Floating Wind *Solutions*

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

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DNV

Organized by FWE Quest Offshore

FWS

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Purpose

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

Introduction

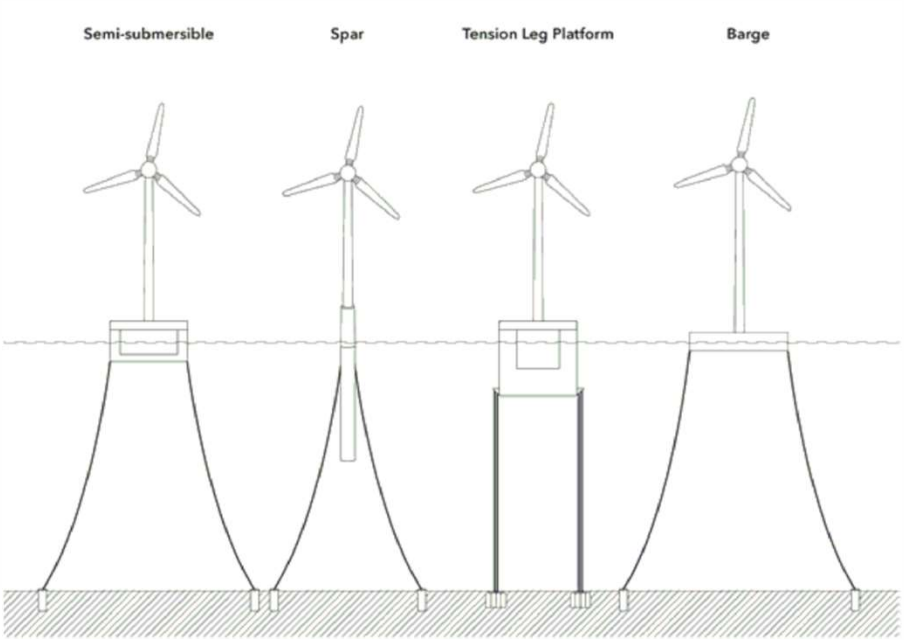
Introduction

- 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

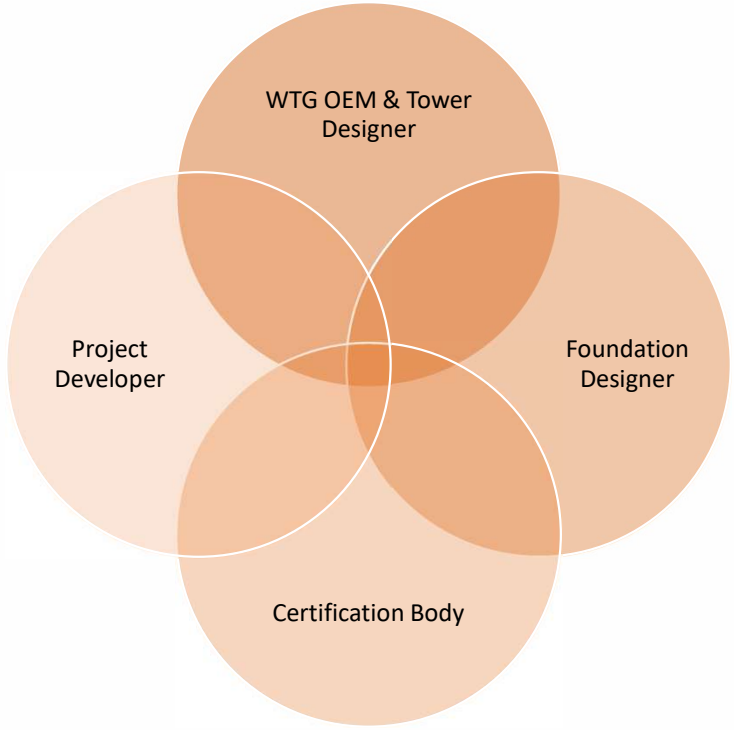
- Semi-sub
- Spar-Buoy
- Tension Leg Platform (TLP)
- Barge

- Currently over 40 different concepts in development
- What is the “Best” Solution?



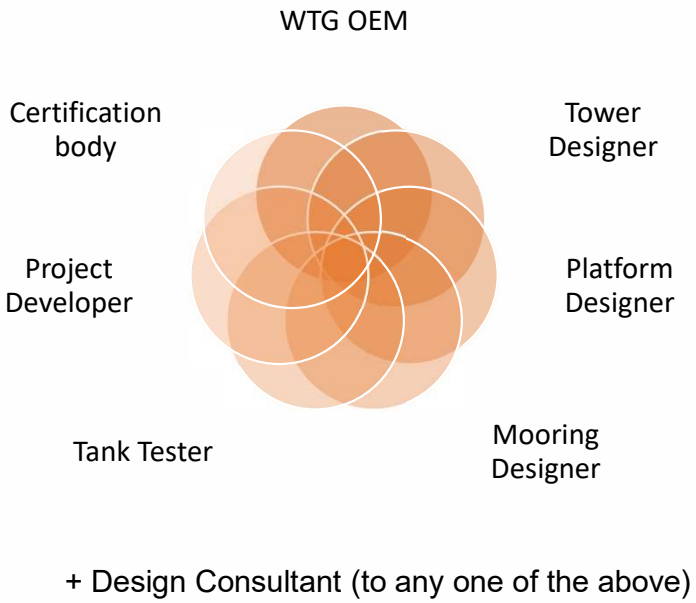
Project Structure of Floating Wind Design

Project Partners – Fixed Wind



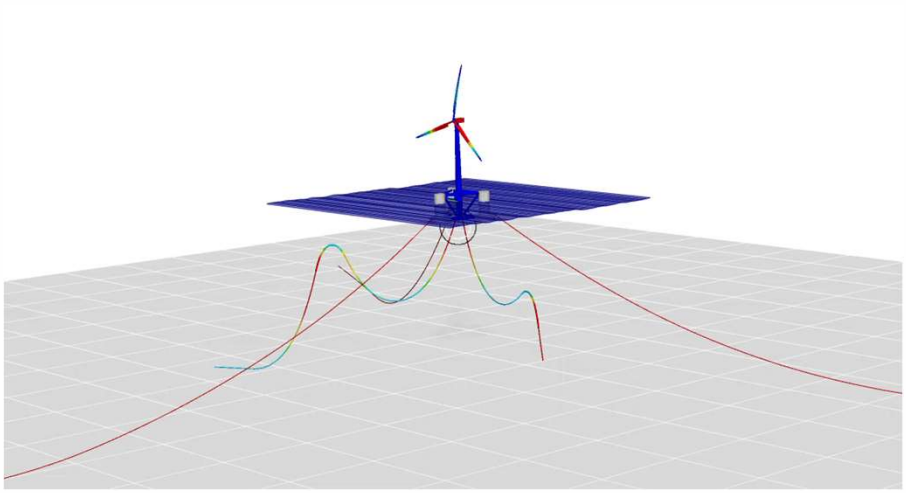
+ Design Consultant (to any one of the above)

Project Partners – Floating Wind



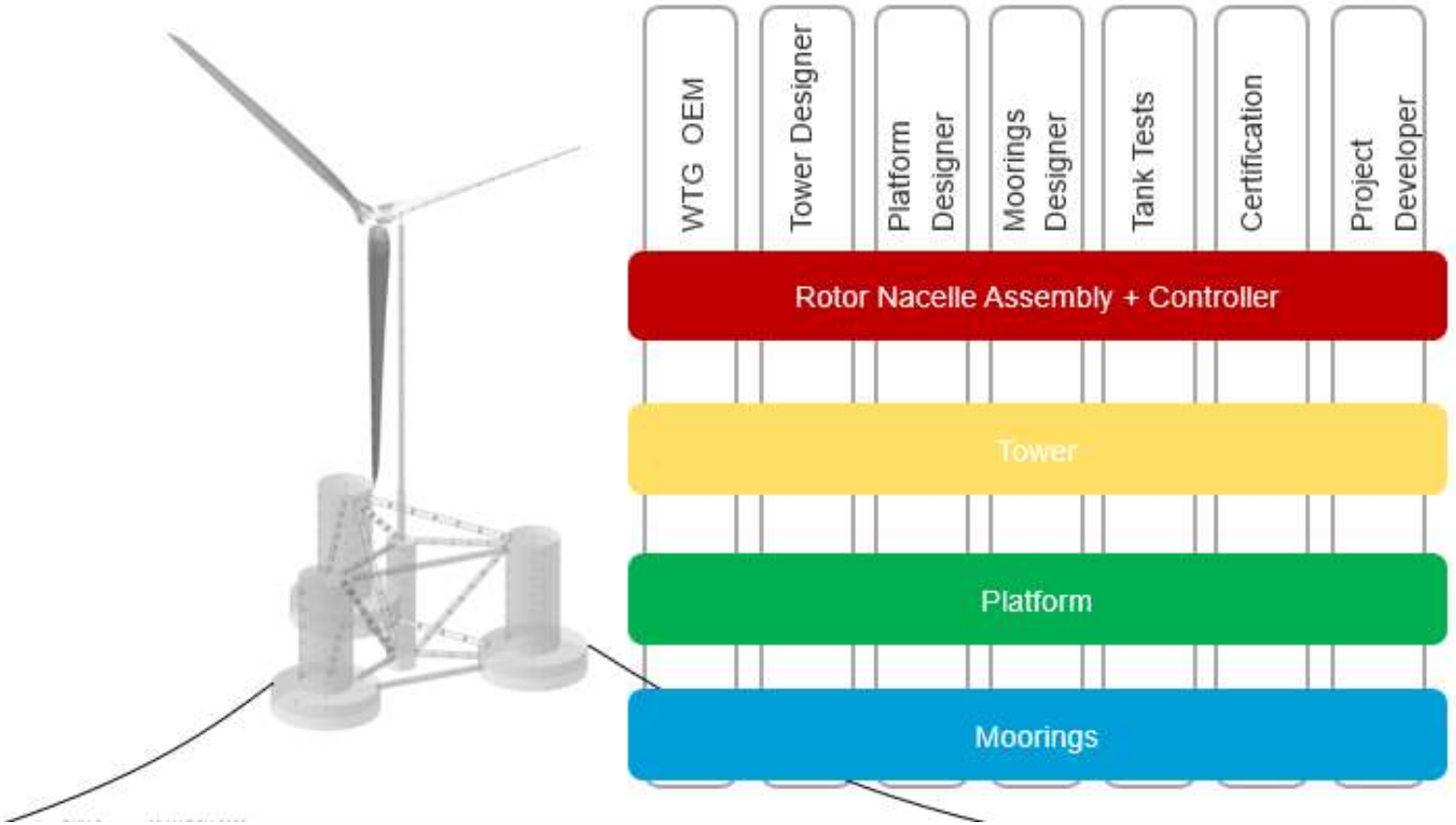
- Different software, practices and standards used… to model the same physics!
- Several verification/validation exercises required
- Joining the know-how from different industries: wind power, oil & gas and maritime
- A strong integration is required
- The practical coupling can be even more challenging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

Floating Wind – The Theoretical Coupled Analysis Challenge

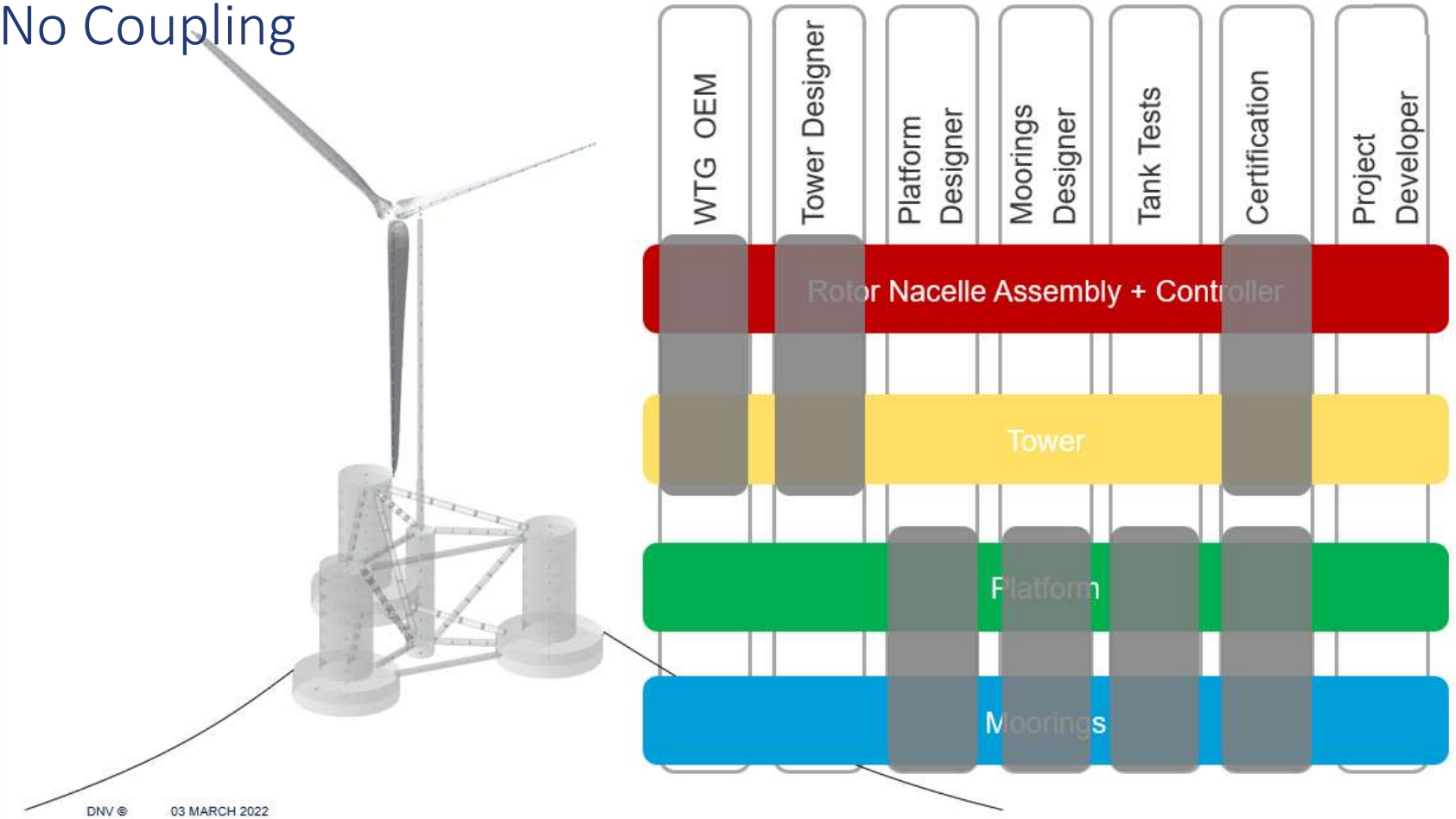


- Need to calculate internal **loads** and **response** for each component: wind turbine, tower, platform, moorings, …
- It's an active system and highly coupled!
  - Aerodynamics
  - Hydrodynamics
  - Structural dynamics
  - Electrical dynamics
  - Mechanical systems
  - Controller

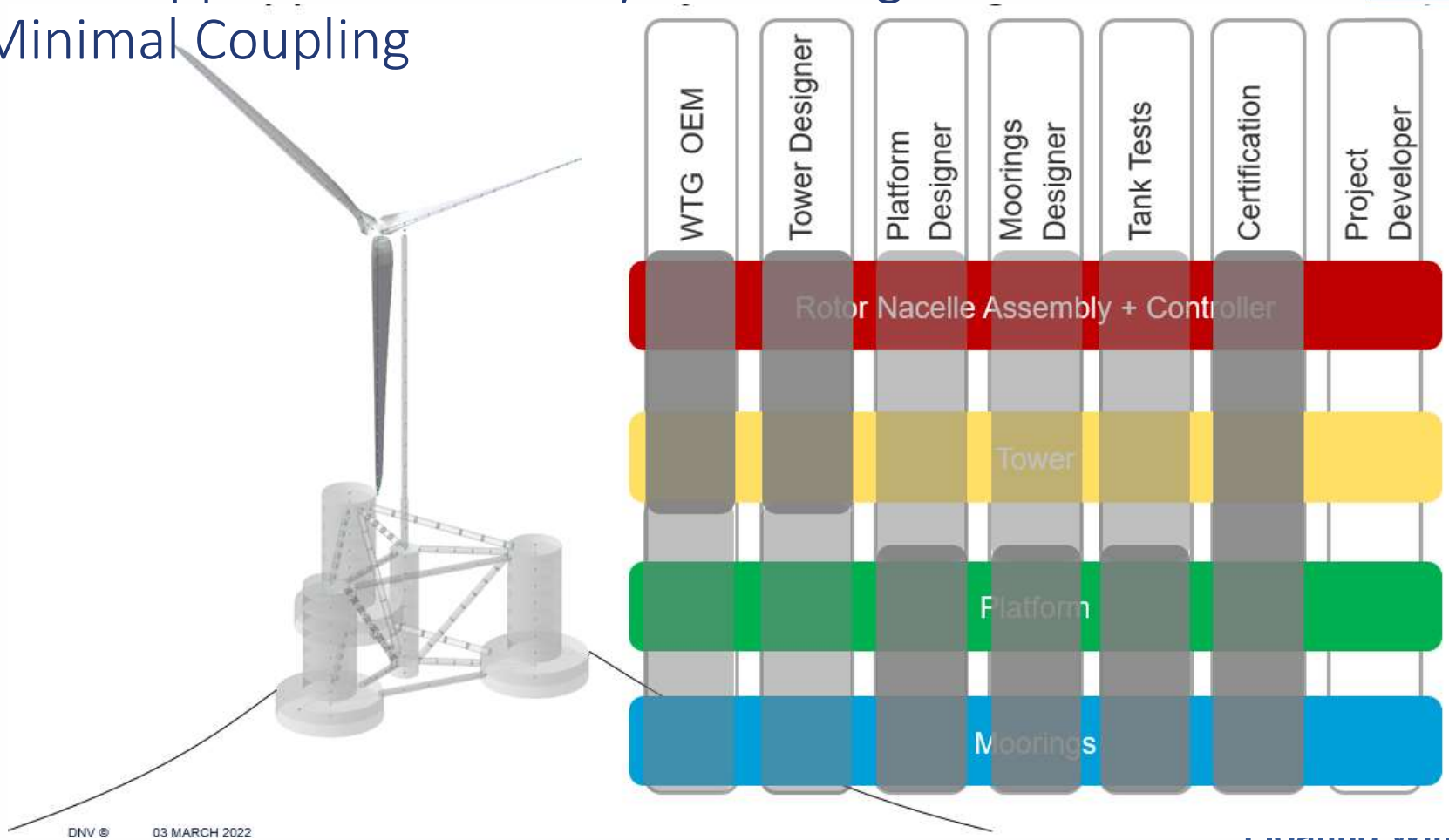
Different Approaches to Analysis & Design



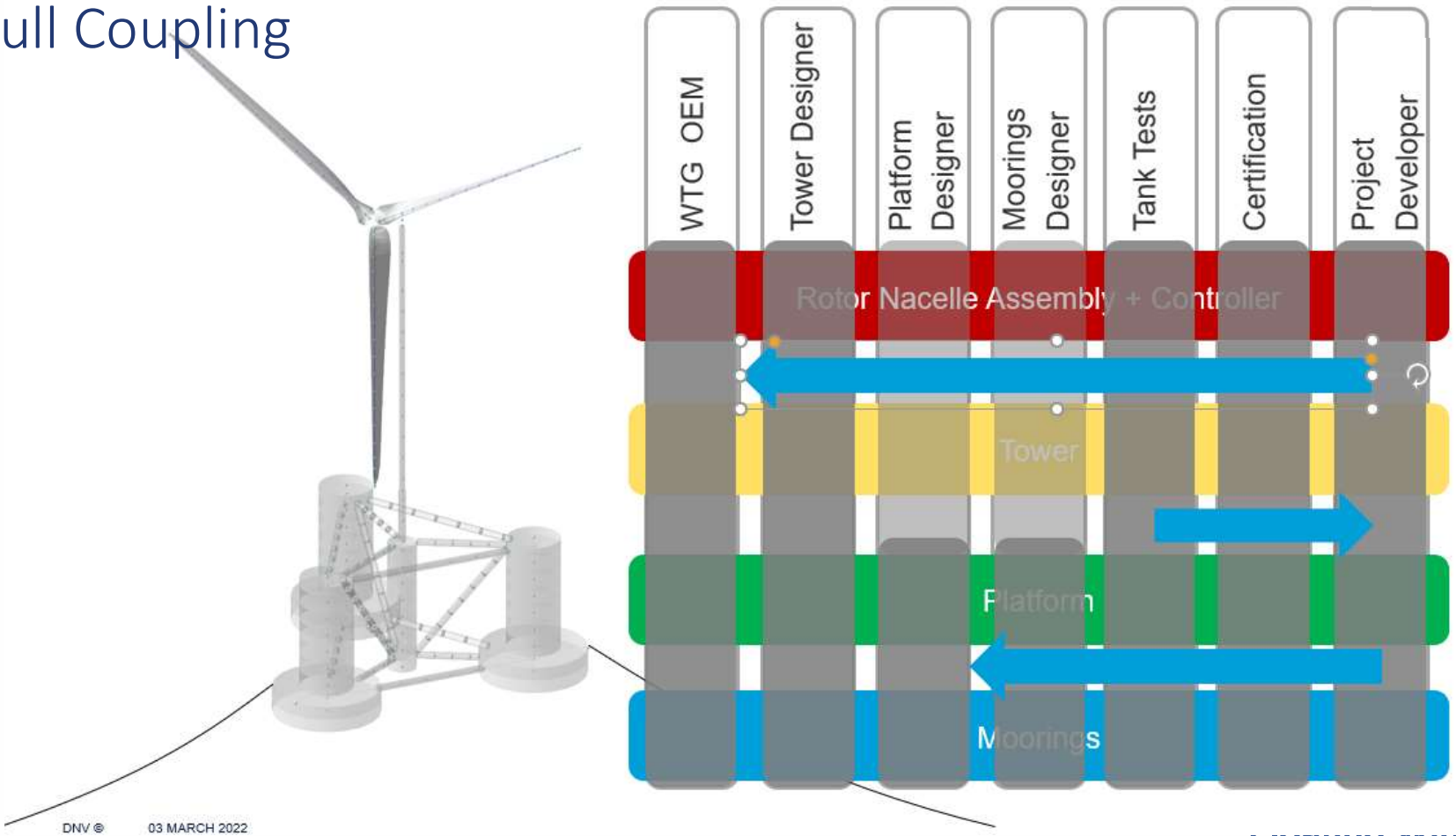
Different Approaches to Analysis & Design: #1 No Coupling



Different Approaches to Analysis & Design: #2 Minimal Coupling

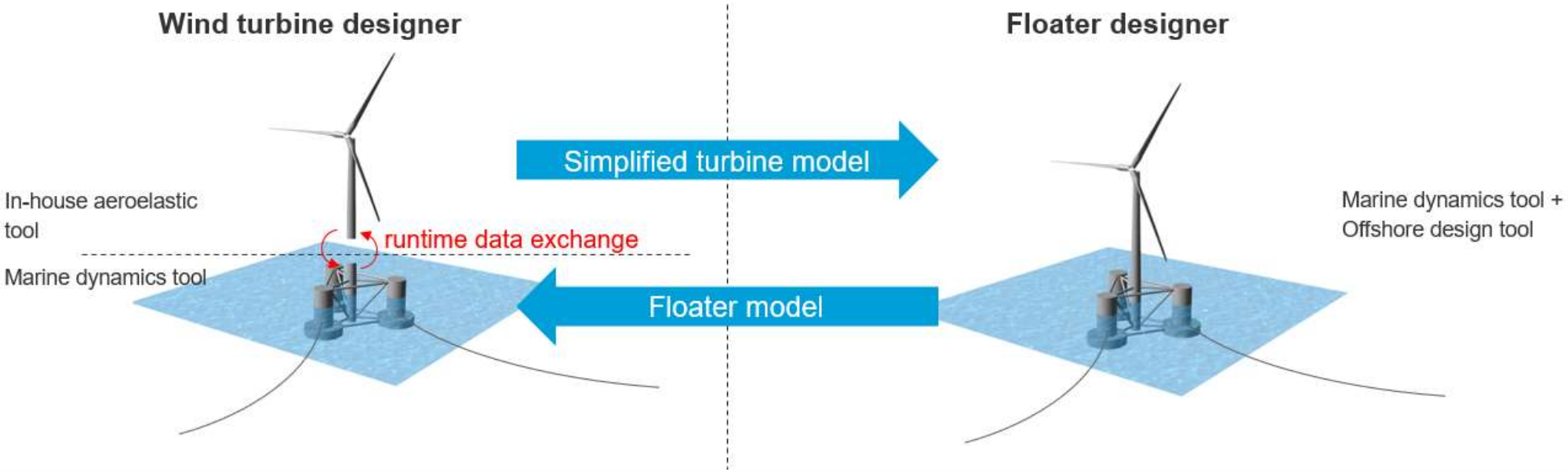


Different Approaches to Analysis & Design: #3 Full Coupling

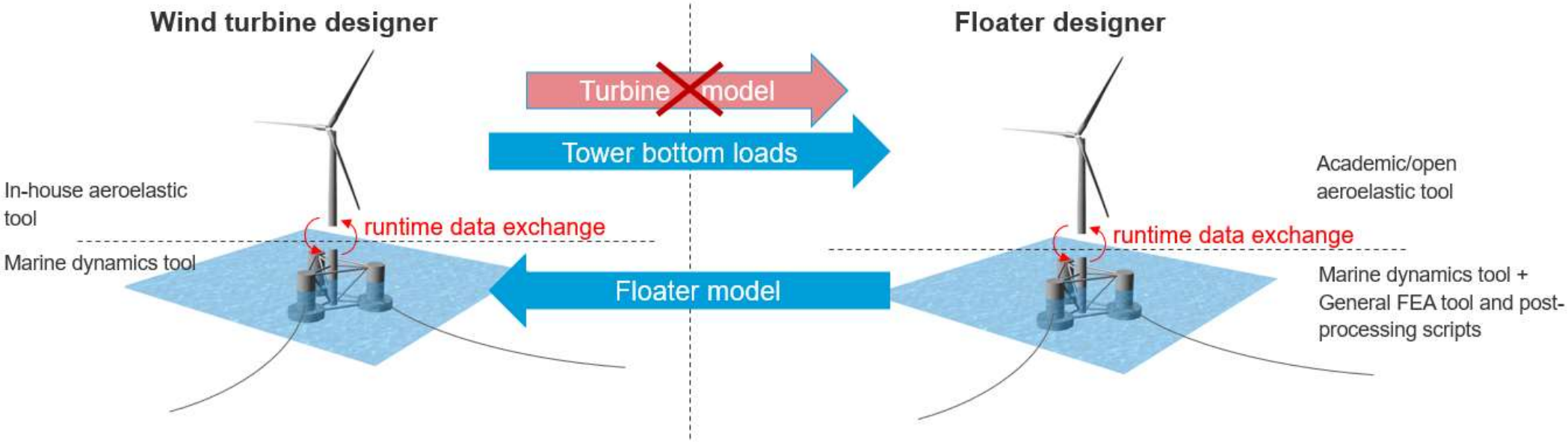


Tools and Workflows for Floating Wind Turbine Design

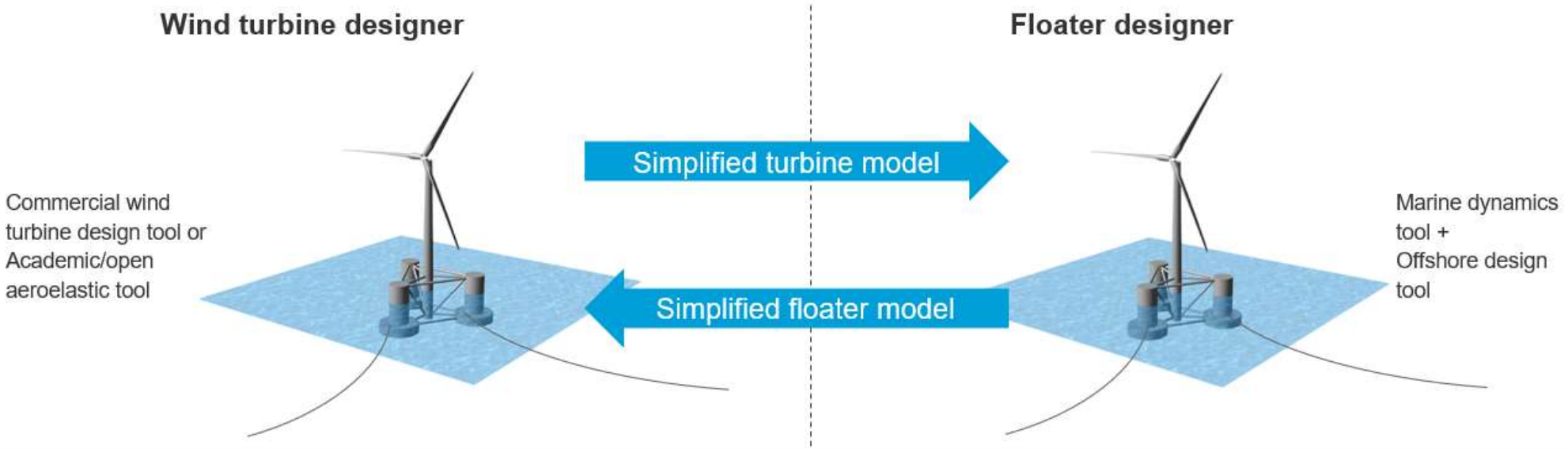
Floating Wind Project Workflows: Example #1



Floating Wind Project Workflows: Example #2



Floating Wind Project Workflows: Example #3



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**

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