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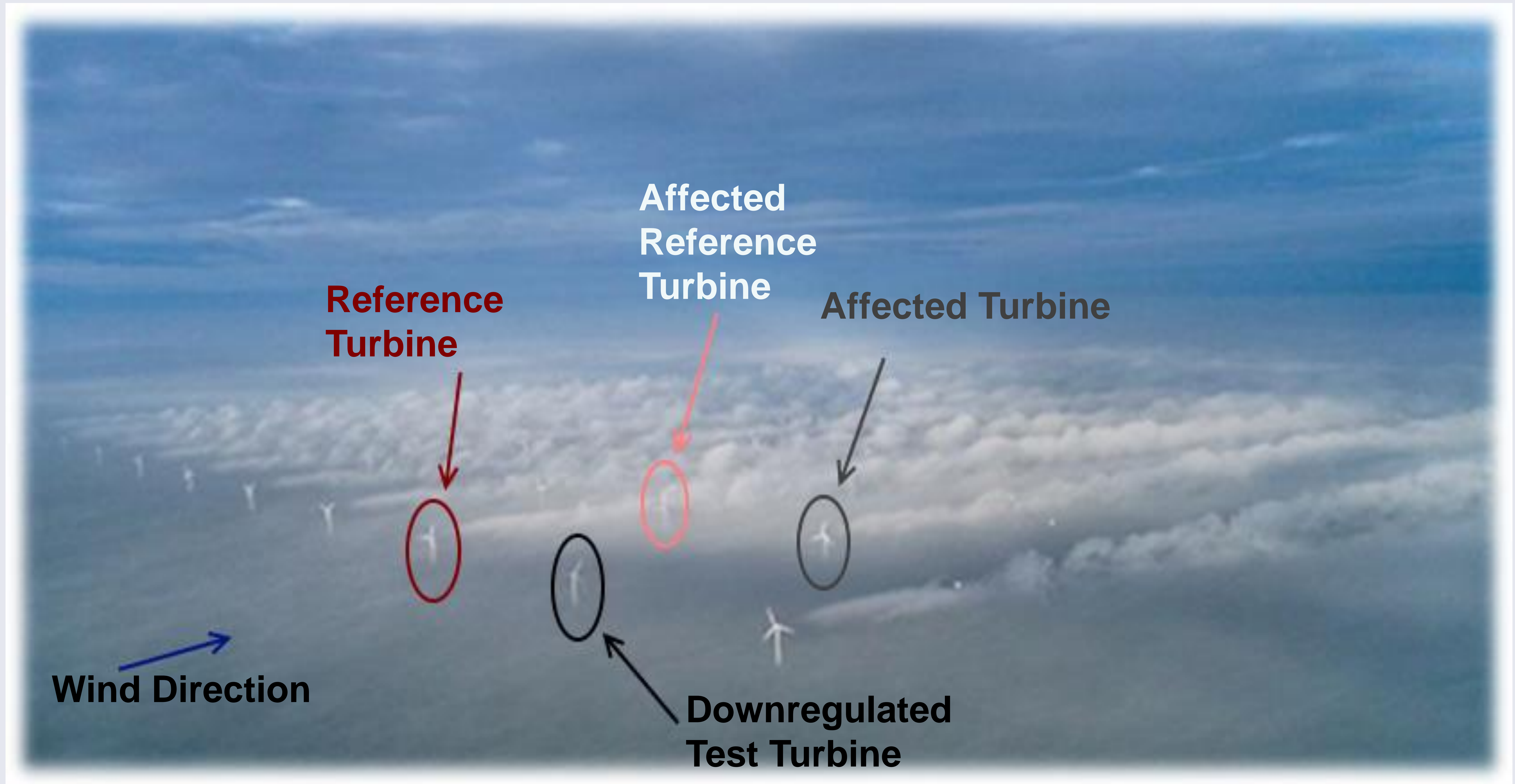
Technical University of Denmark: Department of Wind Energy, Risø¹

Niels Kjølstad Poulsen² Mahmood Mirzaei²

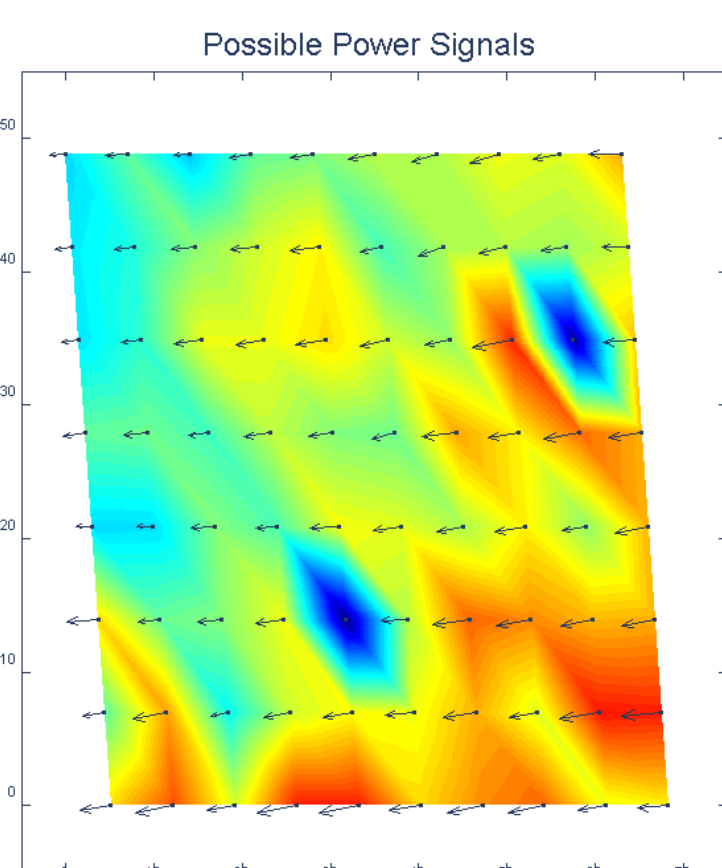
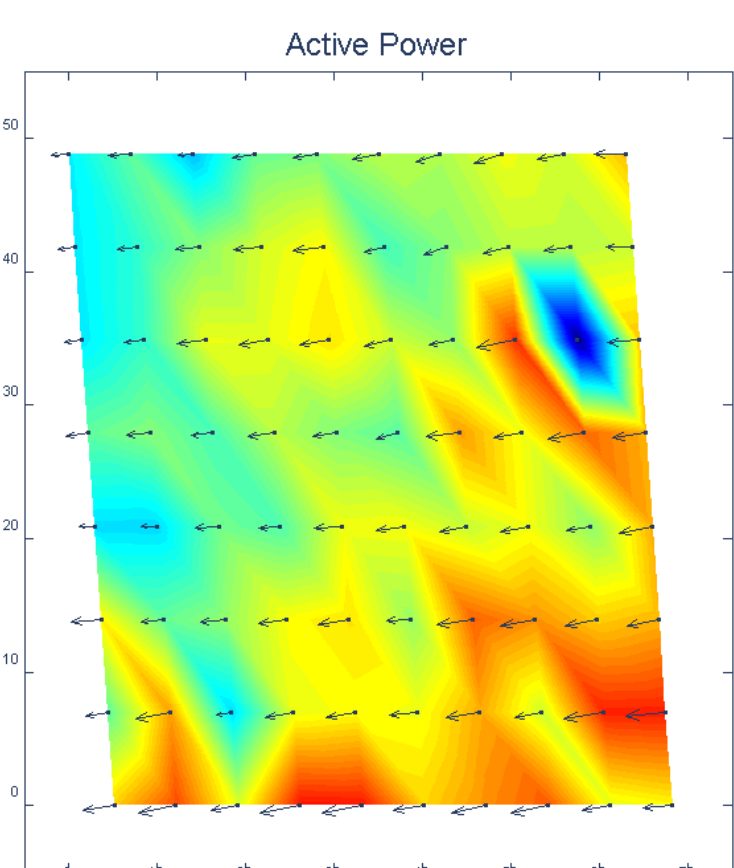
Technical University of Denmark: Department of Applied Mathematics and Computer Science, Lyngby²;

Mads Rajczyk Skjelmoose³ Jesper Runge Kristoffersen³ Vattenfall Renewables Wind DK A/S³

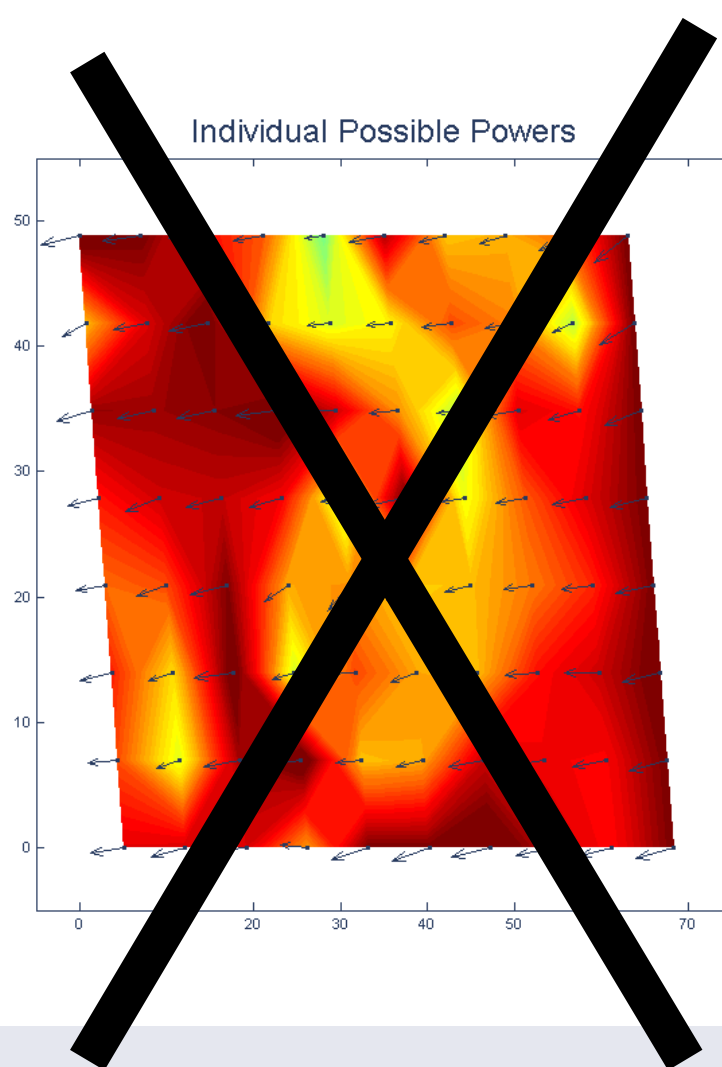
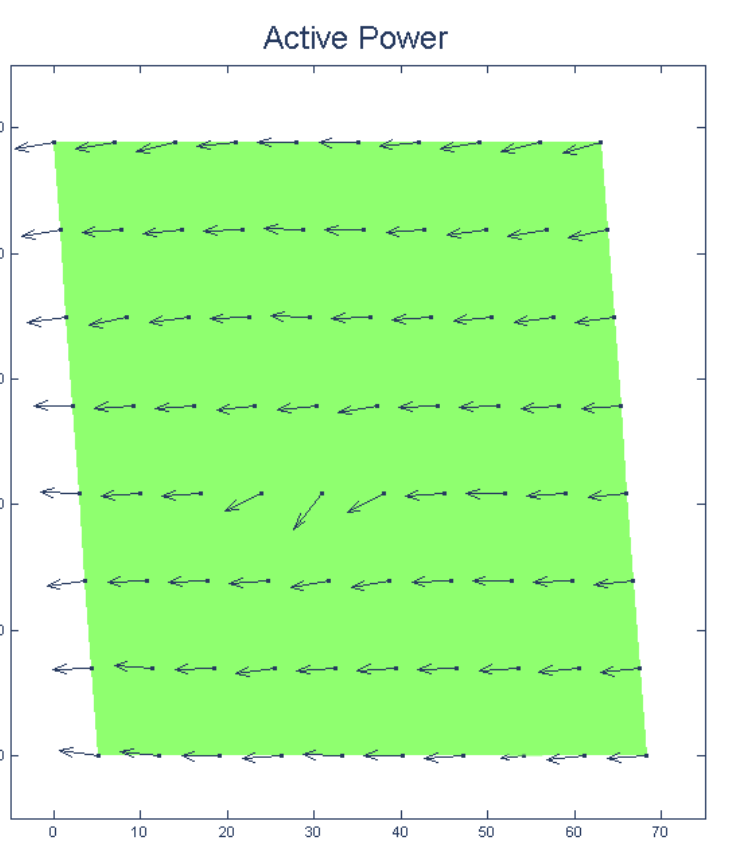
Full scale experiment at Horns Rev



Rationale



We are looking for a verified and accepted way to estimate the available power of down-regulated offshore wind farms. The current approach of summing up individual available powers (lower right) are unphysical.

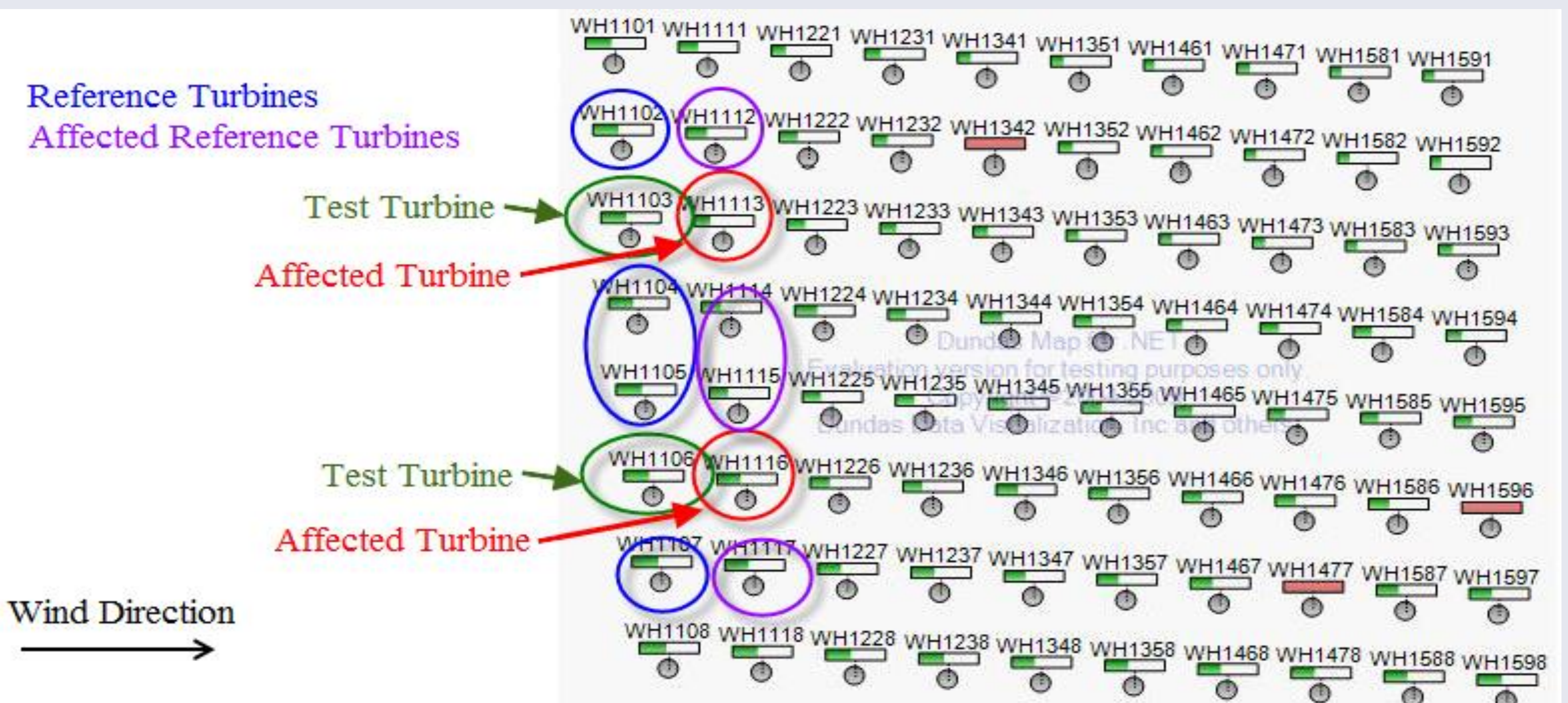


Use cases:

Selling of reserve power: A downregulated farm can sell the upregulation potential on the ancillary services market.

Compensation after mandated downregulation: Usually, wind farms ordered by the TSO to curtail output receive compensation payments, based on the measured wind speed.

Experimental Concept



Wake model verification: comparing two turbines in second row, one behind a downregulated front row turbine, one behind a turbine in normal operation. Triggers for wind direction, wind speed, and turbine availabilities start the tests.

Future experiments: Two turbines, different levels of downregulation, ...

Proposed Algorithm

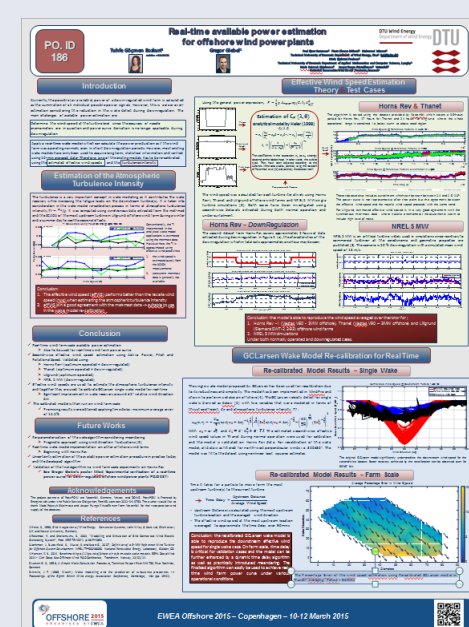
- Calculate local wind at upwind turbine
- Calculate nominal wake effect
- Advect normal wake downwind
- Repeat throughout wind farm

Needed for this:

- The estimation of wind speed using power, pitch & rotational speed
- Real-time implementation of the wake model(s)
- Measurements & verification of the algorithm

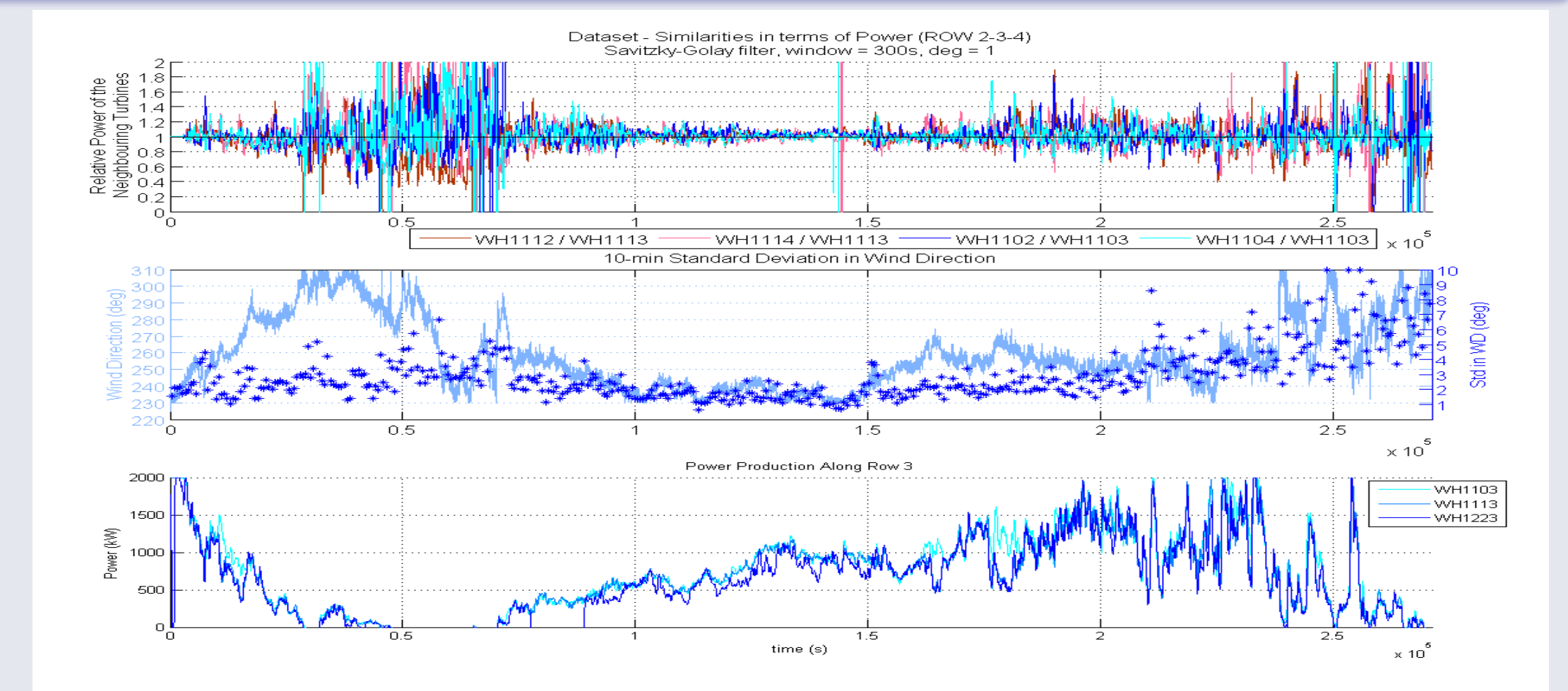
References:

- To 1: Göçmen Bozkurt, T., Giebel, G., Poulsen, N. K., & Mirzaei, M. (2014). Wind Speed Estimation and Parametrization of Wake Models for Downregulated Offshore Wind Farms within the scope of PossPOW Project. Journal of Physics: Conference Series (Online), 524(1), [012156]. 10.1088/1742-6596/524/1/012156
To 2: See poster 186 on this conference:
To 3: Ongoing.



Power Comparison Along Rows

The active power signals for the westerly winds have been compared for a filtered 1-sec dataset. The concept is mainly sensitive to very low wind speed (low power production) and high turbulence (high standard deviation in wind direction) regions.



Acknowledgements

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