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TotalControl

Advanced integrated supervisory and wind turbine control for optimal operation of large Wind Power Plants

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Author(s) information (alphabetical):		
Name	Organisation	Email
Gregor Giebel	DTU	grgi@dtu.dk

Acknowledgements/Contributions:		
Name	Name	Name
ORE Catapult	KU Leuven	Vattenfall

Document information

Version	Date	Description			
			Prepared by	Reviewed by	Approved by
1	31.12.2019	Name	Gregor Giebel		Gregor Giebel

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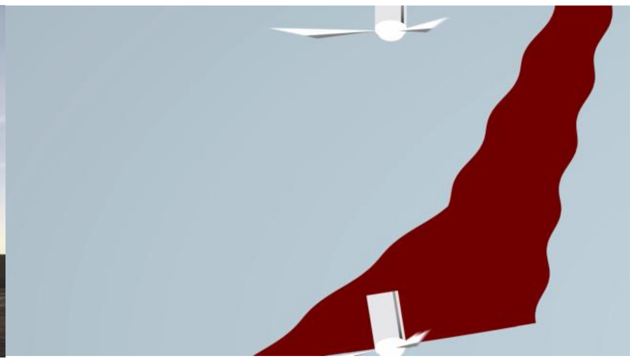
Executive summary

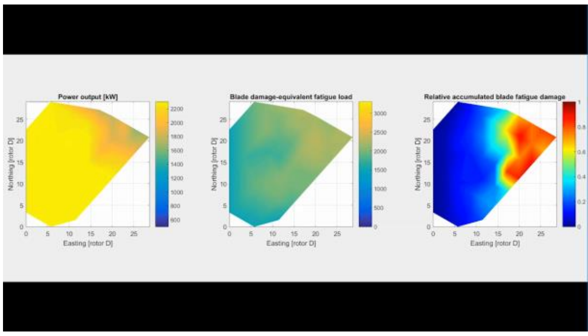
As part of the TotalControl dissemination work package, four short videos will be produced during the four years in which the project is running. This deliverable is the second project video. After the first video gave an overview of .

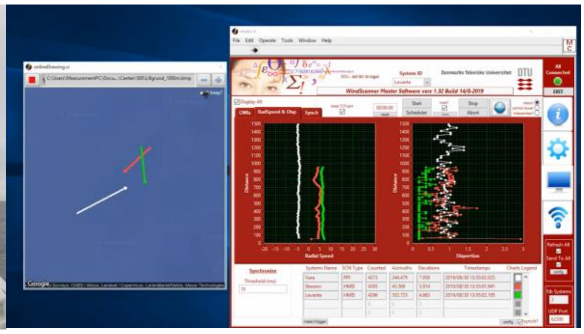
The project video is available at the TotalControl project website and can be accessed through the link on the project website (http://www.totalcontrolproject.eu/dissemination-activities/videos) or from its link on the DTU Wind Energy YouTube channel (https://www.youtube.com/watch?v=tw5CtOXWMhk).

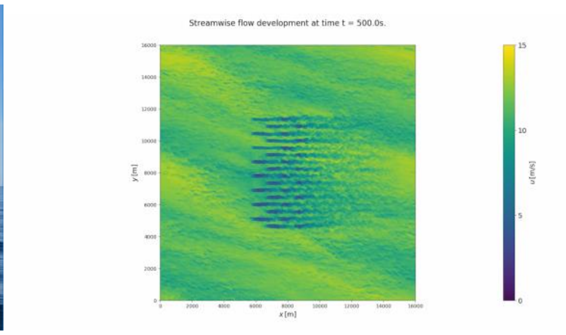
Due to the limitation on file size, the video is not uploaded to ECAS as deliverable. Instead, one will find a compilation of still images from the video below. Interested parties are encouraged to visit the website and see the video.

Screenshots from the video









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SPEAK

The aim of the TotalControl project is to orchestrate collaborative behaviour of the turbines in a wind farm: getting the wind farm to be more than just the sum of the turbines.

Therefore, we're working on a wind farm controller to increase the total power and decrease the loads on the turbines, through clever management of the wind flow.

This controller needs to be verified, and work together with the individual turbine controllers.

We're doing this by measuring the effect on a full-scale offshore wind farm, Vattenfall's Lillgrund wind farm between Copenhagen and Malmö.

The new turbine controller will be tested at ORE Catapult's test turbine in Levenmouth, a Samsung 7MW turbine.

The turbine controller needs to be adjusted in order to play together effectively with the new wind farm controller.

We measure this with advanced laser equipment, a so-called Lidar. It measures the speed of small particles suspended in the air, and can therefore measure the wind velocity at any point within a range of several hundred metres.

One lidar was mounted on the nacelle pointing forwards, another one is pointing backwards. In this way, we can measure the incoming wind and the effect of the turbine and turbine controller on the outgoing wind, the wake.

Since the lidar is positioned on the nacelle, which turns with the wind, the beams always look ahead and behind.

The aim of the new turbine controller is to adjust the angle of the blades and the rotational speed of the turbine to extract the required amount of energy while letting as much air through as possible, to be used by the next turbines.

We will also test the behaviour of the wake in yawed conditions, when the rotor disk is not perpendicular to the incoming wind. In those situations, the wake is deflected away from the turbines behind.

Working in a yawed condition changes the load pattern on the turbine. We will measure the impact of the changed loads, so we can calculate the lifetime of the turbine.

We have models to estimate the effect, and have used those models to develop the turbine controller.

Here you see the gradual buildup of the blade root damage equivalent loads at the back of the wind farm, which is due to wake effects.

The effect of the new controller is measured by switching the controller on and off in a predefined sequence.

From the difference in behaviour at a given incoming wind speed, we can figure out whether the controller does what we think it should do.

In the full-scale wind farm Lillgrund, we installed three wind lidars to determine the wakes in the farm.

We use scanning lidars, which have a steerable head and can measure the wind up to several kilometres away.

For the measurement campaign, we deployed one scanning lidar looking into the wind, and two looking in detail at the wakes within the wind farm.

Where the two beams intersect we can determine more details of the wind.

By correlating the incoming wind with the measured wakes, we can learn about some of the details we can use to further develop the wind farm flow models.

This allows us to develop the wind farm controller, and to predict its actions within the wind farm.

At the end of the project, the developments will be part of an open-source toolbox.

TotalControl is a four-year research project funded by the European Commission under Horizon2020. 8 partners from 5 countries provide a mix of academia, manufacturers and wind farm operators.