Development of Multi-disciplinary Prognostic and Diagnostic Models for the O&M of Offshore Bottom-fixed Wind Farms

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Introduction and aim

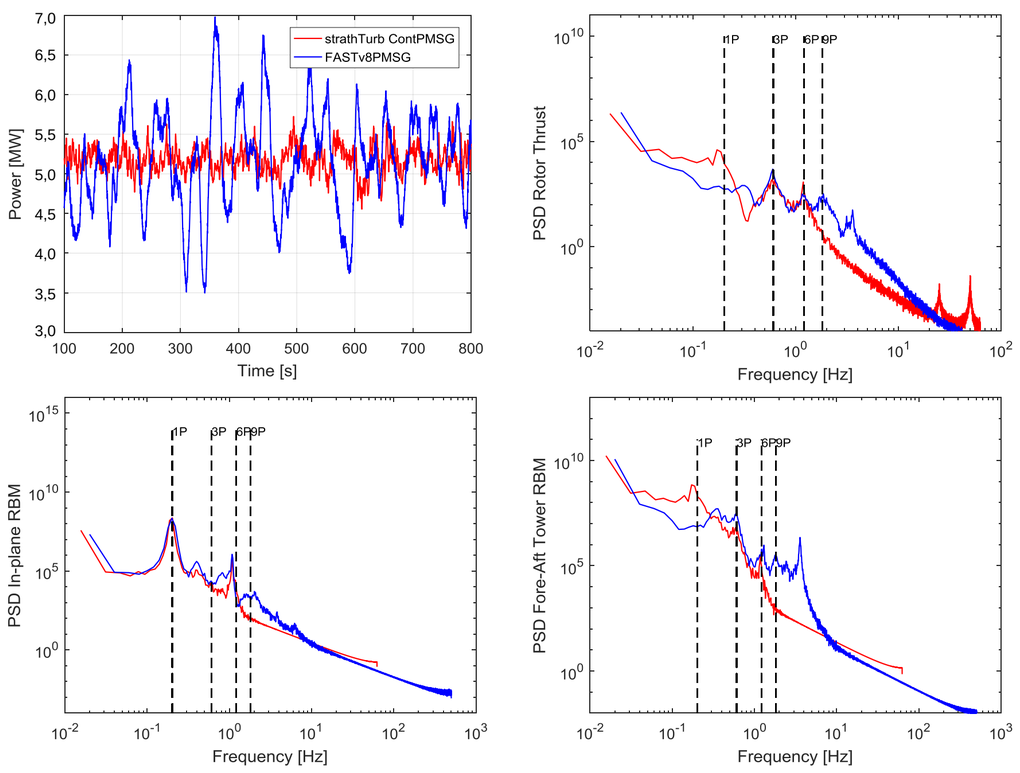
O&M for offshore wind farms represents about 39% of their total life-time cost. Conventional maintenance schemes could lead to additional and unforeseen costs.

This research is aimed to investigate models for the prognosis and the diagnosis of offshore wind turbine failures.

Progresses and discussion

1. Integration of the model for electro-dynamics (from WP1.1) into StrathTurb
2. Comparison against the AHSE model of FAST (v.8) integrated with the electro-dynamics
3. Preliminary results for the wind farm model (StrathFarm)

1.
2.



- wind-only simulations (18 m/s, 11% TI)
- discrepancies due to different set values of torque at the rated condition, and use of: a drivetrain filter and a control loop on the tower top acceleration.

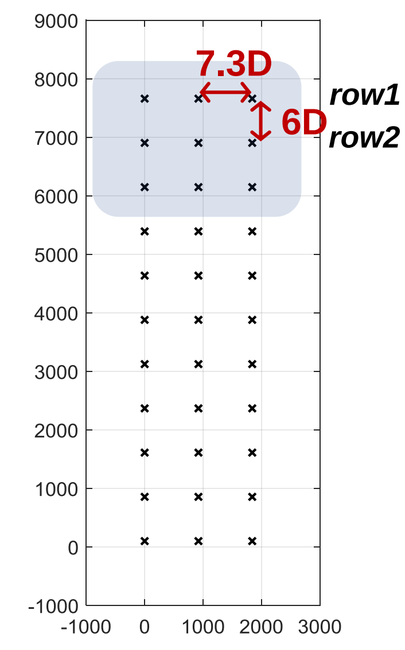
Methodology

1) Identification of critical components for offshore bottom-fixed wind turbines [1,2]
2) Development/adaption of multiphysics models of dynamics for the wind turbines [3], and the wind farm, to support the synthetic-data driven condition-based maintenance.
3) Data-driven techniques [4,5] and models for the selection of damage indicators, and detection

3.

- StrathFarm running 6 StrathTurb models for the NREL 5 MW reference wind turbine (D = 126 m).
- Layout from WP1.1, with spacing as for the Alpha Ventus wind farm
- Wind-only simulations

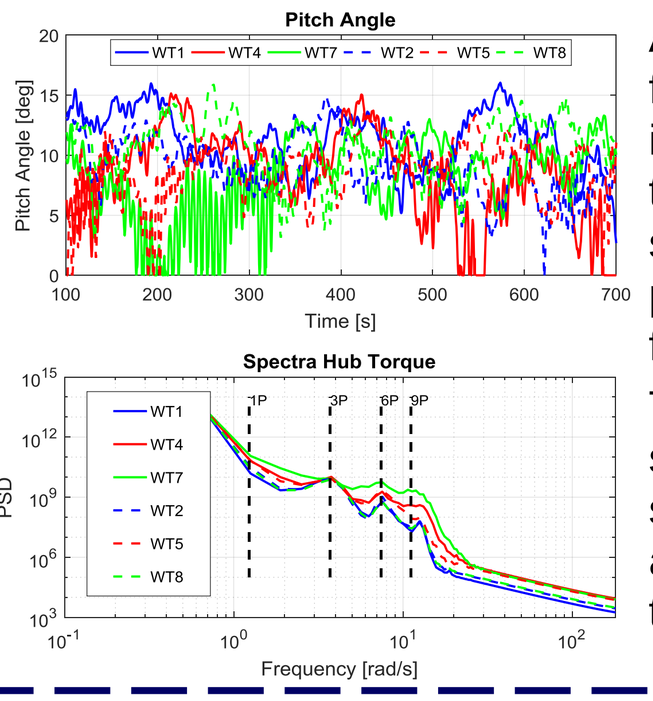
Turbulent wind
14 m/s (TI 10%)



- Mapping of the power output

		position [x/D] 0	7.3	14.6
Mean [MW]	*row1*	4.91	4.85	4.86
	row2	4.86	4.85	4.90
Std [kW]	*row1*	102	286	251
	row2	252	326	171

- Tracking performance/load of/on turbines in array



A Frendsen model for wake dynamics is used to calculate the wake losses, sitting on top of a pre-generated wind field.

To alleviate some structur/mech load, some control loops are included in the turbine controller

Conclusions and future work

- Adapted StrathTurb model represents well the fundamental dynamics of the systems.
- Next step will be the consistent adaption to direct drive of StrathTurb/Farm for HOME 5 MW wind turbine and the investigation of damage identification techniques.

REFERENCES

[1] Cevasco et al., "O&M cost-based FMECA: identification and ranking of the most critical components for 2-4 mw geared offshore wind turbines" in IOP Conference Series: Journal of Physics, 2018, vol. 1102, pp. 1-12. Presented at the Global Wind Summit 2018 (Hamburg, Germany).

[2] Cevasco et al., "Offshore wind turbine reliability: a systematic review towards the identification of the most critical components" submitted to Renewable Energy.

[3] Carmona-Sanchez et al., "An analysis of the impact of an advanced aero-hydro-servo-elastic model of dynamics on the generator-converter dynamics, for an offshore fixed 5 MW PMSG wind turbine". Presented at the 15th IET international conference on AC and DC Power Transmission, 2019, pp. 1–6 (Coventry, United Kingdom).

[4] Lin et al., "Progress on the development of a holistic coupled model of dynamics for offshore wind farms, phase I: aero-hydro-servo-elastic model, with drive train model, for a single wind turbine" in Proceedings of the ASME 37th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2018), 2018, pp. 1–9 (Madrid, Spain).

[5] Lin et al., "Progress on the development of a holistic coupled model of dynamics for offshore wind farms, phase II: study on a data-driven based reduced-order model for a single wind turbine" to be presented at the ASME 38th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2019), (Glasgow, Scotland).

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