FUTURE POWER SYSTEM SECURITY ROADSHOW

OVERVIEW OF POWER SYSTEM OPERATIONS

August 2016

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

SESSION OBJECTIVES

- Introduce concepts and terminology relevant to AEMO's Future Power System Security program:
  - AEMO as the power system operator
  - What is power system security and why does it matter?
  - Key elements of power system security

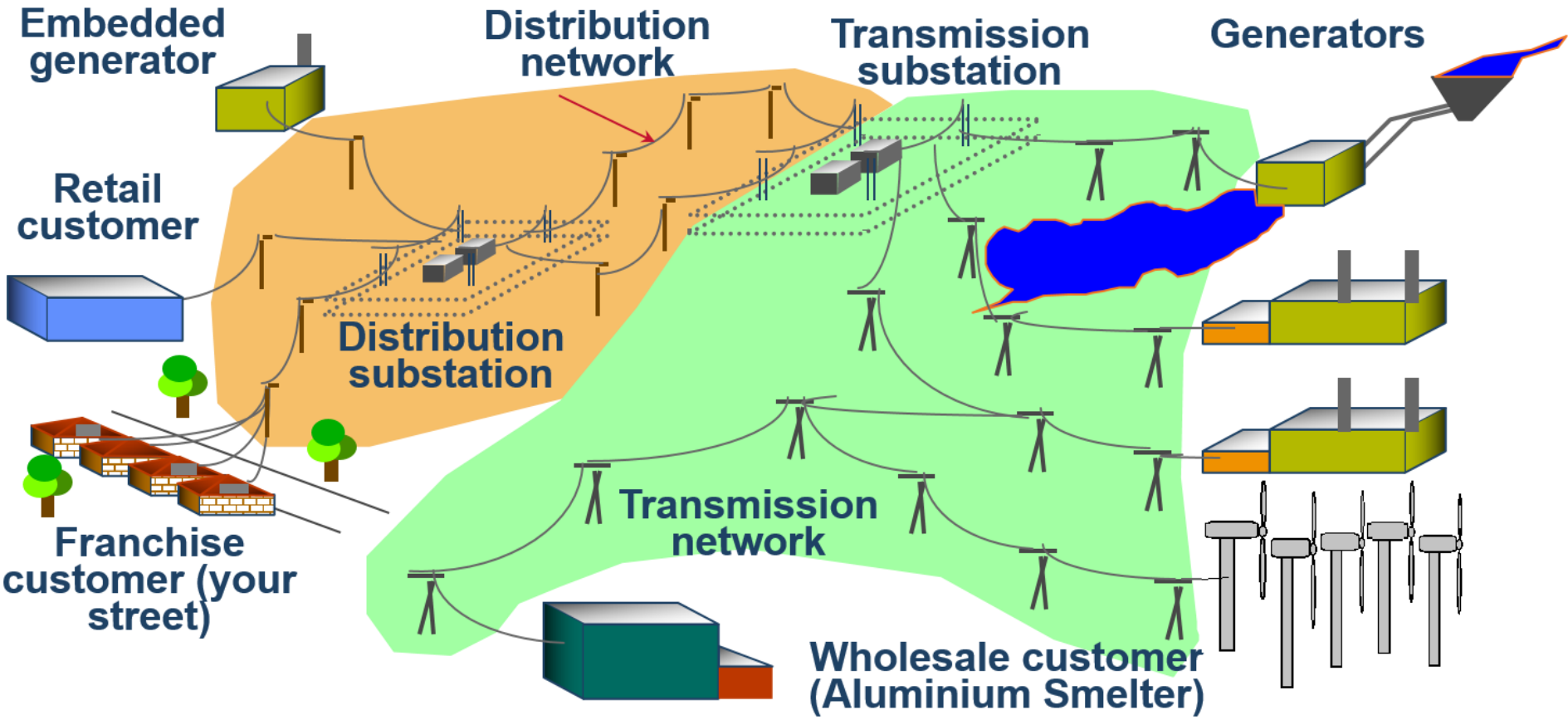
ABOUT AEMO

- AEMO has operational responsibilities across gas and electricity
- In electricity, AEMO is the
  - power system operator
  - market operator
- The National Electricity Market (NEM) – East South West Interconnected System (SWIS) - WA

AEMO AS POWER SYSTEM OPERATOR

- Getting customers the power that they need when they need it while maintaining the system within specified limits
  - For safety, to avoid equipment damage and to avoid widespread disruptions to consumers
- Second-by-second function
- AEMO does not own the physical plant - like power stations or transmission lines
- AEMO monitors electrical properties around the system and sends instructions to generators and network businesses to control plant to keep these electrical properties within specified limits
- This is about the physical operation of the power system

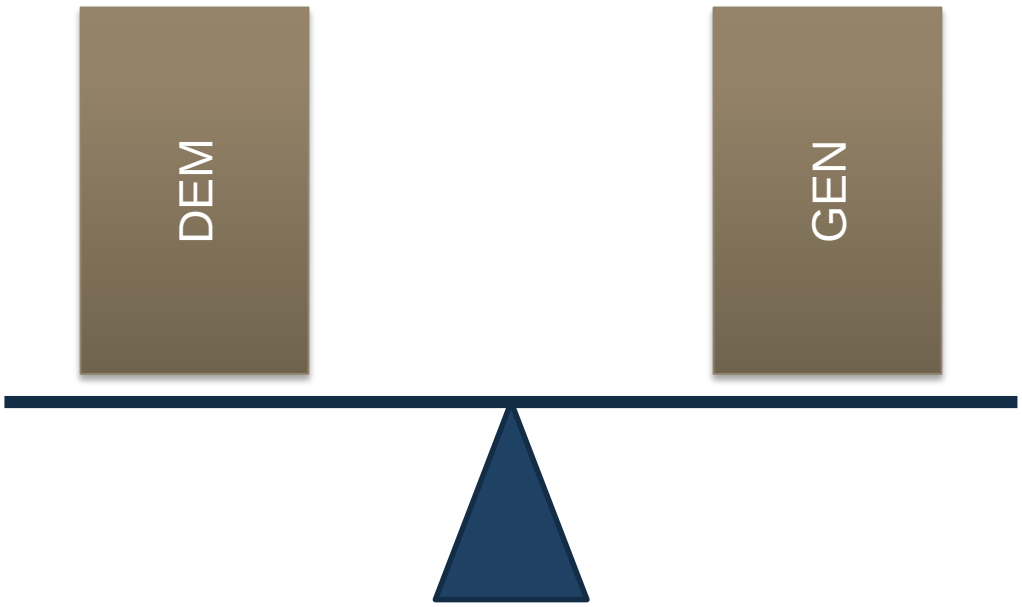
How does the NEM work?
Power System Basics



SUPPLYING CONSUMER ELECTRICITY NEEDS AND POWER SYSTEM SECURITY

SUPPLYING CONSUMER DEMAND

- At all times,
  - Total electrical production = total electricity demand



CONSUMER DEMAND CURVE
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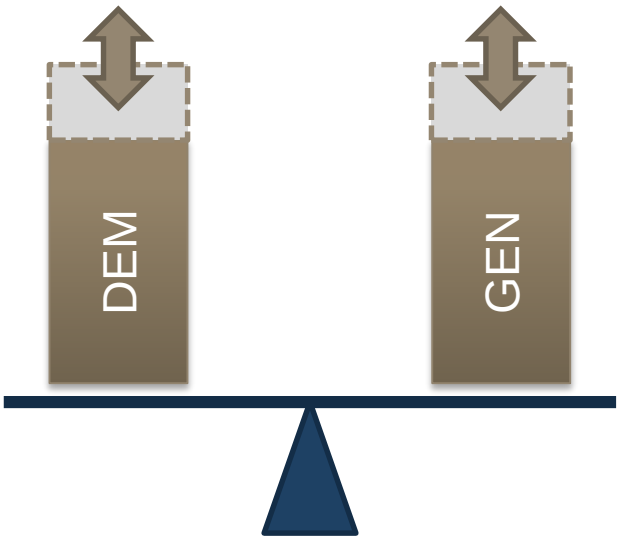
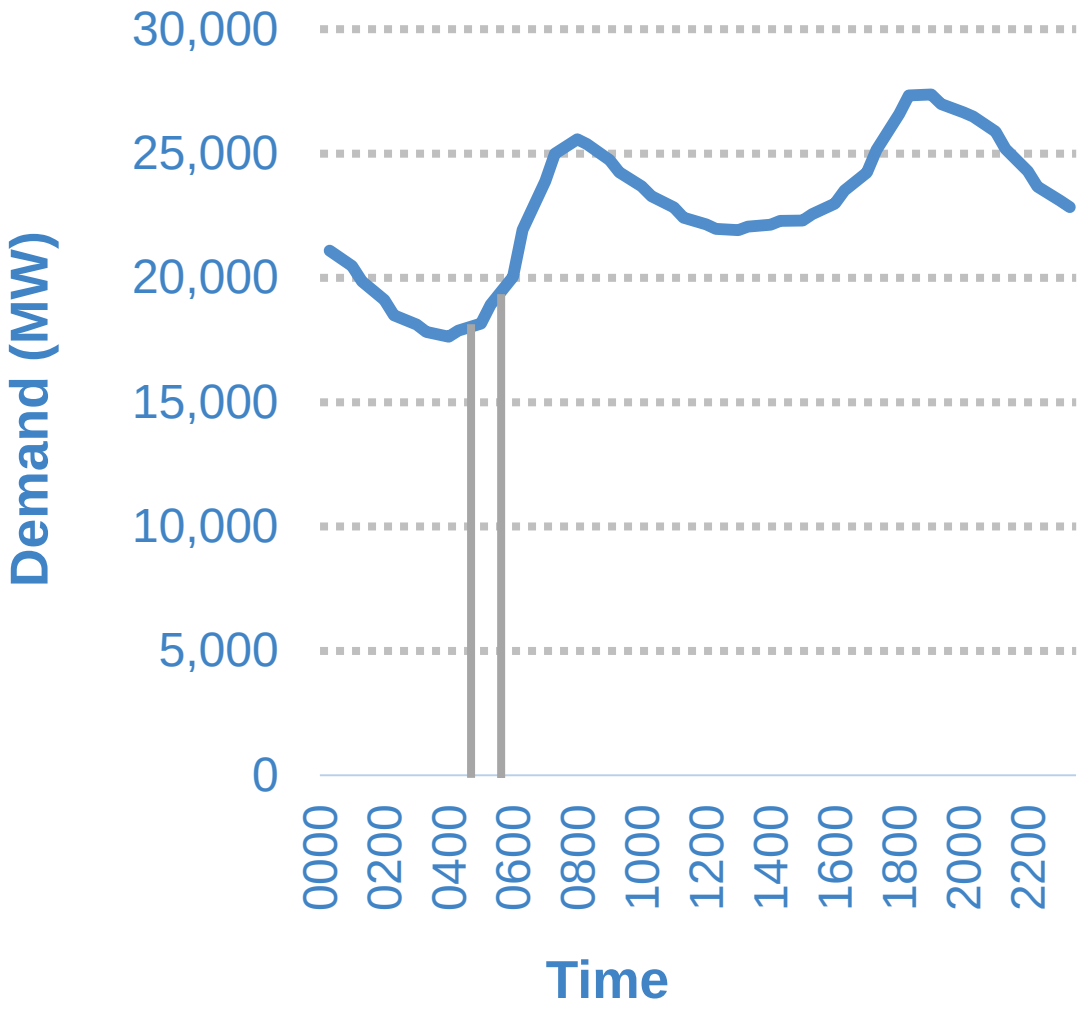
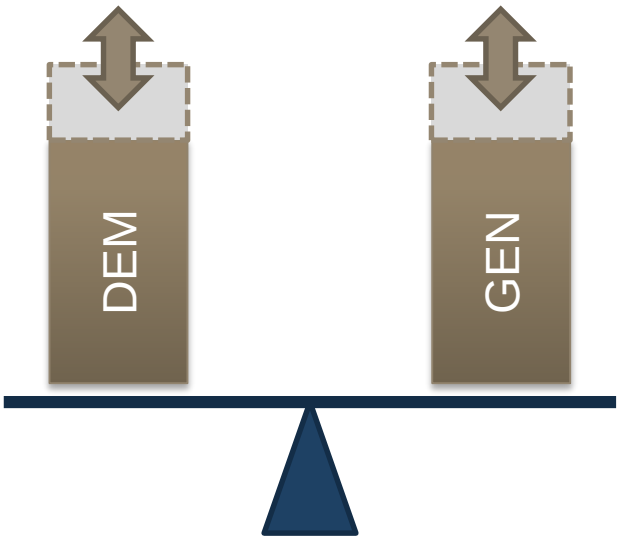




UNEXPECTED DISCONNECTIONS



- Generation can break down
  - The amount of generation needs to be replaced almost instantly or disconnect some load to keep supply and demand in balance
- Transmission elements, such as transmission lines and transformers can disconnect due to faults
  - This can disconnect generation or demand

TWO TYPES OF CONTINGENCY EVENTS

Credible	Non-credible
• Reasonably possible • Examples: unexpected disconnection of a transmission line or generating unit • **AEMO must manage proactively**	• Less likely • Examples: unexpected disconnection of multiple transmission lines or generating units • Limited ability to manage proactively • Can be reclassified as ‘credible’ if more likely due to abnormal conditions (e.g. bushfires, lightning)

- Policy set in National Electricity Rules
- No international standard

POWER SYSTEM SECURITY

- Relates to operating within all specified limits
- Even following the failure of a major power system element (credible contingency event)

POWER SYSTEM SECURITY

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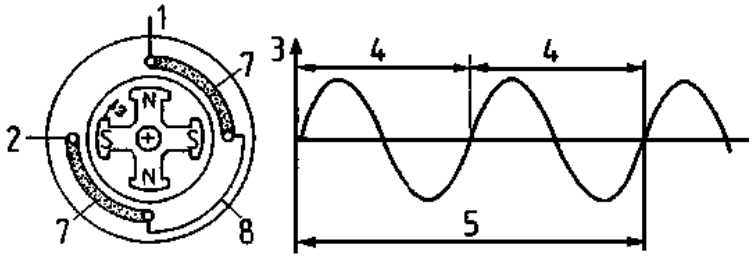
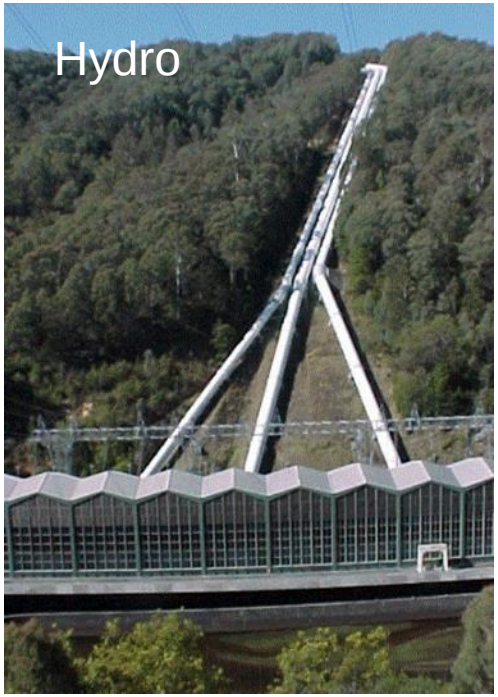
GENERATION TYPES

Generation - Synchronous

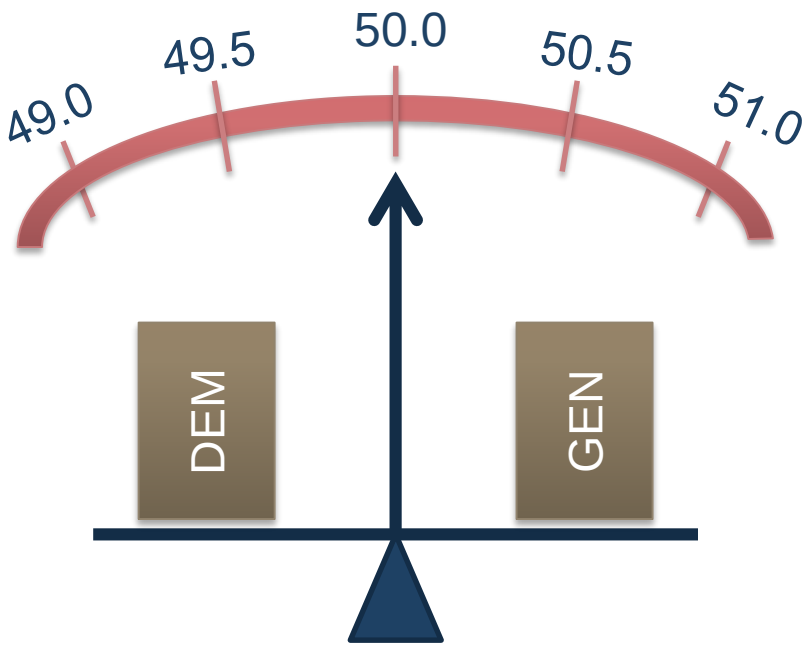




Non-synchronous

FREQUENCY CONTROL

FREQUENCY CONTROL

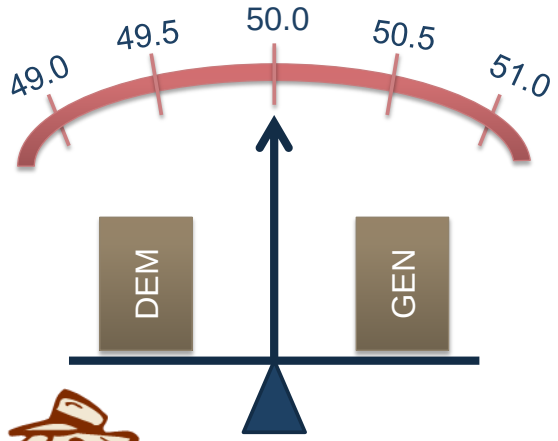


- Frequency is the signal for supply/demand balance
- Needs to be balanced in real time
- Needs to be resilient to system events
- Managed with Frequency Control Ancillary Services (FCAS)

TWO CATEGORIES OF FREQUENCY CONTROL ANCILLARY SERVICES (FCAS)

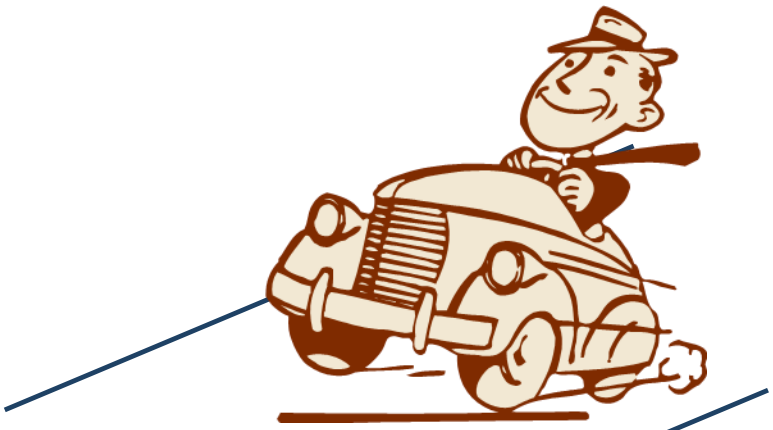
Regulation

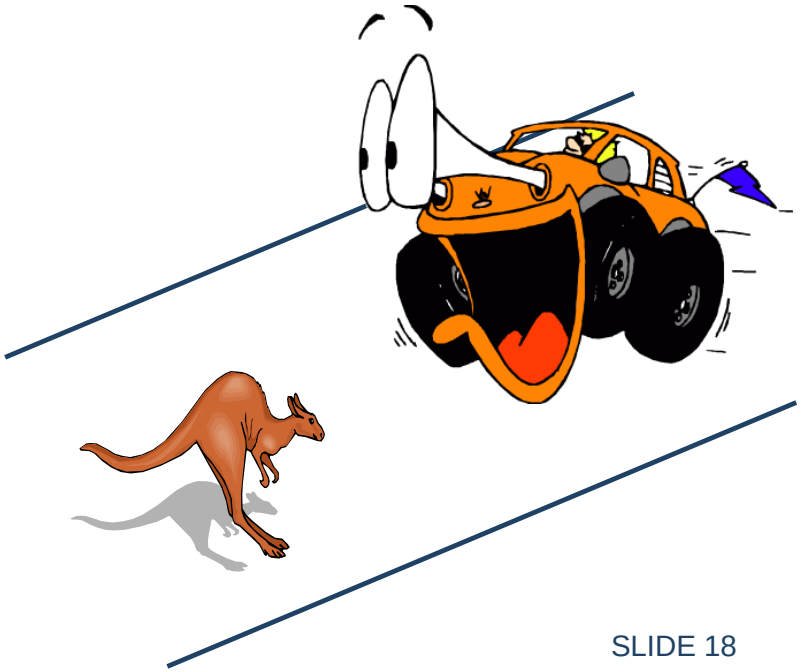
- Small variations in frequency
- Second by second variations



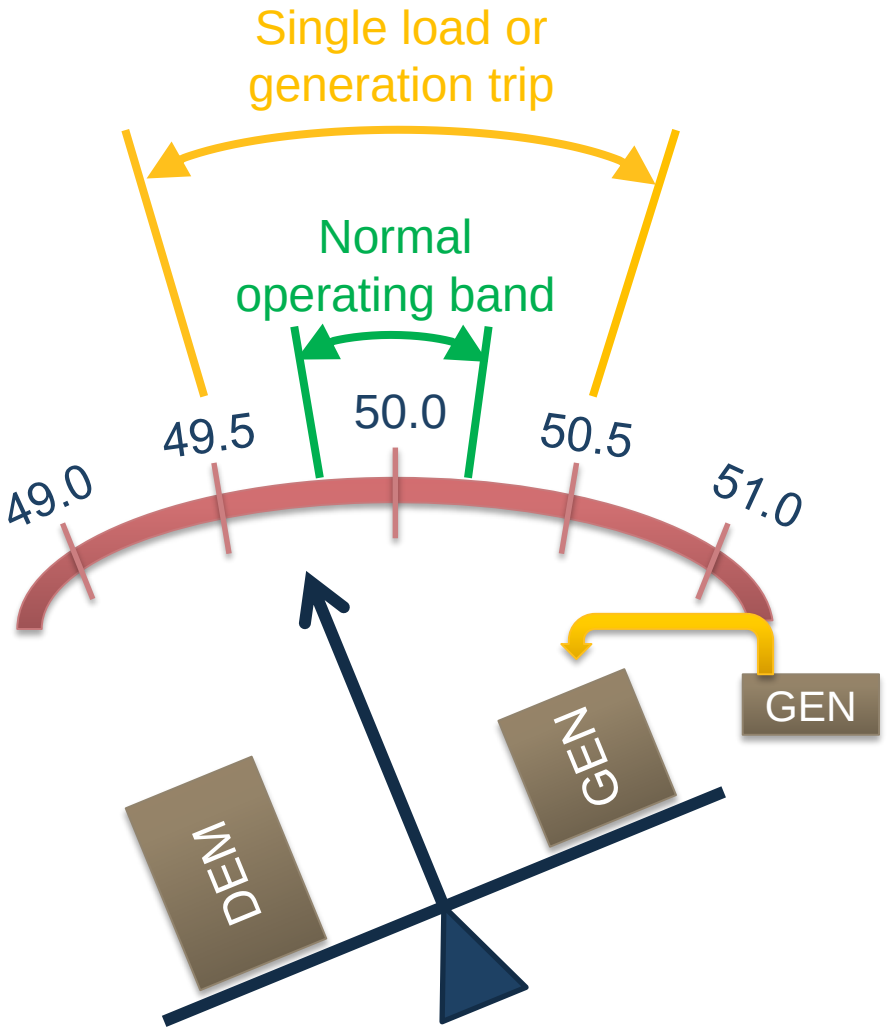
Contingency

- Large variations in frequency
- Major disturbance



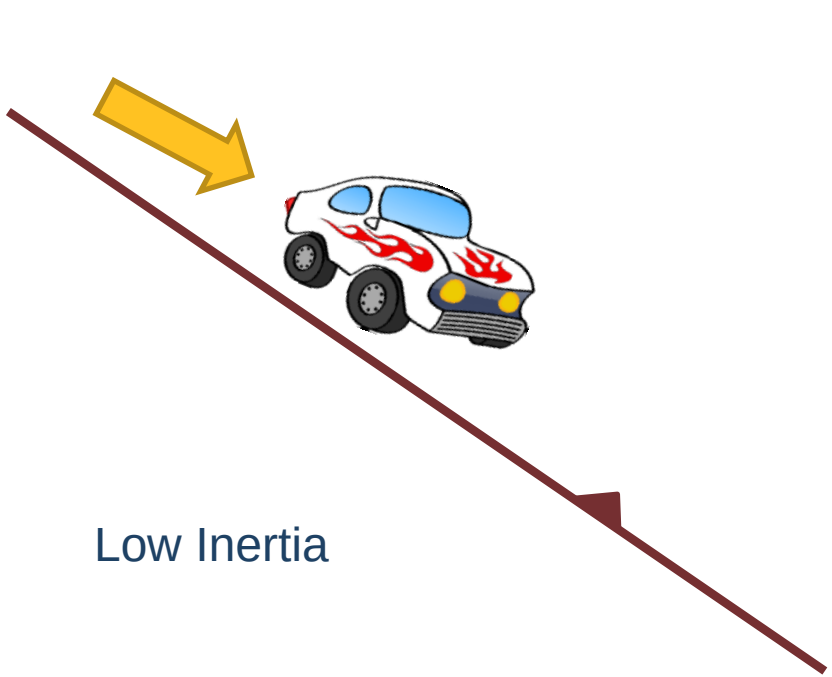


FREQUENCY CONTROL ANCILLARY SERVICES

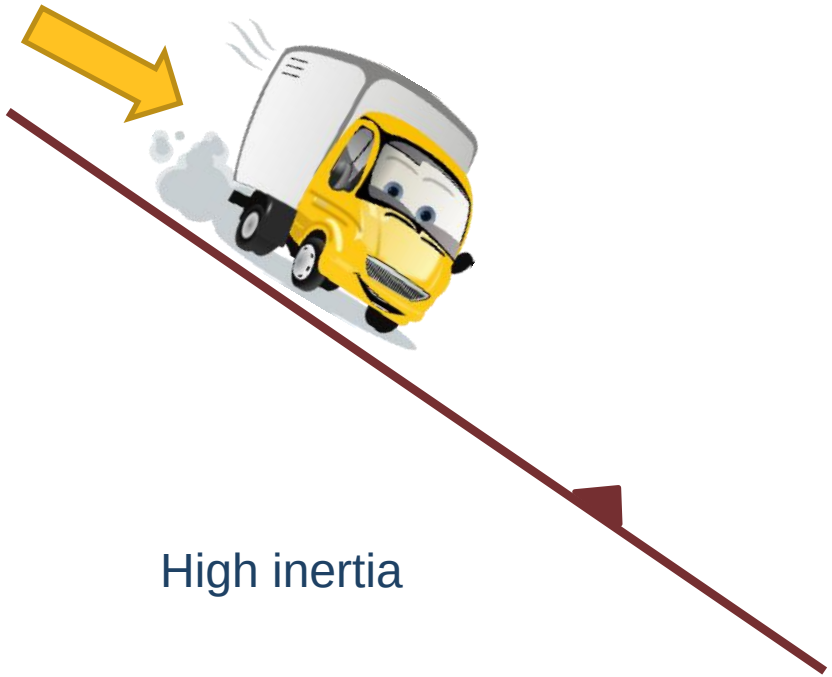


WHAT IS INERTIA?

- The property of a body that resists any change to its uniform motion; equivalent to its mass



Low Inertia



High inertia

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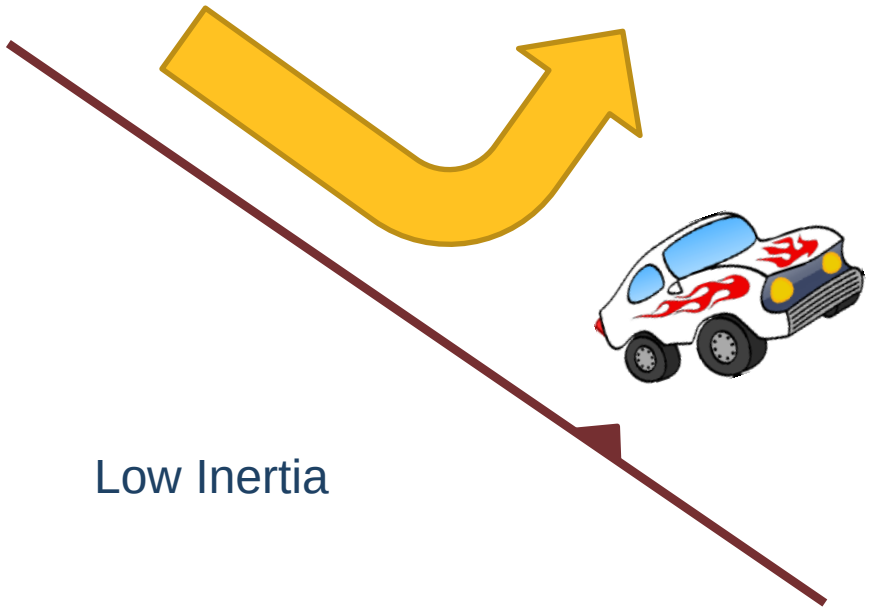

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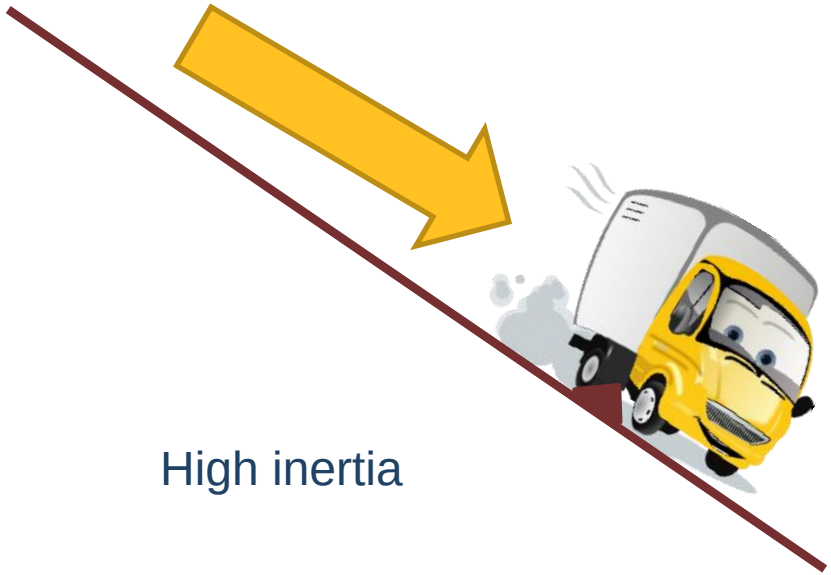
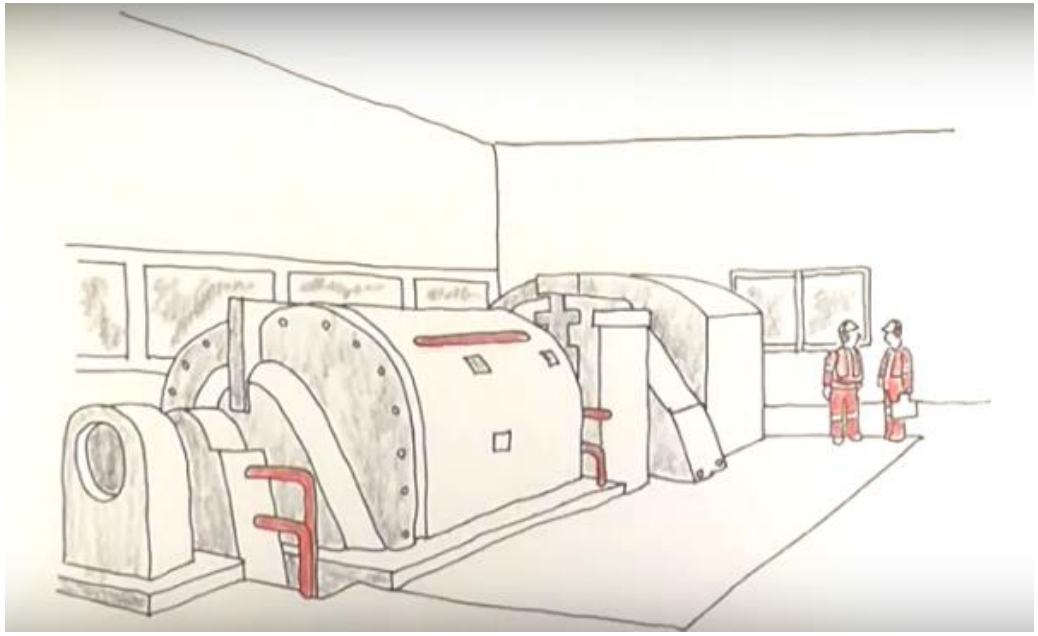
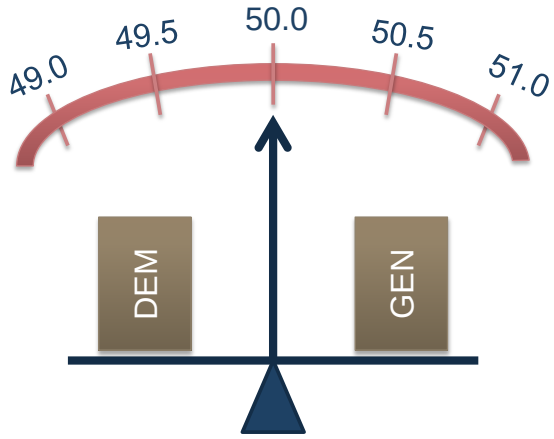


High inertia

WHAT IS INERTIA?

- For the power system this means:
  - High inertia – slow change in frequency following a disturbance
  - Low inertia – fast change in frequency following a disturbance
- Inertia is provided by synchronous machines





SYSTEM STRENGTH

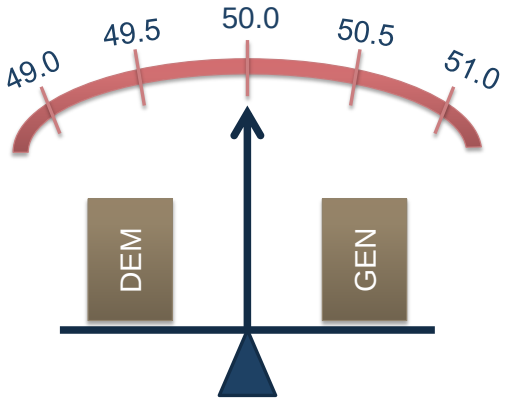
FAULT CURRENT

WHAT IS SYSTEM STRENGTH?

- Lower fault current levels = weaker power system
- Higher fault current levels = stronger power system
- Fault current provided by synchronous machines
- Localised characteristic

WRAP-UP

- Key is keeping the supply and demand in balance all the time



- Power system security relates to the ability to stay within technical limits even after a disturbance
- As well as the production of electricity, we also require other behaviour to keep the system secure and stable

DISCUSSION

Thank you!