

GE Renewable Energy

GE's Haliade* 150-6MW

High yield offshore wind turbine



GE Renewable Energy

Since entering the wind industry in 2002, GE Renewable Energy has invested more than \$2 billion in next generation wind turbines. Whether at the turbine, plant, or grid level, GE continues to focus on providing more value for our customers. Through the use of advanced analytics, GE Renewable Energy is redefining the future of wind power, delivering on proven performance, availability and reliability. With the integration of big data and the industrial internet, the company is helping to manage the variability of wind to provide smooth, predictable power. Our current product portfolio includes both onshore and offshore wind turbines with rated capacities ranging from 1.6 MW to 6 MW and support services ranging from development assistance to site optimization, operation and maintenance.

For more information visit our website:
www.gerenewableenergy.com

Haliade* 150-6MW... suitable for all offshore conditions

The Haliade* 150-6MW is a three-bladed wind turbine with a 150 m diameter rotor and a rated power of 6 MW. The turbine has been designed following Class I-B specifications of the standards IEC-61400-1 / IEC-61400-3. It is suitable for sites with a reference wind speed of 50 m/s (10 minutes average) and a 50-year extreme gust speed of 70 m/s (3 seconds average).

Strength and durability are maximized in an exceptionally 73.5 m light blade uniquely developed for the Haliade* 150-6MW. The combination of this 150m rotor diameter and the rated power of the generator provides an annual energy production more than 3 times superior compared to conventional and recent onshore wind turbines⁽¹⁾, enabling enough power to supply 5,000 households. The large diameter rotor added to the 6 MW rated power turbine maximizes the capture of energy.

The wind turbine is air-cooled and pressurized. Construction materials and protection treatments are specifically designed for offshore environments. Heat exchangers and pressuring units prevent salty air entering while dehumidifiers prevent corrosion of components inside the wind turbine.

Built upon proven technology

Proven technology and innovation are combined in Haliade* to deliver best in class cost efficiency.

The offshore turbine is equipped with the "Advanced High Density" direct drive permanent magnet generator (PMG), a unique and proven rotor technology. It provides outstanding reliability in the turbine's drive train. With no gearbox coupled to the generator, the turbine consists of fewer rotating parts, which increases reliability, maximizes turbine availability and reduces maintenance costs.

Haliade* also features GE PURE TORQUE® technology, a unique rotor support concept that protects the drive train from unwanted wind buffeting by deflecting it towards the tower, improving turbine efficiency and durability.

With an installed global fleet of more than 30,000 units, GE's technology runs at 98% availability. Together with GE's tailored customer service options, GE can enhance the value of the assets over their lifetime and reduce the cost of electricity for its customers. As one of the world's leading wind turbine suppliers, GE provides an evolutionary wind turbine product portfolio and support services extending from development assistance to operation and maintenance for the successful implementation of projects. This creditable track record supports customers with the finance ability of their wind projects.

⁽¹⁾ Calculation based on 45% capacity factor for the Haliade* 150-6MW and 25% capacity factor for a 3 MW turbine

Technical specifications

OPERATING DATA

Wind Turbine:
Class I-B IEC-61400-1 / IEC-61400-3
Rated power 6.0 MW (net after transformer)
Cut-in wind speed 3 m/s
Cut-out wind speed:
(10 minutes average) 25 m/s
Grid frequency 50 / 60 Hz

ROTOR

Rotor diameter 150.95 m
Blade length 73.5 m
Rotor swept area 17,860 m²
Rotor speed range 4 - 11.5 rpm
Tip speed 90.8 m/s

GENERATOR

Type Direct Drive Permanent Magnet
Rated voltage 900 V per phase
Number of phases 3 x 3
Protection class IPP55

CONVERTER

Type Back to back 3-phase AC/AC
Output voltage 900 V

TOWER

Type Tubular steel
Hub height 100 m (or site-specific)
Standard color RAL 7035

POWER CONTROL SYSTEM

Type Variable speed and independent pitch control by blade

ENVIRONMENTAL SPECIFICATIONS

Normal air temperature range -10 to +40°C
Extreme air temperature range -30 to +50°C
Lightning protection Class I acc. IEC 62305-1

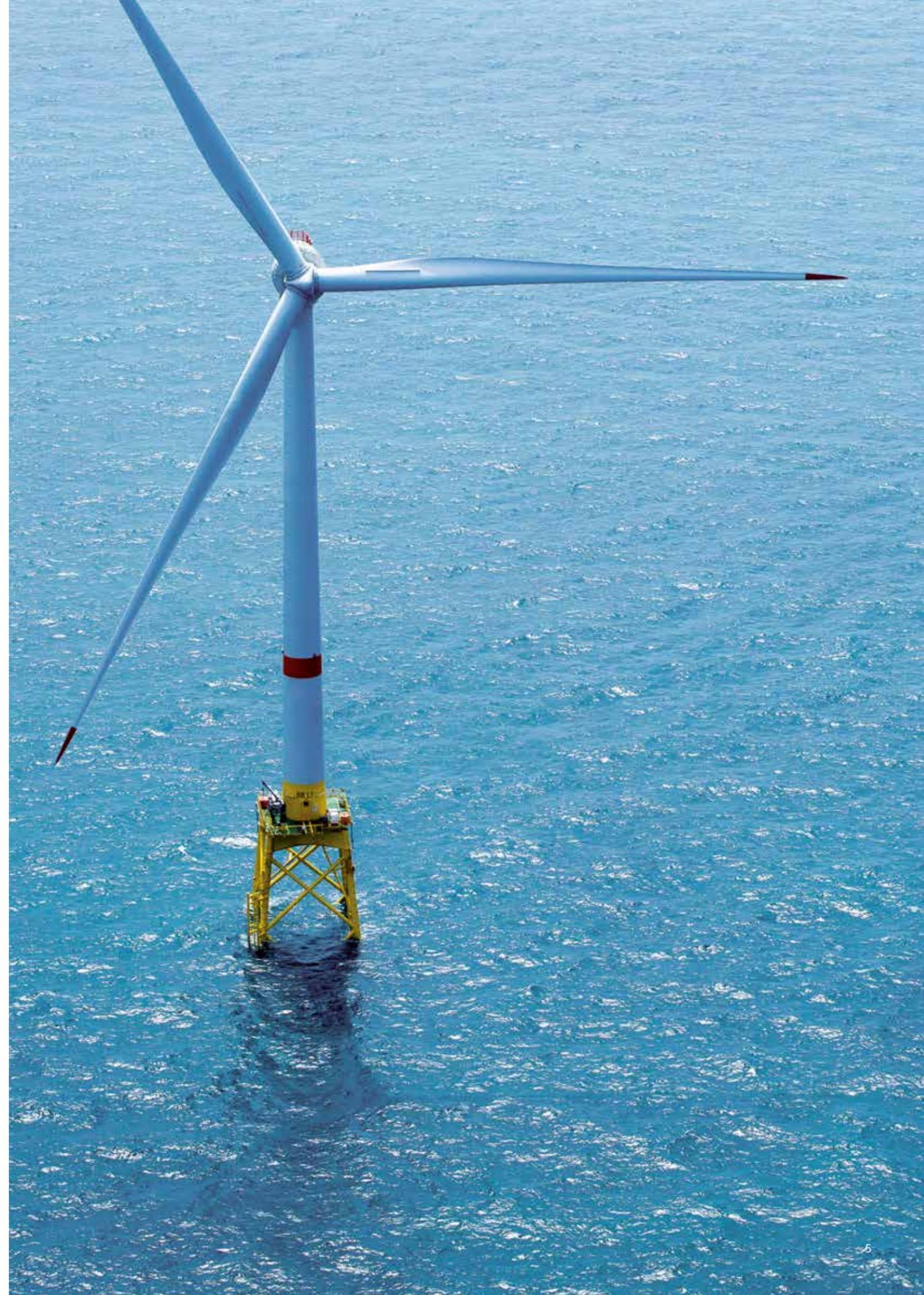
Features & benefits

- GE's separates the turbine rotor and generator to ensure that only turning force – torque – is transferred to the generator. This allows the minimum air gap to be maintained between the generator rotor and stator all times, offering the highest efficiency.
- The permanent magnet generator (PMG) leads to better generation efficiencies and even greater overall mechanical reliability, which is critical in offshore wind.
- The innovative "Advanced High Density" direct drive PMG is a more compact and lightweight design compared to earlier generation of direct drive systems.
- Failure tolerance for continuous production: 3 independent generation and conversion lines ensure uninterrupted operations.
- Software-controlled de-rating strategies guarantee operation in the event of partial faults in the power line or cooling systems.
- An aggressive target weight eases installation and minimizes the cost of both the turbine and supporting structures.

Safety first

The Haliade* 150-6MW is designed to make maintenance as simple and as safe as possible:

- The hub can be accessed directly from the nacelle, allowing major service operations from within the turbine.
- The nacelle is equipped with a 1 tonne capacity crane in the central frame.
- A helicopter winching area allows for quick rescue in case of emergency at sea.



Tailor-Made Service Solutions

A flexible service agreement is offered on GE's Haliade*. Enhance turbine operating performance and life by adding predictive condition monitoring services, unplanned maintenance with advanced services and up tower repairs, as well as options for turbine performance and life extension enhancement. Under this comprehensive package GE provides the customer with high-level performance. For customers that prefer to manage the O&M of their assets in another type of structure, flexible options to support our customers are available:

- Service support
- 24/7 Remote control
- Upgrades packages
- Performance improvements
- Spare part centers
- Lifetime extension

GE's flexible offering uses both helicopters and vessels for the fast and safe transport of personnel and spare parts between onshore base, offshore base and wind turbines. Additional specific vessels are hired as required, for example when heavy lifting equipment must be used.

Financial Services

GE Energy Financial Services has developed a long track record of investing in renewable energy, with a focus on wind and solar power generation. Our portfolio also includes biomass, hydroelectric and geothermal power generation projects. GE Energy Financial Services primarily makes equity investments and can assist partners in raising project debt. In addition, renewable energy assets are included in our loan portfolio.

10

~\$10 billion
IN CUMULATIVE
GLOBAL
RENEWABLE
ENERGY
COMMITMENTS

8

~\$8 billion
IN WIND
COMMITMENTS

1.8

~\$1.8 billion
IN SOLAR
COMMITMENTS



Imagination at work

Making Renewables the energy
of choice for a cleaner future

www.gerenewableenergy.com