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

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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...

- Average global surface temperature relative to pre-industrial level (°C)
- Global greenhouse gas emissions (GtCO₂e)

... threatening to destabilise the world we live in

Level of additional risk due to climate change

<table>
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<tr>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very high</th>
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<tbody>
<tr>
<td>Biodiversity loss</td>
<td>Rising sea levels and flooding</td>
<td>Extreme heat and drought</td>
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1. NOAA Global Temp. 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 below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.”

Source: Ørsted Global Markets Presentation 2021
The offshore wind sector is a buoyant and rapidly growing sector.
Anatomy of a “Grounded” Offshore Windfarm

Wind turbine
Electricity is produced as the wind turns the rotor blades. The blades turn a shaft containing magnets inside loops of copper wires.

Array cables
These cables link the turbines to one another and to the offshore substation.

Export cables
Connect the offshore substation to the onshore substation.

Offshore substation
Converts electricity to a higher voltage so less energy is lost as it transmits to shore.

Connects the electricity supplied from the offshore wind farm to the national grid.

National Grid onshore substation
Converts the electricity to the voltage of the onshore transmission network.

Transmission lines
Carry electricity at high voltages over long distances from power plants to communities.

Distribution
Reduces the voltage at a substation prior to distribution to homes.

Homes
Electricity is used to light our homes, power our appliances and make our lives more comfortable.

Source: Orsted
Project Timelines and Ground Modelling

Business Development

Project Development

Phase Duration: 3 – 5 Years

Project Execution

Phase Duration: 2 – 4 Years

Project Operation

Phase Duration: >20 Years

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

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

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*ML = Machine Learning

Increased Collaboration in a common software environment
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.