TELWIND- Integrated Telescopic tower combined with an evolved spar floating substructure for low-cost deep water offshore wind and next generation of 10 MW+ wind turbines

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Abstract title
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Introduction
Levelised Cost of Energy (LCoE) is a main design driver for offshore wind turbines in deeper water. The presented evolved spar floating foundation combined with a Telescopic tower will reduce the costs of offshore wind. The objective is to design a revolutionary integrated floating substructure concept which shall enable a radical step forward for cost–effective and industrially deployable deep water offshore wind. The research activities within this project are executed by a strong multidisciplinary team of 8 project partners, funded by the European Commission in a Horizon2020 program.

Approach
The proposed floating concept is an innovative wind-specific evolution of the Spar Type floating structure. These are well established, inherently stable, systems, based on keeping the centre of gravity of the system below its centre of buoyancy.
Cost reduction will be achieved with greatly reduced material usage and through simple and reliable manufacturing and installation processes. These provide increased control of risks and increased industrialization capacity by minimizing offshore operations and fully avoiding the dependency on heavy-lift or special-purpose offshore vessels, whose costs, capacity and availability currently impose severe economical and logistical constraints to offshore deployment.

Main body of abstract
Two main novel and ground-breaking systems unite in the TELWIND floating substructure to generate a low-cost integrated system and its simple, fast and economical self-installing process: the evolved spar configuration with suspended ballast tank, and the self-erecting telescopic tower.

The floating substructure is based on an evolved spar configuration with solidary suspended ballast. It consists of an upper floating body connected by tendons to a heavy lower ballast tank which sufficiently lowers the system's centre of gravity to stabilize the structure.

The telescopic tower system consists of tubular tower levels built of precast concrete elements, one steel section and a tower self-lift using heavy-lift strand jacks which have been successfully used for 30 years for much more demanding heavy load operations in all kind of sectors. This system is already developed for onshore and offshore fixed foundation application and is currently being developed from TRL3 to TRL7 in a separate project. The application with a floating system gives added advantages for deep-water application and transportation: A lower wind turbine height for installation and transportation allows for a stable system and the use of existing in-shore infrastructure, where cranes often meet the requirements concerning lifted weight, but not the required height.

A preliminary experimental tank test of the conceptual fundamentals of the solidary suspended ballast tank is performed proofing the feasibility of the innovation. Based on an outline design of the floating substructure a first simulation based on a fully coupled model with a 5 MW reference wind turbine was executed and the results will be presented.

The paper will describe the system in more detail including the installation procedure. Also the upcoming technical challenges during the design and validation phase of the H2020 Telwind project will be addressed in the paper.

Conclusion

The presented TELWIND will reduce LCoE of offshore wind at deep water. The concept will provide important material savings of the floating structure, reduce installation costs by avoiding the need for offshore heavy lift equipment and keep the in-shore assembly works within limited drafts, heights and widths to profit from existing in-shore infrastructure.

Learning objectives

- Seakeeping and stability
- Simulation of mooring
- Structural design of the floater
- Fully coupled modelling of floating wind turbines