MINUTES

MEETING:	National Electricity Market Operations Committee (NEMOC)
MEETING NUMBER:	17
DATE:	Friday, 20 September 2019
TIME:	10:00AM – 3:30PM (AEST)
LOCATION:	AEMO Office Level 2, 20 Bond Street SYDNEY NSW 2000

ATTENDEES:

NAME	COMPANY
Ken Harper *(Chair)*	AEMO
Lenard Bayne *(Secretariat)*	AEMO
Babak Badrzadeh	AEMO
Damien Sanford	AEMO
Ben Skinner	Australian Energy Council
Simon Bolt	Australian Energy Council
Tim Llyod	AusNet Services
Verity Watson	Energy Networks Australia
Gary Edwards	Powerlink QLD
Mike Paine	TasNetworks
Andrew Power	TransGrid

APOLOGIES:

NAME	COMPANY
Dean Sharafi	AEMO
Teresa Smit	AEMO
Wai-kin Wong	Clean Energy Council
Lillian Patterson	Clean Energ Council
Rainer Korte	ElectraNet
Blake Harvey	Energy Queensland
Andrew Kingsmill	TransGrid

PRESENTERS:

NAME	COMPANY
Tjaart van der Walt *(Item 3.5)*	AEMO
James Lindley *(Item 3.6)*	AEMO
Sorrell Grogan *(Item 3.7)*	AEMO
Babak Badrzadeh *(PSMRG)*	AEMO
Darren Spoor *(PSSWG)*	AEMO
Daniel Lavis *(OTWG)*	AEMO
Sujeewa Rajapakse *(OPWG & Item 5.1)*	AEMO

1. Welcome

2. Previous Minutes & Actions Register

Previous minutes were accepted.

3. Discussion

3.1. Membership and structure

Damien Sanford opened the discussion to the group, by asking the following questions about the NEMOC membership and structure.

1. Is the membership right, should it be broader?
2. Are we focussing on the right priorities/issues and are we reporting up to the right bodies.?
3. Do we have the right working groups/taskforces? Do we need more?

Damien opened the floor for comment. The following feedback and observations where captured.

TimL – The NEMOC isn't focussing on the right issues and risks in the network. If we were to take a risk-based approach and action those risk. Develop a matrix of the responsibilities, linkages of the NEMOC and the working groups to avoid overlaps.

BenS – The history of this NEMOC was made up of AEMO and TNSP's. This was called an operating committee for the purpose of looking at real time, degree of reactivity and setting up procedures. Expanding this membership to DNSP's is a positive approach. Overall the Agenda is good and has a more proactive approach.

GaryE – There is a highly disruptive world out there over the last 20 years and there is a need to be different from the past. We need to be future focussed. Where is the influence in what we are doing? There isn't a lot of visibility of what we are doing.

AndrewP – The NEMOC is using a lot of resources from several organisations in the working groups and as well, on this committee and there seems to be a need to prioritise the things that we do, so that we utilise those resources to achieve the best outcome. What are our priorities?

MikeP – The linkages into the Executive Joint Planning Committee (EJPC) and the avoidance of duplication. Sometimes there are things that we can't operate and making sure the linkages into implementation, training and resourcing is done at the planning stage and not after.

In addition, Damien suggested that the NEMOC members discuss the representation of the future NEMOC post the Strategic Operational Risk Workshop. This would identify if additional members would be necessary and/or whether new sub working groups need to be created.

3.2. NEMOC Priorities

Discussed as Item 3.1

3.3. Operating in an increasingly interconnected network

Paper prepared with collaboration with Christian Schaefer (AEMO). Gary Edwards and Mike Paine facilitated the discussion in relation to operating in an increasingly complex operating environment. High level discussions were based around:

- Hierarchy of system controls (deciding on the priority of economic versus security driven issues).
- Coordinated distribution and transmission control system design.
- Operational challenges relating to system strength.
- Growing impact of an increasingly dynamic distribution system.
- Operator training and requirements in an increasingly automated and dynamic power system: dealing with the complexity of the control room.
- Cross jurisdictional interaction: understanding the operating requirements of cross border networks.
- Integration and standardisation of Interconnector Special Protection Schemes (SPS).
- Managing runbacks and SPS of generating facilities in oversubscribed parts of the network; how should this be planned?
- Preparing for unexpected non-credible and High Impact Low Probability events.
- Establishing the boundary of the secure system operating envelope and the tools necessary to manage this; what part must dynamic stability assessment (DSA) tools and ancillary services (AS) play?
- Defining the impact and boundaries of employing untried technology.
- Simplification of concepts and terminology of the energy system for industry participants and policy makers.

Areas that they identified as key areas of concern which they believed to resonate with the NEMOC are;

1. Network planning and generation development.
2. Power system automation and control.
3. Operational tools and operator training.
4. Communication and stakeholder engagement.

3.4. Need for enhanced real time monitoring

Ken Harper facilitated a discussion on a need for enhanced real time monitoring. Ken advised the group that over the last several months, AEMO has identified that it has become apparent for the need of better real-time high-resolution information. AEMO initiated a piece of work early this year to investigate areas of Contingency FCAS and associated Load Relief assumptions. During this program of work, it was identified that Load Relief assumptions hadn't been reviewed and revised since 2001.

As a result of the review, AEMO indicated that observed load response was inconsistent, but significantly lower than the 1.5% level. Accordingly, AEMO is progressively reducing the assumed level of mainland load relief. It was noted that each 0.1% of load relief is adding about 20MW of extra contingency FCAS. AEMO made its first change to load relief and therefore contingency FCAS on Thursday 12th of September 2019, from 1.5% to 1.4%. This will decline by 0.1% every two weeks, with a review at 1%. AEMO will continue towards 0.5% but has committed to a hold and review point of 1%. AEMO will continue to update members as this program of work progresses and in addition advised the committee that an update report will be published once it reaches the 1% mark. It was noted that fortnightly

market notices will be published on the AEMO website reflecting the decrease in load relief assumption by 0.1%.

In addition, Ken noted that AEMO's registration team have been made aware that there may be an increase of registrations due to the increase of the contingency services required by the market.

BenS added praise to AEMO on their approach to this program of work and the way it has been rolled out and communicated to industry.

DamienS added that AEMO has been approached by numerous system operators globally seeking information on how best to approach this issue within their own networks. In addition, Damien raised the concern that the more engagement is required at the distribution level to understand what they are doing in this space to avoid duplication and to share information due to so much complexities occurring in the market.

In addition, KenH raised the issue around Voltage oscillation with NW VIC solar farms and the ability to obtain high speed data and real time data as this would assist AEMO to understand what is happening there. AEMO has raised this a high priority.

3.5. Summer 2019-20 Overview

Tjaart van der Walt provided members a presentation on AEMO's Summer Readiness 2019/20 program of work. The following points were noted.

- Maximum Generator Availability
    - Ensure there is enough generation to cope with high demand during the summer period by: minimising outages, mitigating risks to generators and making sure the appropriate operational procedures are in place for new generators.

Key Project Milestones / Deliverables		
Focus Area	Milestone / Deliverable	Target Date
Outage Management	Confirm with generators their commitment regarding deferral or flexibility of generation to confirm discussions.	October
Communication	Send reminders to generators for a refresher on Generator Recall P1266.	September Completed
Generation risk	Update generation database with newly connected generation risk information	November
Generation EPA limitations	Investigate Generator EPA limits and try to create consistency	October

- Transmission Availability
    - Ensure that the transmission network will have sufficient capacity and will operate securely and reliably during summer by: minimising transmission outages, anticipating maintenance and ensuring protection schemes and emergency management plans are in place.

Key Project Milestones / Deliverables		
Focus Area	Milestone / Deliverable	Target Date
Outage Management	Maximise generation and transmission capacity over the summer period: Update outages recorded in NOS (Network outage scheduler).	August/September Completed
Preventative Maintenance	Maximise plant availability and reliability over summer resulting from completion of maintenance: 1. Summer Readiness Survey completed with all TNSPs responding. 2. All maintenance that has been identified completed prior to summer.	August/November
Interconnector Management	Maximise the transfer capability across interconnectors for the summer: List and review identified upgrade works.	August/September

- Fuel Supply Scope Summary
    - Minimise fuel supply risks to generation during peak electricity demand periods in summer 2019/20.
    - Minimise risks to adequacy of gas supply for the domestic gas market.

Key Project Milestones / Deliverables		
Focus Area	Milestone / Deliverable	Target Date
Coal / Diesel / Water Fuel Supply (*).	1. Undertake informal discussions with key, priority Generators and Gas Participants to determine any risks associated with fuel supplies (stockpile values etc). 2. Based on information gathered, develop a heat map and determine highest risk areas. 3. Develop mitigation strategies and implement. 4. Update Forecasting tool/s (e.g. MTPASA) where necessary to reflect fuel supply constrains.	October
Gas Facility Maintenance Coordination	A South East Australia Gas Maintenance Coordination Workshop which AEMO chairs is planned for 30 July 2019. The objective of this forum is to identify planned maintenance activities that overlap with other planned maintenance or could restrict the supply of gas within South East Australia.	August

- RERT
    - Ensure sufficient off market reserves are available (generation and demand side) to ensure continuity of electricity throughout the summer period.

Key Project Milestones / Deliverables		
Focus Area	Milestone / Deliverable	Target Date
RERT Contracts	1. Long Notice RERT Contracts Awarded 2. Members added to Short and Medium Notice RERT panels	October
NSP and government response	Engage with all TNSP's, DNSPs and relevant government departments re load reduction schemes (including Voltage Control) either through RERT or on a voluntary basis.	August Completed
Training	Review all training needs relating to RERT and ensure a plan is in place to execute	November/December
Resource Management	Ensure sufficient resources are in place, covering both Control Room and Metering/Settlement	October

- Operational Improvements
    - Implementation of operational forecasting and training enhancements.
    - Improvement of forecasting accuracy.
    - Increased transparency to stakeholders of forecasting performance.

Key Project Milestones / Deliverables		
Focus Area	Milestone / Deliverable	Target Date
RTO Training Module Updates	Re-delivery of operational forecasting training to control room operators	November
Operator Training	Review and implement appropriate summer training for NEM RTO	October
Conduct SRAS Training	Delivery of regional specific SRAS training	November
RERT Team Training	Delivery RERT Training priority Scenario based RERT training using 24/25 Jan for AEMO RERT team	December

- Contingency Planning
    - To plan for, practise, and communicate contingency planning arrangements both internally and with external stakeholders.

Key Project Milestones / Deliverables		
Focus Area	Milestone / Deliverable	Target Date
NEMEMF / NGERAC Emergency Exercise	1. Exercise Planning and Development 2. Exercise Rehearsal 3. Exercise Conduct 4. Production of draft exercise report	August Completed
Individual Regional Briefings	1. Planning and logistics of briefings 2. Notification to jurisdictions of timing 3. Conduct sessions (end Oct/mid Nov)	November
NEM Summer Readiness Briefing	1. Planning and logistics of briefing 2. Formal invitations to invitees 3. Conduct of NEM Summer Briefing	End November/Early December
Demand Reduction Calculators	Update demand reduction calculators for all NEM regions	December
Jurisdictional Summer Readiness Sessions	Develop countermeasures and prepare emergency management plans to deal with a range of major foreseeable events: 1. Undertake scenario planning and prepare processes for unplanned events: • Interaction with gas – gas pipeline constraints and/or production/facility outages • Emergency conditions – bushfires/weather • Multiple generator/interconnector outages 2. For these scenarios identify risks of load shedding and ensure these are communicated to jurisdictions ahead of the summer.	October

MikeP raised the question if Basslink would be ready for summer in which AEMO responded that it was in the PASA and would be ready in October 2019.

In addition, it was noted that the EAAP will be published in November 2019.

3.6. NW VIC and SW NSW update

James Lindley provided the group with and update on the situation currently in NW VIC and SW NSW.

AEMO is intending to stage tests in the west Murray region over the coming weeks. The results of the tests will be used to confirm model-based analysis and adjust current system normal constraints as required. AEMO will inform the market of the details and timing of the tests once a plan has been established and agreed to by participating organisations.

AEMO is working with the affected solar farms, equipment manufacturers, and relevant NSPs to address this issue. Work completed to date indicates that a solution involving modifications to plant control systems is likely to totally, or largely, remediate the oscillatory stability issue.

As the oscillatory stability is associated with low system strength conditions, AEMO will also complete a system strength assessment of the west Murray region. AEMO is targeting this work to be completed by the end of October 2019.

AEMO is working with other NSPs to assess whether similar issues may exist in other areas of the NEM. Solutions developed to address the issues in west Murray region may be suitable to address similar issues arising in other areas of the NEM with low system strength.

AEMO is in contact with developers of new inverter-connected generation projects in North-West Victoria and South-West New South Wales, and is working with them to ensure that connection of new projects can continue as efficiently as possible without compromising power system security.

JamesL also noted that this type of issue may occur in other areas of the NEM, and currently working with Powerlink in Queensland.

DamienS noted that this is not a SMA issue, but rather an inverter issue.

It was also noted that there is an extensive test program underway to assist with this program of work.

3.7. Australian Energy Simulator Centre

Sorrell Grogan presented to the group on the program of work that is underway for a new Australian Energy Simulation Centre (AESC). This program of work will be led by AEMO and CSIRO.

It was noted that the Australian energy system is facing unprecedented complexities and that with existing data and tools being no longer fit for purpose and therefore unable to address the growing system complexities.

AEMO and CSIRO have engaged with over 100 stakeholders from more than 60 organisations such as;

- Policy makers
- Market operator
- TNSP's
- DNSP's
- Investors & Developers
- Incumbent generators
- Retailers & Aggregators
- Equipment Manufacturers
- Researches & Academics

The AESC has identified the technology limitations such as;

- Inadequacies in the computations and simulations of the energy system.
- Collaboration is not supported as stakeholders rely on fragmented, conflicting and incomplete data sources.
- Data management and quality varies across the energy ecosystem, data may lag and there is limited use of metadata for tracking and consistency.

It is anticipated that the AESC concept will;

- Deliver advanced tools to provide accurate and fast simulation and optimisation capabilities.

- Host a scalable platform to provide the most complete view of the Australian energy network.
- Lead innovation and research to solve current and future energy challenges.

It is anticipated the AESC will enable users with the capabilities to:

- Operate a complex and dynamic energy system safely, efficiently and reliably.
- Plan and invest to drive energy affordability, reliability and diversification.
- Integrate consumer energy resources while maintaining grid security and safety.
- Conduct forward–thinking research to future–proof the industry.

This scope will include WA with a timeline for this program is approximately 2 – 3 years to work through the 22 use cases detailed in this presentation. In addition, AESC is dependent on funding arrangements.

As the program progresses regular updates will be provided to the NEMOC.

4. Working Group Updates

4.1. PSMRG

BabakB provided an overview of the PSMRG updates which was tabled and an overview of the taskforces that have been created to investigate specific areas. Babak provided the group an outline of the structure of these taskforces.

These taskforces are;

- PSCAD Model development and study methodology
- Synchronous condensers

KenH added that it would be beneficial for a system strength educational piece to provide new players in the market a greater understanding of the rules and requirements. In addition, BenS added that CEC would be in a better position to provide good connections for these sessions.

In addition, a DER presentation was tabled, and an overview was given to the group. The following points were highlighted in the presentation.

DER & Load Behaviour

- Bench testing
- Solar Analytics
- Load tripping
- Energy QLD high speed measurements

Development of Load/DER model

- Load composition
- CMLD Model
- DER_A Model
- Parameter optimisation tool

Next steps

- Immediate
- 2020

4.2. PSSWG

Darren Spoor provided an overview of the recent activities with the PSSWG. The last meeting was held in Brisbane 6th of August 2019 at the Powerlink office. The following topics where tabled and discussed.

Power System Reclassification

- The PSSWG has recently concluded a detailed review into the reclassification framework. SO_OP_3715 will be updated to address the following recommendations:
    - A revised bushfire risk assessment
    - The TNSPs have accepted responsibility for contributing to the bushfire assessment
    - A review of the criteria for lines to be declared vulnerable under "Proven" category
    - A revised reclassification framework for severe weather events
- The PSSWG are recommending that additional factors be considered when determining whether to make a reclassification. There may be wider geographical risks that cannot be managed solely by the reclassification of a non-credible contingency to a credible contingency. Under such circumstances, a risk-based approach should be used to increase the resilience of the power system, rather than simply applying constraints, where a market solution may not be appropriate.

In addition, DarrenS raised a recommendation that considered scenarios where there are wider geographic risks that can't be managed through the existing reclassification framework. Darren provided a hypothetical example where a loss of SCADA occurs, and AEMO is unable to ascertain when operational data would be back online. Darren added that this is a situation where imposing reclassification or reclassifying contingencies won't not necessarily help maintain a secure power system. As a result, the PSSWG members endorsed a recommendation to the AEMC to look and focus on resilient power systems.

UFLS Capability in Load Control Relays

- A discussion centred on the increasing presence of load control relays that have a capability to provide UFLS functionality. The PSSWG believes there is scope for the Power System Modelling Reference Group (PSMRG) to assess the potential benefits in adjusting the controllable load demand profile. This could provide UFLS in locations where there is net export on distribution feeders.

Operational Communications

- AEMO presented the results from recent satellite phone testing with the TNSP's.
    - 39% of 57 connection attempts were recorded as successful
    - 49% of 57 connection attempts failed to connect
    - 68% of 19 connection attempts during cloudy conditions failed
- The PSSWG and the Control Room Working Group (CROWG) will continue to review options for increasing the availability of backup communications links.

In addition, the committee decided to create a new Communication working group as a sub group of the PSSWG.

Next meeting will be held in Melbourne at the AusNet Services office on the 13th of November 2019.

4.3. Operations Training Working Group (OTWG)

Daniel Lavis joined the group to provide an overview of the newly appointed Operations Training Working group.

The inaugural Operations Training Working Group was held in Brisbane on 6 August 2019, with attendance from AEMO, the five NEM TNSP's, Western Power and APA Group.

The Terms of Reference (TOR) were accepted without further change.

AusNet provided an update of their current Transmission Operator training with four new staff in the last 12 months through retirements. These staff members are to attend AEMO system restart training in October / November 2019.

AEMO provided an overview of the training and assessment framework in both the NEM and Gas RTO. A 6-month outlook was presented, including dates for the upcoming Victorian System Restart training to be held in Brisbane and Norwest:

- 18th & 22nd October 2019
- 7th, 12th & 29th November 2019
- 3rd December 2019

AEMO were seeking feedback from members and their staff on the existing format of System restart training and any areas for improvement.

Summer Readiness 2019/20 was discussed with AEMO informing preparation was underway, with early advice from the BOM of hotter than average conditions, with soil levels expected to be dry in the lead up to Summer, indicative of high-level bushfire activity. AEMO's summer readiness training for its Operators will be heavily focussed on bushfire management and reclassification.

Discussion was held into the benefits of developing a more structured trainee exchange program, specifically between AEMO and the respective TNSP's. AEMO and TNSP's will look to coordinate a program for exchange opportunities at the next meeting.

AEMO provided an overview and demonstration of its new Learning Management System, with members providing positive feedback on this tool. AEMO to investigate potential of developing common training modules for training operations staff across the NEM. Examples discussed:

- SO_OP 3715 overview
- Communications protocol.
- Basic Electrical theory

Soft skill (non-technical) training was discussed;

- TasNetworks informed that a recent review conducted into DNSP errors identified a high Human Factor component, including fatigue.
- AEMO advised they intend researching providers of Human Factors training and raised prospect of working in partnership with the TNSPs to provide this kind of training across organisations.

- AEMO progressing a review of verbal Communication Protocols within the NEM. Finding and recommendations to be presented at the next meeting.

AEMO advised of participation in CIGRE Training Working Group C2.39
Initial task set looking at:

- Processes for existing simulator training
- Technical resources used
- Improvements needed in the simulation environment
- Challenges in the modern power system.

Next meeting to be held in November 2019 in Melbourne. AEMO will develop a meeting forward plan for 2020 and present at the next meeting for decision.

4.4. OPWG

Sujeewa Rajapakse joined the meeting to present on recent activities at the Operations Planning Working group (OPWG). It was noted that the last OPWG meeting took place on the 19th of September. This meeting was to focus on finalising the network outage guideline over the summer period. The guidelines will be in place from the 11th of November through to mid-March 2020.

In addition, the OPWG met on 25 June 2019 and in addition an out of session meeting occurred on the 2nd of August to discuss action items which were assigned by the NEMOC committee. These action item discussion papers where included in the NEMOC meeting (20/09) pack and included:

- Development of a discussion paper on voltage control in the NEM under light load conditions
- Prepare a summary of learnings from recent international system black events (Item 5.1)

James Lindley has commenced the two yearly UFLS review. TNSPs have provided required inputs with studies also been completed. These studies are to determine the adjustments to the UFLS settings in SA. Studies for other regions are progressing.

Implementation of OFGS settings of one SA wind farm was outstanding at the time of the OPWG meeting. This was implemented and completed on the 15th August 2019. AEMO are reviewing the relay setting change report.

OPWG commenced developing a discussion paper on Voltage control in the NEM under light load conditions. TransGrid and TasNetworks identified areas to be covered in the discussion paper. The OPWG requested the endorsement for the draft discussion paper from the NEMOC members and in addition how to progress this task moving forward.

Babak Badrzadeh and Ben Blake explained the arrangements in place to manage system strength and inertia requirements in the NEM. Babak referred to the AEMO System Strength Requirements Methodology document published on AEMO's website 1/7/2018 and the Inertia guidelines document These guidelines will be reviewed in June 2020 and cover the planning horizon of 5 years.

Ben Blake explained how constraints are utilised in market system to manage system strength. There are two types of constraints, one type covers requirements of the whole region (for example SA) and another type limiting local generation or number of turbines/inverters in service.

Steven Frimston provided and update to the OPWG on the program of work for the Summer Readiness 2019/20. It was noted that the Summer Network Outage Planning Guideline prepared in consultation with OPWG was used in 2018/19 summer. OPWG members and AEMO acknowledged that the outage planning guideline was effective in managing network outages during this period. OPWG noted that the principles used in the guideline can be used for 2019/20 summer with network elements listed under various categories updated to reflect the changes to the power system.

Several presentations where provided and are listed below,

- NOS improvements – project update was provided by Kate Roche and Chat Rodrigo.
- System incidents since the previous meeting on 26 March 2019 – incident summaries were presented by Peter Biddle
- Robert Chen/AEMO presented the VIC Planning update and reported the progress of three RIT-T processes being undertaken as well as the review of control schemes used in Victoria.
- Elijah Pack/AEMO gave a presentation on the Integrated System Plan (ISP) and its coverage. The draft version of the next ISP will be available by the end of 2019 and the final version will be published in mid-2020.

In addition, as part of the 25 August event, there was an action to review one of the Victorian control system (EMPT). The setting has been reviewed. A temporary set of settings have been implemented in the system.

5. Presentations

5.1. International Black System Events

Sujeewa Rajapakse tabled and provided a presentation on International Black System Events. The below events aim to consider the following areas that are relevant to the NEM. The relevant information is presented in a tabular form for the convenience of comparing observations from the incidents.

- An overview of the effected
- Review the event and pre-event network conditions, key causes, time to restoration, changes made subsequently
- Insights into whether there is risk exposure to the NEM based on review.
- Review trends in equipment and system failures such as CB's or maloperation of control schemes. Are we by way of system transformation moving non-credible to credible event classifications?

The events reviewed were;

- US Blackout on 14 August 2003,

Overview of the power system	Pre-event network conditions, key issues	Trigger of the event	Load interrupted, time for restoration and number of people affected	Causes of the event and corrective measures recommended	Similarities to the NEM and risk exposure
• 320,000 km of transmission lines • Operate at 230kV or above, • 950,000 MW of generation capacity • Three interconnections in North America – electrically independent (except for a few small DC links)	• Normal for a summer day. • Load about 90% of previous peak loads • Inter-regional transfers, voltages and frequency within normal range. • All system elements within limits Generation availability normal for this time of year. • Three notable unplanned outages occurred prior to the event: • Several lines in south-central Indiana tripped, • a generating unit in northern Ohio tripped and shut down automatically, • a 345 kV line in southern Ohio tripped. • These outages did not cause the event but made load restoration after the event more challenging.	• There were four stages of the blackout's initiating sequence: • A normal afternoon degrades, the northern Ohio system operator's computer failures, three Ohio 345 kV transmission line failures and many phone calls, and the collapse of the northern Ohio 138 kV system and the loss of a key 345 kV line.	• 61800 MW of load interrupted. • Restoration took 2 days in most areas, 4 days for other areas for complete restoration. • 55 million people were affected.	• There were 46 recommendations from the investigation into the event. The most relevant to the NEM are: • Strengthen compliance with existing standards and formally track completion of recommended actions from this event and other significant power system events. • Improve operator and reliability coordinator training. • Evaluate reactive power and voltage control practices. • Improve system protection to slow or limit the spread of future cascading outages. • Establish guidelines for real-time operating tools. • Evaluate lessons learned during system restoration. • Improve system understanding of operators – in particular, voltage instability. • Install additional time-synchronized recording devices as needed. • Re-evaluate system design, planning and operating criteria • Improve system modelling data and data exchange practices.	• Situational awareness and effectiveness of power system monitoring tools, • Maintain adequate reactive power support, • Effective vegetation management in transmission easements. • Install additional time-synchronized recording devices as needed.

- The Italian Blackout on 28 September 2003

Overview of the power system	Pre-event network conditions, key issues	Trigger of the event	Load interrupted, time for restoration and number of people affected	Causes of the event and corrective measures recommended	Similarities to the NEM and risk exposure
• Italian 380 kV power system is connected to Switzerland, France, Slovenia, Austria and Greece. • Demand was 27344 MW which included 3487 MW of pump load. • Generation was 20493 MW and had 6951 MW of import.	• Significant differences between actual and scheduled flows on the interconnections with Switzerland and France. • Operating under n-1 security conditions.	• At 0301 hrs a 380kV interconnection between Switzerland and Italy tripped due to flashover with trees. • Automatic and manual attempts to re-close the line failed. • A nearby parallel circuit then overloaded for longer than allowed in the operating standard and then tripped when it flashed-over with a tree. • A parallel 220kV line then tripped immediately and the Italian grid lost its synchronism with the interconnected system. • All remaining interconnections to Italy were disconnected by normal action of protective devices • By 0326 hrs Italy was an electrical island. • Since local generation was equal to only 75% of the load, the frequency declined to 47Hz after three minutes of separation and the Italian network collapsed.	• 27220 MW was interrupted affecting 56 million people. • Took approximately 18 hrs to restore the last customer.	• After loss of the first 380 kV interconnection with Switzerland, the second 380 kV interconnection with Switzerland was loaded above 100 % and the time taken to reduce overload caused the conductors sagging on to trees resulting in tripping. • Major causes of the event were: Not following operational procedures, lack of Situational awareness, instabilities in the Italian network, inadequate tree trimming, unresolved conflicts between trading interests of the operating counties and operators, operating standards and legal instruments lagging economic realities.	• Situational awareness. • Response time for power system emergencies and effectiveness of operational procedures. • Effective vegetation management in transmission easements.

- Argentinian Blackout on 16 June 2019

Overview of the power system	Pre-event network conditions, key issues	Trigger of the event	Load interrupted, time for restoration and number of people affected	Causes of the event and corrective measures recommended	Similarities to the NEM and risk exposure
• Transmission network is mostly 500kV. • 38,922 MW of generation capacity. • Mostly radial connections between generation and load. New lines built since 2012 have made it more meshed. • Flows usually from North (hydro) to North-East (Buenos Aires) and South-West (hydro) to North-East (Buenos Aires)	• System demand was not high, at 13000 MW compared to the peak of 26000 MW. • A section of one of the two links between North and North-East (Colonia Elia —Campana 500 kV line was) out of service for maintenance. • Remaining section of this line was by-passed to the other parallel line from North to North-East (Colonia Elía – Belgrano 500kV line) to increase power transfer capacity. • Pre-fault voltages seemed to be normal.	• Colonia Elía – Belgrano 500kV line tripped and either did not reclose or tripped and locked-out after reclosing. • The wide-area protection scheme DAG) did not trip the expected 1200MW of generation in the north and the frequency in Northern part of grid increased. • South-West to North-East 500kV lines tripped due to power swings or overloading, splitting the grid into North and South electrical islands. • Generators in North island tripped due to over frequency. • Under-frequency load shedding occurred in Southern island tripping 1500 MW of load. • 1500 MW of generation failed to ride to ride through the frequency dip and tripped when the frequency was still 49.0Hz. • Frequency fell below under-frequency ride-through curve and the remaining generators tripped leading to total backout of the system.	• 13000 MW affecting 48 million people. • 95% of load restored within 9 hours	• Wide-area protection scheme did not work appropriately, generators did not meet the under-frequency ride-through requirements, UFLS did not shed the required quantity of load. • Possible recommendation: Generator ride-through requirements. Presently, the generating units only have to survive a frequency depression to 48.5Hz for 20 sec. Another 5 seconds would have most probably prevented the widespread collapse.	• Generator fault ride-through capability. • Performance of complex control schemes. • Effectiveness of UFLS system.

- Major supply interruption in UK on 9 August 2019

Overview of the power system	Pre-event network conditions, key issues	Trigger of the event	Load interrupted, time for restoration and number of people affected	Causes of the event and corrective measures recommended	Similarities to the NEM and risk exposure
• Installed generation capacity is 80000+ MW with multiple DC interconnections with adjacent power systems.	• Generation was 30000 MW at the time of the incident. • Incident took place at round the peak hour of the day. • UK power system was operating at relatively low inertia at the time.	• A lightning strike on a transmission line • north of London caused it to trip. The line was reclosed within set protection times • Immediately following this event, simultaneous loss of from Little Barford CCGT generation (approximately 680 MW) and Hornsea Wind Farm (approximately 750 MW) was experienced. • This resulted in rapid decline in frequency. After approximately one minute, further loss of generation was experienced causing under-frequency load shedding.	• Loss of load on the operation of under-frequency load shedding was approximately 1500 MW. • One million customers were affected. • Load was restored in 45 minutes.	Relevant areas for consideration: • With the coincidence of decreasing inertia and increasing interconnector capability, it is important to find better solutions for mitigating this beyond simply applying more of the traditional reserves and reducing the single largest loss which could be costly and ineffective due to the speed of the RoCoF. • Should the technologies like synthetic inertia from batteries and grid-forming inverters be considered as an avenue to address the low inertia? • Measurement of inertia in the real time and prediction of inertia.	• Maintaining adequate inertia in the power system, • Explore possibility of using new technologies to provide inertia, monitor inertia in the real time and predict inertia requirements.

5.2. The Observer view on Britain's black out

Tabled. Not discussed.

6. Other business

6.1. Next meeting 6 December 2019