

Industrial Design Considerations for Floating Wind Turbines

Denis Matha, Alexander Mitzlaff

Christof Wehmeyer

Ramboll

Germán Pérez Morán

Tecnalia

Kolja Müller, Frank Lemmer

University of Stuttgart

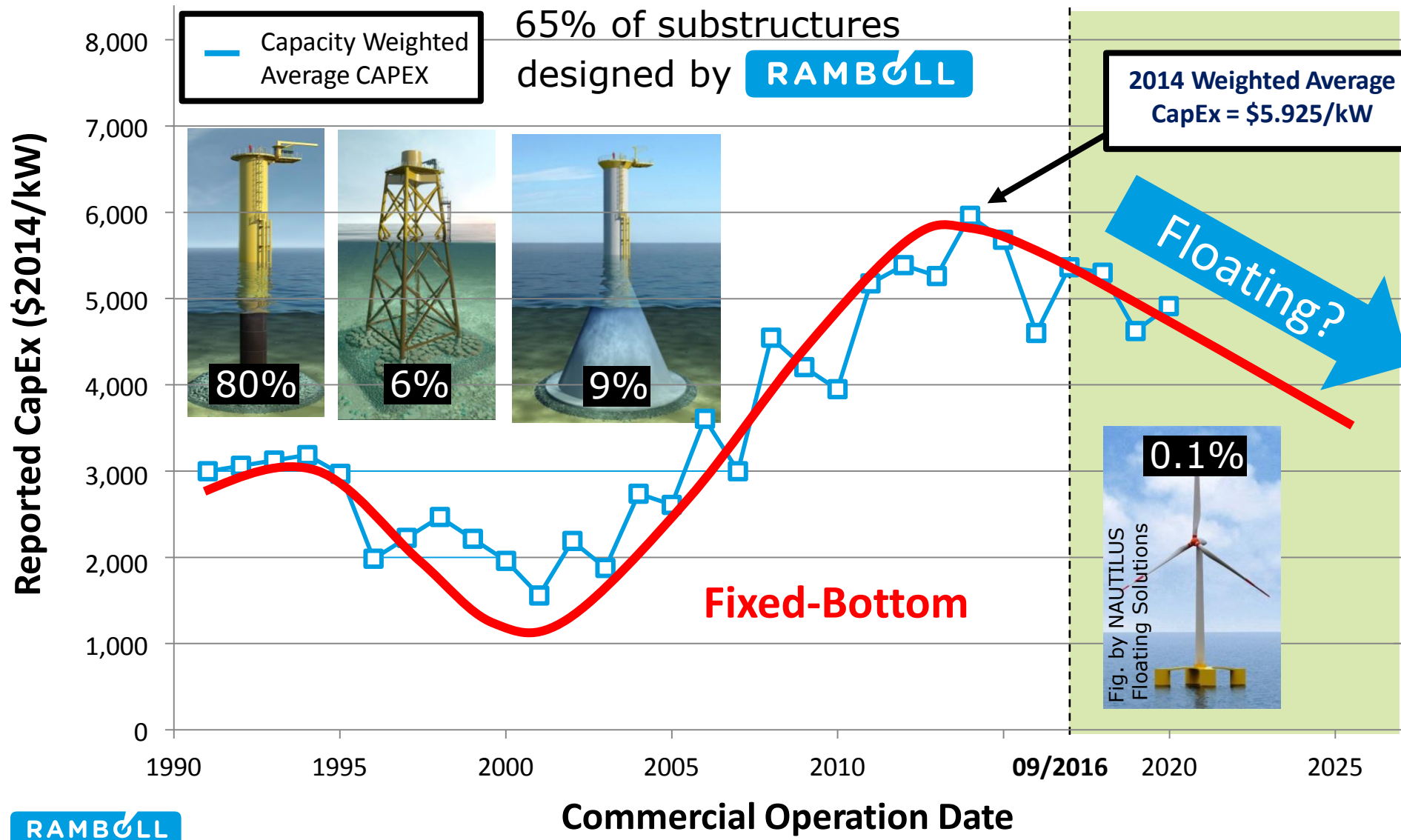


Qualification of innovative floating substructures for
10MW wind turbines and water depths greater than 50m

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



INTRODUCTION



[Fig. adapted from NREL]

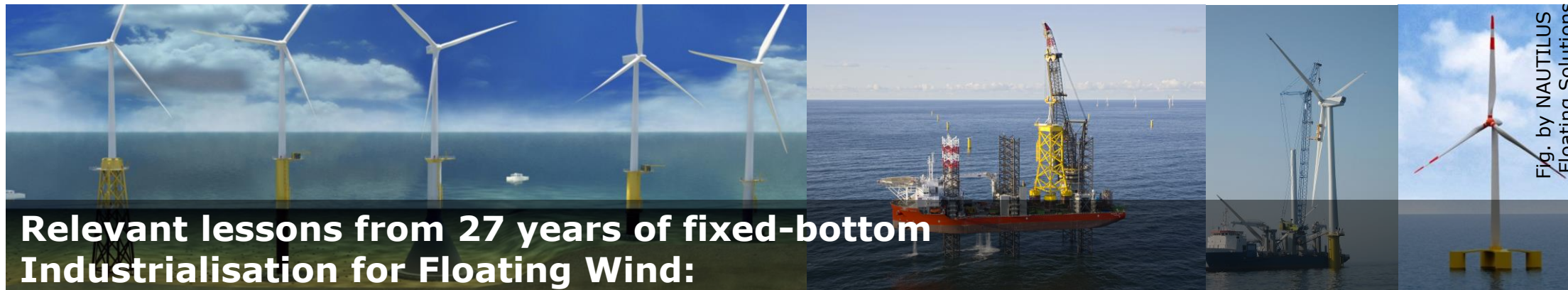
INTRODUCTION

Offshore Wind Costs increased until 2014:

- Unforeseen technical challenges
- Supply chain shortages
- Macroeconomic trends
 - > Oil and commodity Prices, Policy changes
- Appreciation of real cost and risk
 - > conservative pricing from EPCI contractors and suppliers
- Increasingly challenging site conditions

Industrialization is key to reduce cost of Floating Wind

LESSONS LEARNED FROM INDUSTRIALISATION OF FIXED OFFSHORE WIND INDUSTRY



Relevant lessons from 27 years of fixed-bottom Industrialisation for Floating Wind:

Project Management

- ❑ Clearly defined Supply Chain Interfaces & Early involvement of stakeholders
- ❑ Avoid too many open routes by making decisions
- Benefit management (Understand needs, clarify on goals, align if necessary)

Engineering

- ❑ Focus beyond steel/concrete weight
- ❑ Design for fabrication/installation/O&M & High flexibility of engineering
- ❑ Utilize Monitoring/Control/Integrated design to reduce risk and optimize cost
- ❑ Replace “conservatism” by planned contingencies (controlled safety level)

TECHNICAL CHALLENGES FOR INDUSTRIALISATION OF FLOATING WIND

Hybrid Testing Methodologies



POLIMI

MARINTEK

Risk, Uncertainty and Cost Analyses

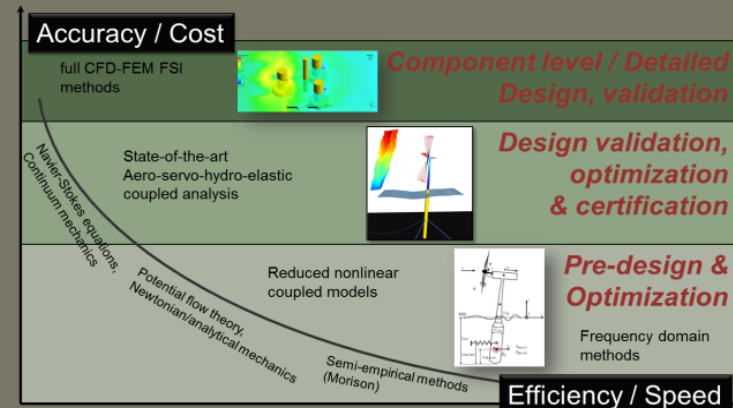


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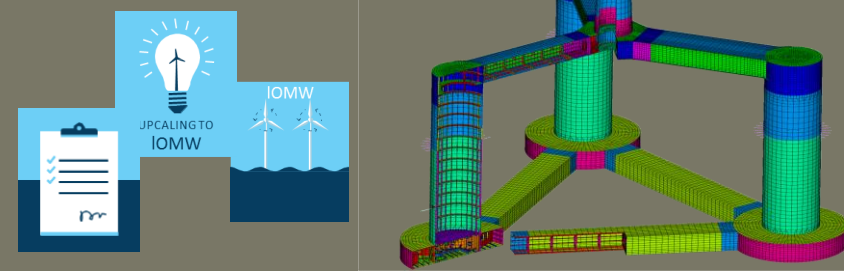
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Numerical Procedures, Optimization



10MW Concept Design Industrialization



TECHNICAL CHALLENGES FOR INDUSTRIALISATION OF FLOATING WIND

Non-Linear Time-Domain Simulation of the System under Combined Loads (Turbine, Seaway, Motion-Induced)

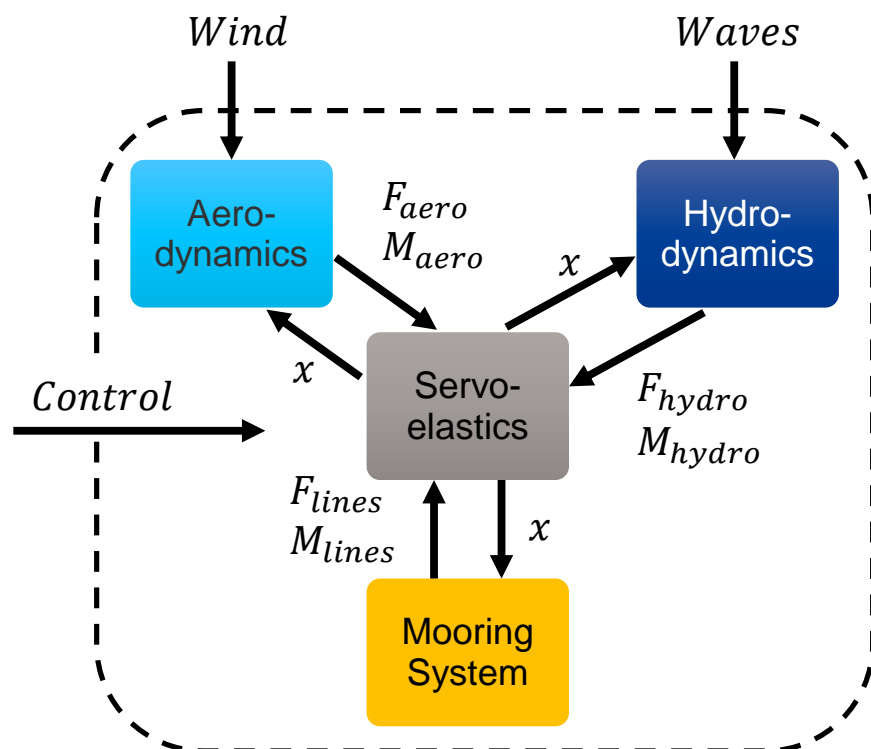
Floater and Tower Design
- Geometry (Hydromechanic) -
- Mass Distribution -
- Structural Details -

Iterative Optimization of
- Wind Turbine Controller -
- Motion Characteristics Floater -
- Mooring System / Dynamic Cable -

OPTIMIZATION OF TOTAL COSTS
Wind Turbine / Tower / Floater / Mooring System
Design for Fabrication and Installation

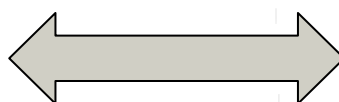
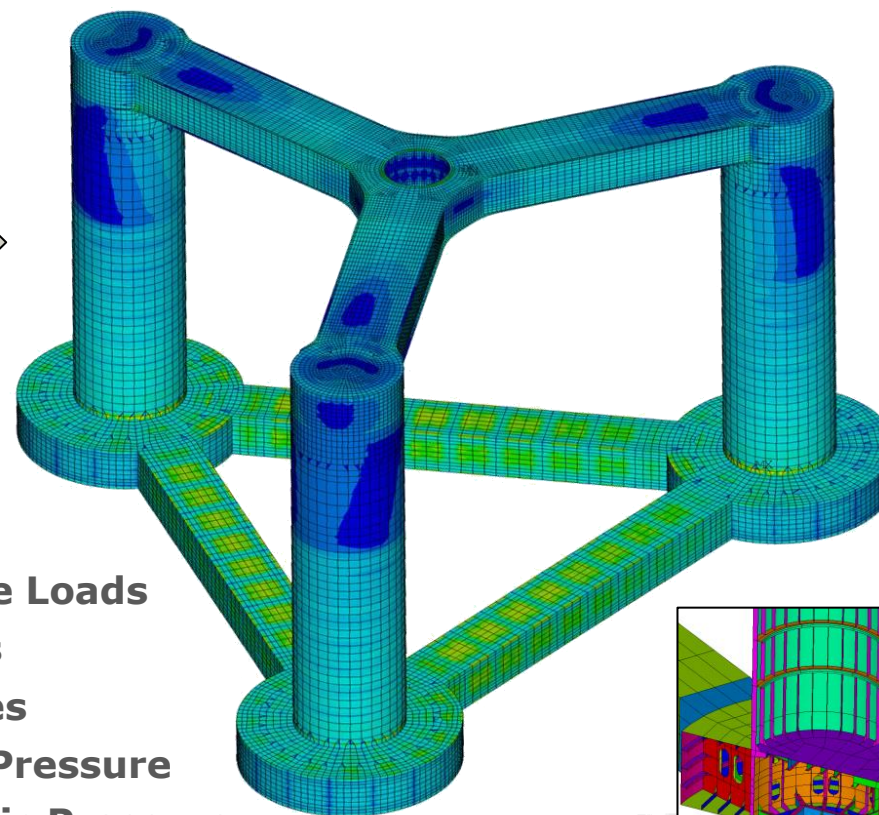
Fig. by NAUTILUS Floating Solutions

TECHNICAL CHALLENGES FOR INDUSTRIALISATION OF FLOATING WIND



**Coupled FOWT Simulation
(Load Exchange Challenge)**

Detailed FEM Strength Analysis for Instantaneous Position



- Wind Turbine Loads
- Static Forces
- Inertia Forces
- Hydrostatic Pressure
- Hydrodynamic Pressure
- Mooring Forces

TECHNICAL CHALLENGES FOR INDUSTRIALISATION OF FLOATING WIND

- **Apply lessons-learned and build-upon existing supply chains from Fixed Offshore Wind and Oil & Gas**
- **Avoid one-dimensional optimization (e.g. steel weight)**
 - > **Consider all relevant cost-drivers**
 - > **Clear consideration of fabrication/installation/O&M**
- **Reduce technical uncertainties**
 - > **Improved numerical and experimental methods**
 - > **Demonstration and Pre-Commercial Projects**
- **Reduce project risk**
 - > **Close cooperation between WTM and substructure designer**
 - > **Involvement of supply chain in early stages**

THANK YOU.

Contact:
Denis.Matha@ramboll.com



LIFES50+



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