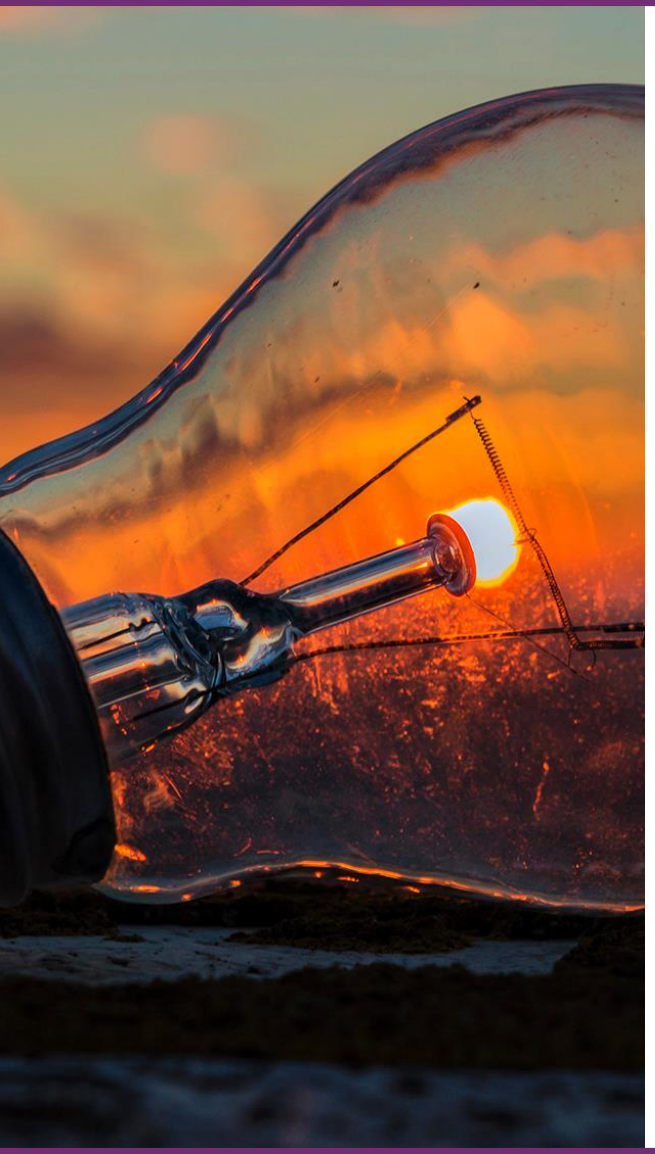
NEM power system design and engineering framework

Information pack

December 2020

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Introduction | Looking to the future



The complex system of systems that is the National Electricity Market (NEM) is changing fast, and roles, responsibilities and activities are dispersed across industry, governments and consumer groups.

We need a whole of system framework, which is based on the technical needs of the system, so together we can prioritise actions that support the interests of consumers, participants, and investors during this rapid re-engineering of the power system.

There are many wide-ranging efforts already underway, with the Australian Energy Market Operator (AEMO), the Australian Energy Market Commission (AEMC), the Australian Energy Regulator (AER), the Energy Security Board (ESB), Network Service Providers (NSPs), and wider industry driving key reforms and pursuing technological solutions to help guide this transition.

As foreshadowed in AEMO's Renewable Integration Study[1] (RIS) Stage 1 report, and the AEMC's System Services Consultation Paper[2], there is a need for a more holistic engineering framework – a map to help all stakeholders stay informed and to structure industry discussions around the prioritisation of future work, so the most urgent issues are addressed first.

The **NEM Power System Design and Engineering Framework**(Engineering Framework) is being proposed to provide this common focus and complement and support industry's ongoing efforts, while also leveraging AEMO's operational experience as the power system and market operator, and engineering design knowledge as the National Transmission Planner.

The framework will explore the range of plausible future NEM operating scenarios, and the sequence of preparatory actions that would be needed for each.

Efforts will be continuously informed by the latest learnings from power system performance, especially under unusual operating situations and disturbances.

AEMO has sought preliminary feedback on the Engineering Framework concept, engaging with market bodies, transmission and distribution NSPs, and the NEM Operations Committee (NEMOC), and had initial discussions with consumer representatives.

This feedback has been invaluable and we have incorporated a range of insights to influence this information pack and planned next steps.

In the next stage of engagement, we will seek feedback from all stakeholders via an open industry workshop in early February 2021. We are currently seeking expressions of interest for workshop participants. Feedback from this forum will contribute to the design of the Draft Engineering Framework, to be published in early March 2021.

This information paper is presented using an interactive format. To navigate through this document, click:

- Click here (bottom right of each page) to return to the title page
- Link — Click on orange text to go to another resource or jump to a linked part of this report. An index of links is provided in Section 6: Index of links.
- Click on the navigation pane to navigate to any part of the publication.
- Clicking on an image of a report will take you to that report.

The Engineering Framework | What is it?

The Engineering Framework will centre around the changing needs of the power system from an engineering design and operability perspective.

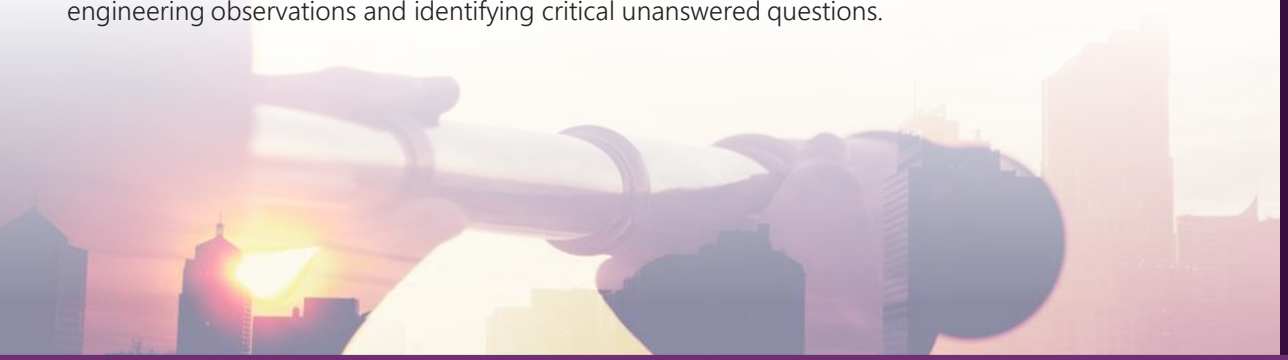
It will focus on what is needed to support the changing system over a rolling three- to four-year window, and seek to bridge the gap between today's urgent operational needs and the longer-term decision-making covered by the Integrated System Plan (ISP).

As we work together in this framework to clarify key challenges for future system operation and identify important next steps for industry and policymakers, the process will make clearer and more transparent evidence available to refine analysis and underpin more informed decisions.

AEMO is seeking to leverage the collective expertise across the NEM (and internationally) to contribute technical inputs into existing processes as well as future priorities, as we fulfill our obligations and role as the market operator in a rapidly changing NEM. Working together, the framework can help the energy industry anticipate and realise emerging opportunities, including guiding future regulatory and market reform priorities.

In managing the energy transition, no one organisation has all the answers. Different focus areas will require leadership from different areas of industry; always with the long-term interest of consumers front of mind. The Engineering Framework is not being developed to duplicate existing or planned processes, but to complement ongoing efforts.

The framework seeks to link as many relevant system design and engineering focus areas for the NEM as possible. Given this breadth, it will focus on calling out AEMO's latest system design and engineering observations and identifying critical unanswered questions.



We are developing the Engineering Framework to ...

1. Help stakeholders **stay informed** of the changing needs of the power system and the **current work underway** to meet these needs

2. **Provide transparency on emerging priorities** for technical, regulatory, and market reforms to support these changing system needs

3. Identify **where technical analysis and insights are needed** to support current and emerging reform processes and where AEMO has prioritised **technical projects** to support the changing system

4. Show how all these moving **pieces fit together**, and how stakeholders can **engage** on a variety of topics

The Engineering Framework | What are the benefits?

As an industry we strive to meet the National Electricity Objective[3] (NEO), which seeks to serve the long-term interests of consumers, and we are making progress to drive key reforms so we continue to realise this objective as the system changes.

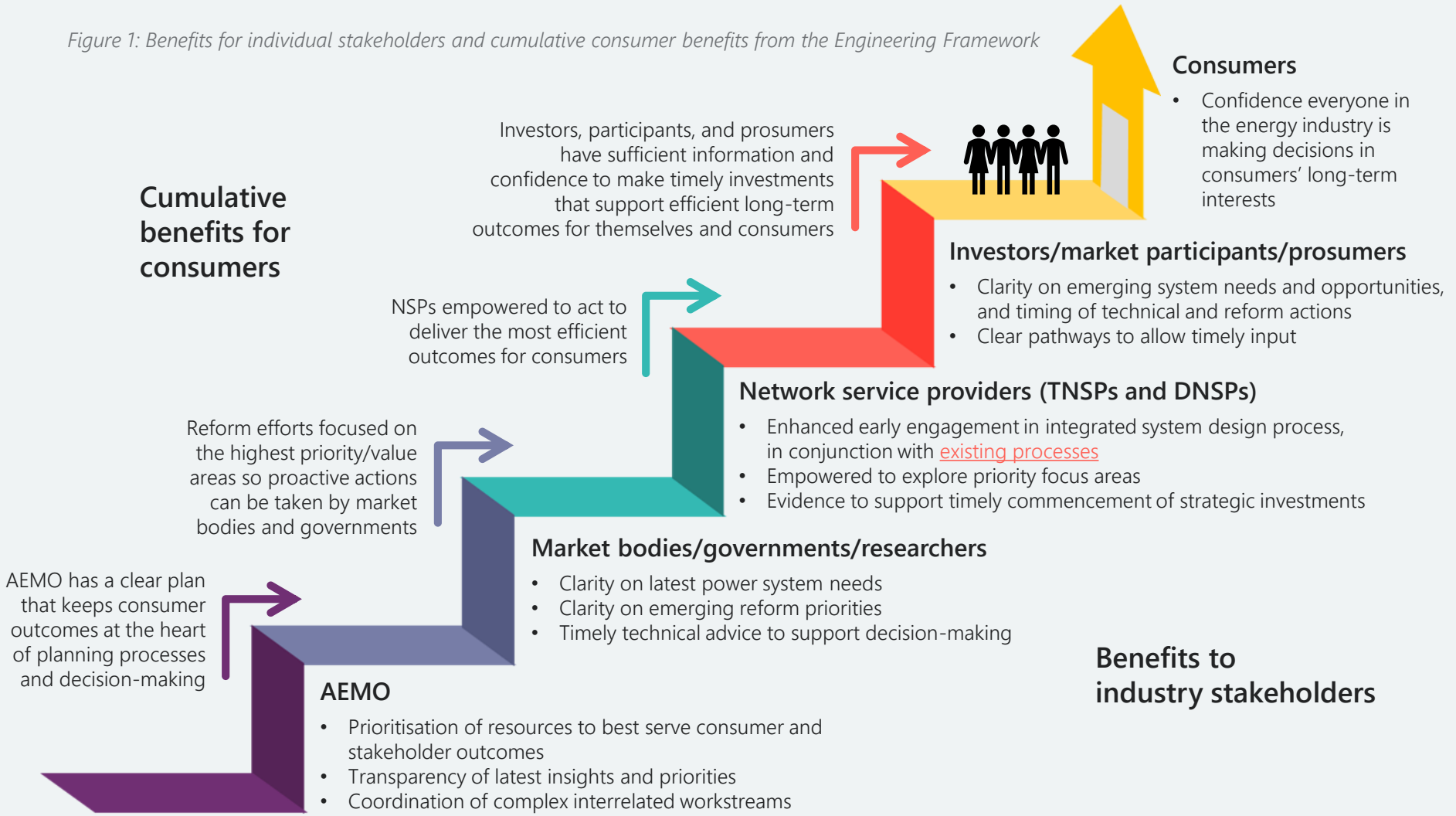
The Engineering Framework seeks to provide an up-to-date foundation regarding emerging power system design and operability needs, as a complement to existing work being progressed across industry.

As Figure 1 shows, this holistic focus can deliver a range of direct benefits across industry stakeholders, and ultimately benefit consumers.

In summary, the key benefits will be:

- More proactive solutions for emerging operational challenges.
- Clear, transparent identification of what is needed over the next 2-4 years to support system needs and desired consumer outcomes, and over 5+ years to support the longer-term decision-making of the ISP and NSP Annual Planning Reports (in conjunction with other AEMO planning publications).

Figure 1: Benefits for individual stakeholders and cumulative consumer benefits from the Engineering Framework



Stakeholder engagement | What to expect

Stakeholder engagement is at the heart of the Engineering Framework. AEMO's vision is that this Framework can support stakeholders in prioritising efforts towards a common goal.

Each industry and market body has a role to play. This framework is about combining the expertise of industry to help define challenges and drive the suite of solutions, and AEMO will engage extensively with industry throughout the drafting and publication process.

Early engagement

Before releasing this information pack, we have had initial discussions with stakeholders, including market bodies, transmission and distribution NSPs, and consumer advocates, and incorporated their valuable feedback.

Next, we are seeking expressions of interest for an all-industry virtual workshop in February 2021.

This workshop will seek to elicit early stakeholder feedback on how the Framework design could be improved, and to answer stakeholder questions.

AEMO welcomes feedback and suggestions on how to maximise contributions from across industry on problem identification and solution planning throughout this process.

Draft Engineering Framework

The Draft Engineering Framework will be published in March 2021.

It will build on the outline of this information pack and stakeholder engagement to provide draft content on:

- Updated focus areas.
- Principles of prioritisation.
- Preliminary gap analysis for future work and priority areas.
- An action-based timeline.
- An indication on how each focus area will be progressed – either via existing industry processes or the development of an action-based timeline within the framework – and notes on work already underway and linkages/interdependencies with industry processes.

The Draft Engineering Framework will be followed by a four-week consultation period and request for submissions.

Informal engagement will then continue until the Final Engineering Framework is released.

Final Engineering Framework

The final Engineering Framework is scheduled to be published in mid-2021. It will include refinements and updates based on consultation following the Draft Engineering Framework.

A living process

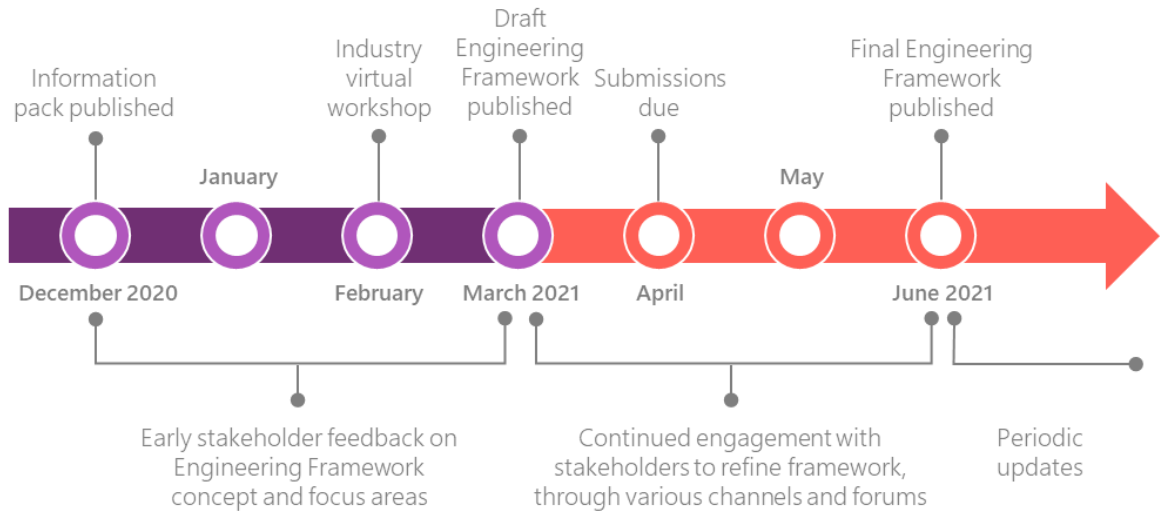
The Framework will become a 'living' process, updated periodically to document the progress of actions, new learnings and insights on system needs, and any changes in forward priorities for AEMO or industry.

Where can I find more information?

Information on the Engineering Framework and links to other related projects are available on AEMO's website[4].

For further enquiries, or to express your interest in attending a workshop on the design of the Engineering Framework, please contact FutureEnergy@aemo.com.au.

Figure 2: Indicative timeline of activities and publications



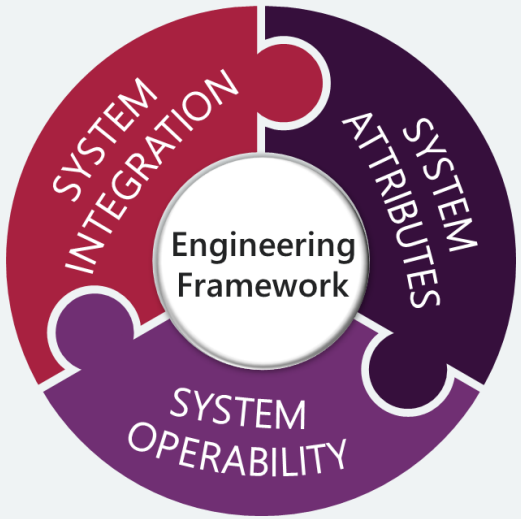
Focus areas | Defining the focus areas

AEMO currently envisages the Engineering Framework developing in 10 interconnected focus areas across three themes, as shown in Figure 3 and outlined on this page.

The proposed focus areas and themes are based on our latest understanding of priority power system needs – including study areas and actions in the RIS Stage 1[5] report – and the early stakeholder feedback we have received.

We look forward to stakeholder input on this starting point.

Figure 3: Engineering Framework themes and focus areas



- Grid Design
- Resilience
- Technology and Innovation
- Distributed Energy Resources
- Resource Adequacy
- Frequency Management
- Voltage Management
- System Restoration
- Control Room and Support
- System Analysis

Grid Design

- Network planning processes to support changing generation mix
- Coordinated planning at the transmission and distribution interface
- Customer connection processes
- Control and protection schemes
- Performance standards

Resilience

- Characteristics of resilient power systems
- Identifying resilience metrics

Technology and Innovation

- Understanding current and emerging technology capabilities and enabling innovation

Distributed Energy Resources (DER)

- Priorities to support the technical integration of DER and manage operability impacts

Resource Adequacy

- Operating reserves to manage uncertainty

Frequency Management

- Primary frequency response
- Inertia, Rate of Change of Frequency (RoCoF), and Emergency Frequency Control Schemes (EFCS)
- Fast frequency response
- Efficient and effective Frequency Control Ancillary Services (FCAS) services
- AEMO frequency management tools

Voltage Management

- Adapting approaches to system voltage control (transmission and distribution)
- System strength priorities

System Restoration

- Priority focus areas for system restoration

Control Room and Support

- Skillsets, capabilities and new functionality for secure and reliable grid operation
- Enhanced data sources to support situational awareness and analytical capability

System Analysis

- Data input quality and continuous improvement
- Fit-for-purpose power system modelling hardware and software
- Industry access to data and tools

Focus areas | Developing focus areas from work to date

Some of the proposed Engineering Framework focus areas came out of recent work on power system needs.

AEMO's Power System Requirements[6] paper provides a high level summary about the technical and operational requirements of running the NEM power system.

AEMO's RIS Stage 1[7] report was a detailed technical analysis on a subset of the requirements which were most affected by increasing penetrations of wind and solar generation.

The RIS Stage 1 report recommended 15 actions to help enable secure system operation with the projected increasing penetrations of renewable generation out to 2025. Since it was released, progress has been made on all recommended actions and some have been completed, as identified in our action update[8].

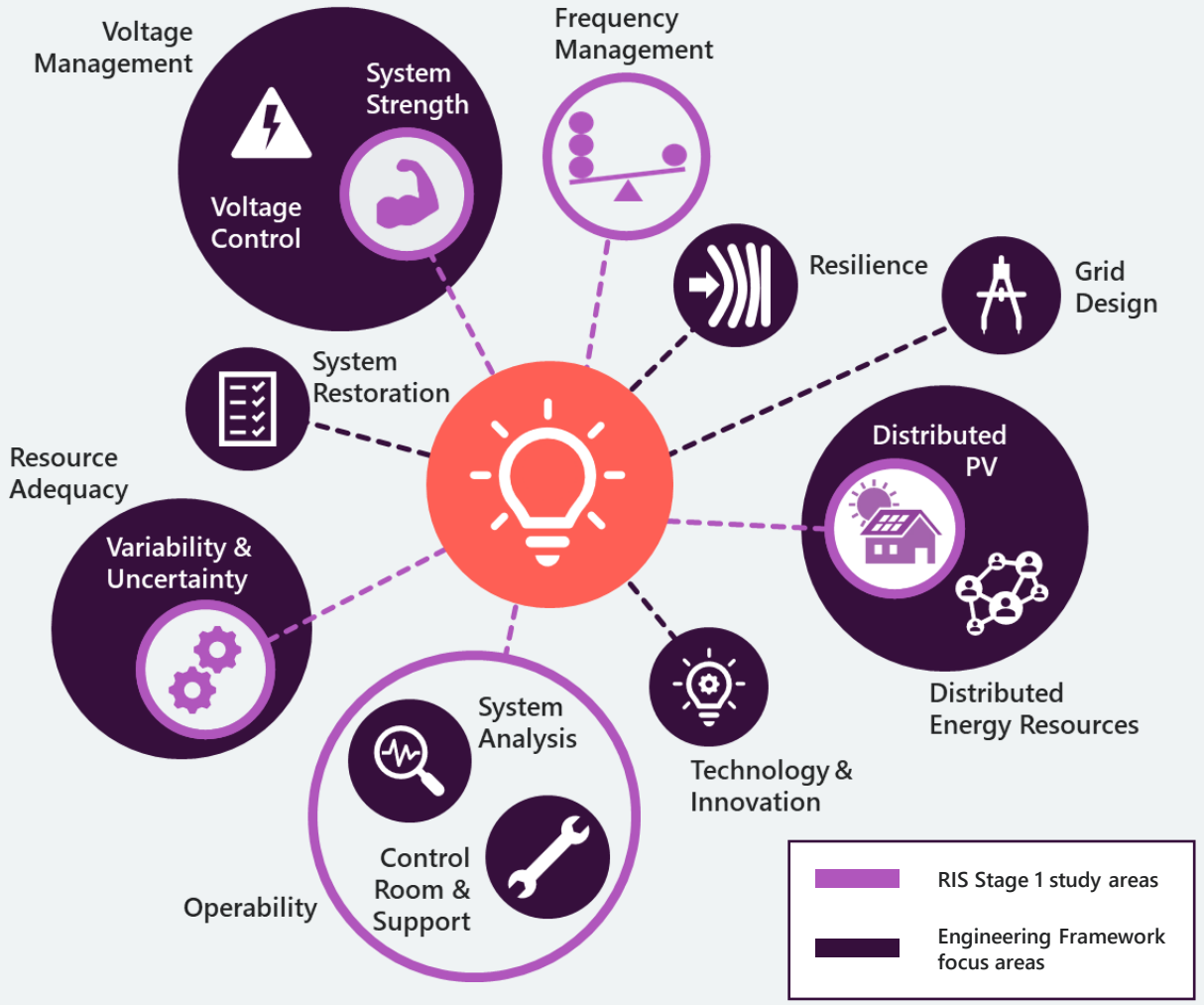
However, as foreshadowed in the RIS and in the AEMC's System Services Consultation Paper[9], work published to date does not cover all the system needs, in a holistic way.

The Engineering Framework's 10 focus areas aim to build on work so far, and work now planned or underway across industry, to take a broader perspective, beyond secure system operation, to think about whole of system integration.

Figure 4 shows how AEMO proposes incorporating the focus areas of RIS Stage 1 (**highlighted**) into the Engineering Framework focus areas:

- **Operability** and **Frequency Management** – these were key focus areas in the RIS Stage 1, and have been retained as separate focus areas.
- **Voltage management** – a summary of **system strength** challenges was included in the RIS and this area has now been expanded to include **voltage control**.
- The RIS Stage 1 included a deep dive on **variability and uncertainty**, including a discussion on operating reserves. This work will be considered further in the **resource adequacy** focus area.
- **Distributed energy resources** – a summary of the challenges and opportunities posed by the NEM's world leading **distributed PV** fleet was covered in the RIS and this focus has been broadened to cover integration of all distributed energy resources.

Figure 4: Linkages between RIS Stage 1 study areas and Engineering Framework proposed focus areas



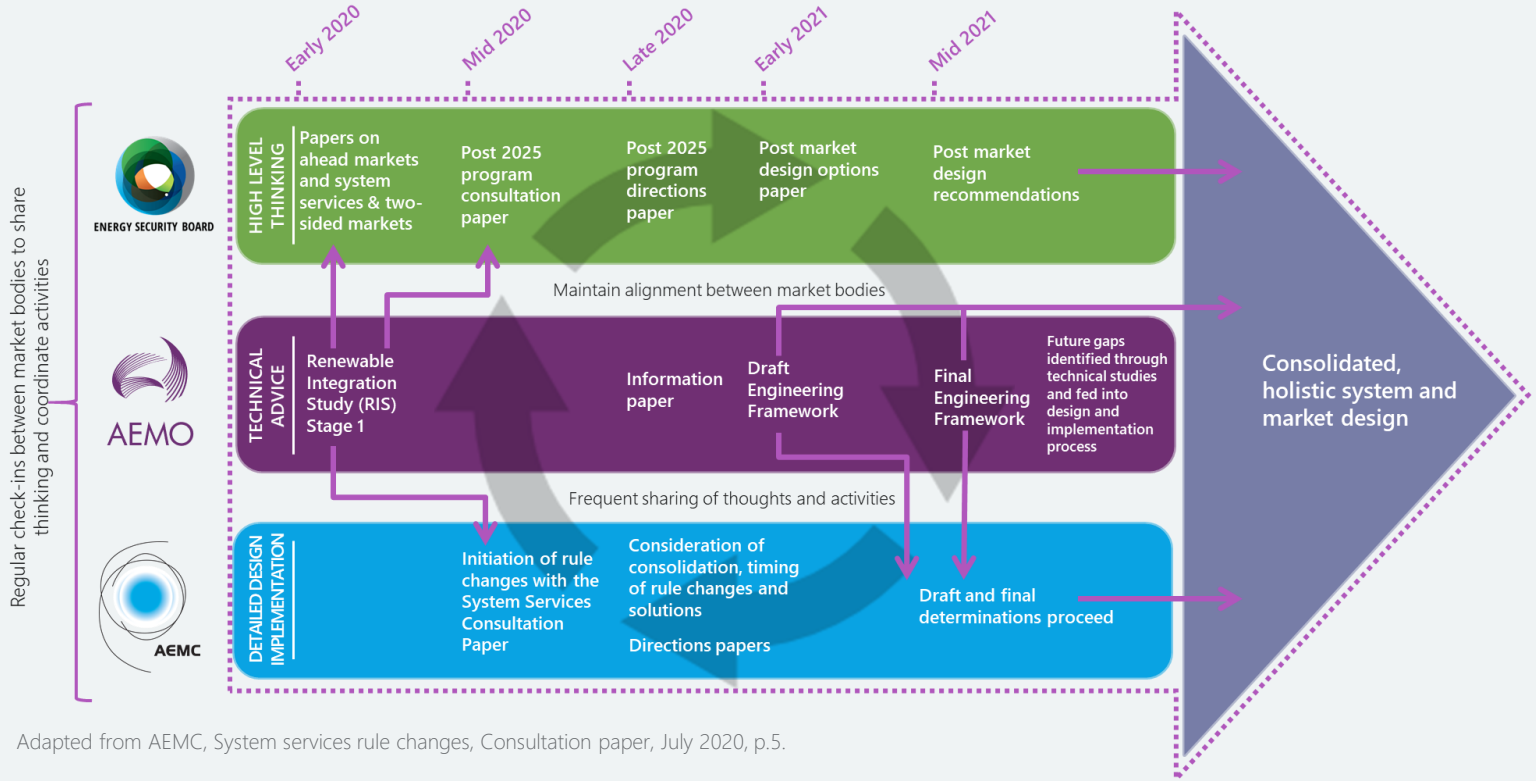
Coordination with other processes | Ongoing reform processes

Agreeing roles, responsibilities and linkages across industry will be critical to the future system being operated in a way that is secure, reliable, efficient and in the long-term interests of consumers.

This Engineering Framework is intended to:

- Be a vehicle to provide transparency to current technical work and thinking across industry around future system operability.
- Promote informed industry discussion around the prioritisation and accountability of tasks that are important to the NEM's transition.

Figure 5: Revised view of coordination between market bodies on future system design



Adapted from AEMC, System services rule changes, Consultation paper, July 2020, p.5.

AEMC and ESB linkages

Figure 5 shows AEMO's view on linkages between the ESB, AEMC and AEMO to develop a future system design. This refines how the work will be coordinated, and includes revisions that consider the latest activities and evolved thinking towards a future end-state.

The ESB, working with the other market bodies, is responsible for the post 2025 NEM reforms, while the AEMC is responsible for detailed design and implementation of the National Electricity Rules (NER) that govern the NEM, in accordance with the NEO.

In 2019 the COAG Energy Council asked the ESB to advise on a long-term, fit-for-purpose market framework to deliver a secure, reliable and lower emissions electricity system at least cost. This is being progressed through the ESB's post 2025 market design project, detailed on its dedicated website[10].

The AEMC has recently received several rule change requests[11] that relate to the ESB's program of work. These Rule Changes will be used to action recommendations arising from the ESB work program.

Figure 5 highlights how, in the current transition, we are working as an industry, building on each other's work to plan and develop market and regulatory frameworks in a way that is grounded in the latest technical advice.

The work activities being progressed by the ESB, AEMC and AEMO are interdependent and complementary. The Draft Engineering Framework will provide detailed mapping between individual projects and activities (for example, those indicated at a high level by the purple arrows).

Coordination with other processes | AEMO's planning publications

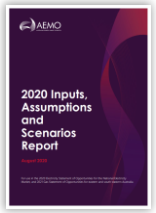
The Engineering Framework will draw inputs from a number of related AEMO reports and processes. It will also become part of a feedback loop that, in turn, informs some of these reports and processes. Figure 6 provides a high level summary of each report's objectives and the relationships between each.

Figure 6: Relationship of Engineering Framework to other AEMO reports and processes

Inputs, Assumptions and Scenarios Report (IASR)

(Annually at minimum)

Presents a range of credible future scenarios representing possible policy settings and technology uptake, which feed into AEMOs planning publications.



Publications over the planning and forecasting horizon consider the credible future scenarios in line with the published methodologies.

Electricity Statement of Opportunities (ESOO)

(Annually)

Forecast of electricity supply, demand and reliability in the NEM, including assessment against the reliability standard for a 10-year outlook. This forecast is used to inform decisions by market participants, investors and policy-makers.

Integrated System Plan (ISP)

(Biennially)

A whole of system plan for the efficient development of the power system that achieves power system needs for a planning horizon of at least 20 years for the long-term interests of the consumers of electricity.

Engineering Framework

(Periodic updates)

A map to help stakeholders stay informed of the changing technical needs of the power system, the work underway to meet these changing needs, how the different pieces fit together, and how they can engage on topics of interest.

Other key publications build off the ESOO and ISP analysis to further explore future system needs and ensure the operability and security of the grid.

System Strength Report

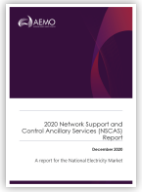
(Annually at minimum)

System strength requirements and shortfall assessments for a five-year outlook for each NEM region. If shortfalls are identified, then transmission planning bodies are responsible for ensuring services are made available.

Inertia Report

(Annually at minimum)

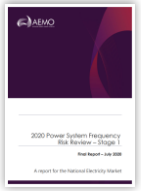
Inertia requirements and shortfall assessments for a five- year outlook for each NEM region when islanded (or at risk of islanding). If shortfalls are identified, then transmission planning bodies are responsible for ensuring services are made available.



Network Support and Control Ancillary Services (NSCAS) Review

(Annually at minimum)

Assessment of the need for NSCAS for a five-year outlook. These services are to maintain power system security and reliability. If gaps are identified, then transmission planning bodies and AEMO are responsible for ensuring services are made available.



Power System Frequency Risk Review (PSFRR)

(Biennially at minimum)

Review of potential large 'non-credible' contingency events, current emergency frequency control schemes, and protected events and options for future management of events, over a five-year outlook.

Renewable Integration Study (RIS) Stage 1

(Stand alone report)

Built off ISP analysis to define system limits under high penetrations of wind and solar out to 2025.

Index of links

1. AEMO, Renewable Integration Study, April 2020, available at: https://aemo.com.au/-/media/files/major-publications/ris/2020/renewable-integration-study-stage-1.pdf?la=en
2. AEMC, System services rule changes, Consultation paper, July 2020, available at: https://www.aemc.gov.au/sites/default/files/2020-07/System services rule changes - Consultation paper – 2 July 2020.pdf
3. National Electricity Objective, available at: https://www.aemc.gov.au/regulation/regulation
4. AEMO, Engineering Framework, December 2020, available at https://www.aemo.com.au/initiatives/major-programs/engineering-framework
5. AEMO, Renewable Integration Study, April 2020, available at: https://aemo.com.au/-/media/files/major-publications/ris/2020/renewable-integration-study-stage-1.pdf?la=en
6. AEMO, Power System Requirements, July 2020, available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power-system-requirements.pdf
7. AEMO, Renewable Integration Study, April 2020, available at: https://aemo.com.au/-/media/files/major-publications/ris/2020/renewable-integration-study-stage-1.pdf?la=en
8. AEMO, Renewable Integration Study Action Update, December 2020, available at: https://aemo.com.au/energy-systems/major-publications/renewable-integration-study-ris/ris-stage-1-action-progress
9. AEMC, System services rule changes, Consultation paper, July 2020, available at: https://www.aemc.gov.au/sites/default/files/2020-07/System services rule changes - Consultation paper – 2 July 2020.pdf
10. ESB, Post 2025 Market Design Project, available at https://esb-post2025-market-design.aemc.gov.au/
11. AEMC, Consultation begins on new ways to deliver system services as the power system evolves, News Article, July 2020, available at: https://www.aemc.gov.au/news-centre/media-releases/consultation-begins-new-ways-deliver-system-services-power-system

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