Haliade-X – Shaping the Future

GE RENEWABLE ENERGY – OFFSHORE WIND

Project Cargo Summit ‘21 Rotterdam
10-02-2021

UNLEASHING LIMITLESS ENERGY

ONSHORE WIND

OFFSHORE WIND

LM WIND POWER

DIGITAL SERVICES

GRID SOLUTIONS

HYDRO

HYBRIDS

$15B	80+	40,000+	40,000+	25%+	90%	400+GW	>10%
REVENUE	COUNTRIES	GLOBAL EMPLOYEES	WIND TURBINES INSTALLED GLOBALLY	OF WORLD'S HYDRO INSTALLED BASE	OF UTILITIES WORLD-WIDE USE GRID SOLUTIONS TECHNOLOGY	INSTALLED BASE THE WORLD'S LARGEST CLEAN ENERGY FOOTPRINT	OF GLOBAL RENEWABLE ENERGY CAPACITY IS PROVIDED BY GE TURBINES

As of December 31, 2019

Our Offshore Wind Footprint

Foxborough (MA)
- Sales and tendering

Quonset (RI)
- O&M (Block Island)

Beijing
- Offices

Jieyang
- Manufacturing site *(operational in 2021)*

Guangzhou
- Development Center

Hamburg
- Sales & tendering
- Project execution

Rotterdam
- Haliade-X 12 MW prototype

Ostend
- O&M (Osterild)

Cherbourg
- Blades site (LM)

Saint-Nazaire
- Manufacturing site

Le Carnet
- Testing site

Nantes
- Offshore HQ offices

Barcelona
- Engineering
- R&D

GE Offshore Wind – key locations

MANUFACTURING FACILITIES

FRANCE

- Opened December 2014 in St. Nazaire, FR
  1st EU factory HEQ certified
- Components: Generators and nacelles (Haliade 6MW-150 & Haliade-X)
- Area: 13 hectares / Constructed area: 19,000 sqm
- Dynamic production line… Quality processes designed by manufacturing experts from the automotive and aircraft industries

CHINA

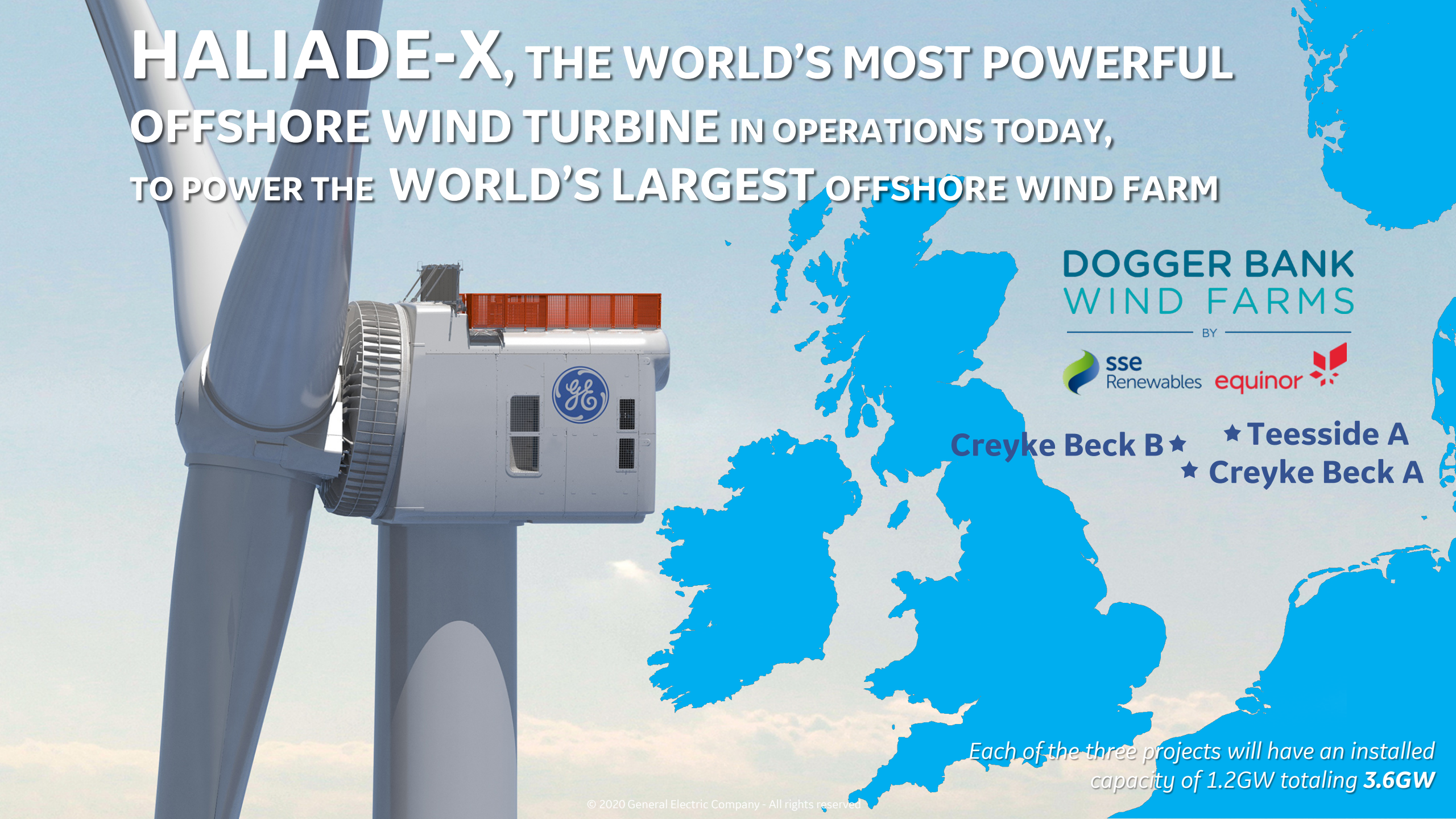
- Location: Jieyang, Guangdong
- Operational: 2nd half 2021, with 73sqm

LM WIND POWER

- In operation since 1978, 14,000+ employees
- Produced > 228,000 blades… 1/5 turbines in the world have LM blades
- 15 manufacturing centers in 10 countries
- Supplier to 30 turbine OEMs

LM WIND POWER

HALIADE-X, THE WORLD'S MOST POWERFUL OFFSHORE WIND TURBINE IN OPERATIONS TODAY, TO POWER THE WORLD'S LARGEST OFFSHORE WIND FARM



*Each of the three projects will have an installed capacity of 1.2GW totaling **3.6GW***

Haliade-X, selected as the preferred wind turbine for 4.8 GW of projects

THE RIGHT TURBINE AT THE RIGHT TIME

Haliade-X 13 MW-220 Backlog

120 MW	SKIP JACK
3,600 MW	DOGGER BANK
1,100 MW	OCEAN WIND

These projects will power more than 5 million households

Safety is our #1 priority

In case of an emergency, please follow the guidelines indicated by the local GE representative.

Be sure to know where the emergency exits are located.

If you see something that could potentially generate a safety incident (i.e. objects on the floor), please let your local GE representative know.

Respect safety measures and remain vigilant.

EHS Priorities for Logistics & Transport activities

GE has a STOP operation policy. All persons involved physically at the load out operation have the power to STOP the operation if they identify , see any risks, potentials hazards.

A task safety analysis shall be issued to conduct the recorded Tool box talk, preceding the lifts.

A risk assessment shall be conducted before the load-out, this risk assessment will include lifting works and all works related to load-out, securing, transportation and offloading to be performed by GE, Vessel's Owners, MWS and all involved parties. A lifting plan shall be issued and approved prior to lifting operations. The lifting plan shall be available in due time to facilitate that all associated hazards identified from the lifting operations are risk mitigated to as low as reasonably practicable. Lifting certificate must be issued by MWS prior any lift onto or from the vessel.

EHS Priorities for Logistics & Transport activities

All deviations from Method of Statement must be approved according to a recorded management of change agreed by all parties.

For any lift, there shall be only one point of communication/decision to lead the lift and its related operations.

Heavy lift is permitted only on daylight unless other instructions notified and approved by GE EHS.

Moreover, following EHS procedures shall considered as part of the contract:

Supplier EHS Requirements – SNA-TSA-GE-00323-HSE

A Risk assessment is mandatory in the vessel's Method statement covering all the vessel's operation.

Saint-Nazaire (manufacturing facilities)

- **Components:** Generators and nacelles
- **Products:** Haliade 150-6MW & Haliade-X (12 & 13 MW)
- **Area:** 13 hectares
- **Constructed area:** 19,000 sqm.
- **Opened:** December 2014
- **Employees:** +300
- Quality processes designed by manufacturing experts from the automotive and aircraft industries
- First European factory HEQ certified

Key locations of GE Renewable Energy in Europe

Offshore Wind - manufacturing facilities

- Components: Generators and nacelles
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Vertical integration to accelerate LCOE ↓

Project Management Operations (PMO)

Transport, Installation & Commissioning

PMO Operations: **Haliade-X Components**

https://youtu.be/XX2-DE0etcQ

NACELLE

- Assembled on its transport frame
- All main components integrated
- Dimensions 22m x 10m x 11m
- GE factory in Saint-Nazaire, France

TOWER

- Not main components in the tower
- All sections can be transported horizontally
- Tower length 111 meters… 2 or 3 sections possible to adapt for project specific needs
- Manufacturing site depending on project basis

BLADES

- Length: 108m, Root diameter 5m
- Transport frame stackable in 3 layers
- LM factory in Cherbourg, France

Best-in-Class support needed for Logistics & Transport

Securing execution extending proven solutions of today

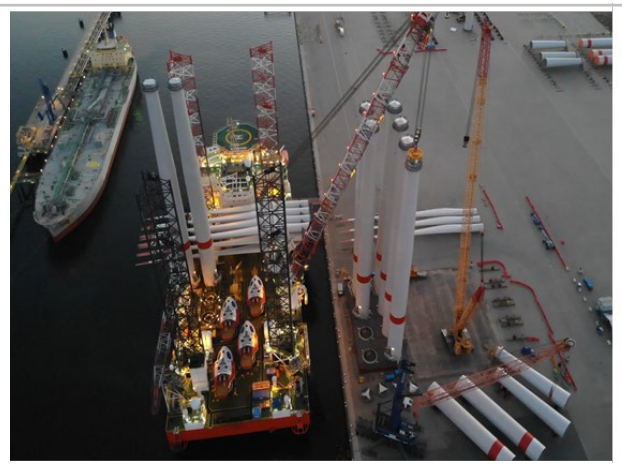
1 Outbound transport/logistic

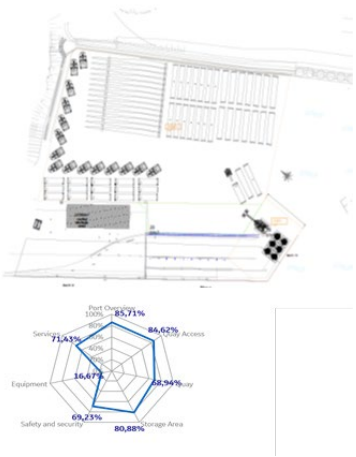
- Road and Sea transport from factory to marshaling hub
- Handling and Lifting at quay of components
- Contracting full geared vessel for round trips

- Volume bundling
- Flexible Tower transportation → 2-3 section up to full tower
- Blades delivered flat in 3 layers stackable frames
- Reusable & multiple usage transport frames, designed for fast & safe sea-fastening
- Nacelle transported on its frame used also for installation

2 Marshalling Hub

- Storage of components and preservation
- Full tower or split tower pre-assembly at quayside before loadout
- Continuity checks and pre-commissioning





- Use of weather dynamic logistic simulators to define storage needs and tower assembly foundations,
- High Standard qualification audits of marshalling hub, on storage, bearing capacities, installation vessel suitability and handling services
- Limited pre-commissioning required
- Tower pre-assembly at quayside before loadout

Pro-active approach from the Logistic & Transport companies for innovative solutions & long – term relationship

Vessel Technical Requirements

Preliminary requests

- Fully detailed specifications of the proposed HLV, including crane curves,
- Lifting plans.
- Preliminary stowage plan based on GE components constraint
- Verification of no clashing of crane with components during all operations mentioned in specification,
- Vessel stability analysis, maximum draft calculation,
- Maximum acceleration calculation on cargoes,
- Transit time for each typical voyage with average speed considered for each Vessel.

Vessel Technical Requirements

Focus points

After analysis and clarification of preliminary requests and Technical packages, the short listed Vessels Owners shall provide and focus **on 2 essential points**:

- **EHS / Risk assessment**
- **Method of Statement**

Which shall be reviewed and commented by GE Inbound Transport Team (Manager, Engineers, EHS, GE Marine Surveyors, quay supervisors) .

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