Impact of Distributed Energy Resources on the South Australian transmission system

Energy Systems Integration Group - Session 3A: Adapting to increasing decentralisation and variable energy sources

24 September 2020

ElectraNet

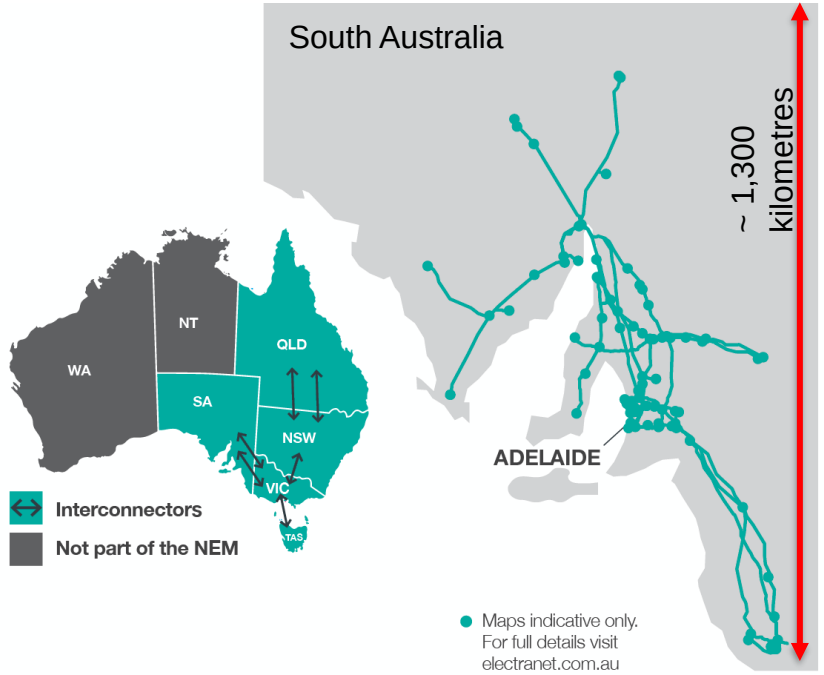
electranet.com.au

South Australia Context

South Australia (SA) is at the forefront of energy transformation

- Abundant high quality renewable energy resources with leading wind and solar penetration levels compared to demand
- Last coal fired power station closed 2016
- Reliance on gas generation and impact of higher gas prices
- SA system black and load shedding events have led to heightened concerns about power system security
- Emerging concern of distributed solar PV ‘shake-off’ for nearby generator unit faults

- ElectraNet is the Transmission Network Service Provider in SA
- Sparsely populated State – 1.7M people with 1.3M in Adelaide
- 3,100 MW maximum demand & minimum demand < 400 MW
- 5,600 km of transmission lines & 96 substations and switchyards



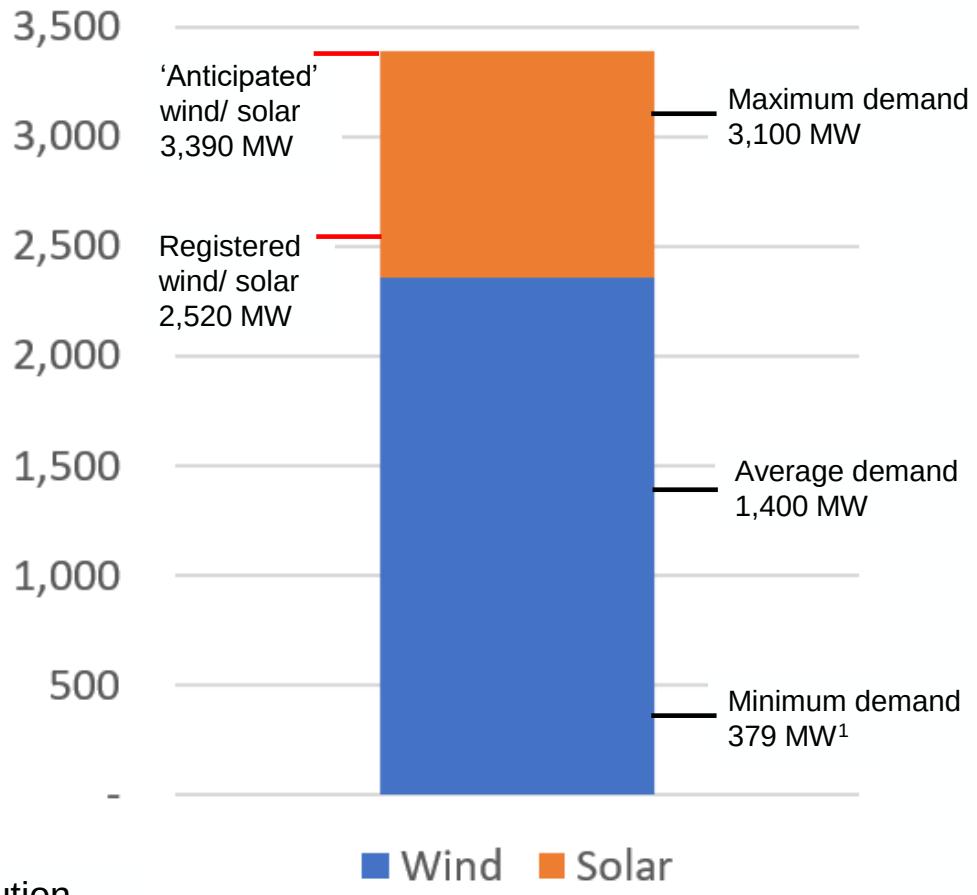
NEM – National Electricity Market
AEMO – Australian Energy Market Operator

Changing Generation Mix

SA faces the prospect of zero (or even negative) grid demand at times

- The challenges seen in SA in relation to minimum levels of synchronous generation are a first in any large scale (GW) power system in the world…
- Registered wind/ solar generation capacity is…
  - About 180% of average demand
  - > 650% of minimum demand

Grid connected intermittent generation capacity relative to demand (MW)



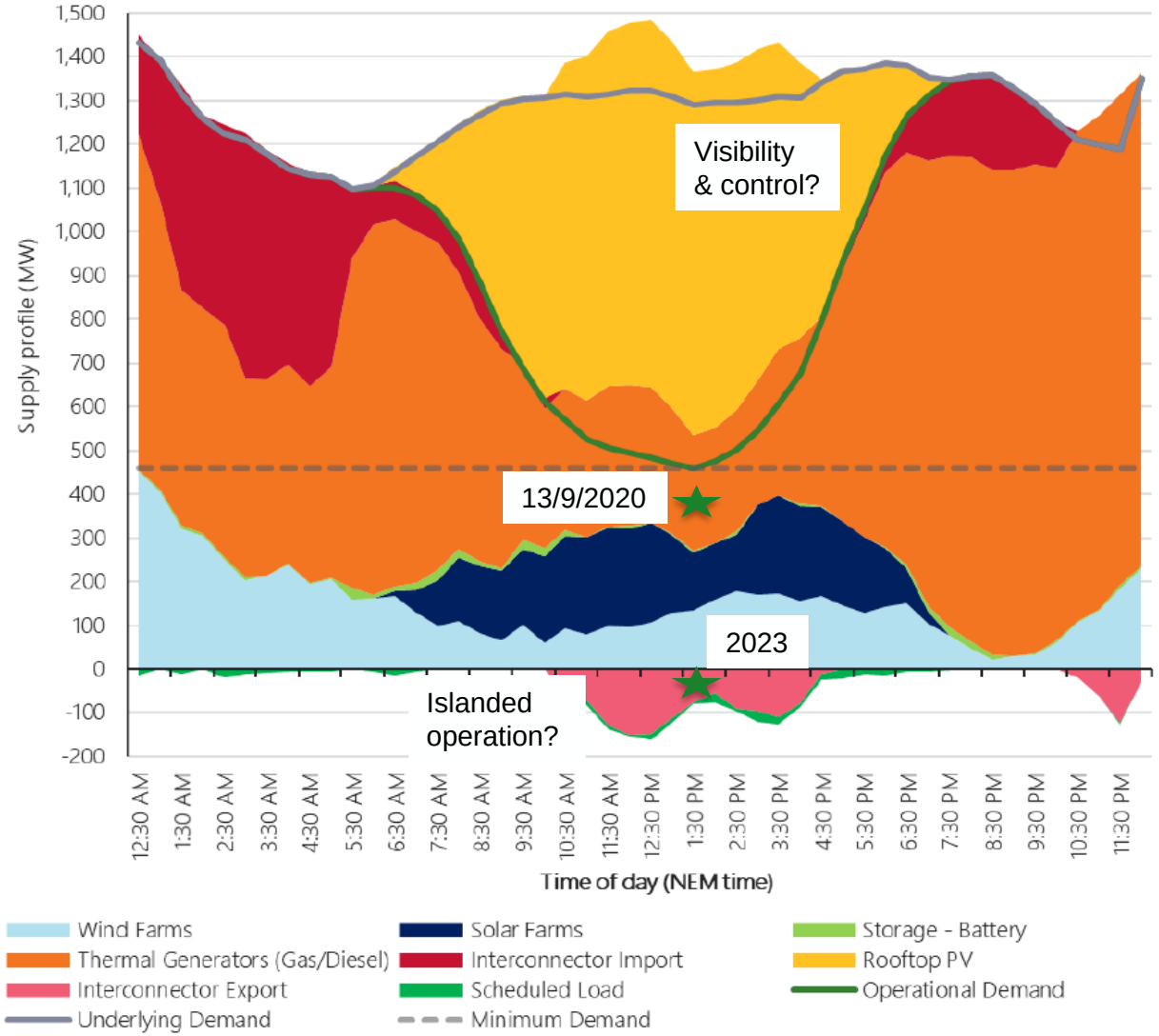
1. Minimum demand includes contribution from embedded, distributed solar PV

Source: Adelaide Advertiser 14 September 2020

Declining minimum demand

- For minimum demand conditions in SA
  - Relying on the Heywood interconnector to export excess generation
  - Semi-scheduled generation constrained
  - The largest (collective) generator is uncontrolled
- Under Frequency Load Shedding (UFLS) becoming ineffective
  - UFLS being expanded
  - Additional constraints on Heywood interconnector
  - Protected Event proposed
- Islanded operation very challenging

Figure 9 Profile of record minimum operational (as-generated) demand day (10 November 2019)



Source: AEMO, SA Electricity Report, 2019

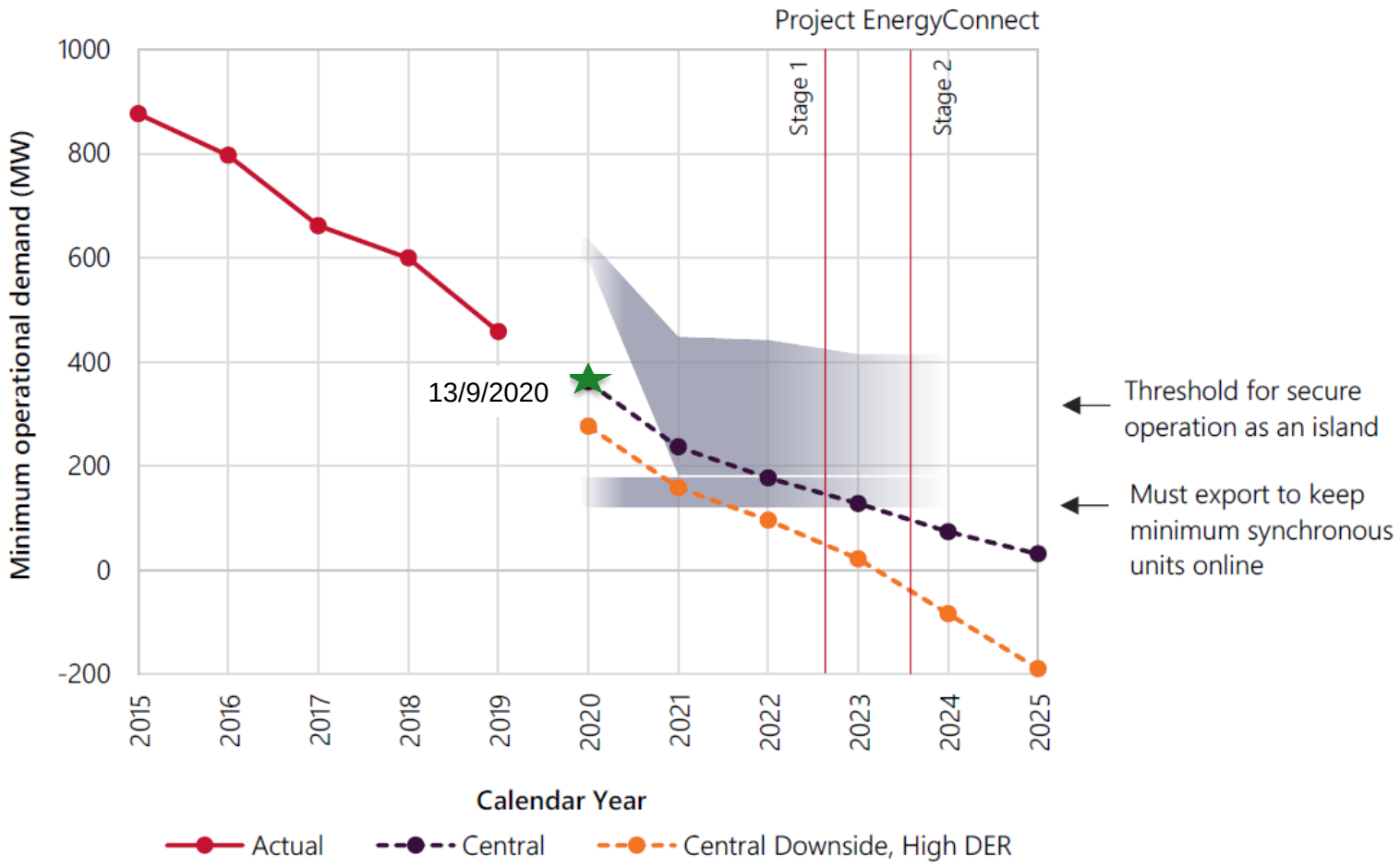
ElectraNet

Declining minimum demand - Islanded operation

- Islanded operation under minimum demand conditions would be very challenging – Today!
- Short term actions:
  - Operator intervention to reduce non-scheduled generation
  - Distribution voltage control
- Other actions:
  - Control of new DER
  - Increase demand, e.g. storage, incentivise via tariffs
  - Improved standards for DER (mitigate DER shake-off)
- Project EnergyConnect would alleviate islanding challenge

Source: AEMO, ESOO, 2020

Figure 31 Minimum operational demand thresholds in South Australia (90% POE as generated)

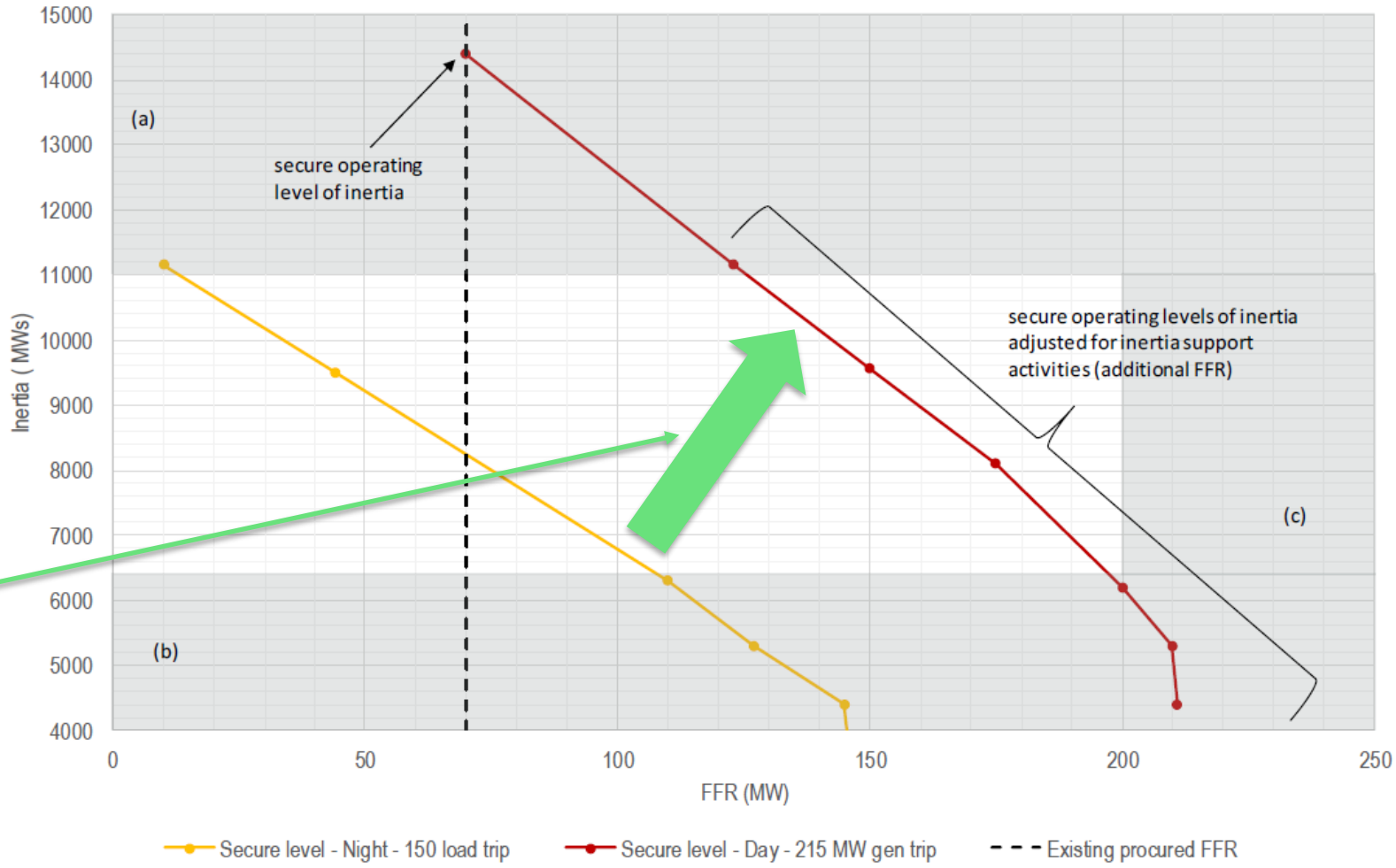


DER shake-off

Source: AEMO, SA Inertia Requirements & Shortfall, Aug 2020

- A transmission fault causing coincident tripping of net DER and load as well as trip of the largest generator in SA
- Has increased credible contingency in SA, resulting in:
  - Modelling of DER behaviour to determine transmission impact
  - Additional constraints on Heywood interconnector transfers
  - Increased inertia/ Fast Frequency Response (FFR) requirement during the day
- Wide area monitoring and control being implemented to cater for non-credible contingencies

Figure 3 **South Australia secure operating level of inertia adjusted for inertia support activities, with four synchronous condensers with flywheels**



ElectraNet

Impact on transmission/ distribution connection points

- Interface historically easier to manage
  - One-directional flow
  - Less load fluctuation
- Current situation in SA
  - High voltages - Lower voltages at connection points requested
  - 50% of connection points in reverse flow on 13 September 2020 (only the start of the minimum demand season)
- New challenges
  - Voltage control and reactive power flow management
  - Transformer thermal limits – in the reverse direction!!
  - What are ‘fit-for-purpose’ parameters to manage the transmission/ distribution interface?

- Conclusion: Control/ scheduling of DER imperative going forward, including reactive response

Thank You

If you have any questions please contact:

Hugo Klingenberg
Manager Network Development
P +618 8404 7991
M +61 430 475 923
E klingenberg.hugo@electranet.com.au