ARENA Short Term Forecasting trial

Clean Energy Council Large-Scale Solar Forum | 16 May 2019

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AGENDA

1. Trial overview
2. Portfolio overview
3. Anticipated benefits

4. System design and implementation
5. Where are we now?
6. What’s next?

1 TRIAL OVERVIEW: An ARENA/AEMO collaboration

Explores and demonstrates the potential for forecasting technologies to provide accurate solar and wind site-specific forecasts;

- Registered Semi-scheduled (wind and solar) NEM Market Participants
- 5-minutes ahead (for use in market dispatch) as optional alternative to the AWEFS/ASEFS-generated forecast

1 Build industry capability

- **Enable a set of proof-of-concept projects** implementing reliable self-forecasts into AEMO systems.
- **Encourage a collective effort** to improve forecasts for intermittent generators.
- **Involve a mix of forecasting technologies** and generator sizes and types.

ARENA-led

2 Build AEMO systems

- **Design and build API to validate and accept participant dispatch self-forecasts** into AEMO's systems.
- **Establish robust processes** to support the validation and integration of 5-minute ahead forecasts from participants

AEMO-led

1 TRIAL OVERVIEW: Objectives are complementary

ARENA 'Short Term Forecasting'

- Demonstrate the ability for large-scale wind and solar plants **to submit 5-minute self-forecasts**
- Demonstrate the ability for self-forecasting **to be more accurate than the existing central forecasts**
- **Explore the potential commercial benefits** of investing in forecasting approaches
- **Examine factors that affect the accuracy of the forecasting approach trialled**; e.g. different weather, operational conditions or geographies

AEMO 'MP5F'

- Validate the ability for semi-scheduled market participants **to submit self-forecasts into an AEMO API**
- Explore whether self-forecasts can be **more accurate than the existing AWEFS/ASEFS forecasts**
- **Understand the potential operational benefits** of more accurate participant self-forecasts
- **Build foundational, future-proofed infrastructure** for new market capabilities

2 PORTFOLIO OVERVIEW

11 projects

$9.41m ARENA funding

33 generators

$21.1m project value

3570 MW

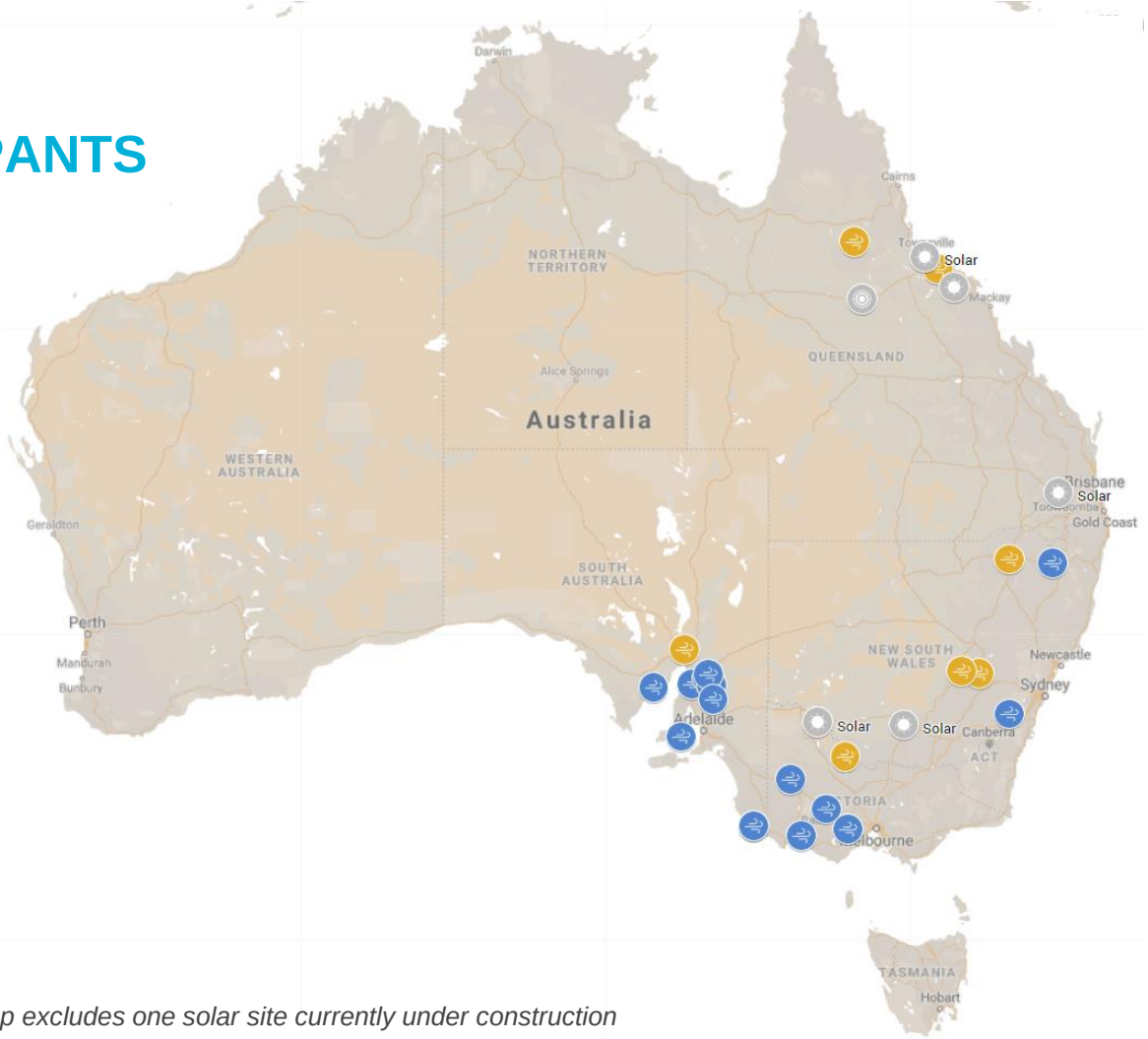
Solar: 1370MW | Sky cameras, satellite, machine learning

Wind: 2200MW | SODAR, LIDAR, SCADA, machine learning

2 PARTICIPANTS

Portfolio includes:

- **17 wind farms**
- **15 solar farms**
- **1 hybrid plant**



Operating:

- Wind
- Solar

Pipeline:

- Solar
- Hybrid
- Wind

NB. *Map excludes one solar site currently under construction*

2 SOLAR PARTICIPANTS – Five projects covering 15 sites

SOLCAST *– satellite, real-time SCADA, sky imagers*

PROA ANALYTICS *– combination forecasts*

SPEF *– Solar Power Ensemble Forecaster Project*

CSIRO Cloud18CAM™

FULCRUM 3D *– CloudCAM sky cameras*

ADVISIAN DIGITAL *–*

Machine learning prediction models

Advisiandigital

3 ANTICIPATED BENEFITS

TODAY: Existing operating principles

To solar and wind operators:

- Reduced FCAS costs
- Increased revenues

To the entire system:

- Greater stability and security
- Better integration of renewables

FUTURE: New operating environment

- Hybrid plant configuration
- Sophisticated operational and bidding strategies in a true 5-minute market
- Future-proofed IT architecture: e.g. hour-ahead forecast capable

APPENDIX: Further detail on 5 solar forecasting projects

SOLCAST:

- Delivering 8 stand-alone self-forecasting trials at semi-scheduled farms in the NEM over a two year period. Projects will leverage Solcast's global satellite based nowcasting services, combined with real-time solar farm SCADA data and sky-imagers to generate short-term power output predictions.
- Further information: https://solcastglobal.com/utility-scale/self-forecasting-for-australian-solar-farms/ , https://arena.gov.au/projects/solcast-nowcasting-solutions-for-solar-farms/

PROA ANALYTICS:

- Will demonstrate Proa's proprietary forecasts which combine skycam, satellite, numerical weather and live data forecasts at Kidston (tropical), Oakey 1 (sub-tropical), and Bannerton (temperate) Solar Farms.
- Will also trial a new IR skycam for improved cloud analysis during the day
- Further information: https://arena.gov.au/projects/demonstration-solar-forecasts/

SPEF – Solar Power Ensemble Forecaster Project:

- Further developing CSIRO's cloud camera that is currently used in remote applications adapting it for large scale grid connected solar farms. The project will also develop the Solar Power Ensemble Forecaster product - 4 solar forecasting models (Skycam, Statistical, Satellite, Blended NWP) in a blended ensemble.
- To be Installed and trialled at 5 solar farms spread across QLD, NSW & Victoria.
- Team includes: Industrial Monitoring & Control (IMC) + CSIRO, UNSW, UniSA
- Further information: https://arena.gov.au/projects/solar-power-ensemble-forecaster/

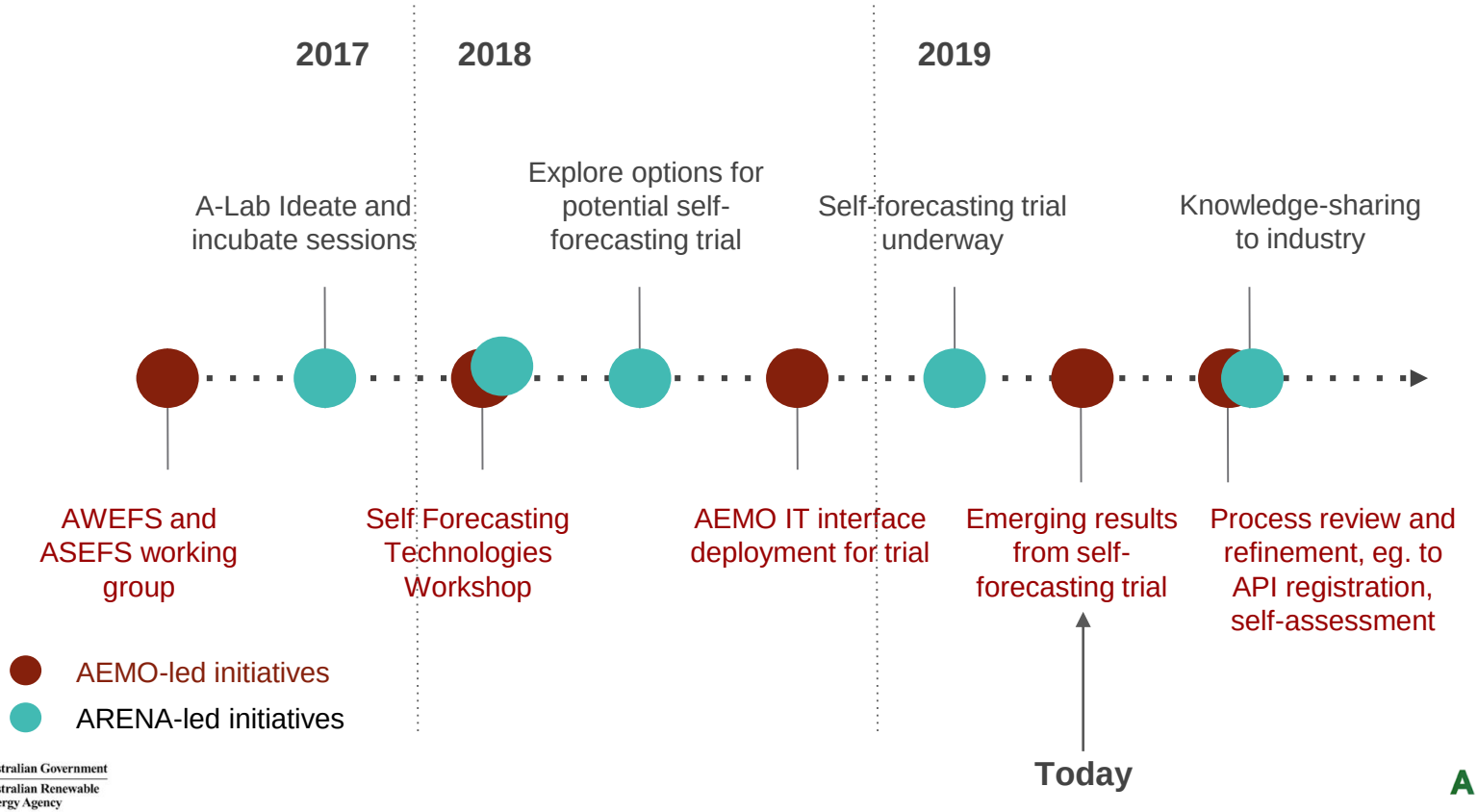
FULCRUM 3D:

- Nine all-sky cameras (Fulcrum3D CloudCAMs) have been installed at Genex Power's 50 MW Kidston Solar Farm in Queensland with all processing occurring onsite, including on-site software generating and delivering 5-minute forecasts to AEMO via MP5F API.
- Will assess factors including ability to reduce causer pays charges, optimise storage dispatch, manage spinning reserve requirements, provide FCAS support
- Further information: https://arena.gov.au/projects/wind-forecasting-nem/

ADVISIAN DIGITAL:

- Advisian Digital will develop ensemble machine learning models trained on historical data within a prediction framework that considers a wide range of variables, including cross-series information. They will be deployed at wind and solar farms in QLD & SA.
- Further information: https://arena.gov.au/projects/advanced-short-term-power-generation/

APPENDIX: What we've done - and where we are going



Clean Energy Council Large-Scale Solar Forum

Self-Forecasting

Thursday 16 May 2019

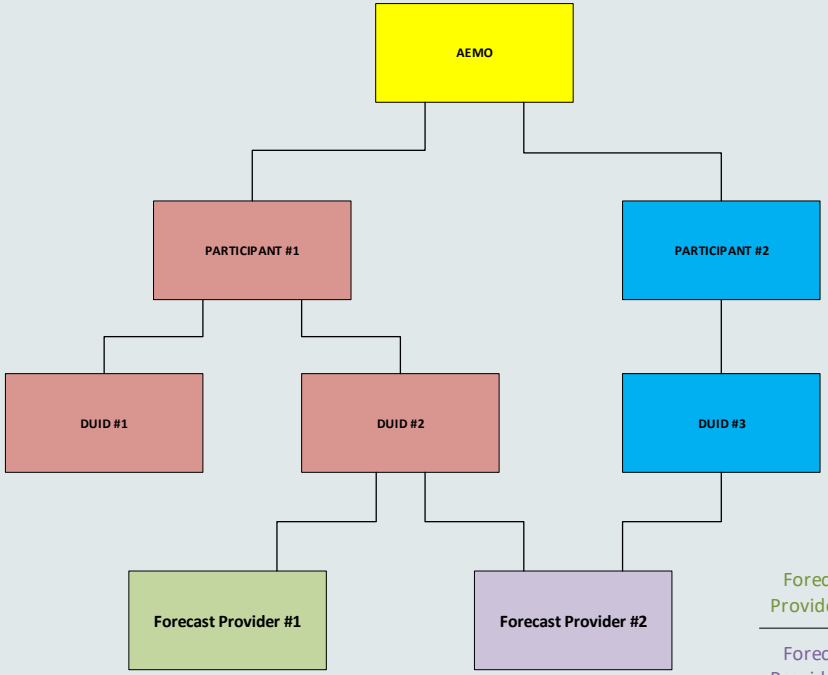
System Changes – Self Forecasting

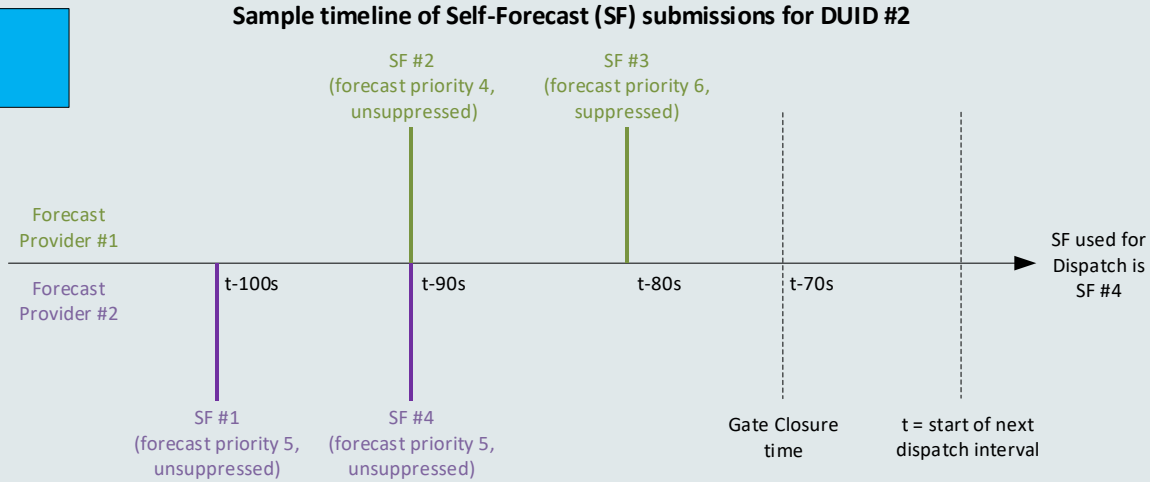
PREVIOUS STATE	CURRENT STATE
AEMO uses its AWEFS/ASEFS to produce forecasts of unconstrained intermittent generation from semi-scheduled generating units over the Dispatch, 5MPD, Pre-Dispatch and STPASA	As previous
Dispatch forecasts from AWEFS/ASEFS are largely based on SCADA data provided by participant	As previous, PLUS: **participant can optionally submit dispatch self-forecasts to AEMO**
Dispatch uses AWEFS/ASEFS forecast, if valid; else ● Uses unit's actual output, if valid; else ● Uses unit's previous dispatch target	**Dispatch process uses the latest of the highest priority dispatch self-forecasts, if valid; else:** ● Uses the AWEFS/ASEFS forecast, if valid; else ● Uses unit's actual output, if valid; else ● Uses unit's previous dispatch target
AEMO can manually disable the AWEFS/ASEFS forecast, and dispatch reverting to above defaults	As previous, PLUS: **AEMO can manually disable the dispatch self-forecasts if not performing, with dispatch reverting to above defaults**

System Implementation – Self-forecast assessment

- AEMO conducts weekly assessments of the performance of dispatch self-forecasts against the AWEFS/ASEFs dispatch forecast, based on mean absolute error and RMS error measures: Semi-Scheduled Generation Dispatch Self-Forecast – Assessment Procedure
- AEMO does not use self-forecasts in dispatch unless they pass assessments
- Two assessment stages:
  - Initial assessment: Reliability and Performance
  - Ongoing assessment: Performance
- AEMO may also disable use of self-forecasts in dispatch if causing market or power system security issues
- Participant responsible for monitoring the ongoing performance of self-forecasts and pro-actively suppressing them, if required

System Implementation – What self-forecast is used in Dispatch?





Where are we now?

- Not many self-forecasts submitted to production API, but several are being submitted to pre-production API for testing purposes
- Pre-production API testing revealed some teething problems and challenges:
  - Misleading documentation on API access requirements
  - User account issues (password expiry and inability to manage accounts for non-registered forecast providers)
  - Incorrect format of API submissions
  - Ambiguous API submission error messages

What's next?

- **Mid 2019:** Review the self-forecast API registration process and associated documentation on AEMO's Participant Forecasting webpage
- **Late 2019:** Review the self-forecast assessment process with stakeholders:
  - Performance Metrics, Benchmarks, Exclusions, Assessment Windows
  - Reporting of assessments
  - Switching between self-forecasts and default forecasts
  - Scope to automate the above processes
- **Beyond:** Extend self-forecasting over longer timeframes
- **Ongoing:**
  - Improvements to AWEFS/ASEFS forecasts
  - Regular stakeholder engagement every 6 months via AEMO's Intermittent Generator Forums

APPENDIX: Background slides

How are self-forecasts validated and used?

- Self-forecasts can only be submitted for the next 5-minute dispatch interval
- Self-forecast must be between 0 and registered Maximum Capacity
- Multiple self-forecasts may be submitted (subject to throttling limits)
- Each self-forecast must have a priority number
- Must submit a self-forecast no later than 70 seconds before the start of the next 5-minute dispatch interval to guarantee its use in dispatch
- All valid self-forecasts are retained by AEMO and published next-day:
  - http://nemweb.com.au/#next-day-intermittent-ds
- **Dispatch uses the highest priority self-forecast (or if equal priority, the latest), as long as the self-forecast has not been suppressed by the participant or AEMO**

Why does AEMO assess self-forecasts?

- AEMO assesses self-forecast reliability and performance before using in dispatch
- Participants develop self-forecasting models and expected to independently assess performance
- AEMO's self-forecast assessments for dispatch purposes will not differentiate between different model forecasts from different forecast providers

Performance assessment criteria

- Both self-forecast and AWEFS/ASEFS forecast performance is measured as Mean Absolute Error (MAE) & Root Mean Squared Error (RMSE)
- Self-forecast performance **must be no worse** than AWEFS/ASEF performance on **both measures** before AEMO will enable (unsuppress) the self-forecast for use in dispatch:

$$MAE_{SF} \leq MAE_{AWEFS\_ASEFS}$$

AND

$$RMSE_{SF} \leq RMSE_{AWEFS\_ASEFS}$$

Initial Assessment

- Each week, AEMO assesses self-forecast reliability and relative performance of self-forecast against AWEFS/ASEFS forecast
- Self-forecast must pass **both** the Reliability and Performance assessments over the over the initial assessment window **before its first use in dispatch**
- There must be sufficient self-forecasts before performance can be assessed
- Initial assessment window starts at 8 weeks, but extends each week by one week (to a maximum 16 weeks) until both assessments pass
- If self-forecast passes both assessments:
  - AEMO unsuppresses self-forecast for its first use in dispatch
  - AEMO progresses the self-forecast to ongoing weekly assessments

Reliability & Performance assessment pre-conditions

Self-Forecast Reliability:

- For at least 95% of dispatch intervals over the current assessment window, AEMO received a self-forecast of at least 70 seconds prior to the gate closure for the dispatch interval
- Doesn't matter if self-forecast is suppressed or unsuppressed by participant

Self-Forecast Performance assessment pre-condition:

- For at least 80% of dispatch intervals over the assessment window:
  - Self-forecast was used in dispatch (Ongoing Assessment stage only)
  - Self-forecast was not suppressed by participant and received at least 70 seconds prior to gate closure
  - Energy Target ≥ Dispatch forecast (unit was not constrained off) <u>unless</u> a good quality SCADA Possible Power is available for use in performance assessment

Ongoing Assessment

- Each week, AEMO assesses relative performance of self-forecast against AWEFS/ASEFS forecast over the previous one, four and eight week windows
- If self-forecast passes the performance assessment **for any window**
  - AEMO unsuppresses self-forecasts (if not already unsuppressed)
- If self-forecast does not pass the performance assessment **for all windows**
  - AEMO suppresses self-forecasts (if not already suppressed)

AEMO Control Room actions

- AEMO control room monitors for gross forecast errors
- Control room may suppress the current forecast used in dispatch (regardless of source) if causing, or could cause, market or power system security issues
- Self-forecast remains suppressed (not used in dispatch) until AEMO's next weekly assessment

Thank you

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

ARENA

Australian Government
Australian Renewable Energy Agency