# WA MARKET REFORM PROGRAM

## POWER SYSTEM OPERATIONS – STAKEHOLDER FORUM

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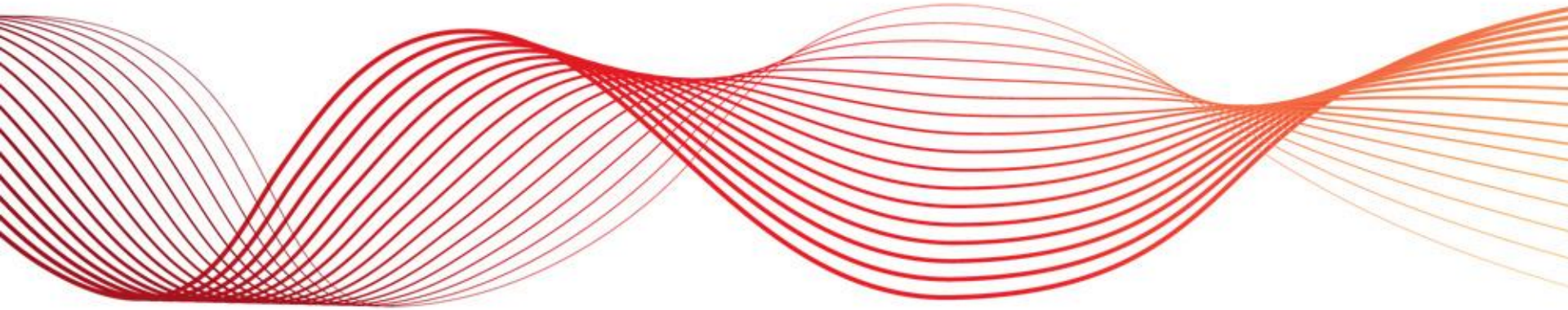
18 October 2016

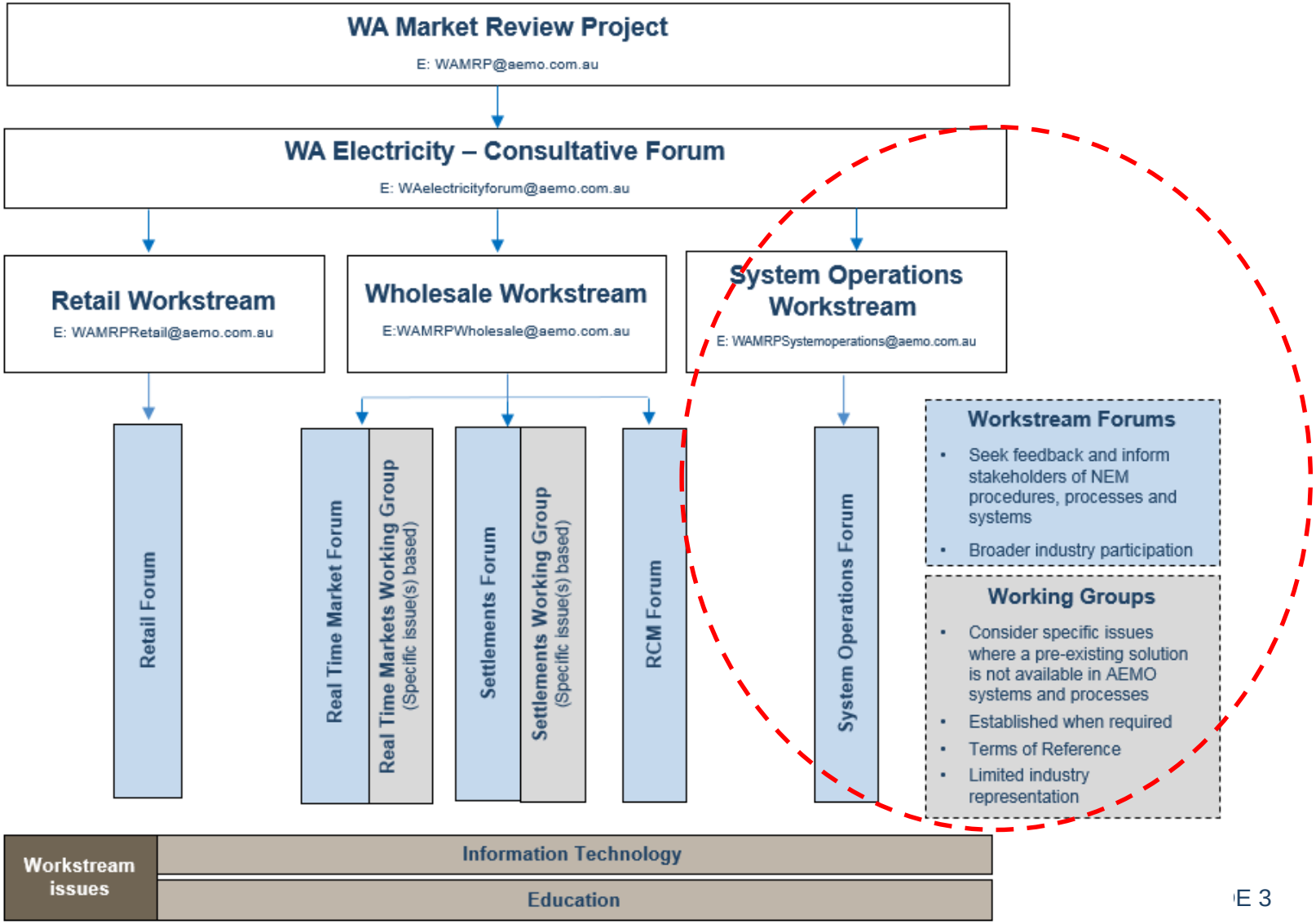


AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

# AGENDA FOR TODAY

- Welcome
- Purposes of the System Operations Forum
- Operational Systems Overview
- Power System Security in the new Market
- Short break
- Modelling and Forecasting
- Dispatch/AGC and Ancillary Service Dispatch
- Other Business
- Next steps

# ENGAGEMENT STRUCTURE



# PURPOSE OF THIS FORUM

- Consultation and provision of information between AEMO and participants on Workstream issues.
- This initial meeting is intended to provide a high level overview of some of the key items being worked through in the Power System Operations stream, namely:
  - Configuration of the SCADA platform
  - A brief understanding of how constraints will be developed in the WEM
  - Some modelling and forecasting concepts
  - An overview of Ancillary Service categories and dispatch arrangements
- At the conclusion of each section, we will seek feedback from stakeholders on the information presented and any other main items being sought
- This forum is also intended to introduce you to some key AEMO subject matter experts who will be involved in delivering the workstream

# PURPOSE OF THIS FORUM

- Some things to keep in mind:
  - The rules are still under development by the PUO, however AEMO is continuing development works based on assumptions and discussions with the PUO to validate these assumptions where relevant. Ultimately the Western Australian Energy Minister will make the final decision on the rule changes.
  - As a result, some of the information in this presentation may change as there rules are developed and released
  - This presentation represents AEMO's current best understanding of what the rules will represent, where this is not developed fully this presentation will identify that there is additional work being conducted that is not yet finalised.

# OPERATIONAL SYSTEMS OVERVIEW

# OPERATIONAL SYSTEMS OVERVIEW – GRID SYSTEMS (SCADA)

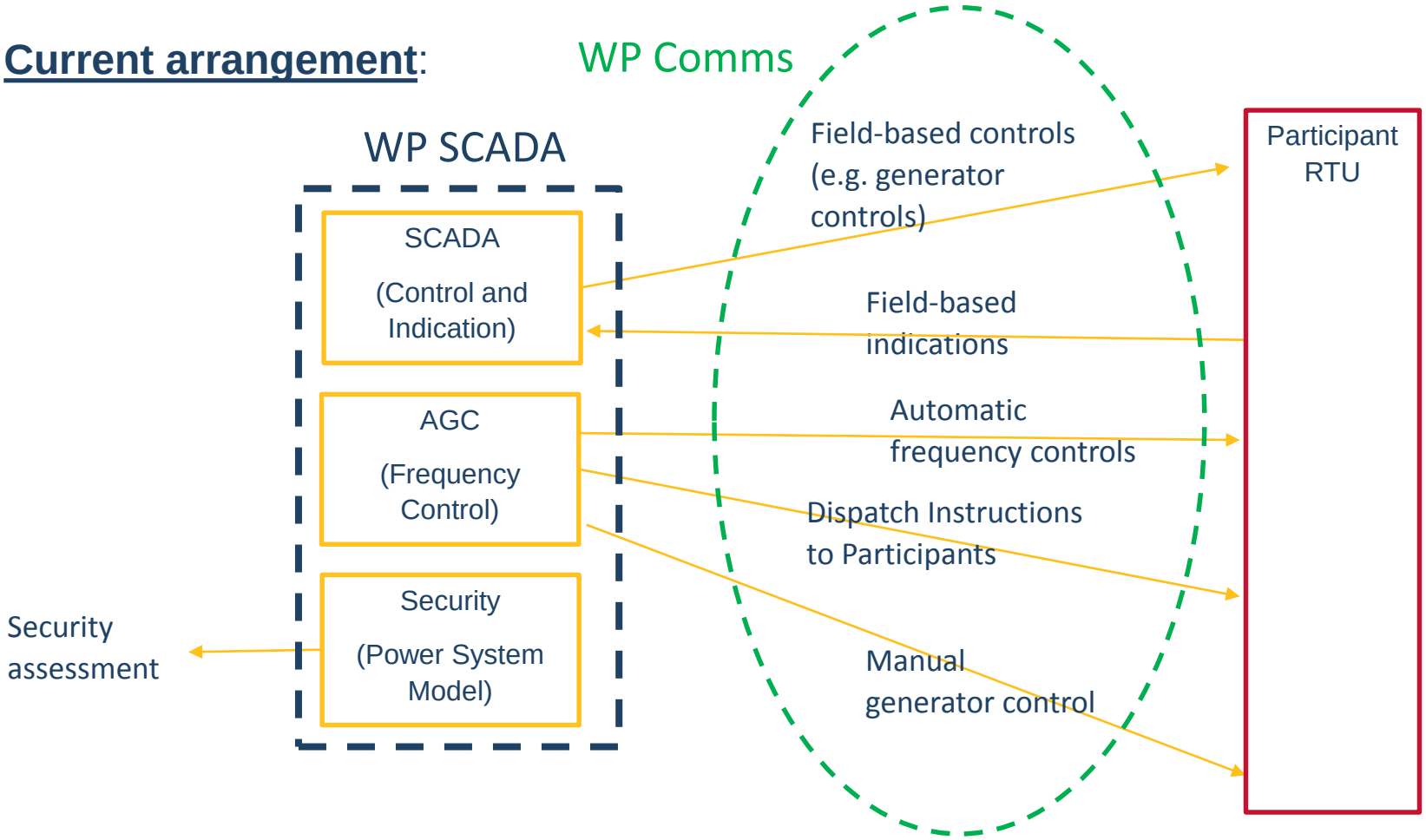
- AEMO uses an Energy Management System with functionality similar to that used by Western Power (and other TNSP's). It is a GE system called e-Terra.
- The e-terra provides the following key functionality
  - SCADA telemetry and controls
  - AGC for frequency control
  - Network models for state estimation, contingency analysis, fault level analysis and voltage stability analysis
  - Dispatch instruction implementation
  - Constraint automation in dispatch timeframe
  - Data for 5-minute dispatch forecasts
  - Historical data retention for compliance monitoring (and settlement where SCADA data is used instead of metered data)

# OPERATIONAL SYSTEMS OVERVIEW – GRID SYSTEMS (SCADA)

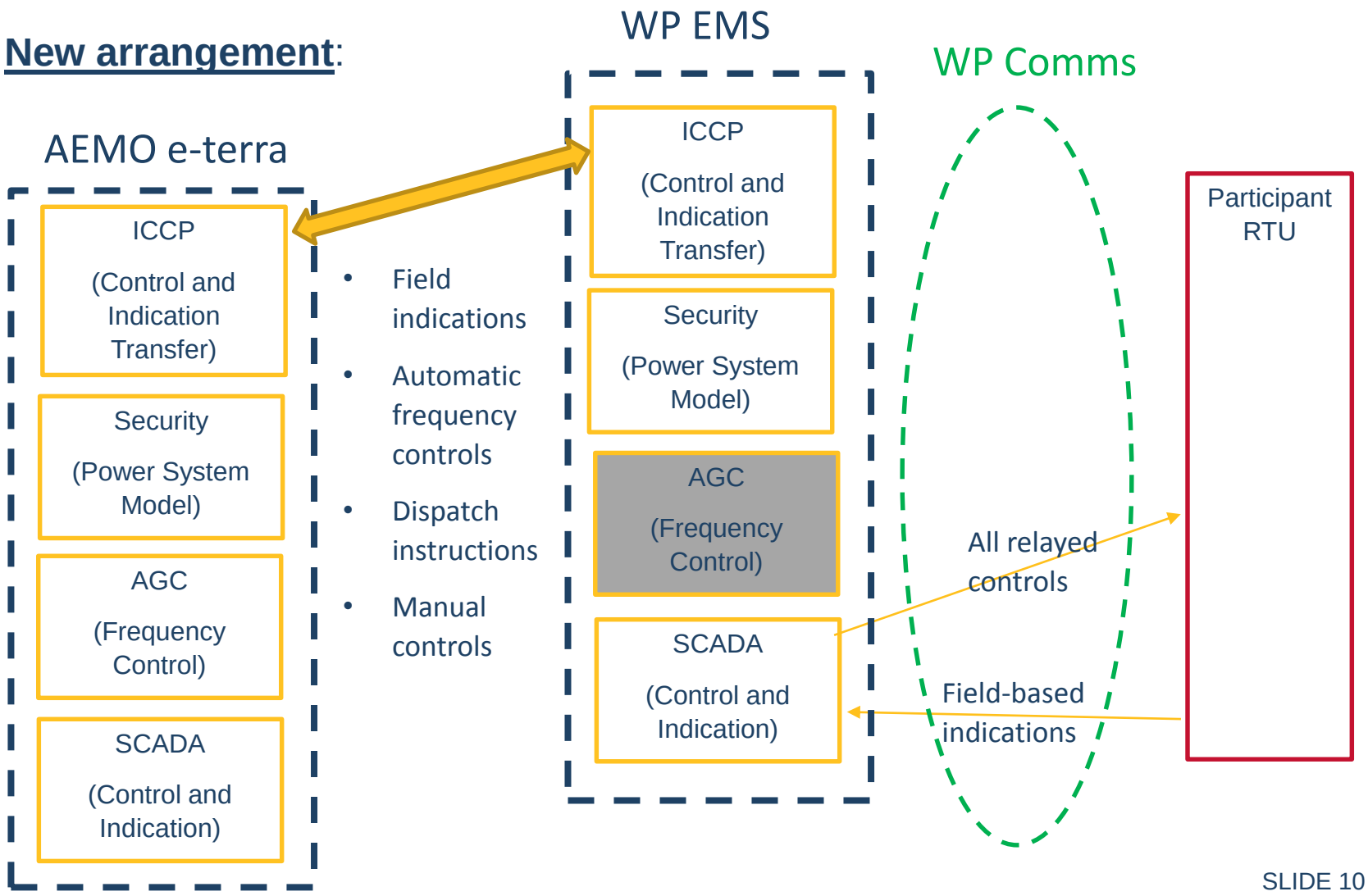
- The existing RTU connections to the Western Power SCADA systems will remain in place, and a new link between the Western Power control system and the AEMO e-terra will be established (ICCP link).
- This will allow for dispatch instructions to be re-directed from the e-terra system, out through the Western Power SCADA and to participant facilities without having to re-commission RTUs and communications links to AEMO.
- Ownership and management of the RTUs and field connections will remain the responsibility of Western Power. Ownership of the ICCP link will be AEMO's.
- AEMO and Western Power will create a shared data library to map and manage all the necessary SCADA points between systems.

# OPERATIONAL SYSTEMS OVERVIEW – GRID SYSTEMS (SCADA)

**Current arrangement**:



# OPERATIONAL SYSTEMS OVERVIEW – GRID SYSTEMS (SCADA)



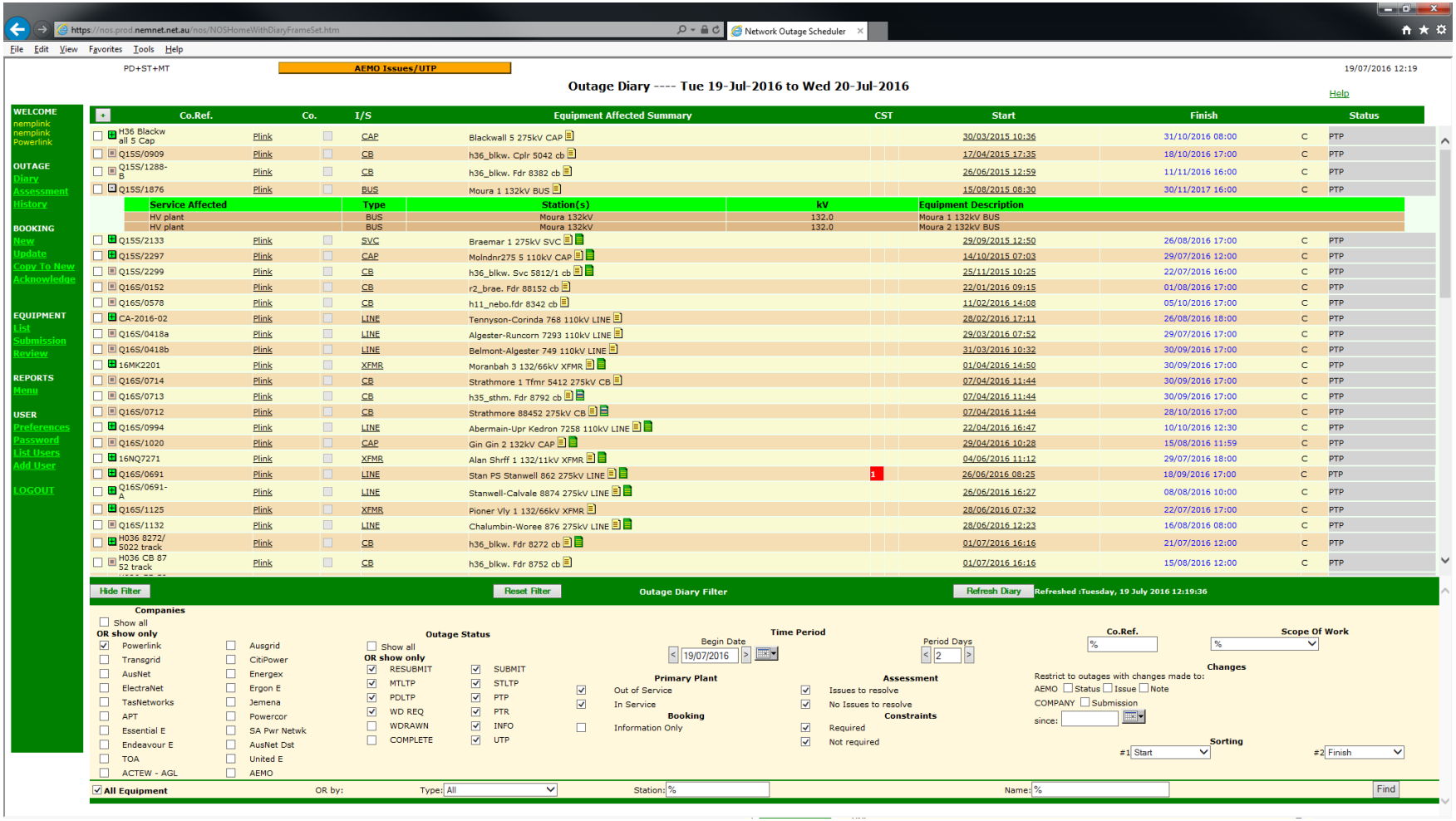
# OPERATIONAL SYSTEMS OVERVIEW – OUTAGE SYSTEMS

## Network Outages

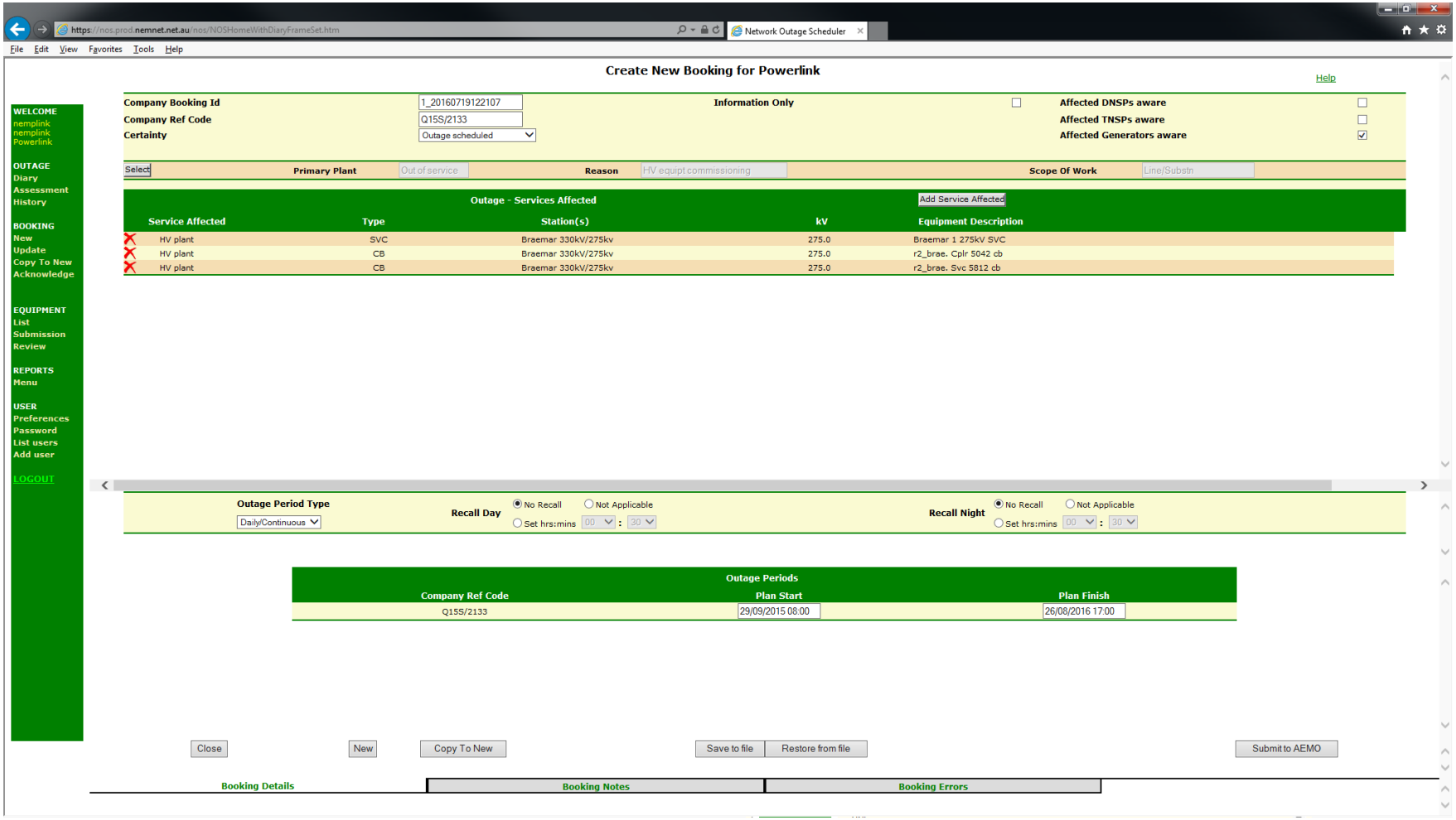
- Network Operators will be able to submit network outage requests through the Network Outage Scheduler (NOS).
- Access is provided through MarketNet, either via a web portal, or via a B2B mechanism.

*The network outage assessment rules have not yet been finalised by the PUO, AEMO's current understanding is that there is likely to remain a similar submit/approve approach to the existing WEM arrangement, although the terminology may change to align more with NEM concepts.*

# OPERATIONAL SYSTEMS OVERVIEW – OUTAGE SYSTEMS



# OPERATIONAL SYSTEMS OVERVIEW – OUTAGE SYSTEMS



# OPERATIONAL SYSTEMS OVERVIEW – OUTAGE SYSTEMS

## Generator Outages

*The generator outage principles and rules have not yet been finalised by the PUO, however current policy positions are that there will remain a requirement for generator participants to lodge outage requests in the WEM and for AEMO to approve or reject those requests.*

- AEMO is currently considering options for which systems would best suit generator outage processing, options include
  - Modifying the NOS to incorporate generator outage requests
  - Modifying the bidding portal to allow for outage requests
- The solution will need to allow for participants to record outage data at the appropriate temperature (based on Reserve Capacity rule requirements)
- The solution will need to allow for Forced Outages to be lodged
- The solution *may* involve participants entering “available capacity” figures, as opposed to “outaged MW” figures as is currently the case

# OPERATIONAL SYSTEMS OVERVIEW – OTHER SYSTEMS

- Forecast systems (to be discussed later in this presentation)
- PASA systems (ST and MT)
  - Reports to be published via MarketNet to participants, as well as on the public AEMO website (forecast processes to be discussed later in this presentation)
- Pre-Dispatch data
  - Reports to be published via MarketNet to participants every 30 minutes
- Demand Side Management dispatch
  - *The rules around DSM dispatch have not yet been finalised by the PUO, however indications so far are that a Non-Balancing Dispatch Merit Order will still be used and so AEMO will need to build the appropriate mechanisms to display this to the operator and allow them to dispatch programs in the necessary order.*
- Other control room user interfaces to support dispatch, reporting and compliance monitoring

# OPERATIONAL SYSTEMS OVERVIEW

- May we please ask for any feedback on the items presented above:
  - Information clarity
  - Content
- Any key items that you would like us to focus on for additional information?

# POWER SYSTEM SECURITY MANAGEMENT

# POWER SYSTEM SECURITY MANAGEMENT

- AEMO in its capacity as System Management currently has the function of ensuring the SWIS operates securely and reliably.
- There are several key ways in which AEMO manages this:
  - Through constrained dispatch of generation
  - By coordinating system voltage levels with transmission system operators and generators
  - By ensuring sufficient capacity is available on the power system
  - Through the procurement and dispatch of sufficient Ancillary Services
  - By coordinating network and generator outages

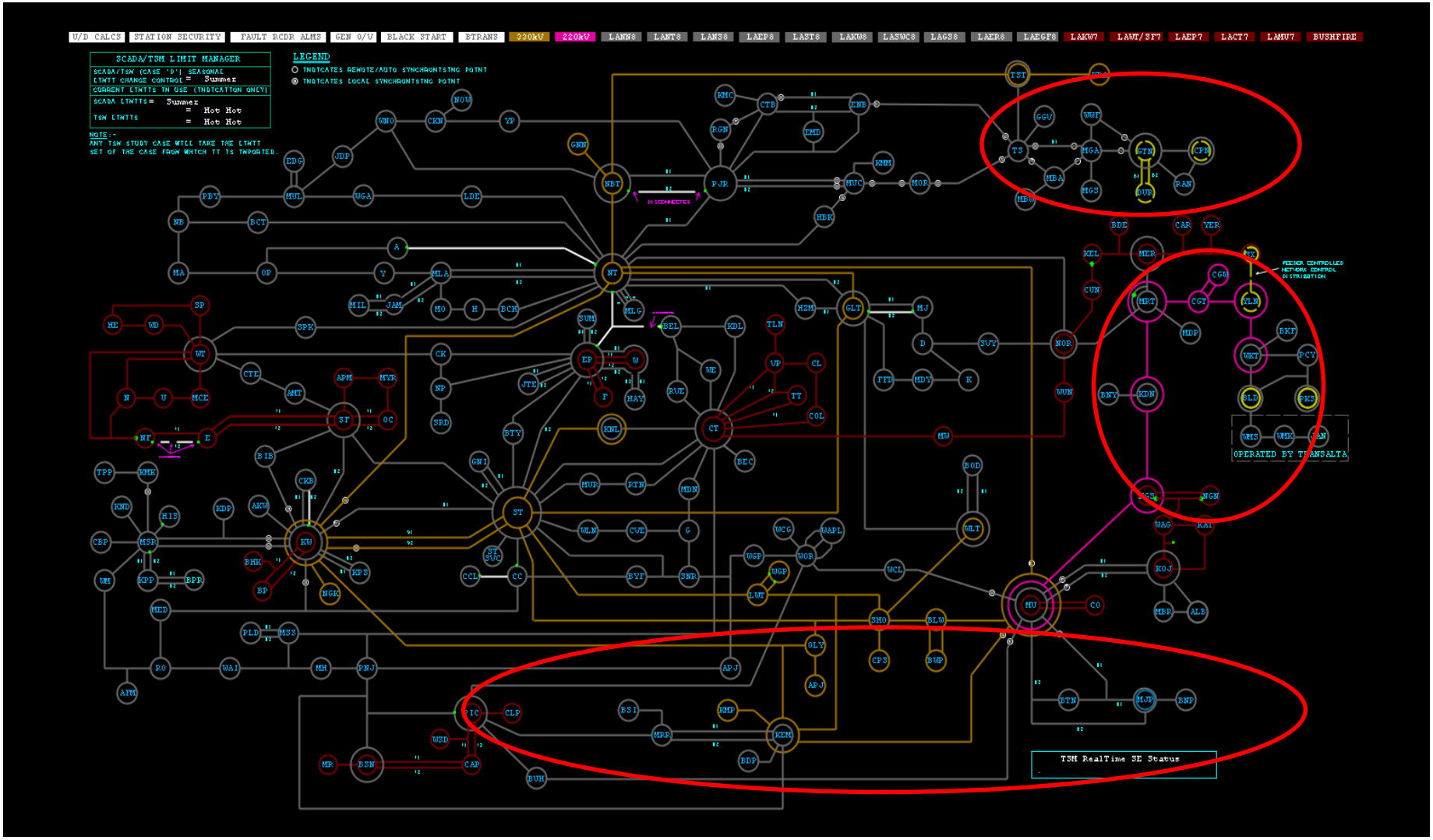
# POWER SYSTEM SECURITY MANAGEMENT

- *Although the rules are yet to be finalised by the PUO, current policy positions are that constrained dispatch of generation in the WEM will change to be more in-line with current NEM practice. This is through the use of constraint equations in the dispatch engine*
- The Power System Operations workstream will be primarily responsible for the production of the constraint equations for the SWIS.
- This requires close interaction with the Network Operator to identify the areas that are subject to constraints, both “System Normal” and “Outage” constraints.

# POWER SYSTEM SECURITY MANAGEMENT

- Western Power, as the primary transmission network operator in the SWIS, will be responsible for producing a series of “Limit Equations” for the network which identify to AEMO any limitations that may apply to generator participants during normal operation, and operations during outage events
- AEMO will take these limit equations, along with standard network rating information and use it to construct “Constraint Equations” to feed into the dispatch engine.
- AEMO uses its own version of the power system model, independent to Western Power’s model, to perform a due diligence on the Constraint Equations before they are put in service.
- The dispatch engine will determine the most cost effective way of dispatch generation based on these constraints, co-optimising this with the costs of allocating FCAS services, and then issue the necessary Dispatch Instructions.

# POWER SYSTEM SECURITY MANAGEMENT



# POWER SYSTEM SECURITY MANAGEMENT

- The rules around power system security are still being defined by the PUO, however indications are that the existing WEM Operating States (Normal, High Risk and Emergency) could be replaced with NEM states:
  - Secure – meaning the power system is operating within all acceptable limits, and will remain operating within all acceptable limits for the next Credible Contingency
  - Satisfactory – meaning the power system is operating within limits, but may not be within limits for the next Credible Contingency (***in this condition AEMO would need to return to a Secure state as soon as practicable***, but in any case within 30 minutes)
  - Reliable – meaning AEMO is taking no action, nor can foresee any action, requiring manual load shedding instructions to be issued (i.e. there is sufficient capacity available to manage power system security)

# POWER SYSTEM SECURITY MANAGEMENT

- In order to ensure the SWIS is operating in a Secure state, AEMO may perform a number of actions including:
  - Invoking a Constraint Equation on the dispatch engine
  - Instructing a Network Operator to adjust a part of the network (e.g. insert an open point, adjust the voltage, etc.)
  - Recall or cancel an Outage
  - Issue manual load shed instructions

# POWER SYSTEM SECURITY MANAGEMENT

- In order to ensure the SWIS is operating in a Reliable state, AEMO may issue market advisories indicating “low reserve” conditions:
  - LRC (Low Reserve Condition) – identified in PASA timeframes as a warning to the market that there may be insufficient capacity
  - LOR1 (Lack of Reserve Condition 1) – first level of capacity issue
  - LOR2 (Lack of Reserve Condition 2) – second level of capacity issue (more extreme than LOR1)
  - LOR3 (Lack of Reserve Condition 3) – most extreme level of capacity issue
- These conditions are used by AEMO in the NEM to initiate various actions (e.g. reserve contracts).

***The rules around identifying and managing low reserve conditions in the WEM are yet to be finalised by the PUO.***

# POWER SYSTEM SECURITY MANAGEMENT

- AEMO advises participants as soon as practical of a binding constraint through the Pre-Dispatch mechanism
- This is a published set of data every half hour which includes estimated dispatch targets (instructions) based on participant bids, AEMO's forecasts (including Non-Scheduled generation) and known outage information
- Participants may access the Pre-Dispatch information through MarketNet
- Where a constraint binds and becomes "violated" (i.e. there is an insecure situation), AEMO may direct participants to resolve the insecurity, including:
  - Directing a generator to commit/de-commit
  - Recalling/cancelling outages
  - Manual load shedding directions

# POWER SYSTEM SECURITY MANAGEMENT

- Together with the above, it is possible that the existing Dispatch Advisory system will be replaced with a similar Market Advisory system that AEMO would use to notify participants of significant market events, including:
  - Load curtailment events
  - Significant threats to the operation of the power system
  - Significant system outages

# POWER SYSTEM SECURITY MANAGEMENT

- May we please ask for any feedback on the items presented above:
  - Information clarity
  - Content
- Any key items that you would like us to focus on for additional information?

# BREAK

# MODELLING AND FORECASTING

# MODELLING AND FORECASTING

- In order to manage power system security and produce pre-dispatch estimates, AEMO must develop a number of models and forecasts for use in operational processes.
- Models include:
  - Network models
  - Generator models
- Forecasts include
  - Dispatch forecasts
  - Pre-Dispatch forecasts
  - PASA forecasts
  - Intermittent generation forecasts

## Modelling data

- Western Power as a Network Operator will need to provide the parameters of its network model in order for AEMO to conduct due diligence on the Limit Equations provided, and to convert these into Constraint Equations.
- *The rules around provision of modelling data have not yet been determined by the PUO, however in order to understand the behaviour of the power system under different scenarios AEMO will require dynamic modelling information from participants – including models of ancillary equipment such as AVR's and other voltage regulating equipment.*
- *The Western Power network model contains a number of generator models provided as part of the network connection process. It may be possible for participants to provide modelling information through Western Power if sufficient capability exists within the rules.*

## Intermittent Generation Forecasts

- The rules around Intermittent Generation forecasts have not yet been finalised by the PUO, however indications are that AEMO will be required to develop “unconstrained” forecasts for Intermittent generation facilities.
- This will require modelling data and realtime SCADA data to feed into forecast systems, including:
  - The Energy Conversion Model (ECM) for the turbines (or other technology, such as solar)
  - SCADA indications of plant availability, current output, any setpoint limitations
  - SCADA indications for current weather data (wind speed, direction, irradiation, etc. as relevant)
  - Physical attributes (geographical locations, turbine heights, feeder locations, etc. as relevant)
  - Historical weather and output data

## Pre-Dispatch

- The rules around the Pre-Dispatch process have not yet been finalised by the PUO, there are some key differences between NEM and WEM approaches:

| NEM | WEM |
|---|---|
| 16-40 hours ahead | Balancing Horizon (72-48 intervals) |
| ½ hourly average load | ½ hourly end-of-interval loads |
| Published ½ hourly | Not published externally |
| 50% POE forecast | 50% POE forecast |
| | |

## ST PASA

- The rules around the ST PASA process have not yet been finalised by the PUO, there are some key differences between NEM and WEM approaches:

| NEM | WEM |
|---|---|
| 1 week time horizon | 3 week time horizon |
| ½ hourly average load | 6 hourly peak load intervals |
| Published 2 hourly | Published weekly |
| 50% POE forecast | 1st and 2nd Std Deviation forecast |
| | |

## MT PASA

- The rules around the MT PASA process have not yet been finalised by the PUO, there are some key differences between NEM and WEM approaches:

| NEM | WEM |
|---|---|
| 2 year time horizon | 3 year time horizon |
| Daily peak load intervals | Weekly peak load intervals |
| Published weekly | Published monthly |
| 10% POE forecast | 1st and 2nd Std Deviation forecast |
| | |

# MODELLING AND FORECASTING

- May we please ask for any feedback on the items presented above:
  - Information clarity
  - Content
- Any key items that you would like us to focus on for additional information?

# AGC DISPATCH AND OTHER ANCILLARY SERVICES

# AGC DISPATCH AND OTHER ANCILLARY SERVICES

- As discussed above, AEMO is building its own Energy Management System with AGC capability. Once this is in service, Western Power will no longer be required to have its AGC capability in service.
- Many participants currently use the existing AGC interface to receive Dispatch Instruction information via SCADA setpoints. Dispatch targets from the new dispatch engine are also capable of being issued via AGC.
- The e-terra AGC system will issue these via similar setpoint controls which will be sent via ICCP to the Western Power SCADA system and on to the participant RTU. It is envisaged that AEMO will be able to retain and re-use a portion of the existing SCADA dispatch configuration.

*The rules around the formulation of Dispatch Instructions are not yet known, however given the stated intention to move towards a 5-minute dispatch frequency, it is possible that the existing need to issue both a Dispatch Target MW and a Ramp Rate will be reduced to just a Dispatch Target MW.*

# AGC DISPATCH AND OTHER ANCILLARY SERVICES

- In terms of Ancillary Services, the rules around which Ancillary Services will be adopted in the WEM are yet to be finalised by the PUO, however indications are that it will be a similar arrangement to Market Ancillary Services (including Frequency Control Ancillary Services or FCAS) in the NEM.
- FCAS is defined as two primary categories (***Regulation*** and ***Contingency***), with different timeframes within those categories:
  - Regulation Raise and Lower – this is similar to LFAS in the WEM and is bidirectional
  - Contingency Raise – similar to Spinning Reserve in the WEM
  - Contingency Lower – similar to Load Rejection in the WEM

# AGC DISPATCH AND OTHER ANCILLARY SERVICES

## Regulation FCAS

- Regulation Raise/Regulation Lower
- Uses AGC to issue dispatch setpoints to enabled units at 4s intervals
- Setpoints issued by the AEMO e-terra AGC, then over ICCP to the Western Power SCADA system and out to the participant

*The rules around aggregation (or not) of facilities able to participant in Regulation FCAS have not yet been determined by the PUO, nor where the dispatch point will be located (i.e. generated or sent-out).*

# AGC DISPATCH AND OTHER ANCILLARY SERVICES

## Contingency FCAS

- Fast Raise/Lower (6s)
  - Between 0 and 6s to respond, and
  - Between 6s and 60s to sustain the response
- Slow Raise/Lower (60s)
  - Between 6 and 60s to respond, and
  - Between 60s and 5mins to sustain the response
- Delayed Raise/Lower (5min)
  - Between 1 and 5mins to respond, and
  - Between 5mins and 10mins to sustain the response

# AGC DISPATCH AND OTHER ANCILLARY SERVICES

These services are provided through locally installed technologies (i.e. installed at the participant facility), control systems to detect and respond to the frequency variation.

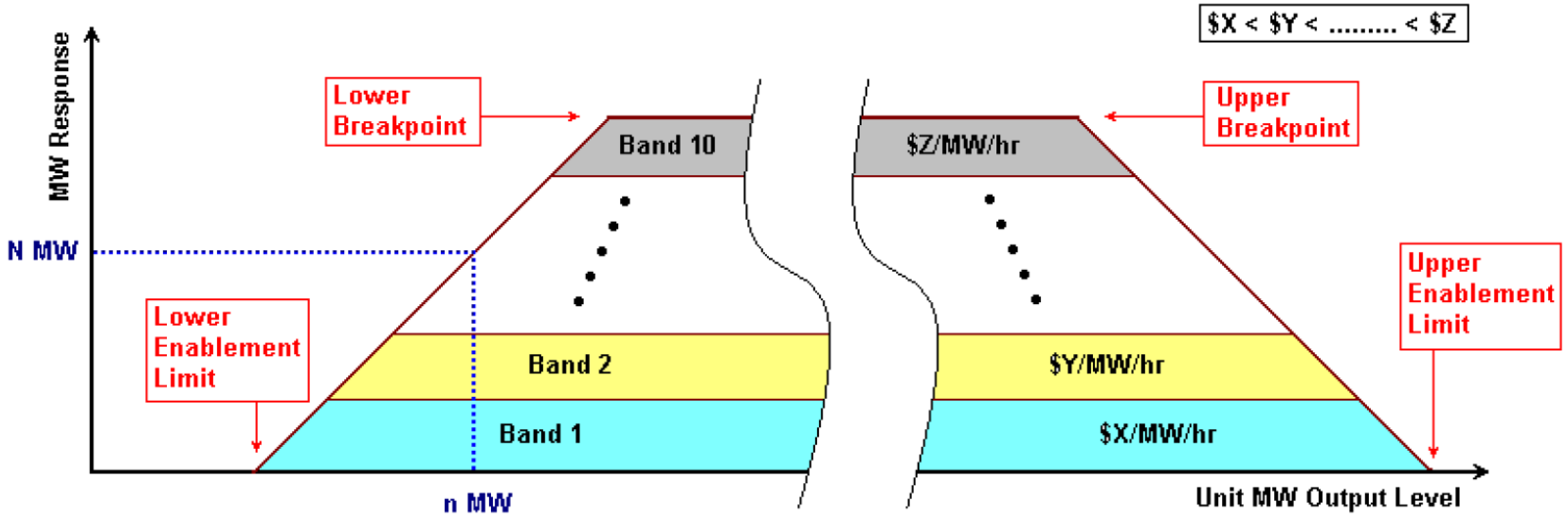
For generators typically a droop governor, for loads typically an under-frequency relay.

For additional information on how Market Ancillary Services are currently defined and measured in the NEM, please see the following link:

http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification

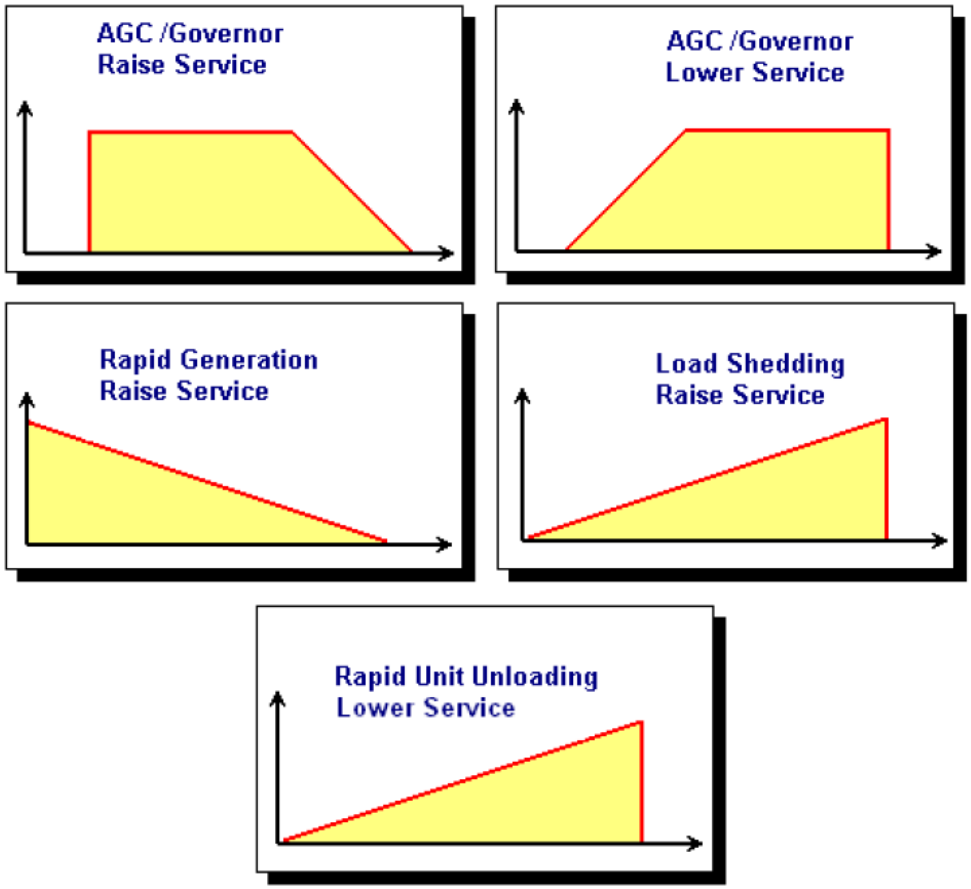
# AGC DISPATCH AND OTHER ANCILLARY SERVICES

Participants provide an FCAS trapezium to AEMO as part of their bids, indicating the amount of FCAS that can be provided (y-axis) for a given MW output (x-axis).



# AGC DISPATCH AND OTHER ANCILLARY SERVICES

Participants may provide multiple trapeziums for different services



# AGC DISPATCH AND OTHER ANCILLARY SERVICES

- Following a significant event on the power system, AEMO may need to conduct an investigation to understand how the event arose and to determine if operational processes need to be altered in the future to avoid the event occurring again.
- Participants providing Ancillary Services may need to provide AEMO with information following a significant event, including high speed fault recorder data showing how the parameters for their facility varied during the event.
- This assists AEMO to check that models are accurate and performing correctly.

*The rules around collection of high speed fault recorder data have not yet been finalised, it is possible that Participants may be required to provide this data on request to AEMO, but that they may be able to source this from Network Operators.*

# AGC DISPATCH AND OTHER ANCILLARY SERVICES

- May we please ask for any feedback on the items presented above:
  - Information clarity
  - Content
- Any key items that you would like us to focus on for additional information?

# ADDITIONAL BUSINESS

Are there any additional items that stakeholders would like to raise in this forum?

# NEXT STEPS

- Focus on completing infrastructure design
- Connections to pre-production/test environments
- Connection to Western Power to allow for ICCP establishment
- Configuration of SWIS network model
- Publish interface requirements

# SYSTEM OPERATIONS WORKSTREAM

The System Operations Workstream will implement processes and systems required by AEMO to ensure the SWIS operates securely and reliably.

| Key Milestones | Timeframe |
|---|---|
| Release ICCP interface requirements (for linking to Network Operator for SCADA data and controls) | Q4 2016 |
| Release AGC interface requirements (for generator dispatch via SCADA) | Q4 2016 |
| Release Ancillary Service control/interface requirements | Q4 2016 |
| Release NOS interface requirements (network and generator outages) | Q4 2016 |
| Release intermittent forecast requirements (SCADA and modelling requirements for Intermittent Generators) | Q4 2016 |
| Release modelling interface requirements (network and generator modelling) | Q1 2017 |

## Next System Operations Forum Agenda

| December 2016 |
| --- |
| Interface requirements (including MarketNet overview) |
| Modelling requirements |
| Outage processing |
| Progress and next steps |

**Other thoughts?**

# CONTACT INFORMATION

## System Operations

### Contact details

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# THANK YOU

Thank you for your time today, we hope that you found the information useful