Managing Frequency

An overview of the RIS technical appendix B

Watch the whole series

- Renewable Integration Study 101
- Renewable Integration Study Technical Overview
- Distributed PV
- Managing Frequency
- Variability and Uncertainty

RIS series available at: https://www.aemo.com.au/energy-systems/Major-publications/Renewable-Integration-Study-RIS

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Today's Webinar

- Key concepts
- Approach
- Core areas of analysis
- Going forward

Key Concepts

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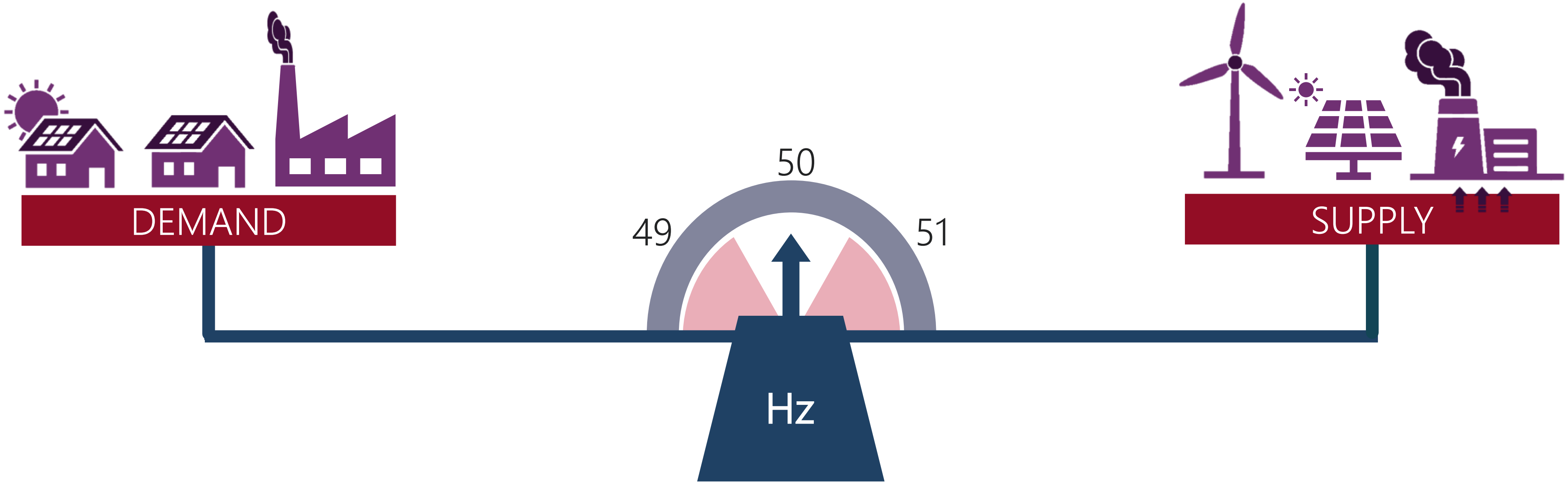
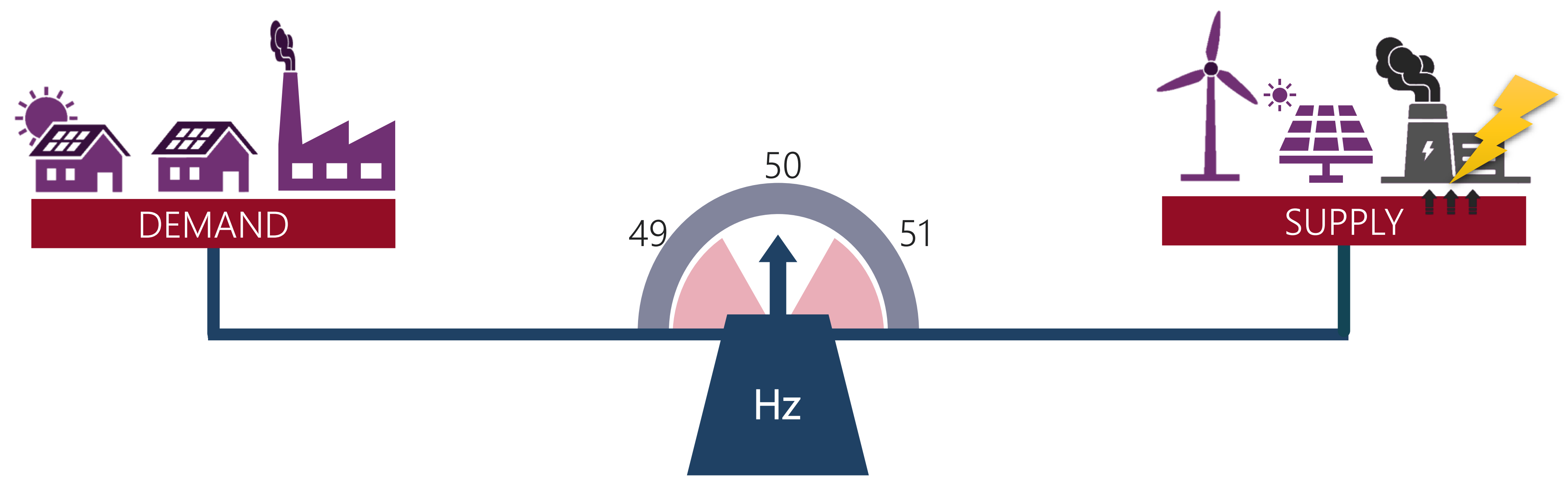
Frequency

Frequency is the **heartbeat of the power system** that ensures everything is in sync. It tells us information about the electricity supply and demand balance in real time.

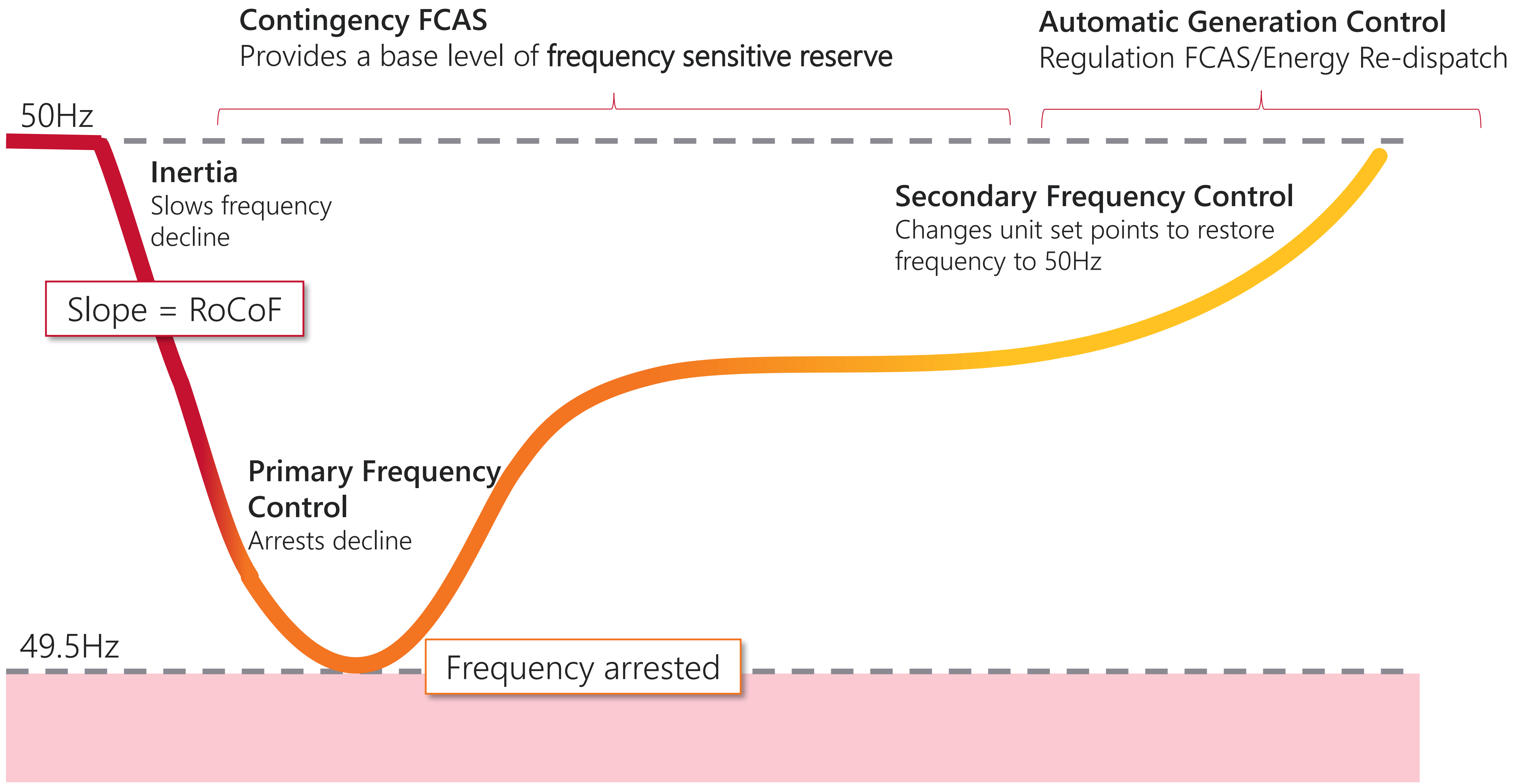


Frequency disturbances

- If electricity demand suddenly exceeds supply, power system frequency will decrease; and vice versa
- Frequency can change too quickly or go outside the designed boundaries under sudden loss of supply or demand on the system. Without frequency control, **equipment or devices can be damaged or trip off**



Frequency control



Approach

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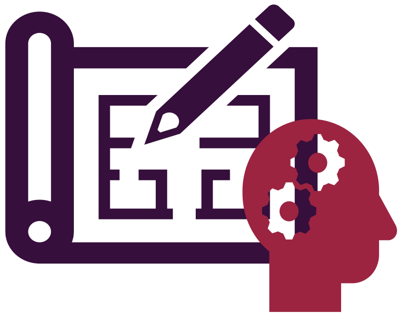
Study objectives

Under the projected system conditions out to 2025:

What is required to manage frequency for **credible events?**

What are the changes to the **risk profile of non-credible events?**

What are the **inertia requirements** (for system intact)?



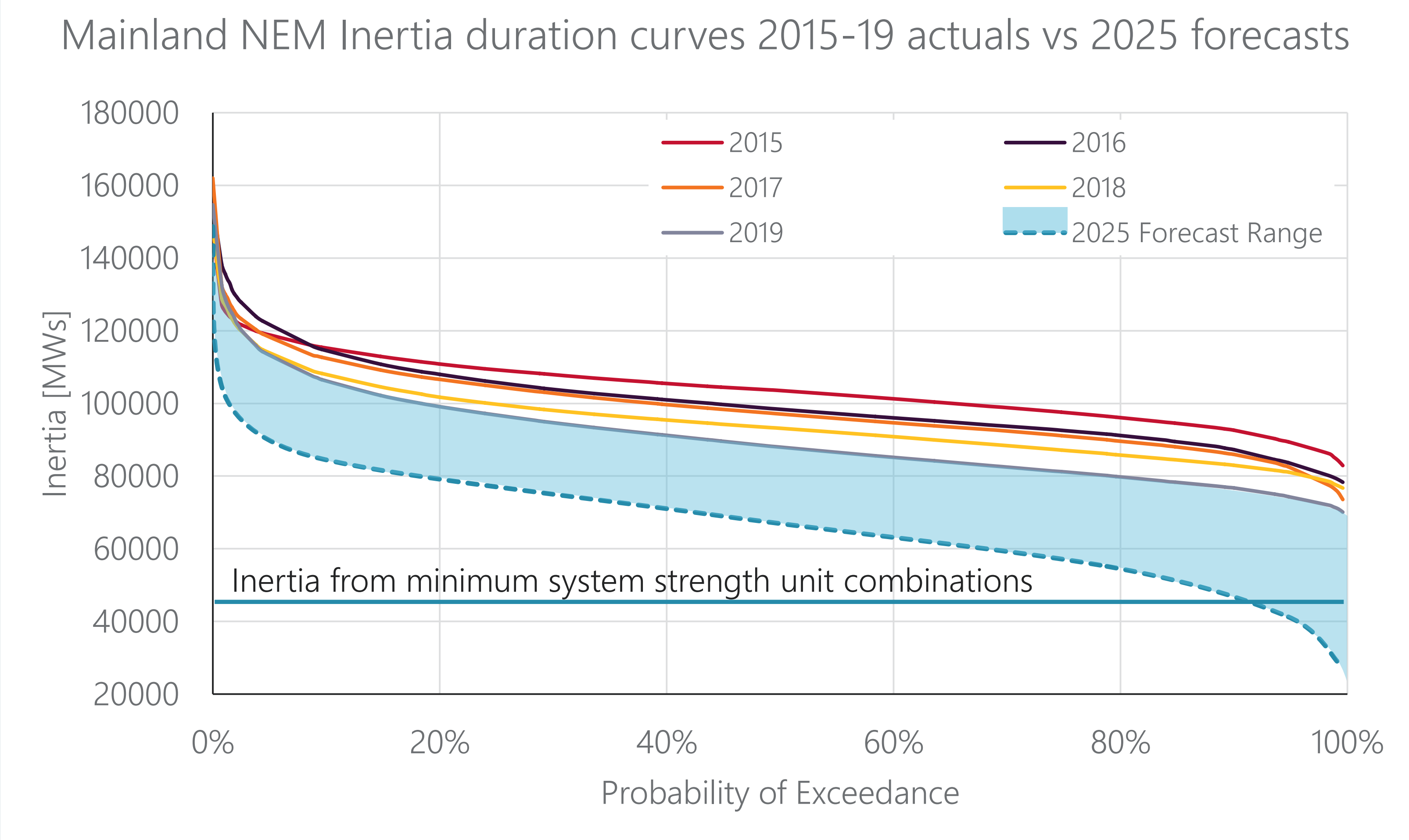
Changes to frequency control

Since the introduction of FCAS markets:

- Increased credible risk size
- Decreasing inertia
- Decreasing load relief
- Changing reserve dynamics
- Secondary risks
- Changing nature of **Non-credible events**

Changing System - Decreasing Inertia

- **Online inertia will reduce** as more synchronous generation is displaced by wind and solar **increasing potential RoCoF**.



Core areas of analysis

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Changes to frequency control

Since the introduction of FCAS markets:

- Increased credible risk size
- Decreasing inertia
- Decreasing load relief
- Changing reserve dynamics
- Secondary risks

→ Impact on Frequency sensitive reserve requirements for **Credible events** → Power system model

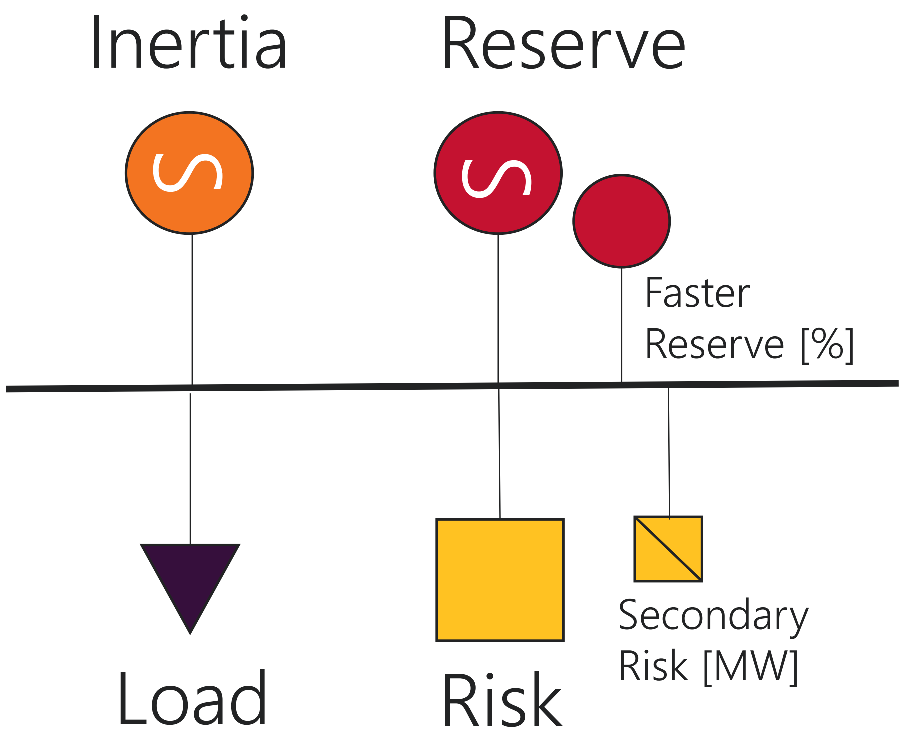
- Changing nature of **Non-credible risks**

Power system model

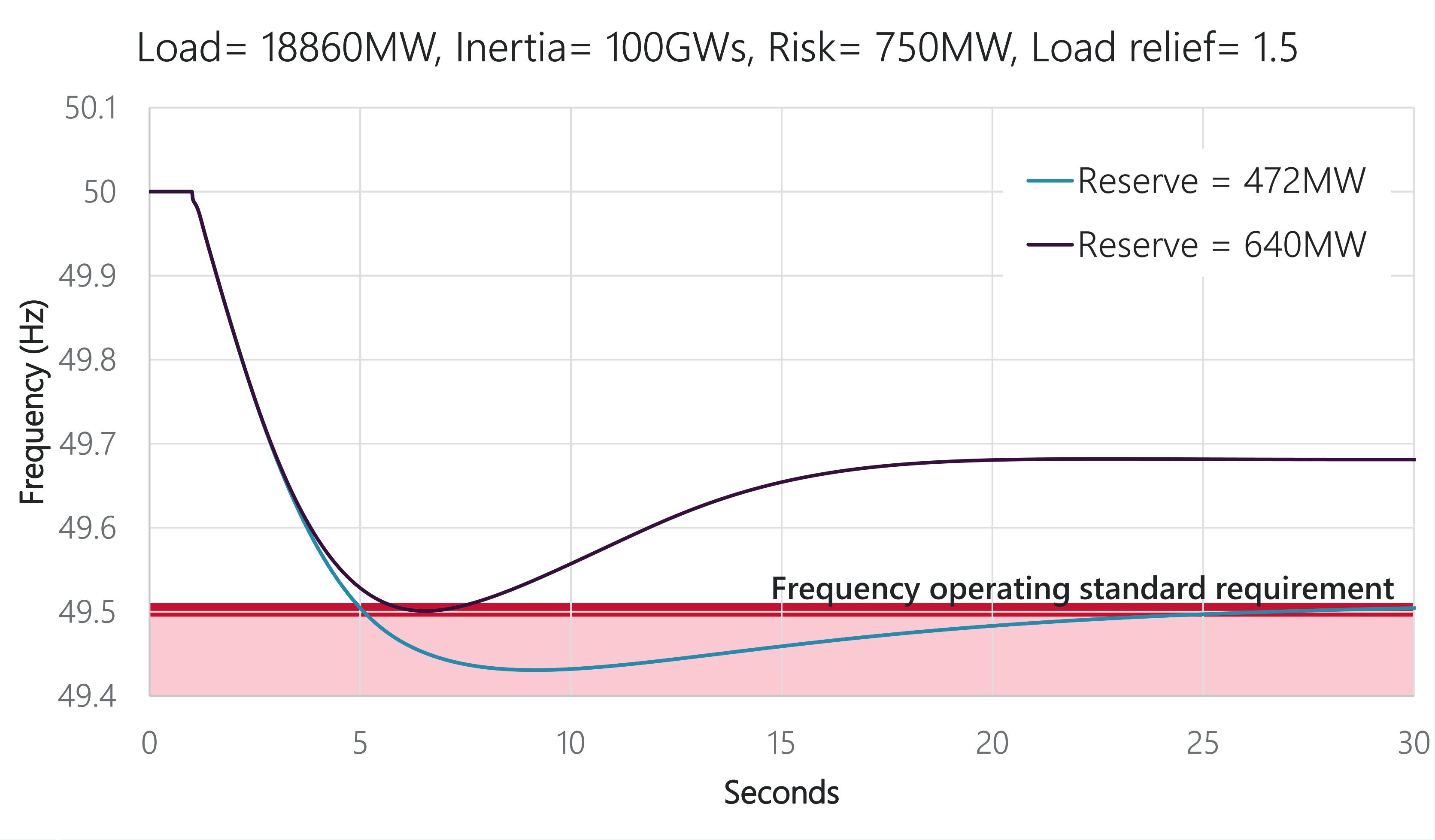
Simulation Parameters

- Inertia [MWs]
- Load Relief [pu/pu]
- Reserve [MW]
  - Base reserve model[MW]
  - Faster reserve [%]
- Size of Risk [MW]
  - Primary Risk [MW]
  - Secondary Risks [MW]

Single Bus Model



Frequency trace assessment



- To arrest frequency, replacement power needs to **fully replace the lost active power.**
- When frequency is arrested depends on the speed of response
- With the same speed, **more frequency sensitive reserve is required**.

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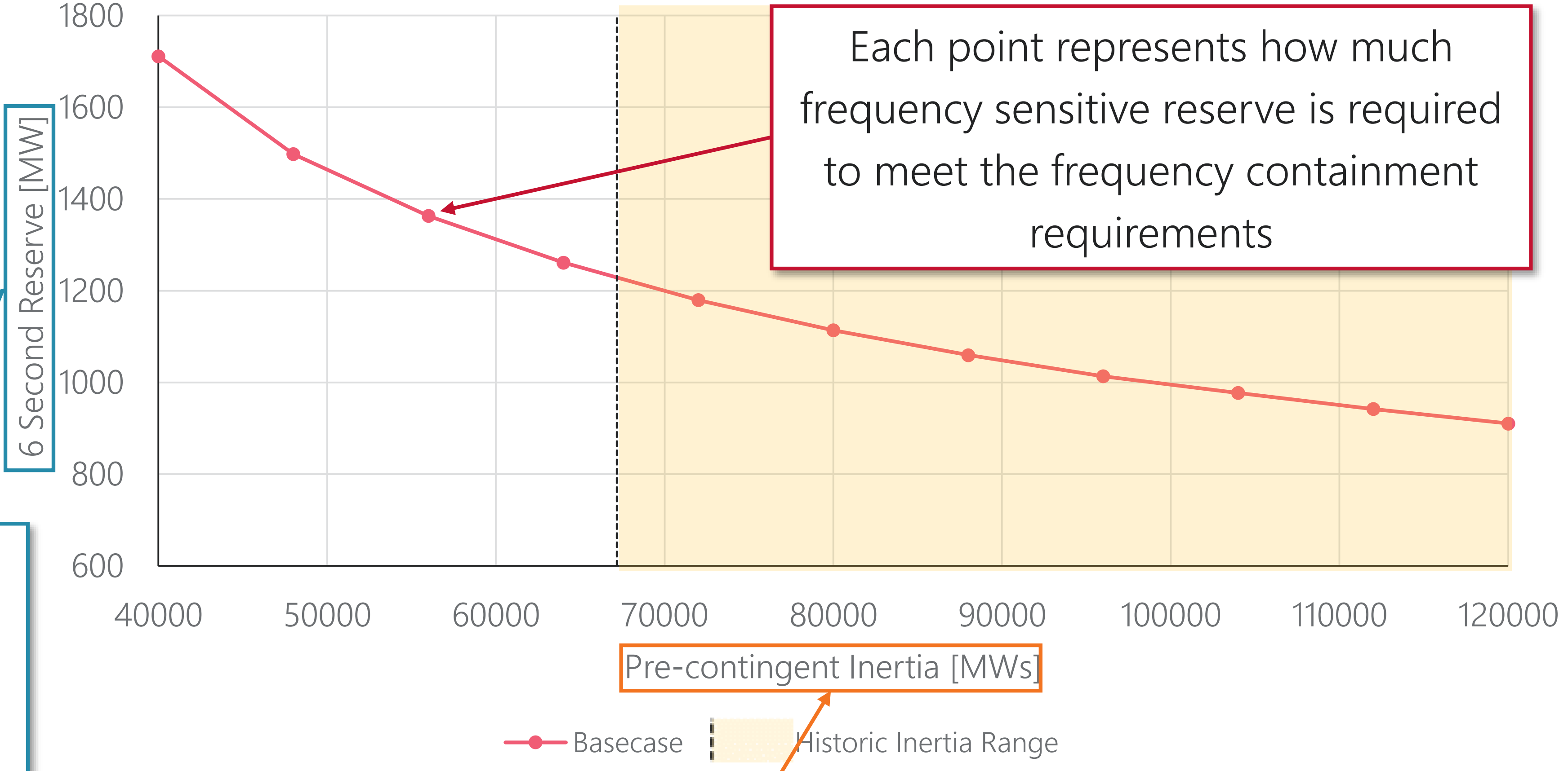
Decreasing inertia

Study parameters

Credible Risk = 750 MW, Low Load = 18860 MW, Load Relief = 0.5



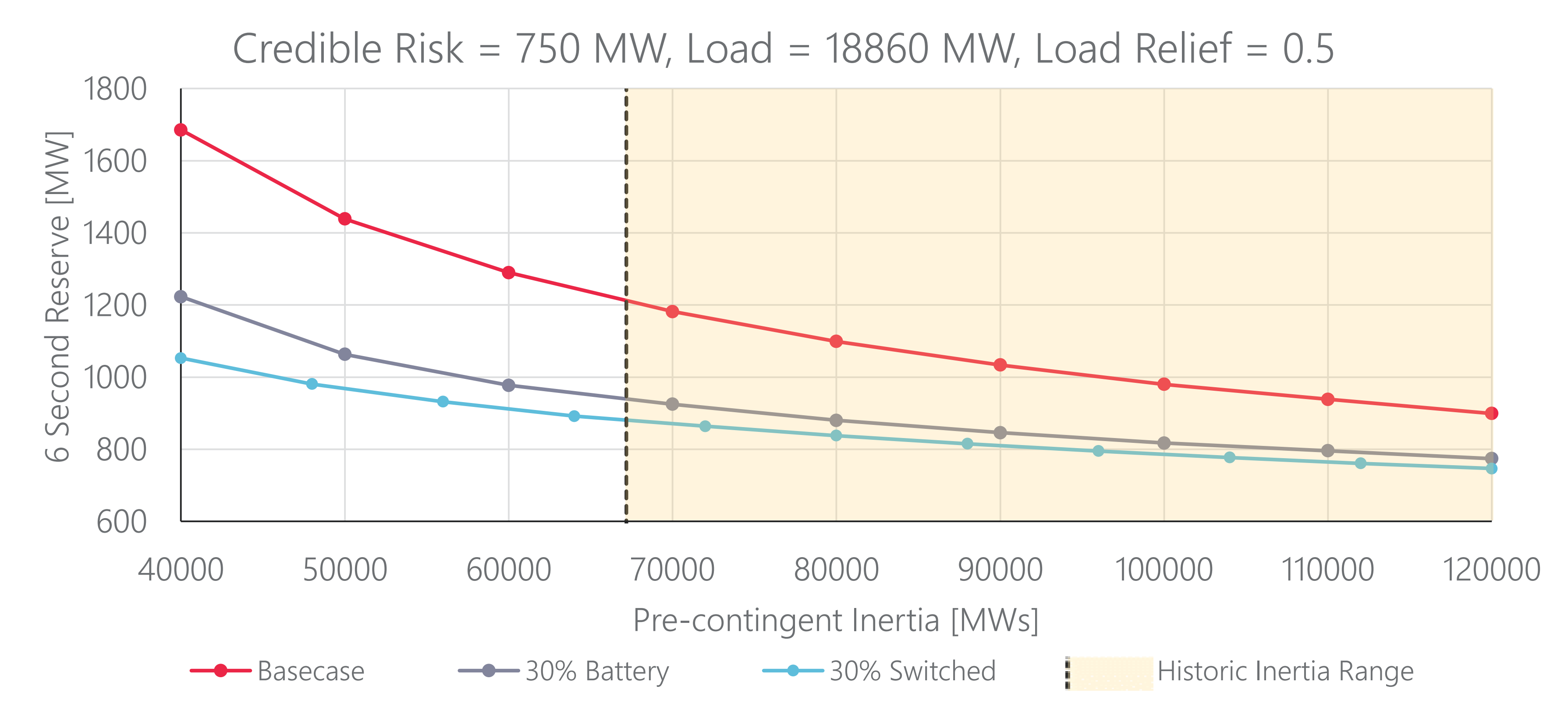
Each point represents how much frequency sensitive reserve is required to meet the frequency containment requirements

The 6 second **reserve requirement** is the amount of frequency sensitive reserve, at a speed equivalent to 6 second FCAS

The **Inertia** on the system before we trip the risk

Changing reserve dynamics

- **Faster reserve:** programmable to respond in 100s of milliseconds
- **Switched reserve:** typically interruptible **loads with switching controllers**



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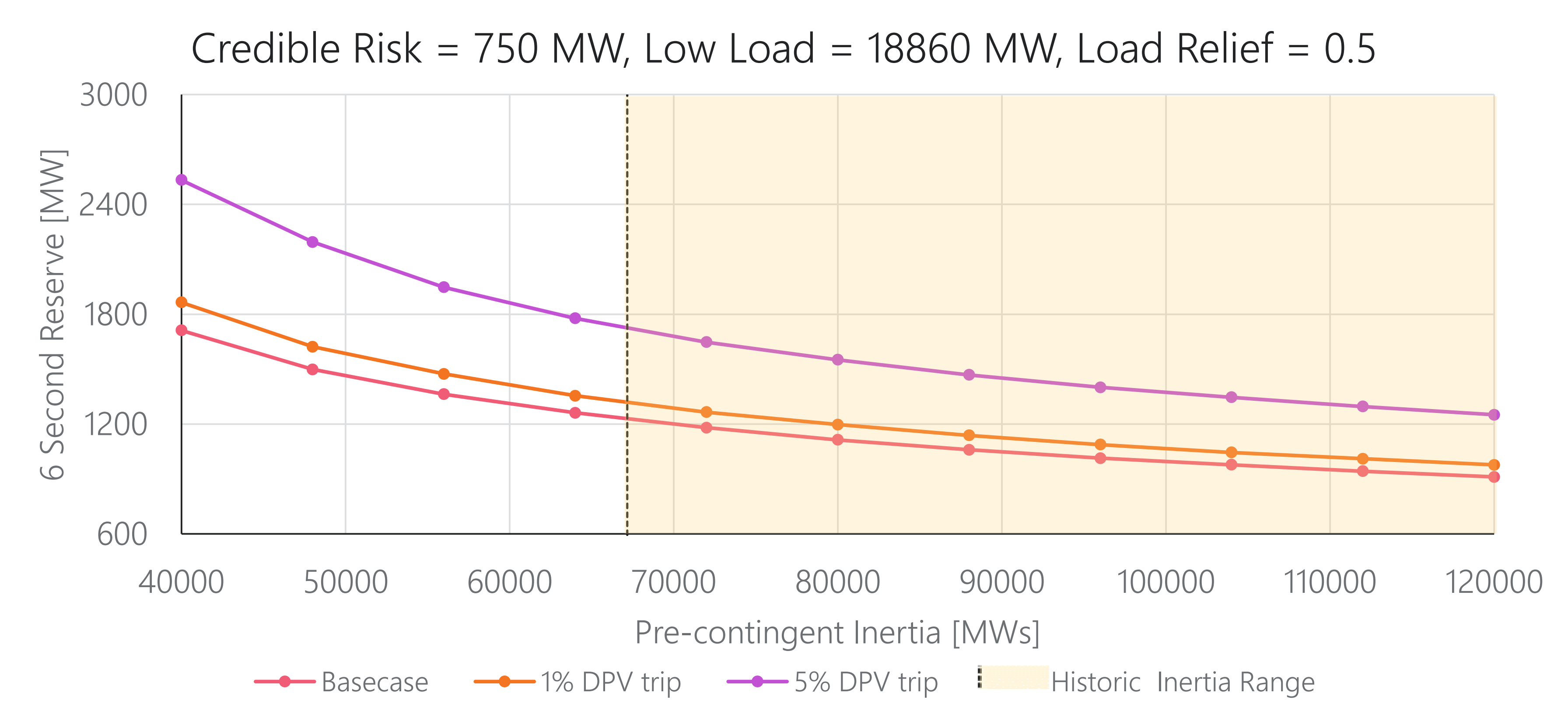
Secondary risks

- **Secondary risk:** the trip or reduction of generation that may occur alongside the trip of a large generator
- For the same amount of reserve, secondary risks can exacerbate underfrequency events



Managing Credible Risks

Volume of required **frequency sensitive reserve** needed increases under lower inertia

Introduction of **faster reserve can help** but **where and how it is provided** needs to be considered

A **minimum amount of dynamic response is required** on the system

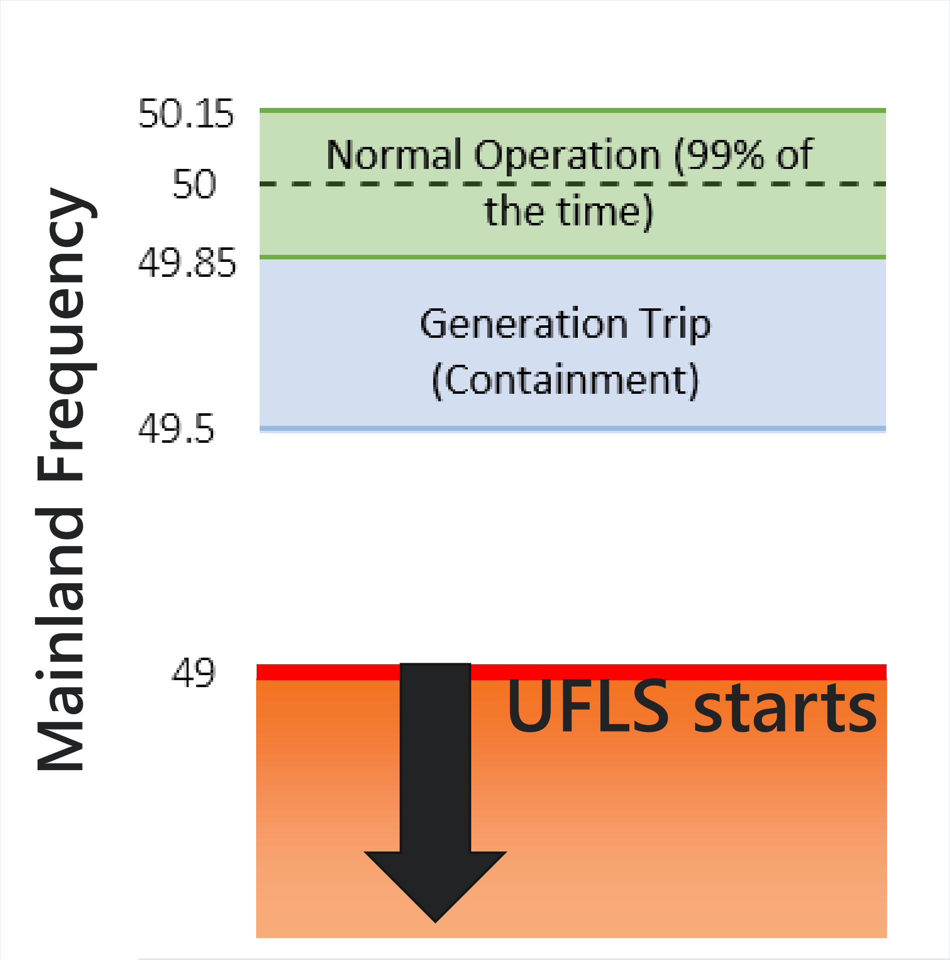
How we manage **Secondary risks such as DPV** needs to be considered

For more information refer to Section B4

Non-credible risks

- **Non-credible events:**
  - More onerous than credible events
  - Trip of multiple generation units OR
  - Trip of double transmission lines

- **Managed using a combination** of:
  - Primary frequency response
  - Emergency frequency control schemes e.g. UFLS



For more information refer to Section B5

Changing non-credible risks

Rate of change of frequency

- Reduced inertia and load relief
- Loss of generation on RoCoF protection

Increasing Complexity

- Loss of DPV during an event
- DPV behaviour, IBR behaviour, and intertrip schemes
- DPV penetration into UFLS

Separation

- Non-credible separation can island a part of the network

For more information refer to Section B5

Managing non-credible risks

1. Mandatory PFR Rule Change
2. Impact of DPV on UFLS
3. Quantify RoCoF limits
4. Investigate regional contingency FCAS requirements

For more information refer to Section B5

Going forward

Managing the transition

System characteristics will continue to shift into **new operating territory**

Revision of **ancillary service arrangements**

A minimum level of **synchronous inertia** is needed out to 2025

Improved knowledge and tools are enablers for progressing to lower inertia

A **staged approach** to operating at lower inertia is recommended

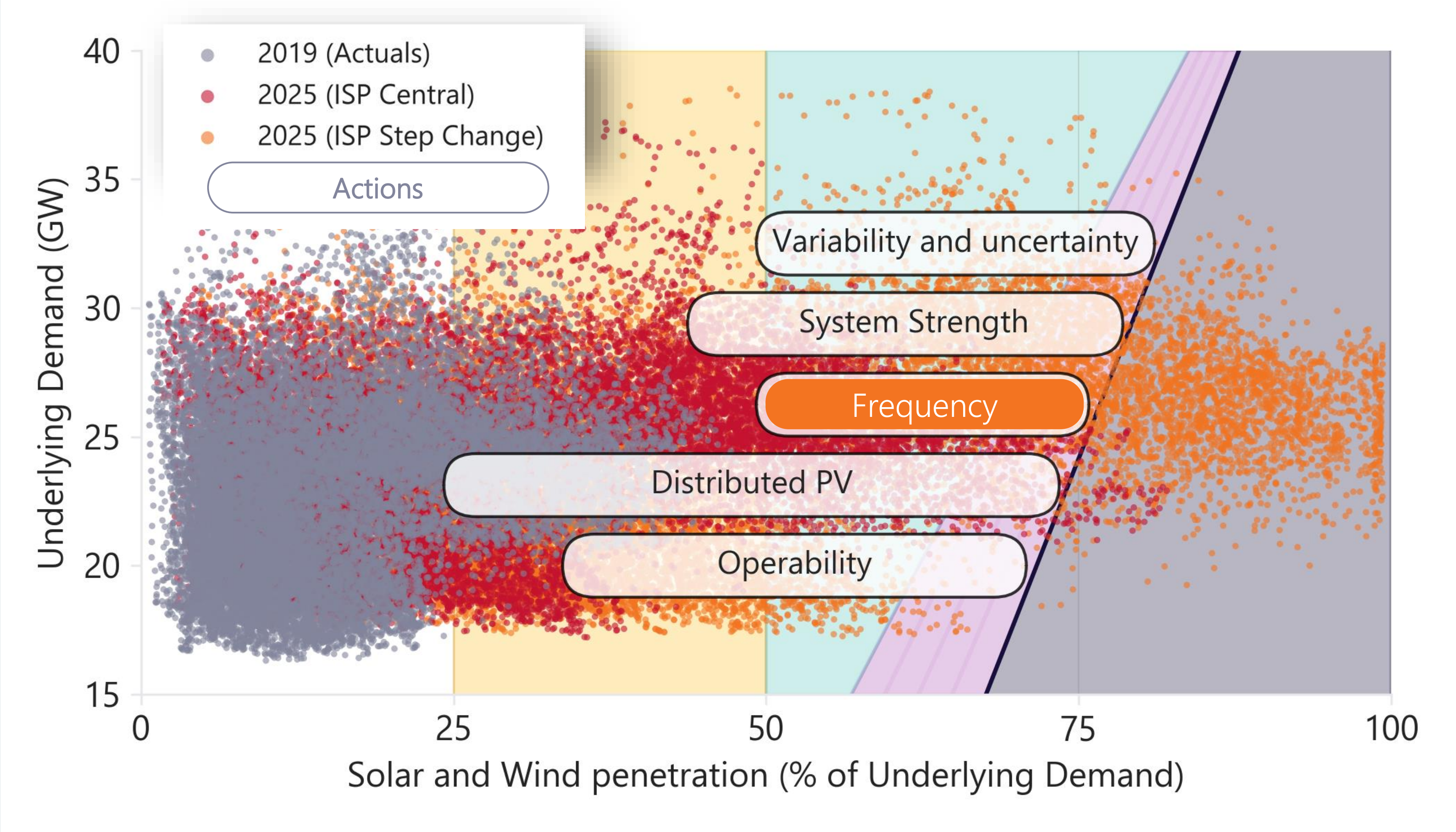
Staged approach to operating at lower inertia

Actions going forward

AEMO to publish a detailed **frequency control workplan** in 2020 covering:

- Revising ancillary service arrangements to match future operating conditions
- Investigating the introduction of a system inertia safety net for the mainland NEM
- Defining System RoCoF limits
- Continued investigation into DPV penetration into UFLS load blocks
- Applying appropriate limits to the total proportion of switched FCAS
- Investigating appropriate regional contingency FCAS requirements
- Improving AEMO’s existing system frequency model

Actions to support changing power system



- By 2025 the instantaneous penetration of wind and solar will **exceed 50%**
- The RIS provides an **action plan to securely meet penetrations up to and beyond 75%**
- If **action is not taken, wind and solar may be limited to 50-60%** of total generation
- No insurmountable reasons why the NEM cannot operate securely at even higher levels of instantaneous wind and solar penetration in future

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