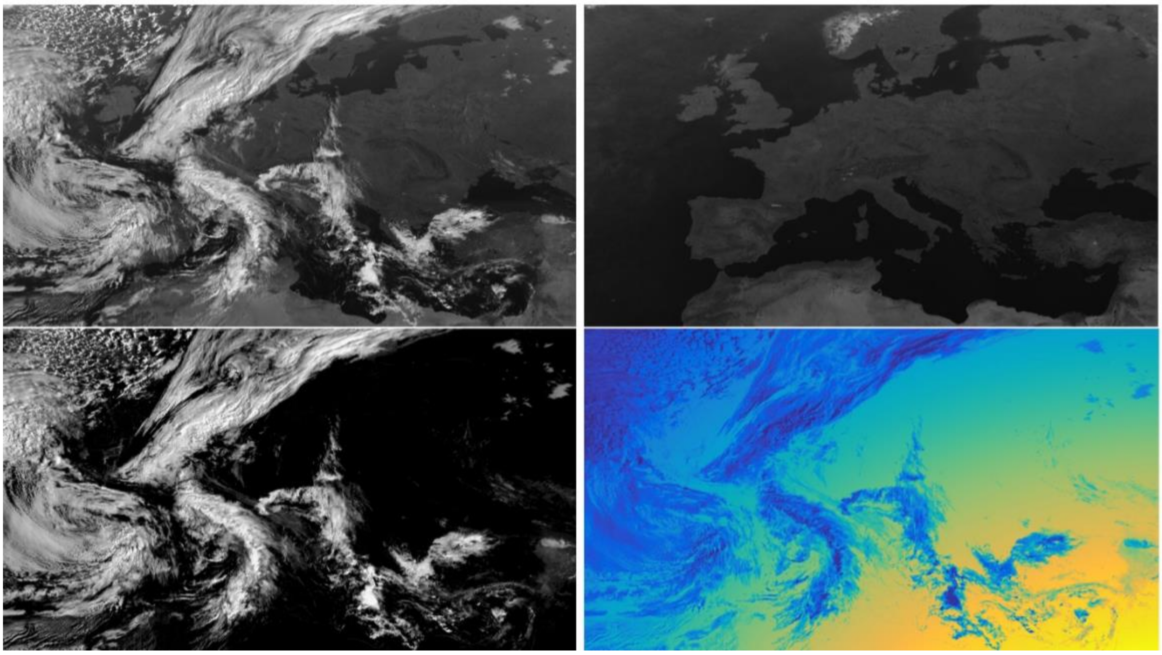
Solcast nowcasting for solar farms and the Australian energy sector

LESSONS LEARNT REPORT No: 2



Forecasting cloud cover and irradiance from raw satellite imagery. Image rendered from Solcast systems

PROJECT DETAILS

Recipient Name	Solcast
Primary Contact Name	Dr. Nick Engerer
Contact Email	nick@solcast.com
Reporting Period	October 2019 – April 2020

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program - Short Term Forecasting funding round.

EXECUTIVE SUMMARY

Solcast has deployed short-term forecasting solutions to eight Australian solar farms in this ARENA funded Project, and an additional eight solar farms outside the Project. The Project has demonstrated forecasts utilising sky-imager technology can improve forecast accuracy over the short-term, but that an ensemble forecasting approach considering multiple inputs is the preferred solution. Solcast has demonstrated reduced forecasting errors compared to ASEFS at all solar farms. Solcast found that configurable hardware options are preferred by solar farms, and that a cloud-hosted centralised forecasting system reduces forecast improvement iteration time and increases the speed of hardware and algorithm upgrades.

INTRODUCTION

Solcast is a global solar data services company specialising in satellite-based measurement and forecasting of solar irradiance and solar production, with offices in Sydney, Glasgow and Canberra. Our vision is a solar future - we're dedicated to developing the data and tools needed to plan, construct, operate and manage solar power systems across the world. The Solcast API is trusted by more than 6,000 users, with data for over 1,000,000 locations around the globe.

In this ARENA funded project, Solcast is demonstrating and refining very short-term five-minute ahead solar power forecasts for eight solar farms in the Australian National Electricity Market (NEM). The forecasts are submitted on behalf of the solar farms to the Australian Energy Market Operator (AEMO) for use in dispatch.

Solcast's approach to five-minute ahead NEM self-forecasting is based upon three elements:

1. 3rd generation weather satellite cloud nowcasting system, which identifies, characterises and models cloud cover in three-dimensions and predicts their future positions through fusion with weather forecasting model outputs;
2. real-time data from solar farm supervisory control and data acquisition system (SCADA) used to reweight background satellite-derived ensemble forecast and to communicate inverter availability and/or active constraint;
3. and one-minute forecasts derived from on-site sky-imagers.

The five-minute forecast is generated in the cloud on centralised servers by blending the three forecast components listed above and is exposed via a Solcast API (Application Programming Interface) endpoint for submission to the AEMO API.

Solcast is now successfully submitting five-minute forecasts to the AEMO API for all eight solar farms. AEMO requires all forecasts to undergo an assessment to establish the accuracy and reliability of the new forecasting system. Key to this is demonstrating lower error than the Australian Solar Energy Forecasting System (ASEFS). Solcast has demonstrated reduced errors compared with ASEFS at all eight solar farms, and AEMO has accredited the forecasts for use in dispatch at six farms. The remaining two solar farms are expected to gain accreditation within the minimum 8-week period necessary.

KEY LEARNINGS

Lesson learnt No. 1: Ensemble forecasting with sky-imagers for short-term forecasting

Category: Technical

Objective: Demonstrate the five-minute ahead self-forecasts are more accurate than the AWEFS and ASEFS

Solcast's short-term forecasting ensemble is configurable with or without a sky-imager. When configured without a sky-imager, the forecasting ensemble uses forecasted irradiance and power values from Solcast's proprietary satellite cloud nowcasting system reweighted by real-time SCADA data. When compared with a persistence-based forecast using SCADA data (such as ASEFS), Solcast finds the addition of satellite nowcasting can reduce forecast errors.

When configured with a sky-imager, the forecasting ensemble uses a high-quality sky-imager forecast to capture the shape and timing of cloud impacts more precisely than satellite imagery. For 30+ minutes ahead forecasting, Solcast finds a high-quality sky-imager forecast adds little value to the forecasting ensemble. Over the 0-30 minutes ahead forecasting period, Solcast was able to further reduce forecasting errors relative to a satellite + SCADA forecast with the inclusion of a high-quality sky-imager forecast. For this Project where the 5 minute ahead forecast is critical, the inclusion of a high-quality sky-imager forecast in the forecasting ensemble is therefore recommended to achieve a lower average forecasting error.

While a high-quality sky-imager forecast is necessary for best performance for short-term forecasting, the sky-imager forecasts are fragile and prone to errors. The most common issue is dirt residue on lens caused by rain or wind, but Solcast has also encountered insects crawling over the lens, birds landing on them, and residue from bird droppings. These are issues are easily rectified by periodically wiping the lens, but can cause well-designed algorithms to produce significant forecasting errors even under completely clear skies by misidentifying local foreign objects as cloud cover.

It is therefore critical that the sky-imager forecast is not solely relied on to produce a forecast, and the redundancy offered by a multi-input forecasting ensemble is required. Further, it is critical that all forecasting elements in the ensemble are subject to real-time error checking and data validation to ensure spurious forecasts are excluded from consideration.

Lesson learnt No. 2: Sky-imager hardware

Category: Technical

Objective: Demonstrate the five-minute ahead self-forecasts are more accurate than the AWEFS and ASEFS

Solar farms have unique siting concerns regarding installation locations and configuration of sky-imager hardware. Primarily these relate to availability of communication links, power source, and suitability of specific install locations. Solcast found that a one-size-fits-all approach to sky-imager hardware can cause delays in installation, or sub-optimum install locations. To address this, Solcast configured sky-imager hardware with multiple communication, power supply, and mounting options to cater for a wide variety of install locations. Future projects should consider investing in flexible options for hardware configurations, both to ensure optimum install locations, and to reduce any expenditure required to modify or customise hardware on an individual basis to suit requirements.

Example sky-imager installation solution with solar power.
Image from Bloomsky

Sky-imager mounted above a solar farm. Image from Bloomsky

Implications for future projects

Solcast's findings in this Project have several key implications for future solar projects in the NEM, and for short-term forecasting in a wide variety of other applications including forecasting for dispatch, ramp rate control, optimising bidding strategies and optimising battery size and operation.

1. Ensemble forecasting with multiple inputs, including critically one or more sky-imagers, can reduce errors compared with persistence forecasting. In the NEM, where solar farms are able to 'self-forecast' and submit their own forecast to the market operator (AEMO), the deployment of an ensemble forecast solution can reduce the FCAS Causer Pays fees levied by the market operator. Extrapolating this, reduced forecasting errors in aggregate from many semi-scheduled weather-as-fuel generators operating in the market will reduce the magnitude of frequency matching services required, and therefore reduce the market-wide cost of FCAS.
2. Configurable and low-cost hardware while centralising the complex and expensive modelling hardware and software is the preferred commercial approach. This solution design allows for rapid iteration and upgrades, flexible install and siting options, quick deployment times, and greater value transfer from forecast provider to the participant solar farm, and to the NEM in aggregate.