SIEMENS

Turbina Sapiens in its natural habitat

Siemens 6.0 MW Offshore Wind Turbine

www.siemens.com/wind

Sapiens /sæp.i.enz/
(present participle from the latin. sapere)
to have sense, to be wise, to know
Turbina (genus) Sapiens (species)

Turbina Sapiens
A different breed of wind turbine

The Siemens 6.0 MW offshore wind turbine redefines the wind industry standards for leanness, robustness and lifecycle profitability.

Based on Siemens Direct Drive technology, the 6.0 MW turbine has 50% fewer moving parts than comparable geared machines and a towerhead mass of less than 350 tons. This unique combination of robustness and low weight significantly reduces infrastructure, installation and servicing costs, and boosts lifetime energy output.

Incorporating the aggregate intelligence of Siemens, the 6.0 MW offshore wind turbine thinks for itself. It constantly manages its own operating load helping it remain within its design criteria irrespective of the conditions. Its advanced diagnostics system provides comprehensive real-time performance data and service requirements and will keep track of lifetime use and its overall asset condition. Even its user interface is clear and intuitive.

It is no coincidence that a product of this simple beauty and intelligence has been created by Siemens. We are world leaders in offshore wind power, with over 20 years of experience.

Lean, robust and reliable technology

Lean

The Siemens 6.0 MW turbine is based on proven Siemens direct drive technology, offering the simplest and most straightforward wind turbine design.

Replacing the main shaft, gearbox and high-speed generator with only a low-speed generator eliminates two-thirds of the conventional drive train arrangement. As a result, the number of rotating and wear-prone parts is vastly reduced, and a Siemens direct drive wind turbine has 50% fewer parts than a comparable geared machine. Crucially important in offshore applications, of course, is that maintenance requirements drop accordingly.

As a rule, the weight of large wind turbines has grown disproportionately to increases in power rating. The Siemens 6.0 MW wind turbine has conclusively broken the trend: with a towerhead mass of less than 60 tons per MW the 6.0 MW wind turbine is genuinely lean. This new low-weight standard for offshore wind turbines offers significant cost benefits in terms of substructure requirements, shipping and installation, all made possible by the use of Siemens' tried and tested direct drive technology.

Robust

Benefiting from our unique offshore experience, the 6.0 MW direct drive wind turbine is designed to exploit the broadest range of offshore environmental conditions.

Designed to IEC 1 Standards, the 6.0 MW turbine can be deployed in any known offshore location. The structural capacity of all components is verified by full-scale testing, and Highly Accelerated Lifetime Tests on all main components and the complete nacelle demonstrate their robustness.

The entire turbine design is dedicated to offshore application. All external surfaces and systems feature offshore-grade corrosion protection, and the completely enclosed nacelle is fitted with internal climate control.

Reliable

The Siemens 6.0 MW wind turbine is designed not merely to continue, but to enhance, the legendary reliability of Siemens wind turbines.

Simple and robust, the direct drive technology offers the best possible basis for high reliability.

The rotor blades combine both lightness and strength through single-cast Siemens IntegralBlade® production.

The nacelle, housing every part of the power system, forms a self-contained unit delivering medium voltage power to the wind farm grid. As a result the turbine can be fully pre-commissioned onshore, leaving only final connection to be performed after installation.

Finally, with the extra nacelle space repurposed as an on-site workshop complete with crane and coffee machine, the maintenance process has been reinvented too.

Mould for the B75 Quantum Blade

A choice of blades

120m rotor for tip height restricted locations

The 120 m rotor, standard equipment with the Siemens 3.6 MW offshore workhorse, also allows the 6.0 MW turbine to be installed in locations where air traffic regulations make it difficult or impossible to exceed a maximum tip height of 150 m.

154m rotor for maximum energy yield

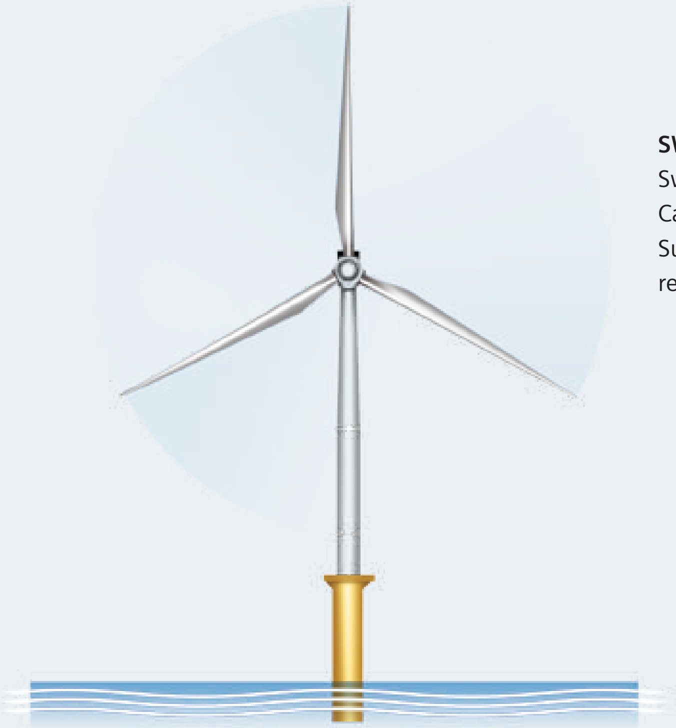
The 154m rotor, designed specifically for the Siemens 6.0 MW turbine, has a swept rotor area of 18,600m^2. It therefore maximizes energy yield at offshore locations, from inland waters with moderate wind resources to the most exposed offshore sites.

IntegralBlade® technology

Both the 120m and 154m rotors use blades manufactured with Siemens' unique, patented IntegralBlade® technology.

Instead of glueing the blades together from a number of spars and shells, they are cast in a single process. This not only enables both low weight and enormous strength, there are no glue joins which could potentially expose the blades to cracking and lightning damage.

The aerodynamic and structural design of the blade for the 154m rotor is based on Siemens' Quantum Blade technology, incorporating unique airfoil profiles and redesigned tip and root sections. The root section uses Siemens "flatback" profiles to minimize root leakage and provide higher lift. The tip has also undergone a fine-tuning process to enhance lift. As a result, Quantum Blades offer superior performance in a wide range of wind speeds.



SWT-6.0-120 for maximum versatility
Swept area 11,500m^2
Can be applied to the same foundation as the SWT-3.6-120
Suitable for environments where maximum tip height restrictions apply, even onshore

SWT-6.0-154 for maximum output
Swept area 18,600m^2
Rated power at a wider range of wind speeds
Quantum blade technology

To know

The Siemens 6.0 MW wind turbine represents all the brainpower of the world's most experienced offshore wind turbine supplier – and more.

The overall 6.0 MW turbine design is based on highly-proven technology. All the classical virtues of Siemens turbines have been retained – ample dimensioning of main components, redundant safety systems, and details designed with the best engineering practices. The ground-breaking IntegralBlade® and direct drive technologies have been deployed in the field for years, and many core components are directly linked to turbines produced in large volumes. The main elements of the generator are scaled-up versions of their 3MW forebears. The converters are identical: the bigger machine simply uses two 3MW converters side by side.

Utilizing Siemens' standard marinisation technologies, most of which were developed for the world's first offshore wind farm at Vindeby, Denmark, in 1991, the turbine's environmental protection makes it eminently suited to the most severe offshore conditions

To learn

Adding to the combined knowledge gained from field-testing a vast fleet of multi-megawatt offshore wind turbines, Siemens continually strives to acquire in-depth understanding of every element in the wind turbine system.

Fundamental to this process is rigorous testing of components and complete systems. At our R&D headquarters in Brande, Denmark, our test facility makes it possible to verify the structural capacity of every component. The facility even enables Highly Accelerated Lifetime Tests on the complete nacelle, simulating 25 years of real life through 3-6 months of overload operation. This process ensures that Siemens' legendary quality runs through every component of our wind turbines.

To sense

On top of its knowledge-based and robust technology foundation, the 6.0 MW turbine cleverly exploits an extensive list of proven and new Siemens innovations, including:

Superior grid compliance

As more wind power enters the grid, there is a greater onus on wind turbine manufacturers to meet stringent grid stability requirements. The Siemens NetConverter® system used by the 6.0 MW is designed for maximum flexibility in each wind turbine's response to voltage and frequency variations, fault ride-through capability, and output adjustment. The grid compatibility of Siemens turbines sets the benchmark for the wind industry, and the advanced wind farm control system provides state-of-the-art fleet management.

Siemens WebWPS SCADA system

The 6.0 MW is equipped with the Siemens WebWPS SCADA system. Via a standard web browser, the system provides a variety of status views of electrical and mechanical data, operation and fault status, meteorological and grid station data.

Turbine Condition Monitoring (TCM®)

Siemens' unique Turbine Condition Monitoring system compares the vibration levels of the main nacelle components with a set of established reference spectra and instantly detects deviations from normal operating conditions. This allows Siemens to proactively plan the service and maintenance of the wind turbines, as any unusual event can be categorized and prioritized based on severity.

Turbine Load Control (TLC)

The Turbine Load Control system continuously monitors the structural loading on the wind turbine. In case the loads exceed normal values, e.g. as the consequence of extreme meteorological conditions, the turbine automatically regulates operation to bring loads back within the design envelope.

In addition, the TLC system monitors the accumulated fatigue loading on the turbine, thereby providing key input for fact-based asset management.

High Wind Ride Through (HWRT)

Wind turbines are normally programmed to shut down if the 10-minute mean wind speed exceeds 25 m/s. This may lead to severe challenges for the grid system if the turbines in large offshore wind farms are shut down more or less simultaneously, e.g. at the passage of a gust front.

The Siemens 6.0 MW turbine enhances grid stability with its High Wind Ride Through system, which replaces the fixed-threshold high wind shutdown with an intelligent load-based reduction in output power at very high wind speeds.

Added efficiencies in logistics, pre-commissioning and installation

Wind turbine design evolution is affecting far more than just the design itself. The Siemens 6.0 MW turbine's manufacturing, assembly and installation processes are prepared with genuine industrialization in mind, creating a scalable production model that will reduce both delivery times and costs throughout the value chain.

A modular nacelle arrangement will reduce onshore port assembly requirements dramatically. And with the entire electrical system – including the medium voltage system and the full converter – included in the nacelle, pre-commissioning testing can be carried out at quayside, reducing offshore work to a minimum.

Further improvements in safety

Safety is at the heart of all Siemens operations. From production, through installation, operation, and service, Siemens strives to set the standard.

Onshore pre-commissioning and testing significantly reduce the amount of work that needs to be done in riskier offshore conditions.

While the simplified direct drive concept in itself reduces service requirements, offshore maintenance has been completely rethought.

Service technicians can enter the turbine via the helihoist platform or via conventional tower access, where a new gangway system enables safer access at rough sea conditions.

The spacious nacelle, housing far fewer parts than usual, provides technicians with safe and easy access to all key components.

The world's first wind farm at Vindeby, Denmark. Installed by Siemens in 1991. The turbines in this project are still running today

Siemens Wind Power – the offshore leader

The world is seeing a dramatic increase in the nature and scope of offshore wind power plants. As larger projects head farther out to sea, the reliability of the wind turbine is paramount.

Given the logistical challenges of offshore projects, where even the smallest issue can amplify costs, having technology that performs to order under some of the harshest operating conditions on the planet is crucial.

With good reason, Siemens is the obvious first choice for assured delivery of high-performing technology. From the very beginning, the company has been the undisputed leader in offshore wind power, and remains so today.

Landmark projects include the world's first offshore wind farm at Vindeby, Denmark. Installed in 1991, the 11 turbines in this project are still operating today.

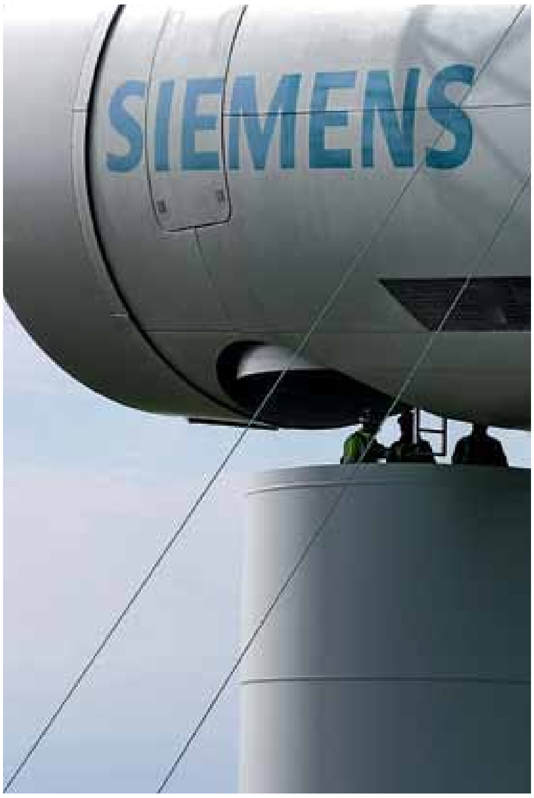
The first offshore wind farm using multi-megawatt turbines was also delivered by Siemens. Installed in 2000 in a single arc off Copenhagen, the 20 turbines of the Middelgrunden project remain the iconic symbol of the offshore wind industry.

For many years the 165MW Nysted offshore wind farm, installed in 2003, held the record as the world's largest offshore project, a record only broken in 2009 by our 200MW Horns Rev II project. The 1GW London Array project, currently being developed, will once again redefine the capabilities of offshore wind power and pave the way for green energy to become the cornerstone of the global energy mix. Not surprisingly, all of these projects are delivered by Siemens.

With over 2GW of installed offshore capacity, the Siemens offshore organisation has deservedly earned the reputation for having the deepest experience and world class project management capabilities. No wonder, then, that despite the immense challenges of installing and commissioning offshore wind farms, every offshore project undertaken so far by Siemens Wind Power has been delivered on time and within budget.

Our infrastructure capabilities are no less proven. Siemens has a wealth of experience of building and integrating substations for national grids and is the only company to have designed, built and delivered offshore substations of up to 500 MW.

And with our dynamic modelling of wind turbine arrays and grid connections through our Power Technologies International (PTI) teams, we lead in dealing with unknowns at the beginning of a project, rather than during it.



The installation
of a 6.0MW wind
turbine onshore

Technical Specifications

SWT-6.0-154

Rotor

Type	3-bladed, horizontal axis
Position	Upwind
Diameter	154 m
Swept area	18600 m²
Speed range	5-11 rpm
Power regulation	Pitch regulation with variable speed
Rotor tilt	6 degrees

Blade

Type	Self-supporting
Blade Length	75 m (B75)
Aerodynamic profile	Siemens proprietary airfoils, FFA-W3-XXX
Material	GRE
Surface gloss	Semi-gloss, <30 / ISO2813
Surface colour	Light grey, RAL 7035

Aerodynamic brake

Type	Full-span pitching
Activation	Active, hydraulic

Load-Supporting Parts

Hub	Nodular cast iron
Main shaft	Nodular cast iron
Nacelle bed plate	Nodular cast iron

Mechanical brake

Type	Hydraulic disc brake

Canopy

Type	Totally enclosed
Surface gloss	Semi-gloss, 25-45 / ISO2813
Colour	Light grey, RAL 7035
Material	Fire retardant GFRP with integrated EMC shielding

Generator

Type	Synchronous, PMG, Direct Drive

Grid Terminals (LV)

Nominal power	6000 kW
Voltage	690 V
Frequency	50 Hz

Yaw system

Type	Active
Yaw bearing	Externally geared
Yaw drive	Electric gear motors
Yaw brake	Passive friction brake

Controller

Type	Microprocessor
SCADA system	WPS
Controller designation	WTC 3.0

Tower

Type	Cylindrical and/or tapered tubular
Hub height	Site-specific
Corrosion protection	Painted
Surface gloss	Semi-gloss, 25-45 / ISO2813
Colour	Light grey, RAL 7035

Operational data

Cut-in wind speed	3-5 m/s
Nominal power at	12-14 m/s
Cut-out wind speed	25 m/s
Maximum 3 s gust	70 m/s (IEC version)

Weights (approximately)

Towerhead mass	360,000 kg

1 Quantum Blade

- Unique design and manufacturing process
- IntegralBlade® one-piece moulding for maximum strength
- Optimized aerodynamics for medium to high wind conditions
- Increased length for higher energy yield
- Blade root – designed for minimized root leakage and increased lift

2 Direct drive generator

- Permanent magnet design
- Totally enclosed, easy to handle and lightweight design
- Optimum reliability and efficiency

3 Nacelle

- Solid and lightweight structure
- Spacious, ergonomic design – maximum serviceability
- 50% fewer parts compared to geared turbines

4 Cooling

- Simple and robust LiquidLink® water cooling system
- Top-mounted passive cooling radiators
- High-efficient two-stage cooling as function of power

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