FULCRUM3D CLOUDCAM SOLAR FORECASTING FOR THE NEM PROJECT (2018/ARP170)

PROJECT RESULTS AND LESSONS LEARNT

Lead organisation:	Fulcrum3D		
Project commencement date:	19 September 2018	**Completion date:**	31 January 2021
Date published:	15 February 2021		
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Acknowledgement:

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program

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Executive Summary

The objective of this project was to provide high accuracy short-term power forecasts utilising all-sky cameras and state-of-the-art software at Genex Power's 50 MW Kidston Solar Farm in Queensland.

The key driver for this project was to reduce Causer Pays charges which can be incurred when a semi-scheduled generator is unable to meet the generation target set by the Australian Energy Market Operator (AEMO) dispatch system. In 2018 AEMO enabled semi-scheduled generators to submit their own five-minute forecasts through their MP5F API. It was expected that self-forecasts that are more accurate than AEMO's forecasts would lower the solar farm's Causer Pays penalties.

Fulcrum3D installed 9 CloudCAMs (cameras) with their associated data loggers and NBN connection at Kidston Solar Farm. These were incorporated with the existing Kidston SCADA system in conjunction with a new, highly detailed power model. The model uses data inputs from power station equipment (including inverters, dataloggers, and met stations) and models the current unconstrained generation capability.

These systems work together to produce five-minute forecasts of Kidston Solar Farm output and submit them to AEMO's MP5F API. This forecast is now being used in dispatch and is consistently outperforming ASEFS and reducing Causer Pays charges. The project has met its contracted outcomes.

The project's core achievement was demonstrating that it is possible to satisfy AEMO's accuracy requirements and achieve zero Causer Pays charges at solar farms via MP5F with generators operating under normal conditions.

Project Overview

Project scope

The objective of this project was to provide high accuracy short-term power forecasts utilising all-sky cameras and state-of-the-art software at Genex Power's 50 MW Kidston Solar Farm in Queensland.

The key driver for this project was to reduce Causer Pays charges which can be incurred when a semi-scheduled generator is unable to meet the generation target set by the Australian Energy Market Operator (AEMO) dispatch system. In 2018 AEMO enabled semi-scheduled generators to submit their own five-minute forecasts through their MP5F API. It was expected that self-forecasts that are more accurate than AEMO's forecasts would lower the solar farm's Causer Pays penalties.

Outcomes

Fulcrum3D installed 9 CloudCAMs (cameras) with their associated data loggers and NBN connection at Kidston Solar Farm. These were incorporated with the existing Kidston SCADA system in conjunction with a new, highly detailed power model. The model uses data inputs from power station equipment (including inverters, dataloggers, and met stations) and models the current unconstrained generation capability.

These systems work together to produce five-minute forecasts of Kidston Solar Farm output and submit them to AEMO's MP5F API. This forecast is now being used in dispatch and is consistently outperforming ASEFS and reducing Causer Pays charges.

The project's core achievement was demonstrating that it is possible to satisfy AEMO's accuracy requirements and achieve zero Causer Pays charges at solar farms via MP5F with generators operating under normal conditions. It is important to note that higher accuracy forecasts alone did not necessarily reduce Causer Pays charges. Our modelling of the FCAS Causer Pays system led to greater reductions than even perfect forecasts could achieve.

Key lessons learnt throughout the project are outlined in the sections below. Some of these lessons have already been published in previous lessons learnt reports and are also provided in our wind forecasting report as most of the key lessons learnt are applicable to both projects. We have selected the most valuable of the previously published lessons for this report which contains the following lessons learnt:

Transferability

Fulcrum3D self-forecasting for the NEM has been commercialised and is now available to all NEM connected semi-scheduled wind and solar farms.

The hardware and software developed through this project is immediately transferable to these generators and requires minimal site-specific integration and tuning.

Fulcrum3D has shared the knowledge developed through discussions with NEM participants, our website, media articles (these are also published on our website) and ARENA Lessons Learnt reports.

Conclusion and next steps

Our key conclusions are that self-forecasting is:

- Helping to improve NEM health by reducing forecast error.
- Providing self-forecasters with the opportunity to reduce their Causer Pays charges (often to as low as zero).
- Commercially viable.
- Enabled by a stable effective IT system.

We would like to congratulate AEMO on the initiative and thank ARENA and AEMO for establishing this self-forecasting demonstration program.

We would also like to acknowledge the incredibly valuable contribution that Genex Power have made. They are excellent partners.

Lessons Learnt

Lessons Learnt Report 1: Most self-forecasting on the NEM is enabling Causer Pays savings

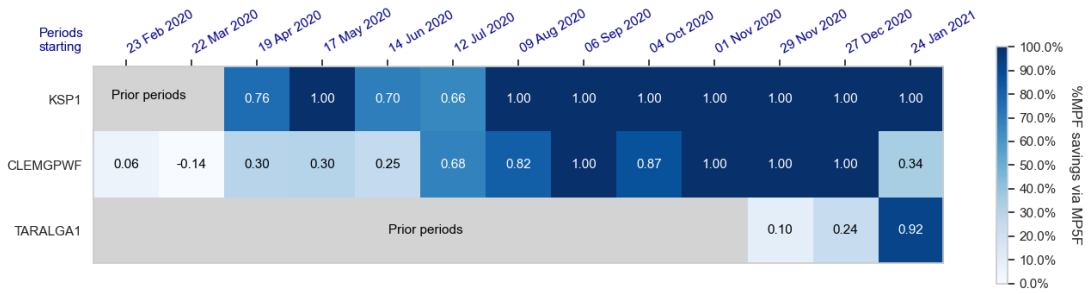
Project Name: *Fulcrum3D CloudCAM Solar Forecasting for the NEM*

Knowledge Category:	Financial
Knowledge Type:	Operation and maintenance
Technology Type:	Solar PV
State/Territory:	All NEM states

Key learning

The key project learning is that our analysis has found that most wind and solar farms that are self-forecasting through AEMO's MP5F self-forecasting facility are achieving Causer Pays savings. The savings at Fulcrum3D forecasting sites are shown in the figure below.

Figure 1: Causer Pays savings at Fulcrum3D Project sites:



Implications for future projects

Future projects could explore other potential benefits of short-term forecasting to generators and the grid system. Particularly as the market moves to five-minute settlement.

Knowledge gap

Whether self-forecasting would lower the cost of operating solar farms by reducing Causer Pays penalties.

Background

Objectives or project requirements

To assess the technical and economic viability of wind and solar farms self-forecasting on the NEM.

Process undertaken

Fulcrum3D developed a Causer Pays model as part of the Project and generated the above table by:

1. Using publicly available NEMWeb data to model FI. 4-second power measurements from NEMWeb for all metered generators and loads are then used to reconstruct the FCAS Regulation raise and lower factors for the entire NEM.
2. Comparing a generator's actual Causer Pays charges with those that would have been incurred if they were not self-forecasting and AEMO were instead using the five-minute forecasts from AWEFS or ASEFS. This requires AEMO excluded dispatch intervals to be accurate.

Lessons Learnt Report 2: Self-forecasting can reduce Causer Pays charges to as low as zero.

Project Name: *Fulcrum3D CloudCAM Solar Forecasting for the NEM*

Knowledge Category:	Financial
Knowledge Type:	Operation and maintenance
Technology Type:	Solar PV
State/Territory:	All NEM states

Key learning

It is possible to satisfy AEMO's accuracy requirements and achieve zero Causer Pays charges at wind and solar farms via MP5F with generators operating under normal conditions.

This reduction in Causer Pays penalties lowers the cost of operating solar farms and should ultimately benefit consumers through lower power prices. The reduction in forecast error also helps to improve grid stability.

Knowledge gap

Establishing whether self-forecasting can benefit the grid, market and/or consumers.

Background

Objectives or project requirements

To assess the technical and economic viability of wind and solar farms self-forecasting on the NEM.

Process undertaken

We found that we could reduce the MPF (Market Participant Factor) and resulting Causer Pays charges to as low as zero in some months.

Lessons Learnt Report 3: CloudCAM system hardware is reliable and robust.

Project Name: *Fulcrum3D CloudCAM Solar Forecasting for the NEM*

Knowledge Category:	Technical
Knowledge Type:	Operation and maintenance
Technology Type:	Solar PV
State/Territory:	All NEM states

Key learning

The CloudCAM system hardware has proved to be sufficiently robust in the high temperatures and often heavy rainfalls of Northern Queensland. It is was installed over 24 months ago and continues to operate well. We have not needed to return to site.

Fulcrum3D detected a small amount of water ingress in two of the nine CloudCAMs and corrected for it in software. The cause of the water ingress was identified and rectified for subsequent builds.

The ability to detect and correct such issues in a rapid manner demonstrates the power of modern "smart sensors", sophisticated communications and software and the upside of being the CloudCAM designer, integrator and OEM.

Implications for future projects

Future projects can confidently utilise the CloudCAM hardware.

Knowledge gap

Whether forecasting hardware is robust and reliable enough to make self-forecasting technically and economically viable.

Background

Objectives or project requirements

To assess the technical and economic viability of wind and solar farms self-forecasting on the NEM.

Process undertaken

Fulcrum3D tested the CloudCAM forecasting system hardware at Kidston Solar Farm for over 24 months.

Lessons Learnt Report 4: The NEM Dispatch Engine zeros negative self-forecasts.

Project Name: *Fulcrum3D CloudCAM Solar Forecasting for the NEM*

Knowledge Category:	Technical
Knowledge Type:	Operation and maintenance
Technology Type:	Solar PV
State/Territory:	All NEM states

Key learning

The NEM dispatch engine sets a zero floor for the dispatch target but the FCAS calculation uses negative numbers when generation is negative (i.e. the plant is a net consumer). So when plants are not generating power but consuming from the grid they can incur FCAS costs that cannot be managed by self-forecasting because MP5F and subsequent pipelines within AEMO's dispatch engine do not allow negative dispatch targets. Operational forecasting meeting notes from 2018 said MP5F would allow negative submissions but this is not the case. AEMO have been able to validate our internal analysis that this effect can contribute 10-20% to a generator's MPF.

It is worth noting that of all the semi-scheduled generators on the NEM, only four solar farms show negative generation for more than 5% of the time, but there are 25 wind farms that do. There appears to be a systematic modification of some SCADA power feeds which may bias FCAS Causer Pays costs towards wind farms.

Implications for future projects

A future project could explore whether the NEM dispatch engine could be modified to deliver negative dispatch targets.

Knowledge gap

Knowledge around whether there are any limitations in the efficacy of self-forecasts.

Background

Objectives or project requirements

To assess the technical and economic viability of wind and solar farms self-forecasting on the NEM.

Process undertaken

Fulcrum3D observed increased Causer Pays during negative generation at some plants and found that this was due to the NEM Dispatch Engine zeroing negative self-forecasts at those plants.

Lessons Learnt Report 5: A rounding feature in AEMO's dispatch engine appears to affect forecast accuracy.

Project Name: *Fulcrum3D CloudCAM Solar Forecasting for the NEM*

Knowledge Category:	Technical
Knowledge Type:	Operation and maintenance
Technology Type:	Solar PV
State/Territory:	All NEM states

Key learning

A rounding feature in AEMO's dispatch engine appears to make it impossible to forecast accurately when the plant is at full capacity.

A setting in AEMO's system appears to round the dispatch target down to the nearest MW in the dispatch engine. This means that it is impossible to forecast accurately when the plant is permitted to produce at full capacity and is doing so.

Implications for future projects

A future project could explore whether the NEM dispatch engine could be modified so that it does not round down to the nearest MW.

Knowledge gap

Knowledge around whether there are any limitations in the efficacy of self-forecasts.

Background

Objectives or project requirements

To assess the technical and economic viability of wind and solar farms self-forecasting on the NEM.

Process undertaken

Fulcrum3D observed unexpected Causer Pays charges when plants were unconstrained, forecasting maximum capacity and operating at that capacity. We found that this was because the NEM Dispatch Engine was rounding the dispatch target down to the nearest MW.

Lessons Learnt Report 6: The MP5F API is increasingly robust and reliable.

Project Name: *Fulcrum3D CloudCAM Solar Forecasting for the NEM*

Knowledge Category:	Technical
Knowledge Type:	Operation and maintenance
Technology Type:	Solar PV
State/Territory:	All NEM states

Key learning

The MP5F API is increasingly robust and reliable. The MP5F API is stable and has been materially streamlined in the last 12 months. This process was recently further improved with an API to enable the password changes that are regularly required. This password change API is also working well.

Implications for future projects

Future projects can proceed with confidence that the MP5F API is robust and reliable.

Knowledge gap

Whether the proposed API could enable effective self-forecasting.

Background

Objectives or project requirements

To assess the technical and economic viability of wind and solar farms self-forecasting on the NEM.

Process undertaken

Fulcrum3D has effectively integrated with the MP5F API and is now using it on over twelve sites.

Lessons Learnt Report 7: SCADA integration is now the most complex part of the self-forecasting system.

Project Name: *Fulcrum3D CloudCAM Solar Forecasting for the NEM*

Knowledge Category:	Technical
Knowledge Type:	Operation and maintenance
Technology Type:	Solar PV
State/Territory:	All NEM states

Key learning

SCADA integration is now the most complex part of deploying a self-forecasting system. Real-time integration with the solar or wind farm SCADA system is critical to effective self-forecasting.

While the MP5F API and our self-forecasting system have matured to the extent they are easily repeatable across sites, site-specific SCADA integration is now the most variable component in the establishment of a self-forecasting system. While this task is not necessarily technically challenging for experienced personal, it can be highly time consuming to configure interfaces and QA all SCADA tags.

Implications for future projects

Awareness that integration with plant SCADA is sometimes not trivial.

Knowledge gap

Challenges associated with self-forecasting.

Background

Objectives or project requirements

To assess the technical and economic viability of wind and solar farms self-forecasting on the NEM.

Process undertaken

Fulcrum3D have integrated our forecasting system with plant SCADA on over twelve NEM plants. Some SCADA systems are old or complex. We have always been successful, but it is worth noting that this integration to establish near real-time plant data feeds is now the most complex aspect of establishing self-forecasting on a new wind or solar farm.