# Tight coupling of simulation tools for offshore wind turbines using a centralised solver

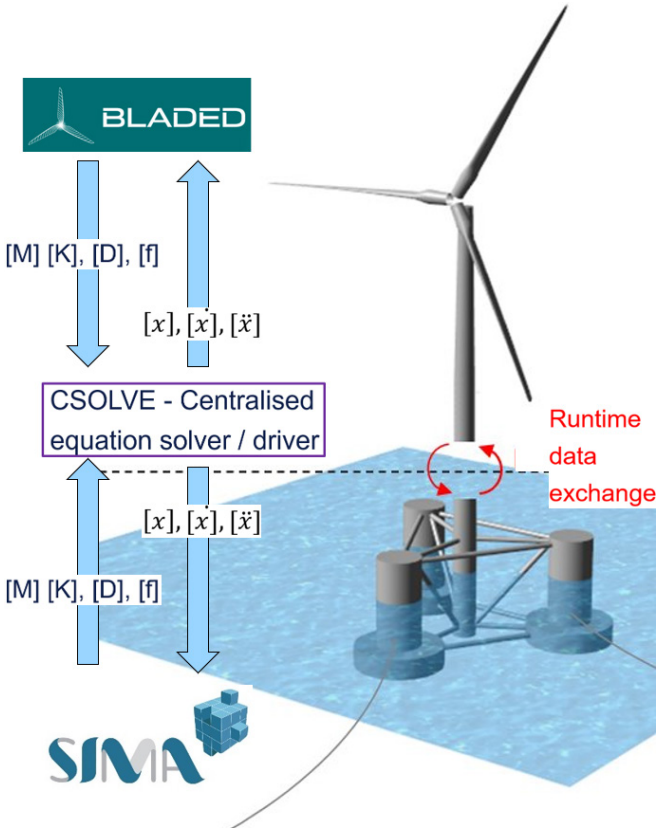
Ole Andreas Hermundstad, Elizabeth Passano, Pål Levold, Marit Kvittem, SINTEF Ocean AS
Erik Nim, Sigurd Jensen, DNV

The behaviour of floating wind systems depends on the complex interactions between various sub-systems such as moorings, foundations, wind turbine and the controller.

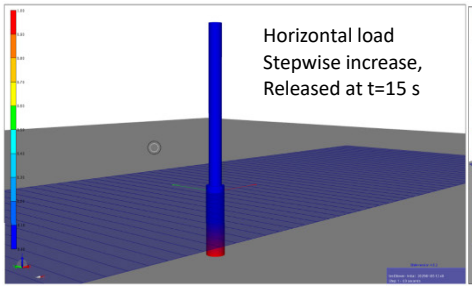
Floating wind design projects involve multiple stakeholders, each with their own area of expertise and preferred tools. Foundation design is often initialised in specialised simulation tools, whose strengths lie in the modelling of floating platforms and moorings. Meanwhile, wind turbine designers understand the complex turbine dynamics and control system and use specialised aero- and servo-elastic models.

To benefit from the complementary capabilities of different specialised tools, co-simulation or other coupling schemes can be used. Co-simulation, such as HLA, FMI/FMU for co-simulation or custom made dll interfaces are usually applied in so-called "soft" coupling of numerical tools. This is an efficient approach for systems where data between the two tools can be exchanged with a time-step that is not too small. For systems that respond on a smaller timescale however, a tighter coupling is required for robustness and efficiency.

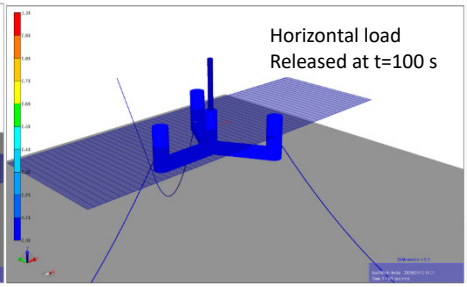
This insight has motivated the development of the centralised equation solver and time integrator CSOLVE; enabling a tight coupling between the Bladed and SIMA tools. Although the selected coupling method is general, the focus in the ImproveFLOW project is to model the turbine/tower in Bladed and the foundation/moorings in SIMA, with a shared coupling node in the lower part of the tower.



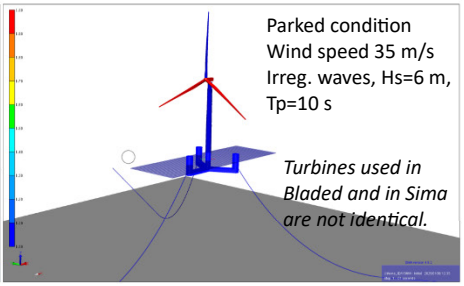

## Monopile + tower in calm water



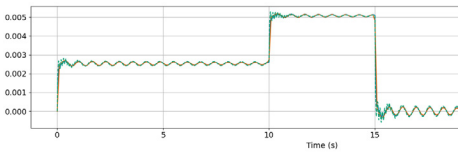

## Floater + tower in calm water



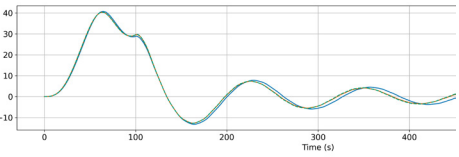

## 15 MW FOWT in wind and waves



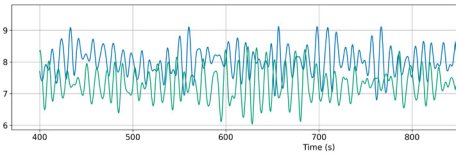

Connection node monopile/tower – Horizontal displ. [m]




Connection node floater/tower – Horizontal displ. [m]




Connection node floater/tower – Horizontal displ. [m]




Legend: sima: Conventional Simo/Riflex csolve-RF: CSOLVE with Riflex only csolve-B-RF: CSOLVE with Bladed tower/turbine and Simo/Riflex floater/moorings

## ImproveFLOW primary objectives

Facilitate more cost-effective designs of floating wind units and farms

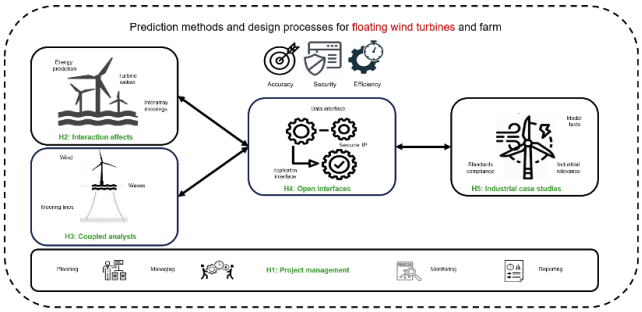
by developing methods and tools

that will reduce uncertainty in the investment and planning phase,

and improve accuracy, collaboration and efficiency in the design and engineering phases

Additional objective: Enhanced collaboration between DNV and SINTEF Ocean

## Work packages




Project partners

DNV, SINTEF, inocean, equinor, COWI, ceetron

With support from

SIEMENS Gamesa RENEWABLE ENERGY, Microsoft, Vestas

Budget: ~23 MNOK

Duration: 2021-2025

The Research Council of Norway