Maintaining Security and Reliability in the NEM

Presentation for the Australian Institute of Energy

19 November 2018

Transformation in the NEM

- **The NEM is rapidly transforming:**
  - **Homogenous to diverse supply resources**
  - **Synchronous to non-synchronous generation**
  - **Centralised to de-centralised system**
  - **Passive to active consumers**
  - **Weather and climate are changing too**

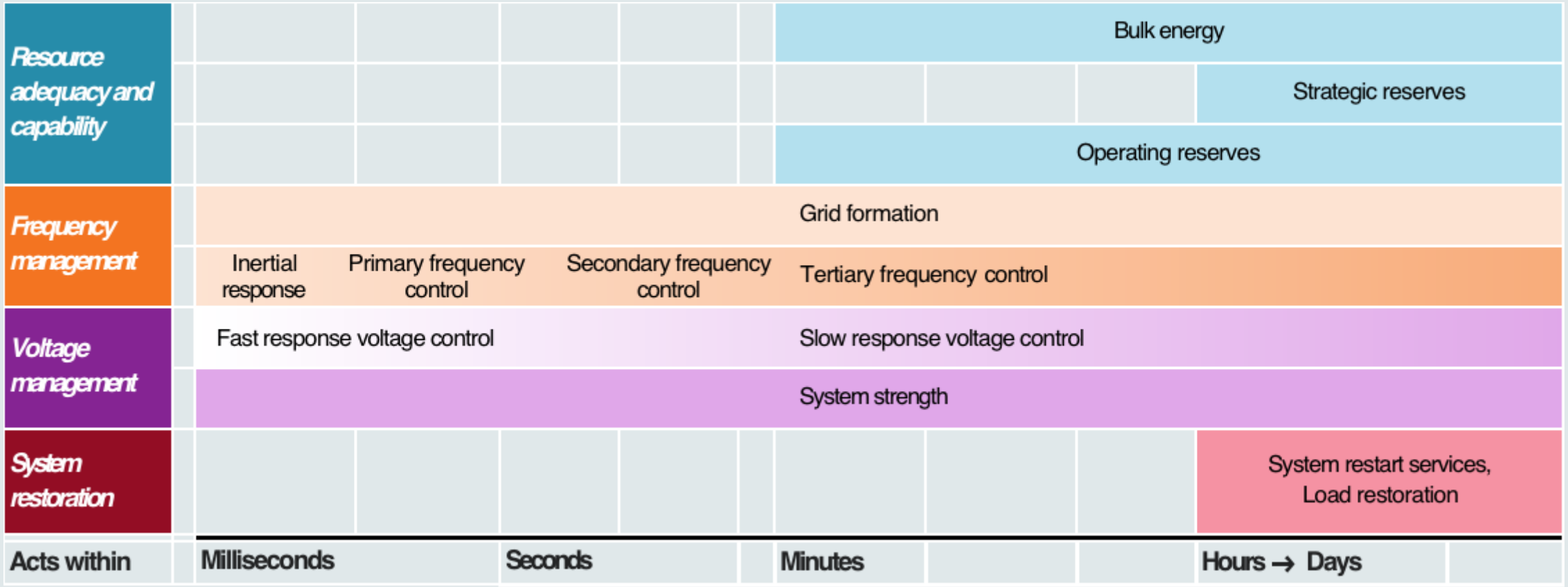
- **Underlying physics remain the same but key phenomena changing**

- **Common theme is increased variability in the system energy balance**
- **Energy system must evolve to manage this, involving all aspects of the system:**
  - **assets, regulations, markets, procedures, systems, etc.**

Security and reliability horizon

The operational timeframe is changing as the system itself is changing

Security and reliability horizon



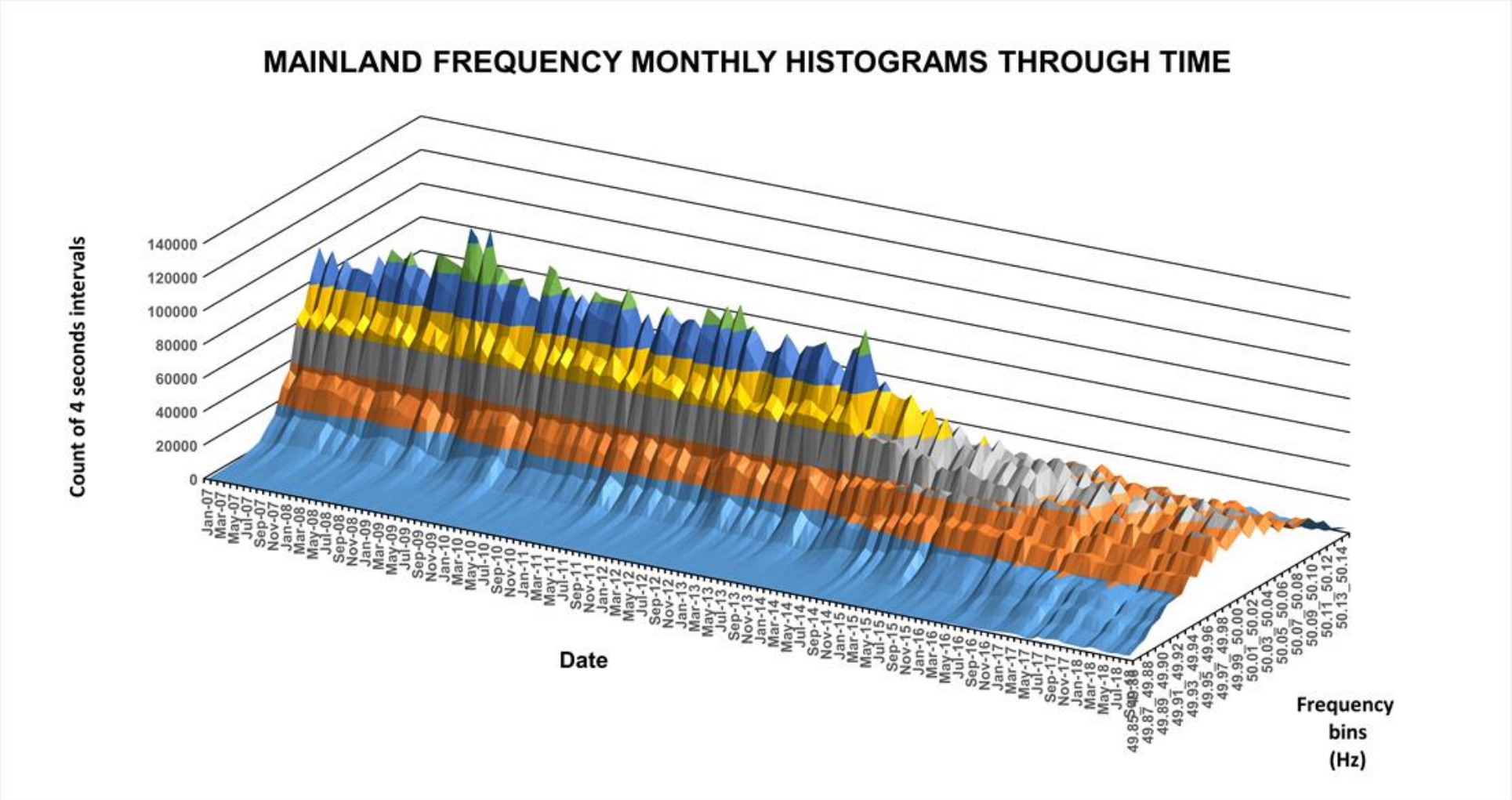
System requirements in the NEM

- **'New' system requirements being identified as the system transforms**
  - Always present, but need to be managed differently
- **Security:**
  - Frequency control
  - Inertia (energy stored in rotating synchronous machines)
  - System strength (measure of ability of system to maintain stability following disturbance)
  - Voltage control
  - Grid formation
- **Reliability:**
  - Reserve planning and procurement, different timeframes for different challenges

Frequency management in the NEM

Overview of AEMO's key work programs

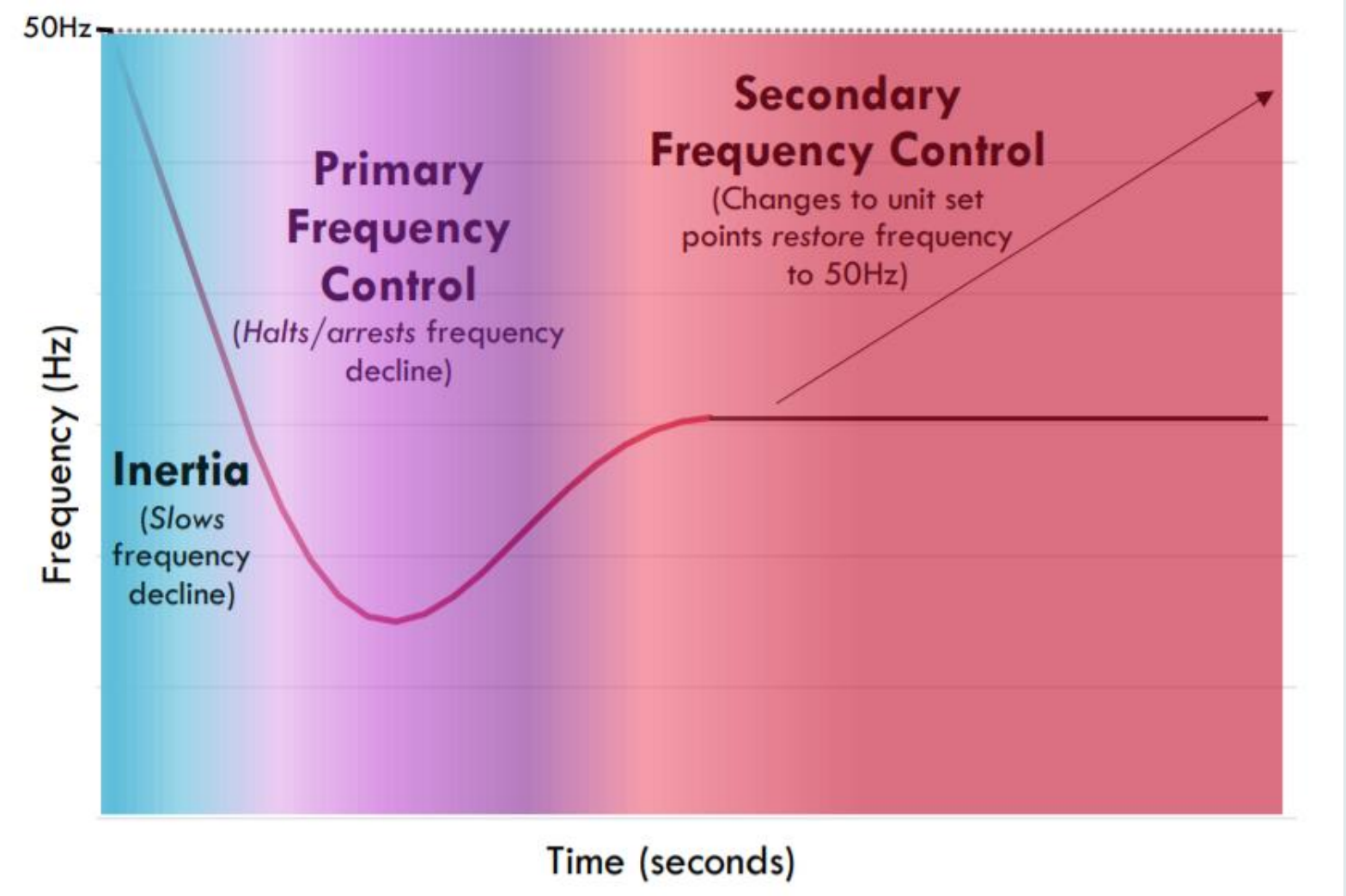
Frequency performance over time



Active work to improve frequency control

- Addressing disincentives to supporting frequency
- Refining specifications of services:
  - Better frequency control
  - Better co-ordination
  - Better measurement and monitoring
  - Enabling new technology
- Frequency control (PFC) trials in Tasmania and mainland (planned):
  - To aid understand of necessary control changes
  - Quantity, distribution, quality of primary frequency control necessary
- Engaging with AEMC to shape potential procurement mechanisms for PFC
- Reviewing and improving AGC operation (AEMO's centralised control system)
- Incorporating learnings from system events
- Exploring future frequency control requirements

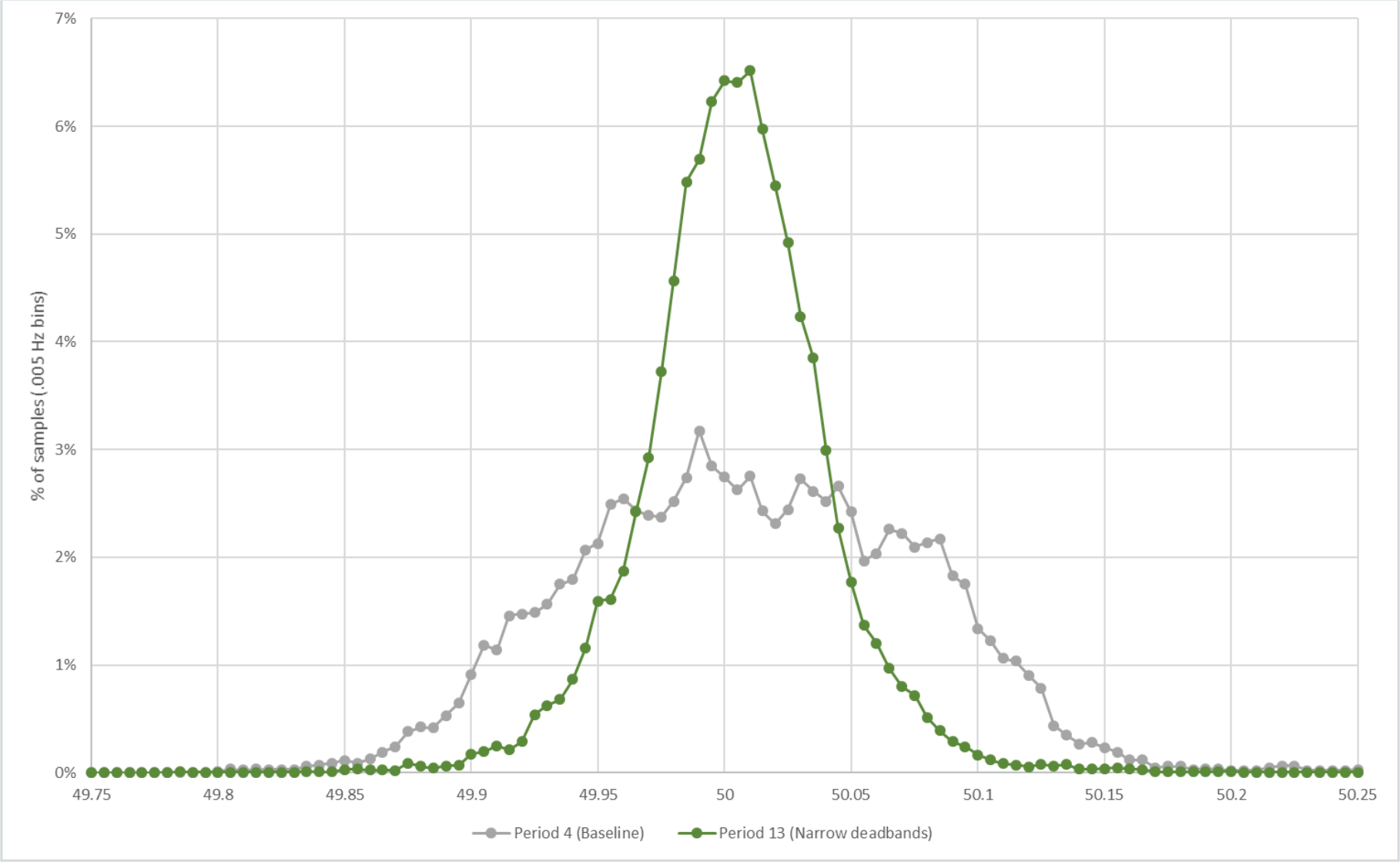
Frequency control continuum



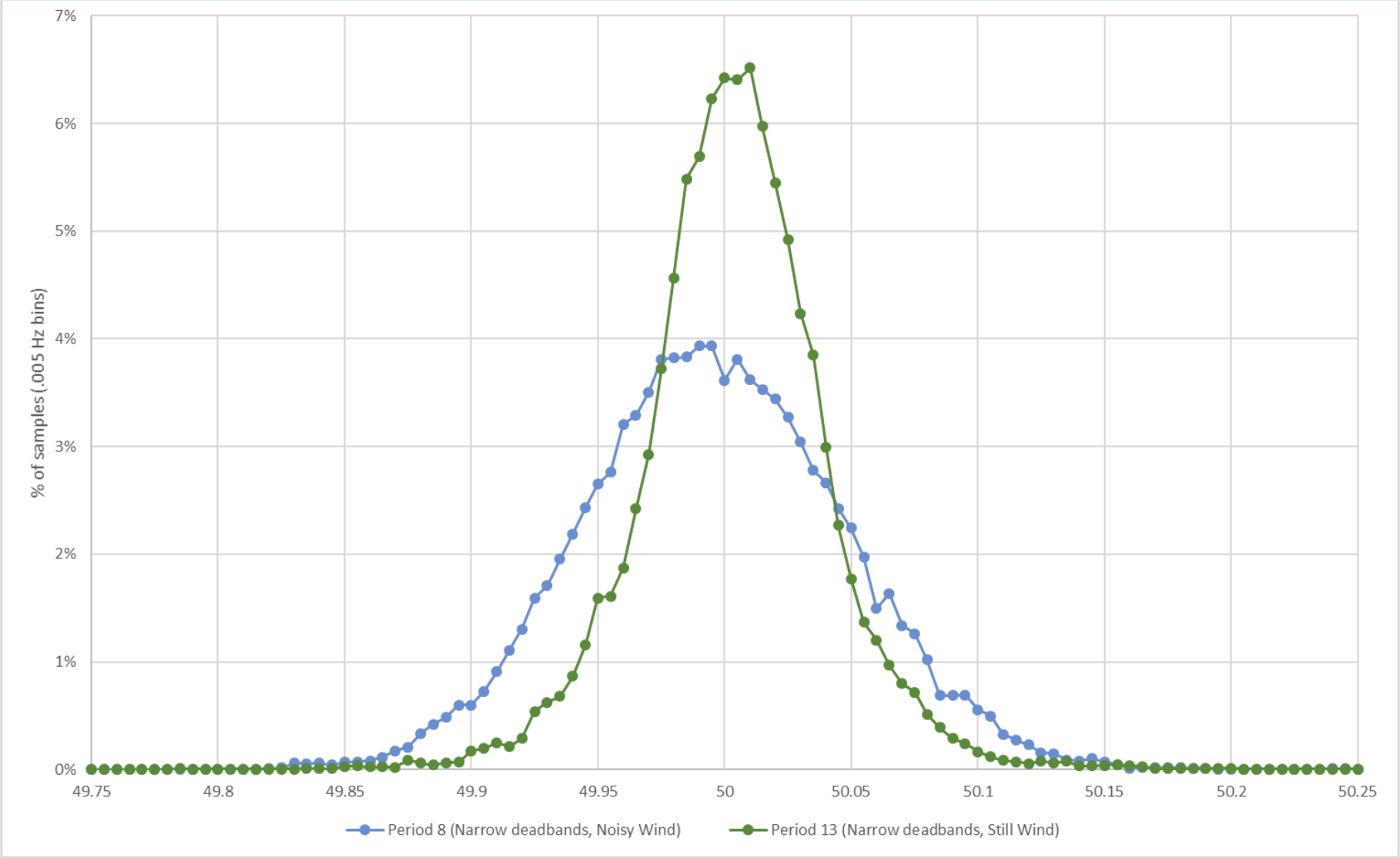
Frequency control trials

- Pattern of frequency performance raised many questions:
  - Is PFC the right tool to address it?
  - How easily can revised control settings be applied?
  - How much difference can PFC make?
  - How much PFC is required?
  - What does providing PFC mean for the resources involved?
- Tests were conducted in Tasmania
- Mainland tests being planned
- Learnings to shape how PFC could be implemented

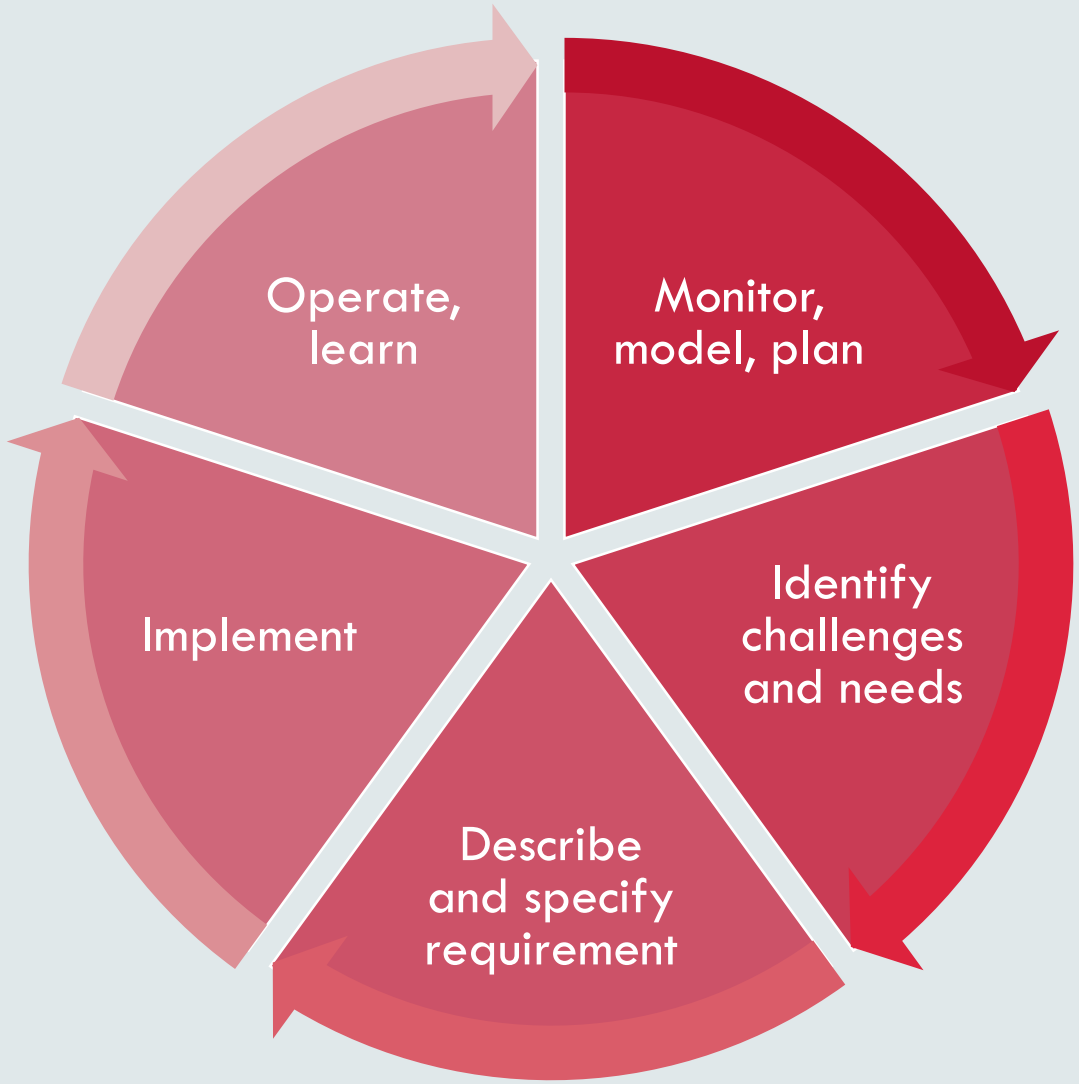
Frequency control trials: baseline vs narrow deadband



Frequency control trials: effect of variability



What's next: evolution of system and services




AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

SECURITY AND RELIABILITY IN THE NEM

AN OVERVIEW OF ACTIVE WORK PROGRAMS FOR THE RULE MAKER TO THE SYDNEY BRANCH OF THE AUSTRALIAN INSTITUTE OF ENERGY

SARAH-JANE DERBY, SENIOR ADVISER, AEMC
BEN HIRON, ADVISER, AEMC
19 NOVEMBER 2018

AUSTRALIAN INSTITUTE of ENERGY

AEMC

What we do

We make and amend the:

National Electricity Rules

National Gas Rules

National Energy Retail Rules

We also provide market development advice to governments

Reliability and security: different challenges, different solutions

Power system security:
the power system's capacity to continue operating within defined technical limits even if a major power system element, like a large generator or a major customer, disconnects from the system.

Power system reliability:
having enough generation, demand response and network capacity to produce and transport enough electricity to meet consumers needs in line with the reliability standard

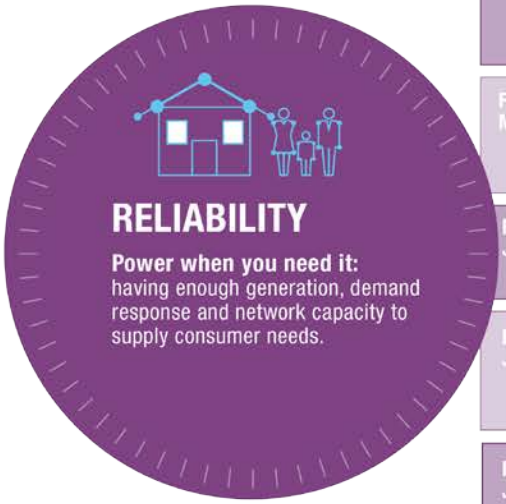
A reliable power system will also be a secure power system; however, a secure power system is not necessarily always a reliable power system.

RELIABILITY

WHAT IS RELIABILITY?

SARAH-JANE DERBY, SENIOR ADVISER, AEMC

AEMC's reliability work program



Final: Apr 2018 ✓
Reliability Panel review of reliability standard and settings 2018
Assessing whether the standard and settings are appropriate to guide efficient investment to meet consumer demand

Final: May 2018 ✓
Reporting on aggregate generation capacity for MT PASA rule
Improves the information AEMO provides to signal whether electricity supply is projected to meet demand in the medium-term

Final: Jun 2018 ✓
Reinstatement of long-notice RERT) rule
Enables AEMO to contract for electricity reserves up to nine months ahead of a projected shortfall under the RERT, the strategic reserve mechanism

Final: Jul 2018 ✓
Making the AER responsible for calculating values of customer reliability (VCR) rule
Requires the Australian Energy Regulator to calculate and update values of customer reliability, used to develop reliability standards

Final: Jul 2018 ✓
Reliability frameworks review
Looking at lowest cost ways to make enough energy available for consumers when they need it, the need for a strategic reserve, the suitability of a 'day ahead' market, and demand response mechanisms

Final: Nov 2018 ✓
Generator three-year notice of closure rule
Requires large generators to give at least three years' notice before closing

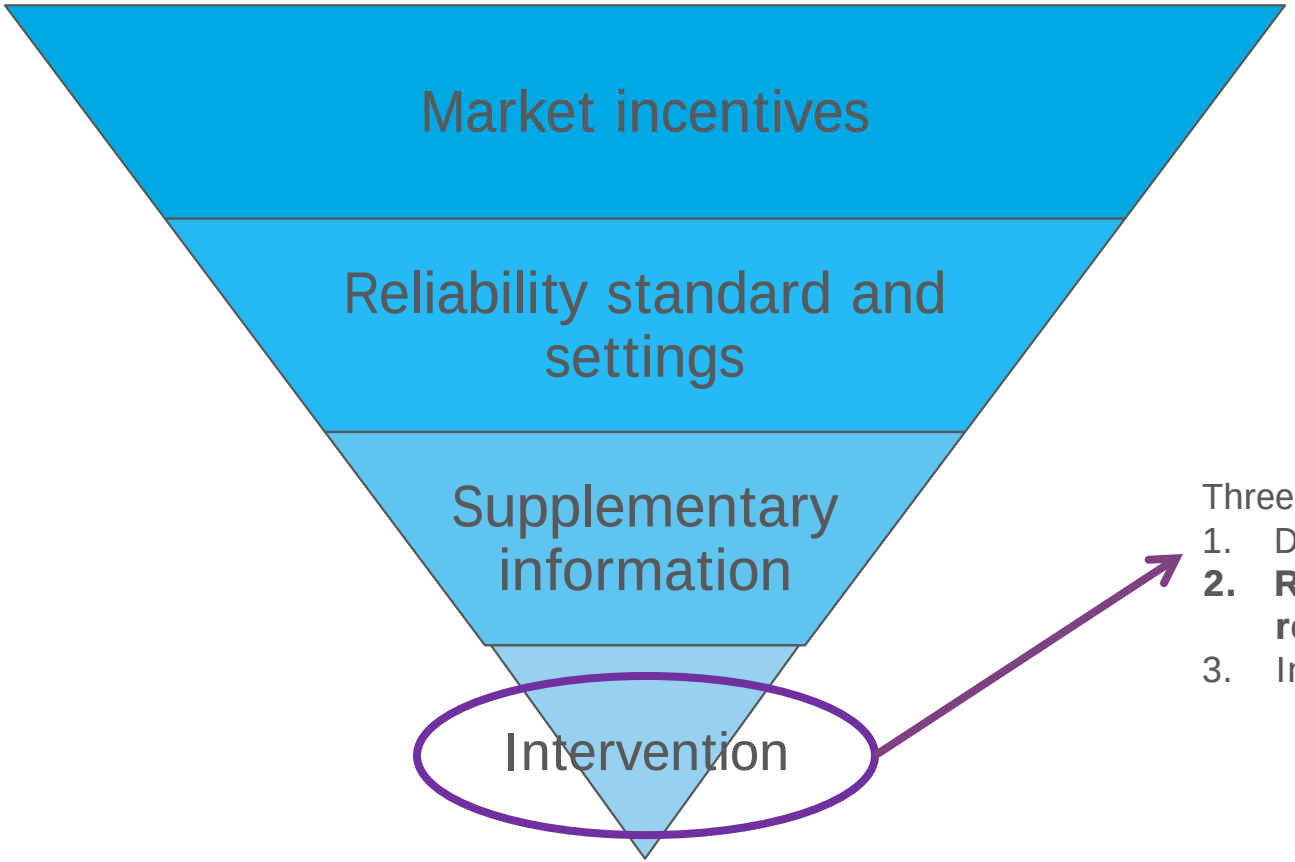
Final: Dec 2018
Coordination of generation and transmission investment review
Options to make AEMO's integrated system plan actionable; and ways to improve the coordination of generation and transmission investment

Draft: Jan 2019
Enhancement to the RERT rule
AEMO request for broader changes to the RERT framework

Final: Jun 2019
Reliability Panel review of annual market performance
Review of the performance of the national electricity market in terms of security, reliability and safety over 2016-2017

Draft: date TBC
Wholesale demand response rule
Would introduce a mechanism, register or separate market to enable wholesale demand response

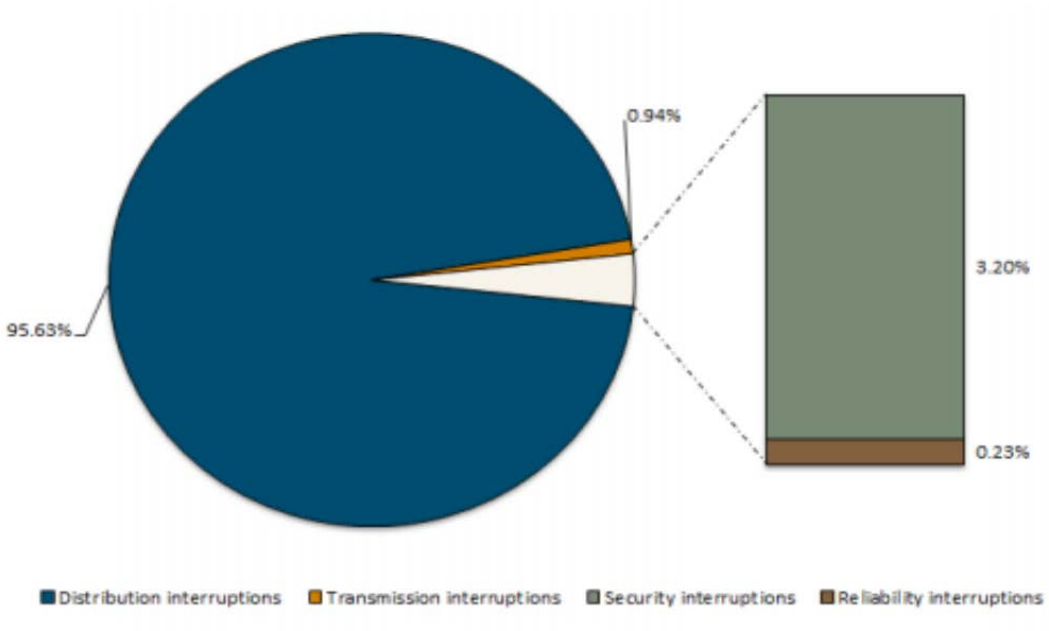
Current reliability framework has an escalating series of interventions



Three key intervention mechanisms:

1. Directions
2. **Reliability and emergency reserve trader (RERT)**
3. Instructions

What are the causes of supply interruptions in the NEM?



Reliability-related supply interruptions account for a small fraction of interruptions to customers

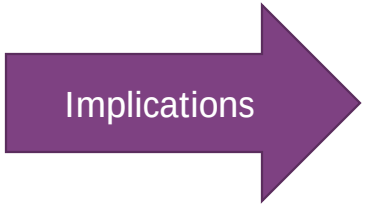
RELIABILITY

WHAT IS THE RERT?

What is the reliability and emergency reserve trader (RERT)?

The RERT is a strategic reserve to guard against blackouts:

- **Intervention mechanism –** allowing AEMO to contract for additional reserves such as generation or demand response that are not otherwise available in the market
- **Important safety net that underpins reliable electricity supply** – allowing AEMO to use it as a last resort when a supply shortfall is forecast, or, where practicable to maintain power system security

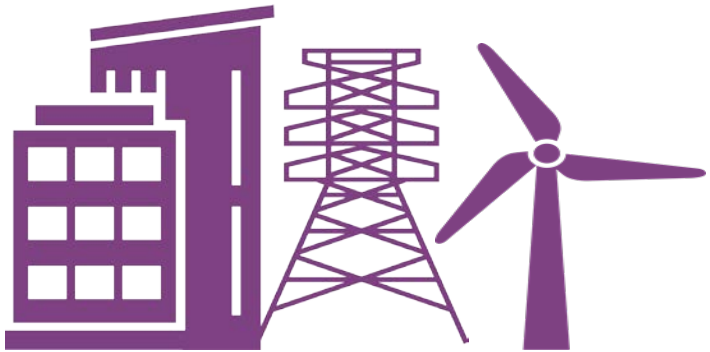


It does carry direct and indirect costs:

- **Direct** costs of the RERT last summer amounted to $52.0 million
- **Indirect** costs are due to the distortionary effects the RERT can have on market outcomes

A brief history of the RERT

- Some form of strategic reserve has always existed in the NEM.
- The NEM's strategic reserve, the RERT, has been designed to minimise costs and distortions.
- Prior to 2017, AEMO had only entered into RERT contracts three times and it had never been dispatched. This changed in 2017, when AEMO dispatched the RERT twice.
- In June 2018, the AEMC made an urgent final rule, to assist with summer readiness, increasing the lead time available for AEMO to procure reserves to nine months ahead of a projected shortfall.



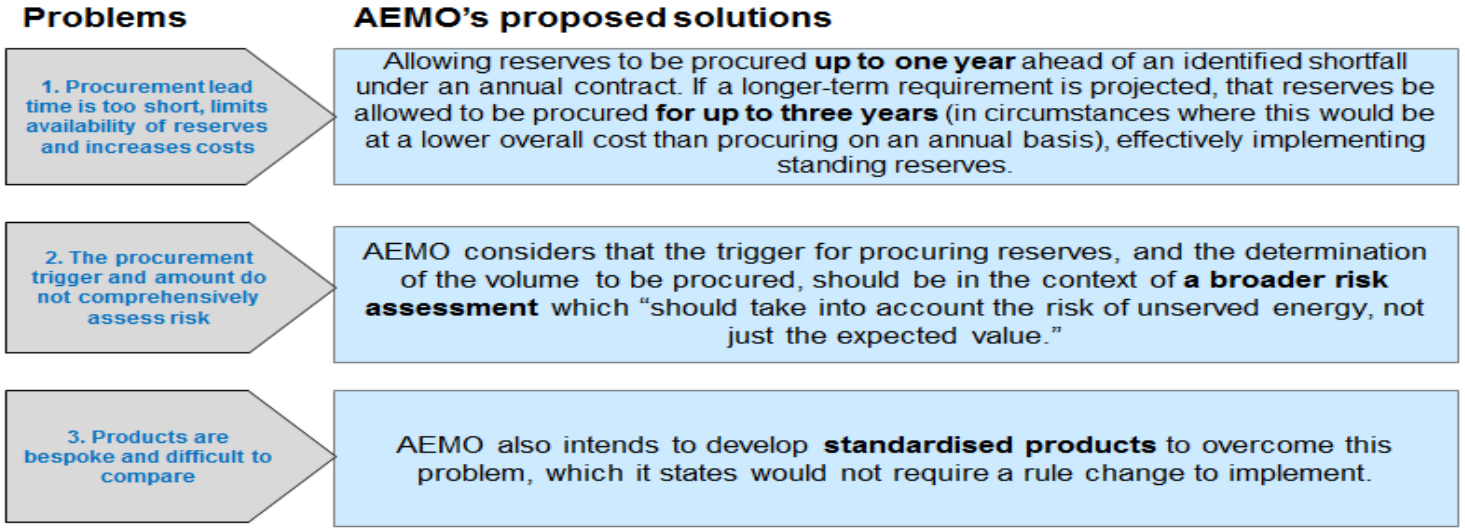
The NEM's strategic reserve, the RERT, has been designed to minimise costs and distortions.

Key features of the RERT

Procurement trigger	Procurement lead time	Procurement volume	Payment structure/costs	Out-of-market
The procurement trigger refers to the defined circumstances under which AEMO may procure reserves. Under the NER, AEMO may determine to enter into reserve contracts to ensure that the reliability of supply in a region meets the reliability standard, and where practicable, to maintain power system security.	This refers to the period ahead of when AEMO may procure the RERT through the identification of a potential shortfall. AEMO may only procure the RERT up to nine months ahead of an identified shortfall under the NER.	The NER do not prescribe the amount that AEMO should procure once it has identified a potential shortfall. Once the procurement trigger is met, AEMO has discretion under the NER regarding the amount of reserves to procure, with some limitations.	The NER do not prescribe any form of payment structure or cost guide. Costs are recovered from market customers (e.g. retailers) in the region where the RERT was used.	To minimise distortions, including the crowding out of reserves, reserves contracted under the RERT must not otherwise be available in the market (often referred to as "out-of-market"). According to the NER, RERT capacity must not otherwise be made available to the market for the trading intervals in respect of which the contract relates.

AEMO's Enhanced RERT rule change request

- AEMO raised three main issues in its rule change request, summarised here.



- In addition, AEMO also provided a **high-level design for an enhanced RERT**, which includes proposed design changes that go beyond the three issues areas identified above.

Rule change process – milestones and next steps

The Commission initiated the rule change request on 21 June 2018.

1. The Commission has been consulting broadly.

2. The Commission published an options paper on 18 October.

3. The Commission will consider input and feedback from these processes.

The Commission will publish a draft determination on 31 January 2019.

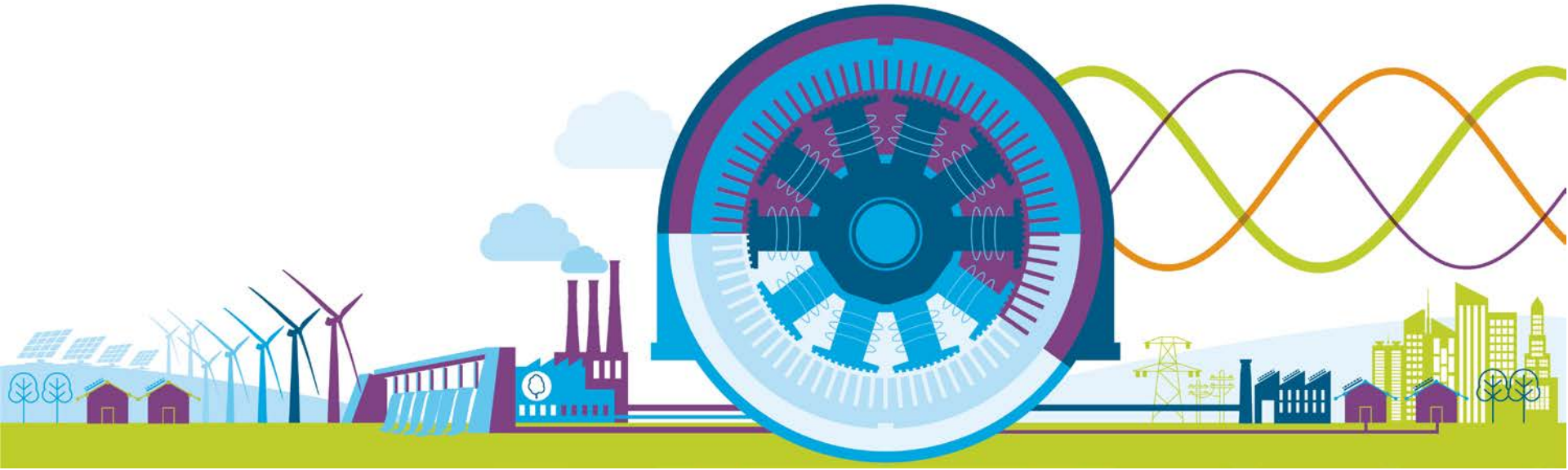
SECURITY WORK PROGRAM

BEN HIRON
ADVISER – AEMC SECURITY AND RELIABILITY

System security focus areas

- Frequency control

- Power system strength



AEMC System Security Action plan

Final: Feb 2018 ✓
Inertia ancillary service market rule
The potential for a market mechanism for power system inertia was assessed through the Frequency control frameworks review.

Final: Jul 2018 ✓
Frequency control frameworks review
Looking at ways to integrate new technologies and demand response to help keep the system secure

Final: Sep 2018 ✓
Register of distributed energy resources rule
Setting up a national register of distributed energy like small-scale battery systems and rooftop solar to help AEMO better manage the power system

Final: Sep 2018 ✓
Generator technical performance standards rule
Updating the technical performance standards for connecting generators and the process for negotiating them

Pending AER review
Review of the system black event in South Australia
The AER is conducting a compliance investigation which will recommend possible changes to regulatory frameworks. When complete the AEMC will consider this, and AEMO's investigation, for possible changes to the regulatory frameworks.

Final: Mar 2017 ✓
Emergency frequency control scheme rules
Enhanced schemes to act as a last line of defence in an emergency

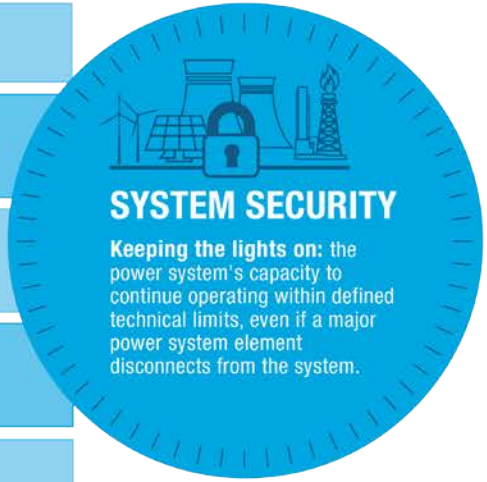
Final: Jun 2017 ✓
System security market frameworks review
Recommendations to deliver a stronger and more resilient system with better frequency control as the generation mix changes

Final: Sep 2017 ✓
Managing the rate of change of power system frequency rule
Makes networks provide minimum levels of inertia

Final: Sep 2017 ✓
Managing power system fault levels rule
Makes networks provide services necessary to meet minimum levels of system strength

Final: Sep 2017 ✓
Generating system model guidelines rule
Requires detailed information on how generators and networks perform

Stage one final: Nov 2017 ✓
Reliability Panel review of frequency operating standards
Assessing whether the existing standard is appropriate to maintain a secure power system as the generation mix changes



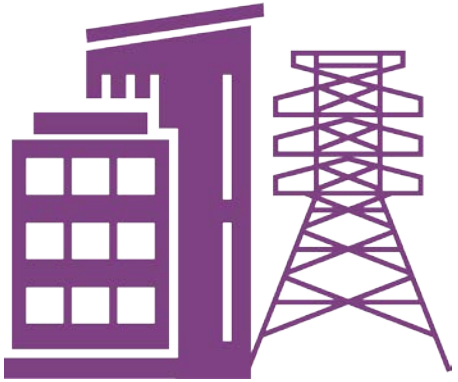
System security final rule determinations – 19 September 2017

- Electricity generation in the NEM is changing
- Most renewable generation is connected to the power system via electronic inverters – this is known as asynchronous generation
- Asynchronous generators do not have the same inherent technical characteristics as traditional synchronous generators in relation to supporting system security

  (although they can be programmed to help)

Maintaining the strength of the power system

- System strength is an inherent characteristic of a power system and it relates to the size of the change in voltage for a change to the load (or generation) at a connection point. Often defined in terms of
  - fault current (kA)
  - fault level (MVA)
  - short circuit ratio (SCR)
- System strength is required to maintain stable operation of power system equipment and support the correct operation of protection systems

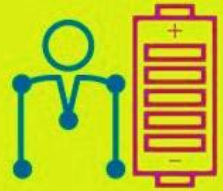


Recent changes to the rules require a minimum level of system strength to support system security

System security final rule determinations, 19 September 2017

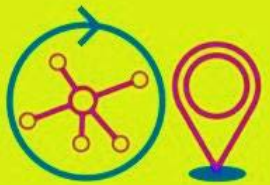
1 MANAGING THE RATE OF CHANGE OF POWER SYSTEM FREQUENCY BY REQUIRING MINIMUM INERTIA LEVELS

Make networks provide minimum levels of inertia when shortfalls are identified by AEMO



With AEMO approval networks can contract with suppliers to provide inertia substitutes like fast frequency response services from emerging technologies like batteries

2 MANAGING POWER SYSTEM FAULT LEVELS BY MAINTAINING MINIMUM SYSTEM STRENGTH LEVELS TO KEEP THE SYSTEM STABLE

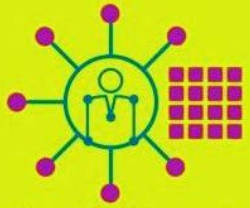


Make networks provide minimum levels of system strength at key locations in the power system when shortfalls are identified by AEMO

New generators must pay for remedial action if they impact system stability

3 IMPROVING GUIDELINES FOR GENERATING SYSTEM MODELS TO GIVE AEMO AND NETWORKS THE RIGHT DATA TO EFFICIENTLY PLAN AND OPERATE THE SYSTEM

Make generators and networks provide more detailed information about how their equipment performs to help AEMO manage the changing power system

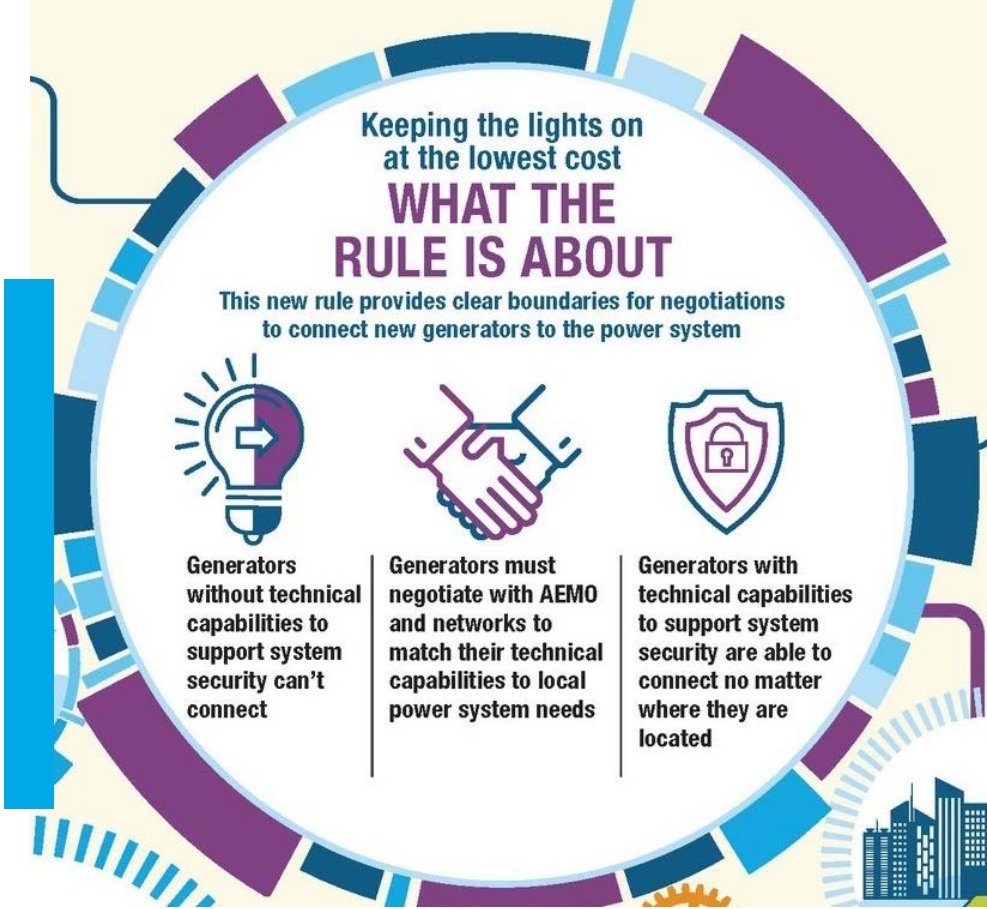


Allows AEMO to request data to assess if remedial action is needed for system strength

Generator technical performance standards rule 2018

Connecting generators are required to be able to:

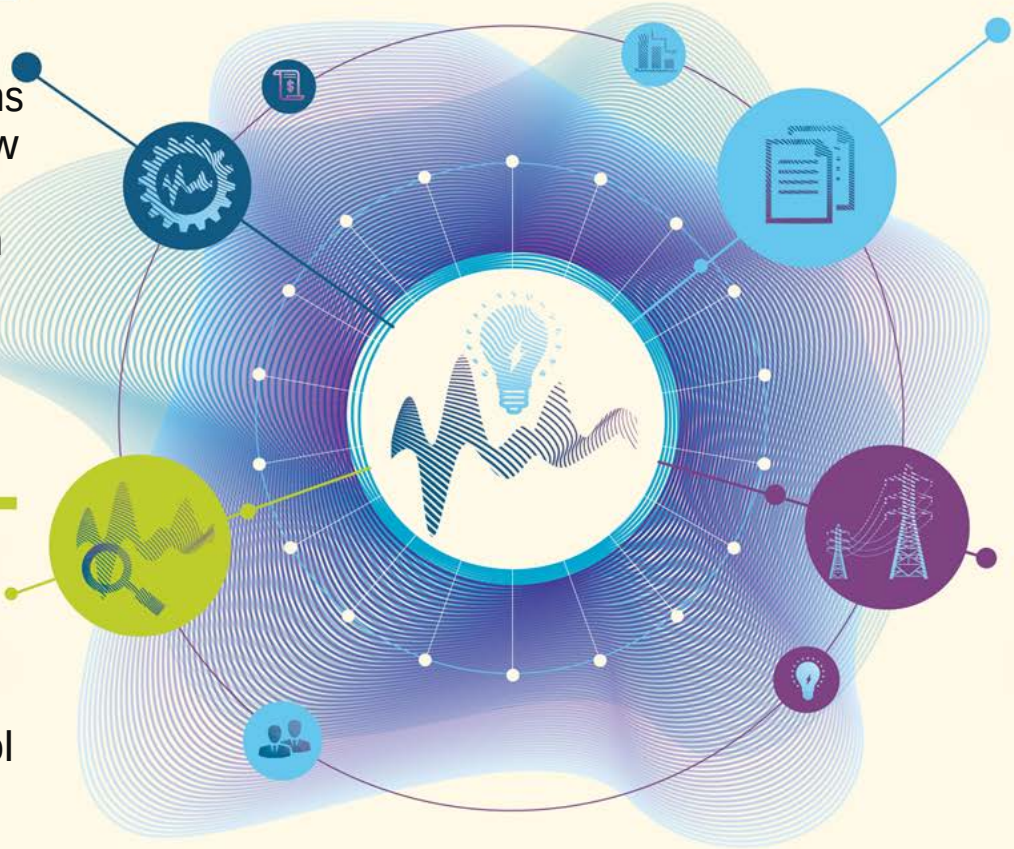
- control their active power output, to limit their contribution to frequency and voltage disturbances
- supply and absorb reactive power for the control of voltage, where required
- inject and absorb reactive current during disturbances
- maintain operation in the face of certain frequency and voltage disturbances (including faults and contingency events).



Frequency Control Frameworks Review - Recommended Actions

- AEMO-led trials and investigations to determine how frequency performance can be improved in the short term

- New rules to enable new technologies and service providers to provide frequency control services

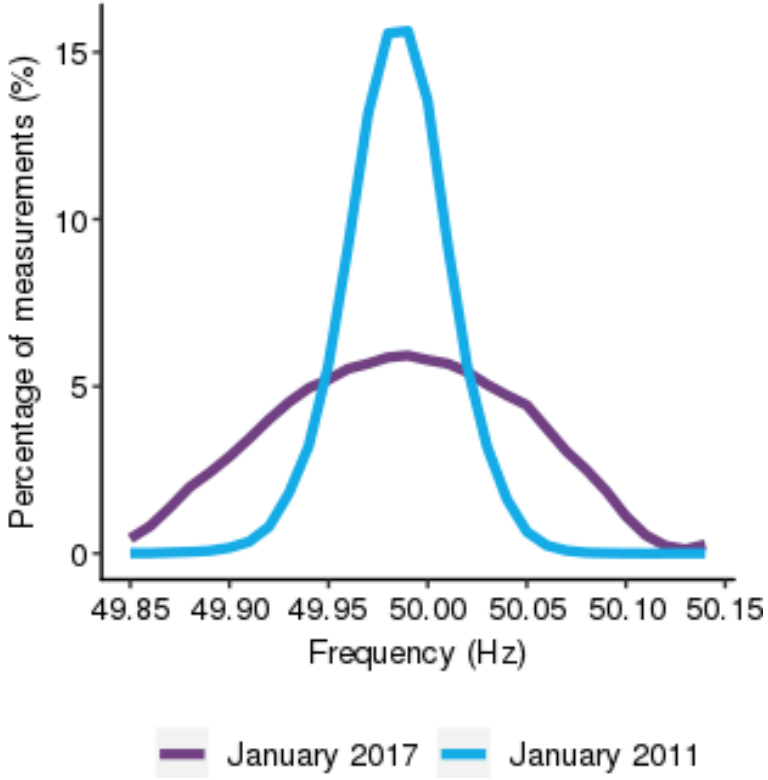


- Detailed consideration of ways to procure essential frequency control services in the long term

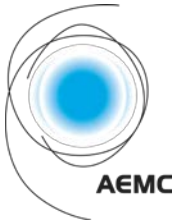
- More regular reporting by AEMO and AER on frequency performance and market outcomes

Degradation of frequency performance in the NEM during normal operation

- Frequency performance during normal operation has deteriorated in recent years
- The main cause of this degradation is the withdrawal of active governor response provided by synchronous generation within the NOFB (49.85Hz - 50.15Hz)
- The existing National Electricity Rules do not require or effectively incentivise market participants to provide primary frequency control during normal operation.
- Therefore, AEMO and the AEMC are investigating potential new regulatory arrangements to deliver sufficient primary frequency control within the NOFB.



QUESTIONS



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