



Wind Farms

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SIEMENS Gamesa
RENEWABLE ENERGY

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Introduction - Company profile

History

Siemens Gamesa Renewable Energy was created in April, 2017, with the merger of Gamesa Corporación Tecnológica and Siemens Wind Power under one roof: innovative spirit, dedication to technological excellence, and determination to provide real and lasting value to all stakeholders and customers.

Today, Siemens Gamesa Renewable Energy is a respected industry **leader committed to providing innovative and effective solutions** to the energy challenges of tomorrow.



Gamesa's history is marked by a spirit of innovation and successful expansion into new markets. What started as a small machining workshop in northern Spain quickly grew into a global company focused on new technology development.

In 1995, Gamesa expanded into wind power, installing its first wind turbine in Spain, and quickly grew into one of the leading manufacturers of wind turbines worldwide with production centers in the U.S., China, India, Brazil and Spain.



The history of **Siemens Wind Power** is equally impressive. The company has been directly involved in the wind power industry since 2004 when it acquired the Danish Bonus Energy. With the acquisition, Siemens gained a wealth of technology and proven experience stretching back to 1980. This history includes providing turbines for the world's first offshore wind farm in Vindøby off the coast of Denmark, in 1991.

Siemens Wind Power grew into the global market leader for offshore business, earning a reputation for technological leadership, strong customer service, and for offering fully integrated end-to-end energy solutions.

Activity



Onshore

70 GW installed in 70 countries.
+9 GW of wind farm developed in 14 countries.
The perfect technological ally for your wind projects.



Offshore

+9.7 GW installed worldwide since 1991.
Most experienced offshore wind company with the most reliable product portfolio in the market.



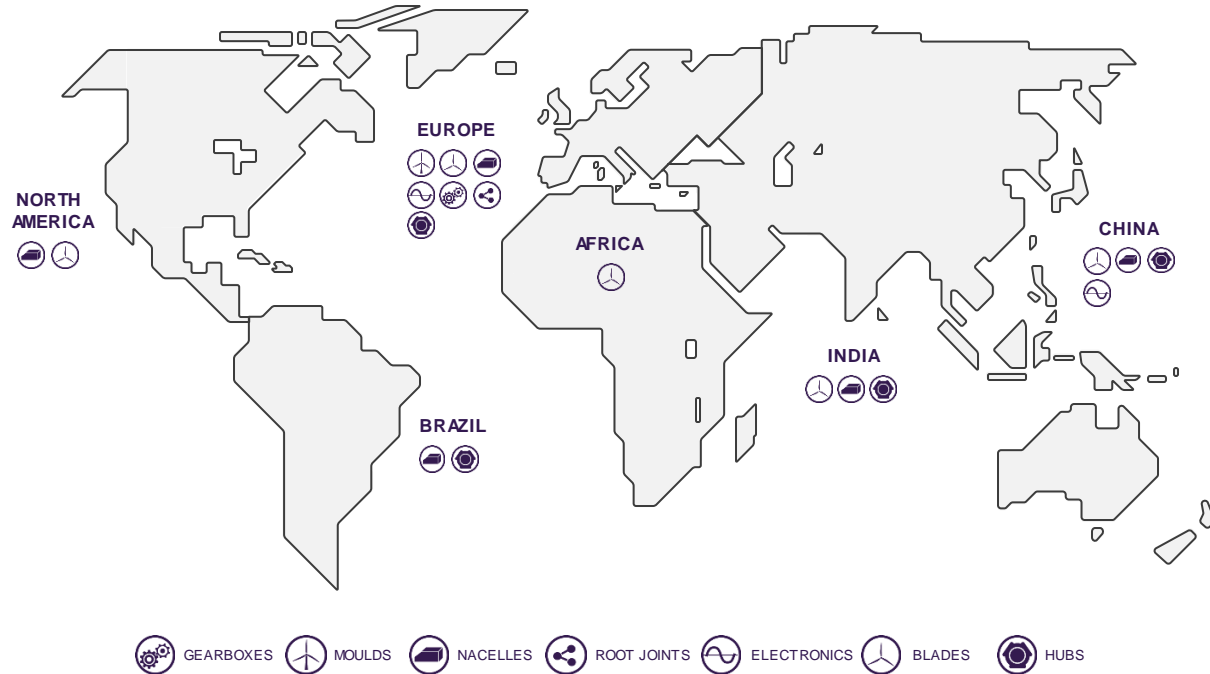
Service

+53 GW maintained.
Commitment beyond the supply of the wind turbine to achieve the profitability objectives of each project.



Three business units strongly positioned in the market

Production centers in the main wind markets



* Siemens Gamesa's participation in Windar tower plants, located in Spain, Brazil, India and Mexico.

- Technical presence close to the customer.
- Supervision of the whole production process: design and manufacturing of wind turbine critical components.
- Establishment of strategic partnerships with leading global suppliers of components:
 - Blades: LM, TECSIS, TPI.
 - Towers: Windar Renovables.
 - Gearbox: ZF, Rexroth, Winergy.
 - Generators: ABB, Siemens.



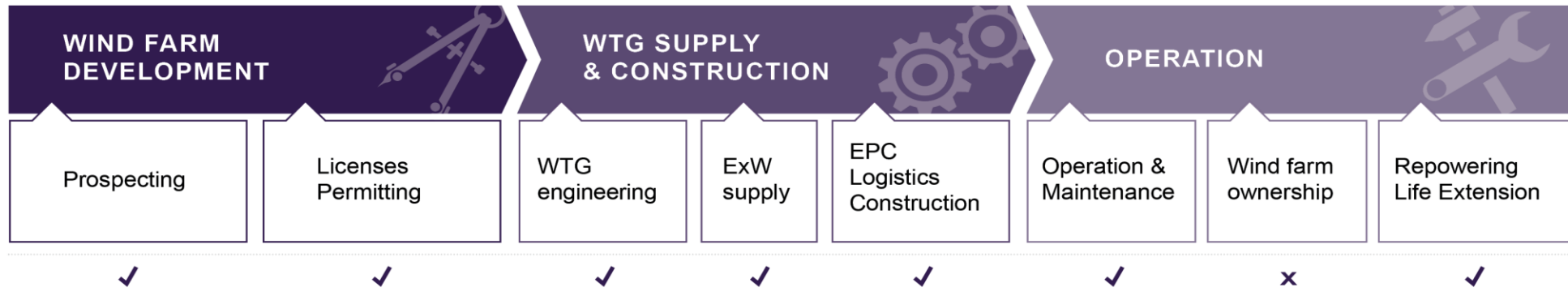
Customer proximity, full process control and delivery optimization



Wind Farm Life Cycle

The only manufacturer with a wide experience

Our wide experience in the whole value chain allow us to lead and advise our clients along the different phases of their wind projects:



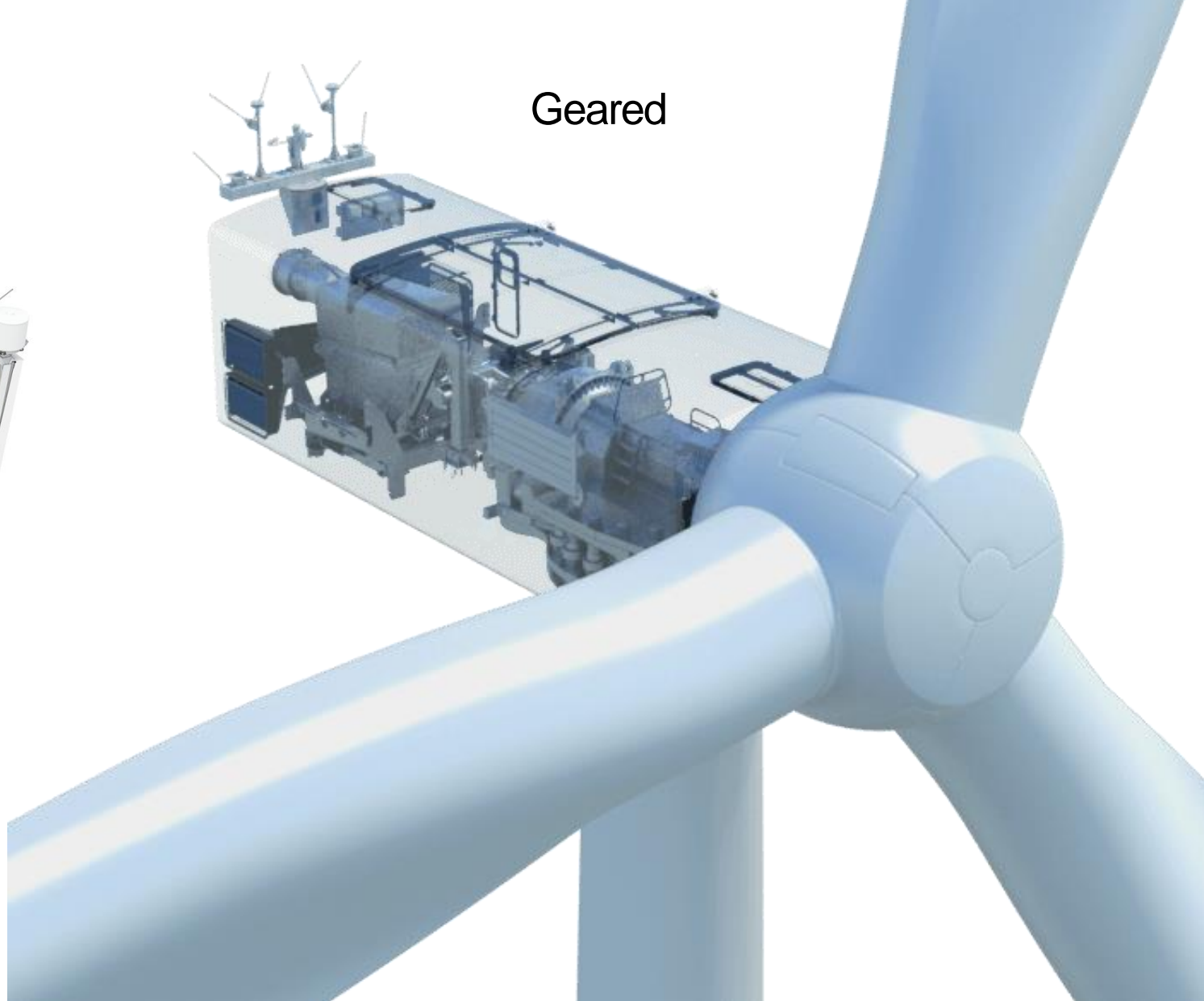
Optimized solutions for each project and in all markets



Examples of different Technologies

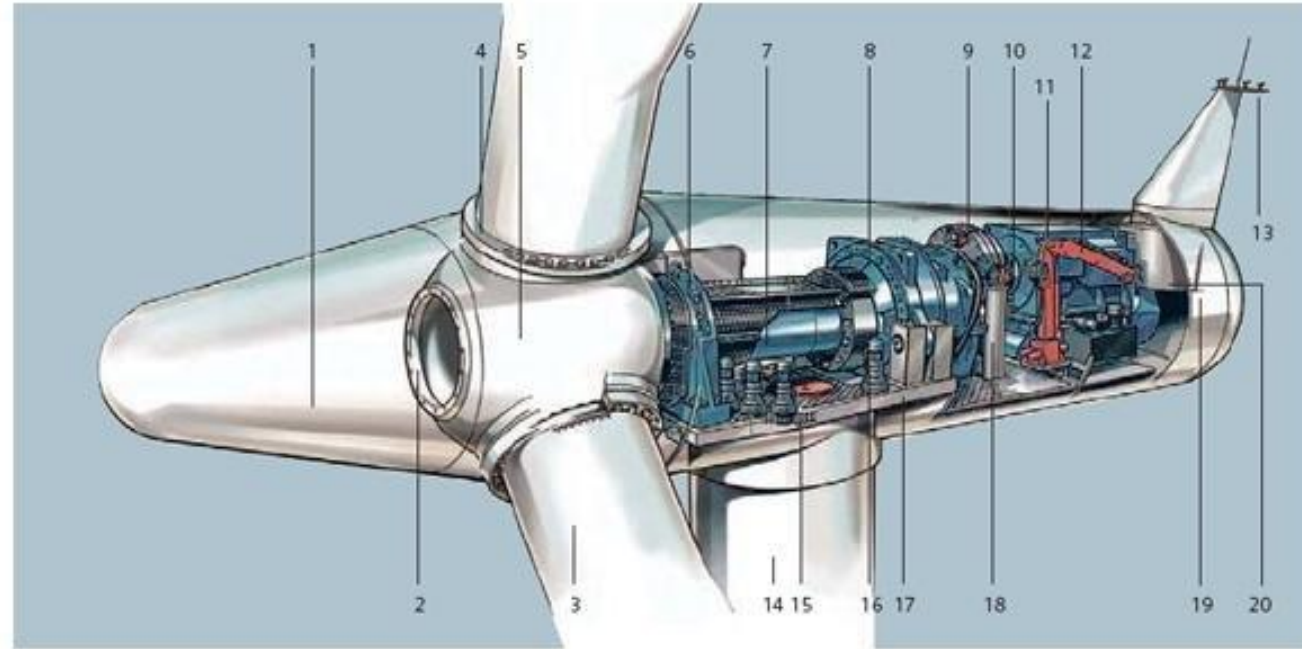


Direct Drive



Geared

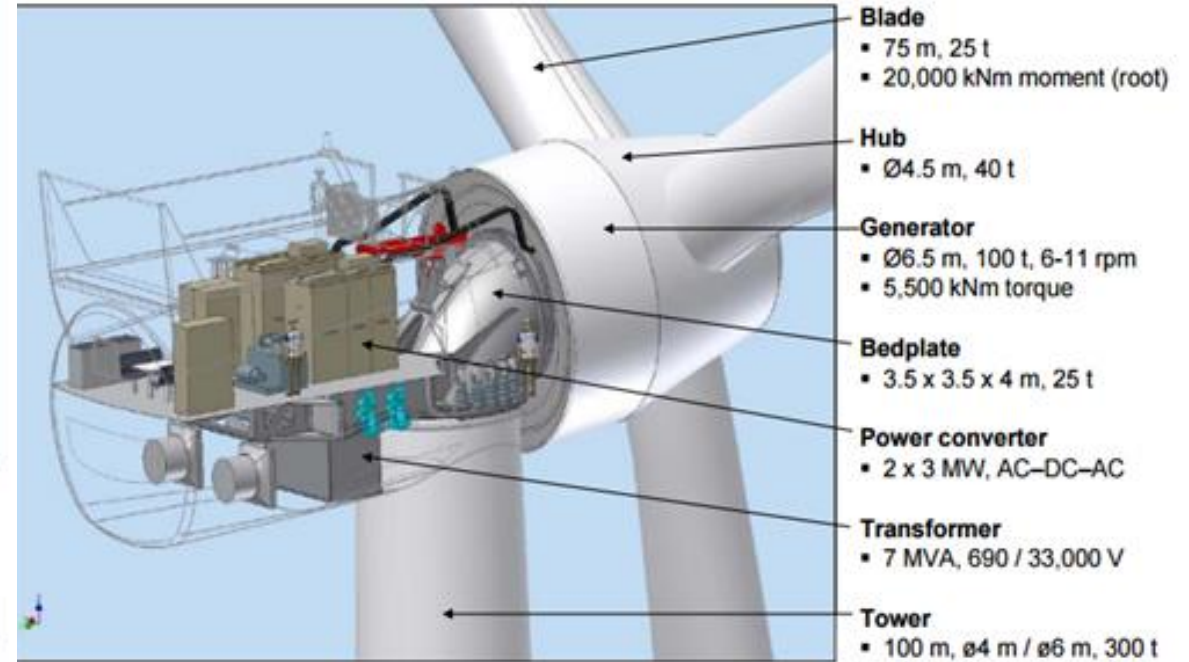
Geared, Onshore Turbine



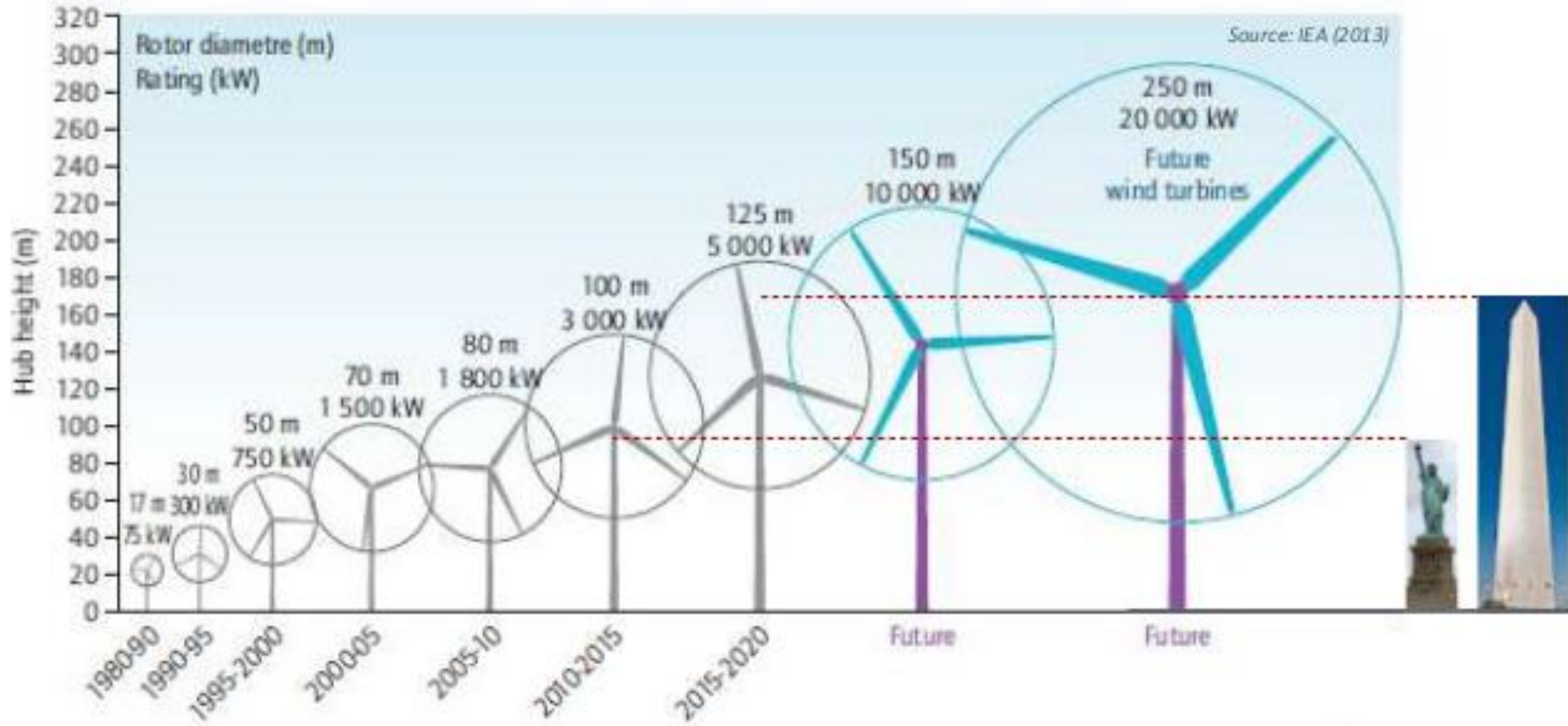
Nacelle Arrangement

1 Spinner	11 Generator
2 Spinner bracket	12 Service crane
3 Blade	13 Meteorological sensors
4 Pitch bearing	14 Tower
5 Rotor hub	15 Yaw ring
6 Main bearing	16 Yaw gear
7 Main shaft	17 Nacelle bedplate
8 Gearbox	18 Oil filter
9 Brake disc	19 Canopy
10 Coupling	20 Generator fan

Direct Drive, Offshore Turbine



Development in time

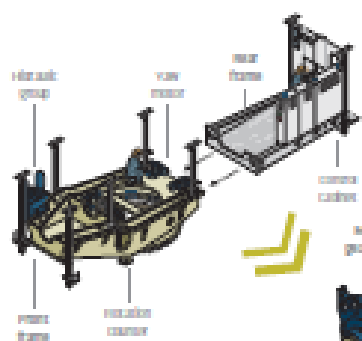


Washington manument photo: David Niff, license: CC-BY-SA 3.0.
Statue of liberty photo: public domain



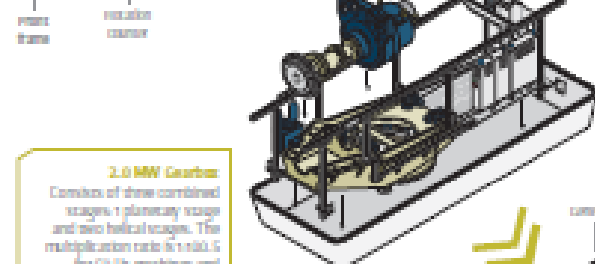
Manufacturing and Assembly Process

Nacelle assembly



I. Frame assembly

Once the yaw system is assembled with its yaw motors, column and hydraulic group and the rotational test is passed, this assembly is connected to the rear frame. Next, the rail beams and the service crane are installed, and cables are run to the control cabinet.



II. Gearbox assembly

The nacelle assembly is placed within the lower housing, and the power transformer and the main shaft/gearbox subset are assembled.

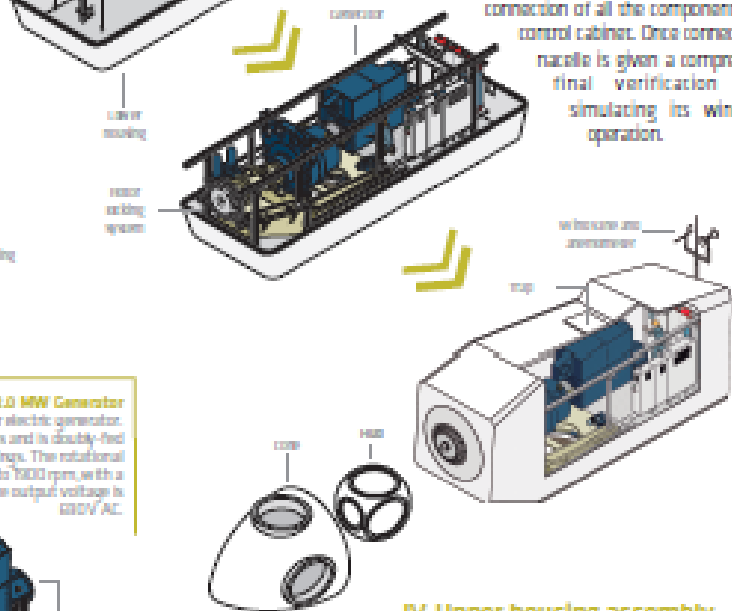
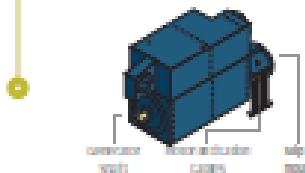
III. Generator assembly

The process continues with the generator assembly and alignment and the electrical connection of all the components in the control cabinet. Once connected, the nacelle is given a comprehensive final verification check, simulating its wind farm operation.

2.0 MW Generator
Consists of three combined stages: planetary stage and two helical stages. The multiplication ratio is 1:100.5 for 60 Hz machines and 1:120.5 for 40 Hz machines.



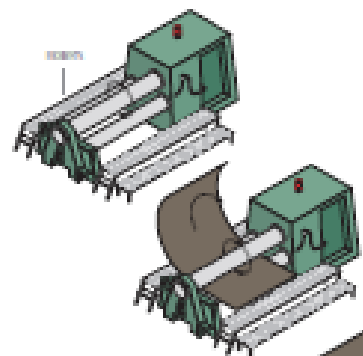
3.0 MW Generator
2 MW rated power electric generator. Highly efficient, it has 4 poles and is doubly-fed with a second rotor and slip rings. The rotational speed range is from 900 to 1000 rpm, with a rated speed of 1680 rpm. The output voltage is 690V AC.



IV. Upper housing assembly

Once the nacelle verification test is passed, the upper housing is assembled and the nacelle is ready to be sent to its corresponding wind farm.

Towers manufacturing process

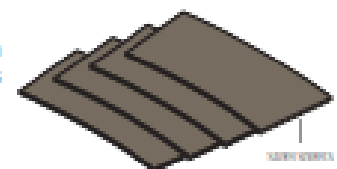


I. Reception and quality control of the steel plates

The cylinders forming the wind turbine tower are made from plated sheets that are flame cut and primed.

II. Shaping

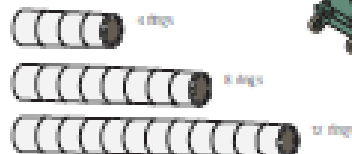
The sheets are inserted in a machine with three large rollers that shape the rings.



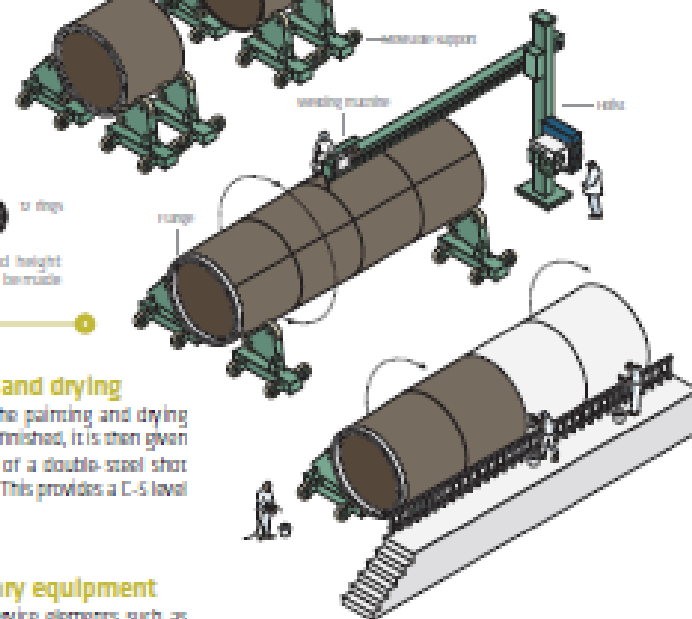
model	width	total height
1.5 MW	2020-2040 mm	44, 46, 50, 54, 58 m
2.0 MW	2020-2040 mm	44, 46, 50, 54, 58 m
2.0 MW	2020-2040 mm	50, 52, 56, 60 m
2.0 MW	2020-2040 mm	52, 54, 58, 62 m
2.0 MW	2020-2040 mm	54, 56, 60 m
2.0 MW	2020-2040 mm	56, 58, 62, 66 m
2.0 MW	2020-2040 mm	58, 60, 64, 68 m
2.0 MW	2020-2040 mm	60, 62, 66 m

III. Welding

The rings are submerged arc-welded, forming sections of different lengths.



Depending on the model and the required height (between 74 and 230 meters), each section may be made up of between 4 and 12 rings.



IV. Shot peening, painting and drying

The structure is placed inside the painting and drying tunnel. Once the tower plating is finished, it is then given a surface treatment, consisting of a double-stage shot peening and three coats of paint. This provides a C-5 level protection.

V. Assembly of the auxiliary equipment

Once the tower is dry, all the service elements such as platforms and ladders are mounted on it.



Movies

1. WF Glunca in Croatia
2. Production Capacity



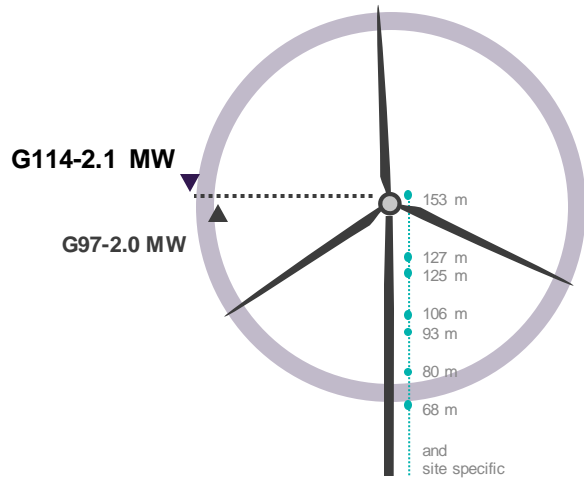
Onshore business State of the Art Technology – Product Portfolio



Product Portfolio

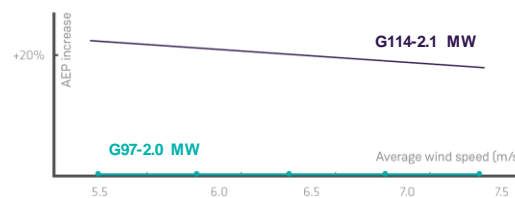
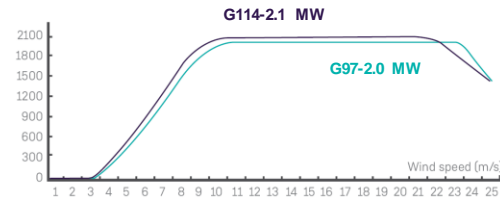
<3 MW geared reference solutions

G114-2.1 MW. The proven benchmark in its segment



SWEPT AREA INCREASE: **38%**

AEP INCREASE: **>20%**



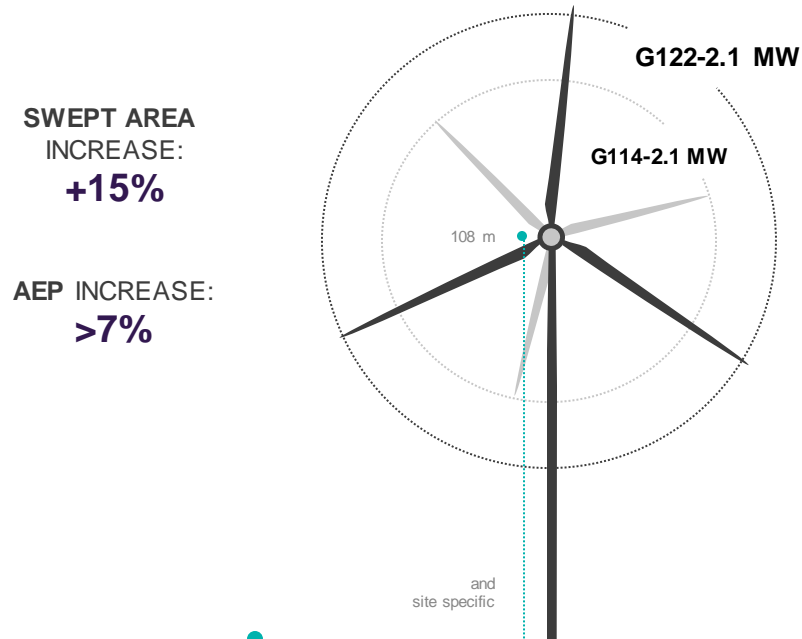
- Optimized for **Class IIA and IIIA**.
- **Geared and proven technologies**.
- **Optimized Class S** solutions for specific wind and environmental conditions in India, China and Brazil.
- **3,246 MW installed and over 5,000 MW in firm orders** of G114-2.0 MW and G114-2.1 MW.
- Availability levels exceeding **98%**.

*Product marketed as 2.0 MW in certain regions.
* Figures as of 2Q2017.*



Solid presence in the market with a remarkable order backlog

G122-2.1 MW. The highest capacity factor in the market



G122-2.1 MW

- Extremely **low power density**.
- Reduced CoE, best-in-class for **low wind sites**.
- Design fully based on the certified **G114-2.1 MW**, with over 5,000 MW orders worldwide.
- Especially suitable for **low-wind low-turbulence** conditions in China and India, but available globally.

Key project milestones

Oct 2017
Official market launch
(China Wind Power)

4Q2017
First 2 Prototypes
(India, Spain)

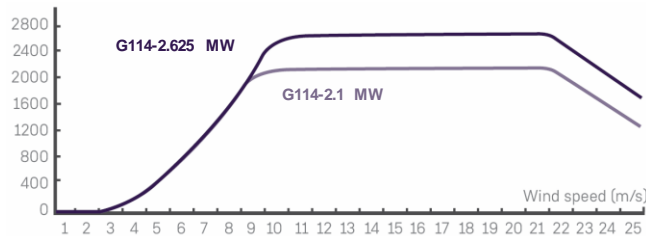
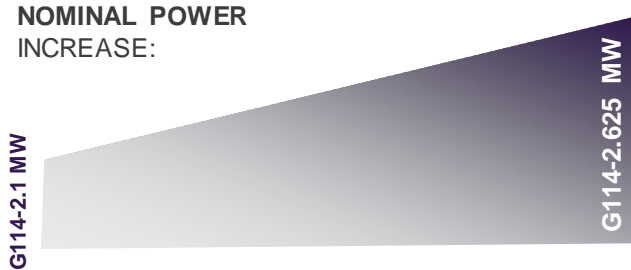
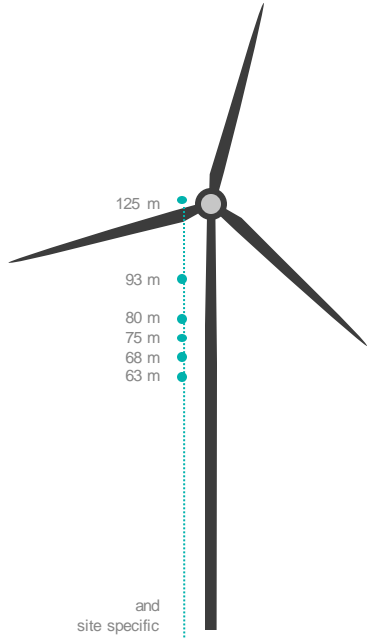
2Q2018
Type
Certificate

3Q2018
Serial Production



High efficiency for sites with low winds

G114-2.625 MW. Boosting production in medium and high wind sites



G114-2.625 MW

- **Class IA and IIA**, with **over 13% more energy production** than G114-2.1 MW.
- **Low technological risk**: same proven technology adopted in the G114-2.1 MW.
- **Over 1,200 MW*** in firm orders of G114-2.5 MW and G114-2.625 MW.

* Figures as of 2Q2017.

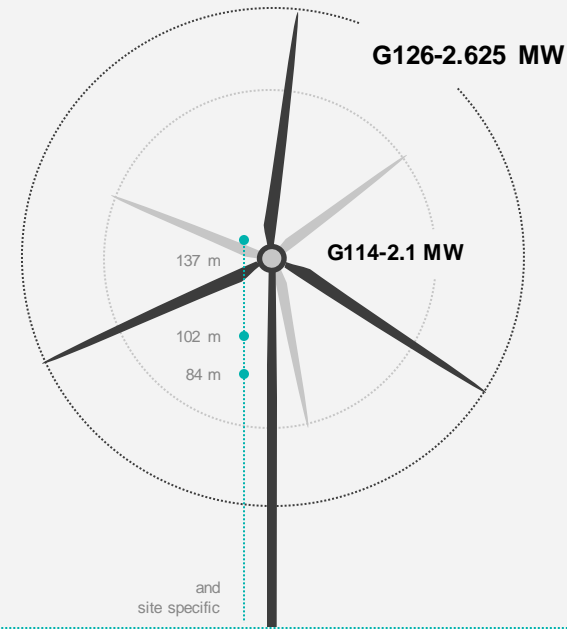


Based on the market benchmark G114-2.1 MW

G126-2.625 MW. Maximum profitability in low wind sites

G126-2.625 MW

- **Class IIIA**, the latest addition to the Siemens Gamesa 2.X Geared product range.
- **Over 20% AEP** vs. G114-2.1 MW in Class III.
- **Proven technologies:**
 - 62 m blade based on the 56 m variant adopted in the G114-2.1 MW.
- **2016 Best Turbine Award** (segment up to 2.9 MW) by Windpower Monthly.



SWEPT AREA INCREASE: **+22%**

AEP INCREASE: **>20%**

Key project milestones

4Q2015
Official market launch
(China Wind Power)

1Q2016
Design
Certificate

3Q2016
First
Prototype

2Q2017
Type Certificate and
Serial Production

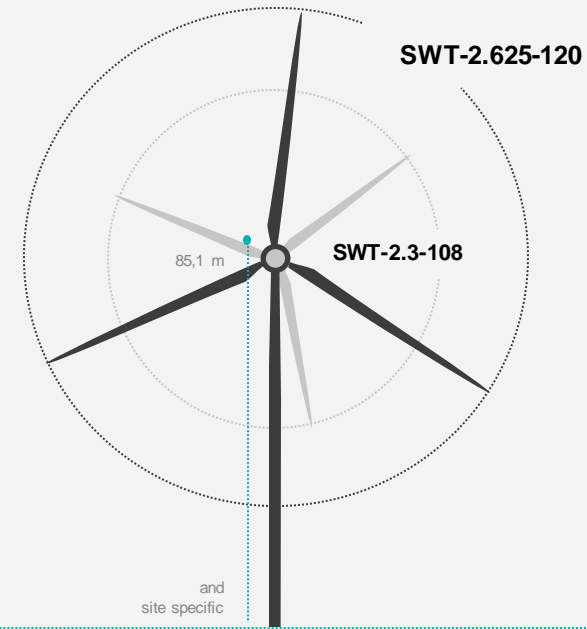


Excellent capacity factor and reduced CoE

SWT-2.625-120. Greater returns for medium wind sites

SWT-2.625-120

- **Class S, IIS, IIIB.**
- Built on the foundation of the **proven 2.3 MW geared product series**, one of the most robust and successful turbine lines in the market with over 8,900 units installed globally.
- **Over 15% AEP** vs. SWT-2.3-108 in Class III.
- **Siemens IntegralBlade® technology**, with Vortex Generators on the entire length of the blade and optimized cross-sections (airfoils) design.



SWEPT AREA INCREASE:
+23%

AEP INCREASE:
>15%

Key project milestones

3Q2017
First
Prototype

2Q2018
Type Certificate and
Serial Production



Optimized performance and high capacity factor



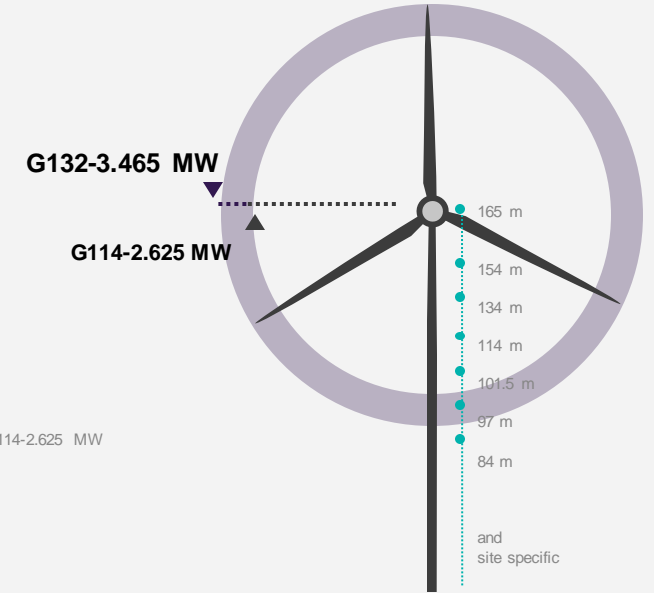
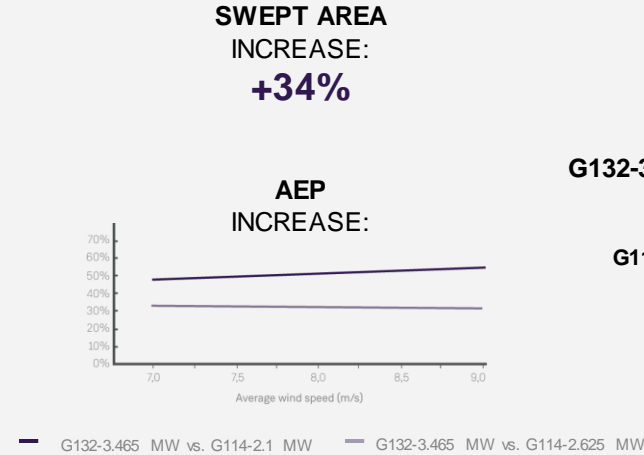
Product Portfolio

>3 MW geared reference solutions

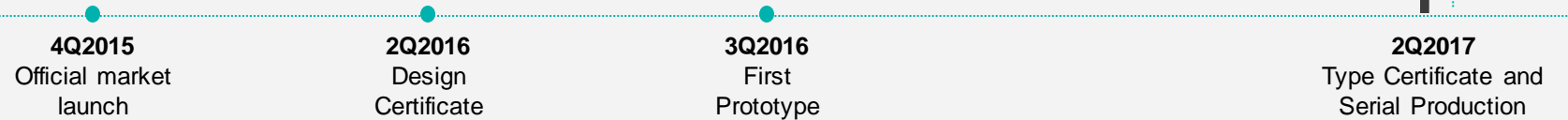
G132-3.465 MW. The most profitable product in its segment

G132-3.465 MW

- Class IIA.
- High nominal power:
 - Over 50% AEP increase vs. G114-2.1 MW in Class II.
 - Over 30% AEP increase vs. G114-2.625 MW in Class II.
- **Enhanced performance based on proven technology:**
 - Same technologies adopted in the 2.1 MW and 2.625 MW solutions.
 - 64.5 m blade based on the fully validated design of the Gamesa G132-5.0 MW blade.



Key project milestones

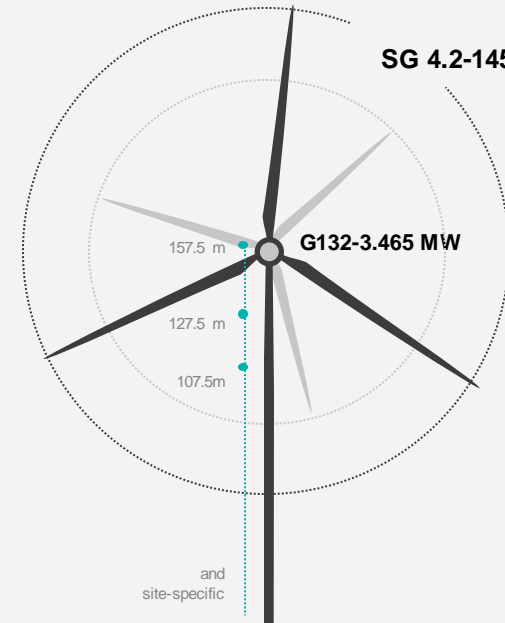


First projects signed in Mexico and Turkey

SG 4.2-145. Achieving new heights in efficiency and profitability

SG 4.2-145

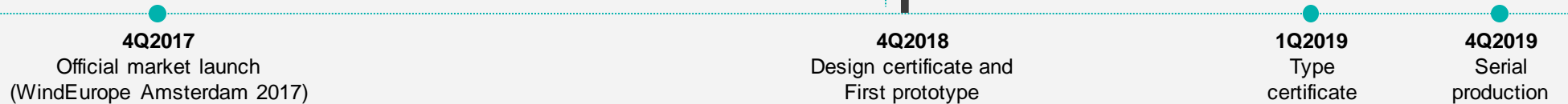
- **First SGRE onshore wind turbine launching.**
- **Best-in-class LCoE >4 MW.**
- **Class IIA design covering a broad range of sites, based on proven technological concepts** such as a 3-stage gearbox and DFIG.
- **Low technological risk:** fully based on the Siemens & Gamesa geared know-how, with a new 71m blade and a nominal power increase to 4.2 MW.



SWEPT AREA INCREASE:
21%

AEP INCREASE:
>20%

Key project milestones



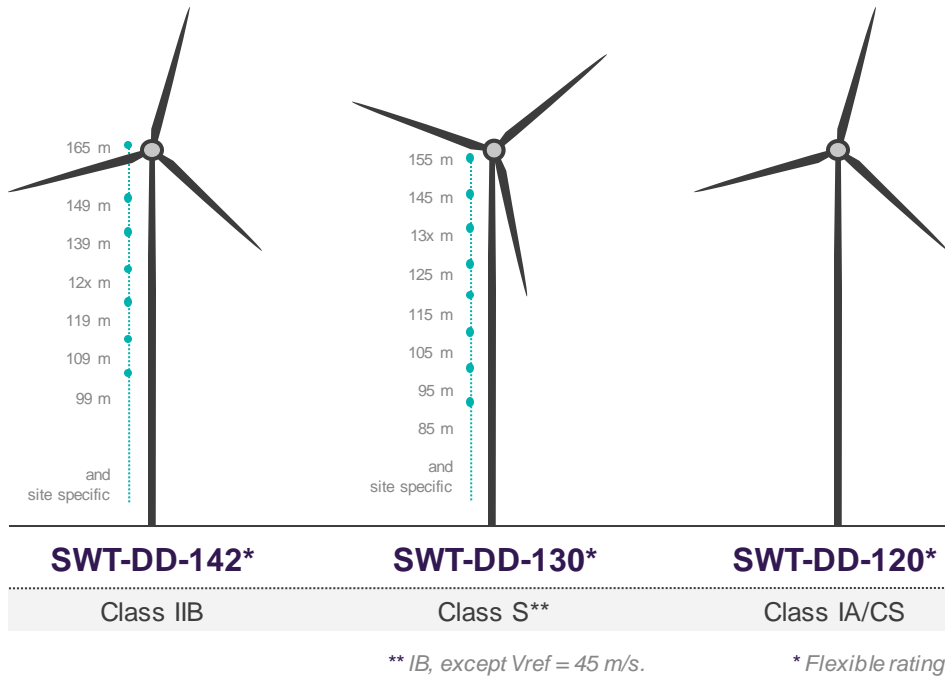
 **First SGRE onshore wind turbine launching**



Product Portfolio

>3 MW Direct Drive reference solutions

Performance and adaptability



- **Direct Drive technology**, high performance in challenging conditions.
- **OptimaFlex** delivers reduced CoE by increasing AEP, optimizing cost, thereby maximizing profitability.
- **Early engagement with customers** combined with advanced siting and design tools allows for optimum site design and maximum asset utilization.
- Flexible rating product platform combined with flexible tower design enables **customizable product solutions** that increase AEP and maximize returns.
- SICS controller and Net Converter provide **real-time power optimization** and increased utilization.

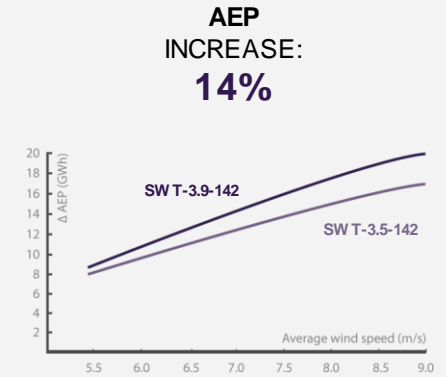
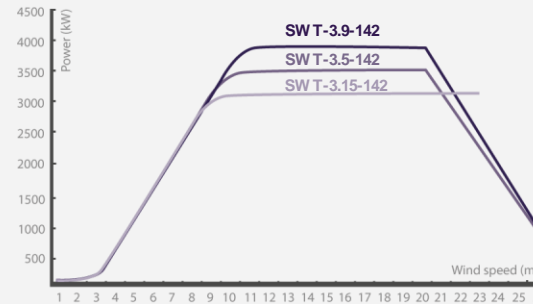


Flexible parameter platform enabling site specific optimization

SWT-DD-142. Direct Drive technology for mid wind sites

SWT-DD-142

- **Flexible rating** with nominal powers ranging from 3.5 MW to 3.9 MW.
- **~14% AEP increase** vs. SWT-3.15-142 in Class II.
- Evolution of the SWT-3.15-142, available in Serial Production from Q4 2017.
- **Technological highlights vs. SWT-3.15-142:**
 - Generator includes new magnets and new segment to allow higher torque level.
 - Higher transformer rating to allow higher turbine ratings.



Key project milestones

3Q2017
Official market launch
(HUSUM Wind 2017)

1Q2018
First Prototype and
Prototype Certificate

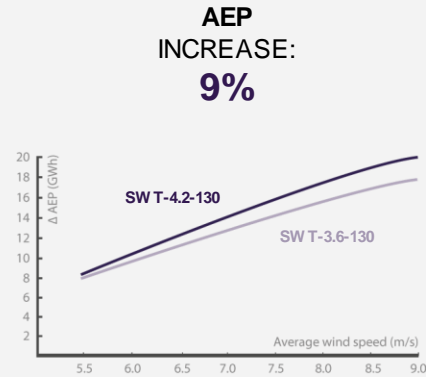
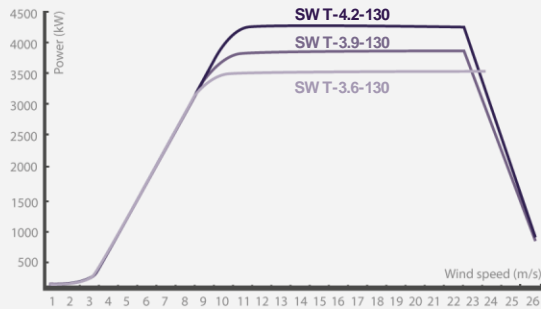
4Q2018
Type
Certificate and
Start of
Production



Full adaptability and optimized power for Class III projects

SWT-DD-130. Robustness and performance for high wind sites

SWT-DD-130



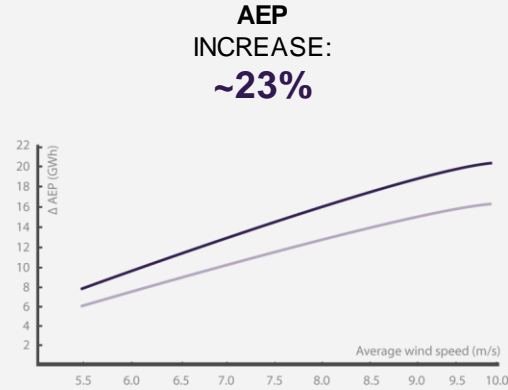
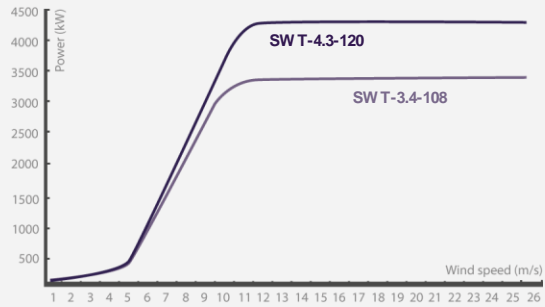
- **Flexible rating** with nominal powers ranging from 3.9 MW to 4.2 MW.
- **~9% AEP increase** vs. SWT-3.6-130 in Class S (IB, except $V_{ref} = 45$ m/s).
- Evolution of the SWT-3.6-130, available in Serial Production since Q2 2017.
- **Technological highlights vs. SWT-3.6-130:**
 - Generator includes new magnets and new segment to allow higher torque level.
 - Higher transformer rating to allow higher turbine ratings.

Key project milestones



Full site adaptability worldwide

SWT-DD-120. The world's first Onshore "Class T (Typhoon)" turbine



SWT-DD-120

- **Flexible rating** with nominal powers ranging from 3.9 MW to 4.3 MW.
- **~23% AEP increase** vs. SWT-3.4-108 in Class I.
- **Best-in-class performance** and proven technology.

Key project milestones

3Q2017
Official market launch
(HUSUM Wind 2017)

2Q2018
First Prototype and
Prototype Certificate

1Q2019
Type Certificate and
Serial Production



Maximizing returns in high wind conditions



Services

Maximum O&M profitability. The best value for money offer of its kind

- Commitment beyond the supply of the wind turbine which **allows to achieve the profitability objectives of the project.**
- The wide range of O&M services includes predictive, preventive and corrective maintenance **adapted to the requirements of each customer.**
- **Comprehensive & modular O&M services and solutions** to upgrade, improve and secure your original business case.



Life Extension Program

Profitability maximization, increasing the service life of wind turbines by 10 years.



Overhaul Service

Converting a V47 turbine into a G47 turbine, upgrading electrical and electronic components and increasing its production by up to 10%.



Energy Thrust

Optimized control logics that increase energy production of oldest platforms by up to 5%, including grid code performance update.



Unique Multi Brand offers

Maintenance Contracts, Repairs, large component upgrades, Fire suppression, MEGA, etc.



Added value services are the backbone of Siemens Gamesa offer



Thank you

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SIEMENS Gamesa
RENEWABLE ENERGY