Qualification of innovative floating substructures for 10MW wind turbines and water depths greater than 50m

The research leading to these results has received funding from the European Union Horizon2020 programme under the agreement H2020-LCE-2014-1-640741.
Outline

1. LIFES50+ Targets and follow-up steps
2. Experimental & numerical evaluations
3. Design methodology & guidelines
4. Data considerations

How to improve tools?

How to improve component design?

How to demonstrate reliability of power supply?

How to design floating wind farms?

How to enable systems engineering?

1) LCOE
2) Risks
3) Carbon footprint
LIFES50+ Targets and follow-up steps

Project objectives
• Optimize and qualify to TRL 5 two innovative 10MW designs
• Develop evaluation and qualification procedures for floating structures

Next steps?
• Full scale demonstrators
• Improve state-of-the-art
• New concepts using LIFES50+ as reference
2. Experimental & numerical evaluations
**Validation:**
- Consideration of experimental uncertainties

**Calibration:**
- Standardized procedures

**Extreme scenarios:**
- Reproduction of complex hydro- and aerodynamic phenomena

**Full scale validation**
- Design assumptions
- Scalability of model test results
- Requirements / standardized procedures
Develop existing tools

- Substructure elasticity
- Substructure CFD
- Cables, Mooring lines
- Aerodynamics
- Larger wind turbines (20MW)

Establish new tools

- Wind farm design
- Controller design
- Process simulation

Systems engineering
3. Design methodology & guidelines
Design methodology

Deterministic approach

- Deterministic system response
- Safety Factors
- Over or under-designed system

Stochastic approach

- Statistical properties of system response
- Reliable system
- Structural reliability analysis

Stochastic approach using safety factor recalibration

- Statistical properties of the system response
- Recalibrate safety factors
- Deterministic system response
- Reliable system
- Updated safety factors
- Structural reliability analysis
Update of the standards and supporting documents focusing on floating wind systems

- **FOWT System design**
  - Site assessment requirements
  - Review of design requirements, safety factors, control systems
  - Transport and installation conditions
  - Analysis tools and requirements for analysis
  - DLC implementation. ULS, FLS, ALS

- **Floating wind farm level design**

- **FOWT specific component design**
  - Cables
  - Mooring lines
4. Data considerations
Data sharing

Systems Engineering / Multidisciplinary design optimization
• Requires quantified constraints, parameters, variables, KPIs

To align and connect all stakeholders of the community, standardized & open data is required as benchmark & reference
• Environmental data
• Simulation models, inputs & results
• Experimental & full scale measurements
• Costs, risks and carbon footprints

Global constraint: technical viability

- Carbon Footprint
- Risk
- Cost

Parameters
Variables

Lifecycle phases

- Planning & Development
- Manufacturing
- Installation
- Operation & Maintenance
- Decommissioning & Repowering

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Data driven design process

FOWT Concept Industrialisation

**Design Process**

- **Challenge:** Automation
  - Simulation of multiple DLC

- **Challenge:** Load Exchange
  - Definition of loads for detailed FEM analysis

- **Integrated simulation tool**
  - Turbine
  - Substructure
  - Moorings

- **Challenge:** Turbine Design
  - Feedback necessary?

- **Detailed floater structural design tool**

- **Detailed mooring structural design tool**

**Fabrication/Installation**

- **Final FOWT system design**

- **Challenge:** Production Process
  - Optimization
  - Shipyard site
  - Standard materials
  - Standard ship building procedures

- **Challenge:** Large Number of Mooring Systems
  - Standard materials
  - Standard solutions suitable?
Data driven design process

1. Upload data
2. Enrich and analyse data
3. Share key
4. Authorize application
5. Consume data through application

My data

Veracity data fabric

Cleaning & enrichment
Analytics & predictions

Data quality, enrichment and analytics are sold as add-on services

Original data
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