

GEOSCIENCE FOR LEAVING CERTIFICATE TEACHERS

Continuing Professional Development Course 2024



OFFSHORE WIND ENERGY AND COASTAL EROSION ADDITIONAL RESOURCES

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Further information: Offshore Wind

Geoscience plays a crucial role in the development, installation, and operation of offshore wind farms. It encompasses a range of scientific disciplines that are essential for understanding the seabed conditions, environmental impacts, and the overall feasibility of offshore wind projects. Below are some of the key geoscience aspects in relation to offshore wind farms:

1. Geotechnical Studies:

Offshore wind turbines require stable foundations, and geotechnical studies focus on understanding the properties of the seabed and sub-seabed materials. This includes:

- **Soil Composition:** Identifying the type and strength of sediments and rocks on the seafloor to determine the most suitable type of foundation (e.g., mono piles, jackets, or floating platforms).
- **Soil Mechanics:** Investigating soil behaviour under different loading conditions to ensure stability for the long-term operation of turbines.
- **Seismic Hazard Assessment:** Assessing earthquake risks in the region, as seabed movement can affect the foundation integrity.

2. Marine Geophysics:

Marine geophysics involves using non-invasive techniques to map the seafloor and sub-seafloor. Methods such as seismic surveys, side-scan sonar, and multi-beam echo sounding help to:

- **Map Seafloor Features:** Identify underwater features such as sandbanks, boulders, and submerged rock formations that could pose challenges for turbine installation.
- **Subsea floor Structures:** Assess the geological layers beneath the seabed for conditions that affect the stability of the foundations, as well as potential for subsidence or erosion.

3. Hydrodynamics and Wave Climate:

Understanding the hydrodynamic conditions of the ocean is essential for wind farm design and operational efficiency. This involves:

- **Wave and Current Modelling:** Analysing the wave height, direction, and frequency, as well as the ocean currents, to predict forces that will be exerted on the turbines and their foundations.
- **Tidal Influences:** In regions with strong tidal forces, tidal flow can impact the stability and maintenance of the turbines.
- **Water Depth:** Offshore wind farms are typically located in shallow to deep waters, and the depth of the water affects both the design of foundations and the overall feasibility of the project.

4. Environmental Impact Assessment (EIA):

Geoscientific studies are vital in assessing the environmental impact of offshore wind farms, which includes:

- **Sediment Transport:** Studying how the installation and operation of wind turbines might affect sediment movement and cause erosion or deposition in surrounding areas.
- **Marine Life and Habitats:** Understanding how changes in seabed conditions might impact marine ecosystems, including benthic organisms (bottom-dwelling creatures) and fish populations.
- **Noise and Vibration:** Evaluating how construction and operation may produce underwater noise that could disturb marine life, particularly marine mammals.

5. Seafloor Mapping and Site Selection:

Geoscience helps identify the most suitable sites for offshore wind farms by considering factors such as:

- **Accessibility:** Proximity to infrastructure, such as ports and grid connections.
- **Water Depth and Distance from Shore:** Shallow waters close to shore are ideal, but deeper waters may require floating turbine technology.
- **Seismic and Geological Stability:** The site should be geologically stable, minimizing the risk of landslides, subsidence, or underwater seismic activity.

6. Geothermal Considerations (for Floating Wind Farms):

In some cases, particularly with floating wind turbines, understanding geothermal conditions at depth can be important, as floating structures rely on dynamic positioning and anchoring systems. While this is less of a concern for fixed-bottom structures, the geotechnical analysis for floating turbines may also assess how deep-sea geology might affect anchoring systems and line stability.

7. Monitoring and Maintenance:

After installation, ongoing geophysical monitoring of the seabed, currents, and seabed stability is important to detect changes that could affect the integrity of the wind farm's infrastructure. Regular geophysical surveys may be used to monitor:

- **Seabed Settlement or Erosion:** Monitoring for any displacement of the seabed due to turbine foundation loading or other environmental factors.
- **Marine Environment Changes:** Changes in the water column, sediment deposition, and marine ecosystems need to be observed over time to ensure that the wind farm is not having unintended ecological impacts.

8. Subsurface Resource Evaluation (for Hybrid Energy Systems):

In some cases, offshore wind farms are being paired with other energy sources, such as offshore oil and gas platforms or even undersea geothermal energy systems. Understanding the geoscience of the surrounding environment can help in managing these hybrid systems effectively.

Conclusion:

The geoscientific considerations in offshore wind farm development are vast and multidisciplinary. Successful offshore wind projects rely heavily on detailed geological, geophysical, and environmental data to ensure that turbines are safely and efficiently installed, and that the long-term performance and environmental impact are optimized. By leveraging advances in geoscience, offshore wind farms can be developed in increasingly deeper and more challenging environments, supporting the growth of renewable energy worldwide.

40 minutes

<https://www.youtube.com/watch?v=yLWVuiOAmMM>

<https://youtu.be/Vo2DVVdZKFI?t=21>