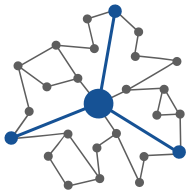

IRPWind

Integrated Research Programme on Wind Energy

Project acronym: IRPWIND
Grant agreement nº 609795
Collaborative project
Start date: 01st March 2014
Duration: 4 years

IRPWIND Infra-Structure project **ScanFlow**

Work Package 3

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Lead Beneficiary: DTU (DTU and ECN)
Delivery date: February 2017
Dissemination level: Public

The research leading to these results has received funding from the European Union Seventh Framework Programme under the agreement GA-2013-609795.

IRPWIND Infra-Structure project: ScanFlow

Full title:

High-resolution full-scale wind field measurements of the ECN's 2.5 MW aerodynamic research wind turbine using DTU's 3D WindScanner and SpinnerLidar for IRPWind's and EERA's benchmark (ScanFlow)

Participants: DTU and ECN
Facility: ECN test site

Executive summary

In the framework of the IRPWind 1st call for joint experiments DTU and ECN have executed the ScanFlow project. Aim of the project is to establish a unique turbine power performance and induction zone benchmark experiment by operating a DTU developed high-resolution nacelle integrated 2D SpinnerLidar installed at a 2.5MW ECN research wind turbine. The benchmark will be available through an open access e-science platform also beyond project time.

In order to meet this objective a measurement campaign was carried out from the 16th of December 2016 until the 20th of February 2017 comprising meteorological mast measurements, ground- based vertical profiling lidar measurements, turbine SCADA data, SpinnerLidar measurements and short-range WindScanner measurements. The SpinnerLidar operated from December 16th to 28th, 2016 (stopped due to power loss) and from January 16th to February 16th, 2017. All other instruments except the ground-based WindScanners worked continuously. The short-range WindScanners have been measuring during mid-January 2017 to mid-February 2017 when the wind direction was appropriate, i.e. in between 185° and 245°. These events occurred on January 29th, February 4th and 5th, 2017.

All data are publically available and can be downloaded via the website www.irpwind-scanflow.eu. Here, in the tab 'Download' clear instructions are provided.

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1. Description of the work and major results

The project was granted end of May 2016 and officially kicked-off in June 2016. The first and second work packages were on the preparation of the scanners and the preparation of the campaign, respectively. Because of instrumental issues and other project obligations, the DTU scanners were ready for the experiment (D1) beginning of December 2017. A draft version of the measurement plan (D2) was ready in September 2016 (final version January 2017). The SpinnerLiDAR was installed on the 17th of December 2016 and the short range scanners were installed on the 18th of January to the 20th of January 2017. On the 17th of February 2017 the SpinnerLiDAR was dismantled (M2) and on the 20th of February the short range scanners were dismantled (M1).

The final dataset is being made available via the website www.irpwind-scanflow.eu (M3) with clear download instructions. This website was announced at the DeepWind conference 2017 (D4). The project as whole was presented at the IRPWind conference 2016 and the DeepWind conference 2017 and finally reported in IRPWIND final report and in this summary report (D5). The final report also contains a section on post-processing and proof of concept (D3).

Additional external communication is achieved via the IRPWind newsletter, a DTU news item and an ECN news item.

2. Compliance to the expected results, KPIs and the advancement of TRL according to the application

The deliverables, milestones and KPIs have been met and are depicted in the table below.

The proposal indicates that the used facilities, i.e. the ECN test site and WindScanner.dk, have TRL 9 and 8, respectively. Although, these TRLs have not changed in this project, nor was this promised, significant experiences in the use of the facilities have been gathered. The proposed measurement concept was indicated to be TRL 6 and because cooperative inflow measurements with all scanners used, was achieved, this TRL has gone up one step, i.e. TRL 7. It is expected that the research users of this project, i.e. inflow wind field research, induction zone research and aerodynamic research, indicated to be TRL 3-6, will be enhanced. However, because this is outside the scope of the ScanFlow project, this enhancement cannot be quantified.

Planned project results	Achieved	Comments
KPIs/Milestones		
6 weeks of SpinnerLidar measurements	Yes	
2 weeks of short-range WindScanner measurements	Yes	
6 weeks of turbine, meteorological mast and ground-based vertical profiling lidar data	Yes	
Public database	Yes	Download scheme in www.irpwind-scanflow.eu
Deliverables		
D1: SpinnerLidar and short-range WindScanners ready for experiment	Yes	
D2: Measurement plan published	Yes	ECN-Wind-2017-010 [14]
D3: Report on experiment and proof of concept	Yes/Alternative solution	The report on the experiment and the proof of concept is part of the IRPWIND ScanFlow final report.
D4: Final workshop	Alternative solution	The public database is announced at the DeepWind 2017 [15] conference and in the IRPWind newsletter [16]. It is made available via the website www.irpwind-scanflow.eu with clear instructions and project information.
D5: Final project report	Yes	IRPWIND ScanFlow 4-page final report (this report)

3. Description of the benefit for the IRPWind and EERA programme

The suggested experiment using the research wind turbine facility at ECN test site in combination with the newly developed WindScanner research infrastructure at DTU combine efforts within WP3 of the IRPWIND core project. The links to the EERA Wind Energy sub-programmes 'Aerodynamics' and 'Wind Conditions' are very strong. In both Sub-programs there is high priority on improved inflow wind fields measurements and modelling. Within 'Aerodynamics' sub-program new types of data, e.g. from WindScanner, are particularly important for understanding atmospheric flow and aerodynamics for very large rotors. Flow at large wind turbines but without accessible WindScanner data are investigated in the on-going EU AVATAR project as well as EU INNWIND. Within 'Wind Conditions' the coupling between meso- and micro-scale models and the progression from siting to loads are very important

challenges. Specifically, the ScanFlow measurements on flat land are complementary to the New European Wind Atlas (NEWA) ERANET project that has focus on detailed inflow description in complex terrain and coastal areas.

4. Future perspectives and research

The experimental database is expected to be used for analysis by researchers in IRPWIND, EERA and beyond both in science and education. More specifically the research on SpinnerLidar data for inflow conditions is expected. Also the comparison of 3D WindScanner and SpinnerLidar data will be of particular interest in the wind energy community dealing with nacelle lidar data to further progress insight to the novel methods of full scale detailed fast data.

5. Availability of databases and the level of openness to other parties

Signals that exist in the database are turbine SCADA data, meteorological mast data and ground-based vertical profiling lidar data both in 10 minute averages as well as high frequency. SpinnnerLidar exist in the database in sampling rate of exactly 400.2305328 Hz. The short-range WindScanners periods are listed in the table.

Run [-]	Start (YYYY-MM-DD HH:MM:SS)	End (YYYY-MM-DD HH:MM:SS)
1	2017-01-29 02:09:35	2017-01-29 13:00:00
2	2017-02-04 02:56:11	2017-02-04 06:00:00
3	2017-02-05 07:12:03	2017-02-05 17:00:00

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6. Expected publications

It is expected that analysis on anti-Cyclop buster will be published. This is unique novel comparison and validation results. Furthermore inflow observed with SpinnerLidar at large wind turbine jointly with all necessary ancillary data is very likely to be published.

7. Dissemination activities

Below an overview is provided:

- IRPWind conference 2016 in Amsterdam (NL) during the Research Facilities session the ScanFlow project was orally presented.
- DeepWind 2017 conference in Trondheim (NO) the ScanFlow project and the ScanFlow Public database.
- IRPWind newsletter
- ECN news item
- Website www.irpwind-scanflow.eu

Acknowledgements

The work described here has received support from IRPWind, a project that has received funding from the European Union's Seventh Programme for Research, Technological development and Demonstration.