Renewable Integration Study
Frequently Asked Questions

This Frequently Asked Question document provides answers to the most commonly raised questions and themes that arose from the Renewable Integration Study (RIS) industry and one-on-one engagements during May and June 2020.

The RIS is the first stage of a multi-year plan to maintain system security in a future National Electricity Market (NEM) with a high share of renewable resources.

More information about the RIS can be found on the AEMO website, including the full RIS stage 1 report, technical appendices on Distributed PV, Managing Frequency and Variability and Uncertainty and webinars on all technical areas of the study as well as technical and non-technical overviews of the study.

This summary of questions from AEMO's consultations is intended to provide a comprehensive overview of questions and discussion topics gathered through AEMO's RIS consultations, categorised according to context, actions, technical areas of study and engagement.

Context

1. How has the RIS addressed the National Electricity Objective (NEO)?

The NEO is "to promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity with respect to:

- price, quality, safety and reliability and security of supply of electricity
- the reliability, safety and security of the national electricity system."

The RIS supports the NEO through building on the Integrated System Plan projected future scenarios to identify:

- Limits that affect how much wind and solar PV generation can operate securely at any one time.
- How close NEM regions are to these limits now, and how close they are expected to be by 2025.
- Actions that can overcome these barriers so the system can operate securely with higher penetrations of wind and solar generation.

2. How will the RIS findings feed into the ISP?

AEMO envisages a feedback loop between the RIS and the ISP. The Draft 2020 ISP established the core inputs for the RIS and the RIS supplied insights into the Final 2020 ISP. The majority of RIS Stage 1 insights were related to operational and short-term measures to ensure the security of the power system out to 2025. The RIS did not identify any insurmountable reasons why the NEM could not operate securely beyond 2025.

The Final 2020 ISP will look out to 2040, outlining a dynamic whole-of-system roadmap for nationally significant and essential investments to ensure the efficient, secure and reliable operation of the power system. The ISP will assume that some RIS recommendations are ultimately implemented, while focusing on medium and long-term solutions that go far beyond the RIS horizon.

AEMO sees this RIS report as a starting point not only to feed across into the ISP but also into the Energy Security Board's (ESB) post-2025 work and regulatory processes that the AEMC is progressing.

3. How was the instantaneous wind and solar penetration graph created?

Many different questions have been asked about the headline instantaneous penetration graph from the RIS (Figure 1, page 6). The Future Energy Systems team have created a detailed guide to understanding the RIS instantaneous penetration graphic which can be found on the RIS website.

Actions

4. Who will be responsible for delivering the recommendations identified in the RIS?

Table 1 in the RIS stage 1 report identifies where the responsibility lies for delivering each recommendation, where possible.

The actions sit with the regulatory bodies, including AEMO, AEMC and ESB, although most of these recommendations are assigned to AEMO and many relate to AEMO's internal systems and processes. For example, recommendation 4.2 commits AEMO to publish more integrated priorities in the frequency control space in 2020.

5. How will the RIS recommendations be costed?

As the RIS is a technical study, a cost benefit analysis has not yet been conducted on the actions proposed.

To the extent possible, the 2020 ISP will look to integrate the RIS recommendations into its analysis and put a cost on the actions identified in the RIS.

Further, the RIS work provides an input to several regulatory processes, including those led by the AEMC and ESB. These regulatory reforms will provide the process through which the RIS recommendations can be costed.

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6. Do the actions in the RIS overlap with or duplicate work being done elsewhere such as the AEMC and ESB?

Ensuring minimal duplication of effort was a key consideration in developing the action plan in the RIS. Many recommendations that the study highlights are already in progress, and the direction of these actions will be determined by the AEMC and the ESB. Rather than the actions duplicating effort, they instead complement each other, with the RIS forming an evidence base to inform some of these existing processes.

7. Does the RIS support particular market mechanisms in meeting its action plan?

The RIS is a technical study. It provides an evidence base that is intended to inform other regulatory processes, such as AEMC and ESB processes which are assessing different market mechanisms and reforms.

8. How will the recommendations identified in the RIS change if transition occurs faster than forecast in the ISP central scenario?

The challenges identified in the RIS are agnostic to timing. For example, the findings can be translated to the ISP Step Change scenario instead to show that the recommendations identified in the RIS increase in urgency but not in nature.

The RIS highlights that all recommendations need to start immediately, regardless of lead time, so that they can be enabled when needed. If transition occurs faster than the recommendations can be implemented, then there will be increased inefficiencies and renewables may need to be curtailed until challenges have been addressed.

Technical areas of study

Distributed PV (DPV)

9. Does the RIS underestimate the timing when DPV challenges will arise, since the NEM is currently tracking ahead of the ISP central scenario DPV projections? Will this be further exacerbated by the decrease in demand associated with Covid-19?

The RIS has taken a scenario approach to consider the plausible range of futures out to 2025. The DPV analysis considers both the ISP Central and Step Change projections – corresponding to NEM-wide projected DPV uptake in the range 12-19 GW by 2025, compared to about 9GW today. This is explained in Technical Appendix A, section A2.3.1.

AEMO's 2020 Electricity Statement of Opportunities (ESOO) forecasts, currently under development, will provide updated DER uptake forecasts and an updated view of key DPV integration challenges identified in the RIS. The updated forecasts will also consider the impact the Covid-19 pandemic is having and may continue to have on DPV installations.

10. Why is DPV generation curtailment needed? Are there other options available?

DPV generation curtailment will be needed to manage the bulk power system securely if extreme abnormal events were to occur during high DPV generation, low underlying demand periods. Extreme abnormal events occur rarely in the power system. They include when regions are electrically islanded from the NEM or at an elevated risk of separation (e.g. when bushfires are impacting inter-regional transmission paths) and unusual outage combinations.

AEMO's assessment for the South Australian region has found DPV generation curtailment to be an essential last resort "backstop" measure. This backstop capability is likely to be utilised very rarely but when it is required, the necessary change in the supply-demand balance could be very large and increasing as DPV generation continues to grow.

Following the release of the RIS Stage 1 report and AEMO's Minimum operational demand thresholds in South Australia publication, the South Australian Government announced suite of measures are being considered including harnessing load and storage (both large and aggregated, small-scale batteries) flexibility to 'soak up' DPV generation . These options will help to reduce the need for DPV generation curtailment.

However, today at least, this does not remove the need for the generation curtailment capability to be available as a last resort, due to the scale of imbalances that would need to be manage the power system securely during extreme abnormal conditions.

11. Will retrofitting of existing DPV be required as part of the RIS recommendations?

Recommendation 3.4 in the RIS recommends that AEMO *investigate the need for updating the existing DPV fleet to comply with regional generation shedding requirements*. Where possible it is the view of AEMO that retrofitting of existing systems be avoided unless absolutely necessary.

Work is currently underway to explore the extent to which retrofitting of the existing fleet may be needed in South Australia, or whether efforts to uplift the future DPV fleet through requirements on new installations alone will be sufficient.

This includes understanding the capability of the existing DPV fleet in order to better characterise behaviour in both the distribution network and bulk power system studies.

Additionally, AEMO is working with the SA Government, ElectraNet and SA Power Networks to address risks associated with the mass disconnection of DPV systems following short

duration undervoltage disturbances. This change would apply to all new installs, to minimise the need to apply changes retrospectively.

Given projected DPV uptake and the trajectory of system issues anticipated with increasing levels of passive[1] DPV generation in the power system, AEMO considers the sooner the RIS recommendations for new DPV systems are implemented, the less likely costly retrospective actions on existing systems will be necessary.

12. How can AEMO forecast DPV if it is 'invisible'?

Operationally, DPV generation forecasts are produced for each region, on a half-hourly basis using AEMO's solar forecasting system (ASEFS2), which uses a combination of inputs. This includes statistically significant samples of monitored DPV systems, satellite imagery, weather data, and installed capacity data. Information on the inputs and methods of ASEFS2 are available on the AEMO website. In future, AEMO will utilise data from the DER Register to help improve forecast DPV and battery generation.

Forward-looking DPV generation traces in AEMO's planning work, including the scenarios considered in the RIS for 2025, utilise normalised 5-minute and half-hourly timeseries for each region developed for AEMO by Solcast. These traces were then scaled using the projected installed capacity for 2025, provided by the CSIRO for the ISP. Information on this can be found in Technical Appendix C, section C7.1.

13. Has DPV modelling accounted for future uptake of batteries to support DPV?

Yes. The impact of batteries (and electric vehicle charging) are included in the underlying demand, as per the ISP Central and Step Change scenarios with installed capacities to 2025 as follows:

- Central: 12 GW DPV, 0.9 GW behind-the-meter storage – of which 0.2 GW is assumed to operating in an aggregated manner, and about 100,000 electric vehicles
- Step Change: 20 GW DPV, 4 GW behind-the-meter storage – of which 2.5 GW is assumed to operating in an aggregated manner, and close to 500,000 electric vehicles.

The full set of assumptions was developed through extensive consultation with industry. Tabulated inputs can be found in the Input and Assumptions Workbook available on AEMO's ISP website.

Frequency Control

14. How can Fast Frequency Response (FFR) benefit the system?

The RIS shows that as we progress towards lower inertia, more frequency sensitive reserve - of the current specification - is needed. Some portion of faster response can reduce the overall volume of frequency sensitive reserve needed.

This RIS focuses on the system intact condition, rather than the operation of islanded regions following a separation event. AEMO periodically reviews the requirements for islanded region and regions at risk of islanding as part of the Minimum Inertia Requirements. These special conditions are more onerous to manage and so the utility of faster response may be heightened.

Please refer to Technical Appendix B, section *B4.8 Sensitivity to type of reserve*.

15. Has the virtual inertia capability of some batteries been considered in projections of future inertia levels and requirements?

Virtual inertia is not included in the ISP projections used as an input into the RIS. The year 2025 was chosen so uncertainty relating to the technology mix is kept manageable. AEMO is closely monitoring technology developments in this area including ARENA trials of advance inverter capabilities.

An important thing to note is that the inertia projections out to 2025 are quite different under different market modelling assumptions, resulting in a range of possible inertia outcomes.

16. Primary Frequency Response (PFR) appears to play an important role in frequency control. How does AEMO propose to gain visibility over available headroom?

One of the important messages out of the frequency report is the importance of PFR. For the outcomes of future events to be comparable with what we've experienced historically, broad based PFR will be crucial, particularly under low inertia conditions.

Headroom is one component of PFR, the other part is the dynamic response. The RIS shows the need to expand AEMO's existing models and tools to be able to monitor the effects of the available PFR.

Information on frequency related recommendations are available in the RIS stage 1 report recommendation 4.1 and the Technical Appendix B, section B6.

1 The significant majority of the DPV fleet is currently passive, meaning that it is uncontrollable, and invisible to the system operator (behind the meter and unmonitored in real time).

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System Strength

17. Can synchronous condensers solve all renewable integration problems? What about advanced inverters?

There are a range of different pathways to ensuring sufficient levels of system strength and inertia are provided in a system with high penetrations of wind and solar. On one bookend of this range, there could be a fleet of synchronous condensers in every region allowing provision of system strength and inertia to be completely decoupled with provision of energy. On the other bookend, if advanced inverter technology is developed and is proven, it may allow inverter-based generation to support grid security.

The biggest questions navigating our way through these futures come in two parts:

- To what extent do we need to rely on synchronous machines for provision of essential system services in the future?
- How do we then effectively manage the transition from a reliance on the existing fleet for these services, both from system security and least-cost perspectives?

As part of managing this transition, the market needs to provide meaningful, technology neutral signals to future investment so that new participants aren't locked out and the replacements for these services are mature enough to be relied upon when needed.

There are currently trials underway to test grid forming inverter capabilities in Australia which are funded by ARENA. AEMO is also going to publish a white paper on grid forming inverters later in 2020.

18. Can the minimum number of synchronous units be reduced to zero by adding synchronous condensers, or are they needed for other reasons?

It is theoretically possible, but all the essential system services provided by synchronous generators would need to be replaced, in order to operate without them. This would include replacing all frequency management and voltage management services, and being confident that the system would remain stable under such a configuration for the full range of normal and abnormal operating conditions. While this may seem like a simple substitution, no GW-scale power system has ever been operated without synchronous generation online, so this is uncharted territory internationally.

AEMO is maintaining an active focus on expanding its understanding in this area. The Tasmanian power system is one of the most advanced islanded GW-scale power systems internationally, having reached 82% system non-synchronous penetration in 2020 so far. Despite having reached high penetrations of wind and solar for short periods of time, the NEM still has a high reliance on synchronous generation. In 2019, 82% of annual energy in the NEM was sourced from synchronous generators.

19. What criteria was used and how was the system strength evaluated in the study?

In order to reduce duplication, the system strength chapter in the RIS stage 1 report draws on and summarise work across AEMO and the industry and points towards the body of resources that exist on related questions.

The minimum combinations of synchronous generators for system strength in each region are defined on AEMOs limits advice webpage. The methodology for calculating system strength for key nodes across the transmission system and the assessment of new connections are also on the AEMO website.

Variability and Uncertainty

20. Does the variability studied include DPV? Do you have the ability to forecast DPV?

Yes, the variability section does include DPV resources. See answer to question 12, above, on forecasting DPV.

21. How will conventional units (including coal) operate with increased flexibility and be compensated in 2025?

The RIS Technical Appendix C highlights that participant learning, and new operational strategies will be key to ensuring there is enough flexibility to operate the system reliably and securely in 2025.

In terms of market frameworks to ensure these services are valued, recommendation 2.3 of the RIS stage 1 report points towards the ongoing ESB work, where new market mechanisms are being assessed to value these essential system services and also mechanisms that help operators and give more certainty around how AEMO dispatches those resources to ensure the power system of the future is kept secure.

22. Pre-curtailment of variable renewable energy (VRE) was included as one future option to manage uncertainty. Is a market product (e.g. a ramping equivalent to FCAS) likely to serve this or only operational intervention?

Technical Appendix C section C5, shows that there is a huge number of 'what-if' questions that depend on how participants adapt their operation over the coming years with more VRE and uncertainty. What the RIS shows is that if the flexible resources could be fully utilised, the question will be to what extent existing market signals incentivise participants to provide that response or whether some sort of additional flexibility reserve is needed to manage the gap. There is a rule

change currently submitted with the AEMC and the ESB is considering this.

AEMO, however, does have an obligation to maintain power system security. Operational intervention to curtail VRE will still be needed as an operational lever to ensure security can be maintained under all conditions, even if a market product is introduced.

Engagement

23. What is the timeframe for the next stage of the RIS?

The intention is for this next stage to be an iterative process over the oncoming 12 months. That is, releasing new studies progressively to inform regulatory reform processes so that as best as possible AEMO is clearly communicating our updated best view on priorities.

This platform gives a great opportunity to provide a map of priorities to ensure the most urgent reforms are happening at the right time.

24. Will there be an opportunity for engagement in the next stage?

Written submissions are being taken on stage 1 now, including how you would like to be engaged in stage 2, until the end of June 2020.

AEMO would like to ensure stage 2 is as collaborative and engaged as possible, noting the balance between the need for consultation but also the need to move quickly given the rate of change in the industry.

AEMO welcomes stakeholder feedback on how you would like to engage in future stages of work.

25. Where can I find more information?

A suite of Renewable Integration Study information, supplementary resources and links to other related projects are available on the AEMO website. This includes:

- The RIS stage 1 report.
- Technical appendices on Distributed PV, Frequency Management and Variability and Uncertainty.
- Webinars on an overview of the RIS (technical and non-technical versions available) and all technical appendices.
- Supplementary materials, such as the power system requirements paper.

For any further enquiries, please contact AEMO's Future Energy Systems team at FutureEnergy@aemo.com.au.