EERA-DTOC: European Energy Research Alliance Design Tools for Offshore Clusters

Charlotte Bay Hasager[1], Peter Hauge Madsen[1], Pierre-Elouan Réthoré[1], Luis Mariano Faiella[2], Elena Cantero[3], Gerard Schepers[4], Dorina Iuga[5] for the EERA-DTOC consortium

[1]DTU Wind Energy (Risø Campus, Roskilde, Denmark), [2]Fraunhofer IWES, [3]CENER, [4]ECN, [5]EWEA

Abstract

The EU-funded project EERA-DTOC - European Energy Research Alliance – Design Tools for Offshore wind farm Clusters is focused on wake loss, grid integration, and energy yield of large offshore wind farms and clusters. The project runs from 01/2012 to 06/2016 and consists of 22 partners including valuable industries and science partners across Europe.

Existing design tools from the project partners and possibly also third party design tools are to be integrated through common software.

Existing software

The models on wake and yield being considered include engineering models such as WAsP/Park (DTU), Ainslie (RES), DWM & RDWM (DTU); Linearized/parabolized CFD such as FUGA (DTU) and FarmFlow (ECN); and non-linear CFD models such as ECNS: LES AD/AL (ECN), CRES-Flow RANS AD (CRES), CRES-farm flowNS + engineering model (CRES), CFD OpenFoam RANS AD (CENER), EllipSys LES and RANS AD/AL (DTU), VENTOS RANS AD RANS (UPORTO). Also mesoscale models for the cluster scale are considered including WRF (DTU, CENER, CIEMAT) and SKIRON (CENER) and mesoscale wake models including WRFwake WRF + PARK (DTU), Farm-Farm (ECN) and RESWFYield WRF + Ainslie (RES).

For the analysis of variability and predictability of power feed-in with wind farm clusters CorWind (DTU) is considered. For the electrical grid the selected models include NET-OP (SINTEF), WCMS (Fraunhofer IWES) and grid code compliance (UStrath), with a special focus on providing system services using clusters. The electrical components in the farm could be modeled with e.g. EEFARM (ECN).

Benchmark and validation

The project builds to large extend on the consortiums prior knowledge and established design tools. However, in order to assess the validity of the various models there are plans to do wake bench mark analysis using two or three industry data sets from large offshore wind farms. Furthermore, the work will include a measurement campaign near a large offshore wind farm using both wind LiDAR on a ship as well as mounted scanning LiDARs at or near the wind farm. The measurement campaign aims to collect wake observation in the near- and far-field. In particular, the far field wake is poorly understood and quantified. Another source of information on far-field wake is high resolution Synthetic Aperture Radar (SAR) images from satellites that will be retrieved, processed, analysed and used in the model evaluation.

User involvement

EERA-DTOC project is the direct user involvement in the project of several major offshore developers. This aspect is two-fold: 1) to ensure relevant priority in respect to the EERA-DTOC project development work on the design tool integration, 2) to set up selected scenarios for future large-scale offshore wind farm and produce series of results relevant for developers, strategic planners, etc.

Product Vision

A robust, efficient, easy to use and flexible tool created to facilitate the optimised design of individual and clusters of offshore wind farms.

A keystone of this optimisation is the precise prediction of the future long term wind farm energy yield and its associated uncertainty.

Robust, in the context of EERA-DTOC is understood to mean validated, stable, reliable, reproducible and technically convincing (e.g. would stand up to the scrutiny of an independent engineer during technical due diligence for project finance).

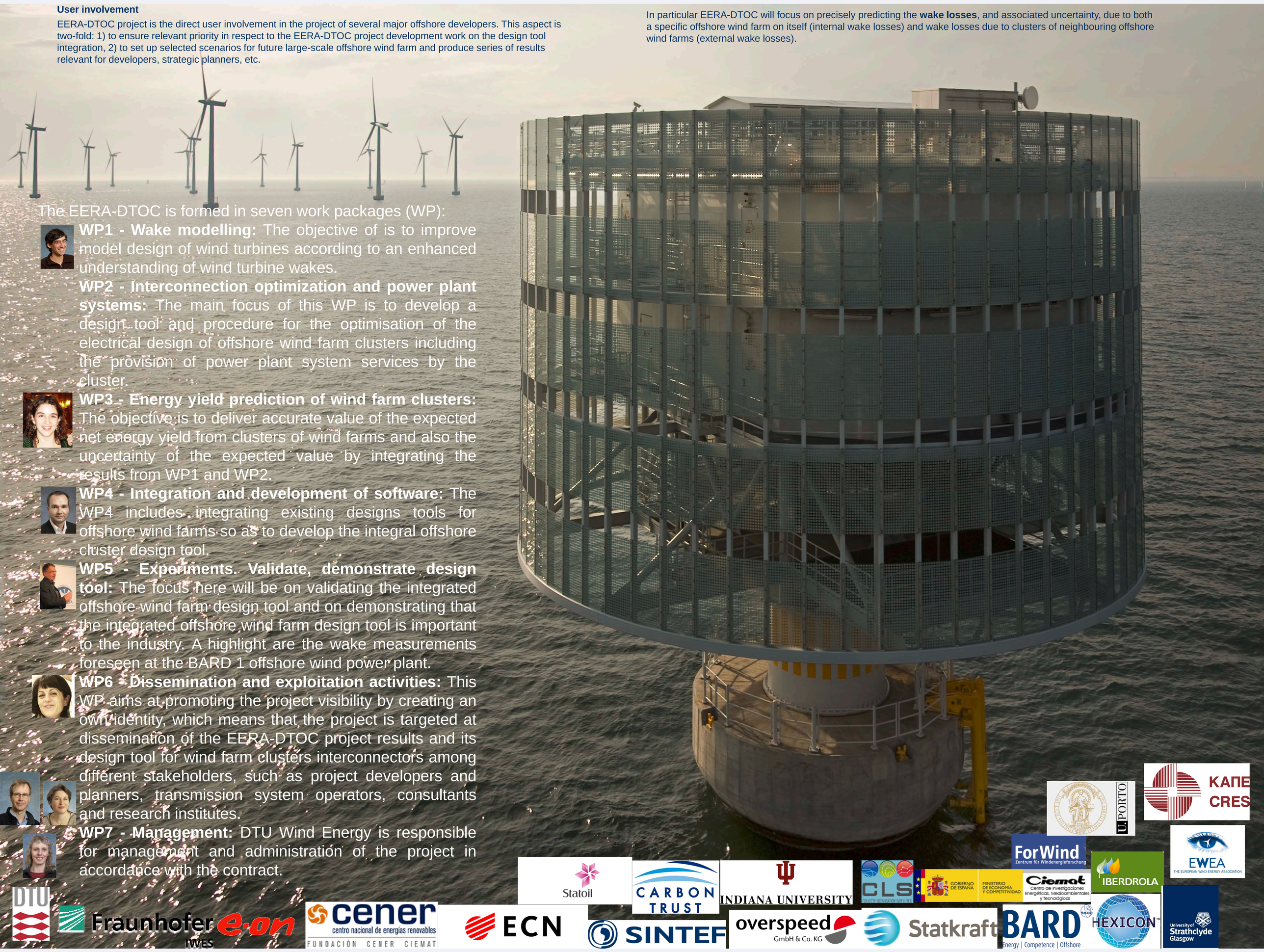
EERA-DTOC is to be built by integrating **existing models** (wake, grid, production etc.).

The design in question is that of the wind turbine **layout** (and/or wind farm clusters) and their associated electrical infrastructure. Design optimisation is with regard to the **total cost of energy** (including cost of finance). The EERA-DTOC tool will facilitate the optimisation process by supporting decision making through the efficient processing of many **design scenarios** for consideration in conjunction with separate cost/financial modelling tools.

At the individual wind farm level the anticipated users are primarily **developers** looking to optimise their specific wind farms subject to the influence of neighbouring wind farms.

At the cluster level the anticipated users are **strategic planners** looking to optimise the location of many offshore wind farms (and their associated electrical infrastructure) within a particular region.

In particular EERA-DTOC will focus on precisely predicting the **wake losses**, and associated uncertainty, due to both a specific offshore wind farm on itself (internal wake losses) and wake losses due to clusters of neighbouring offshore wind farms (external wake losses).



The EERA-DTOC is formed in seven work packages (WP):

WP1 - Wake modelling: The objective of is to improve model design of wind turbines according to an enhanced understanding of wind turbine wakes.

WP2 - Interconnection optimization and power plant systems: The main focus of this WP is to develop a design tool and procedure for the optimisation of the electrical design of offshore wind farm clusters including the provision of power plant system services by the cluster.

WP3 - Energy yield prediction of wind farm clusters: The objective is to deliver accurate value of the expected net energy yield from clusters of wind farms and also the uncertainty of the expected value by integrating the results from WP1 and WP2.

WP4 - Integration and development of software: The WP4 includes integrating existing designs tools for offshore wind farms so as to develop the integral offshore cluster design tool.

WP5 - Experiments. Validate, demonstrate design tool: The focus here will be on validating the integrated offshore wind farm design tool and on demonstrating that the integrated offshore wind farm design tool is important to the industry. A highlight are the wake measurements foreseen at the BARD 1 offshore wind power plant.

WP6 - Dissemination and exploitation activities: This WP aims at promoting the project visibility by creating an own identity, which means that the project is targeted at dissemination of the EERA-DTOC project results and its design tool for wind farm clusters interconnectors among different stakeholders, such as project developers and planners, transmission system operators, consultants and research institutes.

WP7 - Management: DTU Wind Energy is responsible for management and administration of the project in accordance with the contract.

The Science of Making Torque from the Wind: 9-11 October 2012, Oldenburg, Germany