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Advancing Ground Modelling: Integrating the best of the offshore renewables and oil and gas sectors

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[1] Orsted, [2] Schlumberger

September 2022

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Aim: To provide an overview of ground modelling in the offshore wind sector. To highlight the value of cross-sector innovation, the commonality of project timelines and subsurface challenges to the oil and gas sector.

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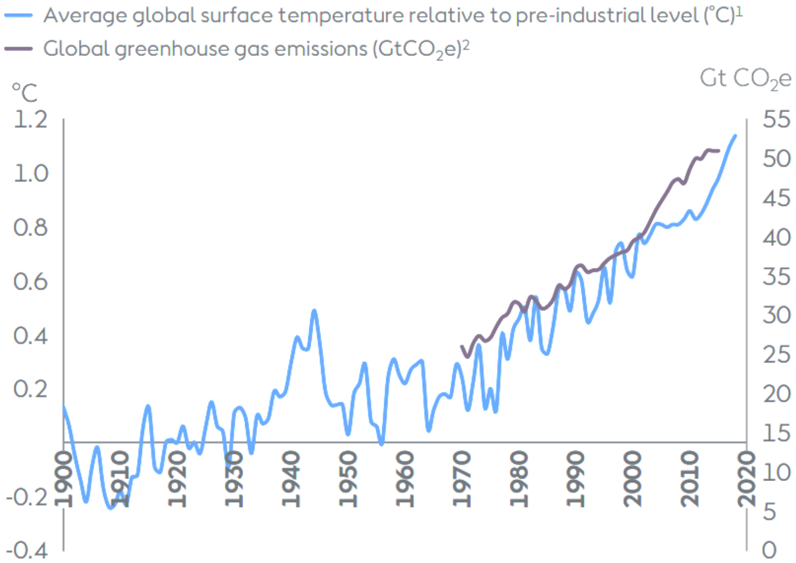
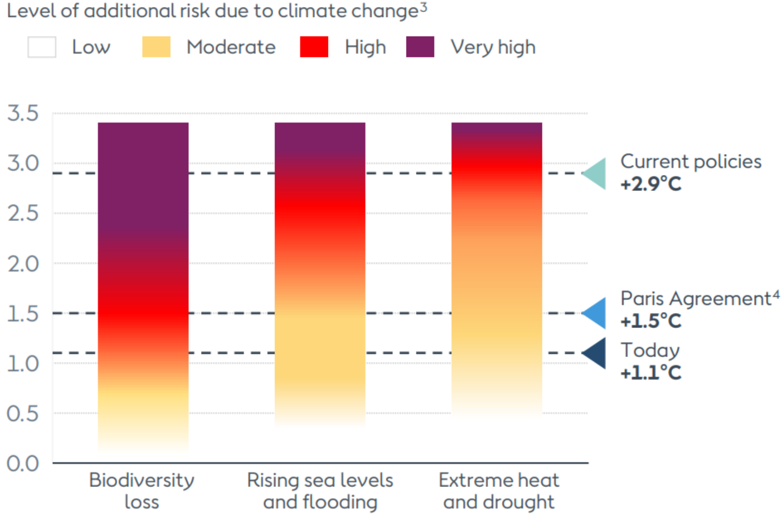
The global climate challenge

Rising greenhouse gas emissions drive up average global temperature...



... threatening to destabilise the world we live in



1. NOAAGlobalTemp. 2. Ørsted analysis, data from World Bank (EDGAR) and Climate Action Tracker. 3. World Resources Institute, data from IPCC. Scenarios from Climate Action Tracker's 2100 Warming Projections 4. The Paris Agreement's official recommendation is "well be low 2 degrees Celsius above pre-industrial levels 6 and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsiu s
2. Source: Orsted Global Markets Presentation 2021

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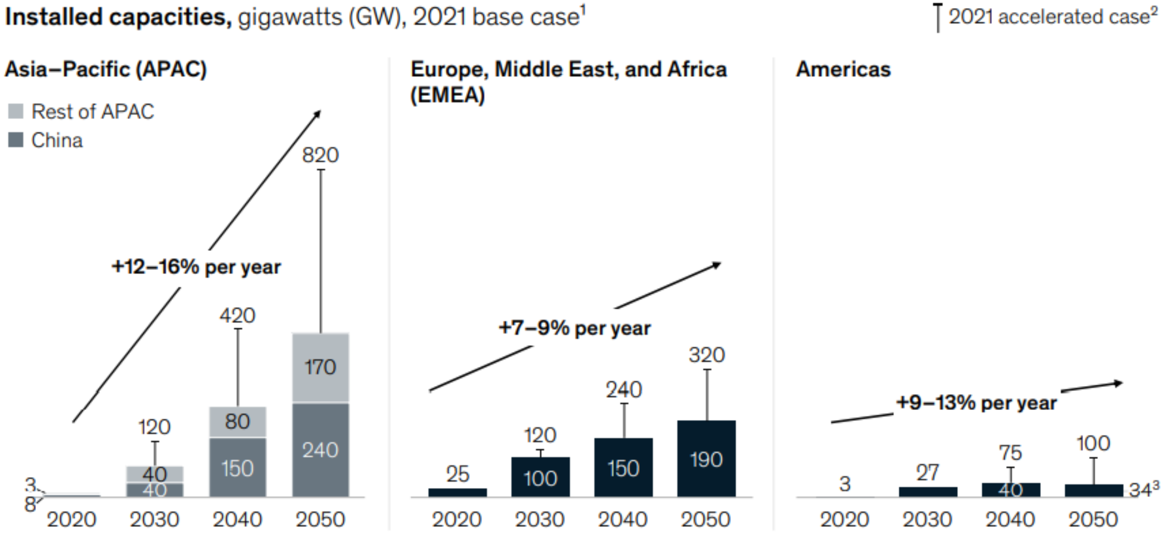
Current State and Projections for the Offshore Wind Sector



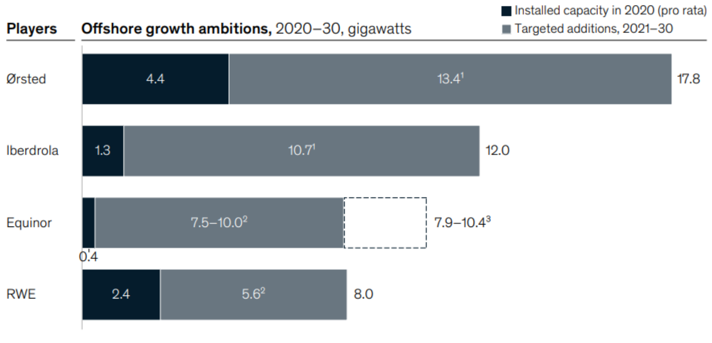
Note: APAC includes OECD Asia–Pacific and non-OECD Asia; EMEA includes OECD Europe, Eurasia, Middle East, and Africa; Americas includes OECD Americas and Latin America.

[1] McKinsey's view on current path of energy transition without major shifts in production and consumption compared to today.

[2] McKinsey's view on an accelerated energy transition, including several conceivable shifts in production and consumption compared to today.

[3] Capacity decrease due to forecasted decommissions.

Source: McKinsey Global Energy Perspective 2021



[1] Gross addition target.

[2] Pro rata addition target; gross addition target most likely considerably higher given that many projects are owned with a 50% stake or less.

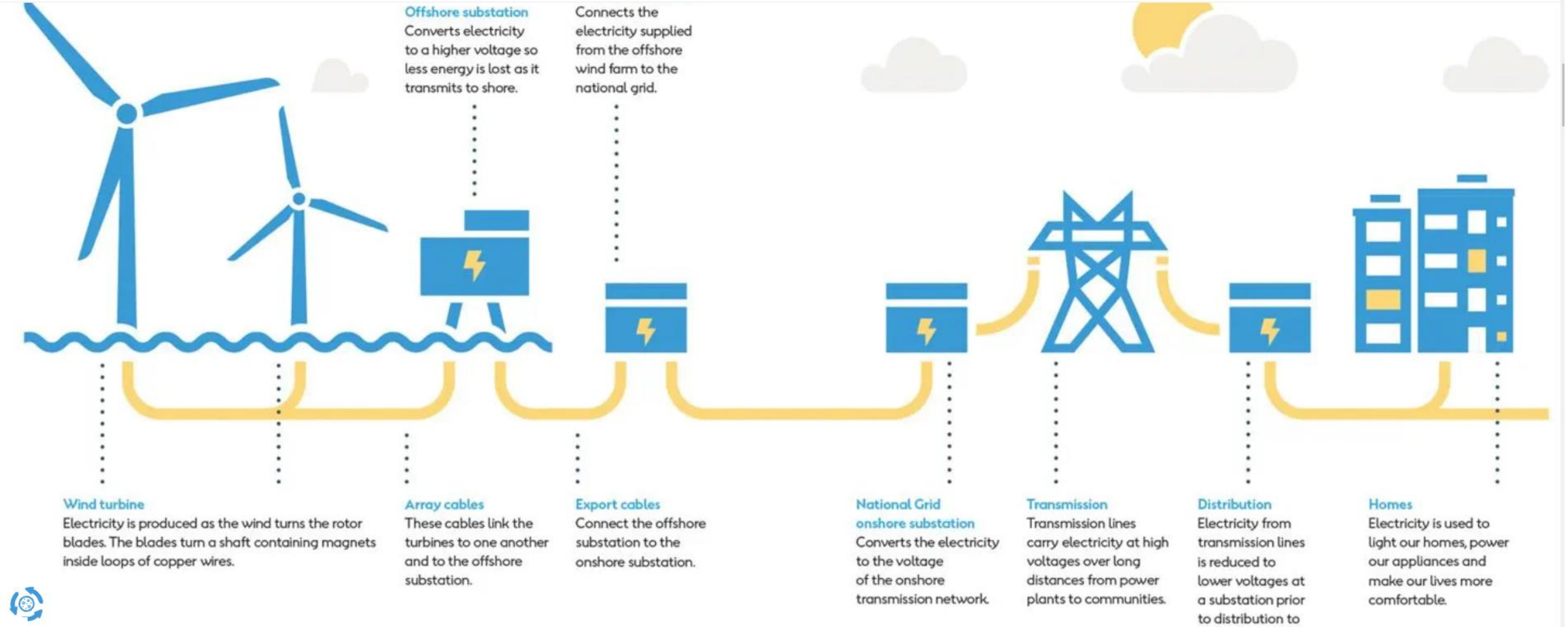
[3] Addition target published as a range.

Source: Equinor; Iberdrola; Ørsted; RWE company reports

The offshore wind sector is a buoyant and rapidly growing sector

*McKinsey, 2022 How to succeed in the expanding global offshore wind market

Anatomy of a "Grounded" Offshore Windfarm



Source: Orsted

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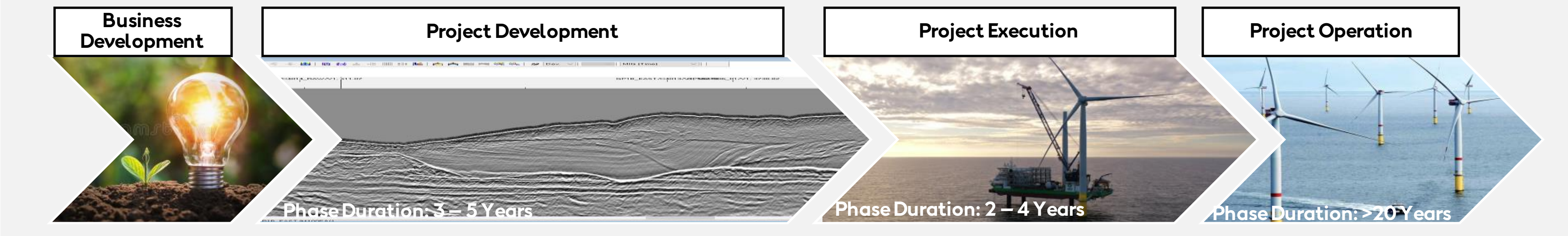
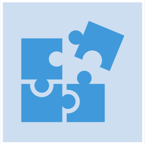
Project Timelines and Ground Modelling



Ground Models are used to support the development of offshore windfarm sites and export cable routes utilising a combination of Geological, Geophysical and Geotechnical Data.



The purpose of the ground model is to

- Provide engineering data for installation and design
- Characterise seabed & subsurface conditions, geohazards & uncertainties that may impact site development
- Optimise future data acquisition scope and planning

We need to utilise existing and develop new technology to accelerate Ground Modelling whilst also enhancing accuracy and precision...

Traditional Ground Modelling in the Offshore Wind Sector

Desktop Review
Investigation into high level geoscience risks and opportunities

- Anthropogenic & Geohazards
- Stratigraphy
- Soil characterisation
- Data Gathering Recommendations

Data Acquisition

Geotechnical Data
Quantitative & Qualitative Understanding of the Subsurface in 1D

- Cone Penetration Test
- Vibrocore
- Lab Data
- Thermal & Mechanical Properties

Geophysical Data
Quantitative & Qualitative Understanding of the Subsurface and Seabed in 3-4D

- Seismic (SBP, SUHRS, MUHRS)
- Magnetometer
- Side Scan Sonar
- Multibeam Echo Sounder

Data Integration

Integrated Ground Model
Integrated product outlining the geohazards and spatial distribution of geophysical-geotechnical units

- Geohazards
- Mapping of GeoUnits
- Characterisation of Soils
- Input for future surveying

Ground modelling is an iterative process and has not fully adopted the advanced software capabilities as developed in the oil sector.

Levers for Ground Model Acceleration

Automated Workflows

- Automation of routine, generic workflows
- Enable interpreters to focus on interpretation
- Standardise reporting outputs

ML*: Automated Interpretation

- Interpretation of high resolution seismic data
- Interpretation is one of the most time consuming tasks in all projects

ML*: Geohazard Interpretation

- Geohazard characterisation utilises multiple datasets
- Opportunity to cross-correlate, condition and assign geohazards would accelerate and standardise ground modelling

Uncertainty Assessment

- Sensitivity and uncertainty analysis across a range of properties and data types
- Optimise facility design, greater understanding of uncertainty will enable less conservative design

3 & 4D: Property Modelling

- To model detailed subsurface properties in 3D and over time (4D)
- Improve data integration and forward modelling of sites incl history match

Increased Collaboration in a common software environment

*ML – Machine Learning

Conclusion

Aim: To provide an overview of ground modelling in the offshore wind sector. To highlight the value of cross-sector innovation, the commonality of project timelines and subsurface challenges to the oil and gas sector.

Conclusion:

- Renewable energy technologies are needed to mitigate the risks posed by the Global Climate Crisis
- The offshore wind sector is a rapidly growing sector with wind farms and cable routes containing a range of components and stakeholders
- Subsurface data is critical for facility design and has significant impact throughout the project
- Ground modelling is collaborative and has developed outside of established oil and gas type geoscience workflows with differing strengths and weaknesses.
- Access to more advanced technology will enable a faster turn around of data and provide more precise and accurate subsurface and seabed information.
- The potential for enhanced collaboration with a "discipline" agnostic solution is another key part in project acceleration and quality improvement

References

- Source: Orsted Global Markets Presentation 2021
- NOAA Global Temperatures.
- World Bank (EDGAR) and Climate Action Tracker.
- World Resources Institute, data from IPCC. Scenarios from Climate Action Tracker's 2100 Warming Projections 4.
- The Paris Agreement's official recommendations
- *McKinsey, 2022 How to succeed in the expanding global offshore wind market

Abstract Submitted and Approved

Orsted has been engaged with Schlumberger in a collaboration to assess the potential of applying Schlumberger petrotechnical technology (Delfi, Petrel, DataIKU) to the established workflows of the offshore wind sector.

Ground modelling is key to integrating Geological, Geophysical and Geotechnical data for offshore wind development, in a similar way that reservoir modelling is a synthesis of datasets in the oil and gas sector. In a similar evolution to the subsurface complexity observed in the exploration & development of oil and gas fields, sites for offshore wind farm development are becoming increasingly complex. Additional complexity requires a greater integration of available datasets with significant value in the integration of 2D data into a 3-4D framework.

The desire for precise and accurate models is offset by the need to deliver ground model products quickly to enable stakeholder planning, project scoping and acceleration of construction – shortening the development cycle.

The implementation of automated technologies through the Petrel suite and DELFI environment has the potential to accelerate ground model construction and provide greater insights into potential variability and uncertainty. The implementation of more advanced machine learning capabilities offered by Schlumberger offers a potential step change in the “industrial” delivery of machine learning workflows into the Petrel and Techlog platforms.

The integration and redevelopment of petrotechnical software in offshore renewables offers a significant lever for ground model acceleration. The opportunity to deploy advanced workflows and processes via DELFI and Petrel provides a further step change in detail and data integration with many avenues of development to explore.