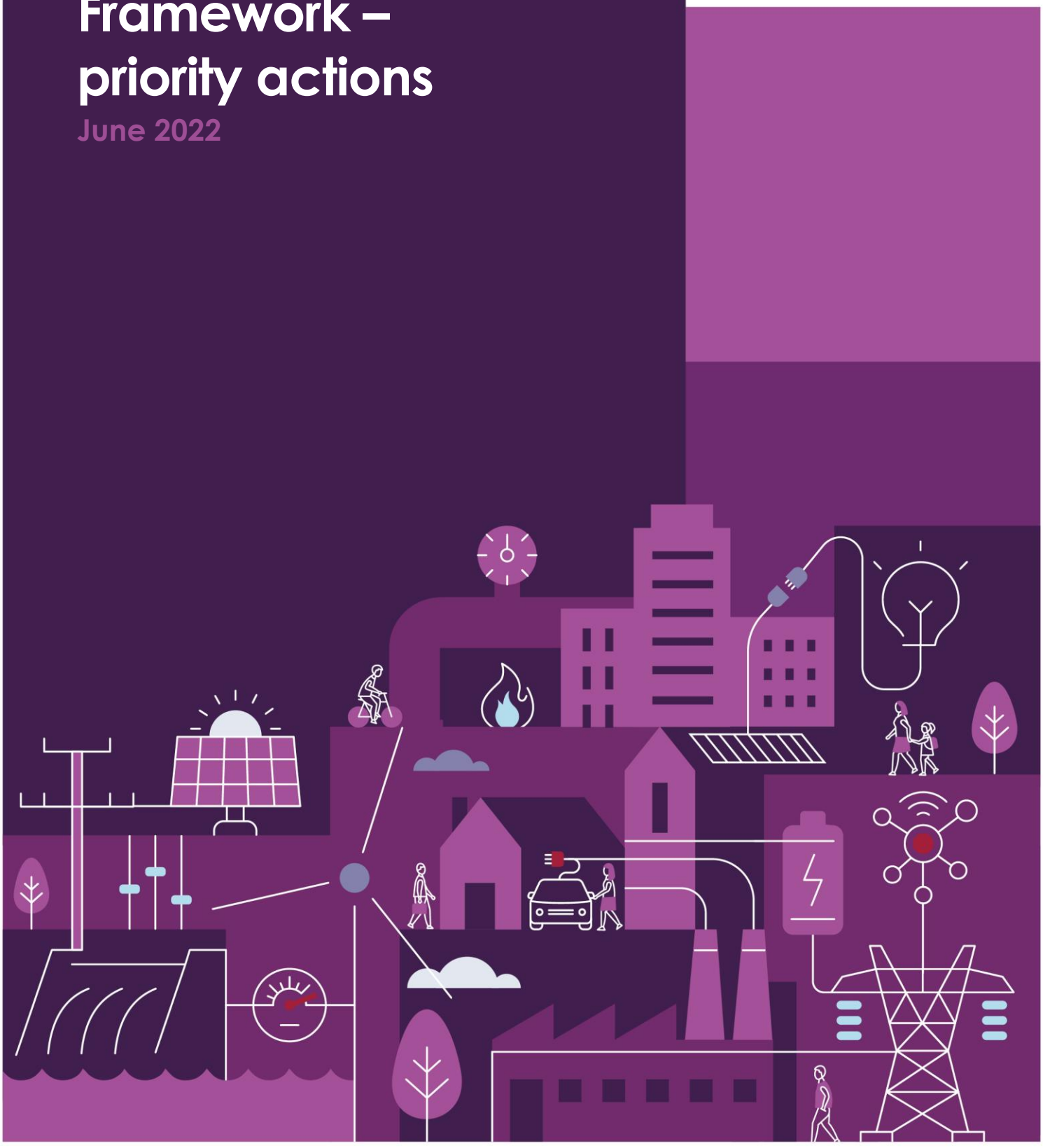
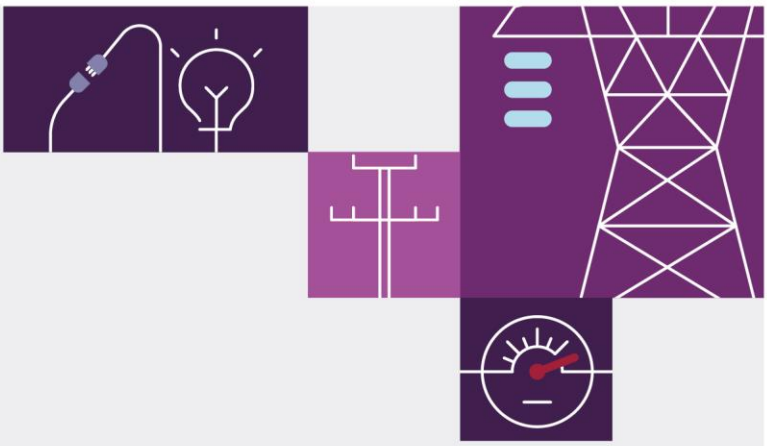
NEM Engineering Framework – priority actions

June 2022





Important notice

Purpose

This publication provides stakeholders with an update on the status of the NEM Engineering Framework, outlining a list of near-term priority actions needed to prepare the NEM power system for six identified future operational conditions, including preparation for 100% instantaneous penetration of renewables. It includes a number of key actions being led across industry, AEMO's action commitments by end of June 2023, and identifies some proposed priority actions where appropriate implementation pathways and stakeholder accountabilities are still to be confirmed.

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This document has been prepared by AEMO using information available at 31 May 2022. Information made available after this date may have been included in this publication where practical.

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Version control

Version	Release date	Changes
1	8/6/2022	Initial publication

AEMO acknowledges the Traditional Owners of country throughout Australia and recognises their continuing connection to land, waters and culture. We pay respect to Elders past and present.

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1 Priority Engineering Framework actions

In December 2021 AEMO published the National Electricity Market (NEM) Engineering Framework Initial Roadmap[1], summarising the breadth of potential gaps and decisions needed to prepare the NEM power system for six identified future Operational Conditions[2], including preparation for 100% instantaneous penetration of renewables.

Stakeholder feedback in early 2022 highlighted a strong desire to understand the specific actions that will be prioritised in the near term to start addressing the most pressing gaps and decisions. Based on this feedback, AEMO has worked through a compressed prioritisation process with stakeholders (Appendix A2) to identify the actions where AEMO can provide most value in 2022-23 to support the energy transition in the NEM.

AEMO has also identified a number of proposed new actions where the implementation pathway is not yet clear.

Finally, there are several actions already being led across the Energy Security Board (ESB), market bodies, and industry that together are addressing critically important gaps.

Collectively, the actions outlined in this report represent an initial body of high priority near-term actions. Next steps in the iterative Engineering Framework process are explored in Section 2.1.

100% instantaneous penetration of renewables

AEMO has set a goal to have the NEM and Western Australia's Wholesale Electricity Market (WEM) power systems capable of managing periods of 100% instantaneous penetration of renewable energy by 2025. AEMO will do this through extensive collaboration with stakeholders.

This goal recognises that Australia's power systems are on rapid trajectories towards very high renewable futures, and that AEMO, governments, and industry need to urgently prepare the NEM for these new operational conditions before they arise. As at the date of publication, the maximum instantaneous penetration of renewable energy in the NEM reached 61.8% on 15 November 2021. The 2022 *Integrated System Plan* (ISP) will present AEMO's latest projections on renewable energy generation, indicating that from 2025 there could be periods where sufficient renewable energy is installed to meet 100% of customer demand.

This ambitious goal is intended to challenge AEMO and industry to plan ahead for additional potential changes such as earlier-than-expected closure of coal-fired power stations, which could accelerate the trajectory toward high renewable penetrations. By setting this goal, AEMO seeks to plan and prepare for running a gigawatt-scale power system without any large fossil-fuelled generators online – a challenge that has not yet been met anywhere in the world. The aim is to get as close as possible to this goal, being as prepared as reasonably possible for the future, while ensuring the long-term interests of consumers are met.

[1] See https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-initial-roadmap.pdf.
[2] See https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-july-2021-report.pdf.

Figure 1 presents the headline near-term priorities that will help ready the NEM for operation with instantaneous penetrations of up to 100% renewables by preparing for Operational Conditions with *fewer synchronous generators online*, *ubiquitous rooftop solar*, and *extensive grid-scale VRE*. The priorities in Figure 1 are framed in terms of the "Key Decisions on Approach" outlined on page 15 of the Initial Roadmap.

Figure 1 Headline Engineering Framework priorities for near-term action

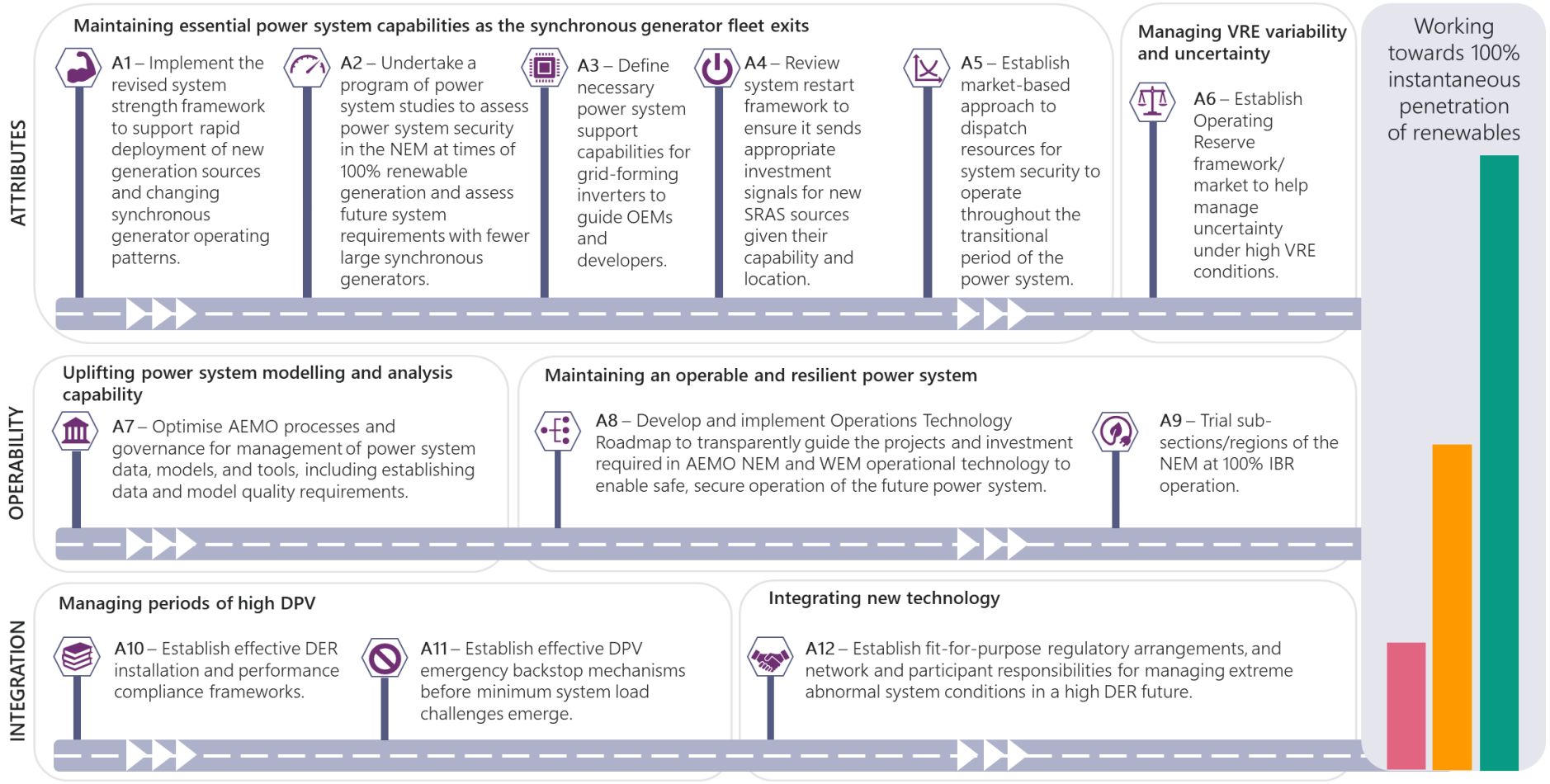


Table 1 presents the full list of priority actions, including the 12 headline priorities identified in Figure 1. It includes additional detail on AEMO's action commitment by the end of June 2023, whether the action is new or existing and who the lead party(ies) for the action are, and identifies some proposed priority actions where appropriate implementation pathways and stakeholder accountabilities are still to be confirmed. It also notes where an action takes steps toward addressing one or more gaps identified in the Initial Roadmap.

Table 1 Priority actions list

Action ID	Target end-state objective for action	AEMO commitment for financial year 2022-2023	Action status and implementation pathway	Related gap IDs from Initial Roadmap report
A1	Implement the revised system strength framework to support rapid deployment of new generation sources and changing synchronous generator operating patterns.	Implement new system strength Rules, including formal consultation on changes to the System Strength Requirements Methodology and Impact Assessment Guidelines. Publish new system strength standards for the coming decade, requiring services to ensure fault levels needed for a secure system as well as services to facilitate future renewable generation connections.	Existing AEMO-coordinated action. System Strength Requirements Methodology and System Strength Impact Assessment Guidelines amendments consultation.	ID016, ID022, ID146, ID174, ID328, ID511, ID450, ID466, ID493
A2	Undertake a program of power system studies to assess power system security in the NEM at times of 100% renewable generation and assess future system requirements with fewer large synchronous generators.	Initiate a program of power system studies to assess power system security in the NEM at times of 100% renewable generation.	New AEMO-coordinated action. Efforts to be aligned with transmission network services providers (TNSPs) and other related industry initiatives.	ID063, ID165, ID022, ID029, ID290, ID177, ID499
A3	Define necessary power system support capabilities for grid-forming inverters to guide Original Equipment Manufacturers (OEMs) and developers.	Collaborate with industry on a voluntary specification for grid-forming inverters.	New AEMO-coordinated action.	ID010, ID065, ID103, ID363
A4	Review system restart framework to ensure it sends appropriate investment signals for new System Restart Ancillary Services (SRAS) sources given their capability and location.	Review current system restart framework, documenting potential areas to improve incentives for new service providers. Provide advice to Reliability Panel ahead of upcoming System Restart Standard review.	New AEMO-coordinated action.	ID068, ID069
A5	Establish market-based approach to dispatch resources for system security to operate throughout the transitional period of the power system.	Advocate for market-based approach to dispatch resources for system security, which will support the operation of the system, remunerate and signal value for system security contributions, and reduce current requirement for directions while helping build understanding of the power system over time.	Existing market bodies-coordinated action. Australian Energy Market Commission (AEMC) Operational Security Mechanism rule change process.	ID21, ID408, ID434
A6	Establish Operating Reserve framework/market to help manage uncertainty under high variable renewable energy (VRE) conditions.	Technical advice to inform AEMC Operating Reserves rule change.	Existing market bodies-coordinated action. AEMC Operating Reserves rule change.	ID002

Action ID	Target end-state objective for action	AEMO commitment for financial year 2022-2023	Action status and implementation pathway	Related gap IDs from Initial Roadmap report
A7	Optimise AEMO processes and governance for management of power system data, models, and tools, including establishing data and model quality requirements.	Uplift AEMO processes and governance for management of power system data, models, and tools, including uplift of model quality.	New AEMO-coordinated action. NSP collaboration. Registered Participant and Original Equipment Manager input and support.	ID191, ID202
A8	Develop and implement Operations Technology Roadmap to transparently guide the projects and investment required in AEMO NEM and WEM operational technology to enable safe, secure operation of the future power system.	Begin implementation of AEMO NEM and WEM Operations Technology Roadmap to enable AEMO to achieve the required uplift in operations technology and capability and help facilitate the renewable energy transition.	Existing AEMO-coordinated action. AEMO Operations Technology Roadmap.	ID053, ID073, ID130, ID412
A9	Trial sub-sections/regions of the NEM at 100% inverter-based resources (IBR) operation.	Determine minimum level of synchronous generation required to operate regions/sub-regions of the NEM that currently, or will soon, have very low levels of synchronous generation. Trial sub-section/region of the NEM at 100% IBR operation if feasible.	Existing AEMO-coordinated action.	ID063, ID171
A10	Establish effective distributed energy resources (DER) installation and performance compliance frameworks.	Collaborate with industry on identified non-compliance risks for small-scale inverters' performance during disturbances. Collaborate with market bodies on enduring frameworks, roles and responsibilities for DER installation and performance compliance.	Proposed new action.	ID420, ID222, ID040, ID394
A11	Establish effective distributed photovoltaics (DPV) emergency backstop mechanisms before minimum system load challenges emerge.	Advocate for and progress introduction of emergency backstop DPV curtailment mechanisms in all NEM mainland regions. Specify technical requirements and operational coordination processes. Advocate for consistency in regional approaches, where possible.	Existing market bodies-coordinated action. Continue with state-by-state advocacy and engagement with Australian Energy Regulator (AER).	ID034, ID344, ID033, ID249
A12	Establish fit-for-purpose regulatory arrangements, and network and participant responsibilities for managing extreme abnormal system conditions in a high DER future.	Identify and progress regulatory reforms to clearly define AEMO, NSP, and participant responsibilities for system security in a high DER, low synchronous generation power system – starting with under-frequency load shedding (UFLS), last resort curtailment, system restart.	Proposed new action.	ID033, ID035, ID038, ID040, ID048
A13	Increase publicly available information of power system phenomena by reporting on NEM inertia. Improved measurement of real time inertia.	Provide regularly updated information on NEM inertia. Support dynamic inertia measurement trial.	New AEMO-coordinated action.	ID010

Action ID	Target end-state objective for action	AEMO commitment for financial year 2022-2023	Action status and implementation pathway	Related gap IDs from Initial Roadmap report
A14	Enable advanced inverter capabilities on new grid-scale batteries.	Support ARENA advanced inverter funding round.	Existing industry-coordinated action. ARENA Advanced Inverters funding round.	ID064, ID103
A15	Redevelop AEMO operational forecasting infrastructure to enable the rapid development of tools and systems that are required to facilitate current and projected growth of VRE, DPV and DER. Shift from deterministic forecasts to probabilistic and consensus forecasting techniques to enable the quantification and management of uncertainty, variability and risk.	Commence implementation of productionised data science environment to enable deployment of new machine learning models. Improve wind and solar dispatch forecasts by commencing uplift in AWEFS/ASEFS forecast models. Commence development of tools to quantify and visualise DPV variability.	New AEMO-coordinated action.	ID071, ID072, ID085, ID139, ID175, ID243, ID359, ID360, ID361, ID362, ID367, ID375, ID376, ID428, ID438, ID453
A16	Develop whitelist register for OEM products such as inverters, generators, synchronous condensers, Battery Energy Storage Systems (BESS), and power plant controllers.	Collaborate with stakeholders through the Connections Reform Initiative to determine suitable implementation plan.	Proposed new action.	ID075, ID168
A17	Effective frequency control under normal operation during high DER conditions with minimal centralised frequency responsive plant online.	Assess narrowband frequency control during projected operational conditions with very high DPV. Investigate options to achieve sufficient aggregate response.	New AEMO-coordinated action.	ID052, ID343
A18	Effective emergency frequency control capability with increasing aggregate DPV impact.	Review NEM-wide UFLS scheme adequacy, identify need for corrective action and progress resolution.	Existing AEMO-coordinated action. AEMO assessment in collaboration with NSPs as part of routine UFLS reviews and also through the Power System Frequency Risk Review (PSFRR)/ General Power System Risk Review (GPSRR). NSP responsibility to maintain UFLS effectiveness and to resolve any adequacy issues identified by AEMO.	ID035, ID192, ID356
A19	Effective system restart capability with increasing aggregate DPV impact.	Review system restart adequacy across the NEM, identify need for corrective action and progress resolution.	New AEMO-coordinated action. AEMO assessment as per SRAS guideline. Resolution through: AEMO's SRAS procurement, development of operating procedures, and introduction of active DPV management capabilities.	ID038
A20	Demonstrate capability of new technology to provide SRAS.	Advocate for demonstrating capability of new technology to provide SRAS.	Proposed new action.	ID024, ID069, ID226

Action ID	Target end-state objective for action	AEMO commitment for financial year 2022-2023	Action status and implementation pathway	Related gap IDs from Initial Roadmap report
A21	Establish consistent performance standards for <5 MW connections in the distribution network.	Collaborate with distribution network service providers (DNSPs) to understand current status of performance standards for <5 MW connections, and identify any uplift required.	New AEMO-coordinated action. Collaborate with DNSPs and AER. Engage with OEMs.	ID247, ID283
A22	Develop technical specifications for energy and frequency control ancillary services (FCAS) provision from aggregated DER.	Consider the requirements for energy and FCAS provision from aggregated DER within the delivery of reform initiatives.	Existing AEMO-coordinated action. Integrating Energy Storage Systems (IESS) rule change implementation project. ESB Scheduled-lite process. 2022 Fast Frequency Response (FFR) Market Ancillary Services Specification (MASS) review.	ID010, ID233, ID403, ID503
A23	Achieve optimal deployment of synchronous condenser capability in new and existing synchronous generators.	Promote the addition of synchronous condenser capability in new and existing synchronous generator investment and retirement decisions.	Proposed new action.	ID010, ID021, ID062, ID013, ID326, ID338
A24	Uplift engineering resources and skills in Australia to support increasing demand for power system engineering expertise.	Work with industry to advocate for uplift in supply of skilled power system engineers in Australia.	Proposed new action.	ID271
A25	Establish scalable and resilient communications architecture fit for a highly decentralised and distributed future power system.	Assess functional requirements for communication architecture in the future power system. Explore options to efficiently, securely, and scalably meet functional requirements.	New AEMO-coordinated action.	ID265, ID403, ID502
A26	Establish foundational operational data exchange processes and standards for a highly decentralised power system.	Collaborate with stakeholders to review operational data exchange needs for AEMO, DNSPs, and industry to support increasing DER uptake and new forms decentralised participation.	Existing industry-coordinated action. DER marketplace and aggregation trials. Operations Technology Roadmap. AEMO review of power system data communication standard. ESB DER Implementation Plan.	ID403, ID502, ID503
A27	Simplify treatment of grid-forming inverter projects in the connections process.	Publish a fact sheet to clarify the pathway for grid-forming inverters through the existing connections process.	Existing AEMO-coordinated action. AEMO progressing recommendations from Advanced Inverters white paper, feeding into National Electricity Rules (NER) access standards review where relevant.	ID064, ID103, ID397

Action ID	Target end-state objective for action	AEMO commitment for financial year 2022-2023	Action status and implementation pathway	Related gap IDs from Initial Roadmap report
A28	Establish minimum device-level requirements for cyber security for DER, Internet of Things (IoT) and other internet-enabled devices.	Advocate for and collaborate with industry on foundational device capabilities, configuration, and networking practices for internet-connected DER devices.	Existing industry coordinated action. Distributed Energy Integration Program (DEIP) DER cybersecurity working group. National DER cyber security policy development.	ID129, ID304, ID417, ID446, ID475
A29	Establish failsafe behaviour requirements of DER for secure and reliable power system operation.	Assess with industry, effective DER device configuration and behaviours under loss of communication and other contingency scenarios in a high DER future.	Proposed new action.	ID038, ID498, ID500
A30	Deploy new weather monitoring infrastructure to support renewable energy zones (REZs).	Advocate for new weather monitoring infrastructure requirements to support REZs.	New AEMO-coordinated action. Bureau of Meteorology (BOM), other weather providers, and jurisdictions.	ID117, ID372
A31	Establish operational visibility of 100 kW to 5 MW DER embedded in the distribution network.	Explore and assess feasible visibility options and AEMO-DNSP system integration actions.	Proposed new action.	ID248, ID297, ID360, ID032
A32	Establish system integration, data exchange and functional requirements for dynamic operating envelopes.	Inform development of system integration, data exchange and functional requirements for dynamic operating envelopes.	Existing industry-coordinated action. DEIP Dynamic Operating Envelopes working group.	ID237, ID294, ID500
A33	Establish an agreed approach for representation of DER in network topology representations, adopted and utilised by NSPs, AEMO, aggregators and other coordinating parties.	Advocate for need, and collaborate with NSPs and service providers on approach.	Proposed new action.	ID245
A34	Develop mechanisms to efficiently leverage ability to adjust and tune generator and network asset controls in real time or over life of connection.	Investigate feasibility of leveraging ability to adjust and tune generator controls in real time or over life of connection.	Existing industry-coordinated action. Connections Reform Initiative.	ID200
A35	Simplify connection and registration processes for hybrid generation facilities.	Explore options to simplify connection and registration processes for hybrid generation facilities.	Existing industry-coordinated action. Connections Reform Initiative 6.6 (led by the Clean Energy Council [CEC]). IESS rule change implementation.	ID369
A36	Establish minimum DER device requirements for interoperability (including electric vehicles [EVs]).	Collaborate with industry on minimum device capability for coordination and aggregation, and power system operational use cases in a high DER future.	Existing market bodies-coordinated action. DEIP Interoperability Steering Committee. ESB DER Implementation Plan.	ID233, ID308, ID489

Action ID	Target end-state objective for action	AEMO commitment for financial year 2022-2023	Action status and implementation pathway	Related gap IDs from Initial Roadmap report
A37	Establish effective grid interactive performance standards for electric vehicle charging and other flexible demand.	Collaborate with industry on disturbance withstand, grid support and grid connection requirements for EV and EV supply equipment (EVSE). Inform EV grid integration efforts.	Proposed new action.	ID233, ID489, ID088, ID094, ID306, ID308
A38	Establish confidence in DER register data, including robust data entry, validation and compliance arrangements.	Highlight known data quality and completeness issues with DER register data by validating against alternate data sources. Advocate for more robust validation processes at the data collection stage for new DER installations. Advocate for stronger compliance arrangements for data entry.	New AEMO-coordinated action. Collaborate with industry on alternate data sources. AEMO development work. Engage with AER and jurisdictions.	ID222, ID487
A39	Establish appropriate performance requirements for new loads.	Establish a working group to determine and scope any necessary regulatory changes to support appropriate performance requirements for new loads.	Existing industry-coordinated action. Working group with TNSPs, potentially feeding into NER access standards review.	ID081, ID089, ID094, ID485
A40	Establish operational coordination architecture for AEMO-NSP-aggregator interactions.	Assess functional requirements for setting, communicating and managing network limits with increasing levels of aggregated participation. Consider roles and responsibilities of actors.	Proposed new action.	ID237, ID323, ID330, ID242, ID244
A41	Establish DER device and distribution low voltage (LV) network monitoring and data access frameworks.	Continue to engage with OEMs and data providers to grow pool of data available for analysis, model validation and forecasting. Collaborate with DNSPs on requirements for monitoring data needs for a high DER future. Contribute to ESB Data Strategy.	Existing industry-coordinated action. University of NSW (UNSW)-led Project MATCH (Australian Renewable Energy Agency [ARENA] funded) on data for compliance assessment. ESB Data Strategy. AEMC metering review.	ID488, ID280, ID097
A42	Establish a register of EVSE standing data, including data collection and storage processes.	Develop implementation options for a register of EVSE standing data, including data collection and storage processes.	Existing market bodies-coordinated action. ESB Data Strategy initiative.	ID234
A43	Establish widespread phasor measurement unit (PMU) coverage and high-speed data ingestion/automation processes.	Promote widespread PMU roll-out and high-speed data ingestion/automation.	New AEMO-coordinated action. Collaborate with NSPs and market bodies. AEMO Operations Technology Roadmap for development of control room tools.	ID118

Action ID	Target end-state objective for action	AEMO commitment for financial year 2022-2023	Action status and implementation pathway	Related gap IDs from Initial Roadmap report
A44	Establish clear roles and responsibilities across the energy sector for remote interactions with DER devices.	Collaborate with industry to consider use cases for different parties remotely interacting with DER devices. Progress policy development on governance, roles and responsibilities and compliance.	Existing market bodies-coordinated action. ESB DER implementation plan. AEMC review of DER technical standards. National DER cyber security policy development.	ID444
A45	Establish appropriate measures for effective management of over-frequency events in the NEM.	Evaluate the coordination of over-frequency management settings in all NEM regions including any recommended mitigations.	Existing AEMO-coordinated action. Existing over-frequency generation shedding (OFGS) scheme reviews. AEMO to undertake studies as part of the PSFRR/GPSRR to identify potential need for OFGS in other NEM regions.	ID133
A46	Develop clear guidance on use of EMT and RMS analysis in performance study assessments.	Develop clear guidance on use of electromagnetic transient (EMT) and root mean square (RMS) analysis in performance study assessments.	Existing industry-coordinated action. Connections Reform Initiative.	ID075

2 Ongoing development

2.1 Progressive prioritisation with stakeholders

Figure 2 Engineering Framework process and updates

The Engineering Framework is an iterative process that requires ongoing collaboration and commitment across AEMO and relevant stakeholders.

This publication is the first step towards action prioritisation, with significant work remaining to undertake actions and monitor progress. Once this process is sufficiently underway, progress can begin on prioritising and determining the responsibilities for the next set of actions.

This process aims to provide a balance between the need for timely action and the need to develop a comprehensive view of forward priorities. AEMO will be providing an update report on the Engineering Framework in Q4 2022 that summarises the status of all potential gaps identified in the Initial Roadmap, as well as exploring the pathways of future priorities in more detail.

AEMO will reach out to stakeholders for an opportunity to discuss the content of the upcoming end of year Engineering Framework actions roadmap. Please email FutureEnergy@aemo.com.au to provide feedback on this publication or sign up for Engineering Framework updates, including new publications and engagements.

2.2 Pathway toward technology-agnostic service specification and provision

Effectively and efficiently transitioning the power system from reliance on large synchronous generating units requires alternate ways to provide essential power system capabilities. Large power systems worldwide have been built around synchronous generating units, so operating without these units online necessitates fundamental changes to system design and operating principles. This challenge is a key focus for industry, academia, and research institutes worldwide. The ESB considers that the NEM should, where possible, progressively move toward a market where essential system capabilities are procured independently as services.

Micro-grids have been proven to operate successfully for long periods without the support of synchronous generating units. However, to AEMO's knowledge, no gigawatt-scale power system has achieved this without interconnection to other large systems. This presents a significant challenge for Australia, as the pace of transition is rapidly taking the NEM toward periods where sufficient renewable generation potential will exist at times to meet 100% of customer demand. In regions such as South Australia, work is already underway to reduce the minimum number of synchronous generating units required for system security[3], through the deployment of synchronous condensers and detailed analysis of the system under new operational conditions. However, operation with fewer than two synchronous generating units online in South Australia is still under investigation.

Currently, the secure operating configurations of the NEM are determined through modelling and analysis of combinations of generation and network assets that deliver essential power system capabilities. These assets interact and work together to, in aggregate, provide the system strength, inertia, voltage control and other capabilities necessary for secure operation. Today, the modelling approach seeks to confirm the configurations of assets that lead to a secure system. Market and operational process then ensure that the system efficiently remains within the bounds of these secure combinations. The evolution of the NEM's design and investment over many decades has led to these secure configurations relying heavily on the capabilities of existing synchronous generating units such as thermal and hydro generators.

Extensive modelling is required and is being planned to understand the interactions between different assets for a variety of future system configurations. Until this work is completed, it cannot be known whether it is practicable to fully decouple 'services' that are an inherent part of the physics of traditional power system components so that they can be procured individually.

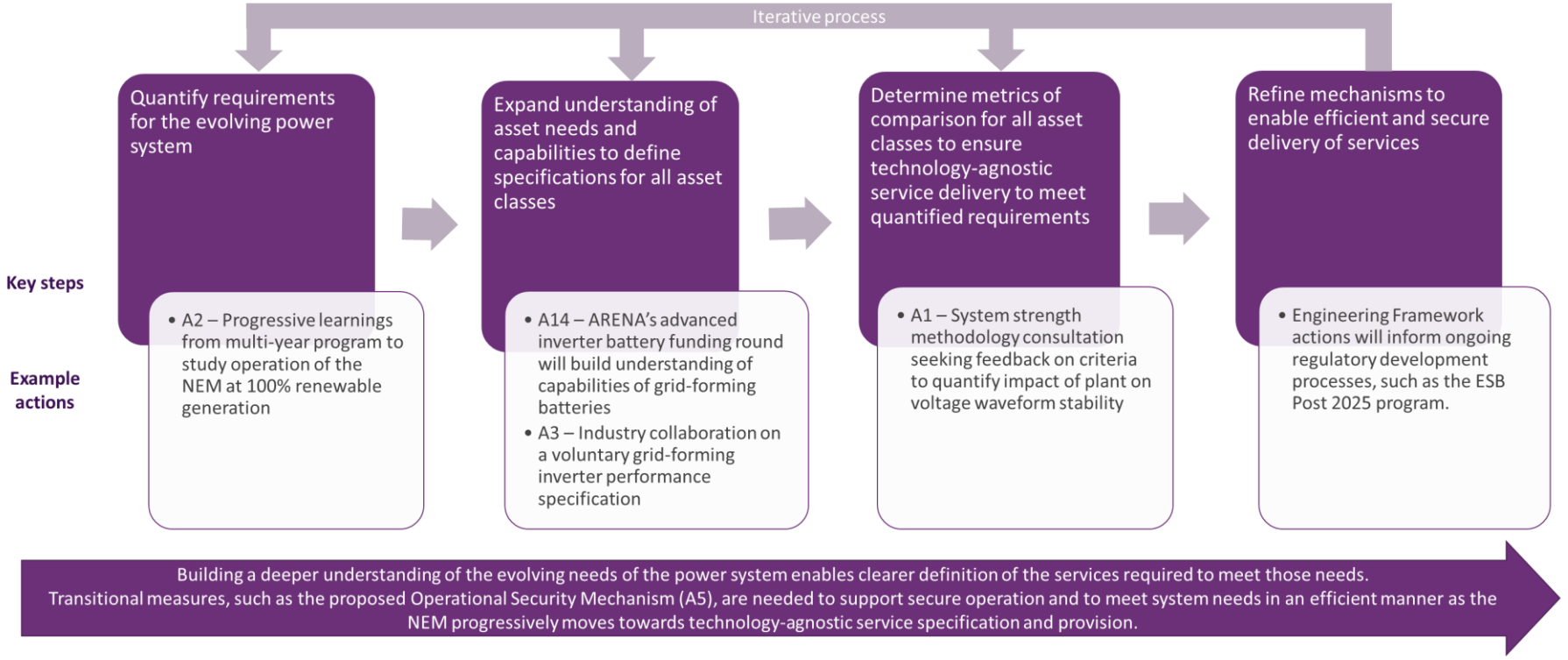
Moving forward, it will be necessary to harness the capabilities of all power system assets in a technology-agnostic manner to maximise flexibility during periods where few or no synchronous generating units are operating. By defining the secure operating envelope of the system and specifying the support capabilities and services it needs, inverter-based resources (IBR), synchronous resources and network assets will be able to meet these requirements in an efficient manner.

[3] See https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource/related-resources/operation-of-davenport-and-robertstown-synchronous-condensers.

Work is progressing to refine the power system requirements of the NEM and to advance the efficient investment in and delivery of capabilities to meet these requirements. The joint Australian Energy Market Commission (AEMC)/AEMO publication on Essential System Services and inertia in the NEM[4] describes the status of initiatives underway, associated linkages and longer-term consideration of an inertia spot market.

Many of the actions highlighted in Section 1 seek to further advance progress toward technology-agnostic service specification and provision for the future NEM. Figure 3 outlines some key steps involved in this journey and provides examples of actions being taken over the next 1-2 years to advance each of these steps.

Figure 3 Key steps and near-term actions toward technology-agnostic service specification and provision



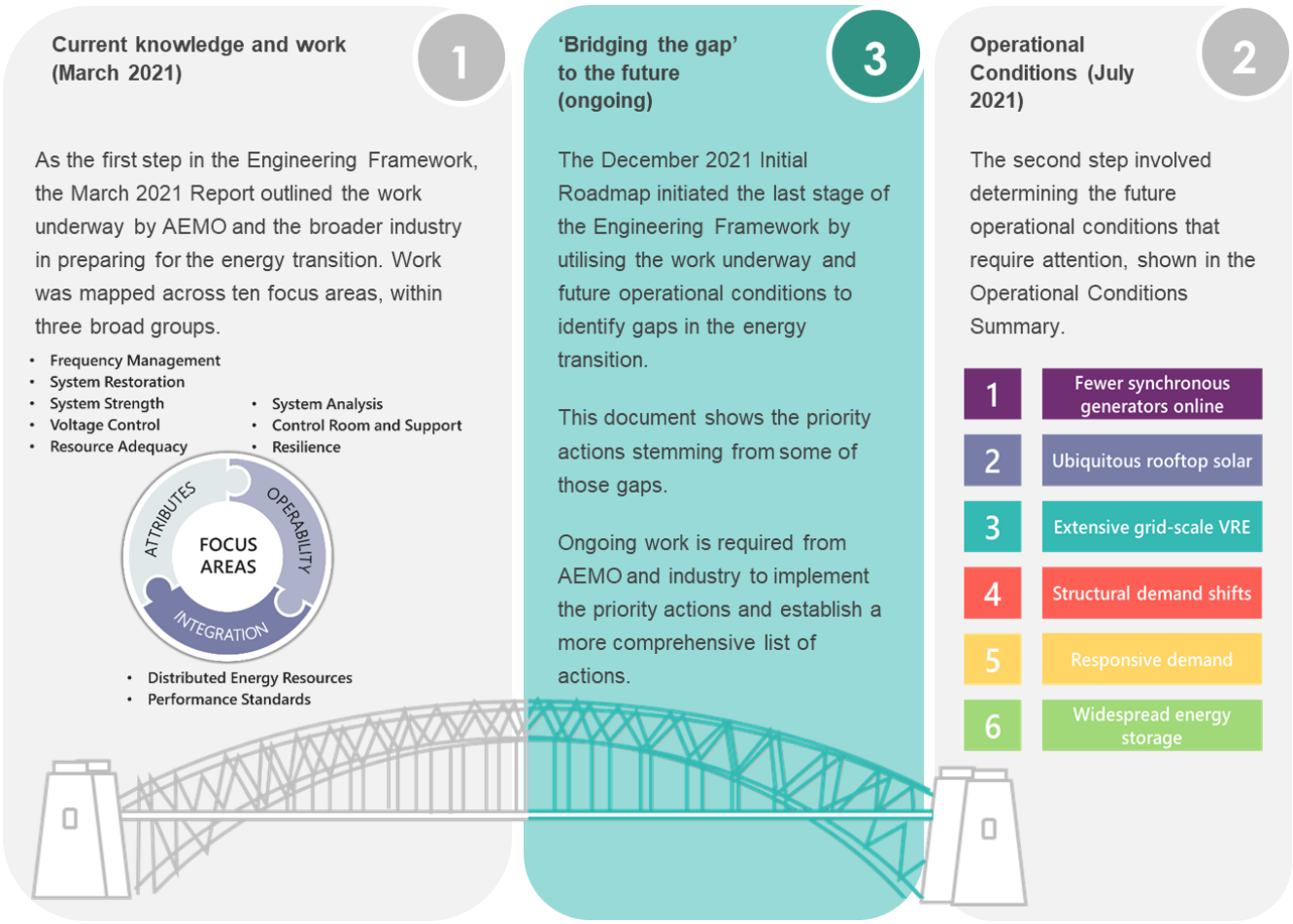
[4] See https://www.aemc.gov.au/rule-changes/efficient-provision-inertia

A1. Engineering Framework background

The Engineering Framework is a toolkit to define the full range of operational, technical and engineering requirements needed to prepare the NEM power system for six identified future operational conditions, including preparation for 100% instantaneous penetration of renewables. It seeks to facilitate an orderly transition to a secure and efficient future NEM power system.

The Engineering Framework recognises the profound transformation underway in the NEM, including rapidly increasing penetrations of IBR and DER. The NEM will soon encounter operational conditions yet to be experienced here or in comparable power systems internationally. A step-change in power system capability and engineering effort is required to maintain secure and efficient operation and investment in the long-term interests of consumers. Figure 4 shows the approach taken to developing the Engineering Framework, from the March 2021 Report[5], to the Operational Conditions Summary[6] and the Initial Roadmap[7].

Figure 4 Developing the Engineering Framework

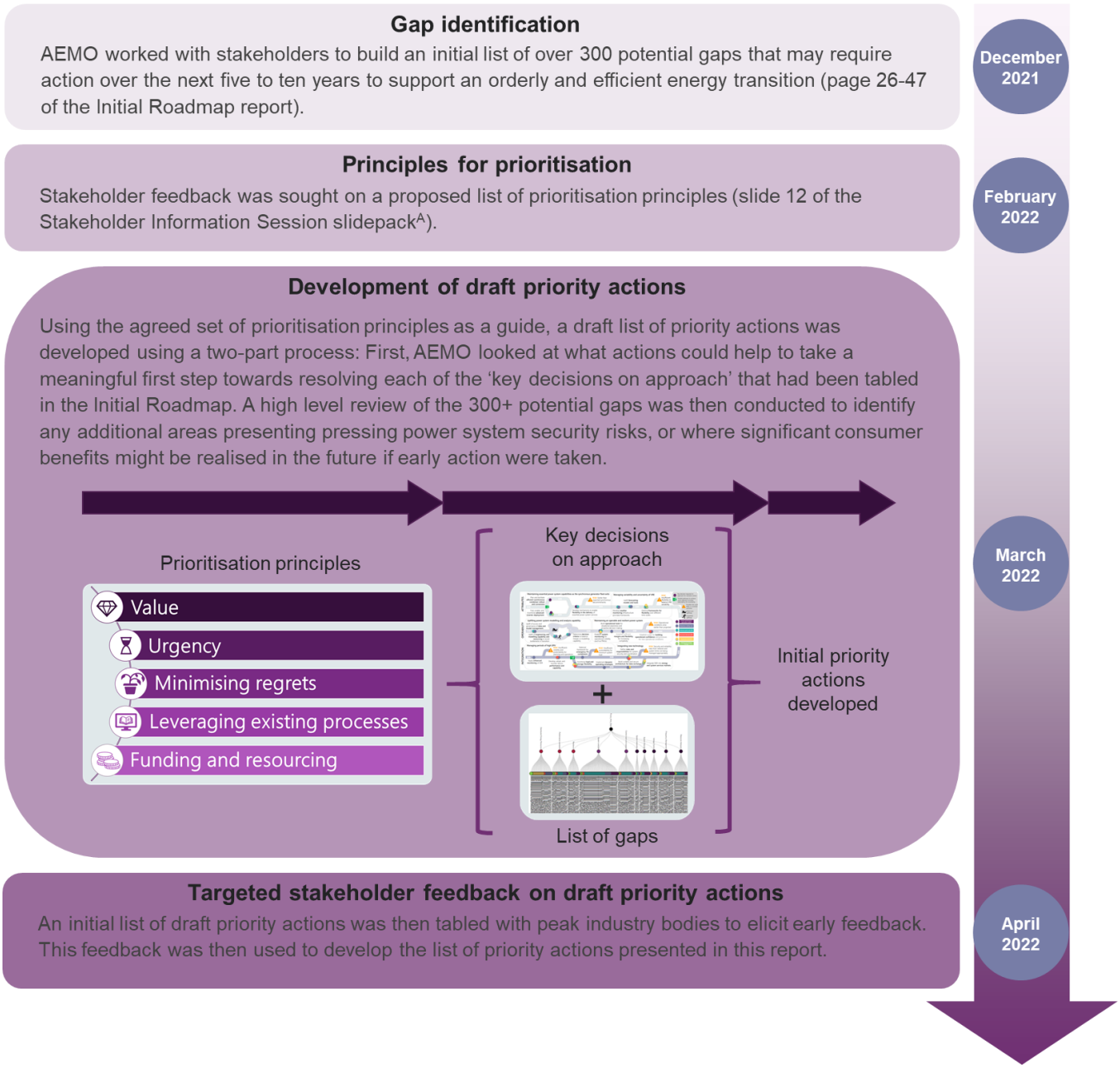


[5] See https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-march-2021-report.pdf.
[6] See https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-july-2021-report.pdf
[7] See https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-initial-roadmap.pdf

A2. Actions development with stakeholders

The near-term actions in Section 1 were developed through an expedited process to balance the need for a long-term view of priorities in the best interest of consumers and the need for timely action. Figure 5 shows the development process and stakeholder engagement used to prepare the list of priority actions in Section 1. AEMO would like to thank stakeholders who contributed to this and earlier stages of the Engineering Framework.

Figure 5 Development of near-term priority actions



A. See https://aemo.com.au/-/media/files/initiatives/engineering-framework/2022/initial-roadmap-information-session-pack.pdf