Intermittent Generator Forum

3 December 2021

Session objectives

- **Provide updates** on system changes and enhancements made since the last intermittent generator session held in July 2021.
- **Seek your feedback** on prospective system enhancements and proposed procedural changes.
- **Provide clarification** on use of inflexible bidding.
- **Remind participants** of your obligations to update MTPASA availability.

Our facilitators

Alicia Webb

Mike Davidson

Rob Selbie

Jack Fox

Anthony Hill

Petar Pantic

Phil Travill

Chris Mock

Agenda

Time (AEDT)	Duration (min)	Item	Presenter
10:00 – 10:05	5	Welcome and Introduction	Alicia Webb
10:05 – 10:30	25	Synopsis – Variable Renewable Energy (VRE) trends	Mike Davidson
10:30 – 11:20	50	Changes and updates since previous forum (July 2021)	Petar Pantic Rob Selbie Jack Fox
11:20 – 11:45	25	Other business • Use of inflexible bids • Non-scheduled wind generators with semi-scheduled obligations • Update MTPASA plant availability data • Advanced inverters white paper	Petar Pantic Anthony Hill Phil Travill Chris Mock
11:45 – 12:00	15	Further questions and discussion	

Synopsis – Variable Renewable Energy (VRE) trends

Mike Davidson
Manager Operational Forecasting

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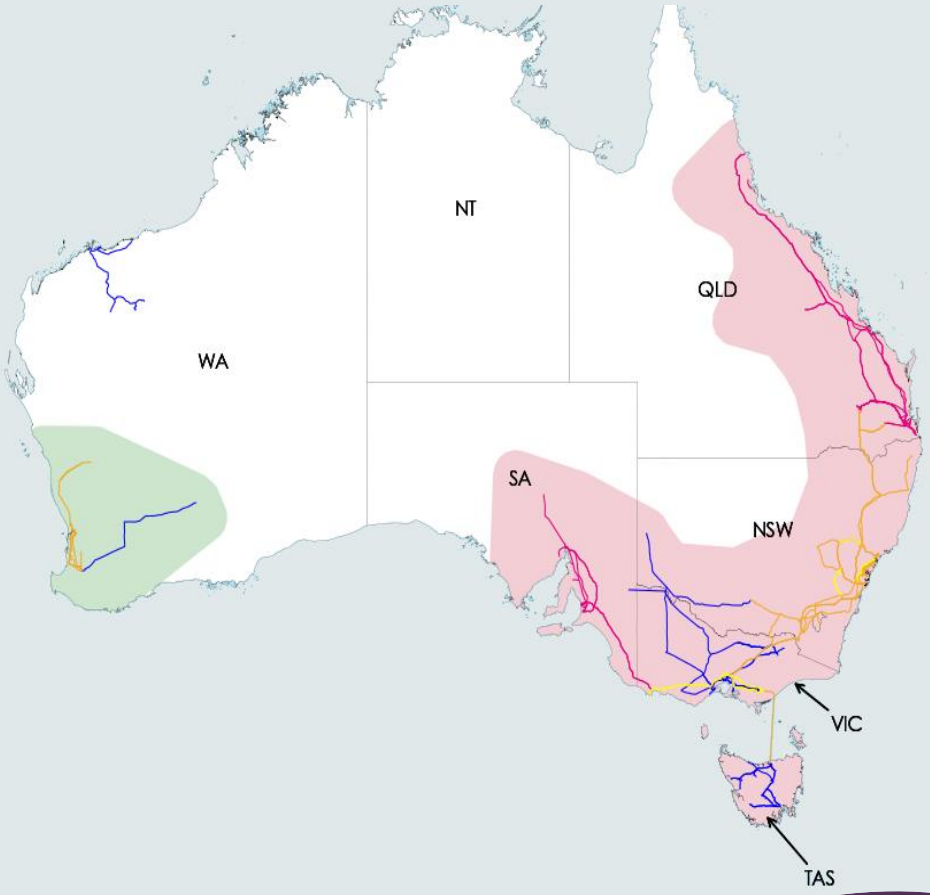
National Electricity Market

Population **22.8 million**

System Max Demand **35,796 MW**
Wind Capacity **9,551 MW**
Solar Capacity **6,789 MW**
Rooftop Solar Capacity **13,863 MW**

Approximately **2.6 million** solar PV system installations



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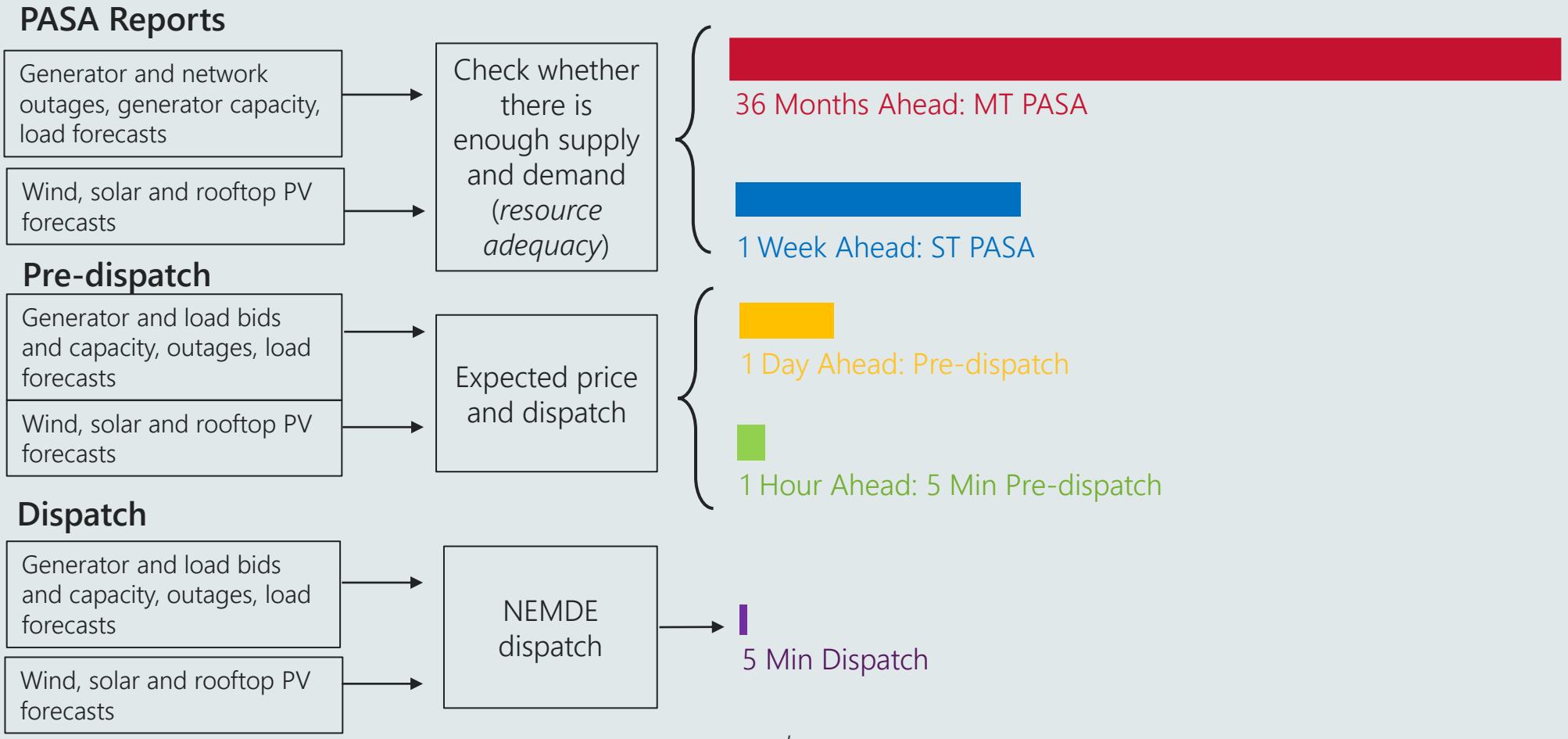
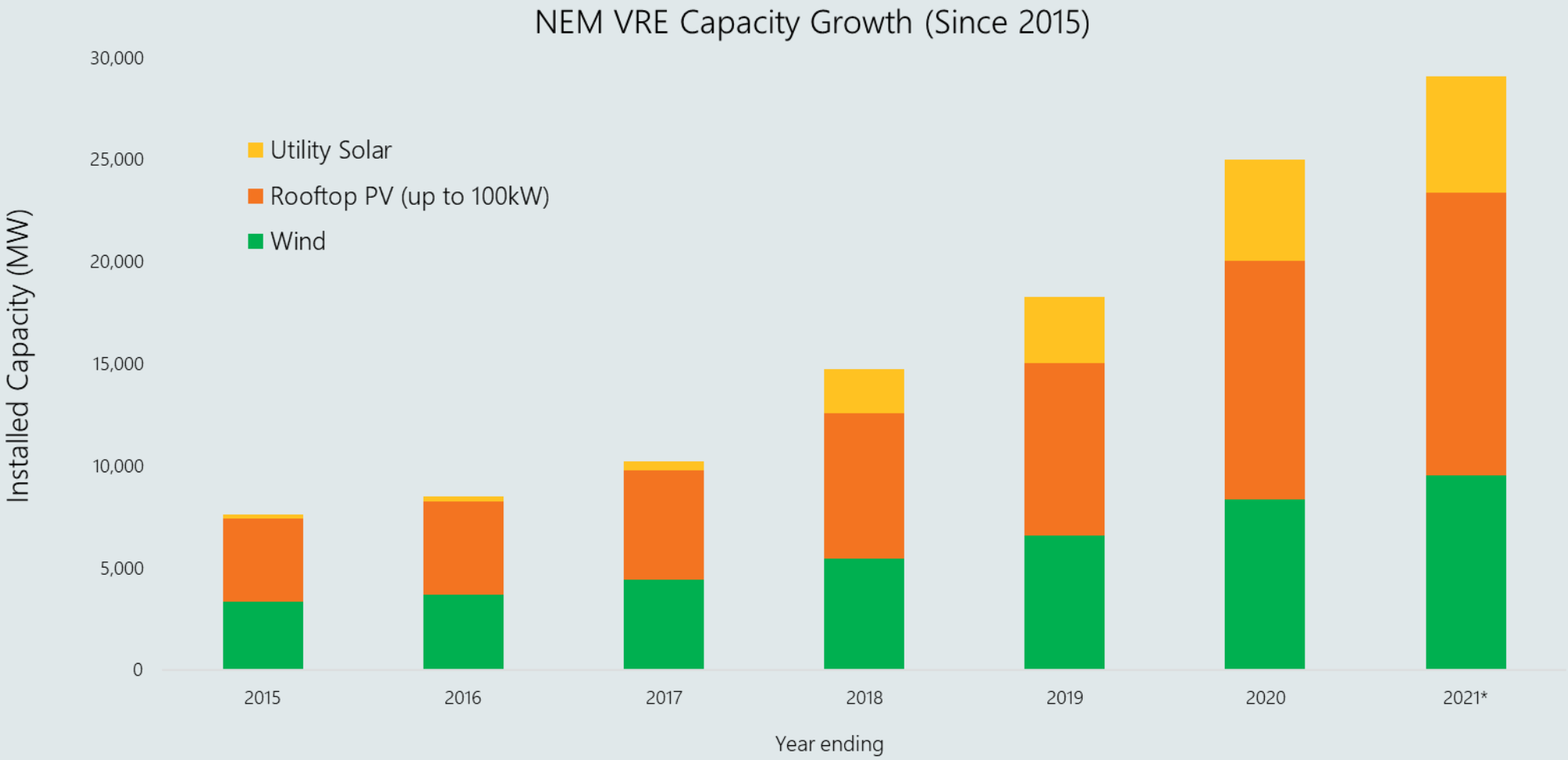
AEMO Forecast Horizons

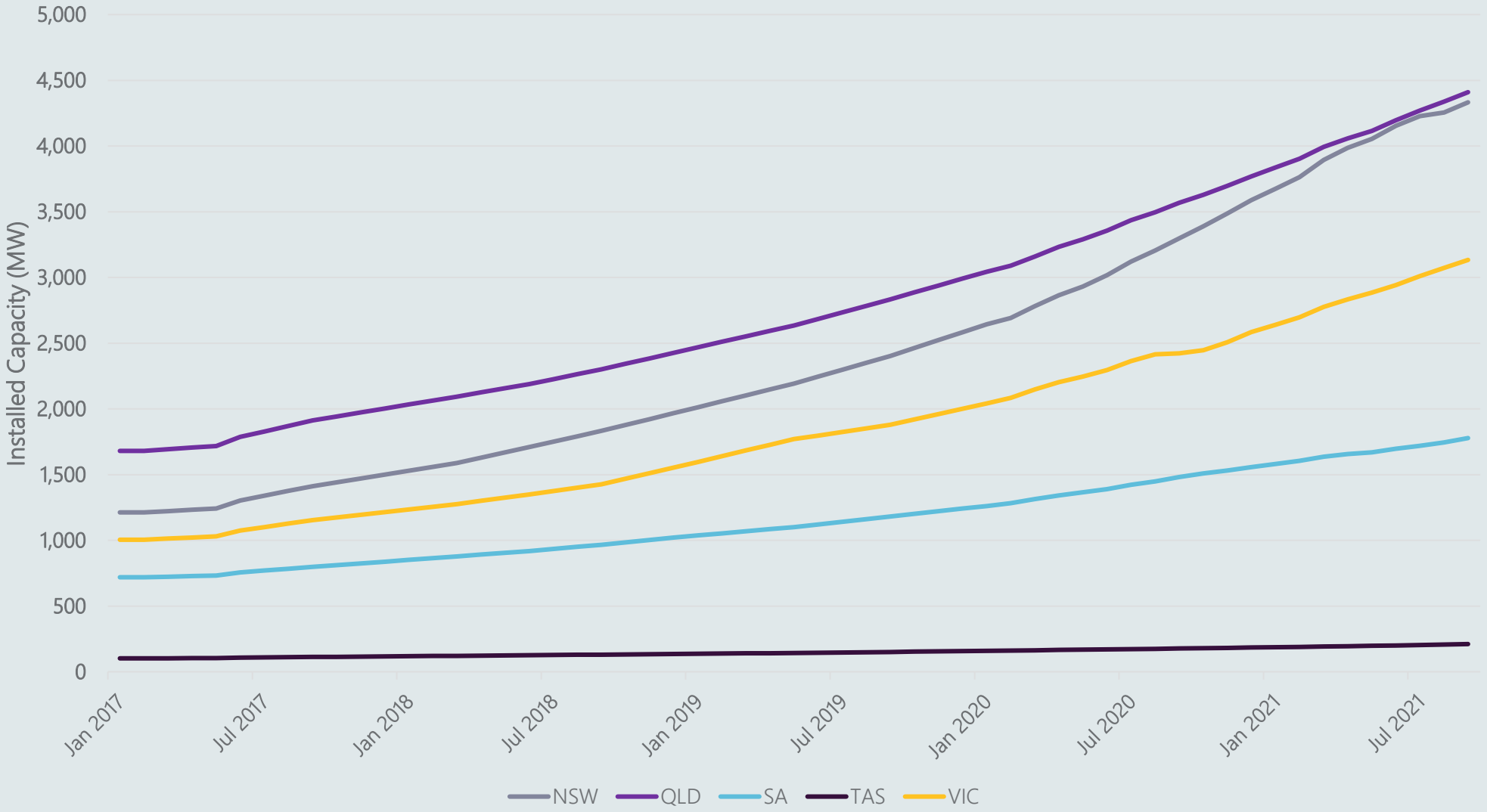


Jargon:
PASA = Projected Assessment of System Adequacy

NEM VRE Growth

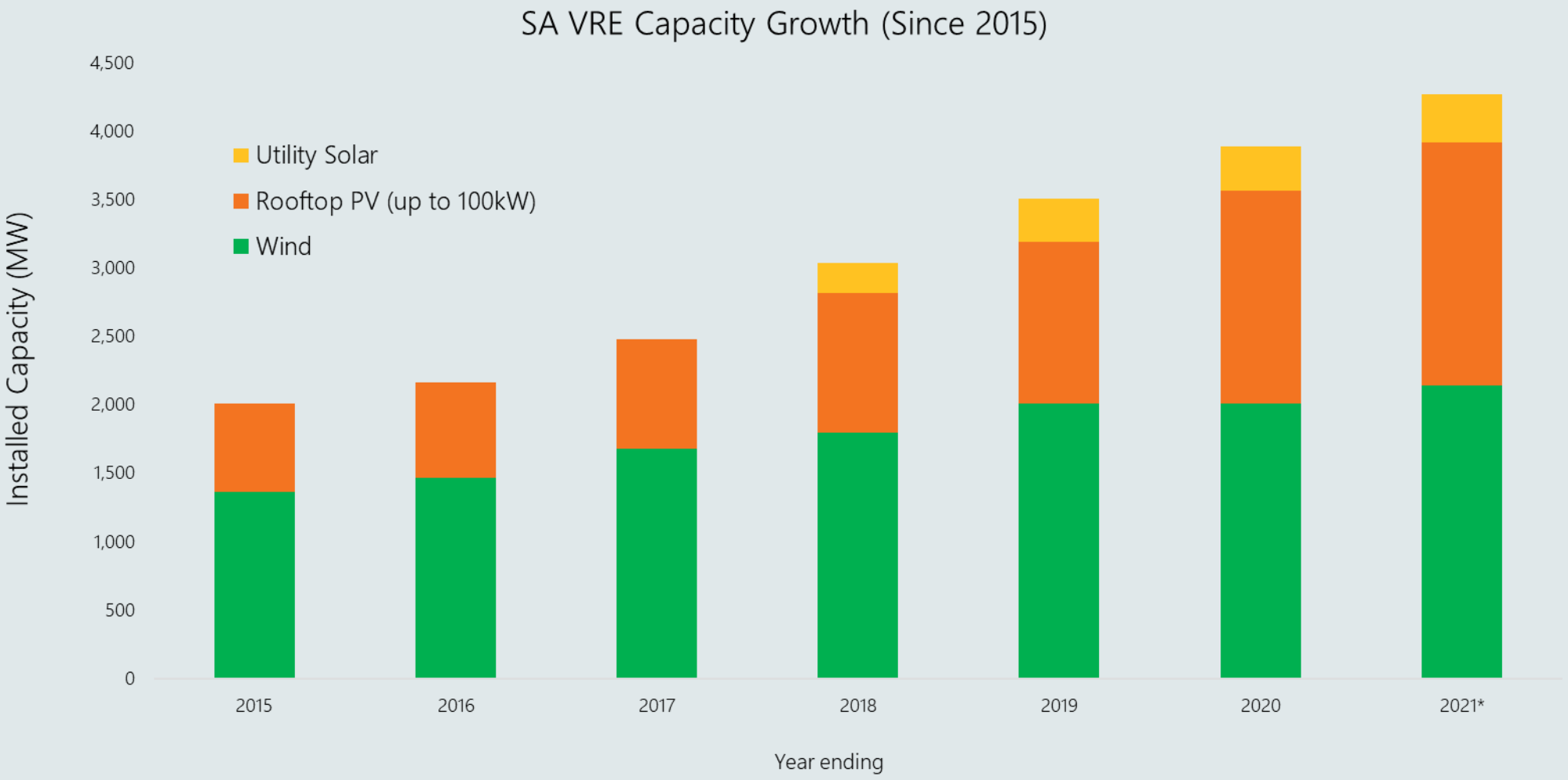


Rooftop Solar Growth per region



*ASEFS2 estimated installed capacity, using CER data for sub-100kW systems

South Australia VRE Growth



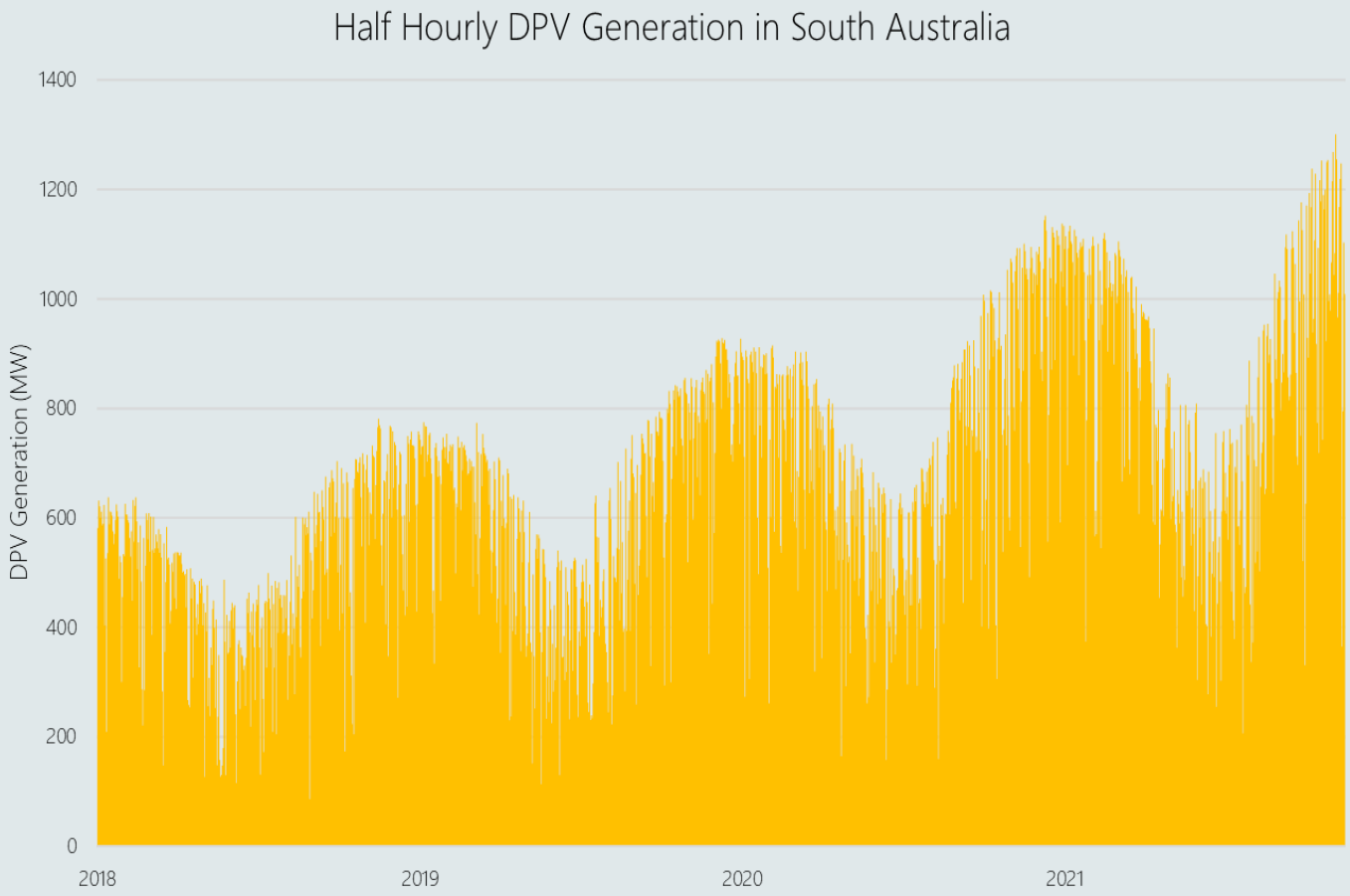
Distributed PV Generation (DPV)

More than one third of SA homes have DPV systems installed

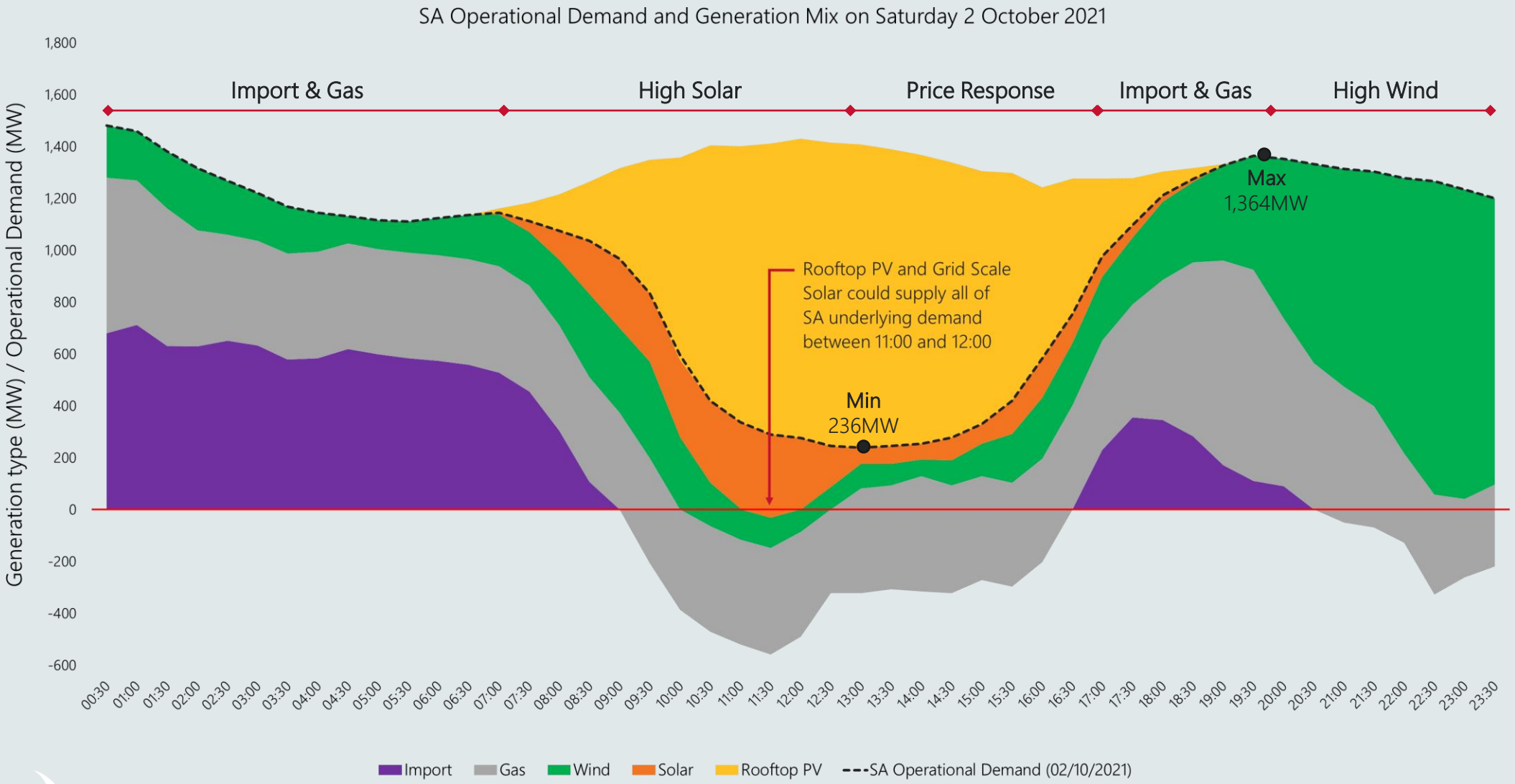
At **~1,301MW** DPV is now the **largest generator**

Installed DPV is **~3.7x** the largest unit in SA

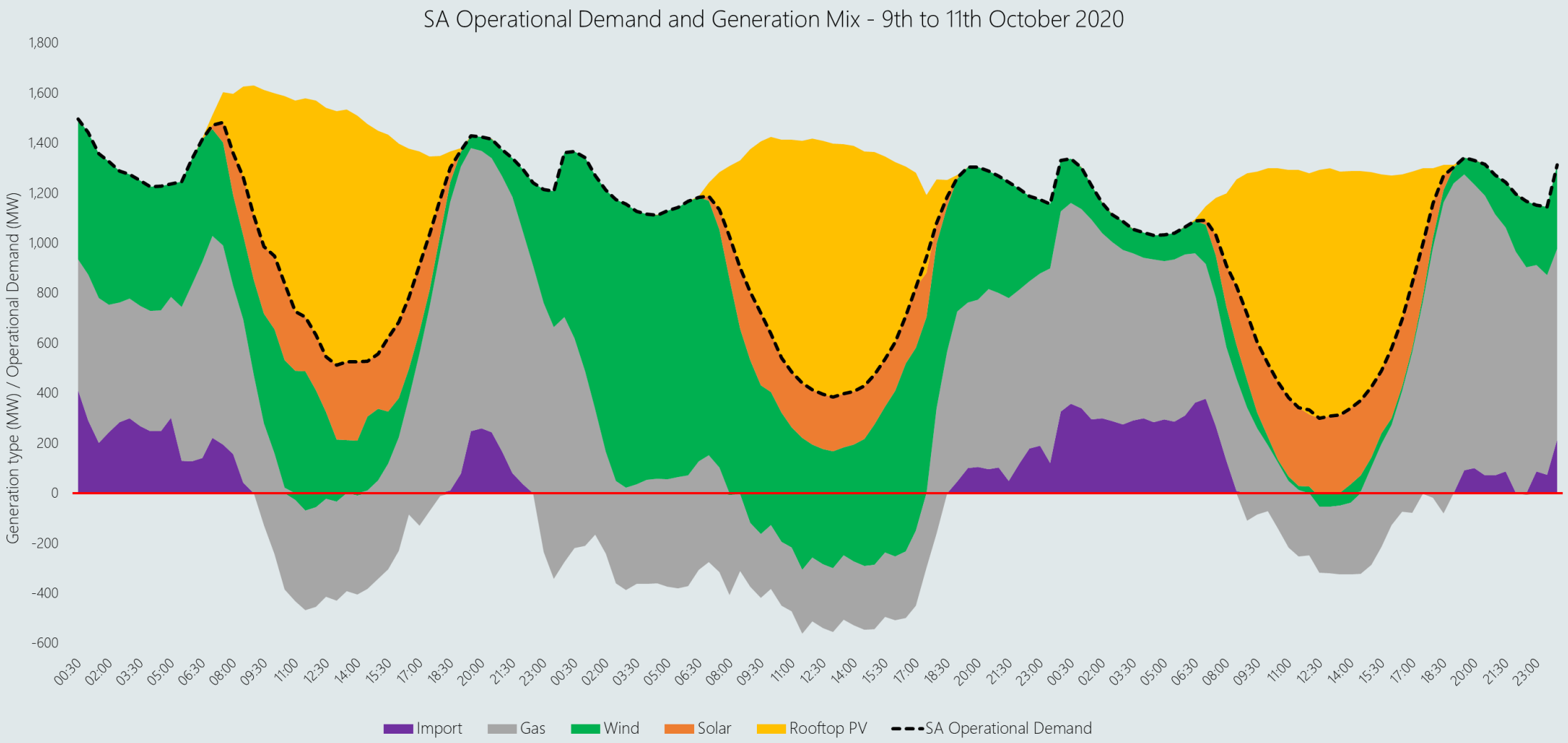
DPV is **distributed, passive** and **invisible**



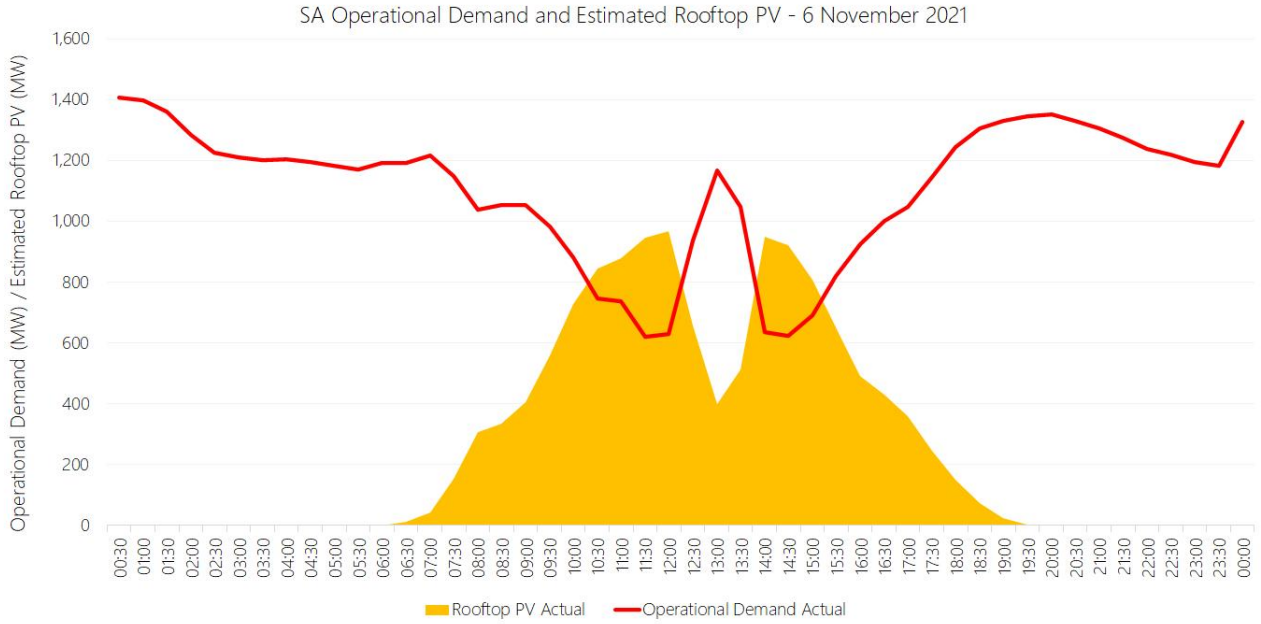
Dynamic plant mix in South Australia



Multiple Generation Fleets

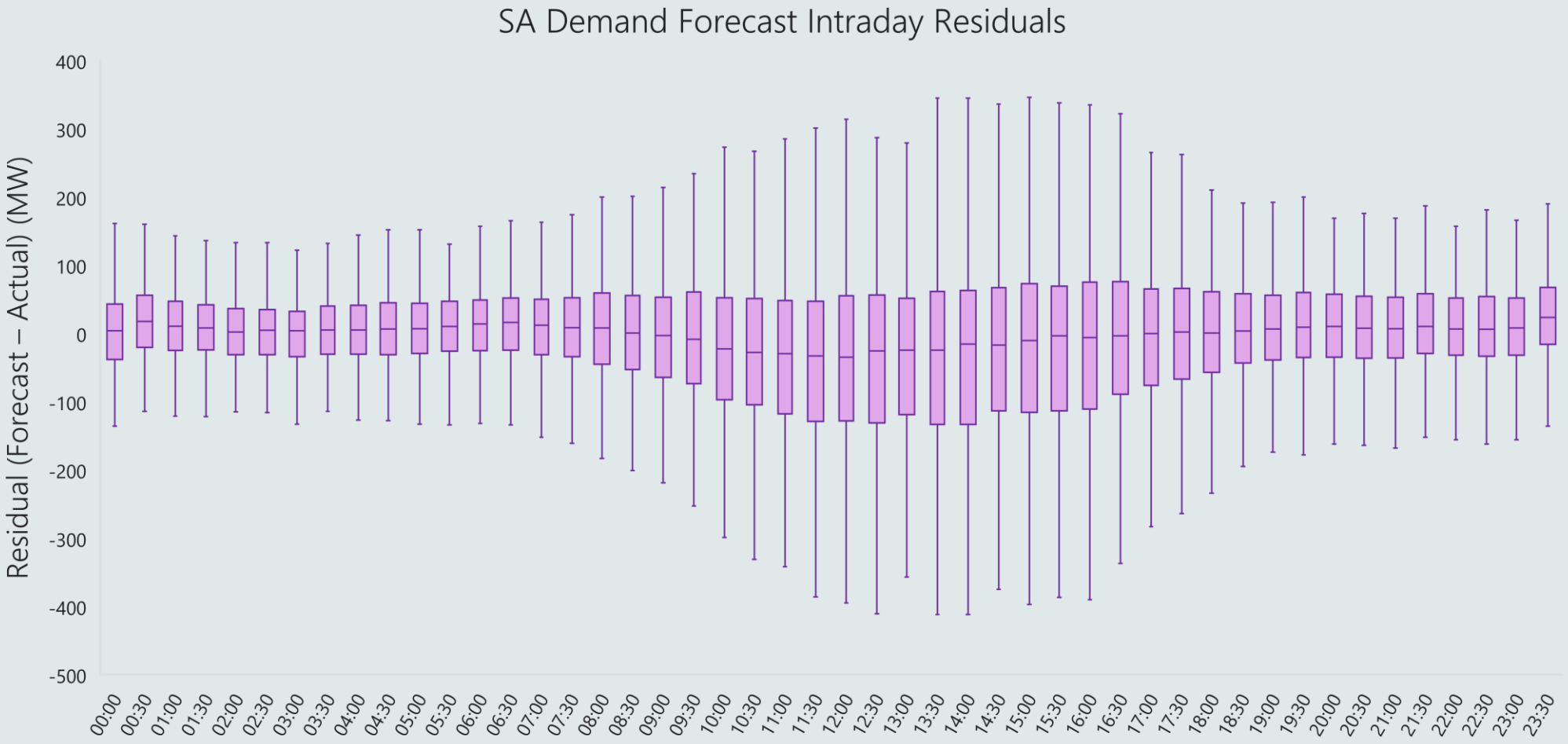


Storm Impact on SA Demand

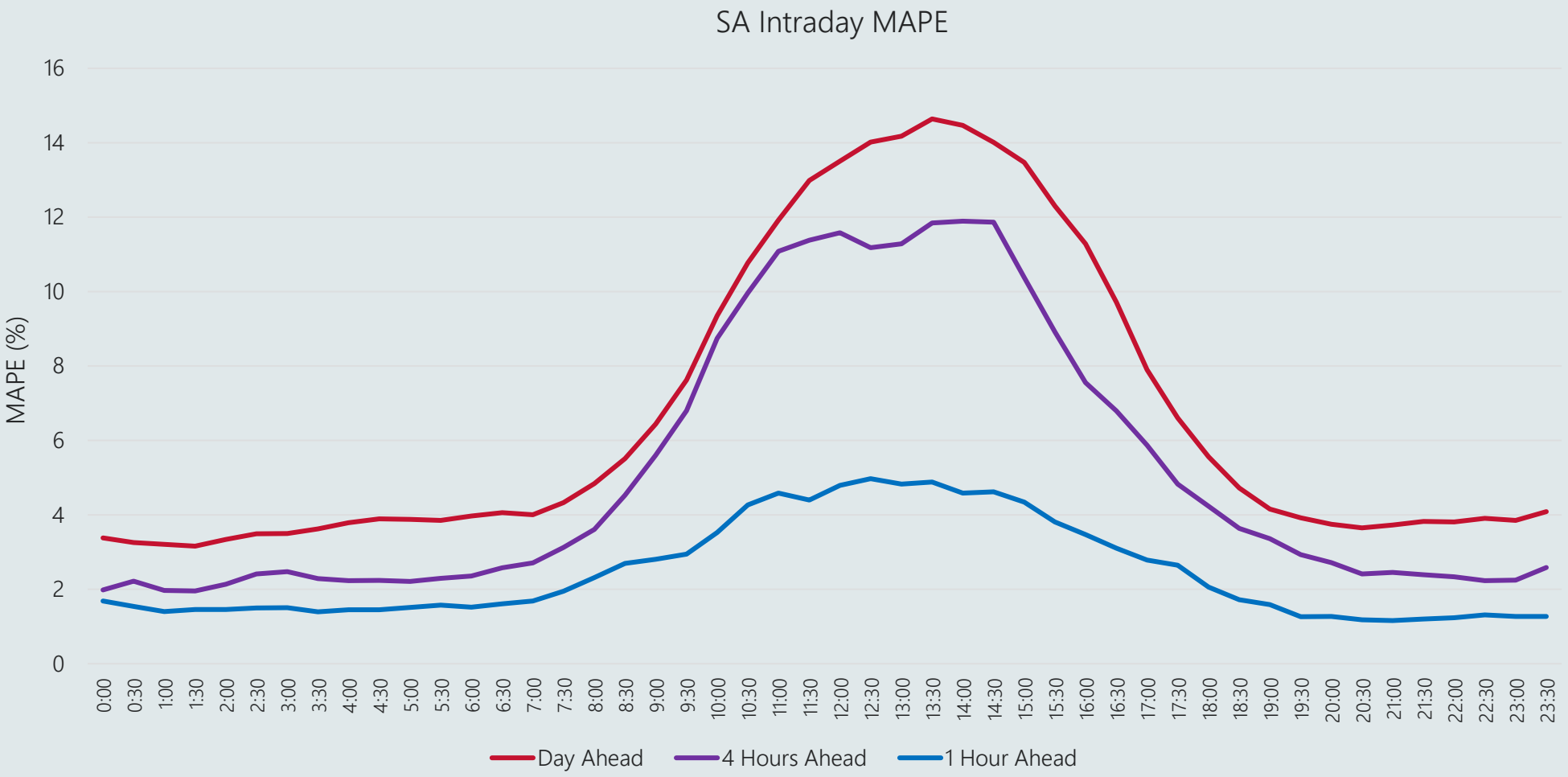


Impact of a storm on SA rooftop solar generation and demand

Demand Forecast Accuracy

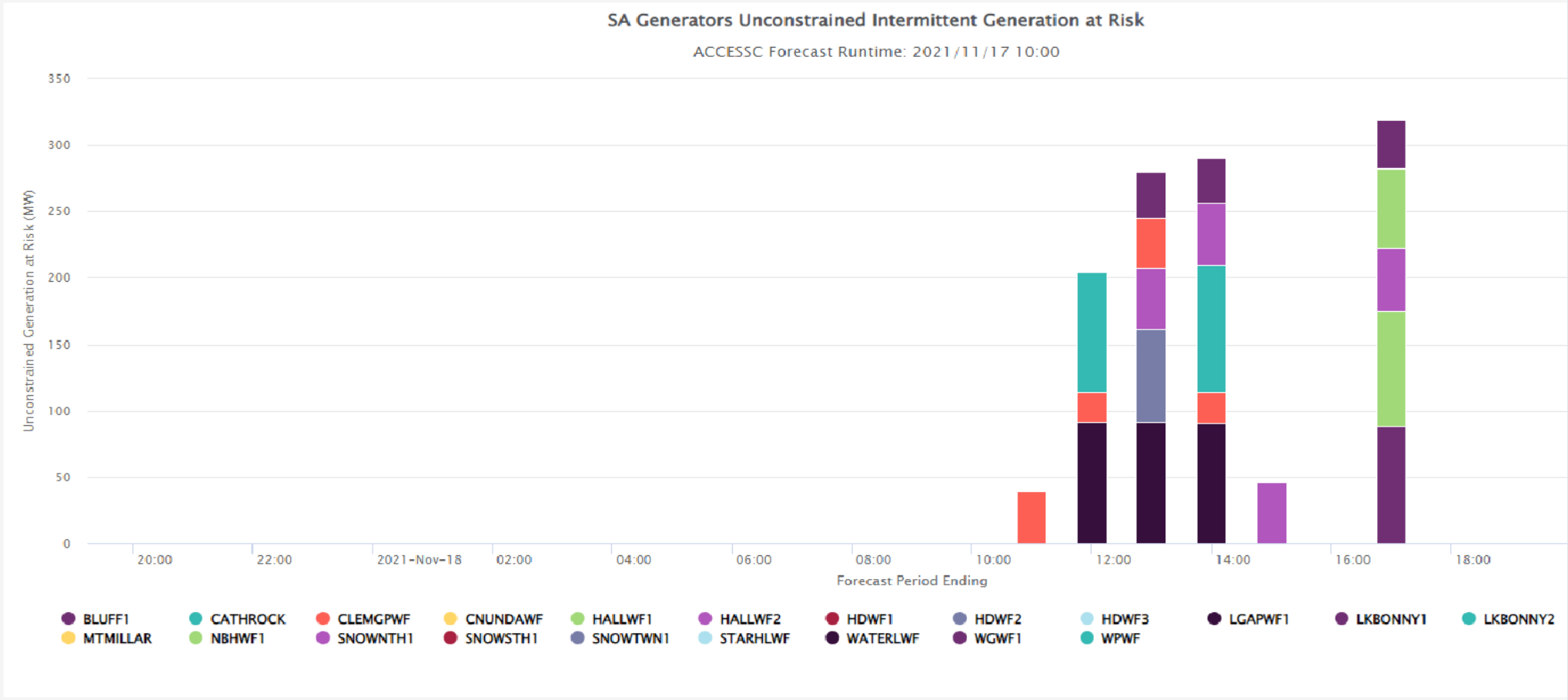


Demand Forecast Accuracy



Wind at Risk

Regional Risk | Generators at Risk | Generator Weather Forecast | Farm Metadata



Other Factors

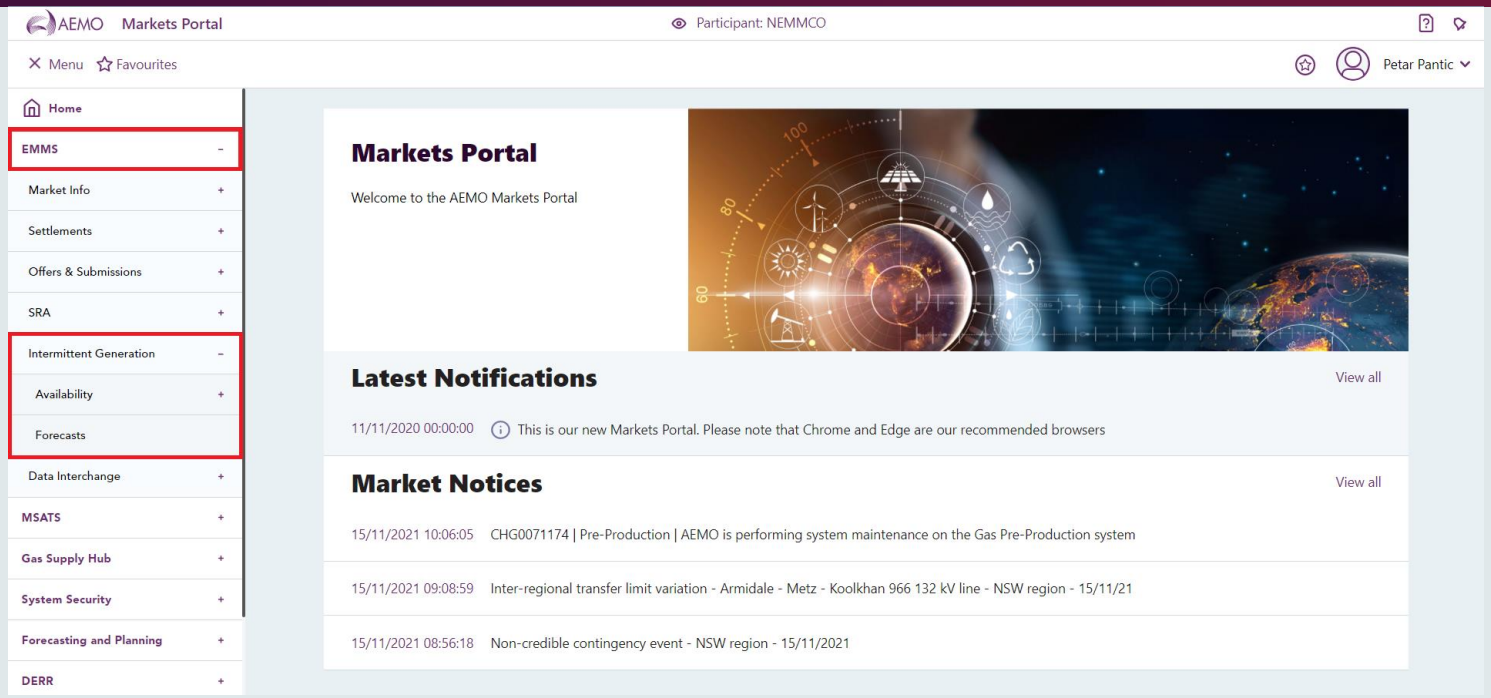
- 2019-2020 Summer bushfires saw extensive attenuation of solar farm output due to smoke
    - More information: Attenuation of large scale solar due to bushfires in Australia[1]
- Dust storms

[1] https://amperon.co/case-studies/attenuation-of-large-scale-solar-pv-production-by-bushfire-smoke/

Changes and updates since previous forum (July 2021)

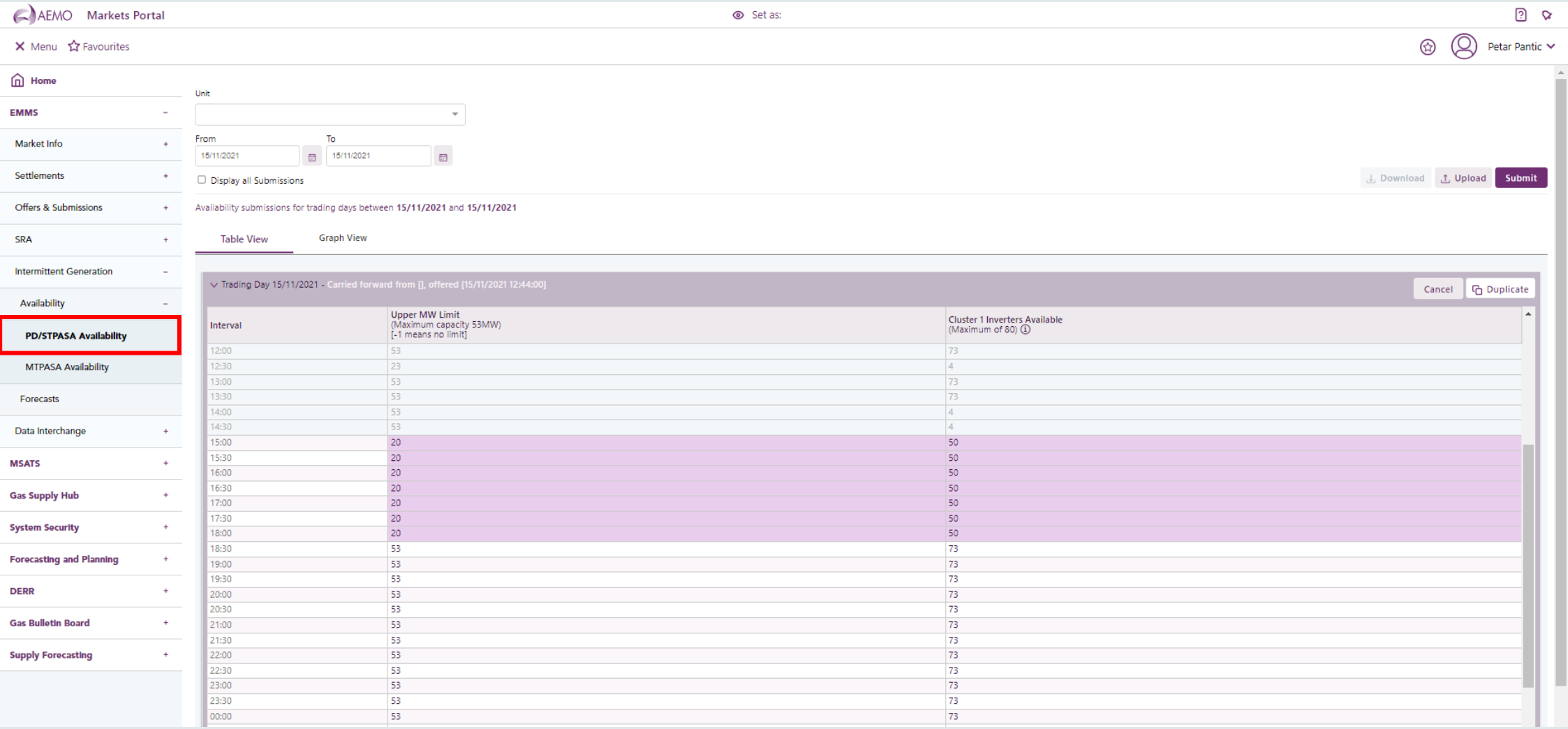
Petar Pantic – Operational Forecasting
Rob Selbie – Operational Forecasting
Jack Fox – Operational Forecasting

Updates to the EMMS Intermittent Generation screens and plant availability submissions



- AEMO has made changes to the usability of the intermittent generator screens and plant availability file submission method.
- These changes are intended to improve the user experience of submitting and viewing plant availability via the portal.
- The new screens and new JSON-based web API file submission method is now available in Pre-Production.

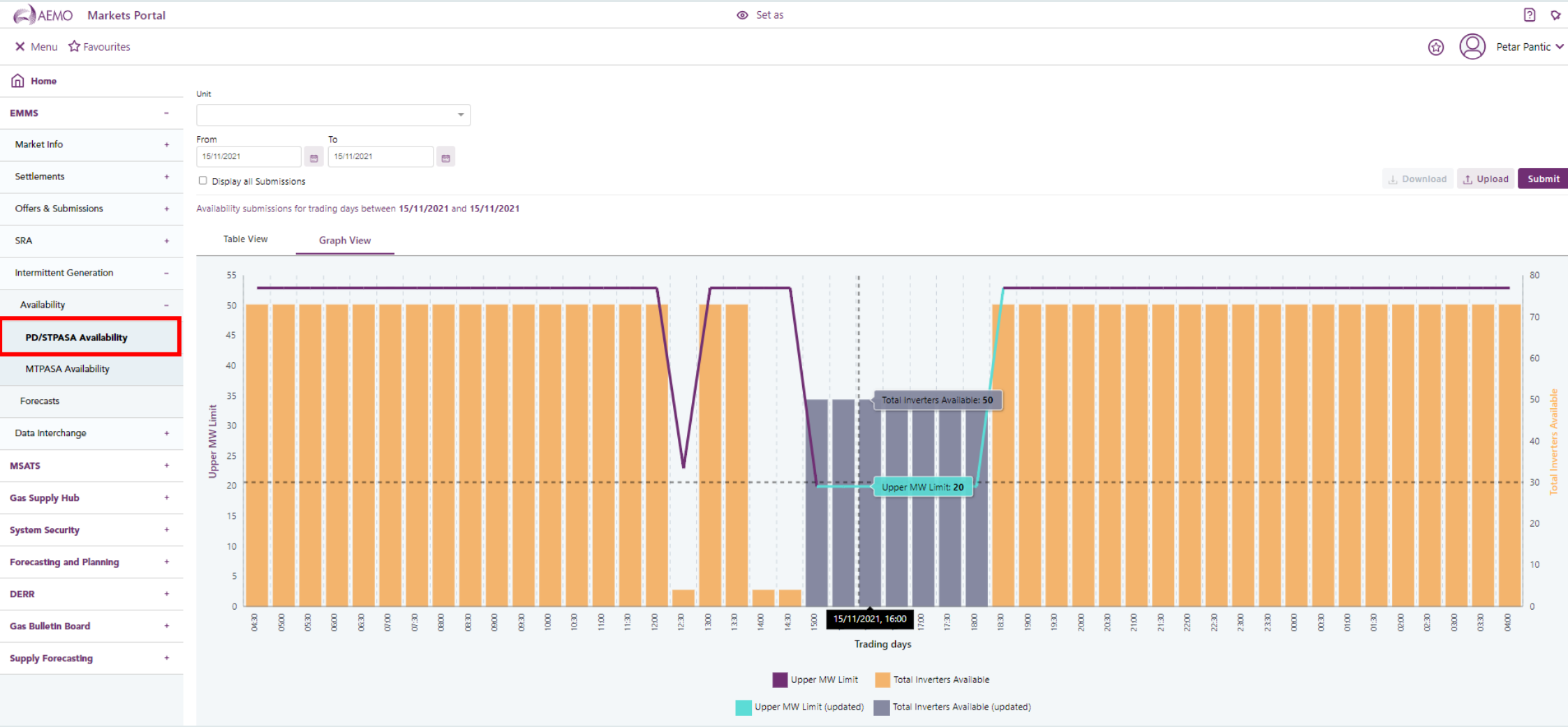
Updates to the EMMS intermittent generation screens



Interval	Upper MW Limit (Maximum capacity 53MW) [-1 means no limit]	Cluster 1 Inverters Available (Maximum of 80)
12:00	53	73
12:30	23	4
13:00	53	73
13:30	53	73
14:00	53	4
14:30	53	4
15:00	20	50
15:30	20	50
16:00	20	50
16:30	20	50
17:00	20	50
17:30	20	50
18:00	20	50
18:30	53	73
19:00	53	73
19:30	53	73
20:00	53	73
20:30	53	73
21:00	53	73
21:30	53	73
22:00	53	73
22:30	53	73
23:00	53	73
23:30	53	73
00:00	53	73

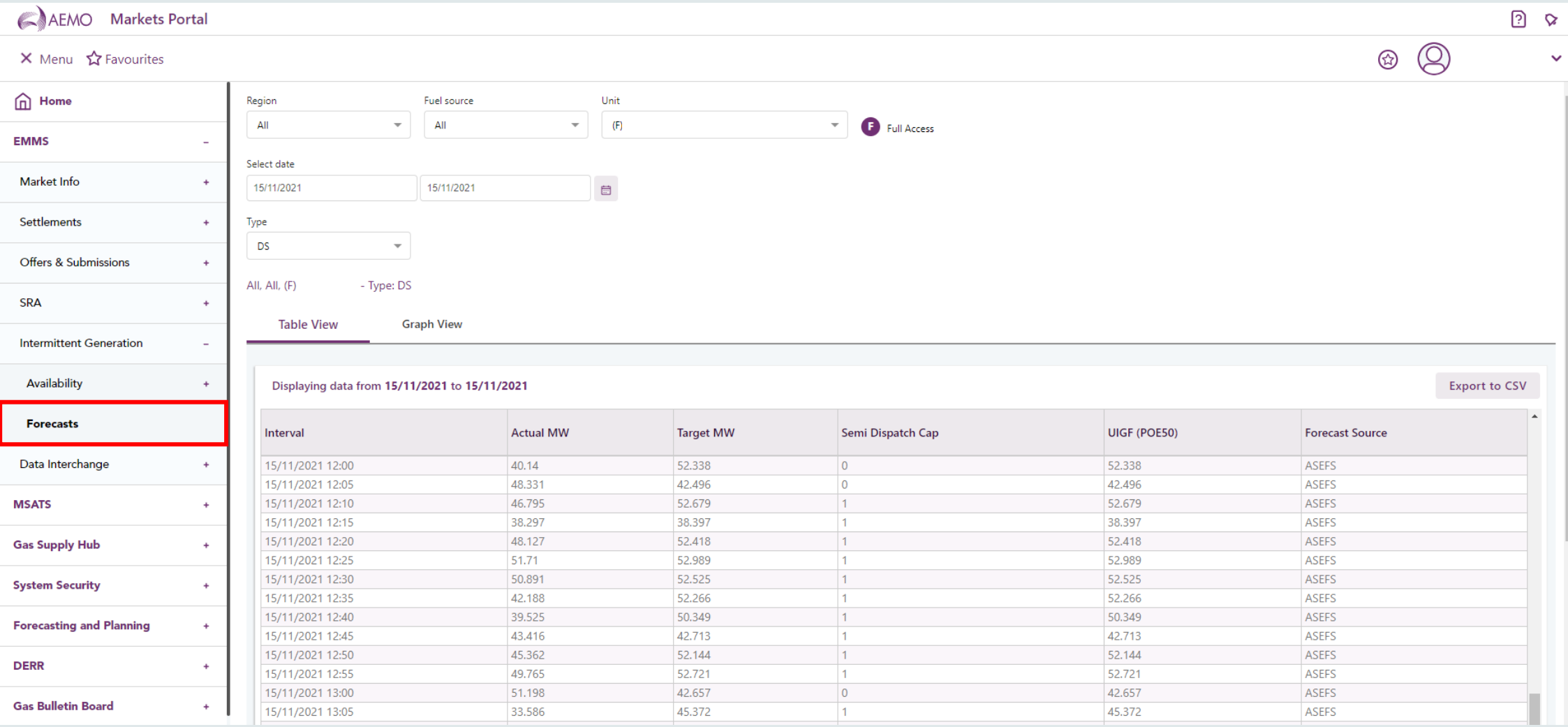
Viewing/editing plant availability in table view

Updates to the EMMS intermittent generation screens



Viewing plant availability in graph view *(new feature)*

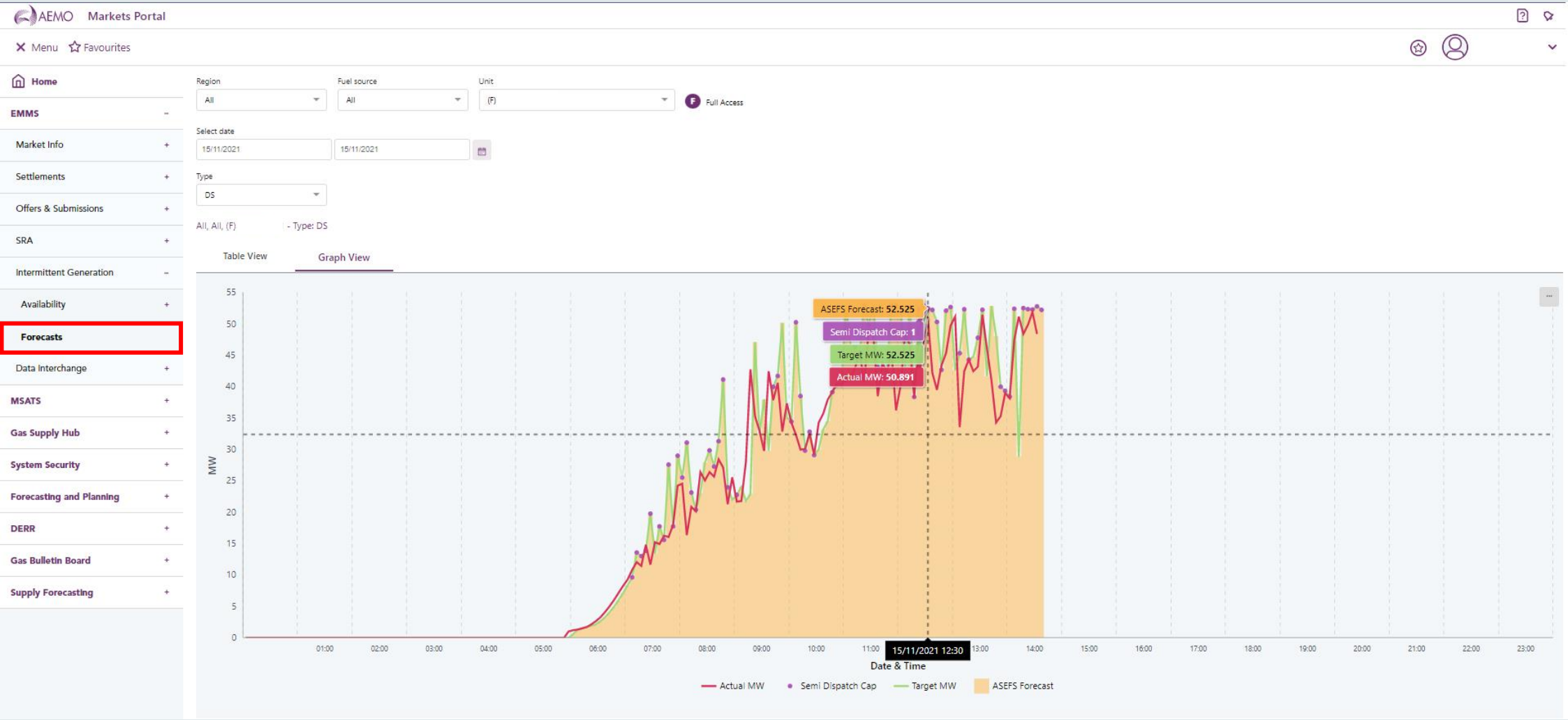
Updates to the EMMS intermittent generation screens



Interval	Actual MW	Target MW	Semi Dispatch Cap	UIGF (POE50)	Forecast Source
15/11/2021 12:00	40.14	52.338	0	52.338	ASEFS
15/11/2021 12:05	48.331	42.496	0	42.496	ASEFS
15/11/2021 12:10	46.795	52.679	1	52.679	ASEFS
15/11/2021 12:15	38.297	38.397	1	38.397	ASEFS
15/11/2021 12:20	48.127	52.418	1	52.418	ASEFS
15/11/2021 12:25	51.71	52.989	1	52.989	ASEFS
15/11/2021 12:30	50.891	52.525	1	52.525	ASEFS
15/11/2021 12:35	42.188	52.266	1	52.266	ASEFS
15/11/2021 12:40	39.525	50.349	1	50.349	ASEFS
15/11/2021 12:45	43.416	42.713	1	42.713	ASEFS
15/11/2021 12:50	45.362	52.144	1	52.144	ASEFS
15/11/2021 12:55	49.765	52.721	1	52.721	ASEFS
15/11/2021 13:00	51.198	42.657	0	42.657	ASEFS
15/11/2021 13:05	33.586	45.372	1	45.372	ASEFS

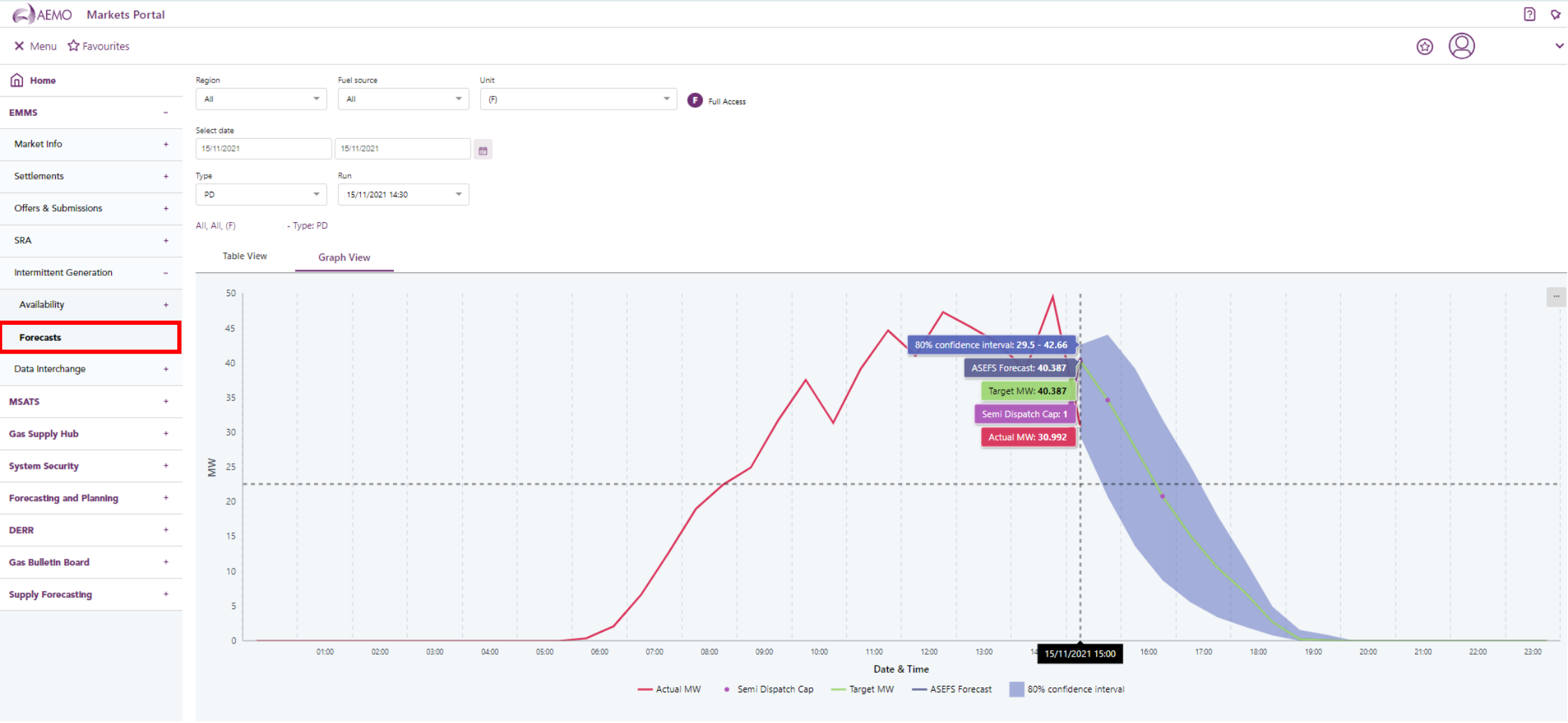
Viewing dispatch information in table view

Updates to the EMMS intermittent generation screens



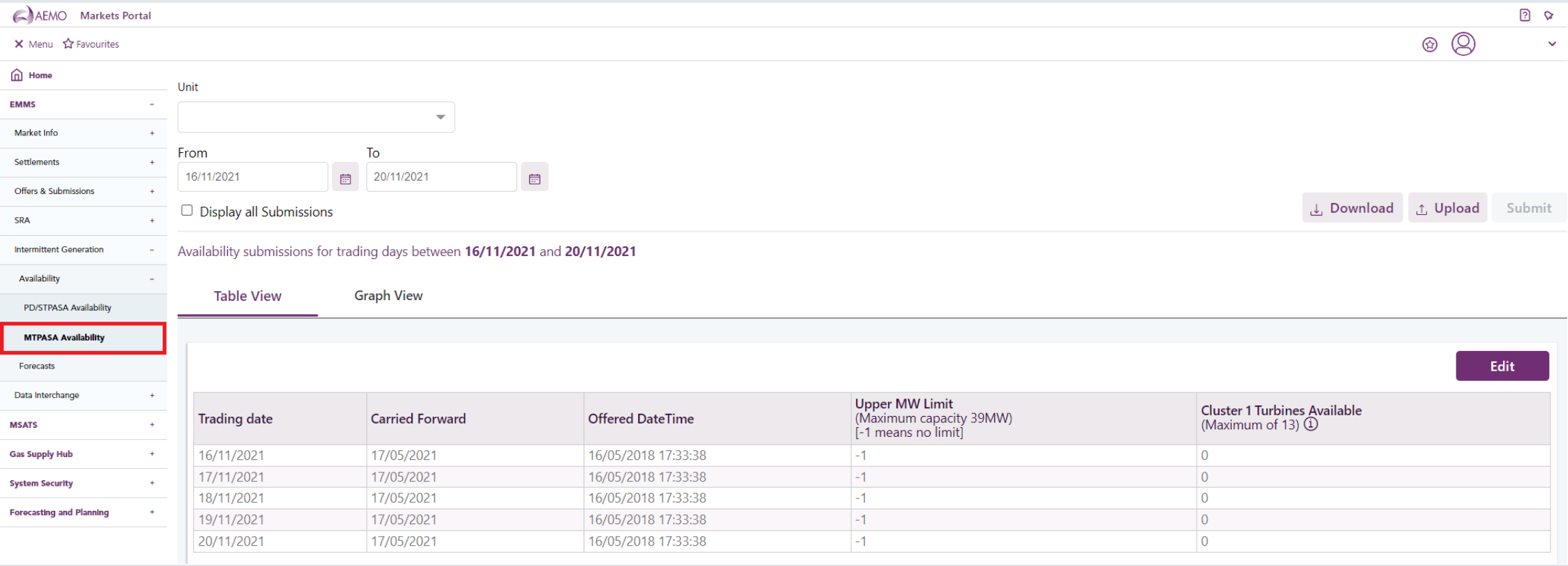
Viewing dispatch information in graph view

Updates to the EMMS intermittent generation screens



Viewing Pre-dispatch information in graph view

Updates to the EMMS intermittent generation screens

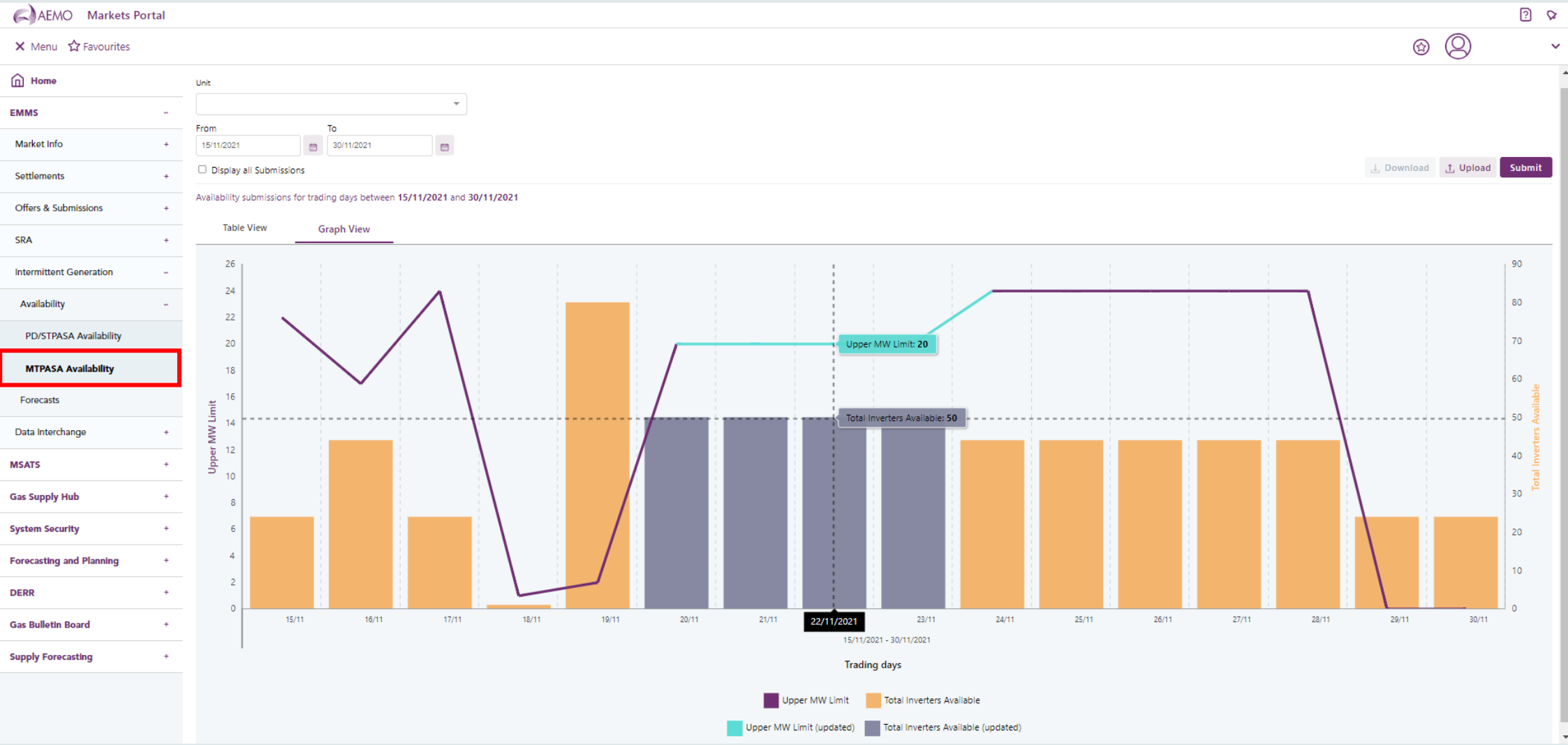


Trading date	Carried Forward	Offered DateTime	Upper MW Limit (Maximum capacity 39MW) [-1 means no limit]	Cluster 1 Turbines Available (Maximum of 13)
16/11/2021	17/05/2021	16/05/2018 17:33:38	-1	0
17/11/2021	17/05/2021	16/05/2018 17:33:38	-1	0
18/11/2021	17/05/2021	16/05/2018 17:33:38	-1	0
19/11/2021	17/05/2021	16/05/2018 17:33:38	-1	0
20/11/2021	17/05/2021	16/05/2018 17:33:38	-1	0

Viewing/editing MTPASA availability in table view

Note: 'Carried Forward' and 'Offered DateTime' columns available from January 2022.

Updates to the EMMS intermittent generation screens



Viewing MTPASA availability in graph view

Updates to participant file server interface for submitting plant availability

- AEMO will be replacing the existing participant file server interface (aseXML) with a JSON-based web API for submitting intermittent generation availability (Upper MW Limit, Turbines/Inverters Available).

- The JSON-based web API is now available in Pre-Production and is scheduled to be available in Production on 8 December 2021. The aseXML file submission method will continue to be made available for participants during a transition period of 6 months post Production implementation (until May 2022).

- AEMO strongly urges all participants to migrate to the API interface within this timeframe to ensure a smooth transition.

Updates to EMMS Intermittent Generation screens and plant availability submissions

- AEMO is offering a 1hr training session at 10am (AEDT) Friday 10 December 2021 to showcase the new intermittent generation portal user interface. *Would this be of interest to participants?*

- Implementation of new screens and API submission:
  - Pre-Production Go-live: 18 November 2021 (https://portal.preprod.nemnet.net.au)
  - **Production Go-live:** 8 December 2021 (https://portal.prod.nemnet.net.au)

- Further screen updates and improvements are scheduled for January 2022.

- Further information can be found in the *EMMS Release Schedule and Technical Specification December 2021* documentation via: https://www.aemo.com.au/-/media/files/market-it-systems/emms/2021/emms-release-schedule-and-technical-specification-dec-2021.pdf

Publishing of plant availability data

- AEMO has commenced publishing PD/STPASA plant availability data (Upper MW Limit, Turbines/Inverters Available) to the public web domain (Nemweb).

Interval	Upper MW Limit (Maximum capacity 53MW) [-1 means no limit]	Cluster 1 Inverters Available (Maximum of 80)
04:30	53	80
05:00	53	80
05:30	52	79
06:00	53	80
06:30	53	80
07:00	53	80
07:30	53	80
08:00	53	80
08:30	53	80

- AEMO is progressing the publication of plant availability (SCADA Local Limit, SCADA Turbines/Inverters Available) on a next-day public basis.

- AEMO will notify stakeholders via email when this data becomes available or provide an update at the next forum.

Proposed update to self-forecast assessment procedure

- The current dispatch self-forecasting assessment procedure requires a **minimum of 80% of DIs** to satisfy the following criteria over the current assessment window(s) for the performance assessment component:

  i. *the self-forecast (SF) was used in dispatch for the dispatch interval, or AEMO received an unsuppressed SF at least 70 seconds* prior to the start of the dispatch interval; and*

  ii. *for the dispatch interval, the generating unit's energy target was greater than or equal to its UIGF (that is, the generating unit is not constrained off), unless the participant submitted a good quality SCADA Possible Power for the dispatch interval*

- The current minimum DI threshold can result in delays in a semi-scheduled generator from being accredited for self-forecasting if the generator is located in a constrained part of the network and is not providing a Possible Power SCADA signal.

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*to be updated to 15 seconds.

Proposed update to self-forecast assessment procedure

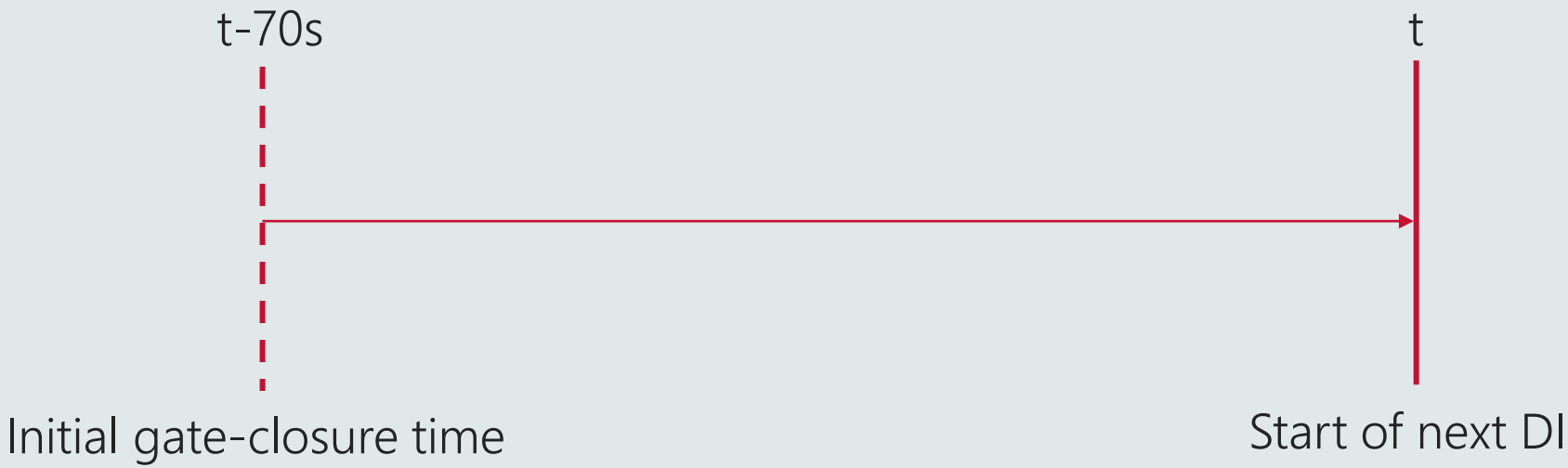
- Given the success of the self-forecasting program and the capability demonstrated by participants and self-forecasting vendors over the past three years, AEMO believes its appropriate to relax the requirement and proposes to *reduce* the **minimum DI requirement** from 80% **to 60%** for the performance assessment.

- This would increase the number of intervals assessed resulting in:
  - reduced delays in semi-scheduled generators being accredited for self-forecasting.
  - improved dispatch outcomes in the NEM as there would be a greater incidence of farms being suppressed and unsuppressed due to poor and improved performance outcomes, respectively.

- Please provide any feedback in this forum or via op.forecasting@aemo.com.au by COB Fri 17 December.

Change in gate-closure time for submitting self-forecasts

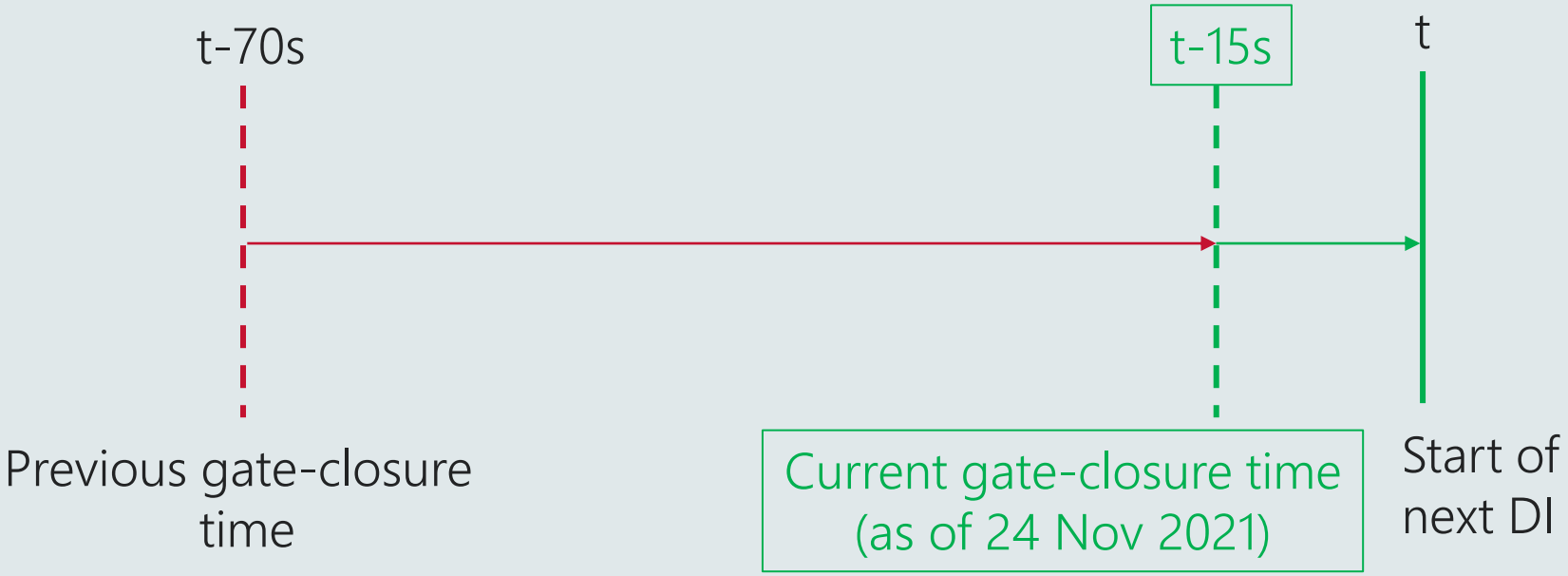
- The current dispatch self-forecasting assessment procedure requires generators to submit a self-forecast at least 70s prior to the beginning of the dispatch interval (DI) to be accepted in dispatch:



- AEMO investigated options to reduce the gate-closure time to allow more recent data and observations to be incorporated in dispatch self-forecasts.

Change in gate-closure time for submitting self-forecasts

- After investigating these options, AEMO initially reduced the gate-closure time to t-40s in late October 2021.
- Further options were sought to reduce the gate-closure time to t-15s.



- This change also allows participants to submit bids up to 15s before the beginning of the DI.
- Note: AEMO reserves the right to adjust the gate-closure time if there are risks to the timely publishing of dispatch instructions.

Change in gate-closure time for submitting self-forecasts

- The change in gate-closure time is expected to provide the following benefits:
  - Improve dispatch self-forecast accuracy thereby increasing the number of farms that are accredited for self-forecasting.
  - Reduce a generator's causer-pays factors (CPF).
  - Increase the time in which participants can submit a bid.

- Self-forecasting providers estimate an improvement of 2-6% on RMSE and MAE is expected with a t-30s gate-closure time (compared to the original t-70s gate-closure time).

- AEMO will be updating the Semi-Scheduled Generation Dispatch Self-forecast Assessment Procedure to reflect the new (current) gate-closure time.

Enabling 'Max Avail' function for semi-scheduled generators

- AEMO has been investigating the necessary changes required to enable the 'Max Avail' function in the energy offer bid for semi-scheduled generators.

Period ID	Period	Max Avail	PASA Avail	Fixed Load	Ramp Up	Ramp Down	Avail 1 $-932.77	Avail 2 $-890.36	Avail 3 $-48.18	Avail 4 $-38.35	Avail 5 $-28.51	Avail 6 $0.00	Avail 7 $287.70	Avail 8 $948.93	Avail 9 $11987.65	Avail 10 $14084.73
1	04:05	101	101		20	20	102	0	0	0	0	0	0	0	0	0

- Enabling the 'Max Avail' function would support operators and participants' bidding teams updating unit availability for farms that do not have the SCADA Local Limit configured or during instances where it is not possible to update the signal to cap the dispatch forecast and hence, cap the dispatch target.

- The 'Max Avail' could be used to reflect commercial decisions or technical limitations such as network outages or any other technical limits not reflected in SCADA Local Limit or AEMO constraints.

Enabling 'Max Avail' function for semi-scheduled generators

- AEMO's proposal on how Max Avail should apply:
  - The 'Availability' used by NEMDE to be the lower of the forecast (UIGF) and Max Avail.
  - When Max Avail < UIGF, then Semi-Dispatch Cap will be set.
  - Publish a new field 'UIGF' in the DispatchUnitSolution table, as well as in 5min Pre-dispatch and 30min Pre-dispatch tables.
- Enabling Max Avail will require changes to a number of processes and systems (including potentially NEMDE) which are currently being scoped and yet to be confirmed.
- Please provide any feedback via op.forecasting@aemo.com.au by COB Fri 17 December.

Other business

Petar Pantic – Operational Forecasting
Anthony Hill – Operational Forecasting
Phil Travill – Reliability Forecasting
Chris Mock – Future Energy Systems

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Use of inflexible bids

- AEMO has received multiple queries from participants regarding the use of inflexible bids during generator testing / commissioning.

Period ID	Period	Max Avail	PASA Avail	Fixed Load	Ramp Up	Ramp Down	Avail 1 $-932.77	Avail 2 $-890.36	Avail 3 $-48.18	Avail 4 $-38.35	Avail 5 $-28.51	Avail 6 $0.00	Avail 7 $287.70	Avail 8 $948.93	Avail 9 $11987.65	Avail 10 $14084.73
1	04:05	101	101		20	20	102	0	0	0	0	0	0	0	0	0

- Participants may choose to bid inflexible if necessary to support hold point testing noting:
  - The fixed load bid must be consistent with actual testing requirements and a valid reason must be submitted in accordance with AER Guidelines*.
  - Dispatch targets will be limited to the minimum of Fixed Load bid and dispatch forecast (UIGF).

*AER Rebidding and Technical Parameters Guideline (2019):
https://www.aer.gov.au/system/files/For publish - Rebidding and technical parameters guideline - final guideline %282019 amendments%29.pdf

Use of inflexible bids

- Prior to all testing activity, whether or not involving an inflexible bid, participants must liaise with the AEMO National Connections team and the relevant NSP(s) to ensure appropriate coordination is undertaken and seek approval from AEMO Operations.

- If the dispatch outcomes result in a constraint violation, the AEMO Control Room can cancel the test and request the participant to remove the fixed load bid or apply a system security constraint.

- Participants may raise any operational concerns on this matter at the CROWG Forum. To register your interest, please contact Mario (NEM RTO) via: mario.rositano@aemo.com.au.

- Any compliance queries or concerns should be referred to the AER.

Non-scheduled wind generators with semi-scheduled obligations

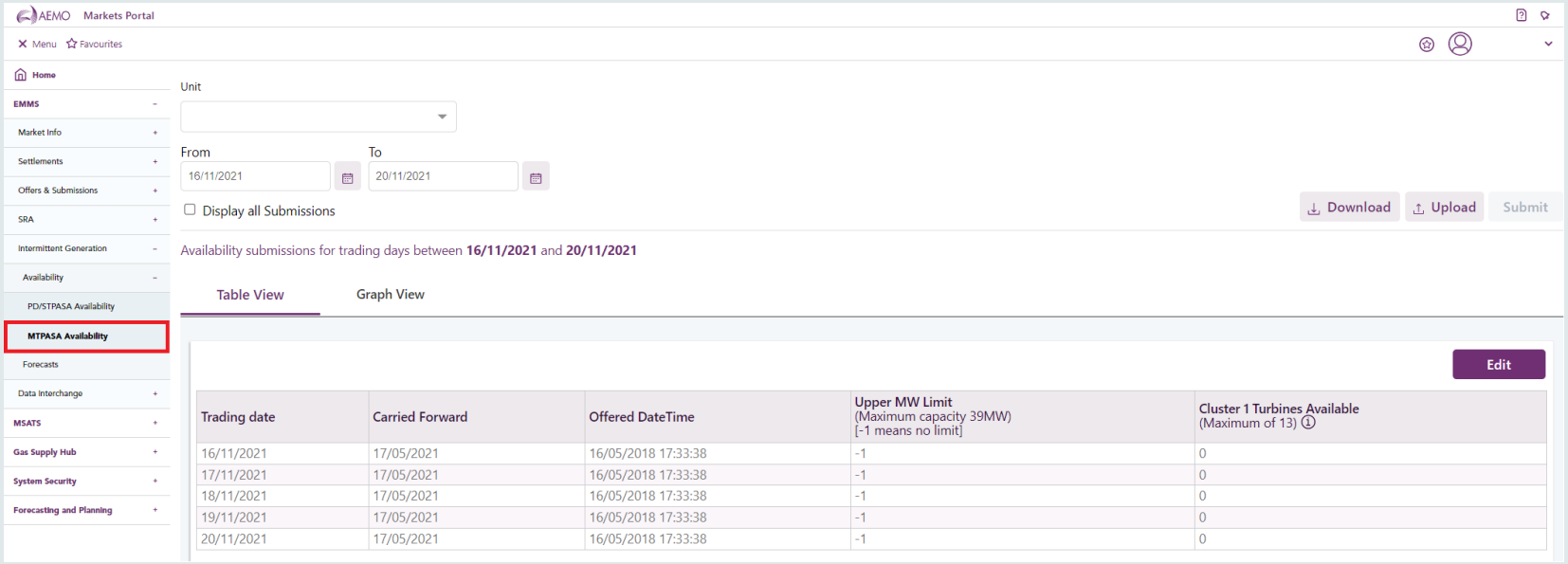
- In January 2021, AEMO contacted affected participants following its review of impacts of large non-scheduled generation on system operation and power system security.

- A total of 8 non-scheduled wind farms were identified, with six located in South Australia (SA), one in Victoria (VIC), and one in Tasmania (TAS).

- Under NER 3.8.2(e), the wind farms will progressively begin participating in dispatch and complying with dispatch instructions over the coming weeks and months.

Update MTPASA plant availability data

- MTPASA is a projection of power system supply adequacy from 1 week to 2 years ahead for which intermittent availability is an important input.
- MTPASA is run every Monday with results published the following day (Tuesday).



- Semi-scheduled and intermittent non-scheduled operators must update plant availability for MTPASA by:
  - Updating either the Upper MW Limit or Elements Available for a Trading Date where the expected limit is more than 6MW below the nameplate rating
  - Once the generator is expected to return to full capacity, submit another entry with Trading Date with Upper MW Limit to max capacity or (-1) and all Cluster elements available.

Update MTPASA plant availability data

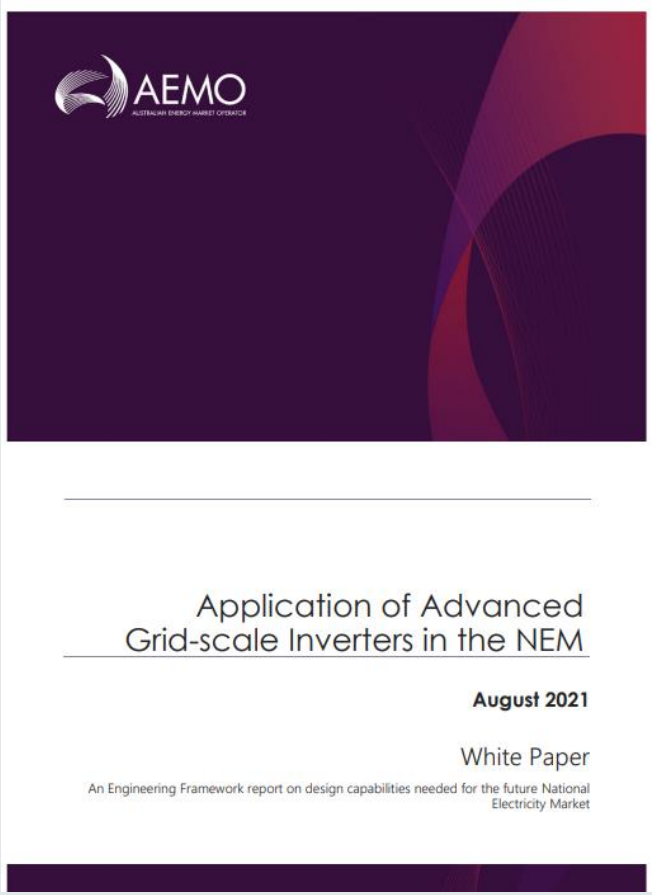
- Availability data carries forward each trading day until it's updated again.
- Data is submitted based on daily availability. If an outage is scheduled for part of a day, it should be submitted for the whole day.
- If an outage or commissioning schedule is uncertain, estimated dates should be submitted. However these must be updated as soon as plans change or more certain data becomes available.
- Semi-scheduled and intermittent non-scheduled generation is determined through traces developed by AEMO.
  - Changes to Upper MW Limit restricts the maximum generated during period specified.
  - Changes to cluster availability reduces the generation at all times during period specified.

Advanced inverters white paper

- AEMO's white paper provides recommendations toward enabling the application of advanced inverter technology to support the NEM as the amount of inverter-based resources (IBR) increases and synchronous generation online reduces.

- With sufficient attention, focus, and investment, advanced inverter technology may be able to address many of the challenges facing the NEM today for the integration of renewable (inverter-based) resources.

- At present this potential is not demonstrated at the necessary scale, and focused engineering development is urgently needed to address the remaining issues and realise the promise of this technology.



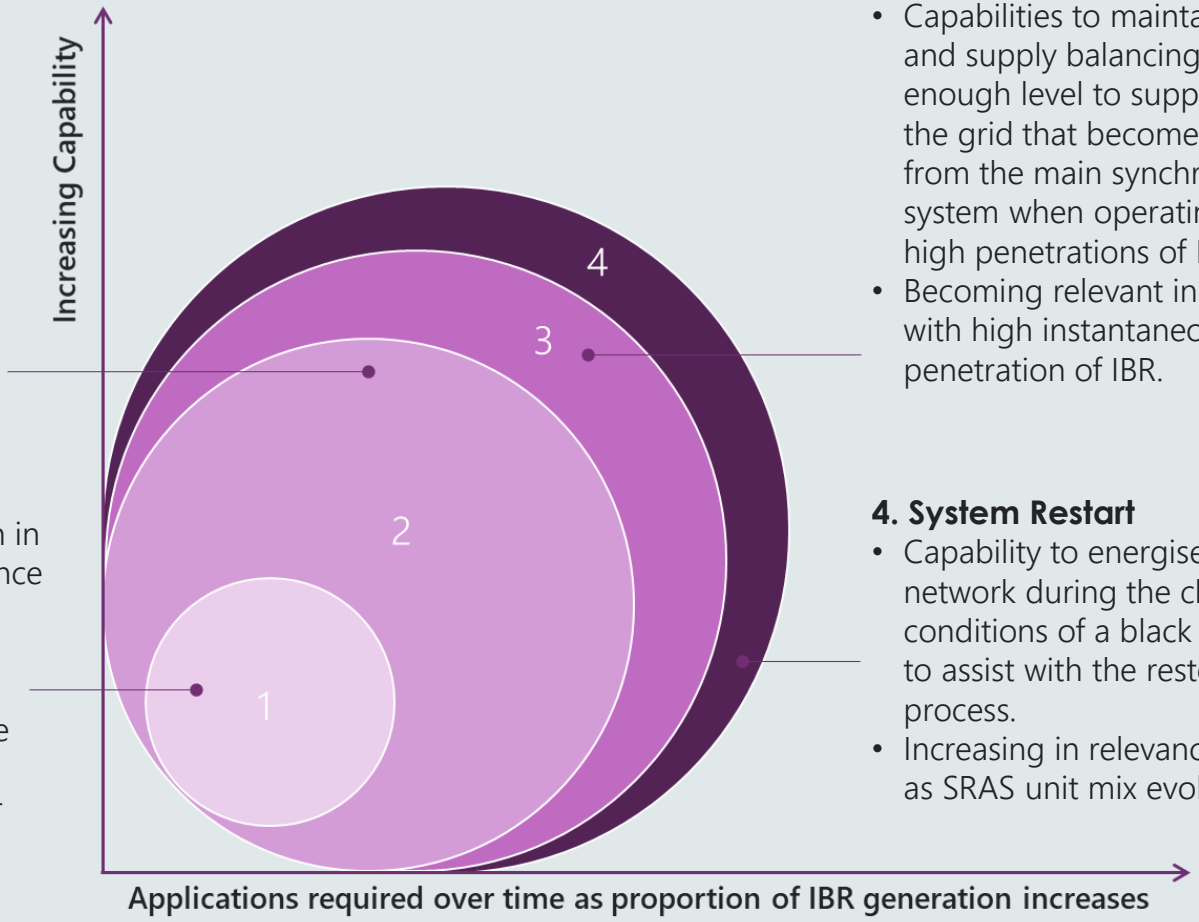
Categories of inverter

Grid-following inverters	Grid-forming inverters
Inverter control system measures and synchronises to the grid voltage waveform, adjusting power output to 'follow' voltage.	Inverter control system sets an internal voltage waveform reference and adjusts power output to help maintain this voltage.
Require a voltage reference signal from other generators to operate. If the inverter loses this voltage/frequency source it shuts down.	No reliance on external grid voltage to maintain predictable power production so can operate with or without the support of other generators.
Can provide grid support autonomously by adjusting output power in response to local measurements of voltage and frequency. However, response speed is limited and high penetrations of grid following inverters can potentially exacerbate disturbances.	Can inherently help stabilise the grid by adjusting output power instantaneously to maintain local voltage and frequency (i.e. synthetic inertia).
Most inverter systems in the NEM today are grid-following, with some providing grid supporting functionality.	There are many different types and implementations of grid-forming inverter control systems, with trials underway internationally and in Australia to demonstrate their grid supporting capability.

Applications of advanced inverters

2. Supporting system security
- Capabilities to maintain system security that are predominantly provided by synchronous generators today, such as inertia and system strength, to support the broader power system.
- Key development focus for the NEM as it transitions to operating with fewer synchronous generators online.

1. Connecting IBR in weak grids
- Capability to maintain stable operation in weak grid areas to meet IBR performance obligations, and potentially to provide system strength to support the connection of other nearby IBR plant.
- Provides localised capability to stabilise nearby IBR generation, but does not necessarily support the broader power system.
- Key importance to VRE project developers.



3. Island Operation
- Capabilities to maintain stability and supply balancing at a high enough level to support areas of the grid that become separated from the main synchronous system when operating under high penetrations of IBR.
- Becoming relevant in regions with high instantaneous penetration of IBR.

4. System Restart
- Capability to energise the local network during the challenging conditions of a black system, or to assist with the restoration process.
- Increasing in relevance over time as SRAS unit mix evolves.

Recommendations in the white paper

Enable connection of grid-forming projects

To enable testing and demonstration of grid-forming projects at scale, a pathway is needed to enable secure and timely connection of projects.

Recommended Action

AEMO to review the treatment of grid-forming inverter projects in the connections process to establish whether any National Electricity Rules (NER), technical performance specifications or procedure changes are needed to enable their efficient integration.

Define necessary capabilities

An absence of clear specifications makes it challenging for developers to specify their requirements from OEMs, and for OEMs to design their inverter offerings.

Recommended Action

AEMO to investigate how to best define a voluntary grid-forming inverter specification to assist OEMs and developers in delivering solutions to meet power system requirements.

Enable capabilities on new grid-scale batteries

There is a window of opportunity to build a fleet of grid-forming inverters on currently proposed projects. However, grid-forming carries cost and risk for the project developer.

Recommended Action

Further funding and support is needed to assist new grid-scale battery deployments to incorporate grid-forming technology, to build a fleet that can support the transition to high IBR penetration by 2025.

Further questions and Discussion

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Further information

Dispatch (SO_OP_3705) – Dispatch procedure providing instructions and guidelines covering market operations in relation to the operation of the power system.
https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3705-dispatch.pdf

Energy Conversion Model (ECM) Guidelines – Current AWEFS and ASEFS ECM Guidelines.
https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/dispatch-information/policy-and-process-documentation#forecasting

Guide to Data Requirements for AWEFS and ASEFS - Supplementary Wind and Solar ECM material.
https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/dispatch/policy_and_process/guide-to-data-requirements-for-awefs-and-asefs.pdf

Guide to Intermittent Generation - Information regarding submitting intermittent generation availability to AEMO.
https://www.aemo.com.au/-/media/files/market-it-systems/guide-to-intermittent-generation.pdf

Further information

Limits Advice – Congestion information resource regarding transfer limits advice
https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource/limits-advice

NEM Operational Forecasting and Dispatch Handbook for wind and solar generators – A guide to key requirements of semi-scheduled generators and some non-scheduled intermittent generators for forecasting and dispatch in the National Electricity Market (NEM)
https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/dispatch/policy_and_process/nem-operational-forecasting-and-dispatch-handbook-for-wind-and-solar-generators.pdf

Network Outage Schedule (NOS) – Transmission network outage information on AEMO website
https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/data-nem/network-data/network-outage-schedule

Participant Self-forecasting - Information and registration of semi-scheduled generators providing their own (self) dispatch forecast.
https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/operational-forecasting/solar-and-wind-energy-forecasting/participant-forecasting

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