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Smart Wind Farm Control: Practical Use Of Probabilistic Wind Power Forecast in a Congested Distribution Grid

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Abstract

Distribution system operators (DSOs) today face substantial challenges to integrate large wind power plants on distribution level. Since this requires expensive and time-consuming investments to reinforce the network, the development of many of these plants can be postponed or even cancelled.

The Belgian DSO Eandis is currently demonstrating through the SWiFT (Smart WInd Farm conTrol) research project how a large wind plant (the *Wind Aan De Stroom* project in the port of Antwerp) can be connected in the short term by using intelligent grid management techniques during congestion periods. These methods are driven by a wind power forecast service at turbine level and allow the minimization of curtailment losses.

This poster presents the practical use of the SWiFT project and the wind power forecast system developed by 3E with a focus on the challenges associated with its operational deployment.

The Smart Wind Farm project (SWiFT)

Goal:
To maximize the integration of wind turbines in the distribution grid at the Port of Antwerp (see Figure 1) while minimizing the amount of lost wind energy at the lowest possible overall cost.

Constraints:
As the distribution grid in this industrial area is already congested, major grid investments to reinforce the network or important curtailment would need to be applied.

Method:
Demonstration of innovative smart grid management techniques - Dynamic Line Rating (DLR), Active Network Managements (ANM) and Demand-side Management (DSM) - to optimize the connection of the turbines in the distribution grid and potentially avoid expensive line upgrades.

Probabilistic forecasts in the short (day ahead) and very short (up to 6 hours ahead) term are required to drive these techniques.

Figure 1 – Waaslandhaven Wind Farm Phase 1 (source: Wind Aan De Stroom)

3E Forecast system in SWiFT

The forecast system developed for the project includes:
- Statistical models (ARIMA)
- Numerical Weather Prediction models (ECMWF, ALARO)
- Near real time production data (Figure 2)

To provide:
- continuous probabilistic forecasts (short and very short term forecast horizons) at turbine level every two hours with a granularity of 15 minutes.

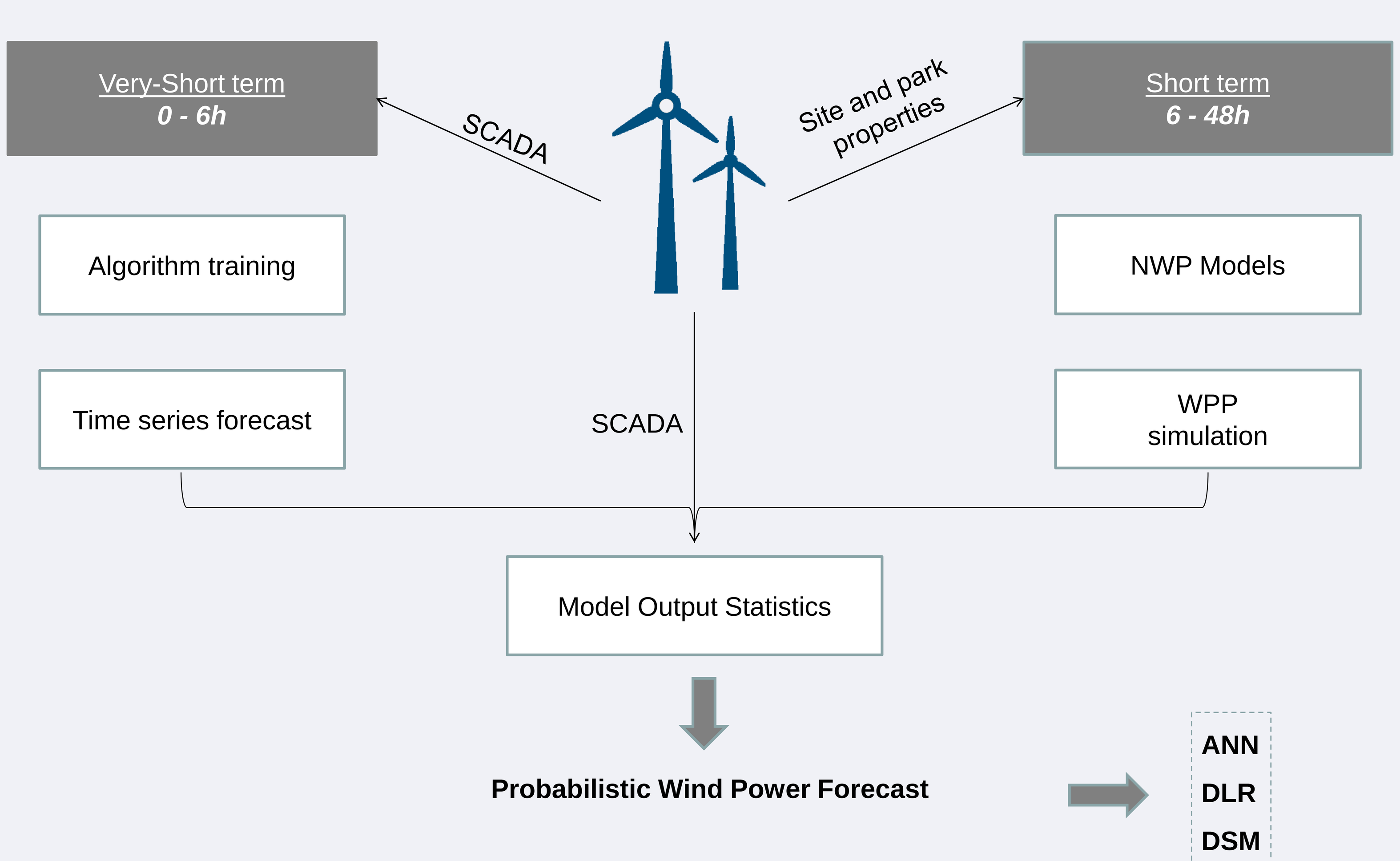

Figure 2 – 3E Probabilistic Wind Power Forecast system

Pre-validation

A pre-validation of the forecast system has been performed for a period of 8 months at a nearby plant (6 turbines).

Figure 3 shows the evolution of the park-level mean absolute error (normalized by installed capacity) of NWP-based, ARIMA and optimal deterministic forecast in the very short-term horizon, and typical accuracy ranges [1]. This pre-validation of the system gives satisfactory results with an average error of 7.3% in the very short-term (0-6h) and 8.8% in the short-term (6-48h) forecast horizon.

Results of the PoC expected end of 2015.

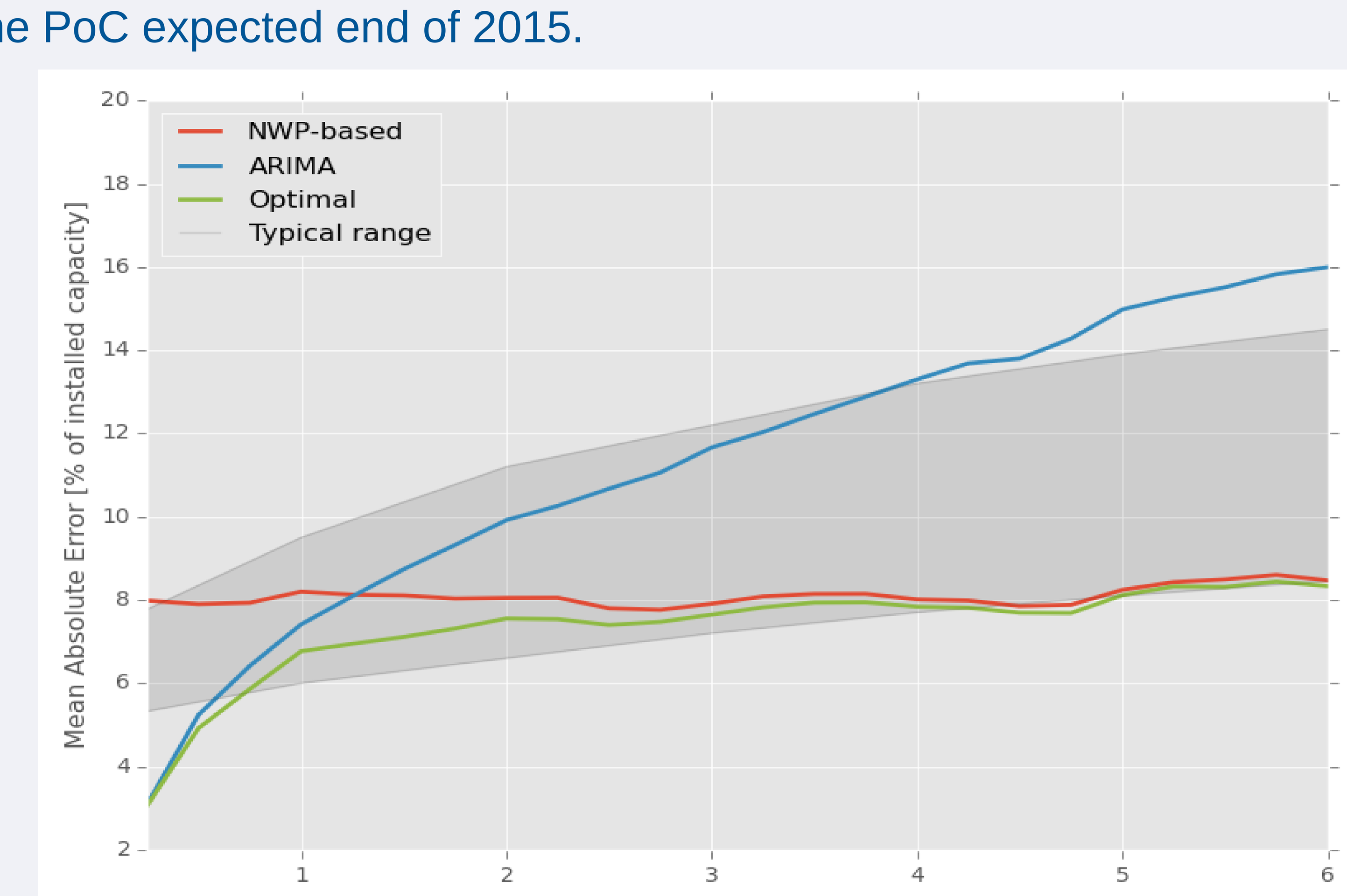

Figure 3 – Deterministic forecast error at nearby plant

Operational challenges

A combination of old & new open-source technologies has been chosen to design a robust, flexible and scalable forecast system suitable for such application. Those challenges are typically not encountered at pure research level.

References

1. Brower, M., Zack, J., 2014. Uncertainty in wind forecasts: status and prospects. Proceedings of EWEA 2014, Barcelona, Spain.
2. Wilks, D.S., 2011. Statistical methods in the atmospheric sciences, 3rd ed, International geophysics series. Elsevier/Academic Press, Amsterdam.

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