MERIDIAN ENERGY AUSTRALIA: **Wind Forecasting Demonstration Project**

LESSONS LEARNT REPORT 4

Project Details

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EXECUTIVE SUMMARY

This report outlines lessons that Meridian Energy Australia and the University of Melbourne have recently learnt regarding assessment methodology to estimate the savings the self-forecast has generated compared to utilising the AWEFS forecast for Mt Mercer. It has also identified the two philosophical approaches to forecasting – one which targets a reduced MAE and RMSE whilst another which focuses on correcting grid frequency irrespective of the accuracy of the forecast. We have to date adopted the former approach and expect that overtime as all generators work toward an accurate forecast for their generator that the market and rules will continue to reward this behaviour. We have also identified some new learnings associated with the setup and running of a longer horizon (24 hr) forecast using publicly available BOM data.

KEY LEARNINGS

Lesson learnt No.1: The financial viability of a LIDAR is largely dependant on intended participant usage.

Category: Commercial

Objective: Investigate the potential commercial benefits of wind and solar farms investing in short-term, self-forecasting solutions.

Details: Using the causer pays analysis code detailed in Progress Report #4 we carried out an analysis to determine if and when the scanning Doppler LIDAR unit would pay for itself. We considered two possible uses, for self-forecasting and for alignment of the wind turbines to incoming changes in wind direction (leading to increased power generation revenue and increased LGC creation). The LIDAR based self-forecasting causer pays savings were considered relative to the existing self-forecast, which uses only the available SCADA data when the project began. In the self-forecasting only cases, the LIDAR unit was not able to pay for itself over the project life of 20 years. This included scenarios where its best single day performance was applied to a year's worth of self-forecasts. By contrast, if the LIDAR is used for *a priori* turbine alignment, the LIDAR unit would be able to pay for itself within just a few years.

Implications for future projects: Projects should consider their intended uses for a scanning Doppler LIDAR unit before purchase; if it is only being used for self-forecasting the unit is unlikely to ever pay for itself.

Lesson learnt No.2: Peculiar findings relating to the ancillary service charges from self-forecasting.

Category: Commercial

Objective: Investigate the potential commercial benefits of wind and solar farms investing in short-term, self-forecasting solutions.

Details: Using our causer pays duplication code that we've previously highlighted, we were able to determine a certain number of "peculiar days", one of which we will detail and is shown in Figure 1. On these days, we see much lower error in the self-forecast than AWEFS (as shown in the left-half of the image), however, on this day we find that we would have had a positive causer pays factor if we were using AWEFS over the same day. This is due to the larger AWEFS forecast error acting to stabilize the grid when raise or lower services were required. This is contrasted with the smaller self-forecast error which served to minimise Mt Mercer's deviation from its linear dispatch trajectory. Hence we have a day where it is financially better to a larger forecast error (and use AWEFS) than to self-forecast because the error is of the "correct sign". It is important to recognise that in general, over a long period of time, having a lower forecast error leads to an improved causer pays factor and lower causer pays payments; yet this day highlights the fact that the current system can also financially benefit generators with less accurate forecasts that are instead focussed on responding to grid frequency deviations.

Implications for future projects: Wind farm operators should be aware that the causer pays cost recovery mechanism may not financially reward the most accurate forecast methodology. Reduced Regulation FCAS costs for a generator are more closely tied to having the sign of the error align with the current need for raise or lower services; hence higher error forecasts can be more financially beneficial than lower error forecasts.

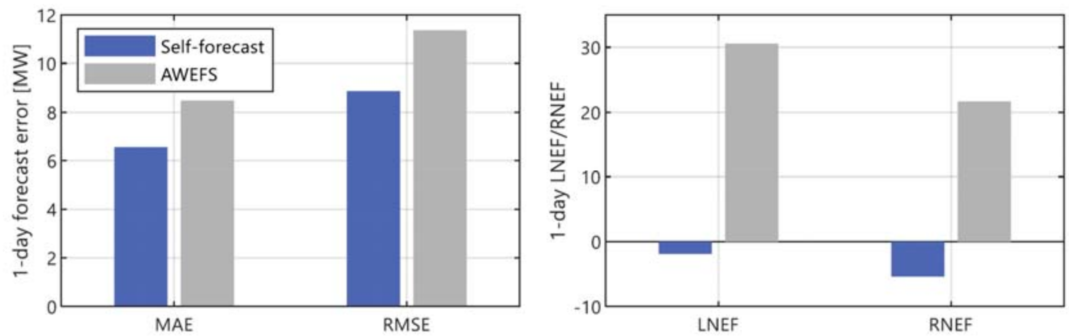

Figure 1: Analysis from 30Sep20.

Lesson learnt No.3: LIDAR based forecasts can be delayed due to both hardware and software reasons; and a secondary forecast should be in place for when they are not available.

Category: Technical

Objective: Demonstrate the ability to submit five-minute ahead self-forecasts via AEMO's web based MP5F API.

Details: Recently we've encountered two types of errors with our LIDAR based forecast that have led to changes in its performance. These changes have stressed how essential a secondary forecast is (one that does not rely on the data from the LIDAR) in the event of one of these occurrences. The software change occurred after LIDAR maintenance, where the previously used file format was removed and the code had to be updated to deal with a new format. This lead to a brief period in which we were unable to use the LIDAR to forecast. The second delay is one that has been exacerbated by the international border closure with COVID-19; one component of our LIDAR has failed and the technicians certified to replace it are unable to travel from France to repair our device. As such, our maximum measurable range has been decreased and that continues to impact our pre-production forecasts.

Implications for future projects: Participants using devices such as a LIDAR or external sensor not part of the SCADA system should have a contingency plan in the event the device fails for a period of time.

Lesson learnt No.4: Provision of sufficient data storage/overwriting of old data.

Category: Logistical

Objective: Other

Details: To prevent potential lapses/failures in self-forecasts, participants should ensure they either have an expandable data-storage setup or have a setup which will overwrite their oldest data and allow them to continue with a fixed amount of data storage.

Implications for future projects: Projects should ensure they provision sufficient data storage in a framework that is suitable for an ever increasing influx of data.

Lesson learnt No.5: Correcting our estimated savings based on the causer pays cost recovery mechanism (part 1).

Category: Commercial

Objective: Investigate the potential commercial benefits of wind and solar farms investing in short-term, self-forecasting solutions.

Details: We discovered that we had been using an incorrect value of our causer pays charges to estimate our causer pays savings (we had included all ancillary service charges instead of just the regulation charges). We also found that we had incorrectly accounted for the delay between the period over which our causer pays factor is calculated based on wind farm performance, and the period over which that calculated factor is applied to our payments. We have since corrected these discrepancies and feel we have accurately captured our savings due to our reduction in ancillary service charges.

Implications for future projects: Projects should be extremely careful when calculating their savings and ensure their assessment methodology aligns with AEMOs.

Lesson learnt No.6: Correcting our estimated savings based on the causer pays cost recovery mechanism (part 2).

Category: Commercial

Objective: Investigate the potential commercial benefits of wind and solar farms investing in short-term, self-forecasting solutions.

Details: As we looked further in correcting our ancillary service savings code, we found that the AEMO provided FCAS files (http://www.nemweb.com.au/Reports/Current/Causer_Pays/) do not provide a linear interpolation between forecasts to determine 4-second deviations. Instead, step values are provided. However, the causer pays procedure requires calculating the 4-second deviation from a linear trajectory between dispatch targets. Therefore the AEMO provided data must be adapted in order to calculate a linear trajectory prior to undertaking the assessment.

Implications for future projects: Projects should be extremely careful when calculating their savings and ensure their assessment methodology aligns with AEMOs.

Lesson learnt No.7: Significant implications from Bureau of Meteorology (BoM) ACCESS Model upgrade (Oct 2020).

Category: Technical

Objective: Other (use of BoM data for longer horizon forecasts)

Details: In Oct 2020, the Bureau of Meteorology (BoM) made a significant upgrade to the ACCESS-VT model (APS2 to APS3 version) which is being used to develop the 24-hour ahead wind and power forecast for Mt Mercer. The upgrade led to changes in the available data, including

- changes to data file formats;
- availability of new meteorological variables and the removal of others;
- changes to file names under which different variables are stored;
- changes to variable names, both external and internal to metadata;
- some variation to the underlying model topography; and
- changes to the recording of timestamps.

Such significant structural alterations to the available BoM data required considerable adaptation of code written to download, read and process the new datasets. It also has

significant implications for forecasting methodologies, where models trained on the previous version will no longer be applicable to the latest available data. Assuming therefore that applicable data for the development of the 24-hour ahead forecasts is only available from Oct 2020, it is most appropriate to use a moving window approach to model training.
Implications for future projects: Projects should pay close attention to upgrades or changes to externally sourced input data streams, with significant adaptation potentially necessary.

Lesson learnt No.8: Operational set-up of a 24-hour ahead forecasting system can have significant implications for accuracy.
Category: Technical
Objective: Other (use of BoM data for longer horizon forecasts)
Details: In developing a 24-hour ahead forecasting system, the operational set-up, such as the frequency of forecast runs or the time of day that a forecast is projected, can have significant impacts on the accuracy and consistency of results. The MAE and RMSE were considered for a number of models when run once a day, every 6 hours, or every hour. It is noted that the BoM ACCESS-VT model is initialised every 6 hours, and so new meteorological data is only available four times a day. It can also be shown that different ACCESS runs achieve different levels of accuracy. Forecasts incorporating observed wind speed or power output from Mount Mercer benefit from being run more frequently to capture the most up to date data, but this benefit is only evident in the first few hours of the forecast horizon. Detailed analysis as well as understanding the strategic goals for the forecast are required to optimise the operational set up of the forecast system.
Implications for future projects: Projects should be aware of the impacts of operational set up on forecast accuracy and consistency and consider steps to balance operational constraints with strategic aims.

Lesson learnt No.9: Night time boundary layer phenomena can have an impact on power output on otherwise still nights.

Category: Technical

Objective: Other (meteorological phenomena observed on site)

Details: Historical analysis of vertical scan data from the LIDAR has shown the occurrence of nocturnal boundary layer phenomena known as Low-Level Jets (LLJs) at Mount Mercer. During otherwise still nights, it is possible to see an injection of strong winds from the upper atmosphere which have the potential to increase wind speeds at hub height when they would otherwise be relatively low. A number of LLJ cases have been identified around 300-500m above the surface when increased wind speeds are also observed at the 80m met masts on site. Concurrent increases in power output from Mount Mercer can also be seen. An example of this behaviour is shown in Figure 2 on 10th January 2020.

Implications for future projects: Projects should be aware of the potential impacts of such phenomena on power output at seemingly unusual times.

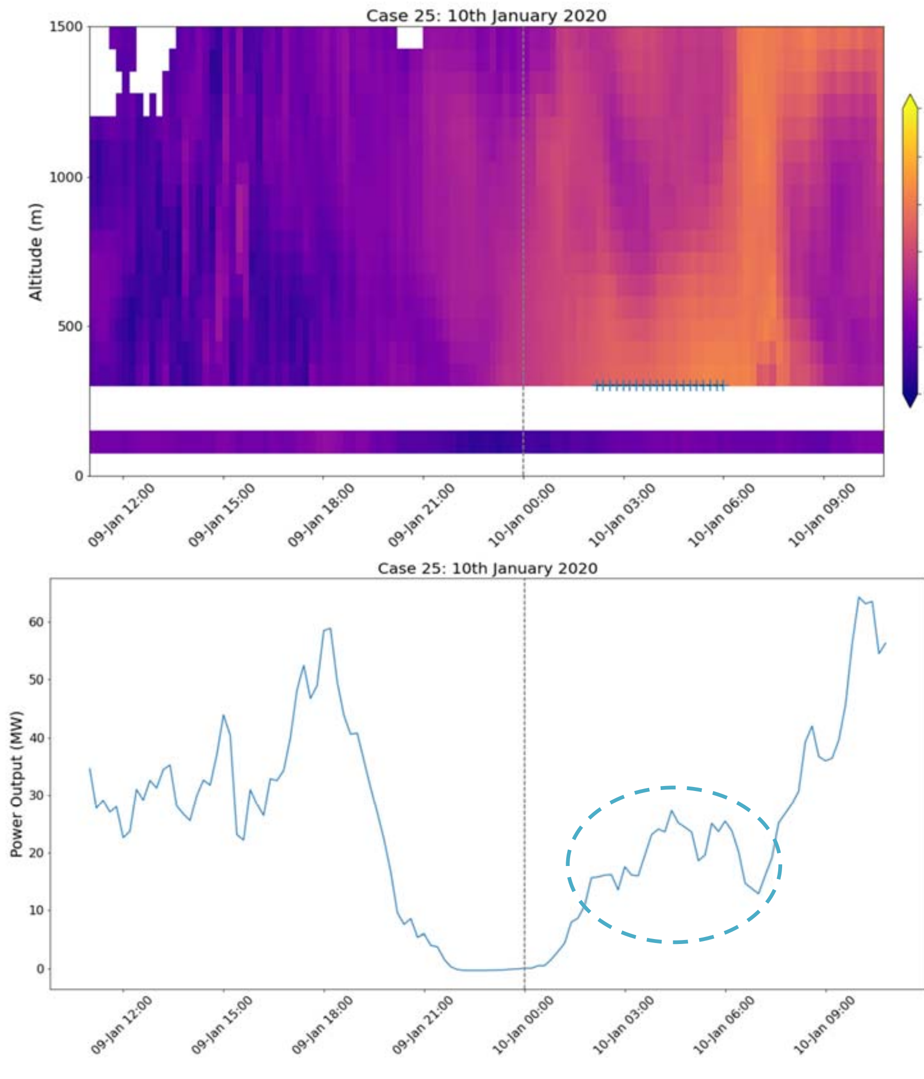

Figure 2: Identification of low-level jet (shown in orange in top pane) on 10 Jan 2020, and the concurrent increase in power output (circled in bottom pane).