

Managing change in the SWIS

The System and Market Operator's perspective

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Acknowledgement of Country

I would like to acknowledge that this presentation is being given on Aboriginal land, the land of the **Whadjuk** people of the Noongar Nation. I pay my respects to their Elders past, present and future.

Overview

Minimum demand continues to decline in the South West Interconnected System (SWIS) predominantly by continued record growth in rooftop PV.

2020 also saw grid-scale wind and solar generation on the SWIS **almost double in scale.**

This rapid transformation is providing challenges and opportunities for current and future operation of the power system and market.



International developments



National developments



Local developments



World view



Renewables, utility-scale and consumer-scale, continue to be installed at record rates

- Facilitating a change to a decentralised, democratised, decarbonised ... electricity industry.
- International Energy Agency "Renewable power additions defy Covid to set new record".



Across the world significant effort is going into facilitating increasing renewables penetration

- France renewables study*._
- AEMO is engaged with CIGRE, IEEE, GO15 and G-PST to share learnings albeit the transformation is happening at different rates and in different constructs.



Major incidents continue to occur across the world

- February 2021 Texas generation shortfall during record winter demand.
- January 2021 System Separation in the Continental Europe Synchronous Area.
- August 2020 Sri Lankan blackout.



Learnings for Australia

- These High Impact / Low Frequency events can be due to climate change, insufficient planning, inadequate market signals, unluckiness or other reasons – but histories show that a series of unlikely events can occur in unison.
 - With the electricity industry in transition, this is important for reform, regulatory, technical and market arrangements.

* [Conditions and Requirements for the Technical Feasibility of a Power System with a High Share of Renewables in France Towards 2050](https://rte-france.com/en/conditions-and-requirements-for-the-technical-feasibility-of-a-power-system-with-a-high-share-of-renewables-in-france-towards-2050) (rte-france.com)



National view



Renewables, utility-scale and consumer-scale, continue to be installed at record rates

- AEMO quarterly energy dynamics and ESOOs
- Clean Energy Council "Australia's clean energy transition accelerated again in 2020"



Significant effort is going into facilitating increasing renewables penetration

- AEMO Engineering Framework building on its NEM Renewables Integration Study, and NEM Low load studies/work
- AEMC suite of rule changes to address present and emerging security and reliability issues and market effectiveness
- ESB NEM 2025 work program



Major incidents continue to occur

- Summer 2019/20 East Coast Bushfires
- October 2020 SA-VIC Interconnector Failure
- January 2021 SWIS Heatwave and generator availability challenges
- March 2021 SA Islanded, explosion at power station and high DER
- April 2021 Cyclone Seroja impacting northern end of SWIS
- May 2021 Queensland tripping of multiple lines/generators



Learnings for Western Australia

- Consider deployment of operating schemes and arrangements to be utilised in emergency conditions (e.g. PV control utilised in March 2021 SA event)
- Learn from other jurisdictions - but consider and adapt to WA construct



Local view:

Eyes on the SWIS



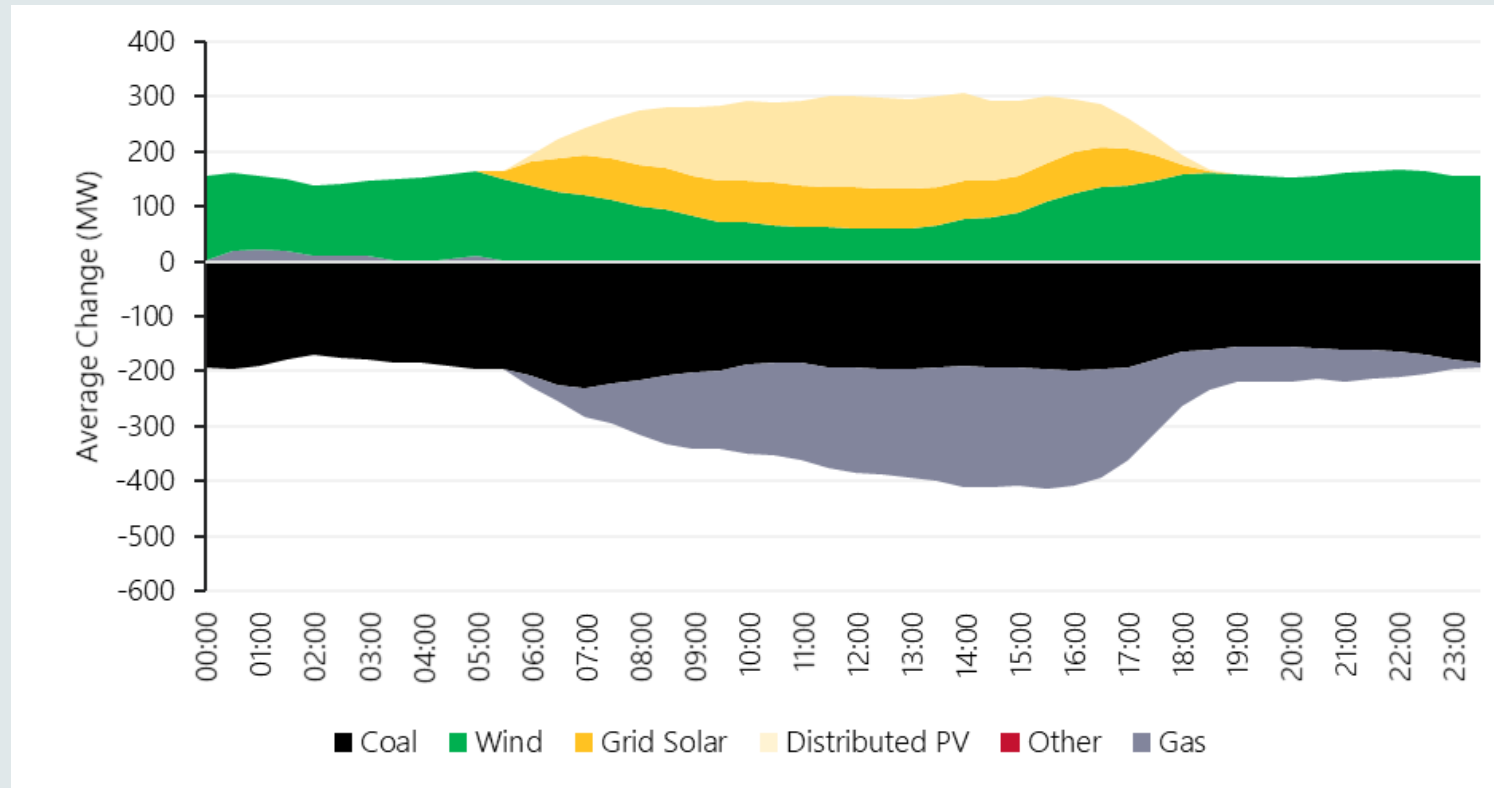
In 2019 AEMO published a report “Integrating Utility Scale Renewables and DER in the South West Interconnected System” which forecast the following:

- Increasing variability ✓
- Increasing Ancillary Services requirement/cost ✓
- Increasing negative pricing including price floor ✓
- Reducing minimum demand and increasing distribution network export ✓
- Reduced dispatch of traditional generators and increasing thermal generation movement when dispatched ✓
- Challenges to Underfrequency Load Shedding Scheme and System Restart ✓



SWIS Transformation: Changes to the Generation Mix

Change in Fuel Type from Q4 2019 to Q4 2020

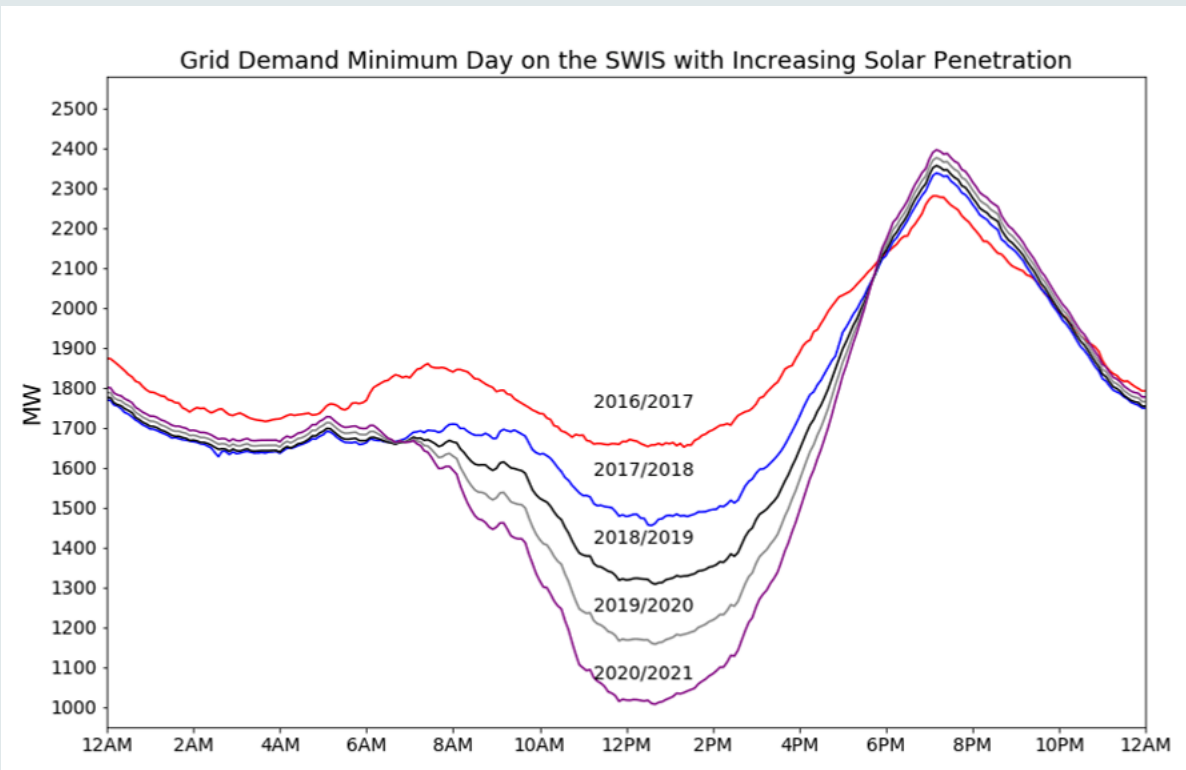


Source: Quarterly Energy Dynamics Report

<https://aemo.com.au/energy-systems/major-publications/quarterly-energy-dynamics-qed>

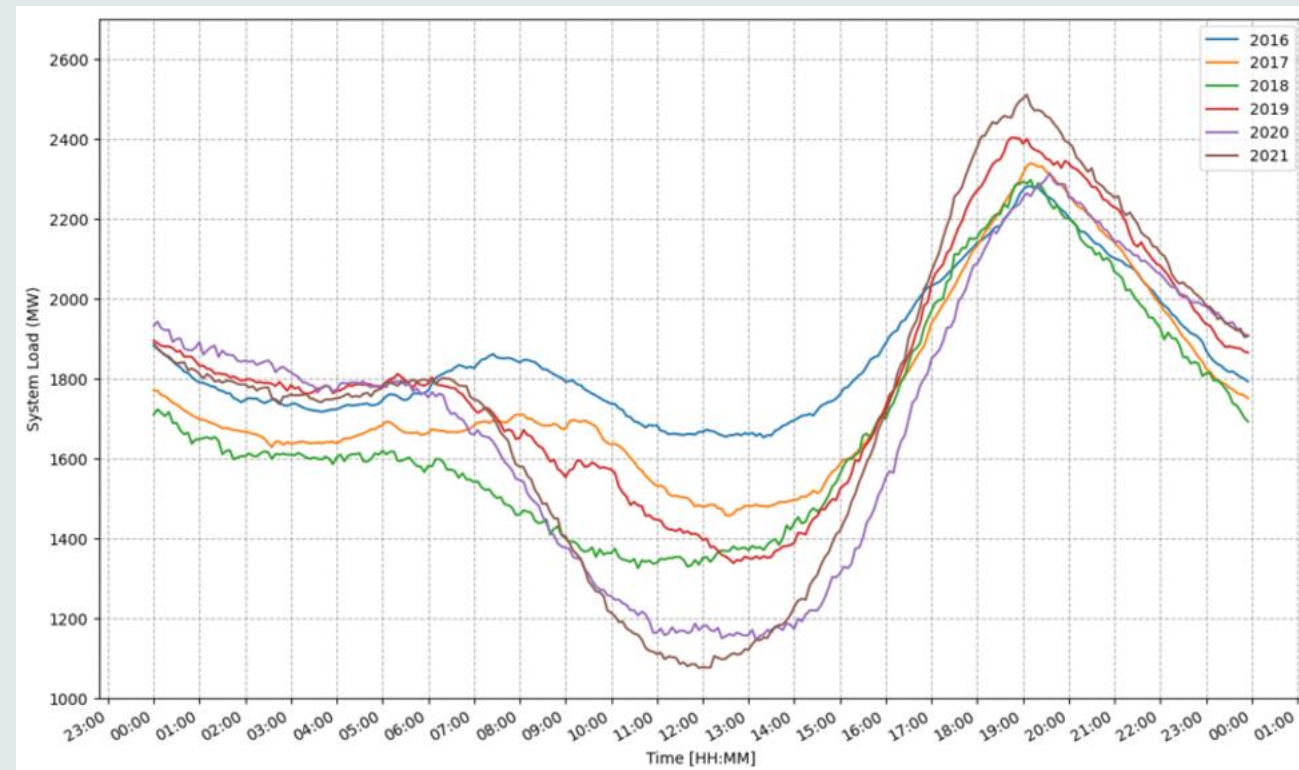
SWIS Transformation: SWIS Duck Curve

Minimum demand day forecast from 2018:



Note that 2016/17 and 2017/18 are actual measured loads

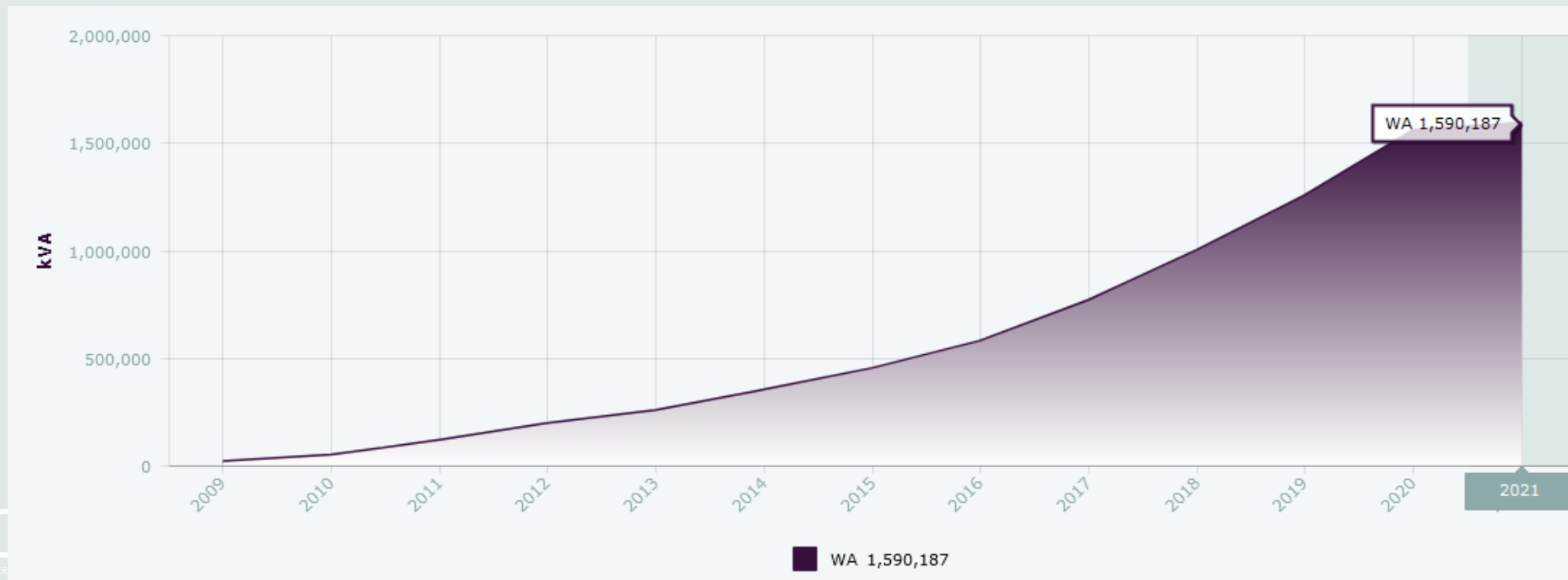
Actual minimum demand days for each year:



The 2021 minimum demand day was on 14/03/2021

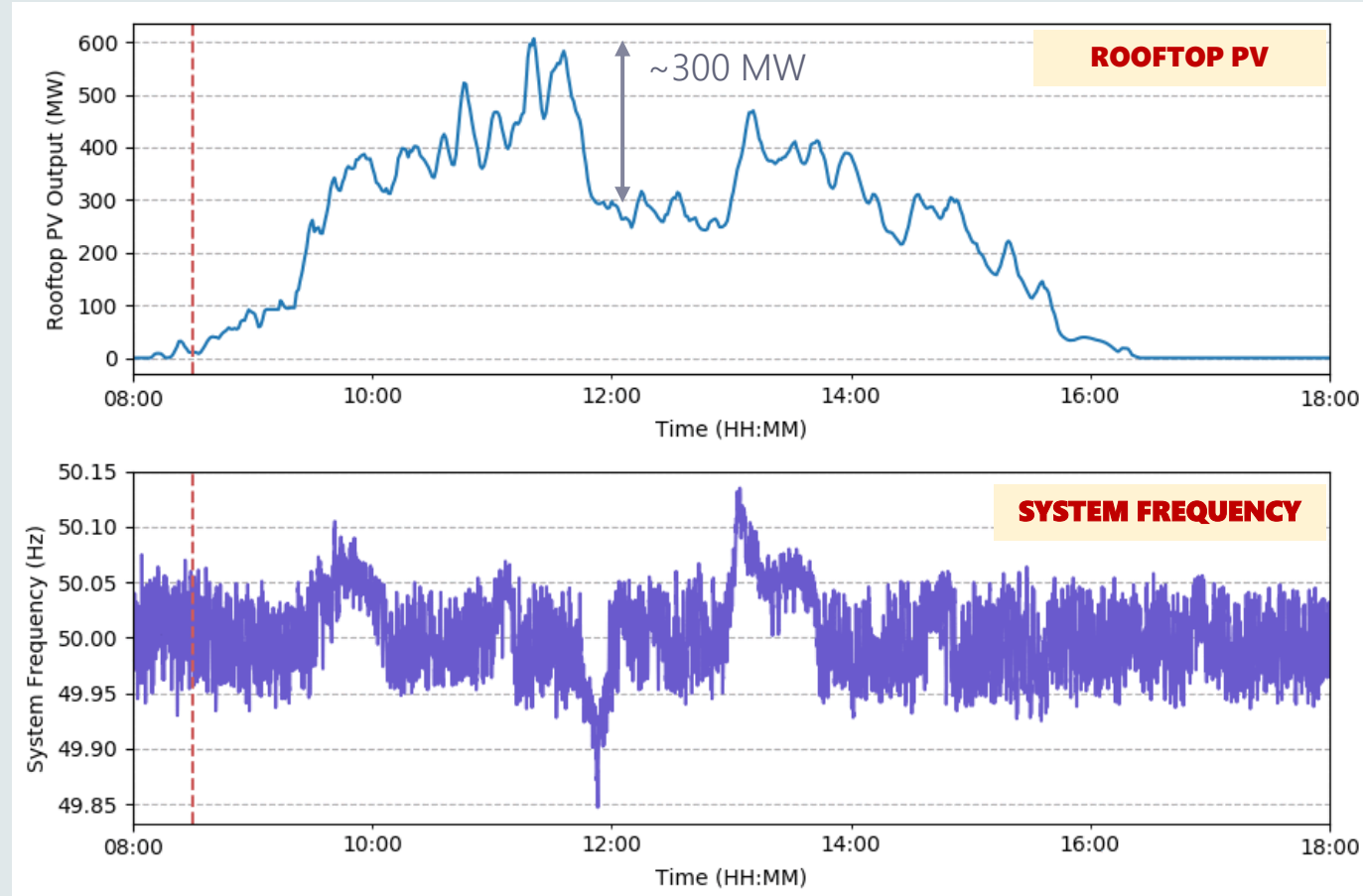
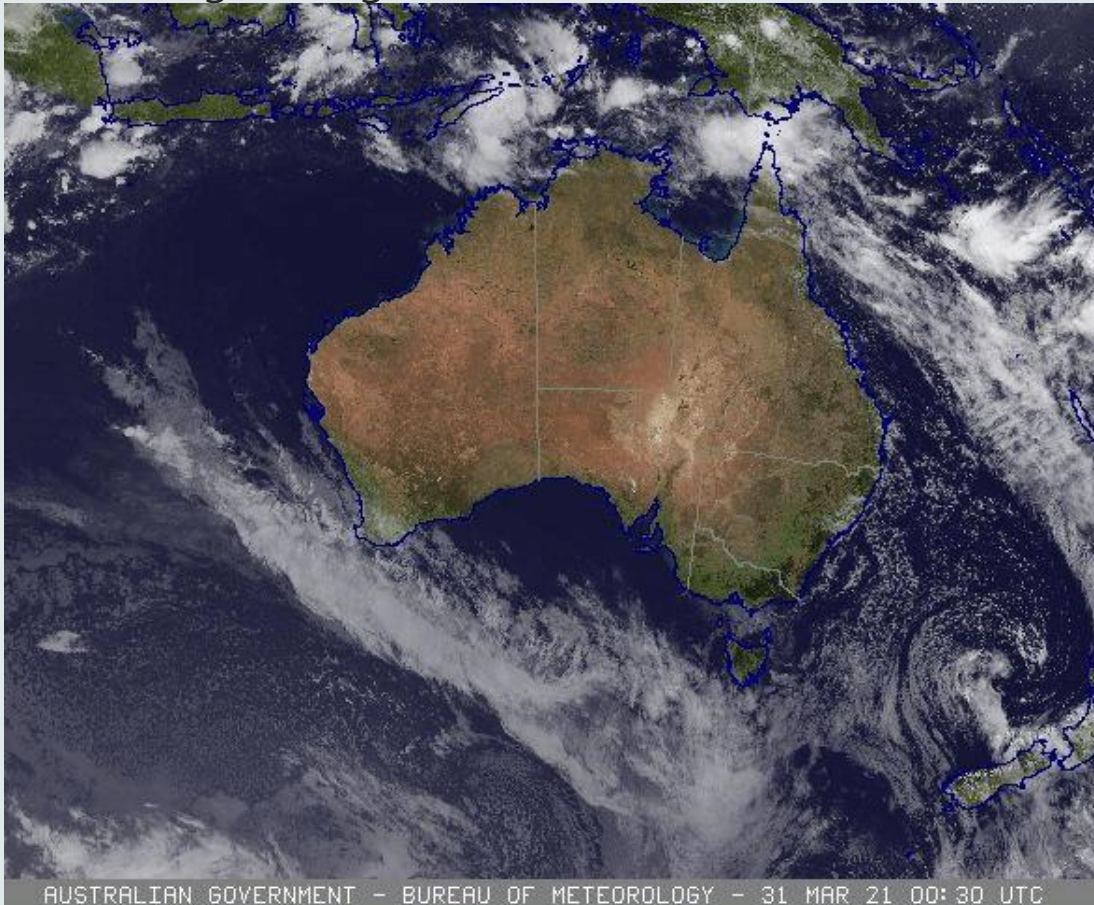
SWIS Transformation: Rooftop PV

Rooftop PV can be considered the largest single generator in the SWIS with approximately **1.59 GW** of grid-connected installed capacity in the SWIS [as at Mar 2021], almost as much as the combined coal-fired capacity in the SWIS (1.65 GW).



SWIS Transformation: System Load Volatility (Large Cloud Band on 31/03/2021)

Whilst AEMO continues to invest in its forecasting systems to address increasing variability, ability to forecast timing and scale of large swings is difficult:

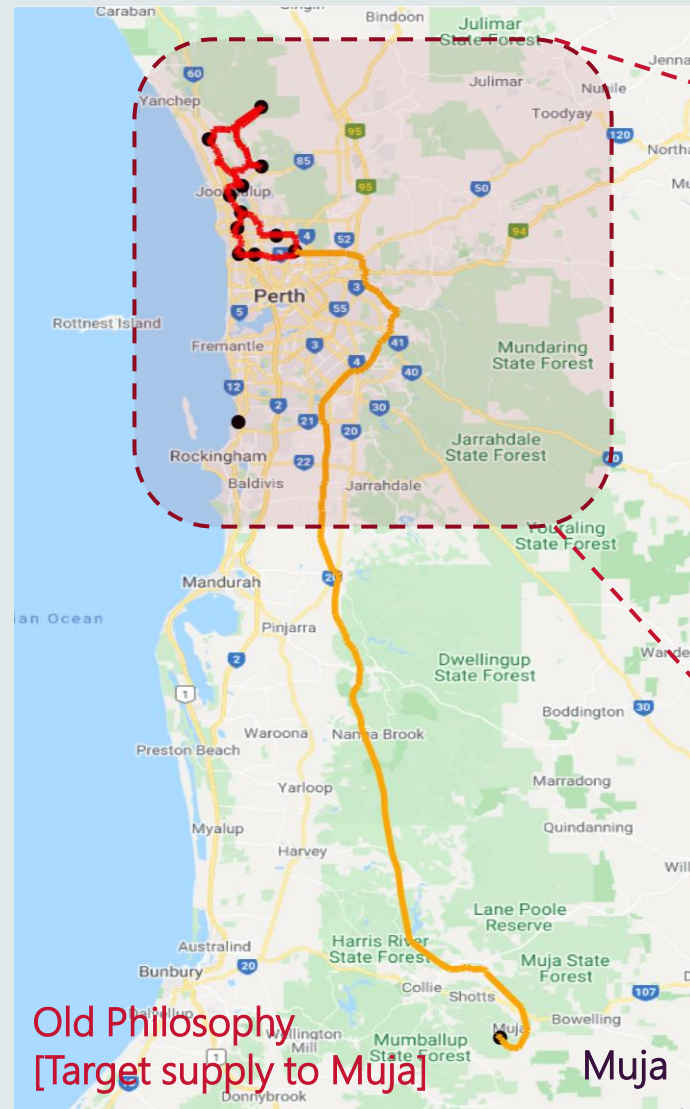


SWIS Transformation: Impact on System Restart

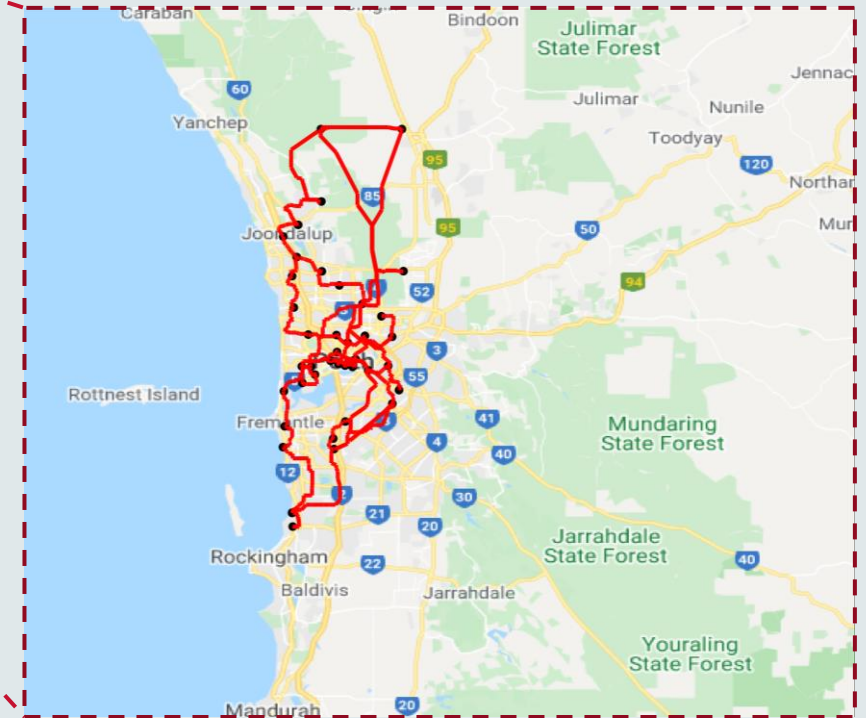
In the event of a complete System Black, the SWIS has to be restarted from specific power stations contracted by AEMO to provide system restart services.

The old restart philosophy (dating back to 1990) prioritised the re-energisation of coal-fired generators at Muja via the 330 kV transmission corridor from Perth.

However, increasing DER has reduced the availability of stabilising load needed to manage voltages when energising long 330 kV lines.

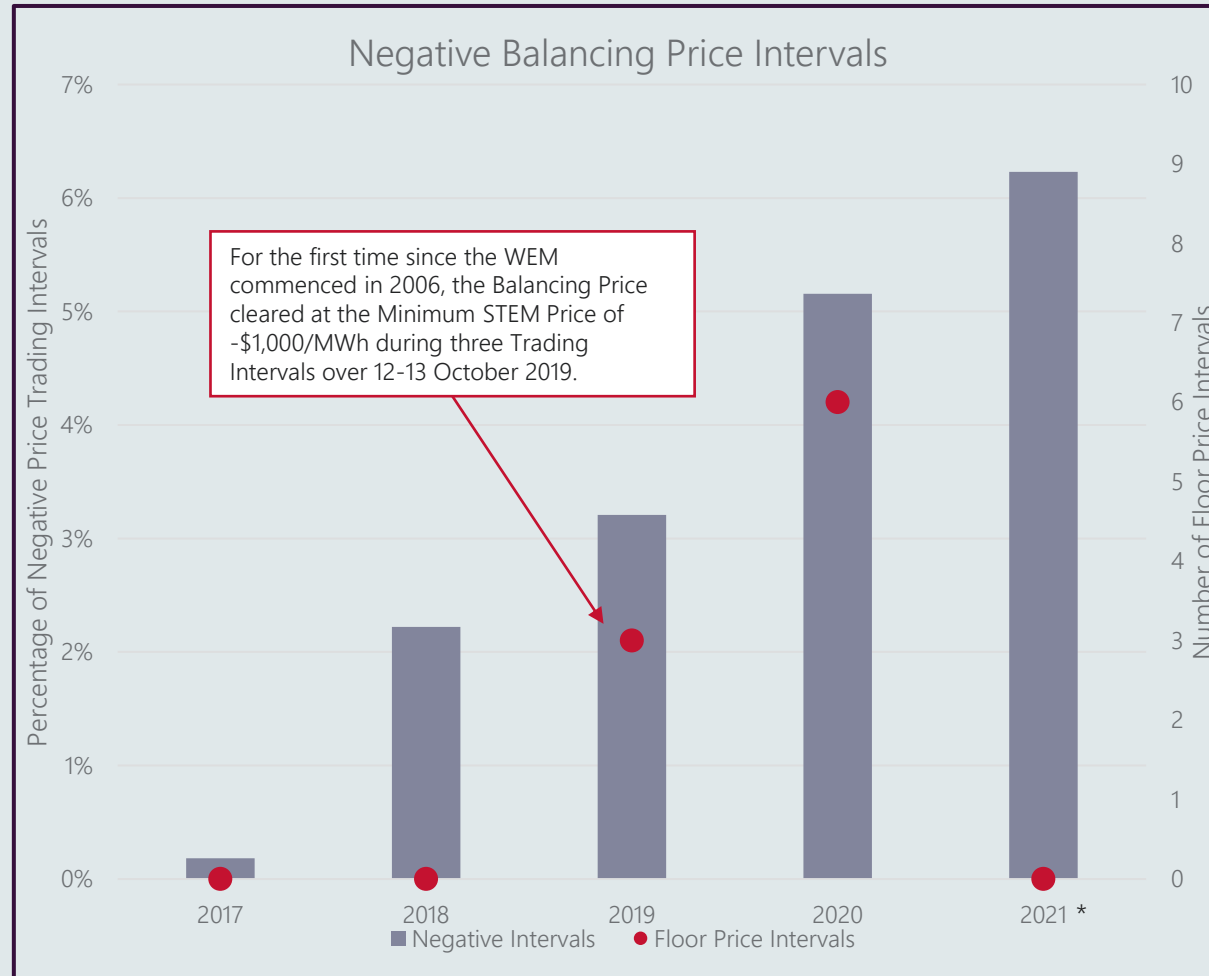


New Philosophy [Target supply to Perth Metro]



The restart philosophy has been revised to target stable Perth inner metro loads (e.g. CBD) with lower exposure to DER.

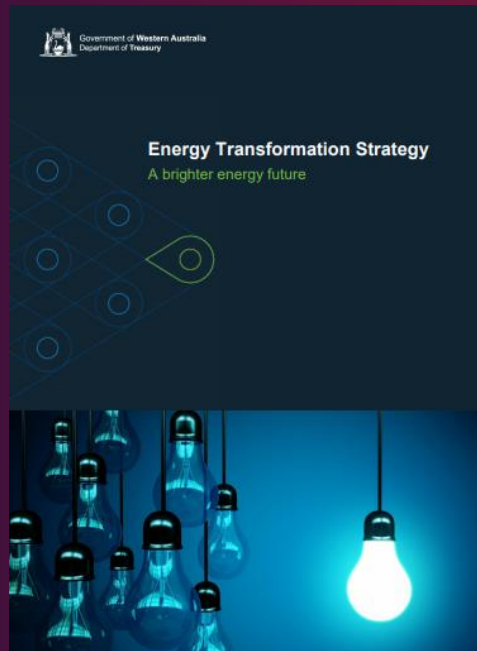
SWIS Transformation: Wholesale Pricing Outcomes



* 2021 includes data up to and including Trading Day 12/07/2021

** Extended forced outages of a large lower cost Facilities through summer and shoulder season meant increased generation from higher cost gas and peaking facilities contributing to higher prices in 2017 .

Transitioning SWIS: Energy Transformation Strategy



The WA Government's Energy Transformation Strategy launched in May 2019 cover many of the recommendations in AEMOs 2019 SWIS Renewables Integration Paper:

- Continue with wholesale market reforms
 - Provides foundation to facilitate energy transition
 - Enables new essential system services, full registration of storage, reduce gate closure and co-optimisation.
- Implement a Distributed Energy Resources plan
- Develop a SWIS Integrated System plan, including identifying system and network requirements, including storage.

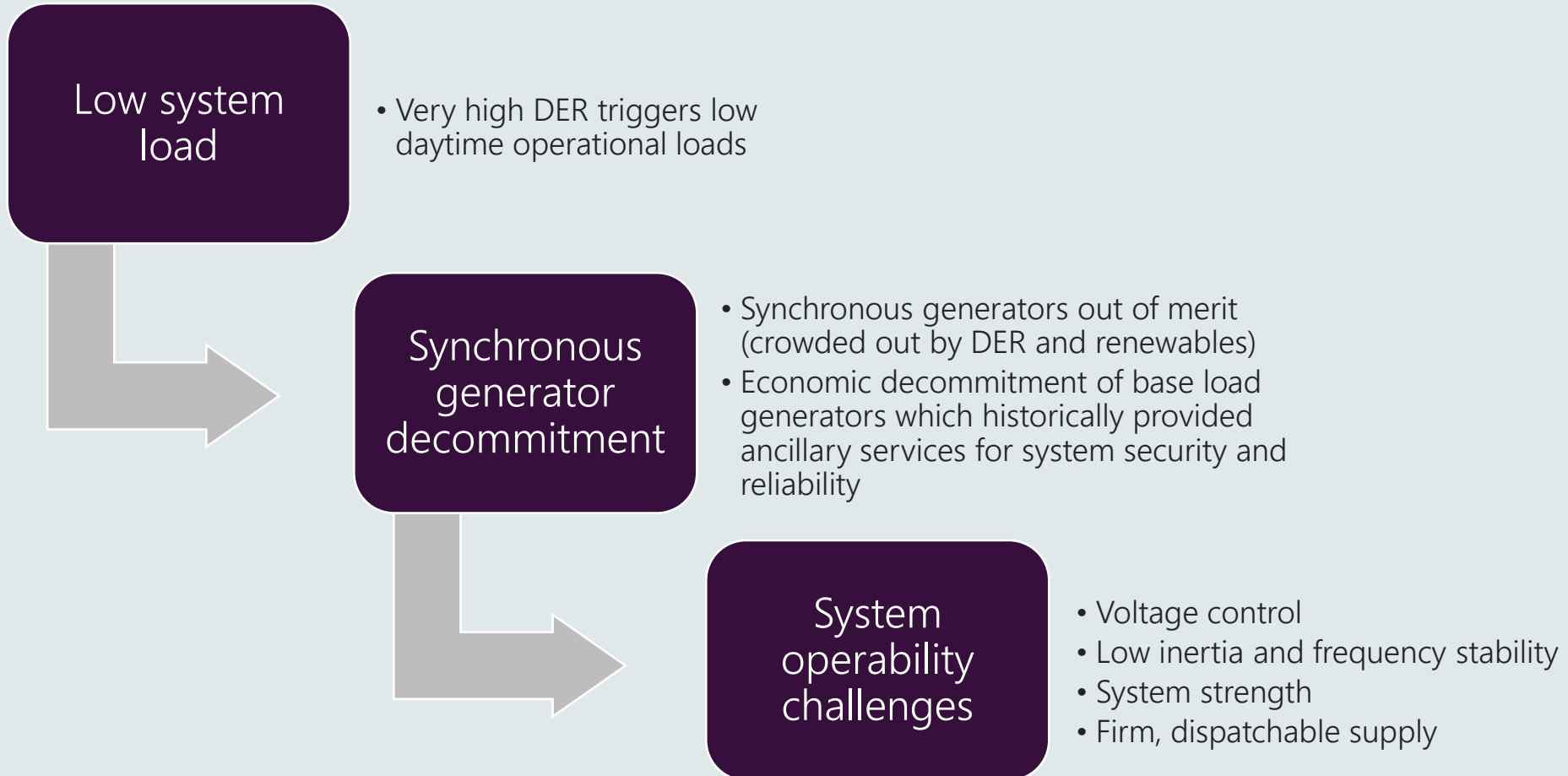


Excellent progress on the ETS has been achieved:

- Implementation of the ETS will resolve the majority of challenges and realise the bulk of opportunities facing the SWIS as they were forecast in 2019 and now occurring.
- AEMO will be publishing this year an update to its AEMO 2019 SWIS Renewables Integration Paper showing that the timeframe for the system becoming unmanageable has pushed out.
- However, as the power system is transforming faster than forecast some actions may need to be brought forward, complementary activities or future reforms undertaken

SWIS Evolution: Low Load Issues

How system operability issues arise from low daytime loads due to high DER penetration:



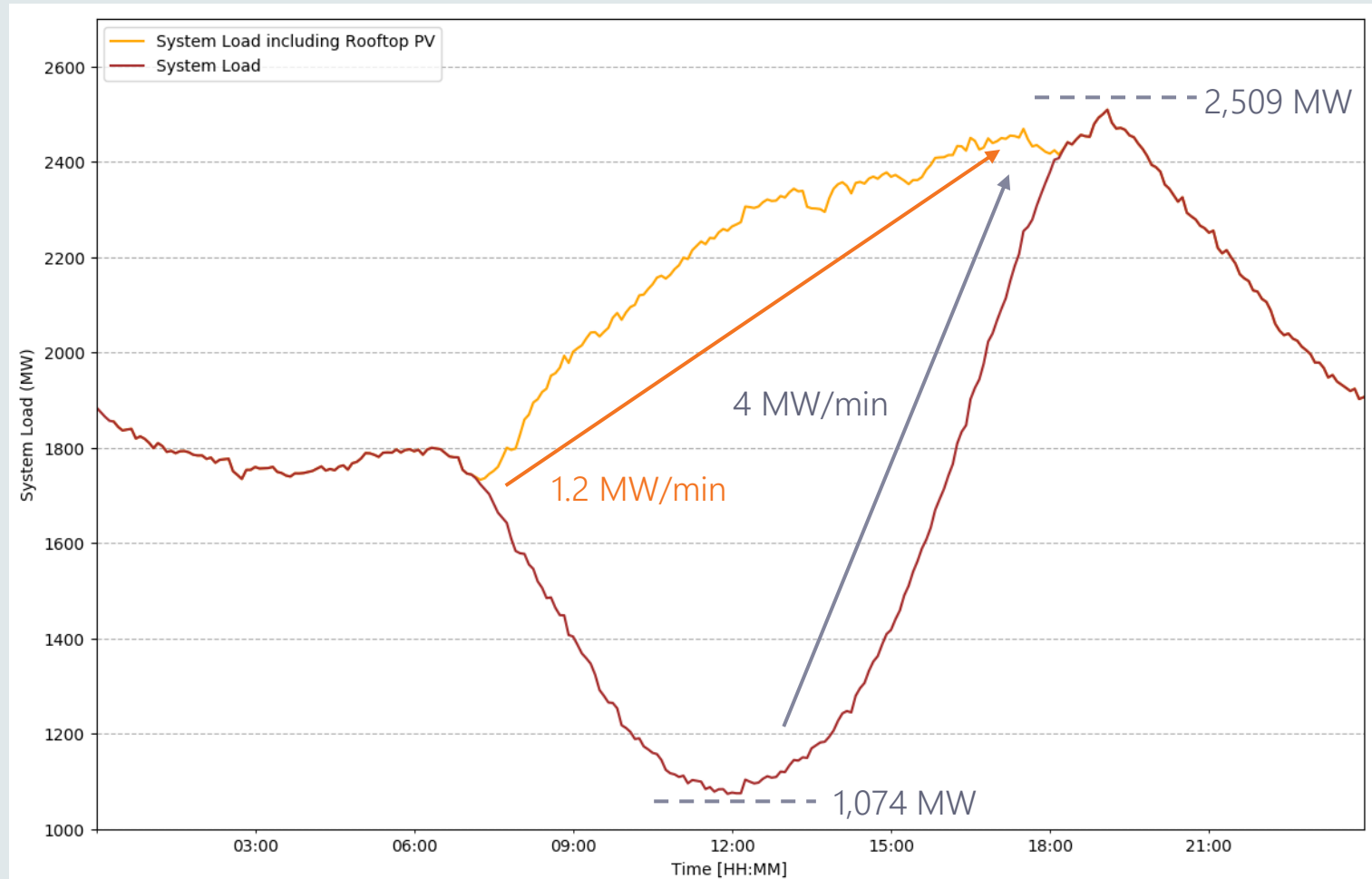
SWIS Evolution: Ramping and Cycling

As the 'belly of the duck' gets deeper, the ramping requirements from midday trough to evening peak become more onerous.

Example from minimum demand day (14/03/2021):

- Trough-to-peak: 1,435 MW (or 134% of load at trough)
- Average ramp rate: ~4 MW/min
- Average ramp rate (without DER): 1.2 MW/min

An increasingly flexible generating fleet is required as duck belly gets deeper.



SWIS Evolution:

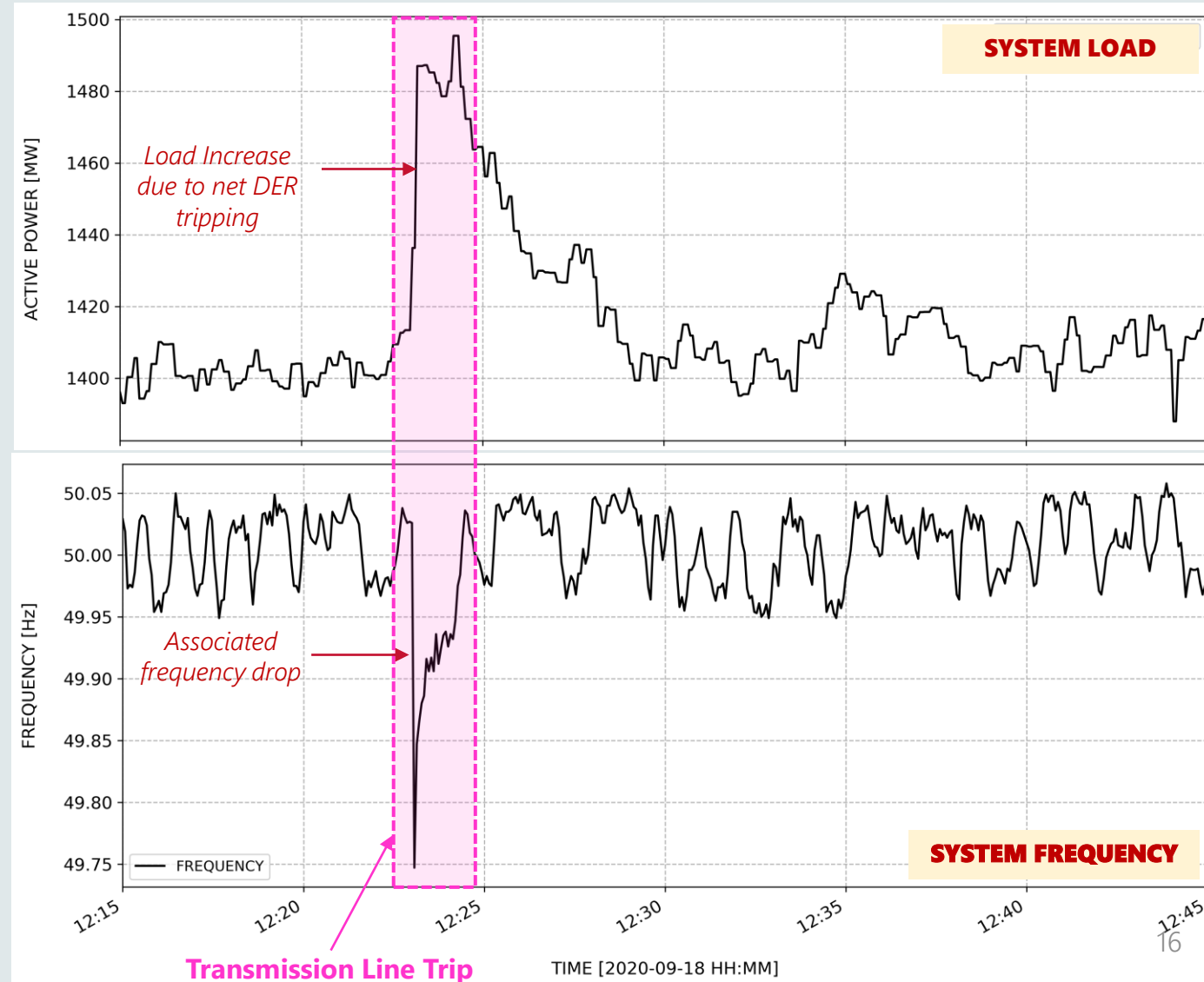
Rooftop PV Tripping Contingency Risks

During system disturbances (e.g. network faults), a portion of rooftop PV inverters in the system have been observed to trip unintentionally.

This was not a significant problem in the past when there was lower penetration of DER in the system (ie DER < load tripping for network faults) and we now have single network contingencies resulting in loss of utility scale generation.

AEMO continuing to build on work done in the NEM to develop models to refine DER tripping estimates and scenarios, including working with UNSW (Project MATCH).

Case study: on 18th September 2020, there was a transmission line trip south of Perth at around noon, which resulted in a system load increase due to DER tripping (~100 MW) and, in turn, a frequency drop in the system.



Minimum demand challenges and potential solutions



AEMO is working closely with Western Power and Energy Policy WA (EPWA) on a program of work to manage minimum demand and related challenges.

- In parallel, AEMO continues to enhance its systems to provide enhanced visibility (e.g. inertia monitoring tool)



This work incorporates actions already planned or underway as part of the WA Government's Energy Transformation Strategy - as well as a few areas where additional complementary work is required (e.g. examination of ramping).



AEMO preliminary analysis has identified a number of 'no regret' ETS actions that should be expedited to de-risk the present power system operational challenges:

- The new Australian Standard requirement of voltage disturbance ride-through capabilities for all new rooftop PV installations,
- Market and incentive frameworks for customer behaviour in order to create load flexibility;
- Incentivising of Battery Energy Storage Systems (BESS);
- Emergency curtailment capabilities for all new DER installations.

Conclusion

We are seeing rapid challenges internationally, nationally and locally.

AEMO is very supportive of the WA Government's Energy Transformation Strategy which is delivering fundamental change and improvements.

Ongoing enhancements to AEMO's systems, along with actions to address current minimum demand issues will enable the SWIS and the WEM to resolve the existing challenges and realise future opportunities.

AEMO looks forward to continuing to engage with Government, industry and consumers in supporting these outcomes.

