# Dynamic robust wind farm control

**Publieke samenvatting / Public summary**

The PPP-toeslag project Dyscon stands for Dynamic robust wind farm control. The main objective of the project was to develop the next generation of active wake control algorithms. Such development is of fundamental importance for industry due to the current slow adoption of the active wake control in current offshore wind farms. Slow uptake is due to the higher uncertainty that exists in the current state of the art approach, which consist in a static optimisation that yields a Look Up Table (LUT) for a combination of wind characteristics (speed, direction).

In order to develop the next generation of active wake control algorithms, TNOs wake model, FarmFlow, was first developed and adapted to allow dynamic simulations. A new near wake model was developed for FarmFlow, which was then validated against wake measurements. A good match between model and measurements was found, showing a good comparison with the wake deflection profile and velocity deficit. The results of this validation exercise can be found here. A new simulation software was then developed where FarmFlow could be simulated with realistic wind conditions, varying in space and time.

The dynamic robust wind farm control algorithm was then developed and implemented. Uncertainties in the wind and farm operation were considered and it was found that wind direction, yaw error, turbulence intensity and the wind velocity were the most important quantities to include in the robust active wake control optimisation. A dynamic adaptation of the algorithm

**Projectinformatie / Project information**

**Projectnummer / Project number**
TKITOE_WOZ_2002_TNO_DysCon
**Subsidiebedrag / Grant amount**
€ 272.500,00

**Algemene informatie / General information**

**Penvoerder / Secretariat**
TKI

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was then implemented, considering a low pass filter, a hysteresis and a sample and hold mechanism, whose parameters were optimised through simulations.

With a realistic case study, it was shown that the developed dynamic robust active wake control algorithm can result in a large reduction of the loading on the yaw drive while at the same time improving the overall power gain, as compared to the conventional nominal active wake control. It was seen that the robust active wake control solution significantly improved over the nominal active wake control in terms of both power gain (2.05% vs 0.56% increase) and yaw duty (around 30-50% lower). Furthermore, the results showed that although the dynamic version increases the yaw duty (factor of 2.5-2.7 higher), the number of start/stop events is less significant (10-50%). The results of this case study is available in the form of a pre print here.

In parallel, another objective of the Dyscon project was the development of a validation methodology to assess the benefits from active wake control from full scale experiments. This methodology requires only data from the Supervisory Control and Data Acquisition (SCADA) system and deals with the many challenges that arise from such a campaign. The methodology is available here and the mathematical details are fully clarified here. The methodology was applied to a one year data set from a pilot project campaign where active wake control was tested in the offshore wind farm Sandbank, a wind farm comprising 72 turbines and located in the north of Germany.

The results of this project contribute directly to the creation of more value from offshore wind energy. It is shown that the dynamic robust active wake control algorithm approach leads to increased power production when compared to the static approach, leading to increase in Annual Energy Production of offshore wind farm assets. Furthermore, performing dynamic simulations where uncertainty is considered as well as having a robust methodology to validate gains from wind farm control - which has been tested on a one of a

kind data set from the pilot project campaign - strengthen the business case of active wake control, incentivising the faster adoption of such solution by industry and increase Annual Energy Predictions from wind farm assets owned by different parties across the world.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.
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