



## Experimental verification of a real-time power curve for down-regulated offshore wind power plants

Giebel, Gregor; Göçmen Bozkurt, Tuhfe; Sørensen, Poul Ejnar; Réthoré, Pierre-Elouan; Poulsen, Niels Kjølstad; Mirzaei, Mahmood; Skjelmose, Mads Rajczyk ; Kristoffersen, Jesper Runge

*Publication date:*  
2015

[Link back to DTU Orbit](#)

### *Citation (APA):*

Giebel, G., Göçmen Bozkurt, T., Sørensen, P. E., Réthoré, P-E., Poulsen, N. K., Mirzaei, M., ... Kristoffersen, J. R. (2015). *Experimental verification of a real-time power curve for down-regulated offshore wind power plants*. Poster session presented at EWEA Offshore 2015 Conference, Copenhagen, Denmark.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.



Gregor Giebel<sup>1</sup>  
mobile: +45 4056 5095



Tuhfe Göçmen Bozkurt<sup>1</sup>

Poul Ejnar Sørensen<sup>1</sup> Pierre Elouan Réthoré<sup>1</sup>

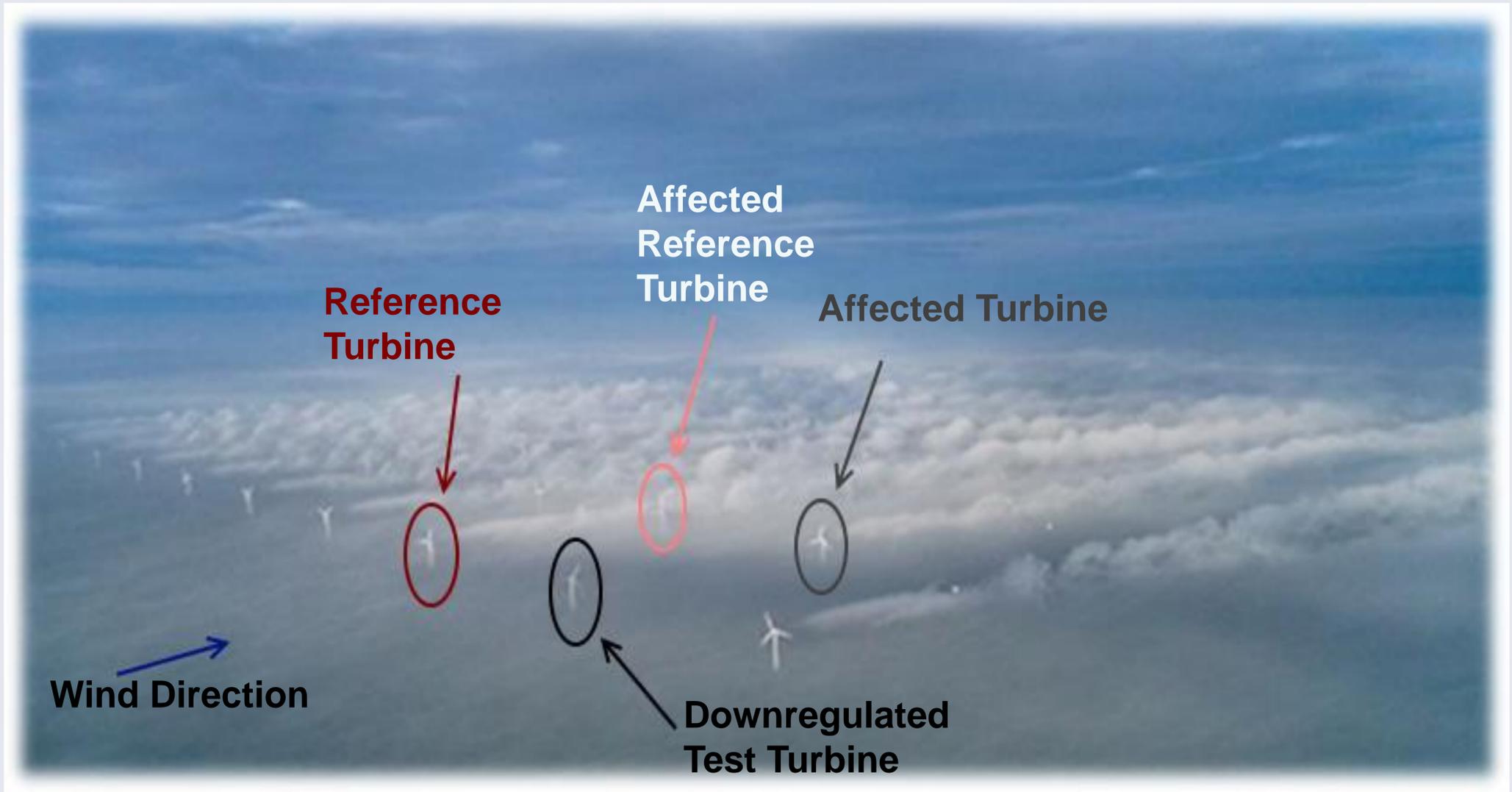
Technical University of Denmark: Department of Wind Energy, Risø<sup>1</sup>

Niels Kjølstad Poulsen<sup>2</sup> Mahmood Mirzaei<sup>2</sup>

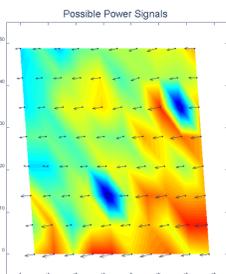
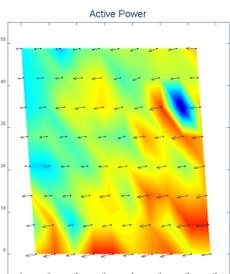
Technical University of Denmark: Department of Applied Mathematics and Computer Science, Lyngby<sup>2</sup>;

Mads Rajczyk Skjelmoose<sup>3</sup> Jesper Runge Kristoffersen<sup>3</sup> Vattenfall Renewables Wind DK A/S<sup>3</sup>

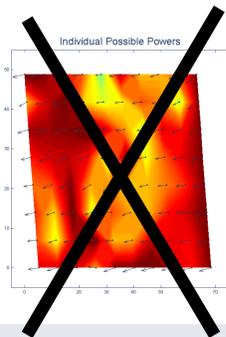
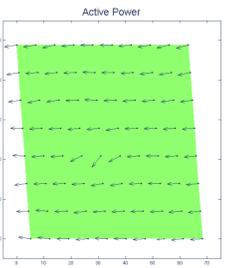
## Full scale experiment at Horns Rev



### 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.

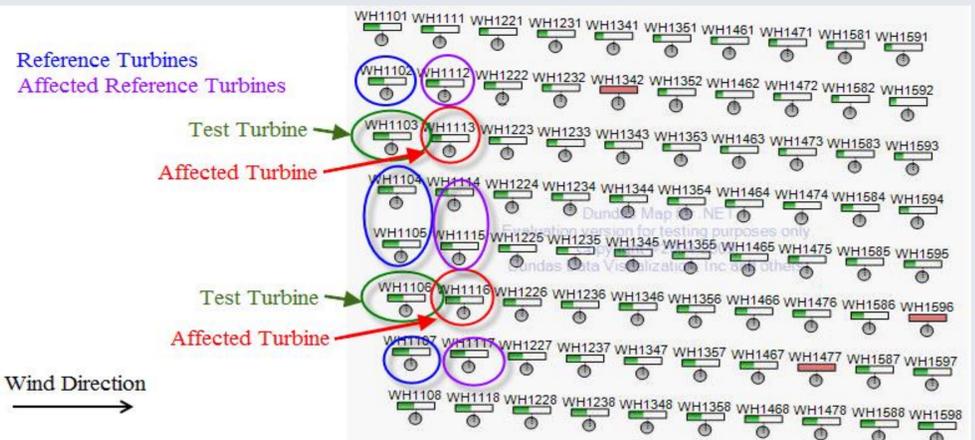


#### Use cases:

**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

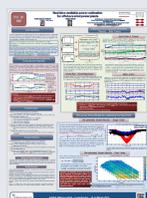
- Calculate local wind at upwind turbine
- Calculate nominal wake effect
- Advect normal wake downwind
- Repeat throughout wind farm

#### 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

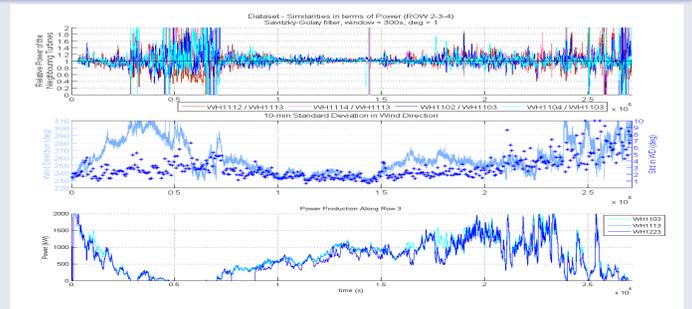
#### References:

- 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

The PossPOW project is funded by Energinet.dk under the Public Service Obligation: Possible Power of downregulated Offshore Wind power plants, ForskEL 10763. The project period is 01.05.2012-31.12.2015.

