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Wind Plant Optimization and Systems Engineering

# Wind Plant Optimization and Systems Engineering Newsletter: Third Quarter, Fiscal Year 2013 (Inaugural Edition)

**July 24, 2013**

This is the first issue of the Wind Plant Optimization and Systems Engineering Newsletter. If you want to receive more issues of this newsletter, please sign up for the newsletter. If you do not, you will not receive any more emails related to this newsletter.

The Wind Plant Optimization and Systems Engineering Newsletter series from the National Renewable Energy Laboratory (NREL) Wind Energy Systems Engineering Initiative highlights current system approaches to the wind energy research, design, engineering, and development. Each quarterly edition provides short overviews of the integrated, interdisciplinary, and holistic work that is happening in this field. The wind industry community increasingly recognizes the need for a systems approach, and this newsletter serves to support stakeholders who engage with this important work.

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## News from researchers and practitioners

### New 10-MW Reference Turbine Model Introduced

**Table 1: Overall 10 MW Reference Turbine Model Characteristics**

| | |
|---|---|
| Nominal Power | 10.0 MW |
| Rotor configuration | Upwind, 3 blades |
| Control | Variable speed, collective pitch |
| Rotor diameter | 178.3 m |
| Hub height | 119.0 m |
| Rated tip speed | 90 m/s |
| Blade pre-bend | 3.3 m |
| Tower mass | 628.4 tons |
| Nacelle mass | 446.0 tons |
| Rotor mass | 230.7 tons |
| Blade mass | 41.7 tons |

*Source: DTU Wind Energy*

The Technical University of Denmark (DTU) has released an open source design for a 10-megawatt (MW) Reference Wind Turbine (DTU 10-MW RWT). The intended use of DTU Wind Energy's reference model is to enable benchmarking for wind turbine design tools, such as high fidelity computational fluid dynamics, finite element codes, blade element momentum (BEM) design codes, and aeroelastic tools. Therefore, detailed descriptions of geometry, CFD meshes, and structural layup are being made publically available. The turbine has a traditional three-bladed upwind layout with overall characteristics as shown in Table 1. The DTU 10-MW RWT has been chosen as a reference turbine in two large EU-funded projects, INNWIND.EU and MareWint. For more information, see the

DTU 10-MW Reference Wind Turbine Project Site or contact Christian Bak or Frederik Zahle.

### CU-WTDTF to Present Model Development Update

Clemson University's Wind Turbine Drivetrain Testing Facility (WTDTF), which is partially funded by the Department of Energy, has been actively engaged in system level dynamic modeling and analysis in support of upcoming commissioning activities. At present, models exist for the drive system and its associated control system, the reduction gearbox, the load application unit and its associated control system, as well as a wind turbine nacelle or unit under test. These coupled models may be analyzed in the time or frequency domain. A description of the modeling strategy and some preliminary results will be presented at the 2013 ASME Dynamic Systems and Control conference being held October 21–23 in Palo Alto, California. Contact Ryan Schkoda, Ph.D., for more information.

### Wind Turbine Design Software Evolves for New Technology

For more than a decade, FOCUS has been used by the international wind turbine industry to design, validate, and optimize wind turbines. The current version, FOCUS6, is an integrated software suite for designing wind turbines and components, like rotor blades. FOCUS6 provides a consistent user interface that integrates a number of aerodynamic and structural wind turbine design modules and automatically manages the data and calculations. These modules are developed by Knowledge Centre WMC and ECN. FOCUS6 has an open architecture allowing embedding user tools within FOCUS6, or to integrate FOCUS6 within external tools. In the 2nd half of 2013, a new interactive offshore support structure pre- and post-processing module will be released. In addition, this release features an updated structural blade design module (improved modeling of pre-bend and aft-swept blades, cross section modeling and FEM export).

### DTU and NREL Develop FUSED-Wind

DTU Wind Energy and NREL are developing a new Framework for the Unified System Engineering and Design of Wind Plants (FUSED-Wind). This framework provides a standardized way for integrating wind turbine and plant models with NASA's Open Source Multidisciplinary Analysis and Optimization (OpenMDAO) software. FUSED-Wind is being developed as a software component that is directly integrated into OpenMDAO for streamlined interconnection and exchange of wind turbine and plant models. A set of classes and variable containers help provide a standard way of connecting models of the same function to the overall framework. In addition, the overall generic turbine input data structure works with the input data structures of both DTU Wind Energy and NREL wind energy models for easy exchange. Various wind turbine and plant models created and used by DTU Wind Energy and NREL are wrapped using the framework so that, as an example, the exchange of one aero-elastic code for another can be made. Additional details will be available in the near future. For more information, please contact the National Wind Technology Center's Systems Engineering Initiative or DTU Wind Energy.

### A New Collaborative Framework for Wind Farm Wake Models

DTU has developed a collaborative framework for system engineering of wind farm wake models. The purpose is to atomize the workflow of wind farm wake models in order to allow more consistent and effective MDAO techniques, such as uncertainty quantification, multi-fidelity optimization, data acquisition (model recalibration, machine learning), and model averaging. The open source framework, which is based on Python, OpenMDAO, and FUSED-Wind, is meant as a collaborative tool between researchers and is intended to be "industry-ready" to reduce the gap between research and industry. The framework is currently in alpha version. Please contact Pierre-Elouan Réthoré for more information or with interest in collaboration.

## Conferences and Workshops

Several conferences and workshops from this past year highlighted wind plant optimization and systems engineering work. A few recent conferences include:

- The 10th World Congress on Structural and Multidisciplinary Optimization (WCSMO) took place on May 19–24 in Orlando, Florida. Wind-related presentations included topics such as wind plant layout optimization, multidisciplinary optimization of wind turbine component design, and overall turbine design.
- The 2013 International Conference on Aerodynamics of Offshore Wind Energy Systems and Wakes (ICOWES) took place June 17–19 in Copenhagen, Denmark. Interesting multidisciplinary works involved control strategies for wake mitigation, integrated airfoil and blade design, and fatigue loads from a wind farm perspective.

Several upcoming conferences feature opportunities to present and attend presentations on wind plant optimization and systems engineering. To organize a meet-up for interested persons at one of the upcoming events or to notify us about relevant upcoming events, please e-mail the Systems Engineering Initiative.

- The North American Wind Energy Academy (NAWEA) 2013 Symposium: August 6–7, 2013, in Boulder, Colorado, USA
- 2013 Wind Plant Reliability Workshop: August 13–14, 2013, in Albuquerque, New Mexico, USA
- AWEA Offshore Windpower 2013 Conference and Exhibition: October 22–23, 2013, in Providence, Rhode Island, USA
- EWEA Offshore 2013: November 19–21, 2013, in Frankfurt, Germany
- AGU Fall Meeting: December 9–13, 2013, in San Francisco, California, USA. Call for abstracts closes August 6, 2013.
- AIAA SciTech 2014: 10th AIAA Multidisciplinary Design Optimization Specialist Conference/32nd ASME Wind Energy Symposium: January 13–17, 2014, in National Harbor, Maryland, USA. Call for papers now closed.
- EWEA 2014: March 10–13, 2014, in Barcelona, Spain. Call for abstracts closes October 13, 2013.
- AWEA Windpower 2014 Conference and Exhibition: May 5–8, 2014, in Las Vegas, Nevada, USA. Call for abstracts not yet open.
- 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference: June 16–20, 2014, in Atlanta, Georgia, USA. Call for papers not yet open.
- The Science of Making Torque from Wind 2014: June 18–20, 2014, in Copenhagen, Denmark. Call for abstracts not yet open.

## Contribute to this Newsletter

We invite all researchers and practitioners to submit their own contributions (up to 100 words along with any weblinks) to share with the greater community. The key requirements are that the work represents a true integrated, interdisciplinary and preferably holistic approach to wind energy research, design, engineering, and development. Contributions highlighting research, software, or technology development are all welcome. We recognize that, for our industry colleagues in particular, sharing information via this forum may be difficult. However, if there is a recent press release or publication that can be highlighted and referred to, we are happy to share that information as well. We would also like to highlight upcoming relevant conferences and workshops. Please send contributions to systems.engineering@nrel.gov.

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