WHEN TRUST MATTERS

Moving Wind Farm Control towards bankability

First results from a Joint Industry Project

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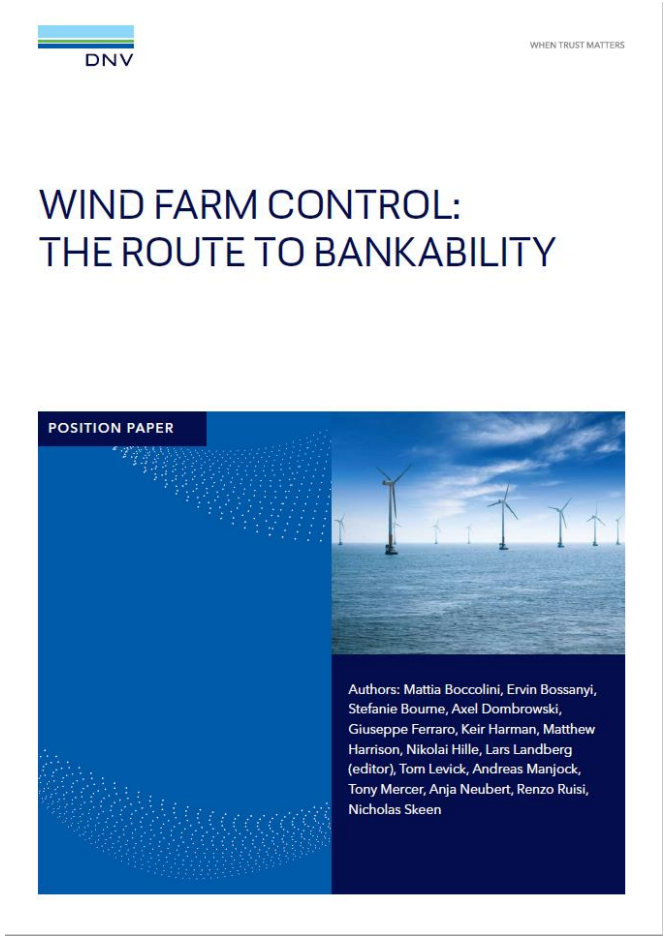
Contents

- The JIP
  - Why?
  - Goals
  - Partners
  - Project stuff 
- The Data
- Calculating the gain
- Webinar
- … one more thing..

Why a JIP?



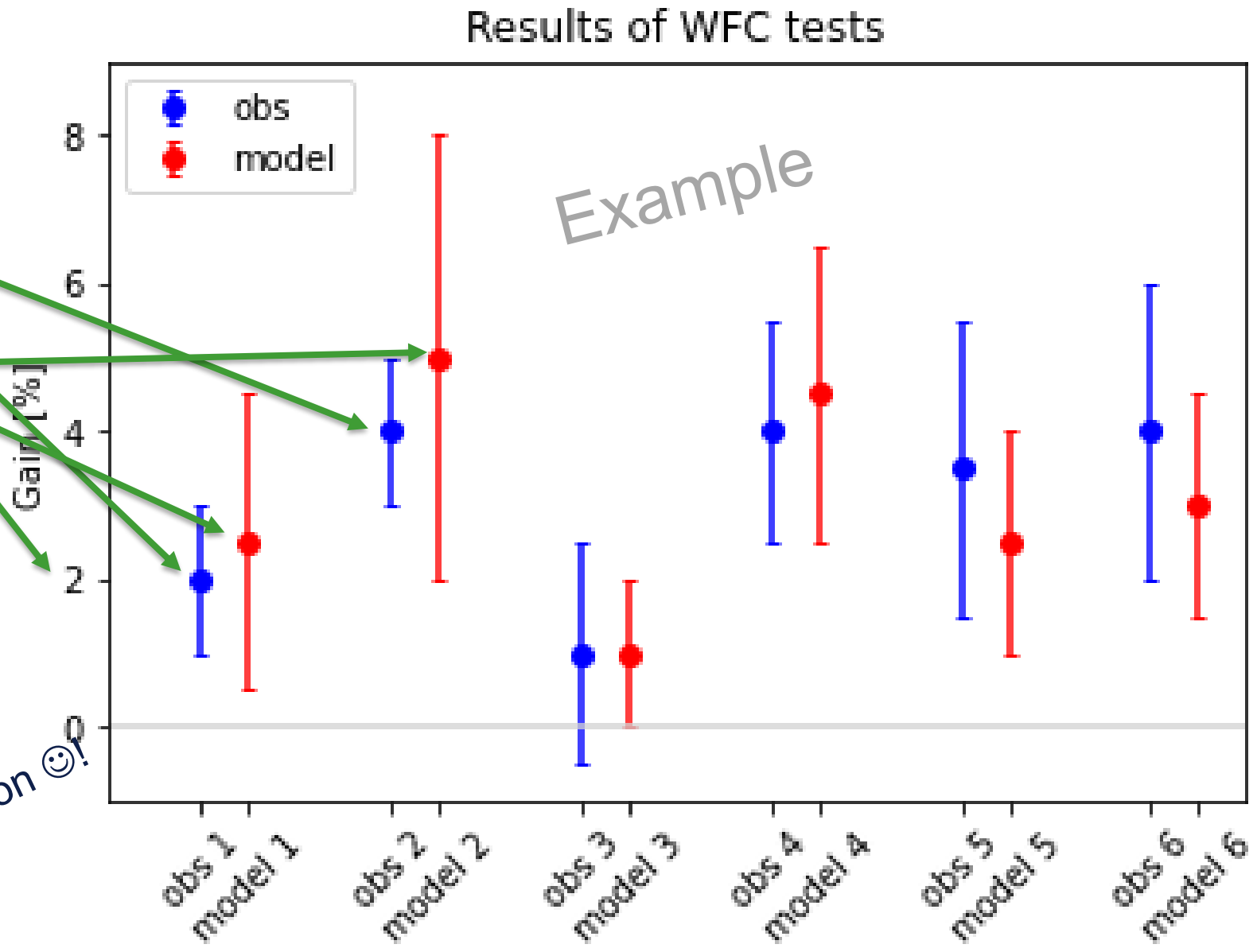
More cases:

→ Implementation, results, model verification →

Goals of the JIP

1. We can do it!
2. There is a gain
3. We can model it

Bankability



Real plot to be available soon ☺!

Partners

4 roles

- Observer
- Data-set provider
- Wind farm provider
- System developer

Time plan

03.23-09.23:	Set up
10.23-10.24:	Run
11.24-03.25:	Analyse

The WP structure

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

WP1: coordination

The purpose of this WP is to ensure that the entire JIP is coordinated and that all the WP interfaces are working optimally. General project admin will also be carried out.

- Coordination of JIP overall
- Assistance to steering committee
- Progress meetings for JIP participants
- Progress in WPs
- General admin (tracking and reporting)

All partners will be invited to bi-monthly technical meetings and quarterly steering committee meetings

WP2: WFC development/implementation/analysis

Wind farm with no existing WFC:

- Obtain necessary permissions (including loads analysis and OEM agreement) for trial [resp: partner]
- Develop and test algorithm [resp: DNV]
- Implement algorithm [resp: partner]
- Run test [resp: partner]
- Evaluate and analyse results [resp: DNV]

Contributing partners will get: algorithms, evaluation and analysis

Wind farm with existing WFC data

- Evaluate and analyse results

Contributing partners will get: evaluation and analysis

A full open-access case study

All partners will get: summary report, and open-access case study report

Purpose is to develop and demonstrate WFC on as many wind farms as possible and report on the findings

WP3: WFC models

- Evaluation of the performance of the different models used in the tests
- Benchmarking and validating existing models
- Update state of the art catalog of current WFC models and algorithms
- Output: input to reports and JIP meetings

All partners will get: current WFC models and algorithms report

The purpose of this WP is to ensure that all JIP partners have an up-to-date overview of the existing WFC models and algorithms

WP4: Certification aspects of WFC

- Study all certification aspects related to implementing WFC on wind farms, existing as well as planned.
- Requirements and documentation needed
- Output: reports, input to meetings

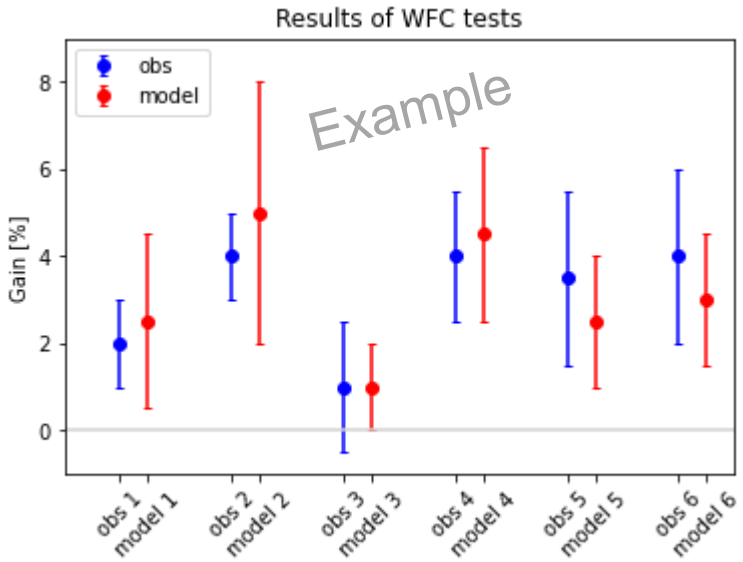
All partners will get: certification aspects report

The purpose is to make sure that all certification aspects of WFC are covered

WP5: reporting/dissemination/webinars

- Reporting (internal/external)
- External comms
- Output: reports, webinars, press releases etc

All partners will get: final report



The purpose of this WP is to document and report the findings of the work carried out in the JIP. To JIP partners in great detail, and to external parties to a degree agreed by the partners

Data Sets

Name	N turbines	Type of test
Farm 1	Part of 48 turbine farm (Offshore)	Induction, swap toggling
Farm 2	Part of 9 turbine farm (Onshore)	Steering
Farm 3	Part of 12 turbine farm (Onshore)	Steering
Farm 4	20 turbine farm (Onshore)	Steering
Farm 5	Part of 56 turbine farm (Offshore)	Steering
Farm 6	Part of 21 turbine farm (?)	Steering
Farm 7	21 turbine farm (?)	Steering
Farm 8	Part of 10 turbine farm (Onshore)	Steering
Farm 9	Offshore farm	Steering
SMARTEOLE	Onshore	Steering

Analysis and modelling methodology

Aims of analysis are:

1. Is there a change in energy yield with wake control implemented?
2. Can we model the change?

Analysis and modelling methodology

Preparation

- Generate signals (speed, turbulence)
- Calibrate direction measurements
- Identify reference turbine(s): un-waked, not part of test, close to test turbines.
- Filter data
- Split into toggle on/toggle off

Analysis and modelling methodology

To calculate uplift:

- Bin by speed and direction at reference turbine
- Filter bins by *t-significance* to find gain at a specific significance level.
- Resample and bin data for N bootstraps (BS). N is the number required for convergence of uplift and uncertainty.
- Find gain
- Find uncertainty: take weighted mean of bin BS standard deviations following approach in Kanev 2020

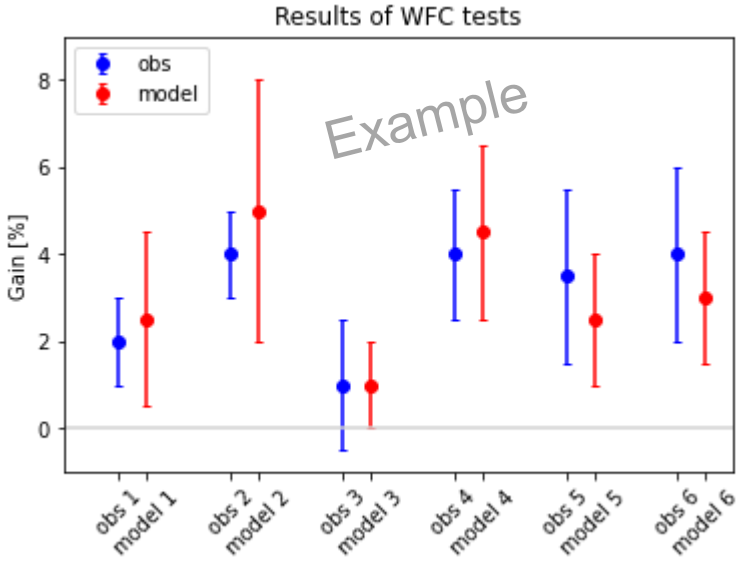
Analysis and modelling methodology

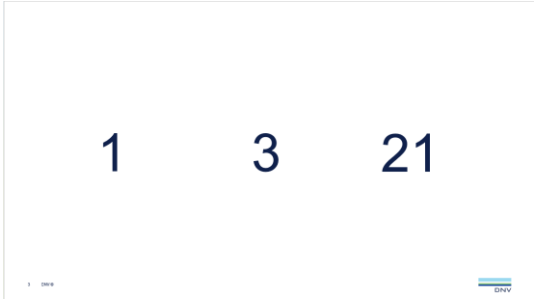
To model gain:

- We are interested in modelling what **happened,** not what was **expected** to happen.
- Input wind conditions based on reference wind conditions and ratios between test and reference turbines.
- Yaw offsets/setpoints applied are those measured during the test (what happened).
- Turbine-specific power loss with yaw is fitted to measured data and used in modelling.
- 5 models being tested. 3 by DNV, and two by external partners under blind conditions.
- Model results processed in the same way as measured: binned, corrected, t-tested, bootstrapped.

Summary

- Joint Industry Project on Wind Farm Control
- 21 partners
- Purpose: move WFC towards Bankability
- 3 goals:
  - We can technically do it
  - There is a positive gain
  - We can model it, with acceptable accuracy
- No results yet!





Webinar with results

- Probably around end-April 2025
- We will share what the JIP partners have agreed can be shared

…One more thing

- JIP 2!!
- Main goals:
  - More data analysed for better results
  - Agree on how to reach the AEP gain
- Will start mid-March ‘25

Thank you!

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