Proa Analytics Pty Ltd: Proa Analytics Solar Forecasts Project

LESSONS LEARNT REPORT 2

Project Details	
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EXECUTIVE SUMMARY

This is the second public Lessons Learned report from the ARENA funded Proa Solar Farm Short Term Forecasting Project.

Proa (proa.energy) is an Australian solar forecasting and energy system modelling company founded in 2016. Proa's solar farm forecasts have already achieved the milestone of the first self-forecasts approved by AEMO for NEM Dispatch[1], including Proa's forecasts for the Kidston Solar Farm as part of this project.

Figure 1: Example of Proa skycam system at NEM solar farm.

As part of this project, Proa will demonstrate its solar forecasting services at three NEM solar farms in the three main climate zones of the NEM:

- Tropical: Kidston Solar Project (QLD) in partnership with owner and operator Genex Power
- Sub-tropical: Oakey 1 Solar Farm (QLD) in partnership with owner and operator Oakey 1 Asset Company
- Temperate: Bannerton Solar Project (VIC) in partnership with owner and operator Foresight Australia.

This project will continue until January 2021. As the project progresses, we continue to learn more about self-forecasting the NEM and techniques to increase forecast accuracy. This Knowledge Sharing report is intended to share some of the Lessons Learnt during the project, noting that this is an interim report. The Lessons Learnt presented here include:

1. Commercial benefits of self-forecasting
2. Benefits for self-forecast providers to manage AEMO password renewal themselves
3. Benefits of skycams for short term-forecasting

1 https://www.aemo.com.au/News/AEMO-approves-first-solar-farm-forecast

4. Importance of cleaning skycam lenses

KEY LESSONS LEARNED

Lesson learnt No. 1: Solar Forecasting

Category: Commercial

Objective: Commercial benefits of self-forecasting

Self-forecasts from Proa have already reduced the Causer Pays factors for Kidston Solar Project (KSP) from an average over 5 months of 0.383 to 0.200. This reduction has already produced significant financial benefits for KSP.

Causer Pays Factors are the mechanism by which AEMO recovers the cost of Regulation Frequency Control Ancillary Services (FCAS). Regulation FCAS is the service which maintains NEM frequency in a narrow band around 50 Hz during normal operations. Each 28 days, the Causer Pays Factor for a generator is determined by the average deviation (defined in a particular way) between the generator's actual output and its NEM dispatch trajectory in each dispatch interval. For solar farms and wind farms, the NEM dispatch trajectory is the forecast for 5 minutes ahead (either a self-forecast or from ASEFS). The full procedure is available on the AEMO website[2]. Note that Causer Pays Factor is also known as Market Participation Factor (MPF). Causer Pays Regulation FCAS costs for all NEM mainland generators rose from $2M in 2014 to $115M in 2019 (source AEMO)[3] and are now a significant cost for solar and wind farms in the NEM.

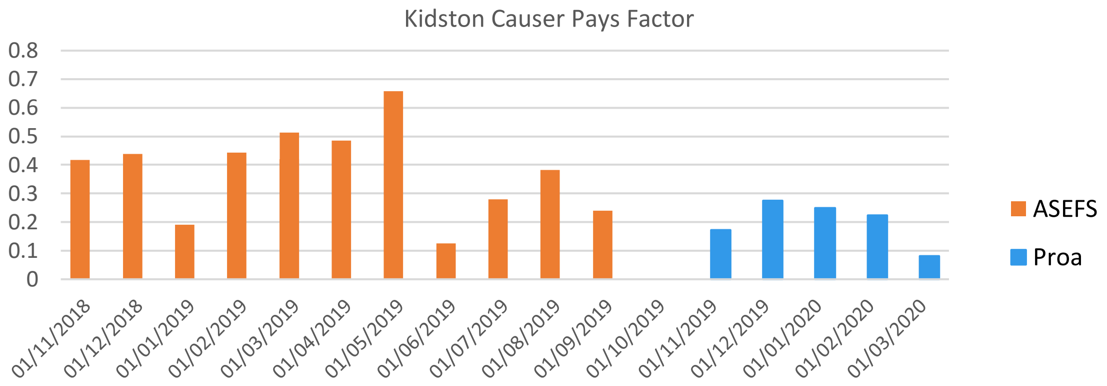

Figure 2: Kidston KSP1 Causer Pays Factor over each 28 period from ASEFS and Proa forecasts. Note that Kidston was offline for the Causer Pays Period beginning 1/10/2019. Source: AEMO

Forecast provider	Average Causer Pays Factor	*Period*
ASEFS	0.382	*11 Nov 2018 – 31 Mar 2019*
Proa	0.200	*10 Nov 2019 – 29 Mar 2020*

2 Causer Pays FCAS Procedure, AEMO, https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/ancillary-services/ancillary-services-causer-pays-contribution-factors
3 Causer Pays FCAS costs data, AEMO, https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/data-nem/ancillary-services-data/ancillary-services-payments-and-recovery

Table 1: Mean Causer Pays Factors for ASEFS and Proa forecasts from the same 5 month period (November to March) in two different years. Note that Causer Pays Periods have a 28 day duration, hence do not begin on precisely the same day each year.

As shown in Figure 2 and Table 1, according to official Causer Pays Data published by AEMO, Proa self-forecasts have produced an average Causer Pays factor of 0.200 for the period of November 2019 to March 2020 compared to 0.383 from ASEFS over the same 5 month period the previous year (November 2018 to March 2019). This method of comparison is simple and also has the advantage that it only relies on official Causer Pays Factors published by AEMO. This reduction is also confirmed by Proa's internal analysis of ASEFS Causer Pays performance during this time. Note that Causer Pays Factors typically fluctuate from month to month, as can be seen in Figure 2, depending on the correlation between NEM frequency and the forecast/dispatch performance of all generators. However, a clear reduction in average CPF over an extended 5-month period demonstrates a clear and material financial benefit to solar farms of self-forecasting.

As this project progresses, Proa looks forward to further demonstration and better understanding of the financial benefits of self-forecasting.

Lesson learnt No. 2: Improved NEM processes

Category: Operational

Objective: Benefits of ability of self-forecast providers to manage AEMO password renewal themselves

AEMO's IT roadmap includes changes to its IT platforms to allow self-forecast providers the ability to reset the self-forecast password via an API. We expect this to be a significant improvement in the process of supplying self-forecasts and maintaining an interface with AEMO systems.

As noted in the ARENA Knowledge Sharing reports in October 2019 from Proa and other participants in the ARENA solar and wind short term forecasting projects, the current method of maintaining a valid AEMO self-forecasting password is time-consuming and contains risk.

In order to submit self-forecasts to AEMO, self-forecasters need to be registered with AEMO and to have a valid individual password for each solar or wind farm. Such passwords expire automatically every 90 days and need to be manually reset before this time, otherwise any self-forecast submission will be automatically rejected by AEMO systems. Currently, this password can only be reset by the Registered Market Participant via AEMO's EMMS portal. For independent self-forecasting companies such as Proa, this meant that we would need to request a password reset from each of our solar farm partners well before the 90 day threshold. Such a process had a significant overhead in communication and administration, as well as creating risk that a key person would be unavailable at a critical time. The additional workload effectively increased the costs for a solar farm in providing self-forecasts to AEMO.

However, Proa understands that AEMO is currently developing and testing a new method for self-forecasters to reset the password themselves via API, and it is expected to be completed soon. Proa appreciates the work done by AEMO to develop this new IT functionality. We believe that when released, it will remove a significant workload and risk for a solar farm to engage a self-forecasting provider, which will help to encourage a sustainable independent solar and wind forecasting industry in Australia.

Lesson learnt No. 3: Solar Forecasting

Category: Technical

Objective: Benefits of skycams for short term forecasting

Solar generation forecasts for 5 minutes ahead are an extremely short time frame, and benefit from the most up to data from the solar farms' SCADA, as well as the highest resolution and most recent information about clouds around the solar farm. Two main sources of cloud images are available for short-term solar forecasts: satellite images and skycam images from cameras located at a solar farm. Currently, Proa uses the satellite images from the *Himawari-8 geostationary* satellite, which provide the highest resolution images available in Australia for solar forecasting. The *Himawari-8* satellite produces images every 10 minutes with approximately 0.5 km x 0.5km resolution. However, delays in data transfer mean that satellite image can be more than 15 minutes old when used to make some forecasts. For solar forecasts of one to six hours ahead, update delays of several minutes have little impact, and that the fact that satellite images cover more than the entire Australian continent mean that satellite images are the most important component of forecasts up to 6 hours ahead. However, for forecasts of five minutes ahead such delays are significant. Moreover, the footprint of solar farms may only be represented by 2-5 pixels in these images, which can introduce inaccuracies when modelling local cloud structures.

The experience of the project to date has demonstrated the benefits of skycam imagery for short term forecasting of generation. Skycam images, installed onsite and operated by Proa can take images as often as required and transferred to our computing servers in a matter of seconds. Skycam images have varying spatial resolution depending on the distance from the solar farm, due to the distorting fisheye effect of the camera, but it is approximately 10-20 times greater for clouds 0.5 to 4 km from a solar farm (depending on cloud height) and remains greater than satellite images for clouds up to 30 km away.

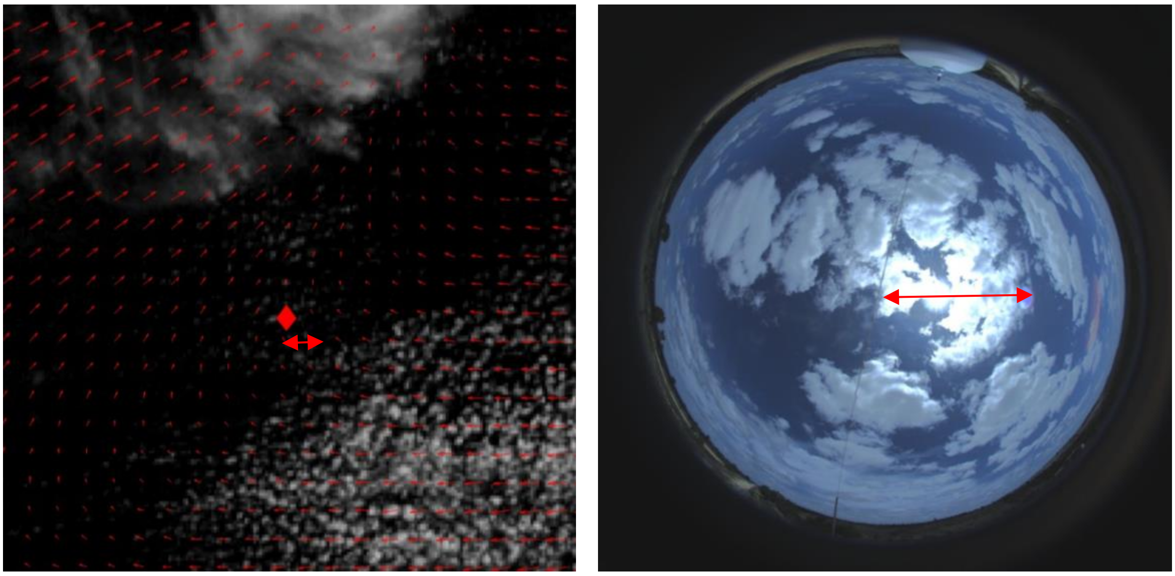

Figure 3: Comparison of cloud images in satellite (left) and skycam (right) at Kidston solar farm at noon on 1/2/2020. Each pixel in the left satellite image represents approximately 0.5 km x 0.5 km, with the red arrow representing around 20 km). The red arrow in the right skycam image also represents around 20 km at ground level (assuming clouds at 3000 m altitude).

The increased resolution of skycam images compared to satellite images is shown in Figure 3: Comparison of cloud images in satellite (left) and skycam (right) at Kidston solar farm at noon on 1/2/2020. Each pixel in the left satellite image represents approximately 0.5 km x 0.5 km, with the red arrow representing around 20 km). The red arrow in the right skycam image also represents around 20 km at ground level (assuming clouds at 3000 m altitude). . This figure shows both satellite and skycam images in the area around Kidston solar farm at noon 1 February 2020. At this time, as is common in tropical areas during summer months, there were numerous small, dense, and rapidly evolving clouds which can form and dissipate over the time scales of minutes. To forecast such clouds is challenging and forecast accuracy is reduced during the wet season compared to the dry season. As a result of this experience, Proa has been developing several new techniques specifically aimed at improving forecasts for such conditions. Testing of these new techniques is almost complete with promising results to date, and we look forward to implementing them into production and reporting on their results in future knowledge sharing results.

Lesson learnt No. 4: Solar Forecasting

Category: Technical

Objective: Importance of skycam cleaning

During the project to date, the impact of skycam lens soiling and the importance of frequent lens cleaning has been evident, echoing the experience reported by other solar forecasting projects.

Figure 4 shows example images of cloud images from both cleaned and soiled (i.e. dirty) skycam lens. A clean lens is required to interpret the cloud image with the full resolution of the skycam image. With a dirty lens, scattering and absorption of light from dust particles on the lens cover makes it is difficult to identify clouds clearly and accurately. Satellite images, despite the lower spatial resolution and update frequency, do at least benefit from being operated in the clean environment of 35,000 km above the Earth, which provides a useful fallback when soiled lenses make the skycam forecasts suboptimal.

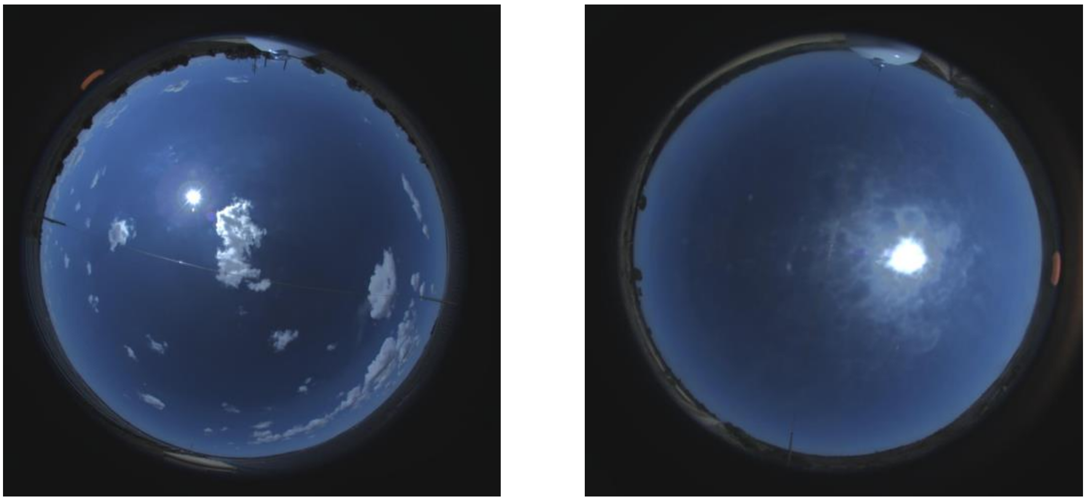

Figure 4: Example of cloud image from clean skycam lens (left) and dirty lens (right)

The need to regularly clean sky lenses at remote solar farm locations is challenging and an important consideration in planning solar forecasting activities. Solar farms are frequently located in arid, sunny environments where dust is common. Over many years, the cost of regular cleaning can be considerable for solar farm operators. There is also a trade-off to be considered when installing skycam systems. Skycams benefit from being installed high above the ground, to have a clear view of the sky unobstructed by the tracking systems, control room buildings, and inverters containers commonly found at solar farms. However, to place a skycam many meters above the ground can make it time consuming and costly to safely clean the lens.

The implication for future projects is to consider the need to regularly clean the skycam system whilst allowing skycams to be installed in locations with an unobstructed view of the clouds above the solar farm. This could include installing safe anchor points, permanent ladders, and/or other systems which simplify regular skycam cleaning.