On the installation of offshore wind turbines Challenges and future perspectives

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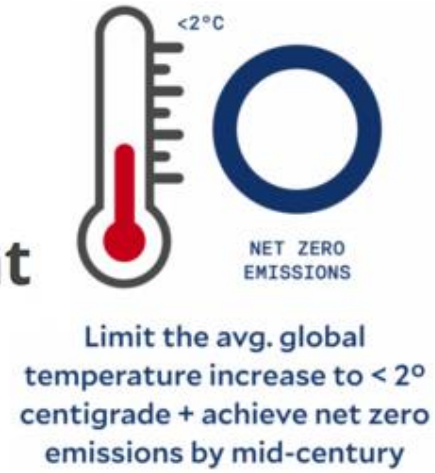
OUTLINE

- INTRODUCTION
- WHAT ARE THE NEEDS OF THE OFFSHORE WIND INDUSTRY
- INSTALLATION OF OFFSHORE WIND TURBINES
- CONCEPTS
- CONCLUSSIONS and FUTURE PERSPECTIVES

INTRODUCTION

- Wind energy is a key technology due to its abundant availability, relatively high TRL, and low environmental footprint.



- By the end of 2022, the total offshore wind capacity installed worldwide is **about 55 GW**.
- European ambitions: **300GW** installed offshore wind capacity by 2050.
- Norwegian ambition: **30GW** installed offshore wind capacity by 2040.

- A significant increase in new offshore wind farms will happen in the next three decades in Europe.

30 GW → 300 GW
2022 2050

What does 300GW look like?

Largest offshore wind farm (OWF)

- Dogger Bank (3.6GW – about 280 OWTs)
- 130 km East from Yorkshire (UK)
- extends over approximately 8660 km²

300 GW = 83.3 x Dogger Bank OWF

~23000 OWTs

~700000 km²

(1.25 x North Sea surface)

What does 300GW look like?

Offshore wind turbines are under continuous development:

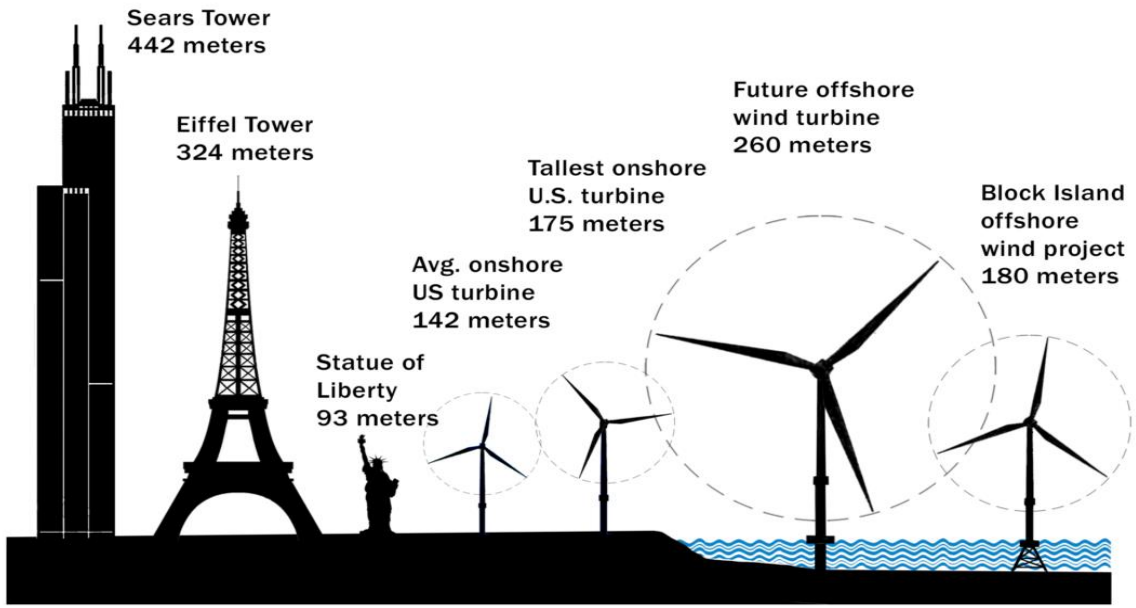
- GE Haliade-X 14MW - full type certificate for operations up to 14.7 MW from DNV.
- CSSC Haizhuang 18MW - the largest and the most powerful wind turbine currently on the market or under development.

300 GW = 16666 x 18MW OWT

300 GW = 20400 x 14.7MW OWT

INTRODUCTION

- The number of OWTs to be installed is enormous.
- Future OWTs will be installed further offshore, in deeper waters.



Source: Bumper DeJesus, Andlinger Center for Energy and Environment.

The main challenge:

No cost-effective solutions for installation and maintenance of 15 MW+ wind turbines in deeper water.

It is necessary to develop cost-effective installation and transportation methods for future wind turbines.

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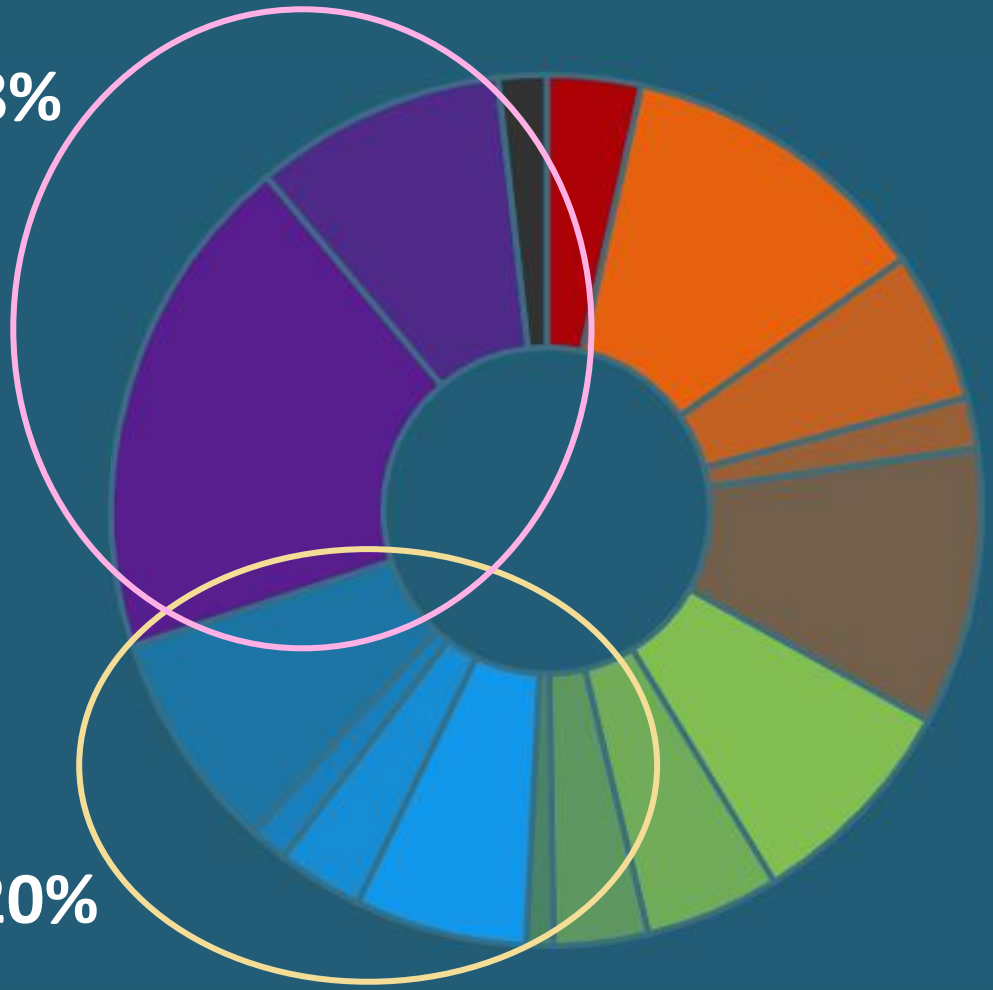
Why improving marine operations will lead to a reduction of LCOE.

Maintenance ~28%

Installation ~20%



Development and project management 3.5%	Nacelle 11.7%	Rotor 5.6%	Tower 1.9%
Other turbine 10.3%	Turbine foundation 8.2%	Cables 5%	Offshore substation 3.5%
Other balance of plant 1%	Offshore cable installation 6.4%	Foundation installation 3.2%	Turbine installation 1.4%
Other installation 8.2%	Maintenance & service 18.9%	Operations 9.3%	Decommissioning 1.8%

The pie chart shows the contribution of each major cost element to levelised cost of energy (LCOE).

BVGAssociates

INSTALLATION OF OFFSHORE WIND TURBINES

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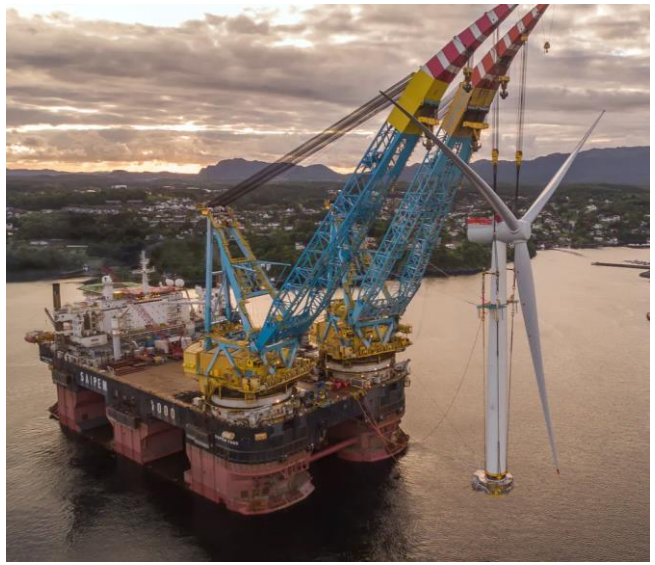
OWT INSTALLATION METHODS

Jack-up crane installation vessel

Floating heavy-lift vessel



Onshore crane installation

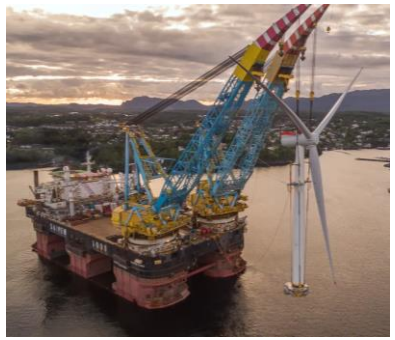
OWT INSTALLATION METHODS

Jack-up crane installation vessel

drawbacks:

- increased day-rate;
- maximum water depth of 70 meters;

Floating heavy-lift vessel



drawbacks:

- increased day-rate;
- only a few are available in the world;
- cannot be used to install components in harsh environmental conditions,

Onshore crane installation

drawbacks:

- require deep water near shore;
- transportation speed is limited due to the risk of VIV and VIM;

CONCEPTS FOR THE INSTALLATION OF OFFSHORE WIND TURBINES

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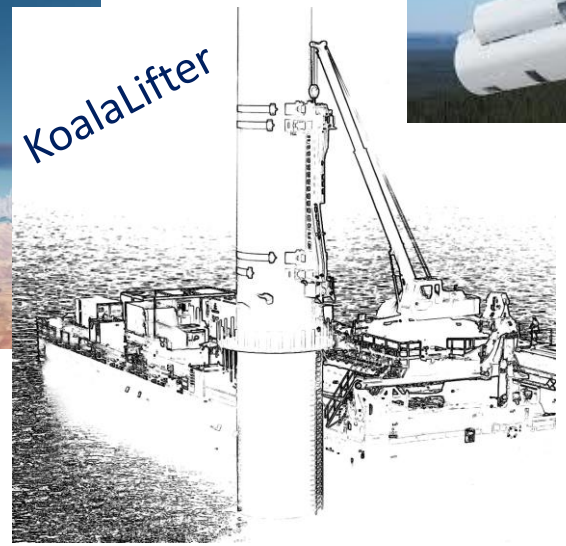
CONCEPTS FOR OWT INSTALLATION

- Specialized devices for the installation and maintenance of different components.
- Specialized vessels for installation of preassembled OWTs.
- Motion compensation solutions.

SPECIALIZED DEVICES FOR THE INSTALLATION AND MAINTENANCE OF DIFFERENT COMPONENTS

KoalaLifter



Liftra LT1200 - self-hoisting Crane

Lagerwey LCC140

self-climbing crane

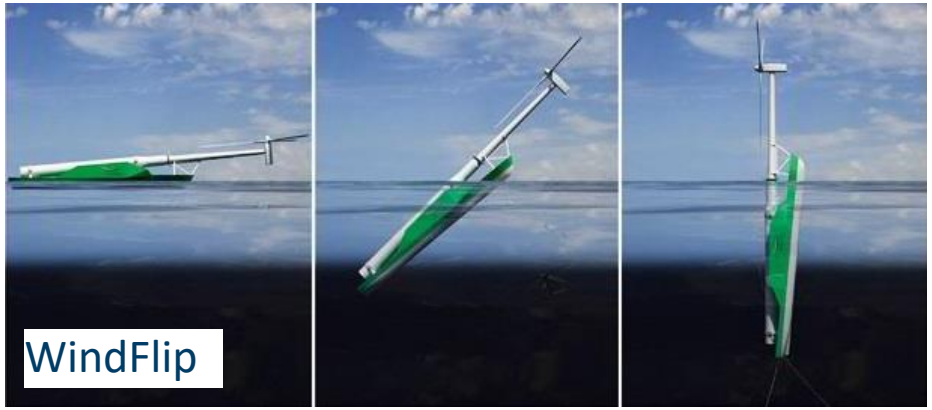
Blade Exchange Tool – by TWD

AXTech Windworker

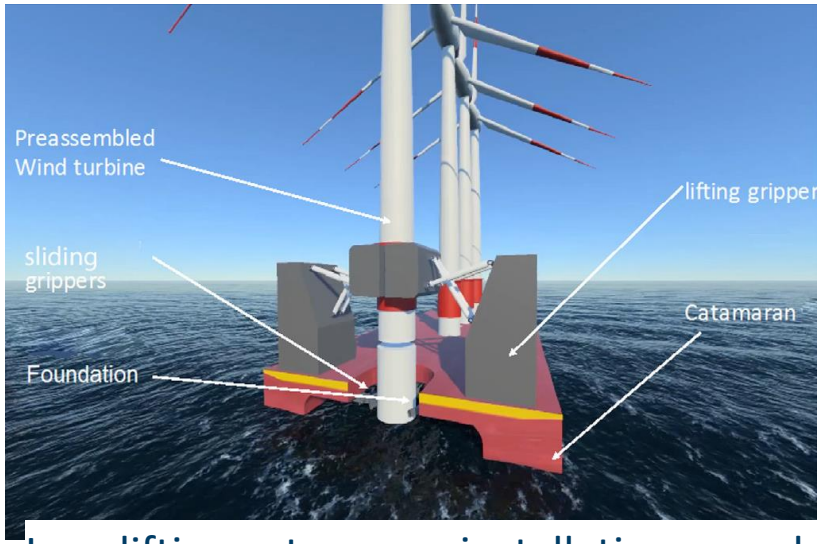
- able to perform major maintenance work (exchange of blade and components of the nacelle).
- commercial solution for onshore wind turbines (concepts for offshore maintenance).
- additional R&D required for upscaling and adapting to offshore use.

SPECIALIZED VESSELS FOR INSTALLATION OF PREASSEMBLED OFFSHORE WIND TURBINES

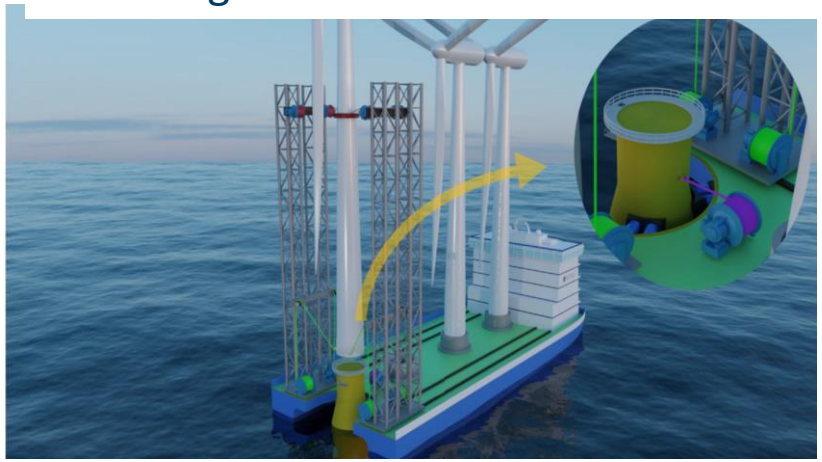

Windlifter


WindFlip


Wind Turbine Shuttle



Low-lifting catamaran installation vessel



MOTION COMPENSATION SOLUTIONS

Lateral motion compensation

proposed by BoomLock

6 DOF motion compensation

proposed by Ampelmann

FUTURE PERSPECTIVES

- **Need of cost-effective installation methods for the wind turbines of the future.**
- Need of more automatizations.
- Development of various motion compensation devices to increase the operability limits.
- Development of fully integrated on-board systems for improving the operability limits using short-term deterministic forecasting of wave-induced motions and loads.

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