

GE Power & Water  
Renewable Energy

# 4.0-110

Offshore **Wind** Turbine



imagination at work



# GE's 4.0 MW Offshore Wind Turbine

## GE offshore wind turbine... right technology, right time

Over the last decade, GE has established itself as a global leader in the wind industry, demonstrating its design expertise and constant focus on improving reliability. In addition, thanks to its scalable supply-chain and manufacturing know-how, GE has brought large-scale production to the wind industry, installing close to 13,500 onshore wind turbines around the world.

Over the coming decades, GE will apply this experience to the offshore wind industry as it matures, growing from a 1.5 GW installed based in 2008 to a forecasted 30 GW opportunity by 2020. Through the development, installation and operation of the Arklow wind farm, GE has gathered more than six years of experience and an understanding of what it takes to deliver and operate offshore wind turbines... lessons learned that have been instrumental in the development of GE's new direct-drive technology, built for offshore applications.

Based on a simple, reliable design infused with GE's proven technology, the 4.0 MW offshore wind series platform delivers a reliable, cost-effective, high-performance solution uniquely positioned to become the new offshore industry standard.

## Proven direct-drive design for offshore applications

The 4.0 MW wind series platform is built around a permanent magnet generator, delivering high efficiency at low wind speed. Two main bearings transfer axial and bending loads from the rotor to the bedplate for higher reliability.

In 2005, 13 direct-drive wind turbines employing the same design principles as the 4.0-110 were installed along the coastline of Hundhammerfjellet, Norway. The turbines have since accumulated 50 years of equivalent operating experience—experience gained under some of the most challenging conditions nature has to offer: salt water, storms and lightning, winds averaging 9.7 m/s and temperatures ranging from -25°C to +25°C.

Built around a direct-drive technology, the 4.0 MW wind series platform removes the single most costly failure in offshore—gearboxes—and replaces it with reliable slow speed components specifically designed for the offshore environment.

With its spacious nacelle and internal hub access, the 4.0 MW offshore wind series platform offers both maintenance and safety advantages. Additionally, GE's offshore wind turbine technology offers redundant operation, automatic lubrication and in-situ repairs wherever possible, maximizing unit availability and reducing operating costs.

Direct-Drive MMW Introduction	SW 3 2005	SW 3.5 2007	GE 4.0 2010
Rotor Diameter (m)	90	90	110
Capacity Factor* (%)	48	44	52 → +8 pts
AEP (GWh)	12.7	13.4	18.3 → +36%

\* Estimated AEP at 10 m/s and 98% availability

## Technical Data: 4.0-110

### Operating Data

- Rated Capacity: 4 MW
- Cut-In Wind Speed: 3,0 m/s
- Cut-Out Wind Speed: 25 m/s
- Rated Wind Speed: 14 m/s
- Wind Class – IEC: 1b

### Features

- Rotor Diameter: 110 m
- Swept Area: 9,567 m<sup>2</sup>

# GE's Wind Turbines—Solutions on Lan

As the offshore solution in GE's fleet, the 4.0 MW offshore wind series platform stands alongside GE's 1.5 MW and 2.5 MW wind turbines. Our 1.5 MW wind turbine is the most widely deployed in the world with more than 13,000 now in operation—and the 2.5 MW wind turbine is the next evolution in GE's wind turbine solutions as proven in European applications, and now available in North America.

The 4.0 MW offshore wind series platform benefits from GE's proven fleet of wind technology platforms, including an Advanced Loads Control solution to help reduce loads, which is currently in commercial operation on GE's 1.5 MW and 2.5 MW wind turbines.

Blades for the 4.0 MW wind series platform are based on GE's proprietary advanced blade technology, in operation and helping to reduce loads since mid-2009.

Finally, GE's proven suite of solutions for improving wind plant performance, including increased availability and reliability as well as seamless grid integration in use in our onshore fleets, will also be applied to the 4.0 MW wind series platform.

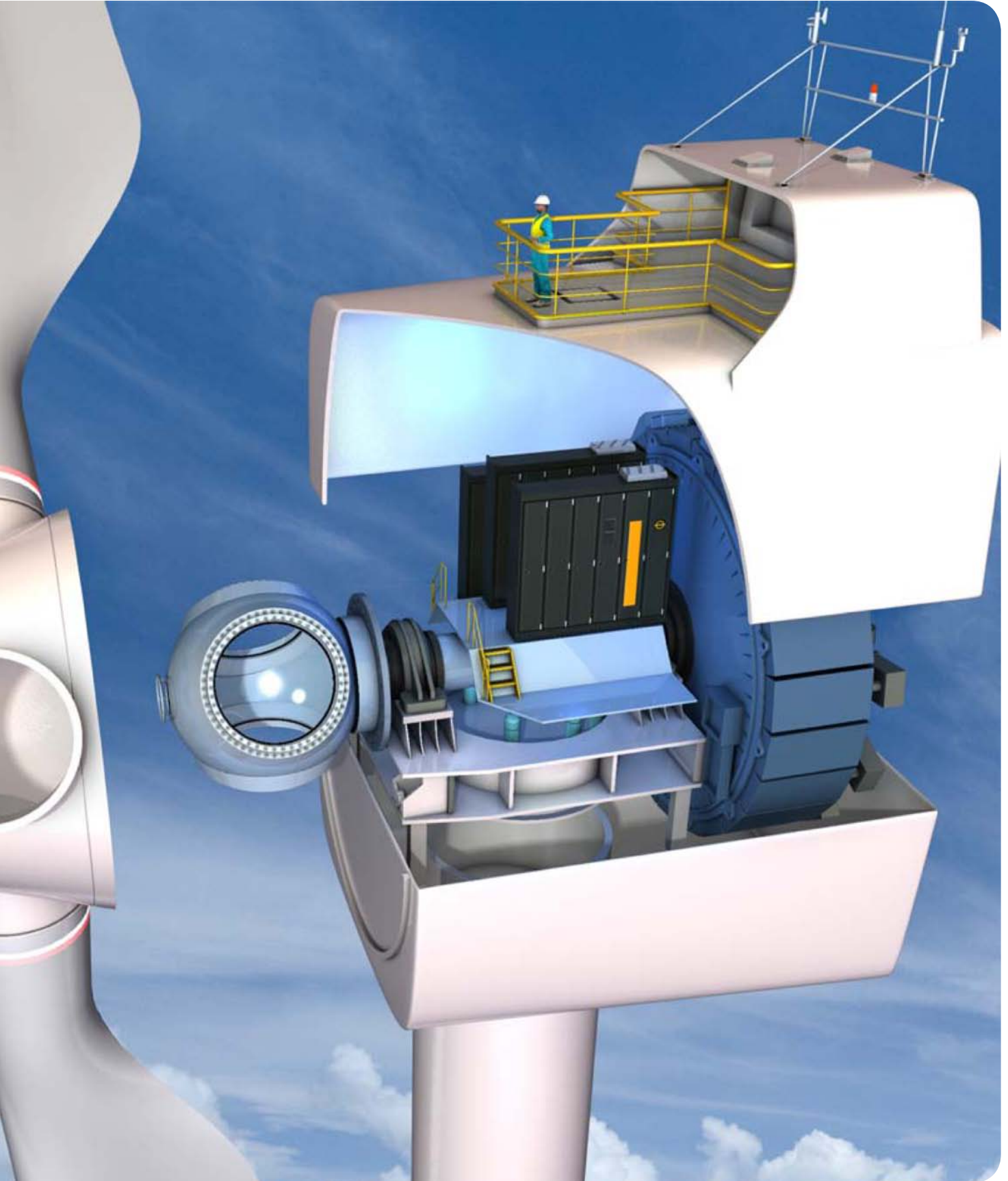
GE's overall wind power product strategy focuses on results vital to our customers' success and the world's energy needs. With a design strategy that emphasizes higher efficiency, increased reliability, maintainability and seamless grid integration, GE wind power solutions are an ever-evolving powerhouse of precision.

Key Components (Featured Highlights)	Benefits
<b>Generator</b>	
Permanent Magnet Generator:	Higher Performance
Redundant Generator with Three Modules:	Increased Availability
In-Situ Exchange of Windings/Segments:	Lower Operating Expenses
<b>Converter</b>	
Full Power Converter:	Higher Performance
Modular Converter with Three Threads:	Higher Performance
In-Situ Repair, Low Weight Breakers:	Lower Operating Expenses
<b>Rotor</b>	
110 m Advanced Blade Technology:	Higher Performance
Automatic Lubrication Bearing/Pinion:	Lower Operating Expenses
<b>Bedplate and Yaw System</b>	
Continuous Close Wind Tracking:	Higher Performance
No Yaw Breaks, No Hydraulics:	Higher Reliability/Lower OPEX





d, at Sea and in the Wind



## Global Footprint

Building on a power generation heritage spanning more than a century, GE Energy is one of the world's leading suppliers of power generation and energy delivery technologies—providing comprehensive solutions for coal, oil, natural gas and nuclear energy; renewable resources such as wind, solar and biogas, and other alternative fuels.

As a part of GE Energy—which includes the Power & Water, Energy Services and Oil & Gas businesses—we have the worldwide resources and experience to help customers meet their needs for cleaner, more reliable and efficient energy.

GE has 11 global locations specifically devoted to wind technology. Our manufacturing facilities are registered to both ISO 9001:2000 and our Quality Management System, providing our customers with quality assurance backed by the strength of GE.

Our wind energy technology centers of excellence in Europe, Asia, and North America, as well as our teams of engineers and scientists, use Six Sigma methodology coupled with the latest computational modeling and power electronic analysis tools to manufacture wind turbines with the performance and reliability necessary to meet our customers' challenges.

As the cornerstone of GE technology for more than 100 years, our four Global Research Centers are focused on developing breakthrough innovations in the energy industry. We believe wind power will be an integral part of the world energy mix throughout the 21st century and we are committed to helping our customers design and implement energy solutions for their unique energy needs.

## World-Class Customer Service

GE's wind turbine fleet is one of the fastest growing and best-run fleets in the world. Utilizing our decades of experience in product services in the power generation industry, GE can provide advanced technology solutions to ensure optimal performance for your wind plant.

At GE, we also understand the need for flexible solutions—that's why we offer a complete program of wind energy service offerings tailored specifically to the needs of our customers. Our global wind services organization works with customers to develop comprehensive and customized service solutions for a range of scopes.

From 24/7 remote monitoring and diagnostics, to routine maintenance, to on-site support whenever you need us, we partner with you to best understand your requirements and to deliver the customized solutions to meet them.

## A Future of Promise

In keeping with its record of innovation, GE continues to enhance its in-market wind series platforms through novel engineering solutions to maximize turbine efficiency, reliability and power in a range of wind-capturing environments.

At GE, we understand that our commitment to enhancing current solutions also drives the evolution of the next generation of energy solutions.



Powering the world...responsibly.

