NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Meeting of Experts on

Mid-Fidelity Wind-Plant Modeling Tools

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Monday June 18, 2018
13:00 – 17:30
Politecnico di Milano, Campus Bovisa (exact room TBD)
Milan, Italy

Background and Motivation

Achieving wind cost-of-energy targets requires improved wind-plant (wind-farm) performance, component reliability, and wind power forecasting, together with reduced uncertainty, capital expenditures, and operation/maintenance costs. Attaining these goals is complicated by the multiphysics, multiscale, and multidisciplinary nature of the wind-plant design problem. Physically, wind-plant performance is driven by mesoscale to microscale interactions, atmospheric phenomena in the boundary layer including turbulence and stability, complex terrain effects, rotor wake dynamics and their interactions between wind turbines in an array, aero-elastic coupling, and individual wind turbine and plant-wide controllers. Furthermore, nonlinearities in the dynamics often necessitate time-domain analyses for obtaining accurate estimates of wind turbine power and structural loads.

Wind-plant design and optimization is an iterative, multi-step, model-based process. The first step relies on simulations of steady-state flow to optimize wind-plant layout through estimates of annual energy production. The next step consists of estimating instantaneous power at the turbines, along with their structural ultimate and fatigue loads. Currently, computational requirements preclude full-plant simulations from being performed for thousands of scenarios in which atmospheric and turbine operation conditions are dynamically varied. As an alternative, simulations are either performed for a single turbine using aero-servo-elastic codes, or a handful of scenarios are simulated with computationally intensive, high-fidelity models. The ability to perform many load-resolving simulations for the entire plant using mid-fidelity wind-plant modeling tools is critical to future wind-plant design.

Mid-fidelity wind-plant tools lie between the two extremes of low-fidelity, inexpensive engineering solutions and high-fidelity, computationally intensive models. They represent a compromise in accuracy and cost, and when combined with low- or high-fidelity tools they are increasingly able to address the challenges in wind-plant design and analysis. Their low computational cost compared to high-fidelity models better supports the often highly iterative and probabilistic design process, and they can therefore be applied to the wind-plant siting and

the wind turbine design processes as the load-resolving complement to the less expensive, steady-state, optimization models that are used for the initial optimization step.

Several groups within academia, research laboratories, and industry are continuously investing in the development of models of various fidelity levels for wind energy applications. To make the most out of this investment, and to ensure that the tools being developed are useful across a wide range of applications and to many users, it is important for the model-development community to come together and discuss the state-of-the-art in these tools, and to come to an agreement on the general direction of their efforts.

Objectives

The main objective of the proposed meeting is to obtain a clear sense of current capabilities and future development needs for mid-fidelity wind-plant engineering tools, consensually among a large group of international experts.

Intended Participation

Participants will include representatives from academia, research laboratories, and industry with expertise in mid-fidelity wind-plant tools, as well as experts in low- and high-fidelity modeling and experimentation so that the complementary and cooperative nature of wind-plant modeling across scales can be discussed.

Expected Outcomes

By the end of the meeting, participants will have collaboratively:

- Identified the present role of mid-fidelity tools within the wind energy model hierarchy and within the context of ongoing developments in other areas (e.g., low- and high-fidelity modeling, experimental measurements)
- Drafted a list of needs and benefits regarding future developments and discussed their relative priorities
- Identified potential paths for achieving the desired goals

An additional outcome is the potential development of new collaborations among participants.

Tentative Agenda

13:00 – 13:30	Introduction of Participants, Including a One-Slide Overview per Attendee
13:30 – 13:45	Meeting Overview and Objectives
13:45 – 14:00	Introduction to Break-Out Session 1
14:00 – 15:00	Break-Out Session 1: The Current Landscape of Mid-Fidelity Tools
15:00 – 15:15	Coffee Break
15:15 – 15:30	Introduction to Break-Out Session 2
15:30 – 16:30	Break-Out Session 2: The Future of Mid-Fidelity Tools
16:30 – 17:30	Group Discussion on the Break-Out Sessions

Please RSVP

This half-day meeting will take place on Monday June 18, 2018 from 13:00-17:30 at the Politecnico di Milano, Campus Bovisa (exact room TBD) in Milan, Italy. Note that the

international conference “The Science of Making Torque from Wind” (TORQUE 2018) will take place on June 20-22 at the same venue; our hope is that the combination might help justify the travel investment. Those interested in attending the meeting should RSVP to Paula Doubrawa at paula.doubrawa@nrel.gov by May 28. Further details on the meeting will be forthcoming and we do hope that you will be able to attend.

If you cannot attend yourself, please forward this invitation to someone you think would be a knowledgeable alternate for yourself.

Sincerely,

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