Current State of the Art of Floating Wind Turbine Design and Simulation

Chris Kubes – Principal Engineer

DNV
Purpose

• Introduction
• Project Structure of Floating Wind Design
• Tools and Workflows for Floating Wind Turbine Design
• Innovations Required
• Conclusions
Introduction
Introduction

• Significant Growth in Offshore Wind
• More Floating Wind Projects
  • R&D
  • Full Scale Deployment
  • First Commercial Floating Farms
• Floating Wind can be deployed further from shore in deeper water → more favourable wind resources
Types of Floating Wind Turbines

- Semi-sub
- Spar-Buoy
- Tension Leg Platform (TLP)
- Barge

- Currently over 40 different concepts in development
- What is the “Best” Solution?
Project Structure of Floating Wind Design
Project Partners – Fixed Wind

+ Design Consultant (to any one of the above)

WTG OEM & Tower Designer

Foundation Designer

Certification Body

Project Developer
Project Partners – Floating Wind

- Different software, practices and standards used... to model the same physics!
- Several verification/validation exercises required
- Joining the know-how from different industries: wind power, oil & gas and maritime
- A strong integration is required
- The practical coupling can be even more challenging than the theoretical one!
Floating Wind – The Theoretical Coupled Analysis Challenge

- Need to calculate internal **loads** and **response** for each component: wind turbine, tower, platform, moorings, ...
- It’s an **active** system and **highly coupled**!
  - Aerodynamics
  - Hydrodynamics
  - Structural dynamics
  - Electrical dynamics
  - Mechanical systems
  - Controller
Different Approaches to Analysis & Design
Different Approaches to Analysis & Design:
#1 No Coupling
Different Approaches to Analysis & Design: #2 Minimal Coupling
Different Approaches to Analysis & Design:
#3 Full Coupling
Tools and Workflows for Floating Wind Turbine Design
Floating Wind Project Workflows: Example #1

Wind turbine designer

In-house aeroelastic tool
Marine dynamics tool

runtime data exchange

Simplified turbine model

Floater model

Floater designer

Marine dynamics tool + Offshore design tool
Floating Wind Project Workflows: Example #2

Wind turbine designer

<table>
<thead>
<tr>
<th>In-house aeroelastic tool</th>
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<tbody>
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<td>Marine dynamics tool</td>
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Floating data exchange

Turbine model

Tower bottom loads

Floater designer

<table>
<thead>
<tr>
<th>Academic/open aeroelastic tool</th>
</tr>
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<tbody>
<tr>
<td>Marine dynamics tool + General FEA tool and post-processing scripts</td>
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</table>

Floating data exchange
Floating Wind Project Workflows: Example #3

Wind turbine designer

Simplified turbine model

Commercial wind turbine design tool or Academic/open aeroelastic tool

Floater designer

Simplified floater model

Marine dynamics tool + Offshore design tool

Floating Wind Solutions
Challenges in the Industry

**PHYSICS**
- Tools evolved from O&G and onshore wind
- Many different floater concepts
- No tools fully support floating wind turbine standards yet

**INTERFACE**
- Protection of intellectual property gives limited willingness to exchange models and results between floater and turbine designers
- Different companies using different software tools
- Use of assumptions and simplified models, inaccurate and possibly inconsistent analysis results and an inefficient design process

**EFFICIENCY**
- Large number of load cases
- Full analysis requires massive amounts of computing power and generates extensive amounts of data

Floating Wind Solutions

The Marriott Marquis, Houston  1-3 March 2022
Innovations Required

PHYSICS
Tools to fully support floating wind turbine standards

INTERFACE
Allow for more integrated coupled design processes

EFFICIENCY
Allow for more efficient analysis processes
Conclusion and Innovations Required
Conclusion

• Many different floater designs today
• More complex project structures and simulation workflows than for fixed offshore wind
  • Floating wind turbine is highly coupled
  • Parties involved with different backgrounds and tools
• No common simulation workflow in the industry

Innovations

• Tools to fully support the floating wind standards
• Allowing for more integrated coupled design process
  • Both regarding simulation tools and project setups
• More efficient analysis processes