Dynamic Cables for Offshore Floating Wind – Impact Of Floater Characteristics On Cable Fatigue Life

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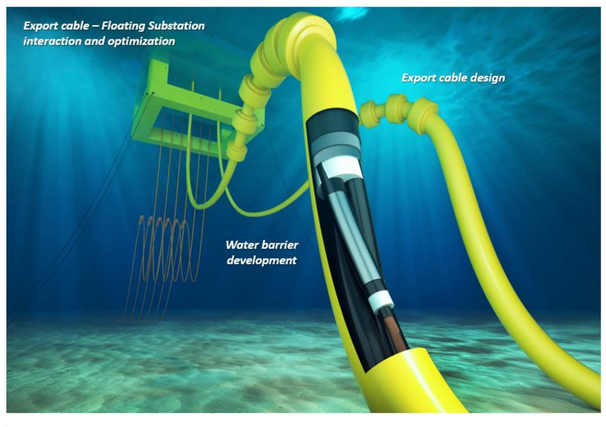
INTRODUCTION



Dynamic cables play an essential role in the realization of offshore floating wind. However, certain technology and knowledge gaps associated with power export at or beyond 145 kV could potentially prevent a cost-efficient realization. In the “Connect-FOW” project, these gaps are addressed both analytically and experimentally by 1) developing new dynamic cable designs comprising with components having suitable mechanical properties and fatigue performance and 2) developing a floating substation with motion characteristics suitable for a dynamic cable. Extending the functionality of an existing software package to facilitate concurrent design of floater, mooring system and power cable is also part of the project scope. The conditions at Utsira Nord, off the west coast of Norway, are currently being considered as this location is relevant for floating wind. However, relevant constraints on cable, cable accessories and substation will be identified to ensure scalability to higher voltage systems or more severe environmental conditions, in effect allowing floating offshore wind to be a viable energy alternative globally.

PROJECT OBJECTIVES

The Connect-FOW project aims to:

- Introduce new water barrier technology with high robustness
- Improve HV dynamic cable designs beyond 245 kV AC & DC
- Improve motion characteristics of a floating substation design
- Develop new software enabling floater and cable design

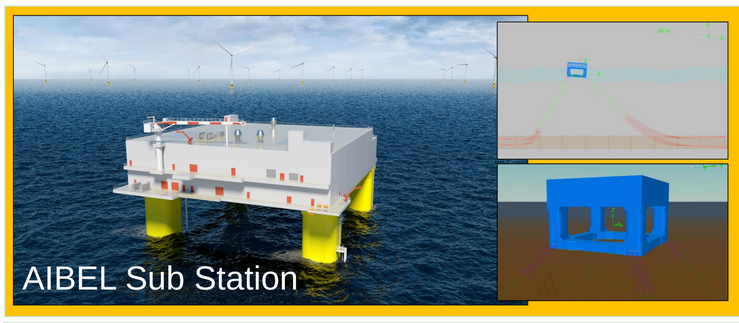
PROJECT CHALLENGES

- Testing and qualification of new water barrier technology
- Designing robust cable considering extreme and fatigue loads
- Designing substation with moderate motion characteristics
- Validating new software functionality

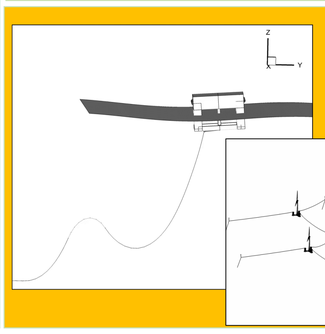
New Water Barrier Development

Assessment of mechanical and functional integrity

Post–mortem investigation of fatigue fracture of water barrier for dynamic cable



- HVDC 1.4 GW
- Unmanned;
- Inter array cables 8-15
- Export cables 3
- 16 m draft
- 75.4 m x 75.4 m

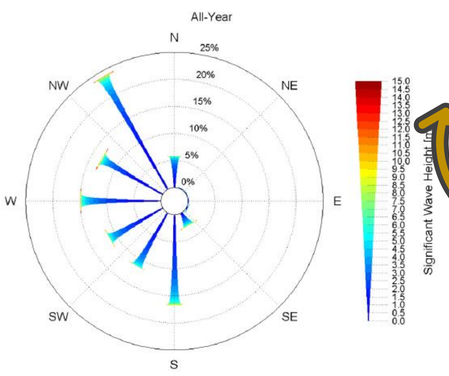


IFE 3DFloat

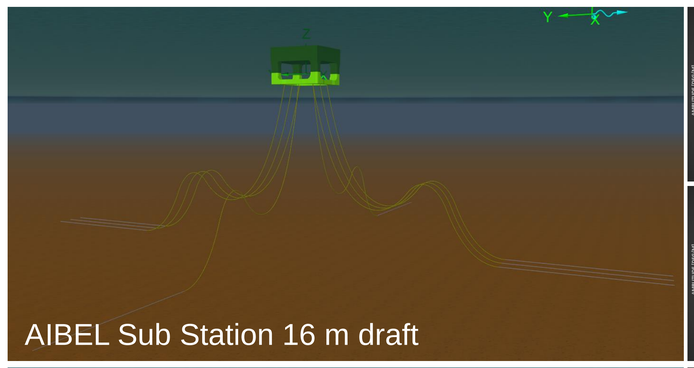
- General Finite-Element-Model core
- Tailored for time-domain analysis with full coupling between loads, large motions and control systems.
- Load models for soil-structure interaction, mooring line-seabed interaction, hydrodynamics, wind turbine and bridge aeroelastic, and ship collision impact.
- Material models including creep, visco-elastic stretch, hysteresis, and strain stiffening.

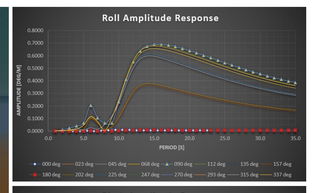
EXTREME AND FATIGUE ANALYSES METHODOLOGY (ITERATIVE FOR OPTIMIZATION)

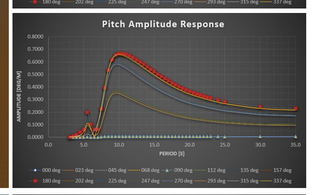
Metocean Data Evaluation

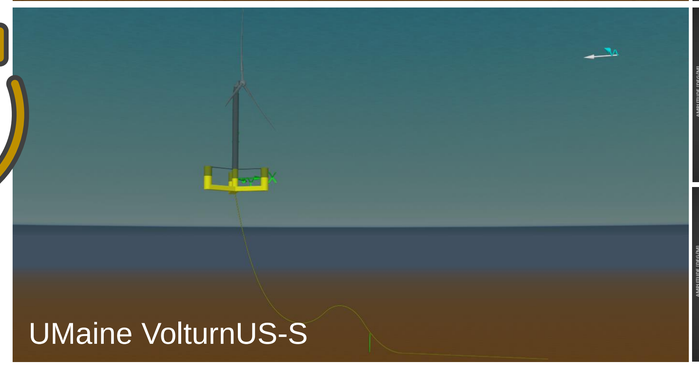


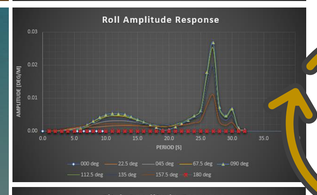
Floater Design & Motion Characteristic Evaluation

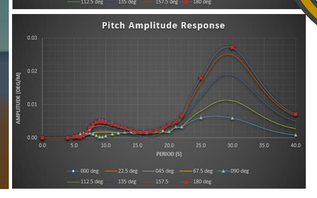




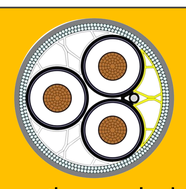








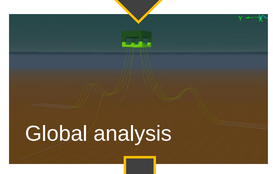
Extreme & Fatigue Analyses

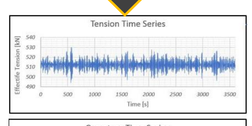


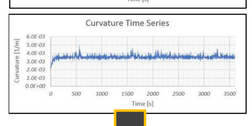
Cross-section analysis:

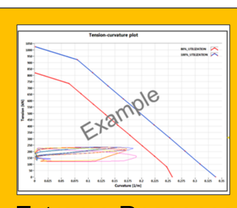
- 145 kV AC 3x1000 mm^2
- 320 kV DC 1x1200 mm^2
- 300 kV AC 3x1200 mm^2

Cable Capacity & Mechanical Properties

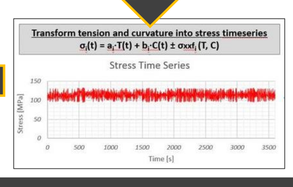








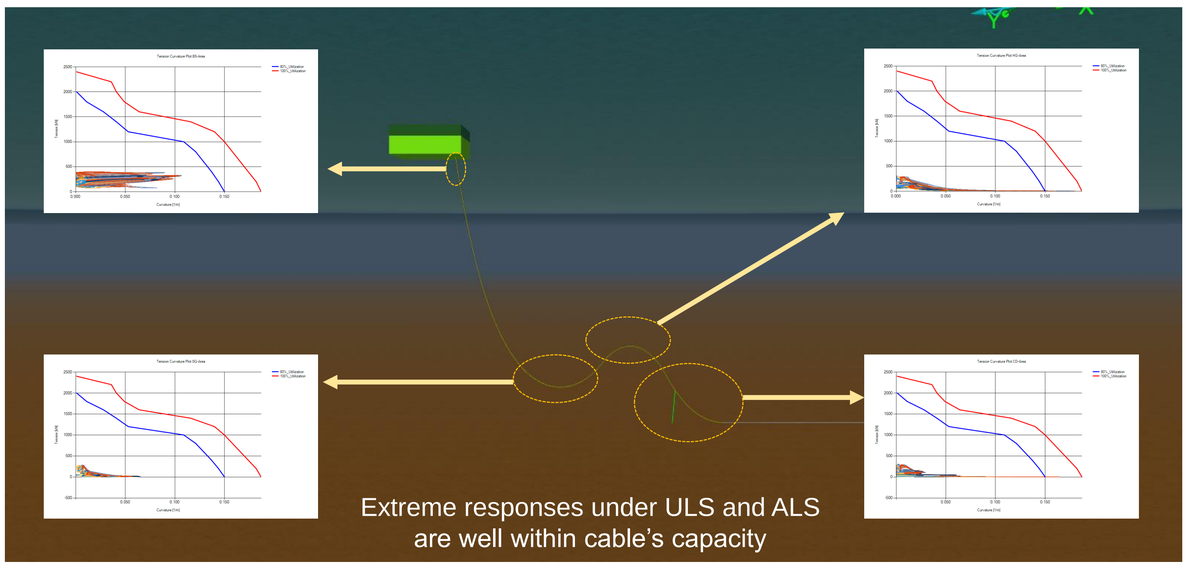
Extreme Responses vs Cable’s capacity



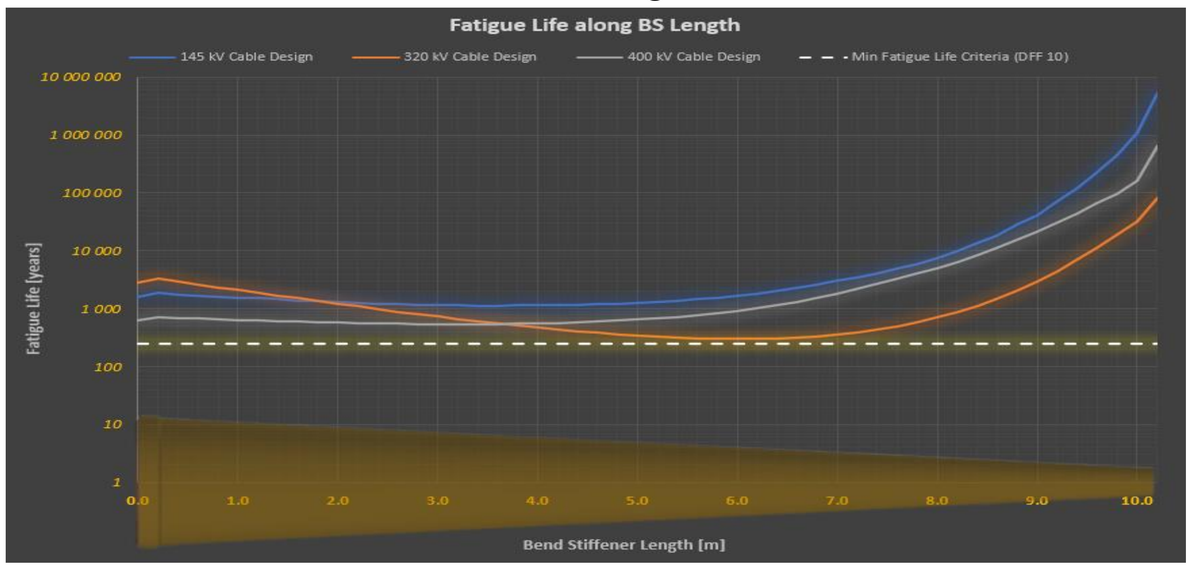
Fatigue damage is calculated by emphasizing water barrier developed fatigue curves

RESULT & CONCLUSION

Cable’s Extreme Response



Cable’s Fatigue Life



Conclusion:
Preliminary results indicate that developing High Voltage (HV) dynamic export cables, both AC and DC, using available and qualified technology is feasible.

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