NEWA Model-Chain Concept Statement

Objectives

NEWA will develop a new reference methodology for wind resource assessment and wind turbine site suitability based on a mesoscale to microscale mode-chain. This new methodology will produce a more reliable wind characterization than current models, leading to a significant reduction of uncertainties on wind energy production and wind conditions that affect the design of wind turbines.

Approach

The model-chain will be thoroughly validated across Europe with dedicated experiments and historical wind resource assessment campaigns from industry. A call for wind data has been launched to engage with potential data providers and establish the validation ground for the New EU Wind Atlas across the wide diversity of European wind climates and terrain conditions.

High fidelity experiments will be executed to address wind energy specific modeling challenges in complex and forested terrain, coastal transitions and offshore. A validation test suite will be generated to guide the model development and evaluation process as part of the IEA Task 31 "Wakebench" verification, validation and uncertainty quantification (VV&UQ) framework.

The reference model-chain code will be offered open-source together with best practice guidelines to help standardizing the methodology in industry. Outreach to the wind industry and the wider research community will be pursued throughout the project with end-users meetings (IEC 61400-15), thematic workshops (EWEA) and public model intercomparison benchmarks (IEA Wakebench).

As a result, the New EU Wind Atlas database will be published open-access, based on a publically available reference model-chain, whose credibility will be built upon strong sense benchmarks.

Features

The characteristics of the NEWA model-chain can be summarized as follows:

- *Multi-scale*: all the relevant scales for wind resource assessment and wind farm design will be considered, from large-scale climate and predictability to local-scale turbulence.
- *Multi-fidelity*: a range of modeling approaches will be tested, from linearized to Reynolds-averaged Navier Stokes (RANS) to large-eddy simulation (LES) models. Benchmarking activities will be tailored to determine which fidelity level is appropriate for which application.
- *Multi-license*: while the reference model-chain will be open-source, based on WRF (at mesoscale) and OpenFOAM (at microscale), other commercial and research codes will be also tested and made compatible to the NEWA approach.
- *Downscaling*: the core development in the model-chain will be interfacing between mesoscale outputs from the wind atlas and microscale inputs of wind farm design tools. One-way dynamic and statistical coupling methods will be evaluated both in terms of their physical insight as well as their adequacy to meet end-user needs.

- *HPC enabled*: the wind atlas production run will be executed in high-performance computing (HPC) facilities from European PRACE facilities. This is not only to cope with the intensive requirements of computational resources but also to create a hub for further research exploitation of the model-chain beyond the project duration.
- *Validated*: as important as the availability of the model-chain it will be to count with a well-established validation suite to quantify performance against other models using fit-to-purpose metrics, support training of end-users and identify knowledge gaps for the next generation of models and experiments.
- *Uncertainties*: the model-chain will include means to associate uncertainties to the variables of interest identified by end-user requirements
- *Open-access*: the model-chain open-source codes, documentation and validation cases will be publically available through open-access repositories like guithub.com (code), zenodo.org (citable documentation) and windbench.net (validation cases).
- *Wakebench framework*: integrating NEWA model development and evaluation activities in the wider international context of the IEA Task 31 offers the following benefits: complement the validation suite with existing and forthcoming validation cases from other projects linked to the IEA, outreach model development activities to a large community of researchers and end-users, adopt well-established model evaluation procedures/workflows, and contribute to a coordinated international framework that aligns research strategies to sustain an effective long-term development by leveraging research data.

Timeline

The following milestones will be followed throughout the NEWA project:

- March 2016 (M12): Model-chain and benchmark strategy defined
- March 2017 (M24): Open-source reference model v1.0 released
- March 2018 (M36): Model-chain installed in PRACE
- March 2019 (M48): Model-chain to wind atlas production run
- March 2020 (M60): Model-chain reference model (final version) and wind atlas validated

Expected Impact

The NEWA model-chain will enable a more meaningful link between meteorological models and wind farm design tools. This multi-scale interdisciplinary approach will allow a seamless characterization of the wind conditions across Europe, in terms of a homogeneous wind atlas and associated downscaling methods to drive wind farm design tools. As a result, there will be a more comprehensive assessment of wind characteristics by wind energy stakeholders, namely: spatial planners, policy makers, wind energy developers, wind turbine manufacturers and wind power utilities.

A well-documented and thoroughly validated open-access reference model will be the baseline for future research and development around wind farm design tools. This can be a key element in the standardization of wind resource assessment methodologies.

Hence, the NEWA model-chain will produce a more reliable wind assessment methodology by improving flow models and reducing user dependencies. Both will lead to reduced costs of uncertainty in project financing.