance

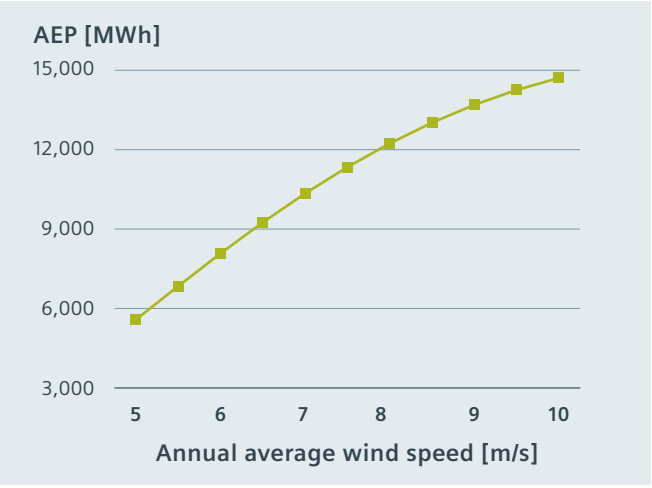
To increase energy production and deliver a high capacity factor and reduced cost of energy for medium wind sites, we have refined certain key features of our proven Onshore Geared product platform:

- 59-meter long aeroelastically tailored blades for reduced structural loading
- 120-meter rotor diameter with 23 percent increased swept area for a high capacity factor and enhanced energy production
- Gearbox and yaw system designed for greater capacity
- Enhanced canopy design for easier access to main components

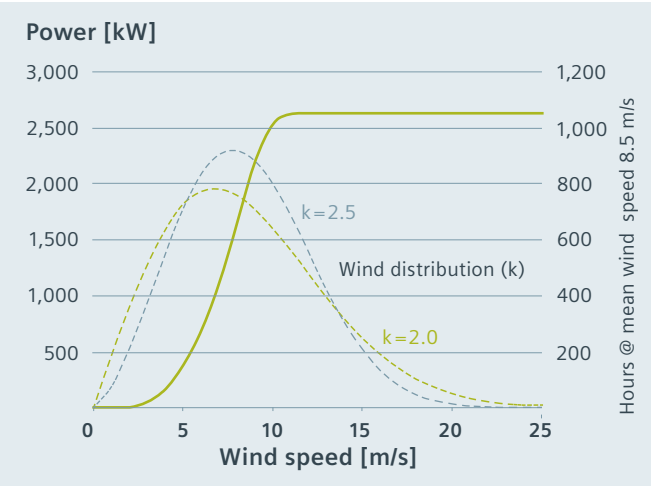
Tailoring service to your specific needs

To sustain your investment, our service team will fashion an intelligent service solution designed to deliver reliability and maximum output. The ultimate goal: optimizing your return on investment throughout the lifetime of your project.

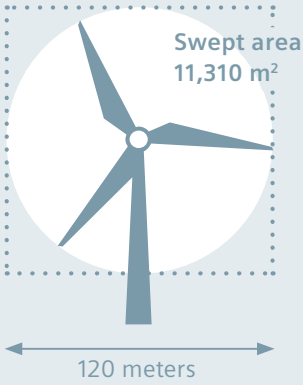
Servicing your wind power plants requires dedication and a long-term partnership with a commitment to care. By tailoring our flexible range of solutions to your specific needs, we can deliver 360° asset care for the lifetime of each turbine. When action is needed, we call on our unique diagnostic capabilities and experience to respond smarter and quicker. We're equally committed to safety. Continual training and a Zero Harm policy make health and safety paramount at all times.



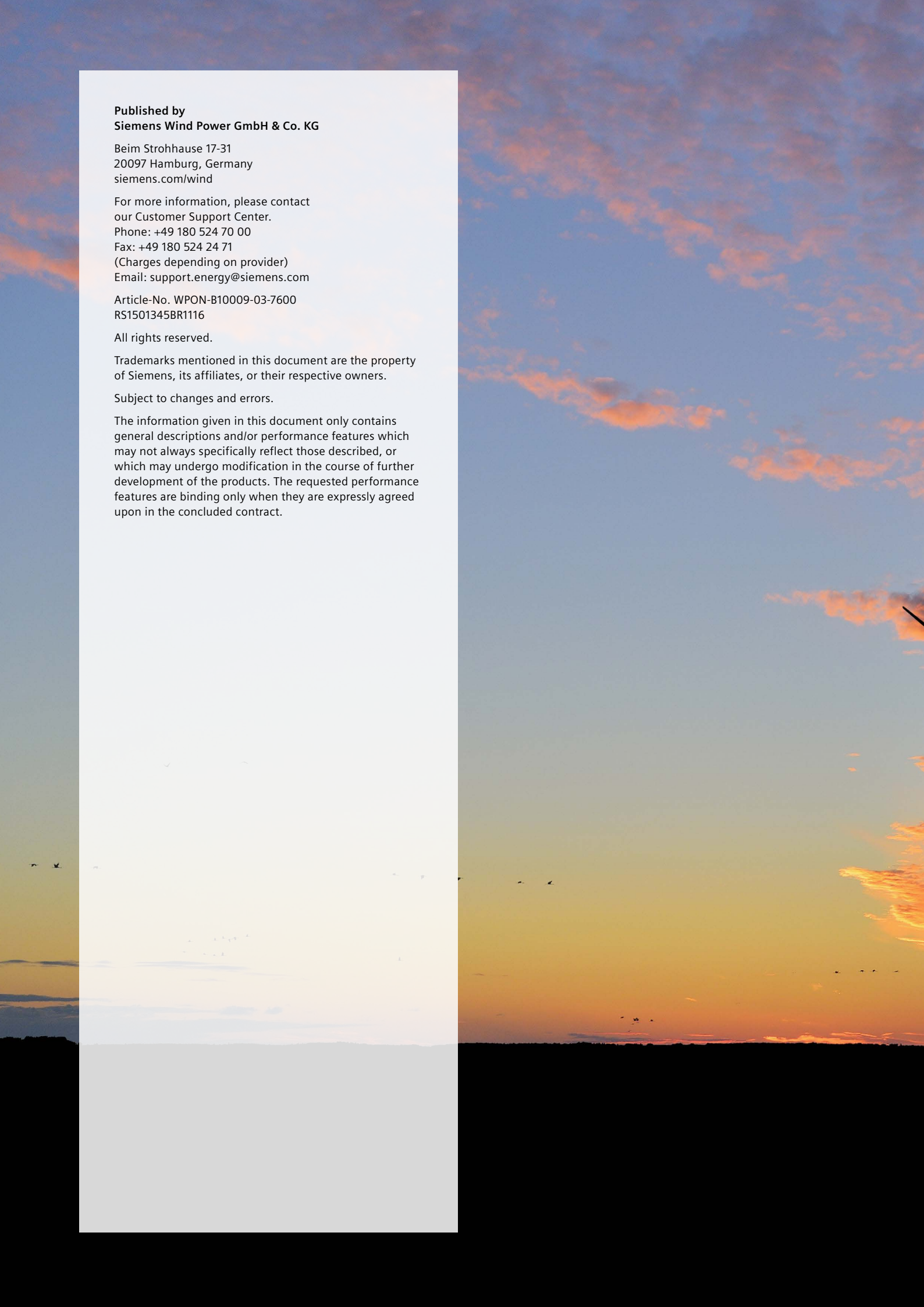
Higher AEP for medium wind sites



Weibull shape parameter k and power curve



SWT-2.5-120 / SWT-2.625-120	
IEC Class	IIB / IIS
Nominal power	2,500 kW (SWT-2.5-120) 2,625 kW (SWT-2.625-120)
Rotor diameter	120 m
Blade length	59 m
Swept area	11,310 m²
Hub height	85.1 m
Power regulation	Pitch regulated, variable speed
Annual output at 8.5 m/s	13 GWh



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Siemens Wind Power GmbH & Co. KG

Beim Strohhause 17-31
20097 Hamburg, Germany
siemens.com/wind

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
Email: support.energy@siemens.com

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SIEMENS

Ingenuity for life

The Onshore Direct Drive platform – your solution for every situation

Picture a turbine that offers maximized performance for your unique wind site under any conditions.

siemens.com/wind

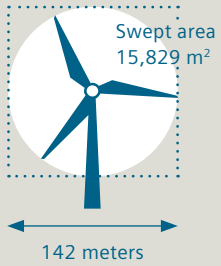
There is a reason why customers continue to rely on Siemens. Because for 30 years, the world has experienced the innovation and risk mitigation that has established Siemens as one of the leading global supplier of onshore wind power solutions.

Returns are secured through the utilization of experience, industry insight, and proven wind turbine technology. The Onshore Direct Drive platform is a prime example of this, a range of turbines flexible in performance and ability to harvest the potential of your unique site and conditions. It combines advanced site engineering with intelligent software to enable real-time, enhanced power optimization.

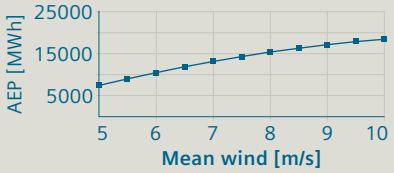
The only constant is the need for adaptability.

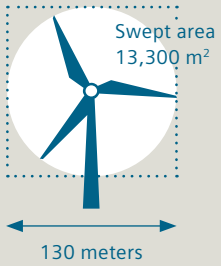
Offering the Complete Portfolio

Whatever your site's wind class, the Onshore Direct Drive platform has you covered.

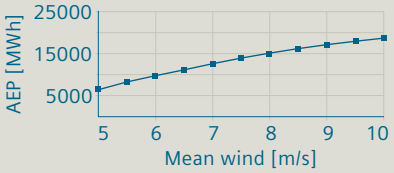


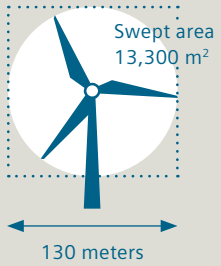
SWT-3.15-142	
IEC Class	IIIA
Nominal power	3.15 MW
Rotor diameter	142 m
Blade length	69.3 m
Swept area	15,829 m²
Hub height	109, 129, 165 m



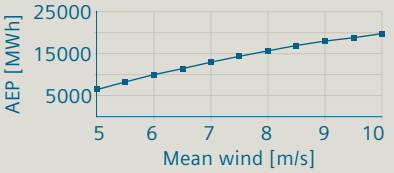


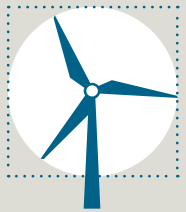
SWT-3.3-130 Low Noise	
IEC Class	IIA
Nominal power	3.3 MW
Rotor diameter	130 m
Blade length	63 m
Swept area	13,300 m²
Hub height	85, 135, 165 m





SWT-3.6-130	
IEC Class	IIA
Nominal power	3.6 MW
Rotor diameter	130 m
Blade length	63 m
Swept area	13,300 m²
Hub height	85, 115, 135, 165 m





IEC I class turbine *	
IEC Class	IA/S

* This turbine is currently under development

Direct Drive Technology

Evolved design for unrivaled efficiency and adaptability.

The Onshore Direct Drive portfolio leverages proven, standard design components, while advancing certain key components and introducing new design concepts for increased flexibility.

The turbine generator has a simple and robust design that is expected to improve efficiency even at low loads. The direct drive technology in combination with the SICS controller enables real-time Power Optimization and can be applied using a single design across all wind classes.

This product portfolio was developed by Siemens by bringing together all the expertise, customer feedback, and experience of 30 years in wind power. By doing so, we are able to offer you a compact, simplified, and efficient range of wind turbines suited to any situation.

Every environment offers unique challenges. But wherever your site, Siemens wind turbines are designed to always offer optimized performance.

Optimized Performance

Ingenuity in every step for your continual benefit.

The Onshore Direct Drive platform optimizes performance by leveraging every single step of a project's lifecycle and is designed to enable customers to achieve maximum return on investment.

Advanced Site Engineering

From the very start, customers have partnered with Siemens during the site engineering process. This consists of collecting preliminary data, measurement, analysis, and modeling. In combination with Siemens' local expertise, this information is used to design the optimal park layout for optimized energy production.

Grid Performance Optimization

In order to maintain grid stability and mitigate risk, Siemens offers adaptable technologies and full-scope solutions that help our customers achieve grid compliance and enhanced stability.

Wind Turbine Site Optimization

Along with advanced site engineering, Siemens' portfolio of performance features helps improve your turbines' performance – even in complex site conditions.

Remote Diagnostic Service

Siemens offers 24/7 remote diagnostic-service monitoring throughout the lifetime of a turbine, to safeguard your investment and ensure continued operation.

Real-time Power Optimization

Flexible so you don't need to be.

Real-time Power Optimization is supported by the direct drive generator – which produces power at a rating across a specific range – and Siemens' intelligent Integrated Control System (SICS) working together.

The SICS is a control unit consisting of a turbine controller and a full-scale converter, which improves power production and power quality. Using innovative features and reading various parameters from the wind farm control system, the SICS offers real-time Power Optimization based on the needs and conditions of the wind farm. By monitoring various sensors and producing power accordingly, the SICS, together with the SCADA system, enable different functions as conditions dictate, supporting noise-reduced operation, bat protection, and shadow-flicker avoidance, for example.

These features help achieve power production while remaining within the design load envelope, and power quality management. Combined, these features result in 'intelligent' wind turbines designed to optimize your AEP at all times.

Optimized grid connection stability

Variable Speed Range – improves turbine efficiency and supports reduced loads, acoustic noise, and flicker at low wind speeds
Local Voltage Control – controls reactive power in response to system voltage variations

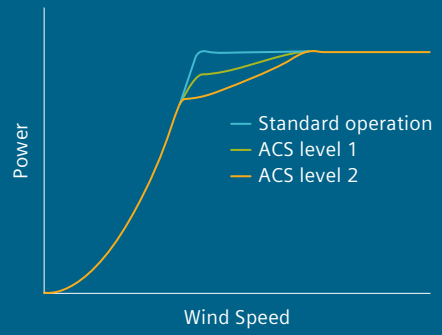
Fault Ride Through – designed to withstand low/high-voltage events without tripping the machine

Inertial Response – supports grid stability in low frequency situations

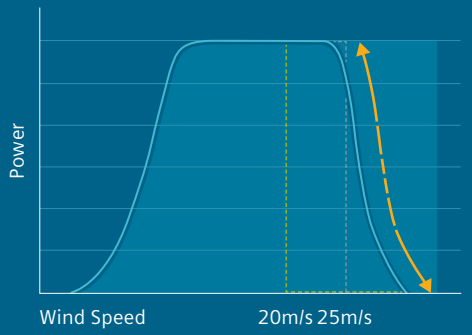
Local Frequency Response – controls active power in response to under- and over-frequency events

Power quality – operates within harmonic content and flicker limits

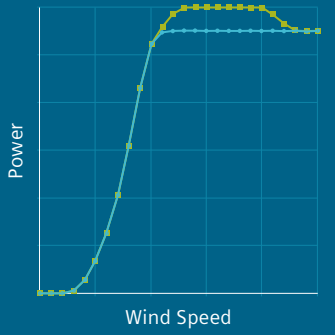
Optimized power production



Adaptive Control Srategy
ACS uses software to allow the turbine to operate under complex climatic conditions, keeping the loads within the design envelope and minimizing power losses.



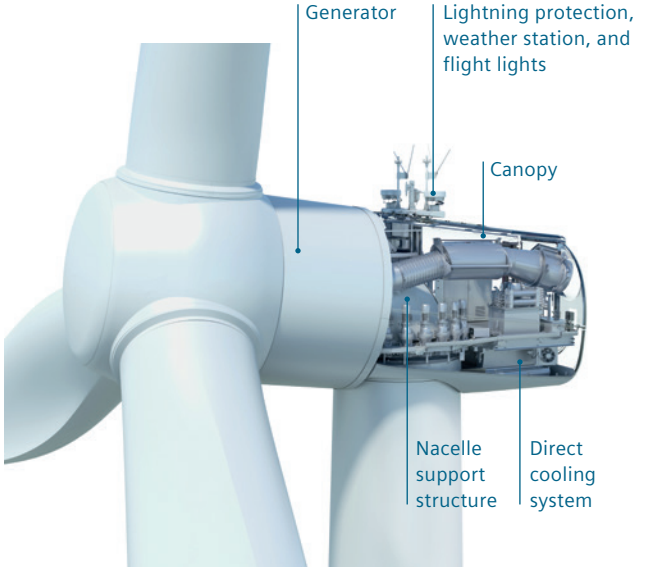
High Wind Ride Through
The High Wind Ride Through feature overcomes shutdowns due to high wind, with an intelligent load-based reduction in output power, to enable more stable energy production.



Power Boost Function
This controller feature can increasea a turbine's AEP by up to 4% depending on site conditions, by raising the output limitation under specific operating conditions.

Proven Technology

Designed for maximum reliability.



Nacelle

- Proven components, rigorously tested for improved reliability
- One nacelle and generator hub for all wind conditions helps drive down LCoE
- Innovative direct cooling system for improved efficiency
- Upgraded generator, yaw and SICS converter for increased performance
- Simple layout of components creates a comfortable workspace for technicians

Blades

- Aeroelastic tailoring of blades has demonstrated optimized energy harvesting while staying within the design load envelope
- Hybrid carbon technology is used to achieve a lightweight design for the larger rotor used at onshore low wind sites
- DinoTail® Next Generation serrations and blade add-ons are designed to control noise levels without sacrificing performance

Tower

- Proven, cost-efficient tubular steel tower concept for short installation time for all wind conditions
- A range of tower heights are offered in each wind class
- 165 m hybrid tower design allows optimal energy extraction in low wind conditions

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Wind Power and Renewables Division
Beim Strohhause 17-31
20097 Hamburg, Germany
siemens.com/wind

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
Email: support.energy@siemens.com

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Vestas®

4 MW PLATFORM

Wind. It means the world to us.™

Are you looking for the maximum return on **your investment** in wind energy?

Wind energy means the world to us. And we want it to mean the world to our customers, too, by maximising your profits and strengthening the certainty of your investment in wind power.

That's why, together with our partners, we always strive to deliver cost-effective wind technologies, high quality products and first class services throughout the entire value chain. And it's why we put so much emphasis on the reliability, consistency and predictability of our technology.

We have more than 35 years' experience in wind energy. During that time, we've delivered more than 83 GW of installed capacity in 75 countries. That is more than anyone else in the industry. We currently monitor over 33,000 wind turbines across the globe. All tangible proof that Vestas is the right partner to help you realise the full potential of your wind site.

What is the 4 MW Platform today?
The Vestas 4 MW platform* was introduced in 2010 with the launch of the V112-3.0 MW®. Over 13 GW of the 4 MW platform has been installed all over the world onshore and offshore making it the obvious choice for customers looking for highly flexible and trustworthy turbines.

Since then the 4 MW platform was upgraded and new variants were introduced utilising untapped potential of the platform. All variants carry the same nacelle design and the hub design has been re-used to the largest extend possible. In addition, our engineers have increased the nominal power across the entire platform improving your energy production significantly.

With this expansion, the 4 MW platform covers all IEC wind classes with a variety of rotor sizes and a higher rated output power of up to 4.2 MW.

You can choose from the following turbines on the 4 MW platform:
- V105-3.45 MW™ – IEC IA
- V112-3.45 MW® – IEC IA
- V117-3.45 MW® – IEC IB/IEC IIA
- V117-4.0/4.2 MW™ – IEC IB/IEC IIA
- V126-3.45 MW® – IEC IIB/IIA
- V136-3.45 MW® – IEC IIB/IEC IIIA
- V136-4.0/4.2 MW™ – IEC IIB
- V150-4.0/4.2 MW™ – IEC IIIB

All variants of the 4 MW platform are based on the proven technology of the V112-3.0 MW® with a full-scale converter, providing you with superior grid performance.

Our 4 MW platform is designed for a broad range of wind and site conditions, enabling you to mix turbines across your site or portfolio of sites, delivering industry-leading reliability, serviceability and exceptional energy capture, optimising your business case.

All turbine variants are equipped with the same ergonomically designed and very spacious nacelle which makes it easier for maintenance crews to gain access, so they can reduce the time spent on service while maximizing the uptime without compromising safety. All turbines can be installed and maintained using standard installation and servicing tools and equipment further reducing the operation and maintenance costs by minimising your stock level of spare parts.

*Formerly named the Vestas 3 MW platform

+60,000

The V112-3.45 MW® and the other 4 MW variants advance the already proven technology powering over 60,000 installed Vestas turbines worldwide - more than any other supplier.

How does our technology generate **more energy?**

More power for every wind site
V112-3.45 MW®, V117-3.45 MW®, V126-3.45 MW® and V136-3.45 MW® are available with several Sound Optimised Modes to meet sound level restrictions with an optimised production. The power system enables superior grid support and it is capable of maintaining production across severe drops in grid voltage, while simultaneously minimising tower and foundation loads. It also allows rapid down-rating of production to 10 per cent nominal power.

Proven technologies - from the company that invented them
The 4 MW platform is a low-risk choice. It is based on the proven technologies that underpin more than 60,000 Vestas turbines installed around the world. Using the best features from across the range, as well as some of the industry's most stringently tested components and systems, the platform's reliable design minimises downtime – helping to give you the best possible return on your investment.

With an operating range that covers all wind classes, our 4 MW platform delivers unrivalled energy production. The proven blade technology from the V112-3.0 MW® is used on the V105-3.45 MW™, the V112-3.45 MW®, V117-3.45 MW® and V117-4.0/4.2 MW™. The industry known structural shell blades are used on the V126-3.45 MW®, V136-3.45 MW®, V136-4.0/4.2 MW™ and V150-4.0/4.2 MW™- a technology which is also used on the 2 MW V110-2.0 MW®, V116-2.0 MW™ and V120-2.0 MW™ variants.

Reliable and robust
The Vestas Test Centre is unrivalled in the wind industry. We test most nacelle components using Highly Accelerated Life Testing (HALT) to ensure reliability. For critical components, HALT identifies potential failure modes and mechanisms. Specialised test rigs ensure strength and robustness for the gearbox, generator, yaw and pitch system, lubrication system and accumulators. Our quality-control system ensures that each component is manufactured to design specifications and performs at site. We systematically monitor measurement trends that are critical to quality, locating defects before they occur.

The 4 MW platform covers all wind segments enabling you to find the best turbine for your specific site.

WINDCLASSES - IEC

TURBINE TYPE	IEC III (6.0 - 7.5 m/s)	IEC II (7.5 - 8.5 m/s)	IEC I (8.5 - 10.0 m/s)
4 MW TURBINES			
V105-3.45 MW™ IEC IA			■
V112-3.45 MW® IEC IA			■
V117-3.45 MW® IEC IB/IEC IIA		■	■
V117-4.0/4.2 MW™ IEC IB/IEC IIA		■	■
V126-3.45 MW® IEC IIA/ IIB	■	■	■
V136-3.45 MW® IEC IIB/ IEC IIIA	■	■	■
V136-4.0/4.2 MW™ IEC IIB	■	■	■
V150-4.0/4.2 MW™ IEC IIIB	■	■	

■ Standard IEC conditions ■ Site dependent

Options available for the 4 MW platform

An option is an extra feature that can be added to the turbine to suit a project's specific needs. By adding options to the standard turbine, we can enhance the performance and adaptability of the wind power project and facilitate a shorter permitting cycle at restricted sites. The options can even be a decisive factor in realising your specific project, and the business case certainty of the investment.

Here is a list of the options available for the 4 MW platform:

- Power Optimised Modes
- Load Optimised Modes
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

Life testing

The Vestas Test Centre has the unique ability to test complete nacelles using technologies like Highly Accelerated Life Testing (HALT). This rigorous testing of new components ensures the reliability of the 4 MW platform.

Is the 4 MW platform the optimal choice for **your specific site?**

One common nacelle – six different rotor sizes
The wind conditions on a wind project site are often not identical. The 4 MW platform features a range of turbines that cover all wind classes and combined across your site they can maximise the energy output of your wind power plant.

Tip-height restrictions and strict grid requirements
With a rotor size of 105 m, the V105-3.45 MW™ IEC IA is the turbine that fits the most severe wind conditions. It has an extremely robust design for tough site conditions and is especially suited for markets with tip-height restrictions and high grid requirements.

Like all the other 4 MW turbines, the V105-3.45 MW™ is equipped with a full-scale converter ensuring full compliance with the challenging grid codes in countries like the UK and Ireland.

Cold climates
The V112-3.45 MW®, V117-3.45 MW® , V117-4.0/4.2 MW™, V126-3.45MW® and V136-3.45 MW® can be combined with Vestas De-Icing and Vestas Ice Detection ensuring optimum production in cold climates.

The Vestas De-Icing System is fully SCADA integrated and can be triggered automatically or manually depending on your de-icing strategy. Automatic control protects your investment, optimising the trigger point so the turbine only stops to de-ice when there is an expected net power production gain.

High- and medium-wind sites
The V112-3.45 MW® IEC IA is a high-wind turbine and has a very high capacity factor. Similar to the other 4 MW turbines, the V112-3.45 MW® IEC IA turbine makes efficient use of its grid compatibility and is an optimal choice for sites with MW constraints.

On medium wind-sites, the V117-3.45 MW® IEC IB/IEC IIA, V126-3.45 MW® IEC IIA/IIB, V136-3.45 MW® IEC IIB/IEC IIIA and V136-4.0/4.2 MW IEC IIB are excellent turbine choices. A combination of the variants can optimise your site layout and improve your production significantly on complex sites.

Low-wind sites
Built on the same proven technology as the V112-3.0 MW®, the V150-4.0/4.2 MW™ IEC IIIB is our best performer on low-wind sites. The larger rotor enable greater wind capture, which in turn produces more energy to reduce levelised cost of energy (LCOE). The result is exceptional profitability in areas with low wind, and new frontiers for wind energy investment.

Large Diameter Steel Towers (LDST) support the added rotor size and rating of Vestas turbines to increase Annual Energy Production on low-wind sites.

LDST is specially designed with a larger diameter in the bottom section that allows for optimal strength at high hub heights.

Maximising old permits
Although the V150-4.0/4.2 MW™ is one of the highest producing low wind turbines available, some old permits may simply be too tight to accept it. Although the V117-3.45 MW®, V126-3.45 MW® and V136-4.0/4.2 MW™ are medium-wind turbines, they still deliver an excellent business case on low-wind sites.

Due to the similar electrical properties and nacelle design, it is easy to mix and match the turbines from the 4 MW platform to maximise production on heavily constrained sites.

Would you **benefit** from uninterrupted control of wind energy production?

Knowledge about wind project planning is key
Getting your wind energy project up and operating as quickly as possible is fundamental to its long-term success. One of the first and most important steps is to identify the most suitable location for your wind power plant. Vestas' SiteHunt® is an advanced analytical tool that examines a broad spectrum of wind and weather data to evaluate potential sites and establish which of them can provide optimum conditions for your project.

In addition, SiteDesign® optimises the layout of your wind power plant. SiteDesign® runs Computational Fluid Dynamics (CFD) software on our powerful in-house supercomputer Firestorm to perform simulations of the conditions on site and analyse their effects over the whole operating life of the plant. Put simply, it finds the optimal balance between the estimated ratio of annual revenue to operating costs over the lifetime of your plant, to determine your project's true potential and provide a firm basis for your investment decision.

The complexity and specific requirements of grid connections vary considerably across the globe, making the optimal design of electrical components for your wind power plant essential. By identifying grid codes early in the project phase and simulating extreme operating conditions, Electrical PreDesign provides you with an ideal way to build a grid compliant, productive and highly profitable wind power plant. It allows customised collector network cabling, substation protection and reactive power compensation, which boost the cost efficiency of your business.

Advanced monitoring and real-time plant control
All our wind turbines can benefit from VestasOnline® Business, the latest Supervisory Control and Data Acquisition (SCADA) system for modern wind power plants.

This flexible system includes an extensive range of monitoring and management functions to control your wind power plant. VestasOnline® Business enables you to optimise production levels,

+33,000

The Vestas Performance and Diagnostics Centre monitors more than 33,000 turbines worldwide. We use this information to continually develop and improve our products and services.

monitor performance and produce detailed, tailored reports from anywhere in the world. The VestasOnline® Power Plant Controller offers scalability and fast, reliable real-time control and features customisable configuration, allowing you to implement any control concept needed to meet local grid requirements.

Surveillance, maintenance and service

Operating a large wind power plant calls for efficient management strategies to ensure uninterrupted power production and to control operational expenses. We offer 24/7 monitoring, performance reporting and predictive maintenance systems to improve turbine performance and availability. Predicting faults in advance is essential, helping to avoid costly emergency repairs and unscheduled interruptions to energy production.

Our Condition Monitoring System (CMS) assesses the status of the turbines by analysing vibration signals. For example, by measuring the vibration of the drive train, it can detect faults at an early stage and monitor any damage. This information allows pre-emptive maintenance to be carried out before the component fails, reducing repair costs and production loss.

Additionally, our Active Output Management® (AOM) concept provides detailed plans and long term agreements for service and maintenance, online monitoring, optimisation and troubleshooting. It is possible to get a full scope contract, combining your turbines' state-of-the-art technology with guaranteed time or energy-based availability performance targets, thereby creating a solid base for your power plant investment. The Active Output Management® agreement provides you with long term and financial operational peace of mind for your business case.

V105-3.45 MW™ IEC IA

Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*Subject to different temperature options

SOUND POWER

Maximum	105.8 dB**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	105 m
Swept area	8,659 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub height	72.5 m (IEC IA)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

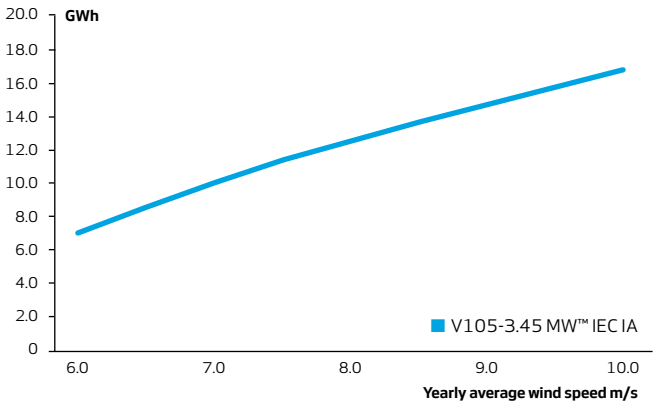
Length	51.2 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Low Temperature Operation to -30°C
- Fire Suppression
- Shadow Detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2, Standard air density = 1.225, wind speed at hub height

V112-3.45 MW® IEC IA

Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	106.7 dB**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	112 m
Swept area	9,852 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

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

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

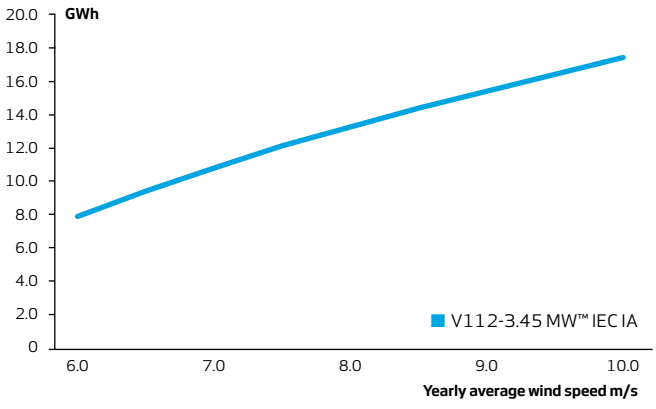
Length	54.7 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2, Standard air density = 1.225, wind speed at hub height

V117-3.45 MW®
IEC IB/IEC IIA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IB/IEC IIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	109.3 dB**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	117 m
Swept area	10,751 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

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

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

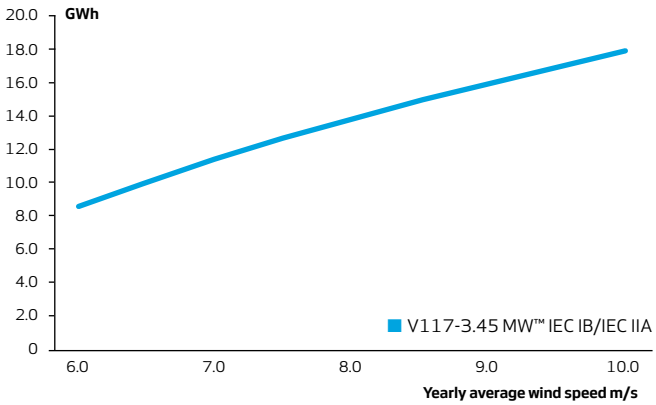
Length	57.2 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2, Standard air density = 1.225, wind speed at hub height

V117-4.0/4.2 MW™ IEC IB/IEC IIA

Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	4,000 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IB/IEC IIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	106 dB**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	117 m
Swept area	10,751 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	91.5 m (IEC IB) 84 m (IEC IIA)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

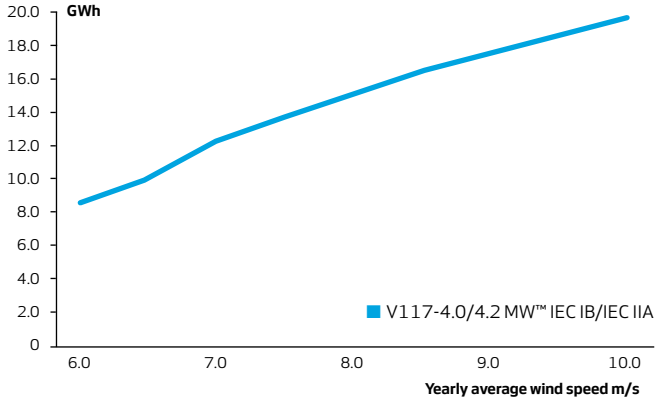
Length	57.2 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 4.2 MW (site specific)
- Load Optimised Modes down to 3.6 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight®

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2, Standard air density = 1.225, wind speed at hub height

V126-3.45 MW®
IEC IIB/IIA
Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	110.1 dB**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	126 m
Swept area	12,469 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights 87 m (IEC IIB/IEC IIA),117 m (IEC IIB/IECIIA/DIBtS), 137 m (IEC IIIA/DIBtS), 147 m (IEC IIIA), 149 m (DIBtS) and 166 m (DIBtS)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

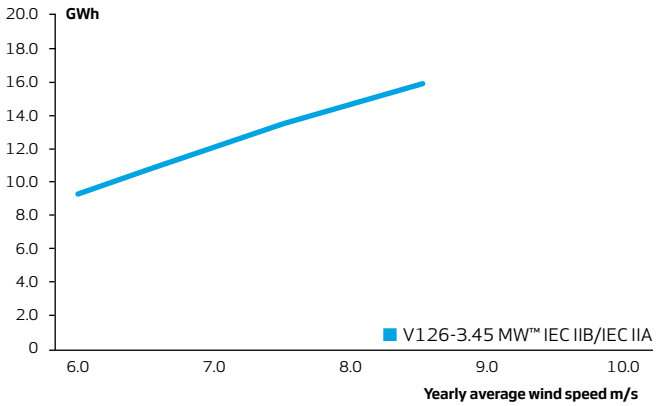
Length	61.7 m
Max. chord	4 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2, Standard air density = 1.225, wind speed at hub height

V136-3.45 MW®
IEC IIB/IEC IIIA
Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIB/IEC IIIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	106 dB**

**Sound Optimised Modes dependent on site and country

ROTOR

Rotor diameter	136 m
Swept area	14,527 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights 82 m (IEC IIB/IEC IIIA), 105 m (IEC IIIA), 112 m (IEC IIB/IEC IIIA), 132 m (IEC IIB/IEC IIIA/ DIBt2), 142 m (IEC IIIA), 149 m (DIBtS), and 166 m (DIBtS)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

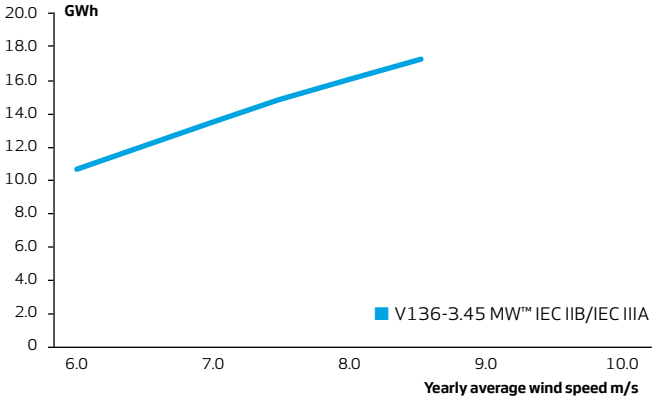
Length	66.7 m
Max. chord	4.1 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 3.6 MW (site specific)
- Load Optimised Modes down to 3.0 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight™

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2, Standard air density = 1.225, wind speed at hub height

V136-4.0/4.2 MW™ IEC IIB

Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	4,000 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IIB

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	103.9 dB**

**Sound Optimised modes dependent on site and country

ROTOR

Rotor diameter	136 m
Swept area	14,527 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	Site and country specific

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

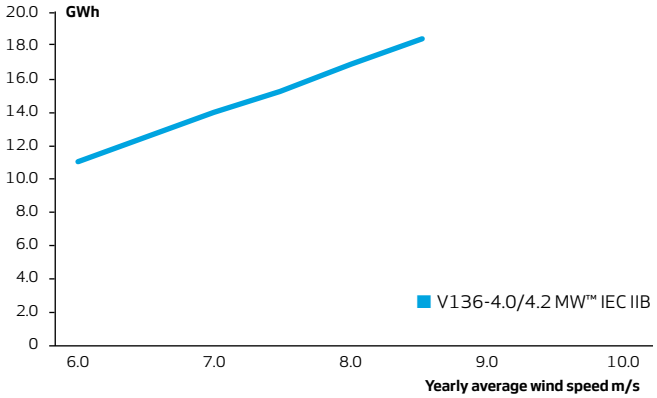
Length	66.7 m
Max. chord	4.1 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode up to 4.2 MW (site specific)
- Load Optimised Modes down to 3.6 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight®

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2, Standard air density = 1.225, wind speed at hub height

V150-4.0/4.2 MW™ IEC IIIB

Facts & figures

POWER REGULATION — Pitch regulated with variable speed

OPERATING DATA

Rated power	4,000 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIIB

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER

Maximum	104.9 dB**

**Sound Optimised modes dependent on site and country

ROTOR

Rotor diameter	150 m
Swept area	17,671 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub heights	Site and country specific

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

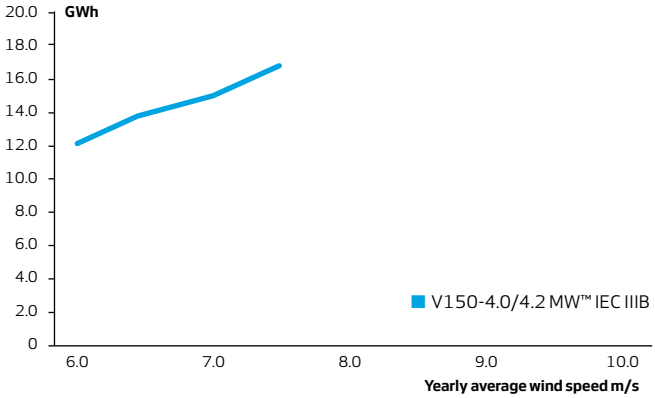
Length	73.7 m
Max. chord	4.2 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- Power Optimised Mode up to 4.2 MW (site specific)
- Load Optimised Modes down to 3.6 MW
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Low Temperature Operation to - 30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Aviation Lights
- Aviation Markings on the Blades
- Vestas InteliLight®

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2, Standard air density = 1.225, wind speed at hub height

Vestas Wind Systems A/S
Hedeager 42 . 8200 Aarhus N . Denmark
Tel: +45 9730 0000 . Fax: +45 9730 0001
vestas@vestas.com . **vestas.com**

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