Aeolius Wind Systems

Wind Forecasting Demonstration Project

LESSONS LEARNT REPORT #1

Funding Agreement Details

Recipient Name	Aeolius Wind Systems
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LESSONS LEARNT

Key Lesson/s
The key learning from the project include: • The short range scanning Doppler lidar provided capacity to map windfield in high spatial resolution (100m) at Macarthur windfarm with a consistent range of 3 km, sometimes longer when atmospheric aerosol loadings are heavier. The maximum distance where data of sufficient quality and quantity could be obtained to derive vector wind fields using AWS proprietary data post processing strategies was approximately 2.5 km. The range capability provided opportunities to evaluate the performance of a limited number of turbines which fell within the horizontal scanning plane (6 in the case of this deployment). • Understanding wake behaviour in large windfarms with multiple turbines is critical to the success of physical based lidar forecasting strategies. This includes quantifying the impacts of “upstream” turbines on leeward turbines to evaluate impacts on power production, and understanding the role of wake transport processes in both the horizontal and vertical plains; • The width, length and turbulence intensity of the observed wakes at Macarthur windfarm were within the theoretical limits identified in the scientific literature. Wake behaviour (in terms of transport and dispersion) was strongly influenced by local atmospheric boundary layer conditions; • It was possible to differentiate between the free flow windfield and turbine wake signatures in the lower boundary layer area using an appropriate lidar scanning strategy and signal processing techniques; • An analysis of the impact of wakes on downwind turbines is required to quantify additional wear on turbines and the consequent increase in maintenance costs. A recent study of almost 3,000 onshore wind turbines in UK shows that wind turbines will continue to generate electricity effectively for just 12 to 15 years, compared to their industry and financial expectation of 20 – 25 years. This work is outside the scopes of the current project; • The assembled data is suitable for the planning for the dual doppler and neural network forecasting demonstration, and refining the forecast strategy at the site once operational. • It’s possible to deploy and implement a lidar based monitoring strategy at an Australian windfarm at relatively short notice (several weeks) if the proponent has access to hardware with range measurement capability beyond 6 km, advanced data post processing software, and analytical skills. • Access to reliable, high speed telecommunication capability is critical to the success of the lidar wind forecaster. Whilst suitable infrastructure may be in place at the windfarm control centre, remote connection may not be available at the site where the forecaster is installed. This challenge needs to be addressed in the early stages of planning a monitoring demonstration;

- Reliable, timely and competent onsite technical support is required to ensure the forecaster operates within acceptable limits. Whist the AWS technology is designed to run autonomously and is controlled remotely by specialised staff, there are occasions where onsite assistance will be required. This includes restarting of the instrument following (localised) power blackouts or unscheduled shut down. Whilst the task of restarting the equipment is relatively simple, it requires someone to go to the lidar location, inspect the equipment to ensure no evidence of damage, and throw a switch.

- For practical and legal (insurance) reasons this task needs to be done by a suitably trained and motivated windfarm employee. In many situations this will be a technician employed by a site management subcontractor such as turbine supplier;

- Hence a commercial arrangement is required with the selected party to ensure fast and competent response to onsite maintenance challenges.

Implications for Future Projects

- The utility provided by the short-range AWS lidar to characterise flow behaviour at greenfield development sites and characterise potential turbine wake behaviour will offer opportunities to evaluate the skill of existing computer-based wake model(s) used in wind energy resource assessment.

  These models are notoriously unreliable due to the difficulty of accurately complex meteorological and topographical processes effecting the 3 – D flow behaviour. Inaccurate predictions on flow field behaviour on greenfield sites can lead to incorrect positioning of turbines (micro-siting) and cost over runs with maintenance. This in term can undermine the wind farm developer’s business case.

  The industry is full of underperforming windfarms!

- An outcome that could be pursued in future project would be the construction of a new predictive model which has application across the entire life cycle of a windfarm. Current industry standard models used in the wind energy sector are generally licenced and operated by third party consultants and are rarely utilised beyond the assessment phase of a project.

  In addition to wind energy resource assessment, the new tool would use the outputs from the forecast lidar and the wind farm SCADA to enhance productivity through fast forward control of turbine orientation, damage avoidance during extreme weather, and lowering maintenance costs.

Knowledge Gaps Identified
• Additional information is required on turbine wake behaviour under unstable atmospheric conditions at the Macarthur windfarm. These conditions are known to amplify the downstream "reach" of wakes resulting in greater than expected reductions on power output from affected turbines. Additional equipment in the form of high frequency sensors are required for this investigation. • A structured monitoring program to confirm the skill of the short range lidar in quantifying velocity resolution (wind speed and direct, turbulence) under different site conditions is required. This activity will necessarily be opportunistic given constraints of availability of lidar technology in Australia. • There is uncertainty in the quality of data being generated from the onsite masts and Vestas turbines at Macarthur. An examination of the available metrological and production data for the neural network forecast applications has identified quality control deficits which needs to be addressed. The above challenges will be addressed in the next stage of the project work plan.

Supporting Information
A technical report describing the findings of the initial investigation at Macarthur windfarm is being prepared. Extracts from this report will be published on the AWS website and published in industry newsletters in 2020.