

ANTICIPATING AND ADDRESSING SECURITY CHALLENGES IN AN EVOLVING POWER SYSTEM

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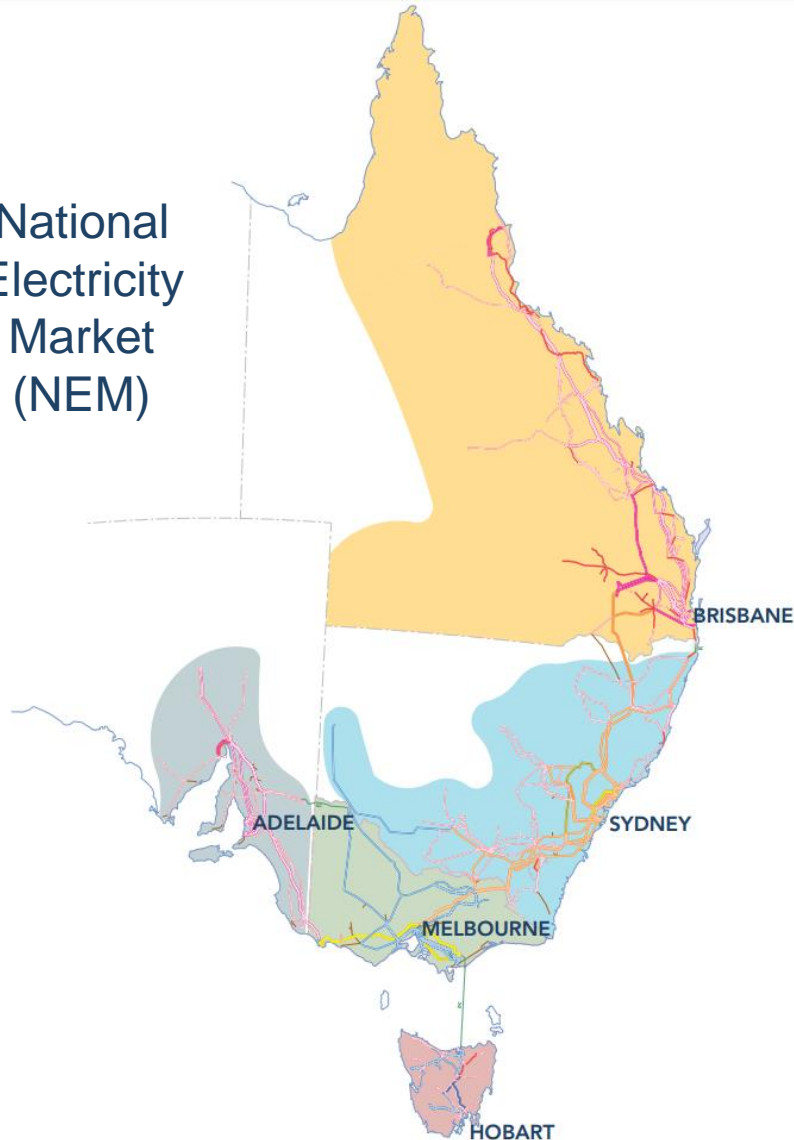


AGENDA

1. Introduction to the NEM
2. Future Power System Security Program
3. Identifying & addressing future challenges
 - Frequency Control
 - RoCoF
 - Fast Frequency Response
 - Availability of regulation frequency control
 - System Strength
4. Black system event – 28 Sept 2016

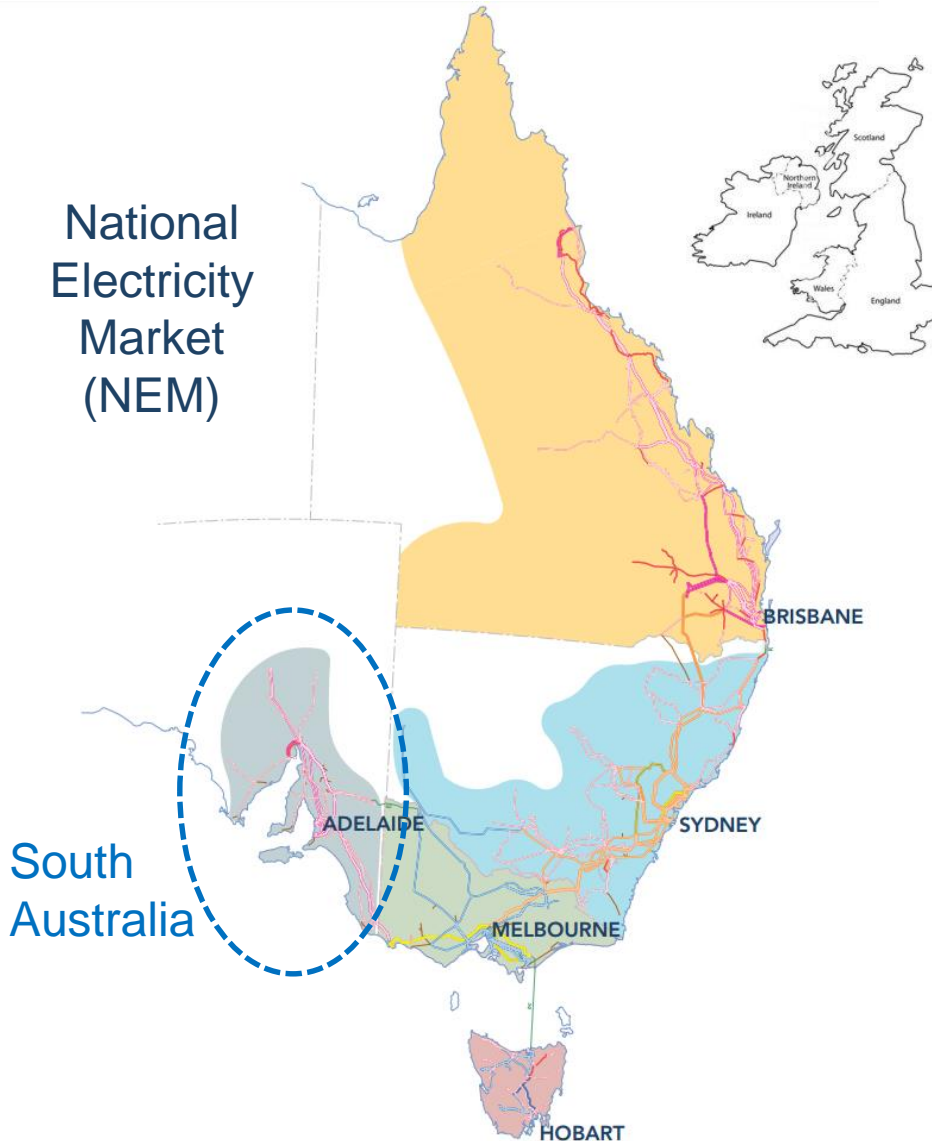
INTRODUCTION TO THE NEM

National
Electricity
Market
(NEM)



- ~85% of electrical load in Australia

SOUTH AUSTRALIA



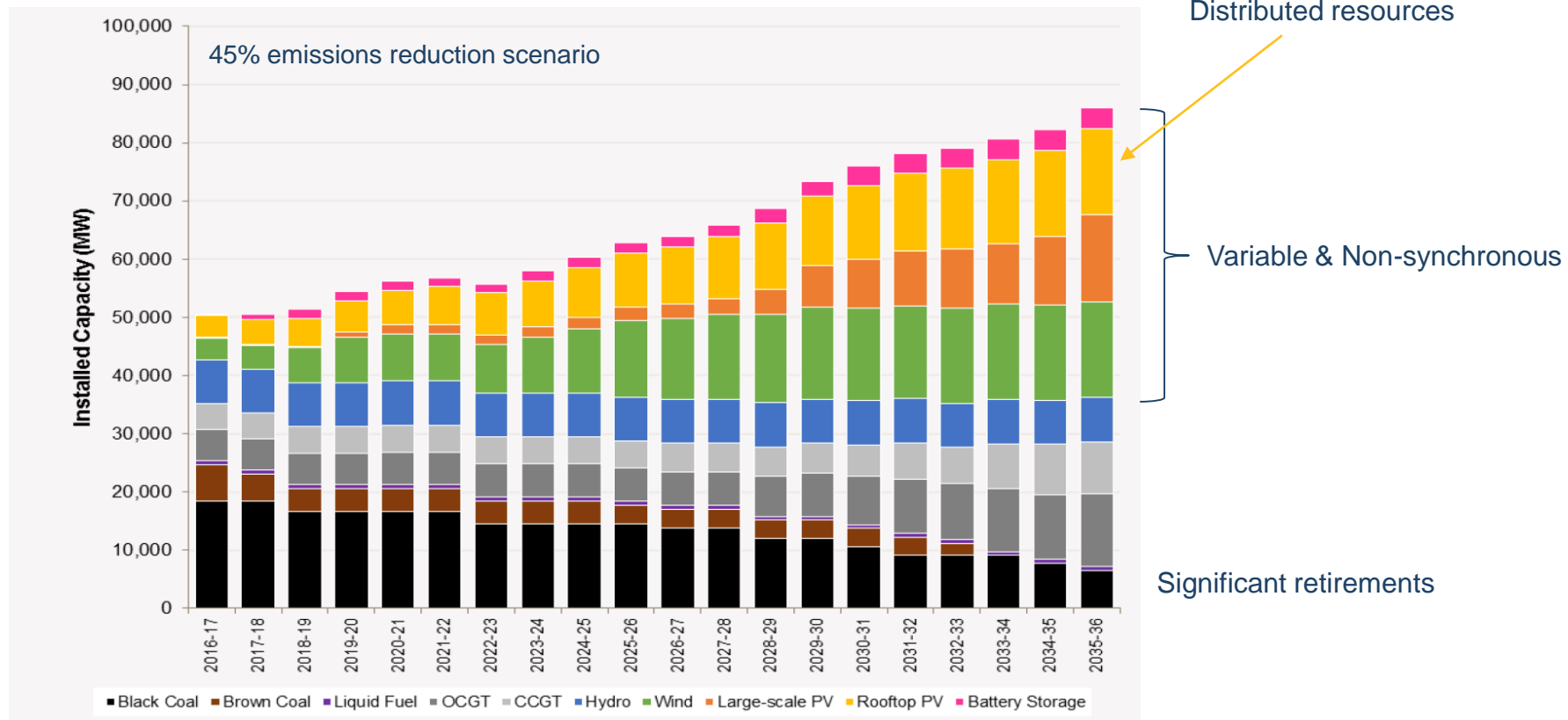
Area	Demand	Interconnections
NEM	15 - 35 GW	None
South Australia	0.8 – 3.4 GW	1 x AC (650 MW) 1 x HVDC (220 MW)

42% non-synchronous generation

- 1.5 GW wind
- 600 MW rooftop PV
- Max instantaneous penetration: 119%

FUTURE POWER SYSTEM SECURITY

- The power system is changing



Adapt AEMO's functions and processes to deliver ongoing power system security and reliability

Short-term

To be transparent in how AEMO intends to meet its obligations

Long-term

To identify, rank and promote resolution of long-term technical challenges

TIMELINE



Dec 2015

2016

2017 →

Identify challenges

Analysis to define operational bounds and risks

Identify technical solutions

Develop solution frameworks

Other technical challenges

IDENTIFYING CHALLENGES

- Stakeholder consultation group
 - Formed a comprehensive list of challenges
 - Prioritised those requiring immediate focus



Frequency control

System strength

**Management of extreme power system
conditions**

Visibility of the power system
(information, data and models)

FREQUENCY CONTROL



FREQUENCY CONTROL ANCILLARY SERVICES (FCAS)



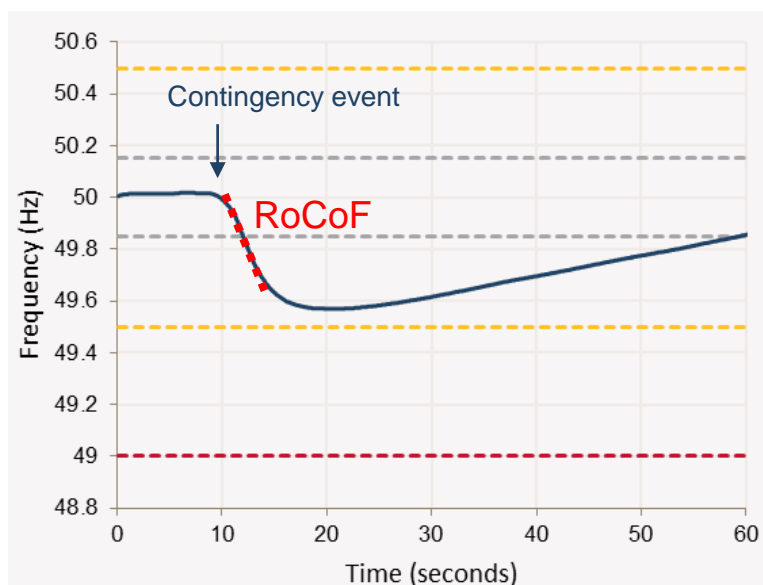
Raise and Lower services for each of:

	Control	Response time	Sustain time
Regulation	AGC (Automatic Generation Control)	Responds every 4s	Enabled each five minutes
Contingency	Local frequency measurement	6s	60s
		60s	5min
		5min	~10min

- Nine separate real-time (5min) markets
 - 8xFCAS + Energy

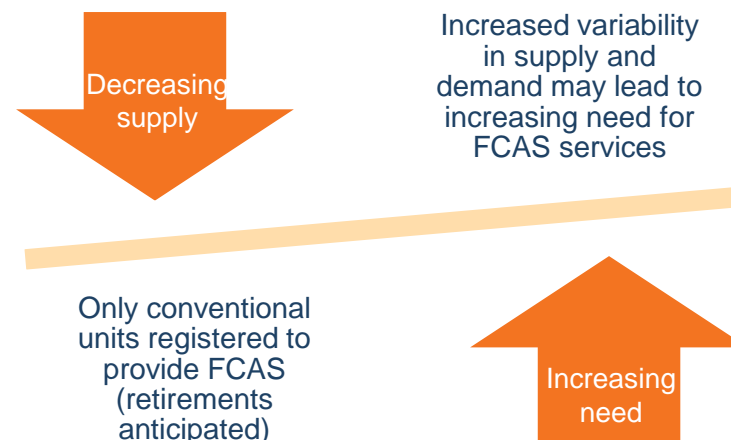
High RoCoF

- If “Rate of change of Frequency” (RoCoF) is too high:
 - May not meet Frequency Operating Standards
 - Could result in cascading tripping
 - Emergency control schemes may not prevent system collapse



Insufficient FCAS

- “Frequency Control Ancillary Services” (FCAS)
 - Will there be sufficient services available in future?



International Review of Frequency Control Adaptation

- What other jurisdictions have encountered similar challenges, and what can we learn from them?

RoCoF Screening

- What is the RoCoF exposure now, and in the future?

Survey of System RoCoF Limits

- Survey of system elements sensitive to RoCoF
- Estimate of secure technical envelope for RoCoF

RoCoF Withstand Capabilities of South Australian Generators

- PSSE modelling of RoCoF withstand capabilities of individual synchronous generators in South Australia

Fast Frequency Response Specification

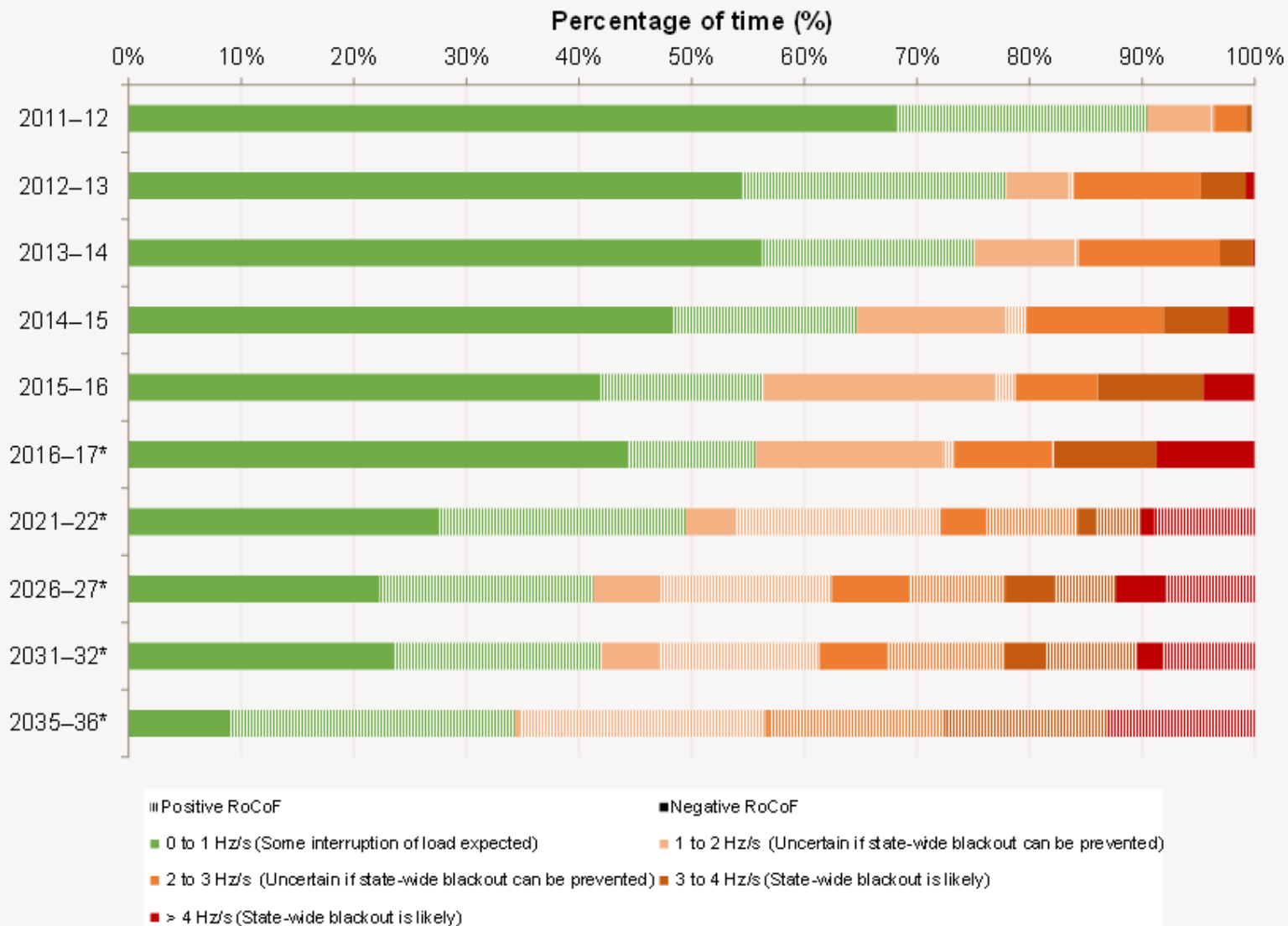
- Limitations and capabilities of technologies that can provide FFR
- Simple power system modelling to identify power system requirements
- Preliminary specification of FFR service

INTERNATIONAL REVIEW

- Very few large jurisdictions experiencing RoCoF challenges
- Important exceptions:
 - EirGrid/SONI
 - National Grid
- Opportunities for collaboration
- FFR services are relatively novel
 - Very few practical examples of very fast frequency control
 - Real technical complexities



ROCOF EXPOSURE IN SOUTH AUSTRALIA



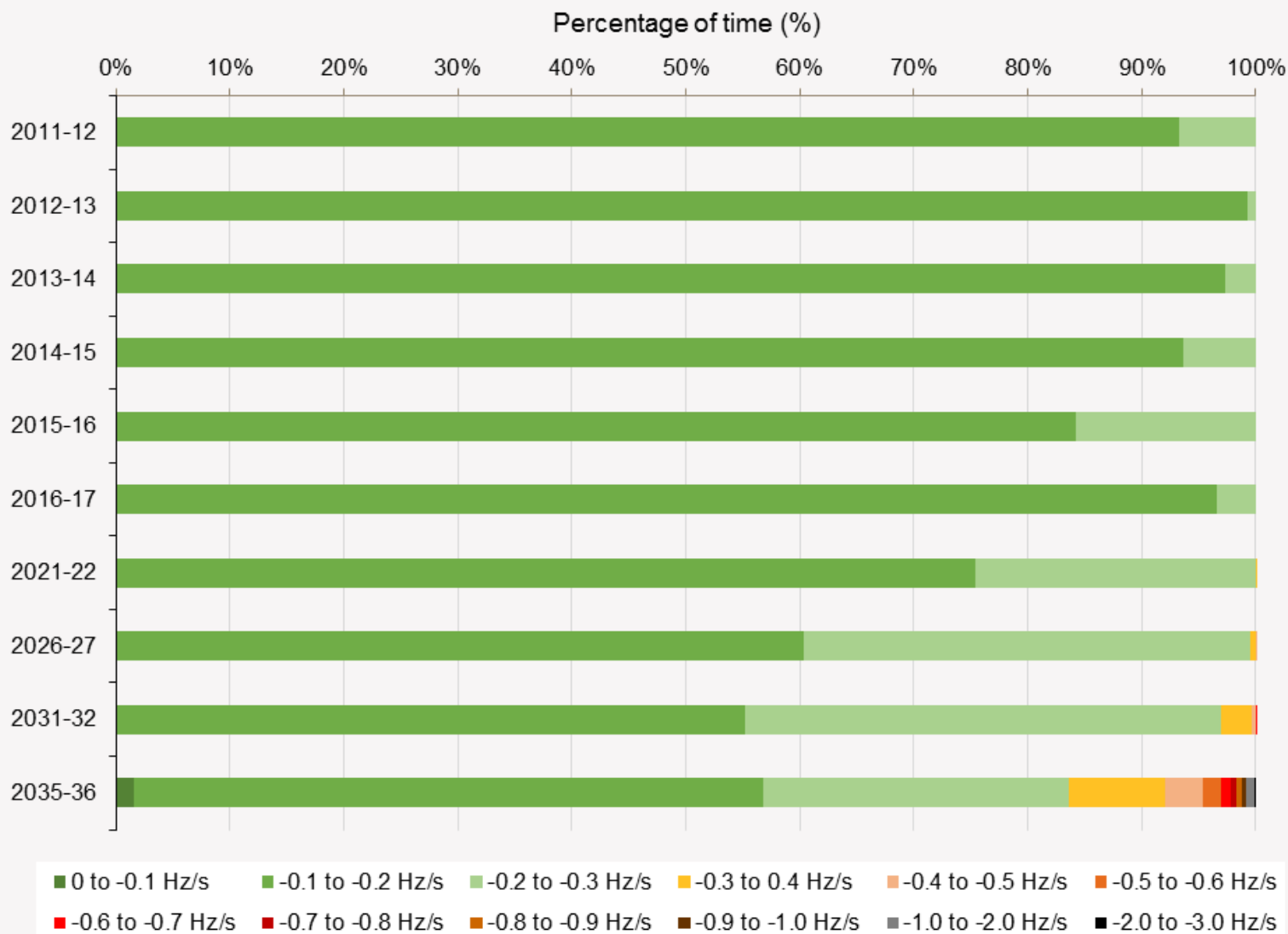
Exposure in SA upon “non-credible” loss of Heywood interconnector (double circuit)

AEMO has **no obligation or authority** to protect against loss of Heywood, unless reclassification of loss as “credible”

Rule change in progress to allow identification of “protected events”, for which AEMO would have some obligations and authority.

- UFLS
 - Issues above 3Hz/s
- Gas Turbines
- PSS/E modelling results:
 - Significant differences between synchronous units identified, some may be particularly vulnerable
 - RoCoF withstand capability depends upon many factors
 - Individual unit (inertia?)
 - Type of event (fault?)
 - Operation of unit (power factor? Unit loading?)
 - Network properties (local impedance?)
- Targeted testing, monitoring and verification required

NEM MAINLAND – CREDIBLE CONTINGENCIES



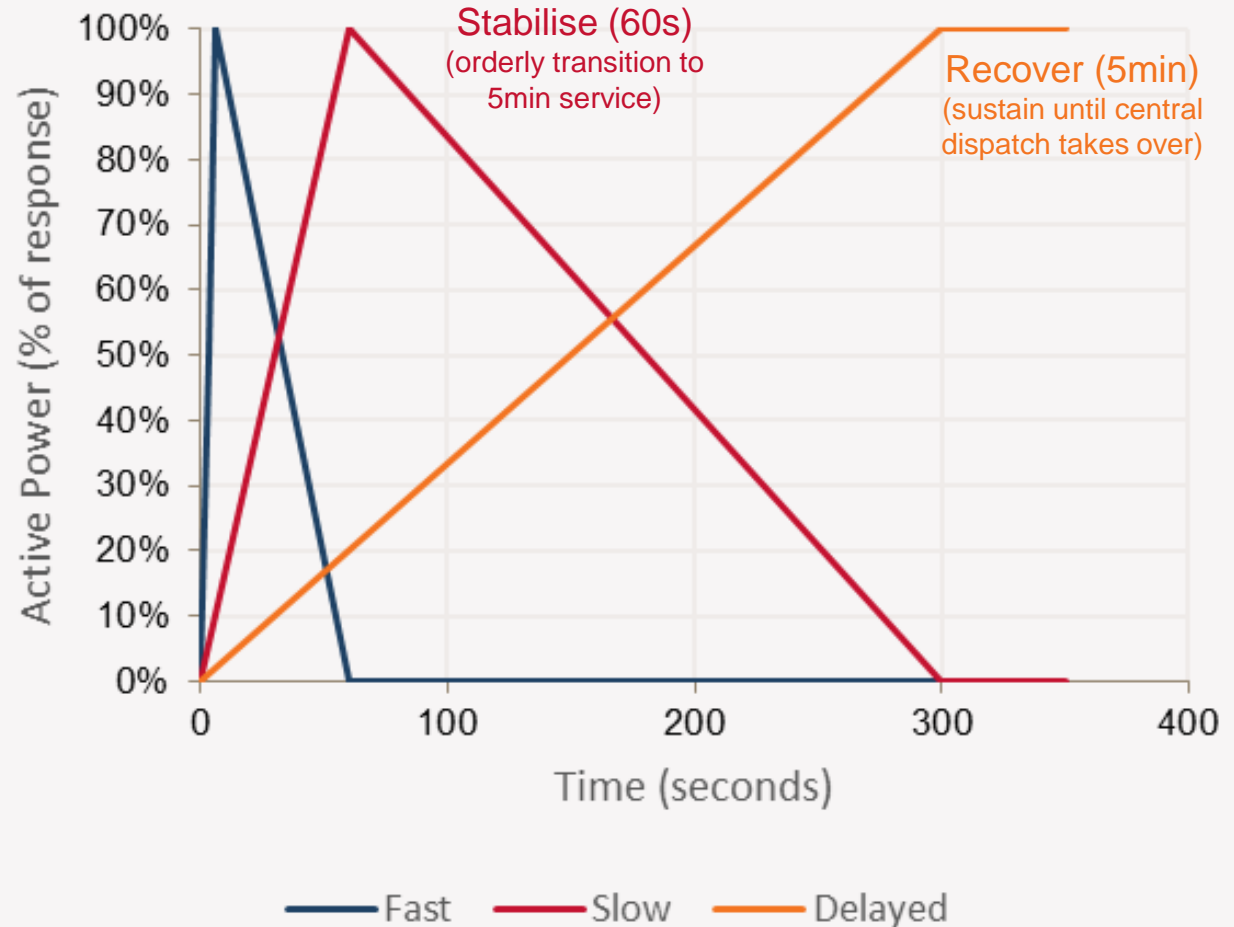
Exposure on NEM Mainland upon credible loss of largest unit

Potential challenges meeting Frequency Operating Standards above ~0.3 Hz/s

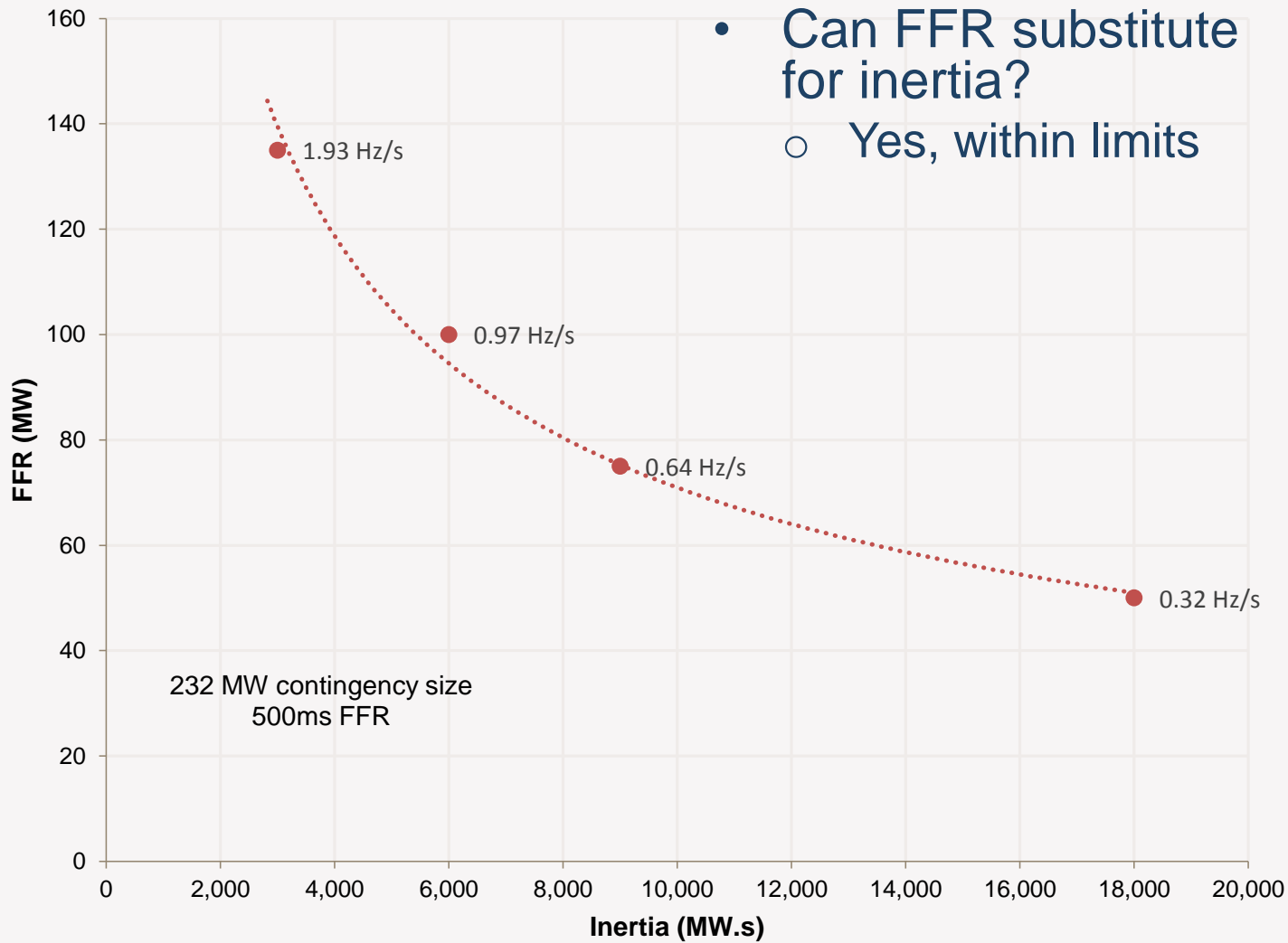
FFR SPECIFICATION

- New 0.5-2s FFR service?
- Sustain to 6s
- Wind recovery period?
- Hydro initial withdrawal?
- Proportional vs switched controls?
- Co-optimisation of FFR and inertia?

Arrest (6s)
(orderly transition
to 60s service)



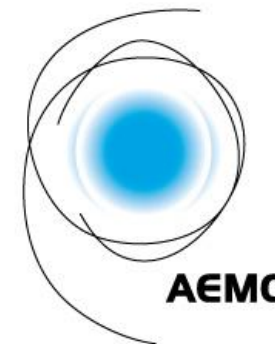
FFR SPECIFICATION



IMPLEMENTATION FRAMEWORKS



Market operator



Rule maker

- Options:
 - Generator obligation
 - AEMO contract process
 - TNSP provision
 - Five-minute dispatch
- Principles:
 - Technology neutral
 - Competition & market signals

FUTURE FCAS NEEDS



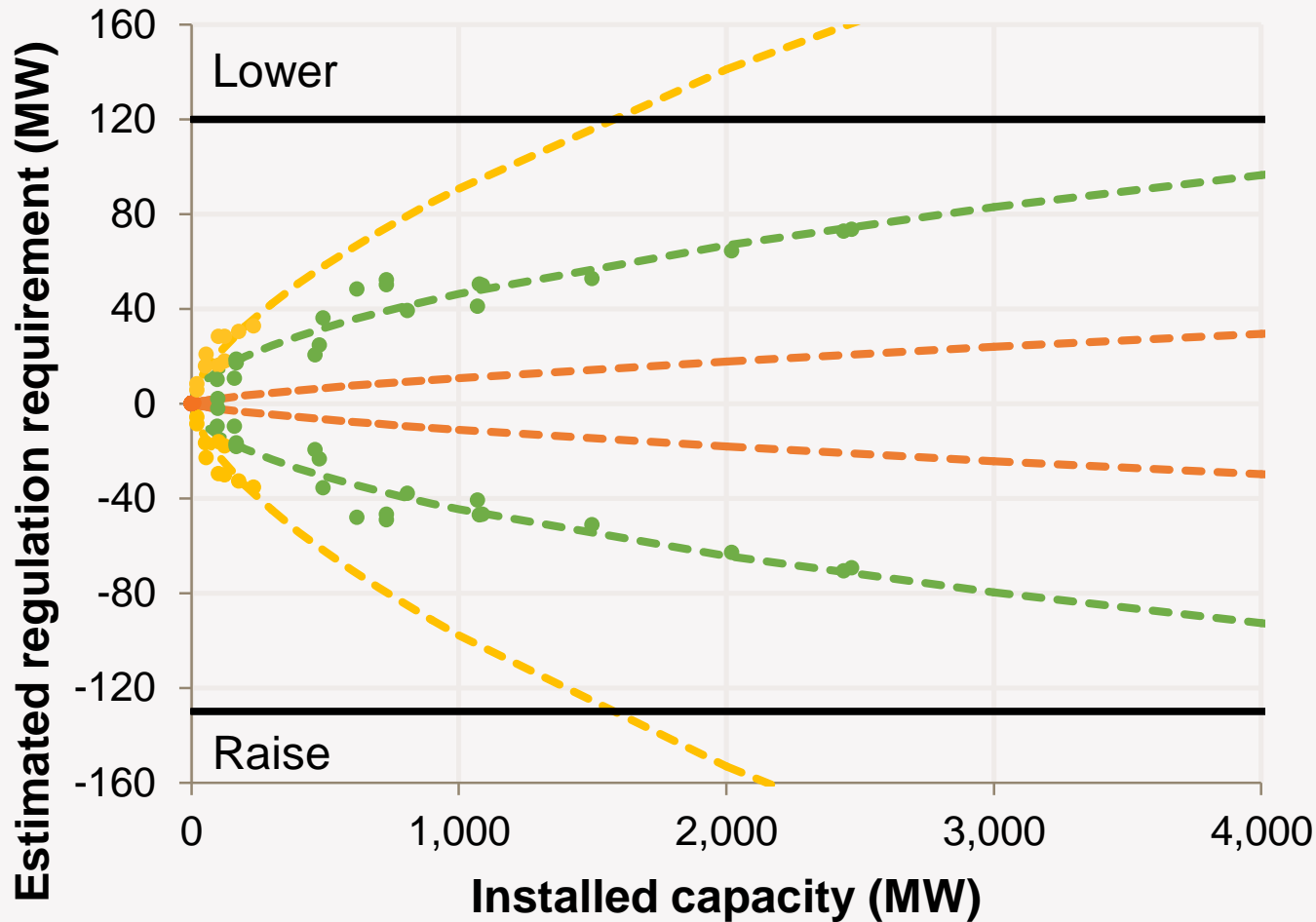
Projecting FCAS supply-demand balance

- How much regulation FCAS will we need in future?

Removing barriers to FCAS participation

- Review of FCAS specifications
- Pilot projects for registration/demonstration of FCAS capabilities?

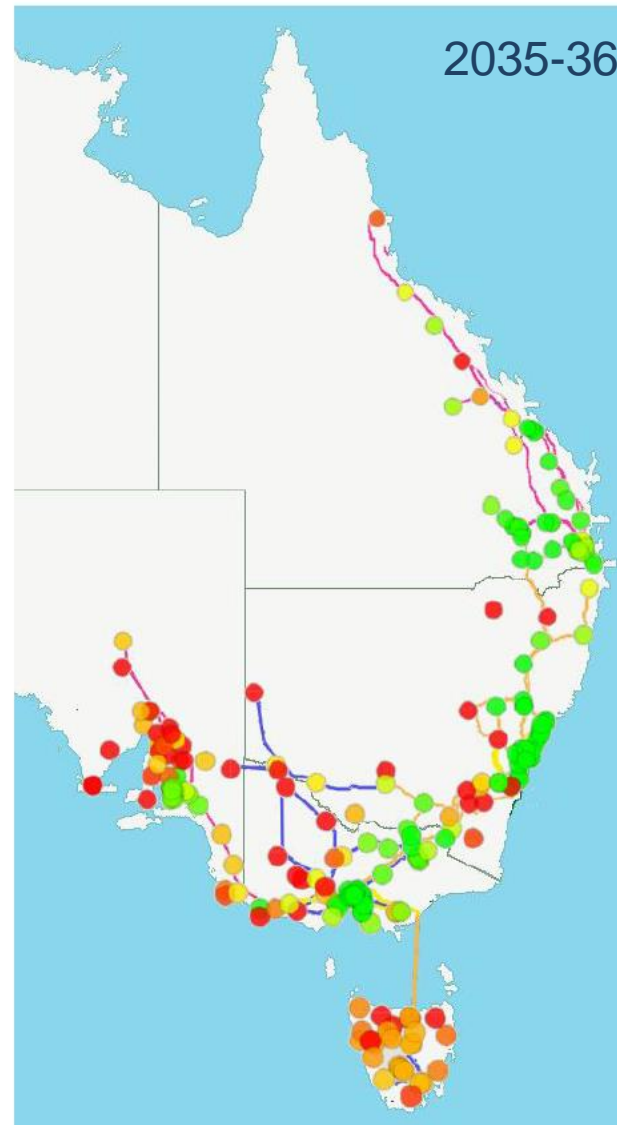
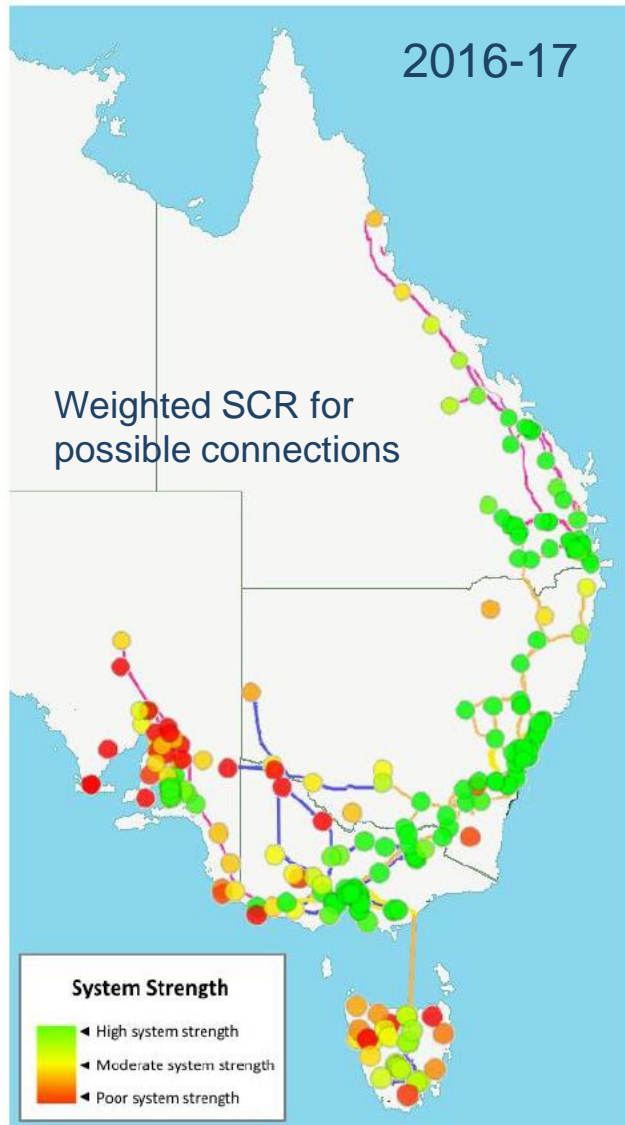
FUTURE REGULATION NEEDS



SYSTEM STRENGTH



SYSTEM STRENGTH PROJECTION



- Connection of 22GW large-scale wind & PV
- Reduction of ~15GW synchronous plant
- Trend towards reducing system strength
- Can be managed for new connections
- How to manage for retirements?
- Who has responsibility?

BLACK SYSTEM – 28 SEPT 2016



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