NEM Engineering Framework

Operational Conditions Summary

July 2021

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

The National Electricity Market (NEM) is changing quickly, with up to 100% instantaneous renewable penetration expected by 2025 if current trends continue, and new operational conditions emerging. Operational conditions are generation mix and loading combinations five to 10 years in the future that necessitate changes to current operational practices. They are a tool to help industry prepare for a secure and efficient energy transition. Successful planning for the first occurrences of these conditions will mean the NEM power system is better prepared for all futures envisioned in the Integrated System Plan (ISP).

This operational conditions summary:

- Summarises the journey to date for the Engineering Framework and how the framework links with ongoing Energy Security Board (ESB) and Australian Energy Market Commission (AEMC) reform processes.
- Explains the purpose of the Engineering Framework operational conditions.
- Consolidates stakeholder feedback on the draft operational conditions developed throughout April to June 2021.
- Summarises the operational conditions selected to be used in the next stage of the Engineering Framework (gaps and opportunities).
- Presents a preliminary view of the future stages in the Engineering Framework process and how stakeholders can get involved.

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Stakeholder engagement

Stakeholder engagement | Journey so far

March 2021

March 2021 report[1]

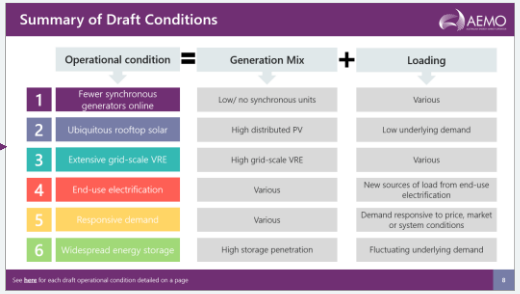
- Developed following the publication of an Engineering Framework information pack[2] in December 2020 and strong industry support in early discussions and an industry workshop in February 2021.
- Introduced the concept of operational conditions as one of three Engineering Framework objectives.
- Demonstrated the need to develop operational conditions with industry.

April 2021

All industry workshop

- Included further context and discussion on initial operational conditions, with over 100 participants.
- A majority of participants said they would like AEMO to develop draft conditions for further discussion.
- A recording[3] of the workshop and the slides[4] presented are available on AEMO's website.

June 2021



Operational conditions workshops

- Two workshops held, including representatives from network service providers, market bodies participants, industry bodies, and research institutes.
- Discussion of six draft operational conditions produced by AEMO, leading to the development of this summary document.
- For workshop feedback, see the key stakeholder insights page.

Industry achievements since March 2021

The March 2021 report[1] illustrated the work underway across AEMO and the energy industry, including progressing the recommended actions from the Renewable Integration Study[5].

In parallel with developing out the Engineering Framework, significant progress has been made by industry since March in several priority areas. For example:

- Continued progress across industry to roll out primary frequency response (PFR)[6] on the NEM generation fleet, alongside the AEMC's consultation[7] on enduring PFR arrangements for the NEM.
- The ESB's release of a Directions Paper and Consultation Paper[8] on Post-2025 Market Design Options.
- The AEMC's publication of a draft Rule determination on the Efficient Management of System Strength on the Power System[9].

For information on how to be part of future work, see Get involved.

The Engineering Framework is built on collaboration between AEMO and the energy industry. It acknowledges other processes already underway, while promoting emerging priorities to support the NEM's transition.

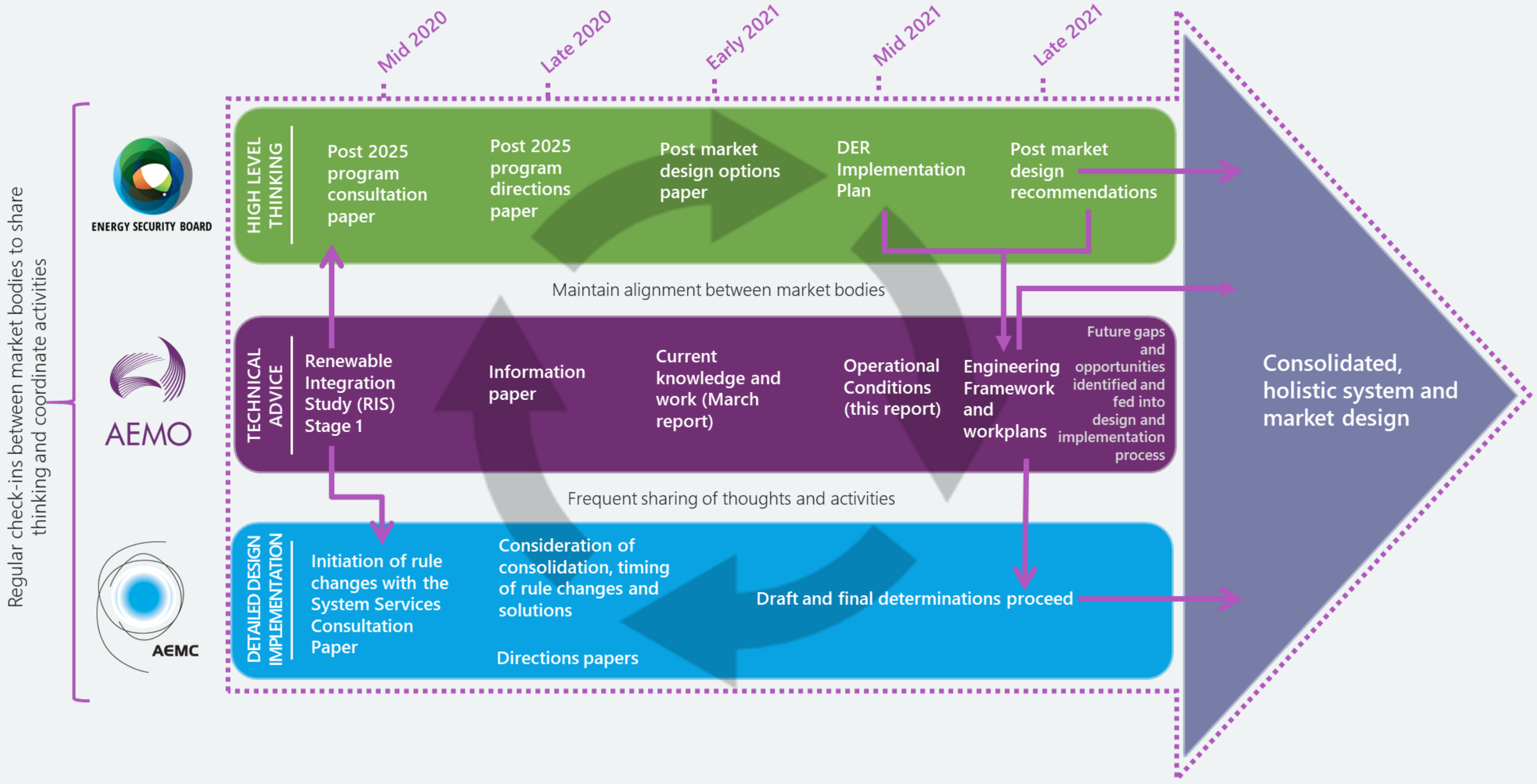
The Engineering Framework integrates, aligns and coordinates with various key industry processes.

AEMC and ESB Linkages

Figure 1 shows AEMO's revised view on linkages between the ESB, AEMC and AEMO to develop a future system design.

This highlights continued efforts as part of the Engineering Framework to feed into the work of other market bodies. Further, it emphasises that the work activities being progressed by the ESB, AEMC and AEMO are interdependent and complementary.

Figure 1: Revised view of coordination between market bodies on future system design



Adapted from AEMC, System services rule changes, Consultation paper, July 2020, p5.
Updated version from figure originally presented in Engineering Framework Information Pack, p8.

Introduction

Introduction | Context

Increasing decarbonisation and decentralisation of generation sources is causing the biggest transformation in the history of the NEM power system.

Most critical transition developments will occur in the next five to 10 years, with the NEM expected to reach up to 100% instantaneous renewable penetration by 2025 if current trends continue. This requires a significant overhaul of current rules, processes, and operational techniques. Through the Engineering Framework, AEMO will work with industry to facilitate an orderly transition towards this future.

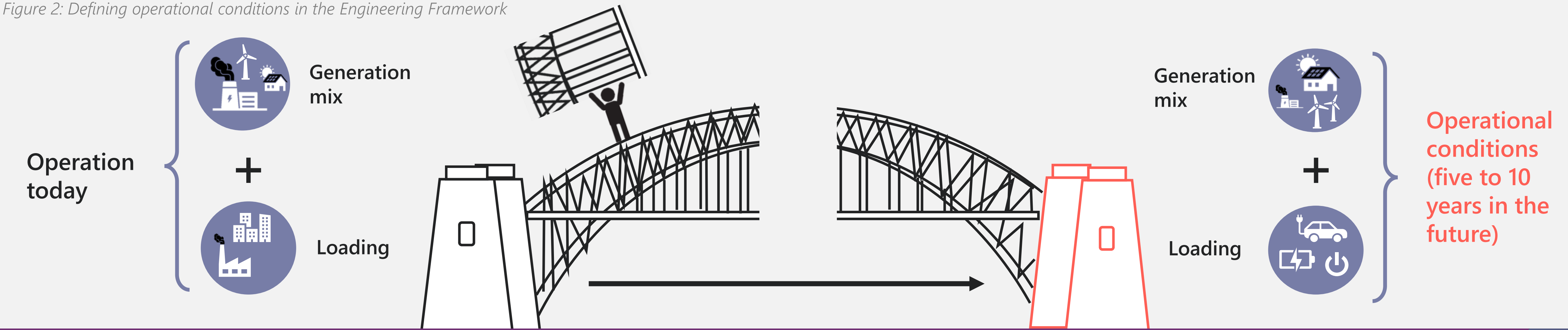
As part of the Engineering Framework, AEMO developed the concept of **operational conditions**. This was presented in the March 2021 report[1] and defined as **a future generation mix and loading combination**.

The chosen **operational conditions are a tool to help guide preparations for future power system operation**. They are future periods which will necessitate new approaches to managing the secure and efficient operation of the power system. In combination, the operational conditions should cover the full spectrum of critical changes that need to be prepared for. AEMO believes that if all conditions are satisfied, the NEM will be well advanced in its preparedness to operate under all plausible future scenarios envisioned in the ISP[10].

This publication presents a set of six operational conditions that **represent the key transitions over the next five to 10 years**. These were developed in consultation with stakeholders.

The next step of the Engineering Framework uses the selected operational conditions to identify missing activities (either gaps or opportunities) needed to enable a secure and efficient power system transition. This process is grounded by the industry work in progress and focus areas explored in the March 2021 report[1].

Figure 2: Defining operational conditions in the Engineering Framework



Introduction | Objective

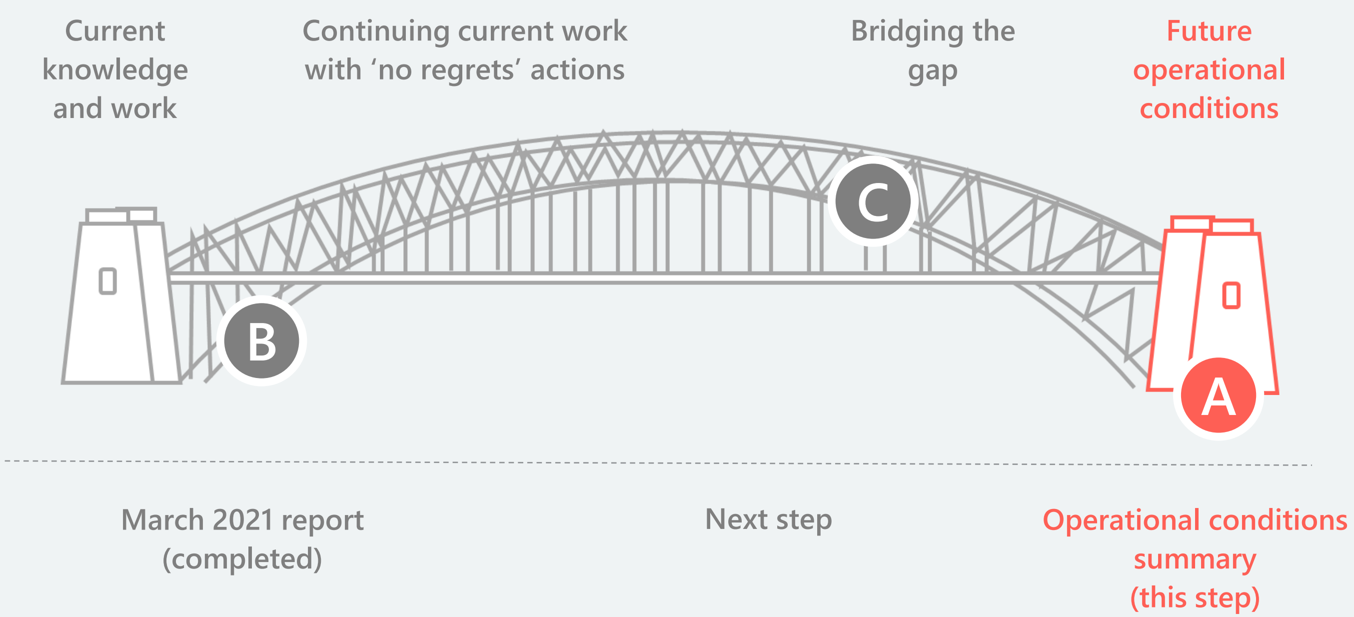
This operational conditions summary focuses on objective A of the NEM Engineering Framework:

A This step – determine **future operational conditions** for the NEM power system with industry.

B Completed – consolidate a common view of the **current work underway across industry**.

C Next step – consult with industry to help **bridge the gap** between current work and future operational conditions.

Figure 3: Engineering Framework objectives



Introduction | The transitional challenge

The energy transition will dramatically change the conditions in which AEMO manages power system security. As the NEM is expected to reach up to 100% instantaneous renewable penetration by 2025 if current trends continue, new operational conditions will emerge.

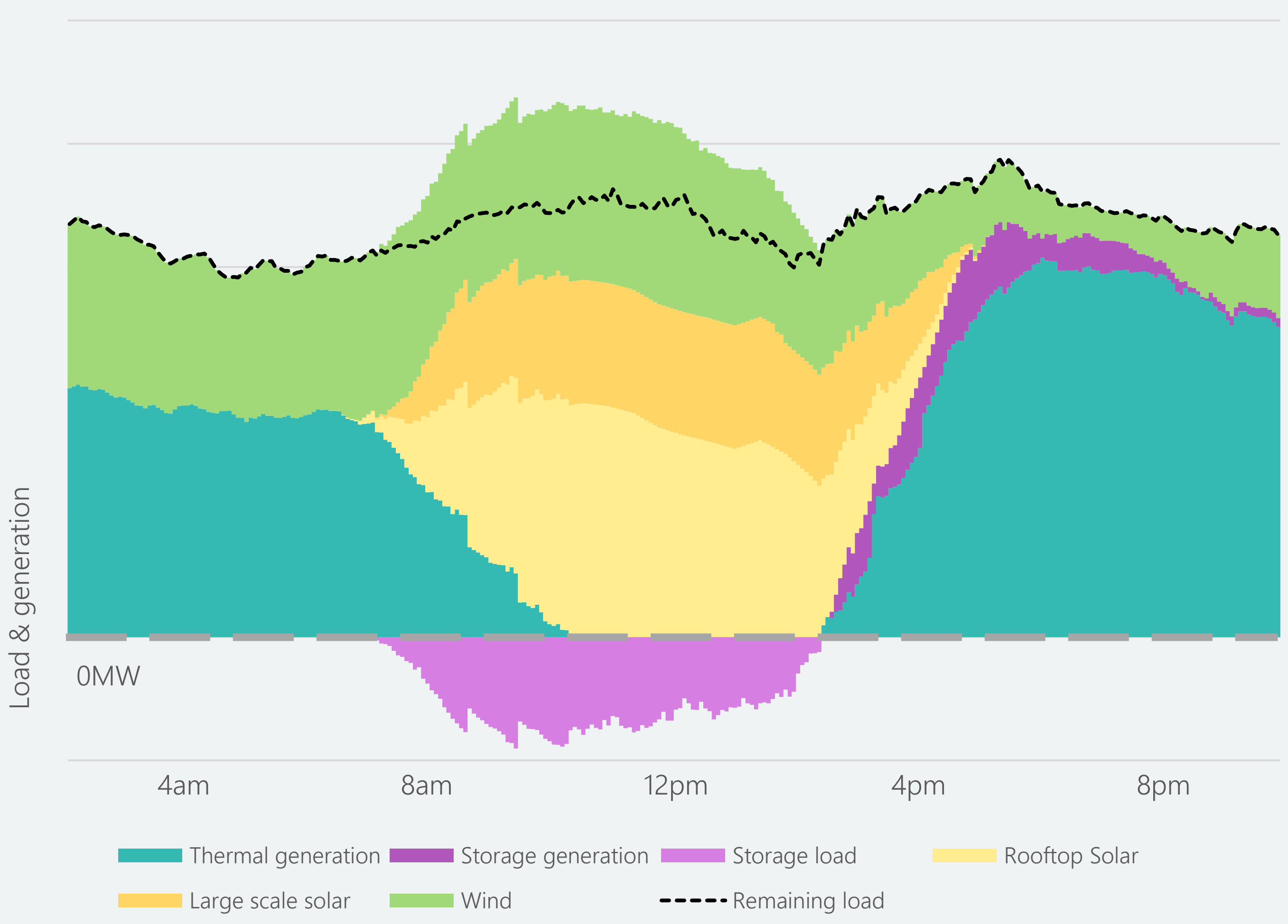
As the transition progresses, the NEM will increasingly rely on variable, inverter based generation sources. In turn this will lead to intra-day shifting between a mostly inverter-based system during daytime and a mostly synchronous one during the evening and night time. Each of these periods brings a unique set of challenges and opportunities in operating the power system.

Figure 4 shows a possible day of future power system operation:

- **Daytime period** – high variable renewable energy (VRE) generation, with storage utilising excess generation. Thermal generation is displaced by VRE and all thermal generators shut down over the daytime. Over this period, operators must manage minimum demands, headroom for frequency control, inertia, and system strength.
- **Evening and night time period** – VRE generation is much lower, with storage and thermal plants turning on to cover the change. Over this period, operators must manage fleet ramping capability and energy storage levels.

The power system must be able to operate securely and efficiently under both of these periods, and during the transition between these periods. The operational conditions developed with industry are designed to capture these cases from the first time they occur in the NEM. This complements the year-by-year scenarios developed in the ISP, allowing AEMO and industry to identify and act on gaps and opportunities throughout the energy transition.

Figure 4: Shifting generation mix in a region over during a possible day in the next five to 10 years



Operational conditions

Operational conditions | Overview

Figure 5 provides a high level overview of the operational conditions developed following industry engagements[11] in April-June 2021. A summary of stakeholder feedback from the June workshops is shown on the key stakeholder insights page.

Generation mix and loading are fundamental to each operational condition. The individual conditions in the following pages provide initial thoughts on sensitivities, gaps and opportunities, which will be expanded upon in future engagements.

The operational conditions have overlap in their coverage (for example, if there are fewer synchronous generators online, it could be due to the realisation of other operational conditions). Despite these overlaps, each operational condition will necessitate different changes to current practices. As an example, fewer synchronous generators online focuses on the reduction of services provided by synchronous generators and how to replace them, whereas extensive grid-scale VRE focuses on managing variability, uncertainty and opportunities for new technologies.

Overarching risks

Overarching risks challenge system security under any operational condition. They will be used to test the timing and extent of changes required to securely operate the future electricity system in the gaps and opportunities stage. Key overarching risks identified with stakeholders include:

- Different network configurations, such as separation events, ongoing network maintenance, and periodic planned outages.
- Weather events, such as extreme heat, wind, or solar droughts, and solar eclipses.
- Cyber attacks.

Figure 5: Overview of operational conditions

	Operational condition	= Generation mix	+ Loading
1	Fewer synchronous generators online	Low/no synchronous generators online	Low or high demand
2	Ubiquitous rooftop solar	High distributed photovoltaics (DPV)	Low underlying demand
3	Extensive grid-scale VRE	High grid-scale VRE	Low or high demand
4	Structural demand shifts	Various	End-use electrification and industrial shifts
5	Responsive demand	Various	Active demand side
6	Widespread energy storage	High on-demand storage penetration	Fluctuating underlying demand

Operational condition 1 – Fewer synchronous generators online

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Operational condition

Generation mix

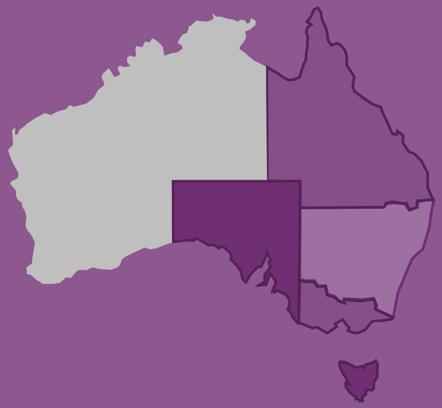
- Low/no synchronous generators online.

Load

- Low or high demand.

Location of condition

Progressing rapidly in South Australia and Tasmania. Starting to emerge in Queensland and Victoria, then New South Wales to follow.



Sensitivities

- Speed of changes in the fuel mix, such as rapid reduction in coal units online.
- Transition to and from this condition over a daily and/or seasonal cycle.
- Reserve margins for all system services.

Initial insights for 'gaps and opportunities' stage

Operational challenges

Note – increasing DPV or more grid-scale VRE are resulting in a reduction in synchronous generation. Operational conditions 2 and 3 deal with the challenges of adding more of these generation types.

Operational challenges associated with transitioning from current level to low/no synchronous generators online:

- **System strength, voltage control and frequency management** – lower system strength, static and dynamic reactive power, inertia, PFR, and frequency control ancillary services (FCAS) as synchronous generators go offline.
- **System restoration** – fewer options for black start units as synchronous generators retire, unless other black start sources are acquired.

Requirements for transition

- Timely development, procurement, and deployment of technology to replace and enhance system security services.
- Planning for emerging challenges and processes to build operational experience and address issues ahead of time (see operational condition 3).
- Transparent modelling tools that better reflect technology performance and capability (including its limitations).
- Better defined system service requirements that change and align as fewer synchronous units operate, to ensure they continue to benefit the majority of power system generators and loads.
- Geographic spread of system services (for example, system strength, narrow-band PFR).

Operational condition 2 – Ubiquitous rooftop solar

Operational condition

Generation mix

- High DPV.

Load

- Low underlying demand.

Location of condition

South Australia first, followed by Queensland and Victoria, then other NEM regions, followed by NEM-wide. All regions experiencing some localised distribution network challenges today.

Sensitivities

- Speed and trajectory of DPV uptake.
- Speed of storage and load flexibility emerging in the daytime (see operational condition 5).
- Timing of potential large industrial load closures (see operational condition 4).
- Effectiveness of updated AS/NZS4777.2:2020 in reducing unintended DPV disconnection in disturbances.

Initial insights for 'gaps and opportunities' stage

Operational challenges

Increasing DPV in the daytime is reducing synchronous generators online (see operational condition 1). The specific challenges of increasing levels of DPV during the day are:

- **Resource adequacy** – most DPV is not controllable even under extreme conditions and is subject to output variability (for example, cloud cover).
- **Frequency** – reduced effectiveness of emergency mechanisms in the daytime.
- **Voltage control** – increasingly wide voltage ranges within the distribution network.
- **System restoration** – availability of stable load blocks, black start units, and other system restart ancillary services (SRAS).
- **Resilience** – increasing generation in reverse power flow, and reduced ability for planned network maintenance outages.
- **Control room and support** – credible contingencies could become larger with DPV disconnection in response to disturbances.

Requirements for transition

- System security requirements established for operation with high DPV, such as emergency curtailment and under frequency load shedding (UFLS) schemes that are independent of DPV.
- Opportunities for load and storage flexibility as a 'solar soak' (see operational conditions 5 and 6).
- Technical performance standards commensurate with DPV's aggregate contribution and compliance arrangements.
- Distributed network service providers' (DNSPs') system security responsibilities in a high distributed energy resources (DER) world defined; DNSPs able to dynamically orchestrate DER exports.
- Social licence from consumers for last resort curtailment and active management of DPV.
- Consumer preferences (such as desire for independence) and participation incentives better aligned with system needs, without having worse impacts for all consumers.

Operational condition 3 – Extensive grid-scale VRE

Operational condition

Generation mix

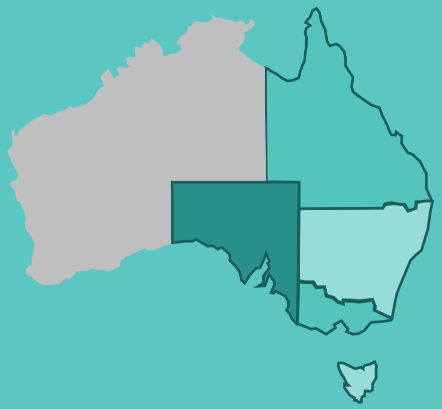
- High grid-scale VRE.

Load

- Low or high demand.

Location of condition

South Australia first, followed by Queensland and Victoria, then other NEM regions, followed by NEM-wide.



Sensitivities

- Different levels and types of VRE generation.
- Grid-following versus grid-forming inverters.
- Late delivery of transmission augmentation.
- Constraints reducing VRE generation.
- VRE ramp uncertainty.

Initial insights for 'gaps and opportunities' stage

Operational challenges

- **Resource adequacy** – managing the supply-demand balance on inter- and intra-day resolutions, due to higher variability and uncertainty (such as fast-moving cloud cover, wind fronts, wind drought/extended cloud).
- **Voltage control** – increasing transfer across long distances, requiring additional reactive support and fast reactive response.
- **System restoration** – availability of black start capable units and other SRAS.
- **Frequency management** – low FCAS raise availability if VRE fleet operates with little headroom.
- **Control room and support** – credible contingencies could become larger as a result of unforecast changes in VRE generation.
- **Resilience** – increasing reliance on interconnectors for transfer of security services, reducing opportunities for network maintenance.

Requirements for transition

- Incentivisation of the VRE fleet to provide expanded system services capabilities (such as PFR, system strength, inertia).
- Improvements and wider access to data forecasting models that consider a wider band of scenarios.
- Development of operational tools and processes by AEMO or network service providers (NSPs) to monitor VRE performance in real time (such as monitoring ramp margins, real-time conformance, or actuals to forecasts).
- Development of sufficient operational experience at higher VRE levels.
- Transparency and improvements in defining contingency events with high VRE, that is, weather-induced variability.
- Coordination of generation development and transmission planning by location and capability (for example, renewable energy zone [REZ] development).

Operational condition 4 – Structural demand shifts

Operational condition

Generation mix

- Various.

Load

- End-use electrification and industrial shifts.
  - New sources of load from sector coupling (such as hydrogen), consumers (for example, electric vehicles [EVs]) or new load blocks (such as data centres).
  - Reduction in load, from large industrial loads closure or consumer grid defection.

Location of condition

Unknown. Affected by state-based policy.

Sensitivities

- Government policy and technology uptake curves.
- VRE generation mix (for example, high solar – both DPV and grid-scale, incentivising daytime demand).
- Speed of demand shifts.

Initial insights for 'gaps and opportunities' stage

Operational challenges

- **Resource adequacy** – available flexibility to manage potential large, correlated changes in load and energy to meet high load demand (such as EV charging before a long weekend); adapting to longer-term developments of new loads such as appliances and new industries.
- **Voltage control** – voltage swings associated with increasing impact on load profile and power quality. Movement of loads (such as EVs) will dynamically change local attributes.
- **Frequency management** – risk of load disconnection during disturbances, with potentially large aggregate impact if not managed, exacerbated with movement of loads (such as EVs).
- **System restoration** – lack of visibility of behaviour impacting availability of stable load blocks.

Requirements for transition

- Control room tools and planning processes better reflecting the dynamic behaviour of the changing load base and impacts of load swings (such as intra-day).
- Improved visibility of new loads, to be used to develop more accurate forecasting of loads.
- Technical performance standards reflective of the increasing system impact of these loads.
- Interoperability requirements to enable these loads to be managed and responsive to system conditions (see operational condition 5).
- Technical specification of the services that emerging loads could provide, and associated grid connection requirements.
- Pathways for participation and incentives aligned with power system needs. Creating opportunities to 'soak up' excess VRE and DPV generation (see operational conditions 2 and 3).

Operational condition 5 – Responsive demand

Operational condition

Generation mix

- Various.
  - Includes responsive DER generation and storage.

Load

- Active demand side.
  - Enabled by aggregation and energy management technologies

Location of condition

Unknown. Affected by state-based policy.

Sensitivities

- Responsive to market (price) versus system conditions.
- Autonomous versus managed response.
- Generation mix (flexible fleet versus baseload).

Initial insights for 'gaps and opportunities' stage

Operational challenges

- **Resource adequacy** – higher demand for system flexibility, due to correlated, aggregated response to a price signal (such as negative wholesale prices) or weather (for example, cloud cover).
- **Frequency and voltage** – fast, coordinated active power response across a geographically dispersed aggregation causing swings in power flow impacting local stability.

Requirements for transition

- Incentives for responsive demand aligned with system needs. This could include incentives for distributed storage or demand response to increase demand in the middle of the day, during periods of minimum demand and reduce demand during evening peaks.
- System integration roles and responsibilities defined for coordination between DNSPs, transmission network service providers (TNSPs), AEMO, aggregators, and original equipment manufacturers (OEMs).
- DNSPs able to orchestrate DER while actively managing network operation (such as dynamic operating envelopes).
- Control room tools (NSPs and AEMO) and models for system analysis reflecting behaviour of responsive load in steady state and dynamic power system conditions.
- Performance and capability defined for devices responding to remote signals.

Operational condition 6 – Widespread energy storage

Operational condition

Generation mix

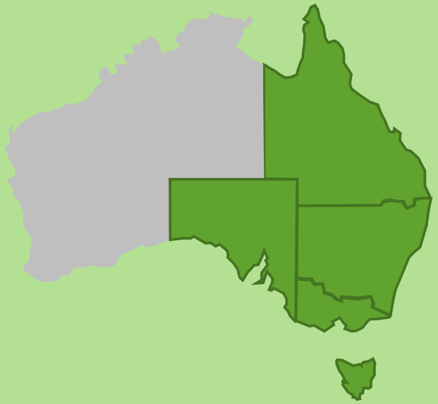
- High on-demand storage penetration.

Load

- Fluctuating underlying demand
  - Storage acting as both load and generation.

Location of condition

All states proposing large storage projects. Distributed storage projected to grow NEM- wide.



Sensitivities

- Large ramp event.
- Grid-scale versus distributed storage.
- Short duration versus long duration storage.
- Grid-forming versus grid-following batteries.
- Different energy storage technologies (including batteries, pumped hydro, solar thermal, and hydrogen).
- Stand-alone storage facilities versus hybrid generation and storage facilities.

Initial insights for 'gaps and opportunities' stage

Operational challenges

- **Resource adequacy** – supply of available energy to meet demand is dependent on state of charge and storage depth/duration.
- **System strength** – contribution to system strength would depend on storage technology, including grid-forming/grid-following properties of inverter-based storage (such as batteries).
- **Performance standards** – performance and data issues from home battery systems.

Requirements for transition

- Development of value/revenue streams for non-energy services that can be provided by storage technologies, and will impact the way storage operates (state of charge).
- Early facilitation of expanded capabilities in relevant new storage technologies (such as grid-forming capability). This includes additional planning, research, and modelling.
- Coordinated policy that supports stable investment signals for flexible capability.
- Improved real-time system monitoring and analysis models. These should integrate battery attributes and behaviours, such as state of charge and cycling (inter- and intra-day).
- Changes to reserve management systems would help detect and communicate intra-day supply inadequacies.
- Development of a diverse mix of storage technologies, that offer different capabilities at a technical and commercial level.

Operational conditions | Key stakeholder insights

Overall feedback

Participants responded positively to the draft operational conditions in the June workshops. Participants did not bring forward any new conditions, but worked on refining the draft operational conditions.

Figure 6 summarises the key stakeholder insights that informed each operational condition.

No other major refinements to the draft conditions were suggested, indicating that the six operational conditions cover an appropriate breadth of power system outcomes to draw out fit-for-purpose gaps and opportunities in the next stage of the Engineering Framework.

Stakeholders brought forward some key themes which will be included in the gaps and opportunities stage, including additional consideration of:

- Ensuring ongoing effectiveness of protection systems.
- Planning a system that allows for ongoing network maintenance and periodic planned outages.

Figure 6: Key stakeholder insights for each operational condition

Fewer synchronous generators online

- Highest priority condition.
- Challenges posed addressed in the near term.
- Zero inertia grids needs defining.

Structural demand shift

- Feedback loop for other operational conditions as implementation may amplify or assist risk.
- Include sudden closures or defection off-grid.

Ubiquitous rooftop solar

- Highly relevant condition.
- Consumers are pivotal to this transition.
- Visibility, compliance, activating DER, and aligning incentives are all priorities.

Responsive demand

- Activation provides opportunities for other technologies.
- Strong collaboration with networks and new technology providers is critical.

Extensive grid-scale VRE

- VRE build should be aligned with declining synchronous generators online.
- Focus needed on service incentivisation and capability.
- Real-time forecasting is key.

Widespread energy storage

- Offers benefits if harnessed and valued.
- Diverse storage technologies, each with unique technical and commercial capabilities.

Next steps

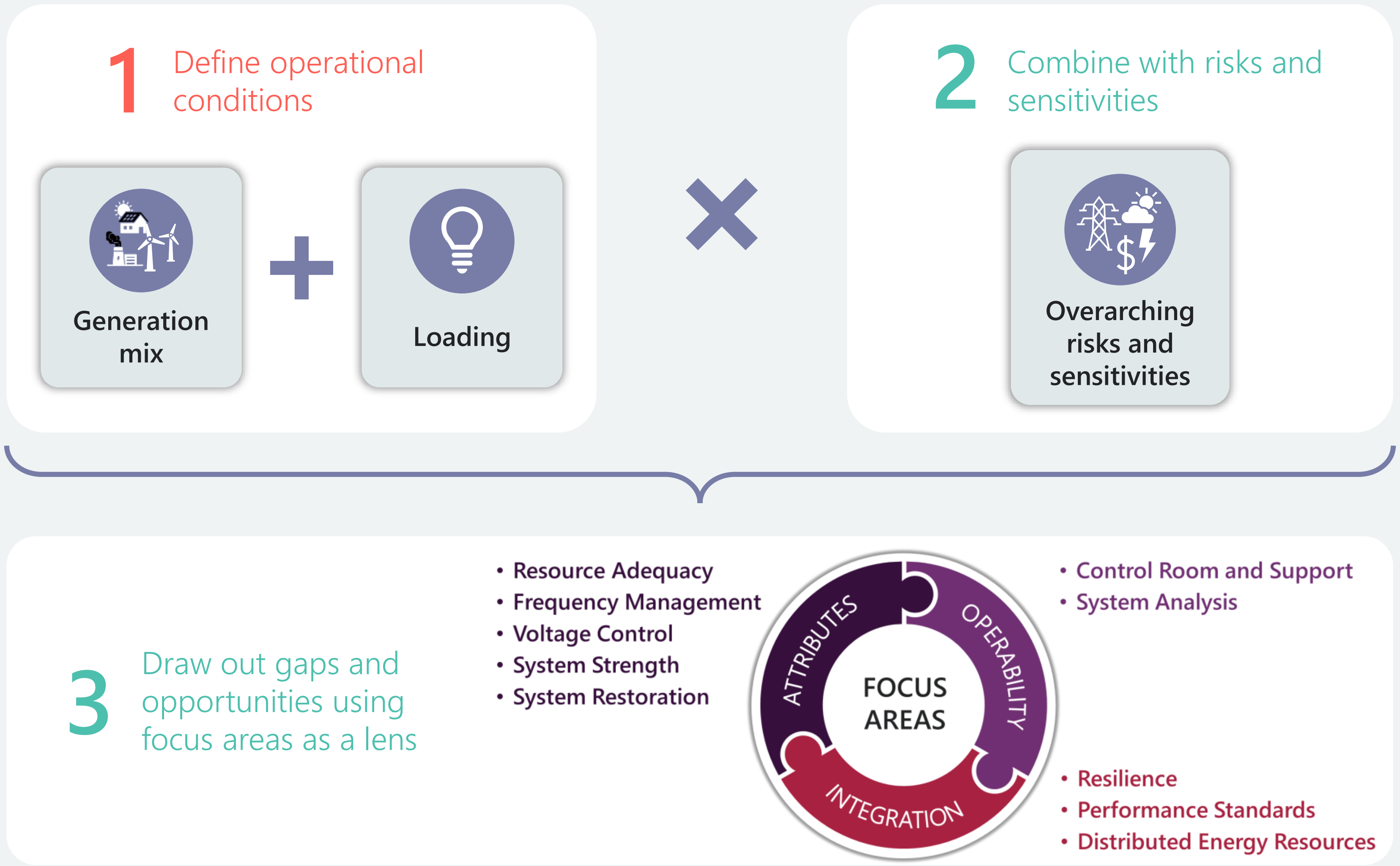
Next steps | Determining gaps and opportunities

The next step of the Engineering Framework involves using the selected operational conditions to identify missing activities (either gaps or opportunities) needed to help enable a secure and efficient power system transition (see Figure 3, Objective C). This process is grounded by the industry work in progress and focus areas explored in the March 2021 report[8].

First, key **overarching risks and sensitivities** will be applied to the **operational conditions** to ensure they have broad coverage. Initial examples of overarching risks and sensitivities are provided in the operational conditions overview.

Next, the Engineering Framework focus areas will be applied systematically to identify **gaps and opportunities** that arise from each operational condition (in combination with overarching risks and sensitivities).

Figure 7: Defining and using operational conditions



Next steps | Bridging the gap

Figure 8: Indicative future activities of the Engineering Framework

Operational conditions (this publication)

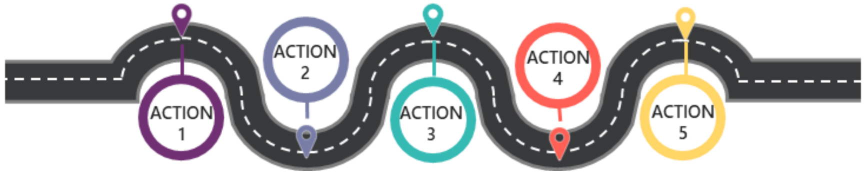
Defines future generation mix and loading combinations for the NEM.

Gaps/opportunities

Working with stakeholders, gaps and opportunities are identified by operational condition and focus area, with risks and sensitivities applied.

Action roadmaps

Collaboration with stakeholders to identify priority actions that address gaps and opportunities to achieve operational conditions. Actions then sequenced and aligned with existing workplans and initiatives.



Implementation Workplans

Collaboration with stakeholders to integrate, align, and coordinate prioritised actions across a variety of industry workplans, both existing and new. These workplans are set based on complex regulatory and commercial frameworks, and will in many cases include activities beyond those identified by the Engineering Framework alone. The Engineering Framework will initiate additional workplans where priority actions are not covered elsewhere.

Application of Advanced Grid-scale Inverters in the NEM

To be identified

Engineering Framework identified workplans

Integrate, align and coordinate

AUSTRALIAN ENERGY REGULATOR
DEIP
Energy Networks Australia
AEMO
ENERGY SECURITY BOARD
AEMC
ARENA Australian Government Australian Renewable Energy Agency

+ other coordinating efforts

Existing workplans and initiatives

Monitor actions

Monitor progress towards completion of identified priority actions, and overall preparedness for each operational condition. Through progress reports, highlight any ongoing gaps that may compromise achieving the operational conditions.

Next steps | Get involved

Figure 9: Indicative timeline of activities

July 2021
Operational conditions (this publication)

August-October 2021
Gaps and opportunities identified

November - December 2021
Action roadmaps sequenced to satisfy operational conditions

Early 2022
Development of implementation workplans for priority actions

Ongoing
Monitor and provide periodic updates to track progress

The Engineering Framework interacts with other processes

Jul 2021
- Advanced Inverter White Paper

Aug 2021
- PFR Advice
- 2021 Electricity Statement of Opportunities (ESOO)

Sept 2021

Oct-Dec 2021
- 2021 Network Support and Control Ancillary Services (NSCAS) Review

Dec 2021
- 2021 System Strength and Inertia Report
- Draft 2022 ISP

The key to developing and prioritising critical gaps and opportunities is extensive consultation across the energy industry.

Stakeholders gave AEMO initial feedback on gaps and opportunities for each operational condition during the June 2021 workshops, as shown in the individual conditions. AEMO will use this feedback to create a set of draft gaps and opportunities for each focus area in July and August 2021.

Next, AEMO plans targeted stakeholder discussions from August to October 2021 to further develop the set of draft gaps and opportunities, and to identify priority workplans early.

AEMO will be soon be reaching out to stakeholders to commence the gaps and opportunities discussion. **Please get in touch with AEMO or sign up to our mailing list at** FutureEnergy@aemo.com.au.

Acronyms and links

Acronyms

Acronym	Name in full
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
DER	Distributed energy resources
DNSP	Distribution network service provider
DPV	Distributed photovoltaic
ESB	Energy Security Board
ESOO	Electricity Statement of Opportunities
EV	Electric vehicle
FCAS	Frequency control ancillary services
ISP	Integrated System Plan

Acronym	Name in full
NEM	National Electricity Market
NSCAS	Network Support and Control Ancillary Services
NSP	Network Service Provider
OEM	Original Equipment Manufacturer
PFR	Primary Frequency Response
REZ	Renewable Energy Zone
SRAS	System Restart Ancillary Service
TNSP	Transmission Network Service Provider
UFLS	Under Frequency Load Shedding
VRE	Variable Renewable Energy

Index of links

1. AEMO, Engineering Framework, March 2021 Report, available at https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-march-2021-report.pdf?la=en&hash=3B1283D31B542115CC56E0ECCDFB3D69

2. AEMO, Engineering Framework Information Pack, December 2020, available at https://aemo.com.au/-/media/files/initiatives/engineering-framework/engineering-framework-information-pack.pdf?la=en

3. AEMO, Engineering Framework industry workshop recording, April 2021, available at https://aemo.com.au/-/media/images/videos/nem-engineering-framework-industry-workshop-20210413-2344-1.mp4

4. AEMO, Engineering Framework industry workshop presentation, April 2021, available at https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-industry-workshop-20210314.pdf?la=en

5. AEMO, Renewable Integration Study Stage 1 Action Progress, available at https://aemo.com.au/energy-systems/major-publications/renewable-integration-study-ris/ris-stage-1-action-progress

6. AEMO, Primary frequency response, available at https://aemo.com.au/en/initiatives/major-programs/primary-frequency-response

7. AEMC, Primary frequency response incentive arrangements, February 2021, available at https://www.aemc.gov.au/rule-changes/primary-frequency-response-incentive-arrangements

8. Energy Security Board, Post-2025 Market Design Directions Paper and Consultation Papers, available at https://esb-post2025-market-design.aemc.gov.au/reports-and-documents

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