DTU Library

Large Scale Offshore Wake Impact on the Danish Power System

Larsén, Xiaoli Guo; Volker, Patrick; Sørensen, Poul Ejnar; Nissen, Jesper; Du, Jianting; Giebel, Gregor; Ott, Søren; Hasager, Charlotte Bay; Maule, Petr; Hahmann, Andrea N.

Total number of authors:
12

Publication date:
2018

Document Version
Peer reviewed version

Citation (APA):
Larsén, X. G., Volker, P., Sørensen, P. E., Nissen, J., Du, J., Giebel, G., Ott, S., Hasager, C. B., Maule, P., Hahmann, A. N., Ahsbahs, T. T., & Badger, J. (2018). *Large Scale Offshore Wake Impact on the Danish Power System*. Poster session presented at European Geosciences Union General Assembly 2018, Vienna, Austria.

Large Scale Offshore Wake Impact on the Danish Power System

Xiaoli Guo Larsén#, Patrick Volker, Poul Sørensen, Jesper Nissen*, Jianting Du, Gregor Giebel, Søren Ott, Charlotte Hasager, Petr Maule, Andrea Hahmann, Tobias Ahsbahs, Jake Badger

#: xgal@dtu.dk * Vattenfall

SUMMARY

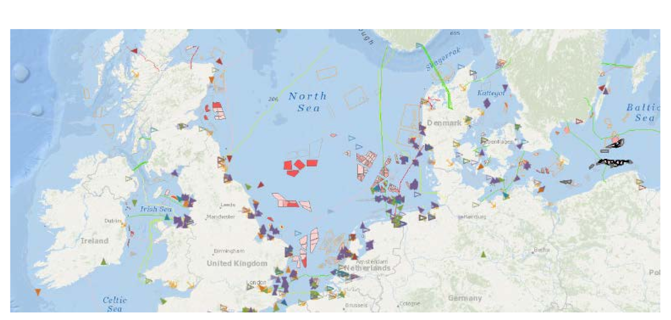
This poster gives an overview of the ongoing Danish ForskEL/EUDP project "OffshoreWake" (2017 - 2020).

The focal point of this project is to develop a calculation system that adds the large scale offshore wind farm wake (WFW) to the power system. There are five components in this calculation system, as shown in FIG 1, with 0, 1 and 2 already existing. OffshoreWake adds components 3 and 4, namely the WFW and surface wave conditions.

RELEVANCE

With a rapid increasing number of offshore wind farms to be installed, wind farm clusters are bound to arise (FIG2). A wind farm will experience mean wind reductions from upstream wind farms. Such reductions (e.g. WFW) have shown to be significant and can extend up to several tens of kilometers downwind. The calculation of the total wakes from the farms thus include not only the single turbine wake but also mesoscale effect.

As offshore wind energy is playing bigger role in the development of sustainable energy system in the coming years, the impact of the growing farm clusters needs to be taken into account regarding wind power reduction as well as the additional wind variability.



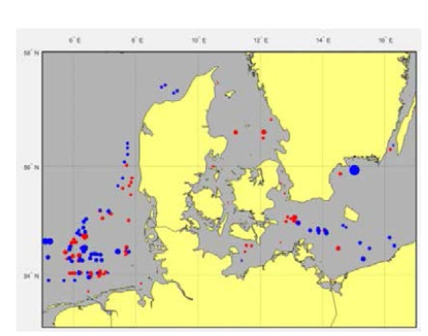


FIG. 2 (left): Overview of offshore wind farms over the North Sea and Baltic Sea. (right): Locations of offshore wind power plants in detailed scenarios for 2020 (red) and 2030 (blue), as developed in the EU TWENTIES project. Here the radius of the wind farm is proportional to the capacity[1].

REFERENCES

[1] www. http://www.twenties-project.eu/node/1

[2] Werner D., Nissen J. N. , Hawkins S. and Madsen J. (2016): FARM-2-FARM: methods on estimating neighbouring windfarms shadowing.

[3] Sørensen P. Litong-Palima M., Hahmann A., Heunis S., Ntusi M., Hansen J.C (2018): Wind power variability and power system reserves in South Africa. Journal of Energy in Southern Africa, vol 29, 1.

[4]Volker P., Badger J., Hahmann A. and Ott S. (2015): The explicit wake parameterization V1.0: a wind farm parameterization in the mesoscale model WRF. *Geosci. Model. Rev.* 8:3715-3731.

[5] Du J., Bolanus R. and Larsén X. (2017) The use of a wave boundary layer model in SWAN. *J. Geophysics Res. – Ocean*. 122:42-62.

NOVELTY & CORE OUTCOME

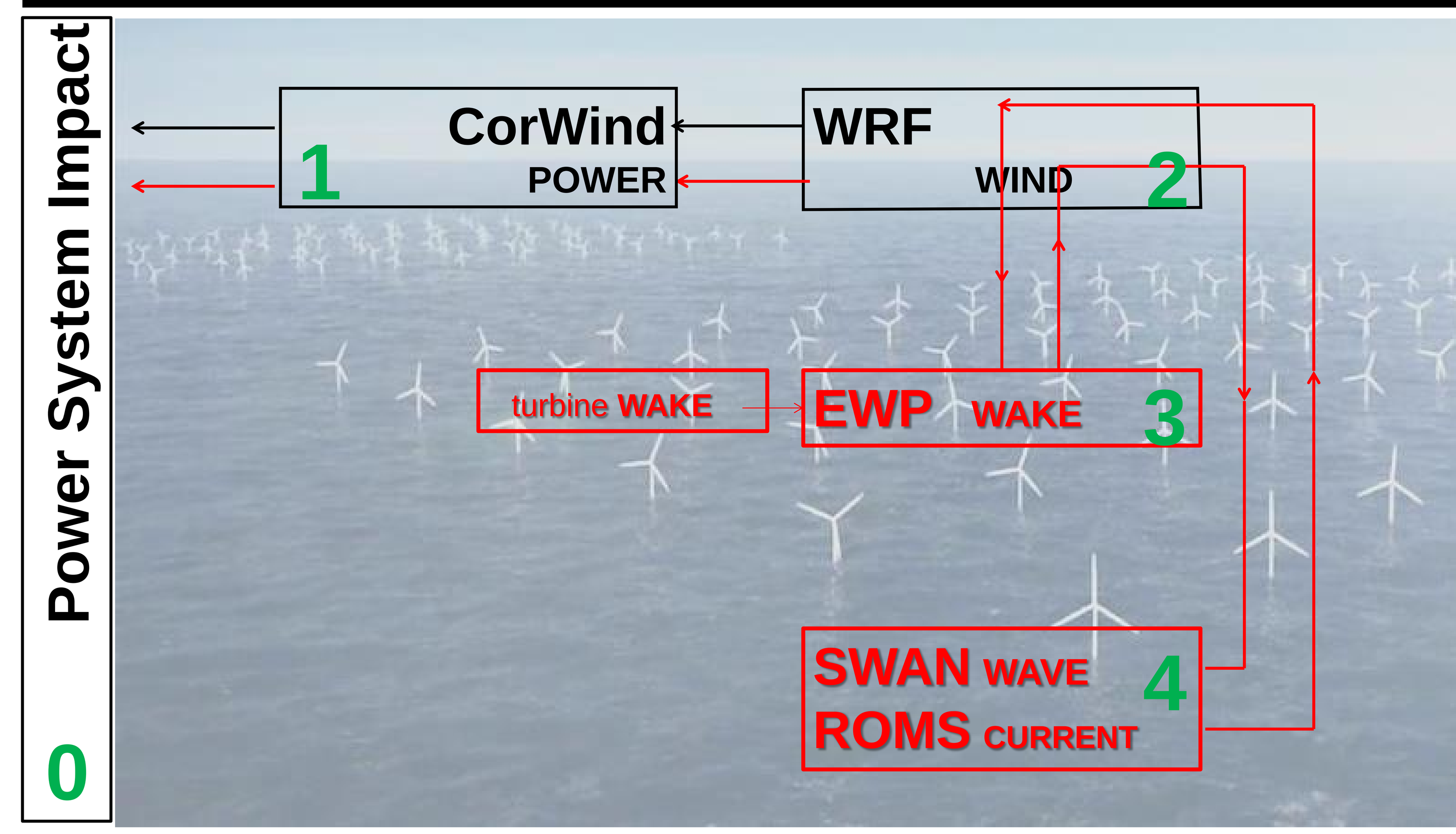


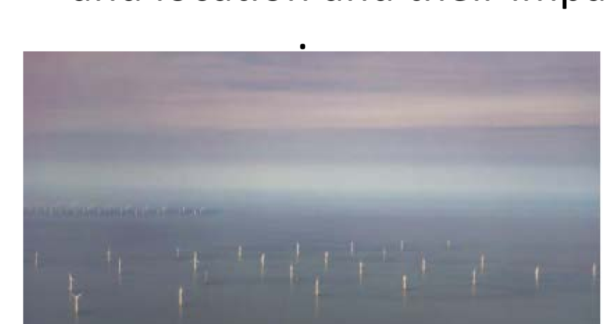
FIG. 1: The OffshoreWake calculation system and its five components. Details of components are illustrated in the panel to the right.

METHOD

The study follows:

1. Build up database of measurements (offshore masts, SCADA, satellite data)
2. Build up the calculation system as shown in FIG 1, with specified test cases:
   1) Experiment 1: Wind farm Egmond aan Zee and Princess Amalia (FIG 3)
   2) Experiment 2: Published cases where wakes are present
   3) Experiment 3: Years of collection of cases to obtain climatological understanding
3. Tests, validation and calibration:

   The development of the modeling system will be examined through (1) WRF only; (2) WRF-EWP; (3) WRF-SWAN(ROMS); (4) WRF-EWP-SWAN(ROMS); (5) WRF-CorWind; (6) WRF-EWP-CorWind; (7) WRF-SWAN(ROMS)-EWP-CorWind
4. Most important elements will be identified from step 3 to obtain an efficient calculation system. The system will be applied to the test case Horns Rev wind farm cluster (FIG 4) and validated by the measurements.
5. The calculation system can be applied to investigate future farm layout, size and location and their impact on the power system.



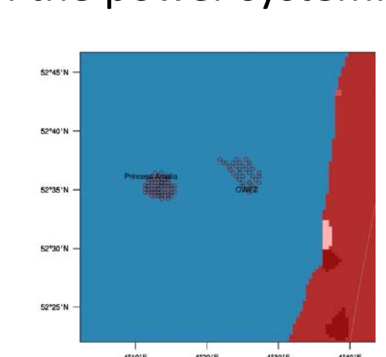


FIG. 3: Wind farms Egmond aan zee and Princess Amalia (actual photo and land use data) [2].

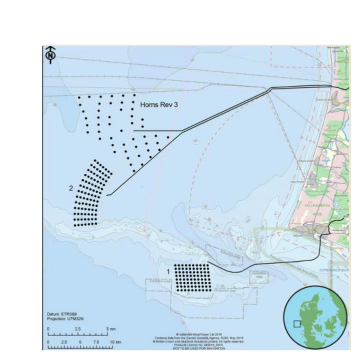
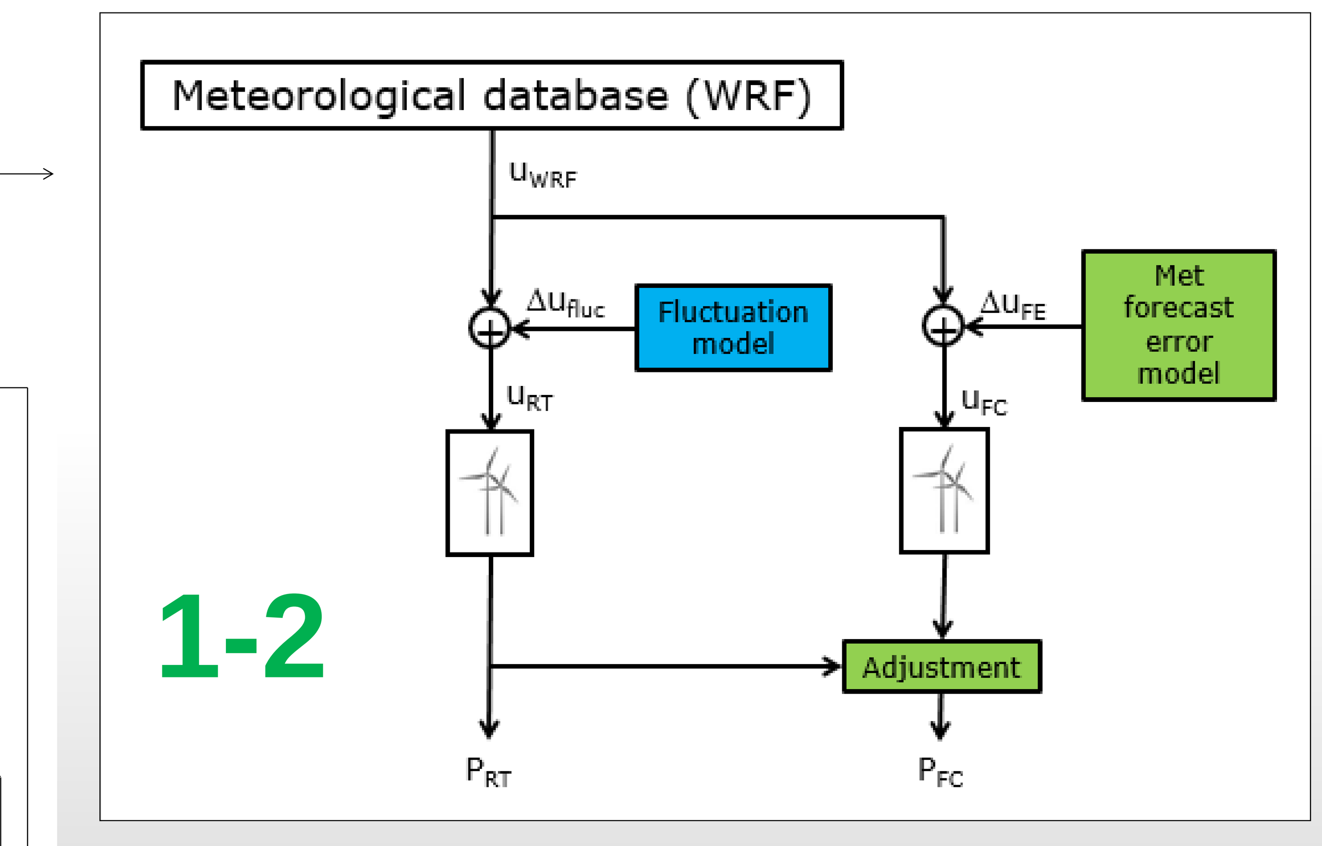
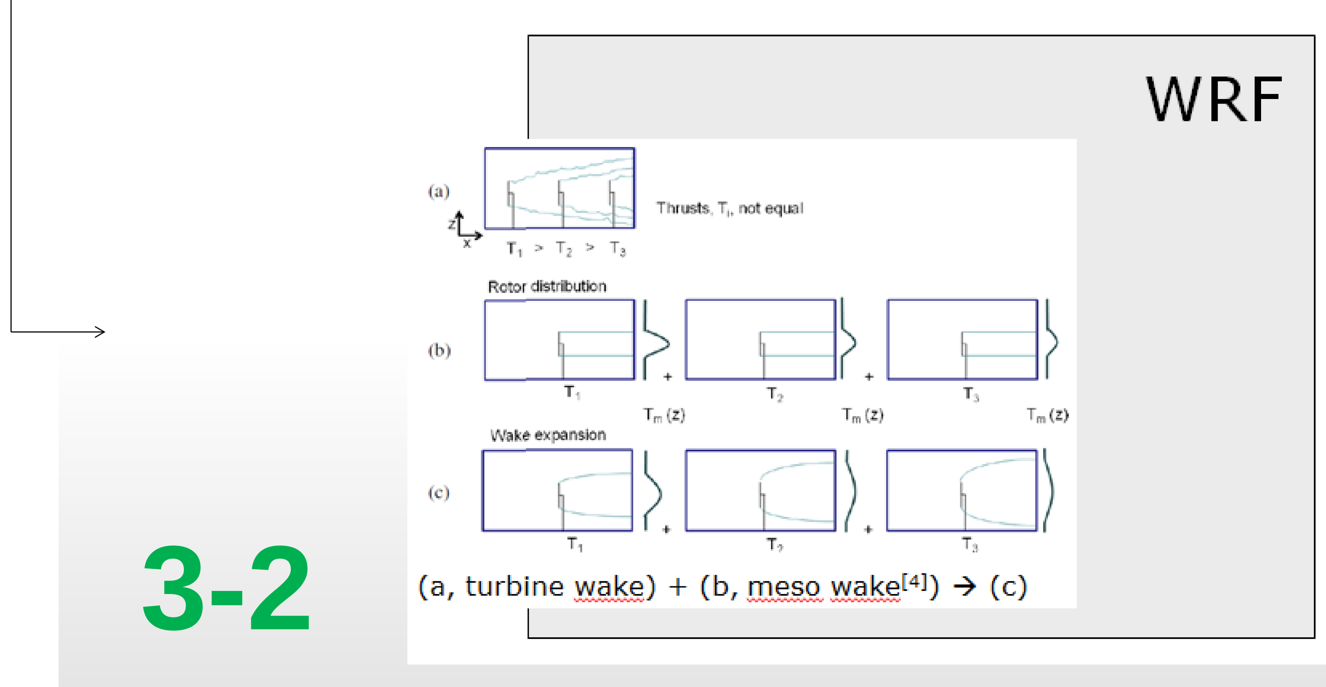


FIG. 4: Wind farms Horns Rev 1, 2 and 3.

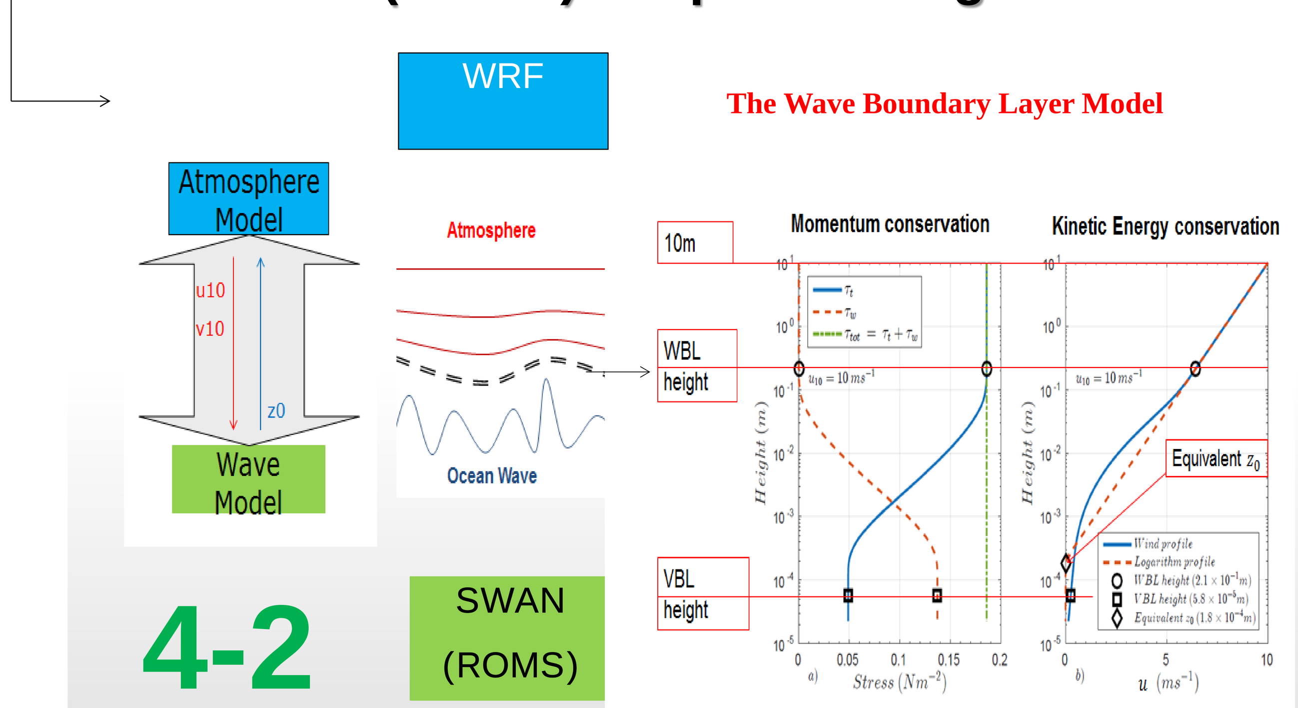
CorWind main structure [3]



EWP-FUGA-WRF [4]



WRF-SWAN(ROMS) coupled through WBLM[5]



DTU Wind Energy
Department of Wind Energy

www.offshorewake.dk

VATTENFALL