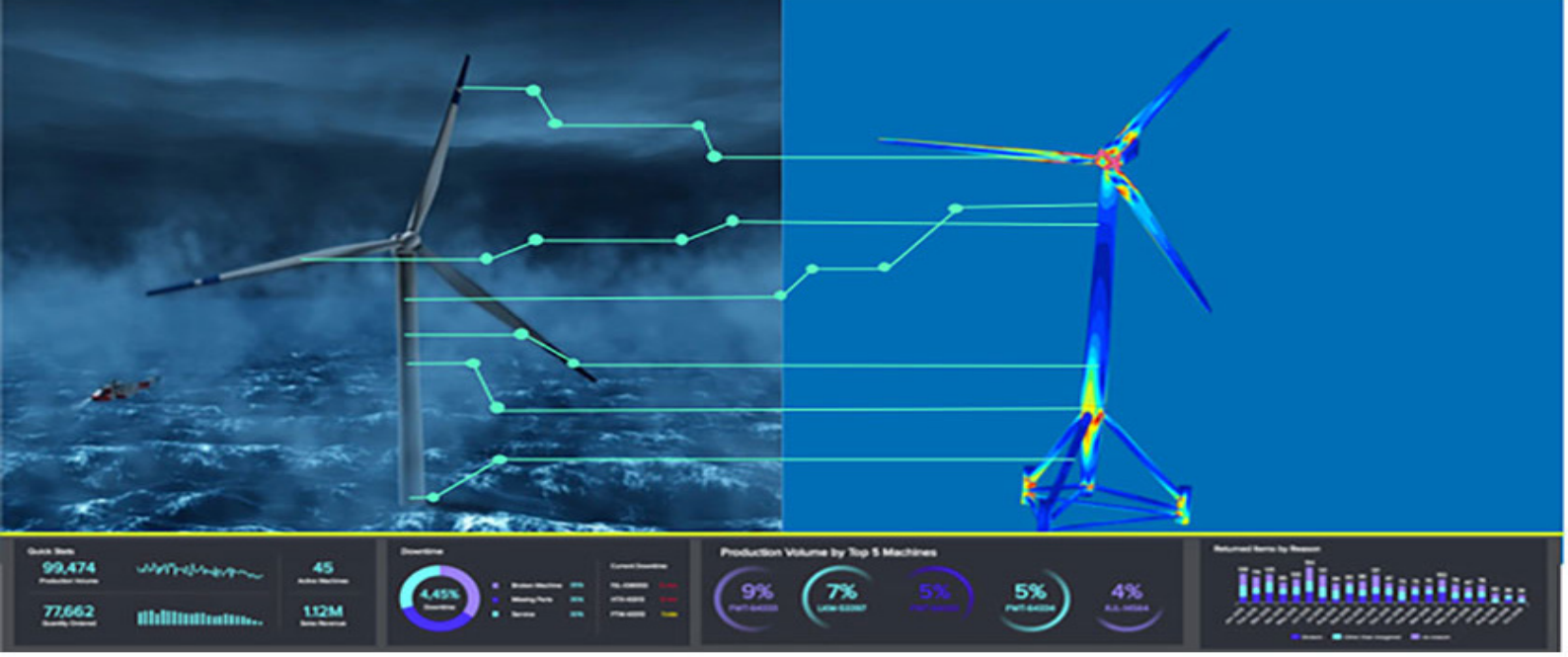


GODESS

GODESS aims at enabling large-scale deployment & monitoring of offshore wind farms at a reduced cost to enable the energy transition. GODESS brings a stepchange in the design of offshore wind farm foundations, by integrating best of-breed softwares for:

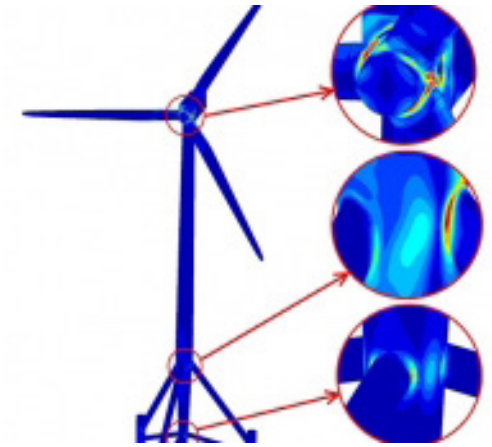
- Structural design

- Asset monitoring

- Cost models

- Optimizers

GODESS leverages the fastest predictive technology, used today to create the largest digital twin in the world, to power a digital feedback loop linking operations and design.



Digital Twin of a wind turbine

Project Purpose

Fixed and floating offshore assets are among the world's largest, most complex structures. They operate under some of the harshest conditions on the planet and are paramountly expensive to operate. From design to operations and maintenance, the inherent complexity of offshore assets cries out for innovative technologies that can optimize all processes for maximum efficiency and safety, with no delays or downtime.

Around 20,000 engineering hours are spent during the design phase of wind farm foundations. As it stands, this knowledge is effectively lost when the wind farm is delivered. Retaining this engineering knowledge and reusing it throughout the lifecycle of the asset will drive new business models for engineering companies. Based on estimates from the European Institute of Innovation and Technology, the innovation, which GODESS aims to deliver could reduce the cost of materials for substructures by up to 25%

Project Funding

The project is funded by Eurostars, which award funds to projects that successfully implement a promising, new and disruptive technology with a clear economic, societal and environmental impact compared to existing solutions. The project is funded with €1,4m.

The Digital Twin

The Digital Twin system was developed in cooperation with Akselos. The project works by creating a full digital loop from design to operations combining paremetric simulations, machine learning and optimization routines allowing companies to use relevant operational data to understand how designs behave under the operational conditions.

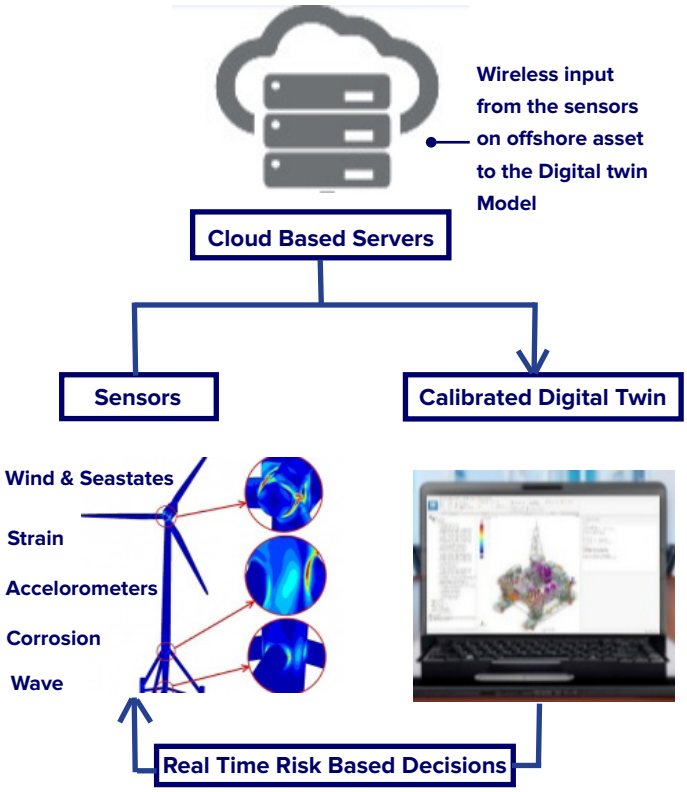
The system will be powered by Akselos' Reduced Based FEA (RB-FEA) technology which implements an acceleration layer on top of traditional FEA technology. LICengineering will develop offshore analysis modules and together with Akselos software code it allows the technology to simulate the responses of the offshore structure exposed to the environmental loads, which are measured and applied to the Digital Twin system.

In fact the RB-FEA system is able to provide 1000x acceleration for analysis of large offshore assets, such as oil & gas platforms or renewable energy structures, without compromising accuracy. Faster and more accurate than the industry standard when modelling large scale assets, the system will offer operators real-time access to the condition of the asset, from anywhere and at any time, and allow a move towards predictive maintenance. This system will enable engineering companies to create their own design optimization modules while reducing OPEX, CAPEX and cut project timescales.

The Digital Twin solution is already about to be implemented on one of the Super Major oil & gas operators' North Sea platform, a JIP project which will deliver proof of concept and give the operator a significantly more accurate modeling and likely increase the lifetime of the asset.

"By combining increased simulation speed with cost-based design, we will be able to make an important step change in offshore wind development and reduce the cost of energy significantly."

Hans Jørgen Riber, Head of R&D, LICengineering A/S



Digital Twin illustration

Test Facilities in Esbjerg

Our test facility at our office in Esbjerg was built in order to:

- Test the SIM System workflow prior to installation
- Validate theory and methodologies applied
- Determine SIM System limits for a controlled case

Our lab experiments are based on lattice structure in 8 levels (1,6 m), which is fixed to the ground by bolted connections. We are using 8 accelerometers at two different levels and 3 displacement sensors at top level. The loading system with servo motors induces seastate-like displacements to the structure. All data is collected through a data collection system, replicating the SIM system to be installed at our clients platform.

Installation

The monitoring system, based on 8 accelerometers, will be installed on two decks above sea level on our clients platform. LIC will provide the procedure for installation if equipment outside of the Switchgear room and setup the equipment that will be installed within the switchgear room. Initial tests will be carried out offshore by LIC staff in order to validate the setup of the SIM sytem.

GODESS Project Timeline

- October 2018: Receives €1,4m funding from EU
- Q4 2018: Appoint team and Director. Benchmark Fatigue Damage
- Q2 2019: Design of Experiments
- Q3 2019: Cost Analysis Module
- Q1 2020: Optimization and Validation of Model
- October 2020: Summarize and publish key findings. Produce Targeted Product. File Patent and Copyright

Media Coverage

- Windfair: Project “GODESS” Gets EU Funding
- OFFSHOREWIND.BIZ: GODESS Gets EU FUNDS
- Energy Live News: EU AWARDS € 1,4m to slash offshore wind material costs

For more information:

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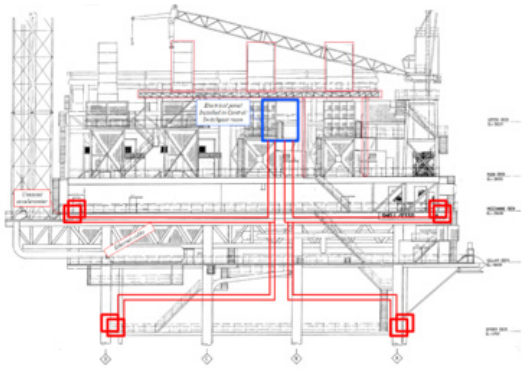
Our lab in Esbjerg where we conduct all testing



Drawing of plan for sensor installation on platform

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