



WHEN TRUST MATTERS

# Wind Farm Control Latest news

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WindDenmark conference, Herning

05 October 2021

# How did we get to here?

- R&D in academia and industry (including DNV)
- Funded research projects, like Farmconners, TotalControl, CL-Windcon, OWP control etc
- First moving developers, owners and manufacturers

# Today's menu

- What is WFC?
- Results!
- What is Bankability?
- The steps towards bankability
- What about certification?
- Position paper
- JIP...



# Controlling wind farm wake interactions



• Reduced power!  
• increased loading!  
Switch this turbine off?

Or reduce the power set-point of this one?

Or maybe yaw the turbine slightly to steer its wake away from the next turbine?

1. What is the optimum\* distribution of power and yaw set-points for all the turbines, in this wind condition?
2. How can we maintain optimum\* performance in dynamically changing circumstances?

\* Optimum has to be defined – depends on energy and loading

# Wind Farm Control

## What<sup>1</sup>

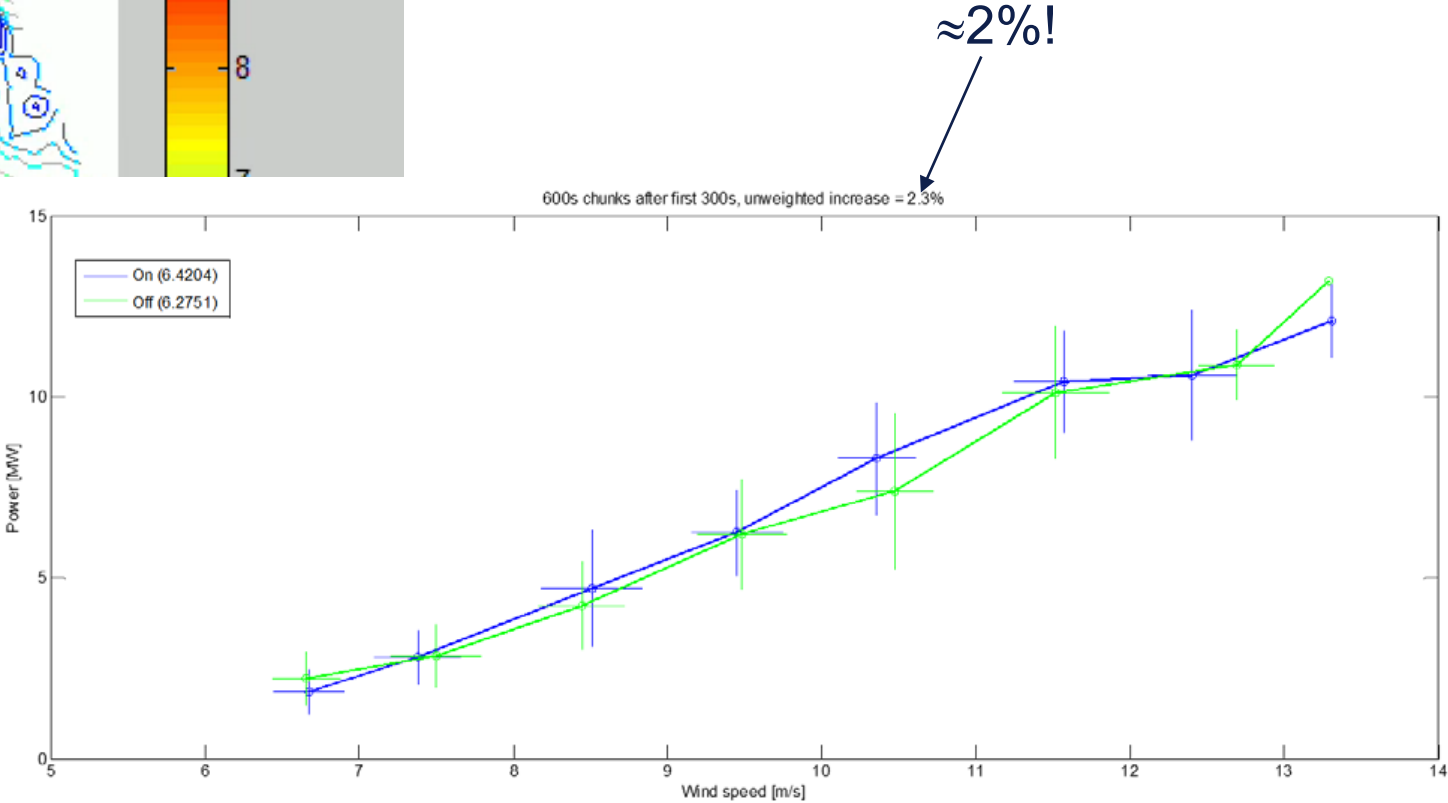
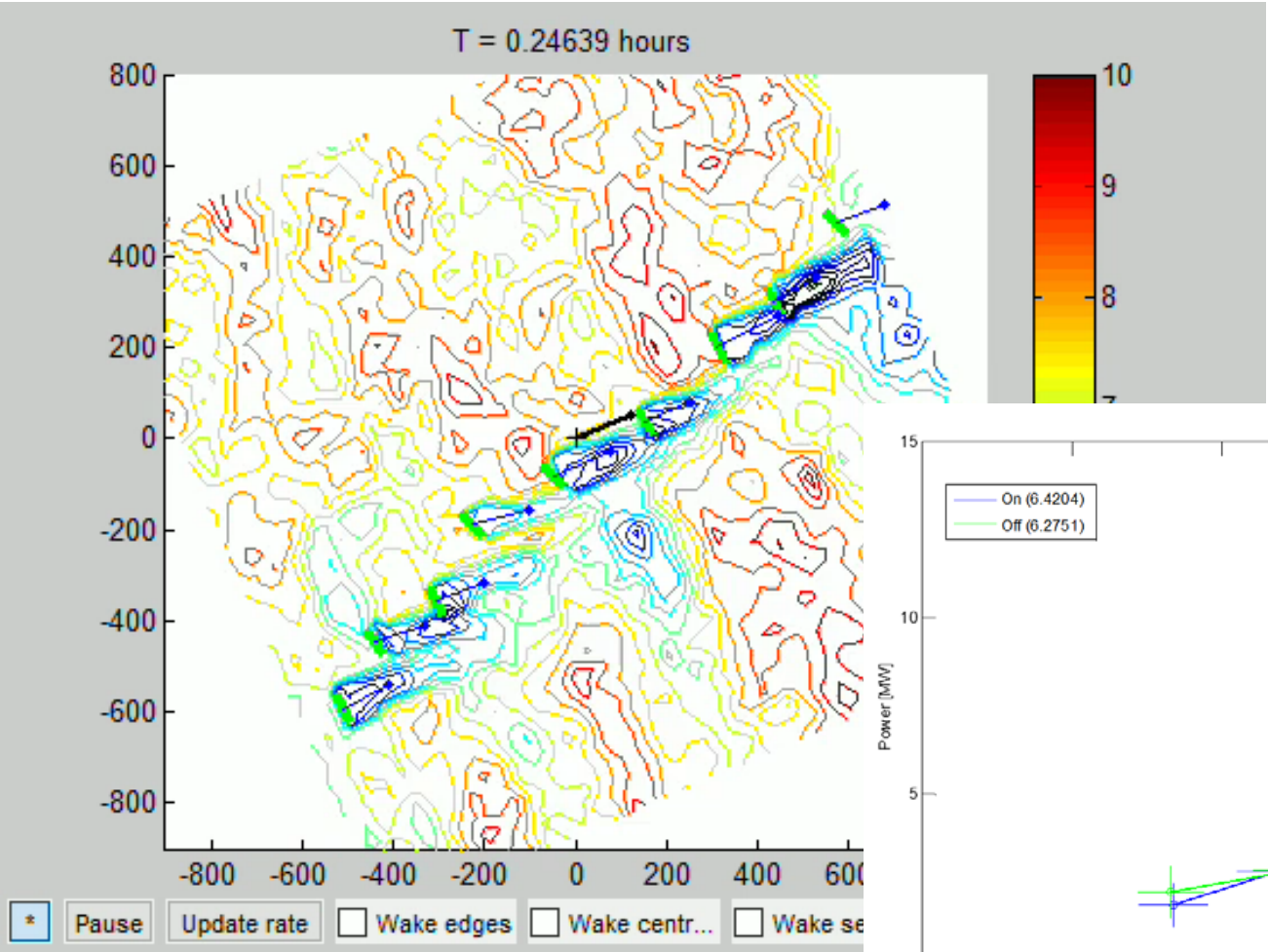
- Wake steering
- Induction control

## Why

- Increased revenue from generation
- Reduction in operational turbine loading
- Extension of the life of the wind turbines

<sup>1</sup> Wind farm control, Group Research & Development white paper 2018 <https://www.dnvgl.com/publications/wind-farm-control-133013>

# It works!



# How?

- Obtain necessary permissions (including loads analysis and OEM agreement) for trial
- Develop and test algorithm
- Implement algorithm
- Run test
- Evaluate and analyse results

# Validation: Toggle test

Hard (impossible!) to find two identical wind farms in identical conditions to test the WFC

So..

Do a toggle test, ie toggle between

WFC ON

WFC OFF (baseline)

Toggle interval eg 35 mins up to 5 h, depending on the case



# What is the next step then?

- More examples of implementations
- More verifications of models
- **WFC needs to be Bankable!**

# Bankability

Bankability can broadly be defined as the **willingness of an established financial institution to finance a project at a reasonable interest rate**. The decision to invest in a given technology will typically be taken once a certain level of confidence is reached, proven track record is observed, and suitable contractual risk coverage is in place.

*Not for DNV to assign bankability to any given project*

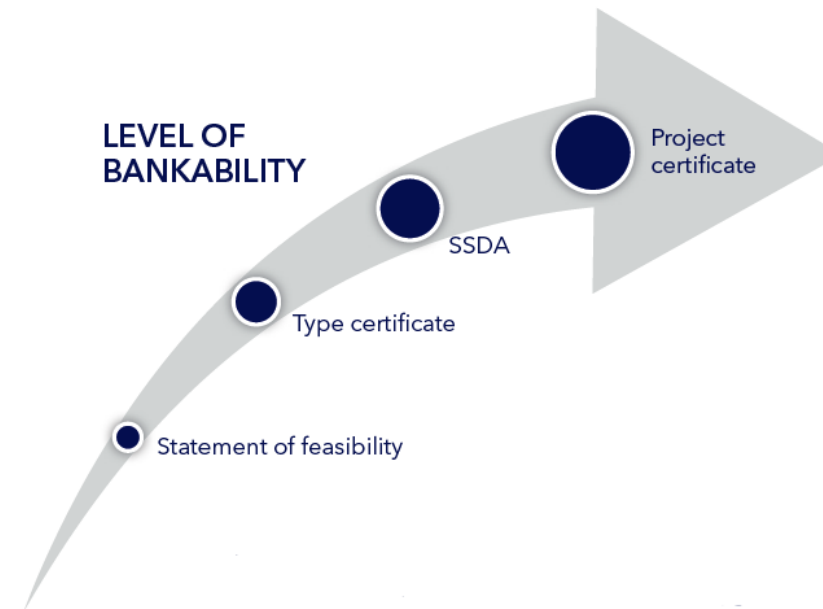
# Steps towards bankability

- DNV framework:
  - pre-qualified
  - qualified
  - commercially proven



# Certification

- Currently, no designated design standard for wind farm control exists prescribing detailed requirements for certification
- However, certification approaches such as measurement-based assessment or risk-based assessment exist and can be applied for wind farm control certification to achieve comparable safety levels to usual standards



# Position paper just out!

<https://www.dnv.com/Publications/wind-farm-control-198162>



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## WIND FARM CONTROL: THE ROUTE TO BANKABILITY

POSITION PAPER



Authors: Mattia Boccolini, Ervin Bossanyi, Stefanie Bourne, Axel Dombrowski, Giuseppe Ferraro, Keir Harman, Matthew Harrison, Nikolai Hille, Lars Landberg (editor), Tom Levick, Andreas Manjock, Tony Mercer, Anja Neubert, Renzo Ruisi, Nicholas Skeen

# JIP

- Duration: 2 years
- No of partners: >10
- Set-up: work packages (can be confidential)
- Output: report

*Please join, starting soon!*



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## WIND FARM CONTROL: JOINT INDUSTRY PROJECT

DNV calls on the industry to help evaluate wind farm control



### Objectives

In early 2021 DNV issued a position paper which detailed the necessary steps towards making wind farm control (WFC) bankable. Our report showed that more evaluations of wind farm control implementations in operating wind farms were needed. The objective of this Joint Industry Project (JIP) is to bring together the industry to carry out a number of evaluations of WFC on operating wind farms. The evaluations will follow a well-defined protocol, including the so-called "toggle tests", to make the results repeatable and firm. The evaluations will use several industry-leading simulation tools in order to compare and contrast these. Certification aspects of all elements of WFC will be addressed on a by-project basis, including example certification.

### Benefits

Each JIP partner will benefit from the following:

- Analysis and evaluation of existing data from WFC trials
- Where applicable, a WFC algorithm to be implemented at a wind farm during the project including evaluation and analysis of the resulting data
- Insight into and an opportunity to demonstrate WFC algorithm design
- An understanding of the certification process related to WFC.

The specific results will be kept confidential; however, general conclusions will be reported more widely. JIP partners will agree on access to data, be invited to workshops, and have influence on the direction of the JIP.

### Deliverables

The main deliverable will be a report detailing the findings from the WFC evaluations. The report will include a full case study, including design, implementation, validation, and certification. The report will also include a comparison of the state-of-the-art WFC simulation tools used in the evaluation. At the request of the JIP partners this report can be either public or limited to the partners. Each partner with data that has been analysed will also receive a detailed - confidential - report, detailing the evaluation for their specific site(s).

### Partners

This JIP is open to all partners with an interest in WFC.

### Questions and contact

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WP1: Coordination  
WP2: WFC development, implementation and analysis  
WP3: WFC models  
WP4: Certification aspects of WFC  
WP5: Reporting/dissemination/webinars

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# Summary & Conclusion

- What is WFC?
- Results!
- What is Bankability?
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# Questions?

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# Pre-qualified

A technology shall enter pre-qualified stage when:

- The technology supplier is able to **simulate** the implementation and impact in terms of energy and loading of wind farm control and the methodology should be accepted by at least one established independent party
- **Robust and repeatable** modelling techniques are demonstrated by the supplier
- A specific technology supplier has demonstrated feasibility and practical plans for implementation on **a range** of projects under different conditions and a related study has been checked by an established independent party

# Qualified

As for pre-qualified and also:

- The technology supplier must be able to demonstrate reliable operation in a range of conditions by means of **validation studies**, which should be reviewed and accepted by an established independent party
- The technology supplier must **demonstrate** all contractual and commercial obligations can be met
- The technology supplier must be able to **provide assurance** from the certification body that this technology may work at least under generic conditions considered in the type certificate.

# Commercially proven

As for qualified and also:

- The technology supplier demonstrates that the calculation methodologies to simulate and calculate the wind farm control outcome **are independently verified, reliable and repeatable** under a range of conditions
- There is **substantial track record** for the specific wind farm control implementation, with several operational applications supported by measurements
- The technology supplier must be able to provide evidence of track record by means of **site-specific design assessment or project certificate** on multiple projects featuring the specific implementation of wind farm control being considered.