FUTURE POWER SYSTEM SECURITY ROADSHOW

OVERVIEW OF POWER SYSTEM OPERATIONS

August 2016
SESSION OBJECTIVES

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

• AEMO has operational responsibilities across gas and electricity
• In electricity, AEMO is the
  o power system operator
  o 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

- Embedded generator
- Distribution network
- Transmission substation
- Generators
- Retail customer
- Distribution substation
- Transmission network
- Wholesale customer (Aluminium Smelter)
- Franchise customer (your street)
SUPPLYING CONSUMER ELECTRICITY NEEDS AND POWER SYSTEM SECURITY
SUPPLYING CONSUMER DEMAND

- At all times,
  - Total electrical production = total electricity demand
CONSUMER DEMAND CURVE
11 AUG 2016

[Graph showing energy demand and generation balance over time]
UNEXPECTED DISCONNECTIONS

• Generation can break down
  o 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
  o This can disconnect generation or demand
## TWO TYPES OF CONTINGENCY EVENTS

<table>
<thead>
<tr>
<th>Credible</th>
<th>Non-credible</th>
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| • 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 - Synchronous

Coal

Gas

Hydro
Non-synchronous

Wind

Rooftop PV

Utility-scale PV
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

Single load or generation trip

Normal operating band

49.0  49.5  50.0  50.5  51.0

DEM  GEN  GEN
WHAT IS INERTIA?

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

- The property of a body that resists any change to its uniform motion; equivalent to its mass.
WHAT IS INERTIA?

• For the power system this means:
  o High inertia – slow change in frequency following a disturbance
  o 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
• 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
Thank you!