



ENERGY SECURITY BOARD
Post-2025 Market Design
Final advice to Energy Ministers
Part A

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Dr Kerry Schott AO
Independent Chair
Energy Security Board



David Swift
Independent Deputy Chair
Energy Security Board



Clare Savage
Chair
Australian Energy Regulator



Anna Collyer
Chair
Australian Energy Market Commission



Daniel Westerman
Chief Executive Officer
Australian Energy Market Operator

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List of Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
C&I	commercial and industrial
CoAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DER	distributed energy resources
ESB	Energy Security Board
ESS	Essential System Services
ESOO	Electricity Statement of Opportunities
EV	electric vehicle
FFR	fast frequency response
GW	Gigawatt
ISP	Integrated System Plan
MW	Megawatt
NEM	National Electricity Market
NEO	National Electricity Objective
PFR	Primary frequency response
PV	Photovoltaic
RAMs	Resource Adequacy Mechanisms
RERT	Reliability and Emergency Reserve Trader
REZ	Renewable Energy Zone
RRO	Retailer Reliability Obligation
SSM	System Services Mechanism
TNSP	Transmission Network Service Provider
UCS	Unit Commitment for Security
VPP	Virtual Power Plant
VRE	Variable renewable energy

Foreword

This paper, prepared by the Energy Security Board (ESB), is a joint and collaborative effort of the energy market bodies: the Australian Energy Market Commission (AEMC), Australian Energy Market Operator (AEMO) and the Australian Energy Regulator (AER).

Over the course of this program, the ESB Board has had different members and those, both past and present, contributed to the directions developed over time for this final advice. The present Board of the ESB would like to acknowledge the significant contributions to the Post-2025 program made by previous Board members: Paula Conboy (AER), John Pierce AO (AEMC), Audrey Zibelman (AEMO), Merryn York (AEMC) and Drew Clarke AO (AEMO).

In carrying out the two-year work program on the Post-2025 redesign of the NEM, the ESB worked closely with a broad range of industry stakeholders, consumer bodies, academics, government bodies and interested parties. Industry and government agreed to second some of their best staff for lengthy periods of time adding particular expertise at important moments. We consulted widely and used many working groups. A large number of people in these groups committed significant time and effort and for this, we offer our sincere thanks. The program and its outputs are greatly enhanced by your thoughtful and considered input.

The project was led by Suzanne Falvi, Jo Witters and Matt Garbutt, and along with the whole ESB team, they should feel proud of their work.

An Advisory Group of senior leaders across the industry convened regularly. Sadly, as we prepared this report, Chloe Munro AO, a member of that Group, passed away. Chloe was the inaugural Chair of the Clean Energy Regulator and a mentor and friend to many of us. Her passion for electrification and decarbonisation is sorely missed.



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Regulator



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Australian Energy Market
Operator

Executive Summary

It is difficult to overstate the scale and pace of change across Australia's electricity sector as, both large and small scale, renewable generation enters the system rapidly and in volume. This relatively low-cost power has caused wholesale prices to fall and emissions to reduce.

The energy transition has created a number of challenges and opportunities that need to be addressed in order to deliver affordable, reliable and low emissions energy services to customers into the future. These include the need for:

- **Resource adequacy mechanisms:** to provide the right incentives to drive investment in an efficient mix of resources (that is variable renewables, storage, and flexible and firm generation) to minimise costs and maintain reliability;
- **Essential system services and ahead scheduling:** to ensure that the essential services required (frequency, control, operating reserves, inertia and system strength) are available to maintain system security;
- **Integration of distributed energy resources and flexible demand:** to deliver benefits to customers through the integration of rooftop solar, battery storage, smart appliances, electric vehicles, and other distributed energy resources into the system in an efficient way; and
- **Transmission and access:** to ensure timely transmission investment, better use of capacity on the network to lower costs for consumers and reduce uncertainty for investors by making future patterns of congestion more predictable.

The Energy Security Board (ESB) was tasked by the former Council of Australian Governments Energy Council (COAG EC), to develop advice on reforms to the National Electricity Market (NEM) to meet the needs of the transition up to and beyond 2025. This paper sets out an integrated framework to reform the NEM, with policy directions across four reform pathways. These pathways sequence a series of reforms necessary to promote a secure, reliable, and efficient energy transition while maintaining affordability for customers. The proposed pathways build on the Options paper published in April 2021.

Pathway for reforms

The reform pathways are set out to reflect the urgency of the situation and fall into three categories: immediate reforms to be done now, initial reforms to be developed and implemented in the near term, and longer-term reforms which should be progressed over time and depend on developments in the industry including technological change.

Together, these pathways deliver appropriate reforms over time. With ongoing oversight, these pathways can be adjusted to address emerging needs, their interdependencies, and uncertainties during the transition. Monitoring progress is especially essential so that as experience grows, and learning occurs adaptations can happen in the new system and changed market conditions.

Resource adequacy mechanisms and ageing thermal retirement

The ESB considers the existing market, and its related arrangements, are unlikely to be sufficient to ensure the commercial provision of the right mix of resources required as the market transitions towards a higher penetration of variable renewables. This is due to a range of uncertainties currently facing investors in the market. These include technological and demand uncertainty through to uncertainty over the timing of the closure of ageing thermal generation plant. Government interventions to drive investment in new generation and those to manage the closure of existing plant also significantly impact the investment environment. These interventions can create investment

uncertainty and dampen spot and wholesale market prices, impacting long term investment signals for the right mix of resources necessary to support the energy transition.

To ensure investment in an efficient mix of variable and firm/flexible capacity that meets reliability at lowest cost, the ESB has proposed several reforms across the workstreams. More specifically, the ESB propose that detailed design work is undertaken on a capacity mechanism to complement existing arrangements. The introduction of such a mechanism is intended to increase government and community confidence that resource adequacy will be delivered by the market reducing the need for interventions. The ESB notes that the current risk appetite for reliability by investors appears to be higher than that of governments.

1. Immediate reforms

The ESB proposes to make provision in the market arrangements for a NEM wide jurisdictional strategic reserve. This will be developed as a nationally consistent mechanism, to provide the option for a jurisdiction to procure any required reserves beyond the national market reliability standard if they consider this necessary.

The ESB recommends mechanisms to deliver enhanced transparency of future generator availability. This will support the orderly exit of thermal plants as they retire from the system, with improved information to market participants, jurisdictions, and other policy makers.

To guide the development of any future jurisdictional schemes, the ESB proposes a set of principles to ensure a common approach is taken consistent with current market signals for investment. Jurisdictions are encouraged to use currently available information on market needs and seek additional information from the market bodies as necessary when considering jurisdictional schemes.

The ESB also propose that a Ministerial lever for the jurisdictions is introduced to trigger the current Retailer Reliability Obligation (RRO), as is currently in place in South Australia. Introduction of this measure will support a consistent national framework but give jurisdictions the ability to strengthen the RRO if they wish while further detailed design work is undertaken on a capacity mechanism.

2. Initial reforms

The ESB recommends the detailed design for a capacity mechanism that ‘unbundles’ the value for capacity from energy be developed over the next 12-18 months. In recognition of significant stakeholder concerns over the significance of such a change to current market design, the ESB will work with stakeholders and jurisdictions to develop the detailed design of a capacity mechanism for Ministers’ agreement in mid-2023. There are a number of policy choices in the design of a capacity mechanism which need to be carefully considered to ensure the recommended design is both effective and efficient, including the complexity of the design, its potential impact on retail competition (including small retailers), commercial and industrial customers, transaction costs and overall affordability.

The ESB intends that its straw proposal for a decentralised capacity mechanism, where the volume of required capacity is determined by liable entities (market participants), should be the starting point for the detailed design work.

3. Long term reform

Following the implementation of the ESB’s Post-2025 reforms, continued monitoring of reliability and overall costs to consumers is necessary. It is important to recognize that operating and regulating a system with significant penetration of variable renewables (both small and large scale) is a new experience globally. Review and monitoring are essential so adaptation can occur as experience grows and learning occurs. While this is happening now the increasing penetration of renewables makes the ‘monitor and adapt’ approach even more important.

Essential System Services and Scheduling and Ahead Markets

The growing role of renewable generation in the power system increases the need for services to be properly valued to maintain the security of the system. This is exacerbated by the retirement over time of ageing thermal generators who currently provide many of these services ‘bundled’ together with their delivery of energy and reserves. The ESB considers that we need to specify and value those essential system services and efficiently procure them, including procurement from non-traditional and new sources such as Distributed Energy Resources (DER). The approach proposed is to use co-optimised market-based procurement where possible and, where not possible or appropriate, structured procurement approaches.

The arrangements need to not only ensure that the range of essential system services are available, but also that they are effectively used in a more complex operating environment. Tools are needed to ensure AEMO can efficiently procure, schedule, and call upon these resources when needed, reducing the cost of AEMO market interventions, and improving overall affordability. The ESB is working closely with the AEMC on rule changes in progress that are developing these arrangements.

1. Immediate reforms

Reforms are underway to refine frequency control arrangements, addressing the need for enhanced arrangements for primary frequency control and a new market for fast frequency response.

2. Initial reforms

The ESB proposes to progress the development of a Unit Commitment for Security (UCS) mechanism to schedule resources providing services under structured procurement arrangements (services without real-time markets). The UCS operates as a tool to support efficient scheduling of system services. Over and above a UCS-only option, a system security mechanism (SSM), as a short-term procurement option, could provide an adaptable operational tool to complement planning-based solutions, including for system strength, and provide the system configuration needed to maintain security. Further work is needed to explore the design of an SSM together with stakeholders and this will be progressed by the ESB and market bodies through AEMC rule change processes which are underway.

The potential for a new operating reserve product will continue to be progressed by the ESB and market bodies (with AEMC rule change requests underway addressing operating reserves services). The current provision of reserves in operational timeframes is implicitly valued through the energy spot market. New products and services may be required to manage growing forecast uncertainty and variability in net demand over timescales ranging from minutes to hours. A new reserve service market could provide an explicit value for flexible capacity to be available to meet these net demand ramps. This could be considered as a potential complement to the suite of resource adequacy reforms, rather than as a mechanism to deliver the necessary long term investment signals.

3. Long term reform

The ESB has identified a spot market approach for valuing and procuring inertia as a long-term priority. In the first instance inertia provision is relying on the current arrangements for Transmission Network Service Providers (TNSPs) to procure minimum levels of inertia along with the potential to use a SSM to procure additional inertia when required. This is an area of interest for stakeholders, and the ESB notes that while current measures ensure system security is maintained, there could be advantages to progressing to a spot market to co-optimize the supply of inertia with frequency control services, operating reserves and energy. This work will be progressed with the ESB and market bodies.

In the medium to long term, the operational challenges of managing the power system with very high levels of renewables will become clearer, and new technologies will arise to supply the necessary services. These operational and technological advances require monitoring and may require further

refinement to the spot market and structured procured arrangements. The ESB and market bodies will continue to monitor and provide advice about market conditions and the need for further unbundling of essential system services or an integrated ahead market.

Integration of Distributed Energy Resources and Flexible Demand

The ESB is focussed on driving value for all customers from integrating DER as an important and integral part of the overall power system. There is significant potential for customers to benefit from using their DER resources. They could provide demand flexibility, enter the wholesale energy and service markets, and provide network services to improve the return on their investment. This changing behaviour can benefit all consumers by potentially lowering the costs of operating the electricity system.

To support these outcomes, the ESB has set directions for how roles of the various parties in the energy system – customers, retailers or aggregators, distribution networks, and AEMO — need to evolve from their current responsibilities. These reform directions have been built into a DER Implementation Plan, which sequences a program to be worked through together with stakeholders and customer advocates over the next three years to deliver technical, regulatory and market reform to integrate DER. To ensure insights about the experience and expectations of customers continue to inform the program, a collaborative Maturity Plan approach is developed to identify priority customer issues for reform.

1. Immediate reforms

A package of immediate reforms is underway, including expanding the responsibilities of distributors to hosting distributed generation and storage, supporting flexible demand, and introducing technical standards for DER that will smooth the customer experience and assist to ensure the security of the power system. New arrangements to provide for larger customers to participate in the wholesale energy market and gain benefits from managing their demand come into force in October 2021.

The rapid uptake in rooftop PV is creating challenges in maintaining system security associated with low system load. The ESB proposes levers are put in place across jurisdictions to ensure emergency backstop measures are available as system conditions continue to rapidly change. It is important that these measures remain genuine and rarely used ‘backstops’, and priority must be given to progressing to more enduring arrangements. These arrangements include enhanced market information by AEMO and the development of ‘turn up’ services that encourage flexible demand to shift to less critical times of the day.

As new retail offers start to become available to customers, foundations need to be in place to ensure customers can easily and safely make choices and switch between DER / non-DER service providers. A key enabler to the success of DER integration is to ensure that consumer trust is developed in new services and products. The ESB has therefore put in place a new risk assessment tool that enables market bodies to test on an iterative and ongoing basis whether the customer protections in place remain fit for purpose.

2. Initial reforms

Initial reforms through the DER Implementation Plan focus on rewarding customers for their flexible demand and increasing value to the system from flexible resources. Customers should benefit from building flexibility into their energy use with potential revenue where this flexibility can be offered (through a retailer or aggregator) to the wholesale market.

To provide these opportunities to customers, changes are needed to make it easier for innovative new retailers and service providers to enter the market, enabling customers to benefit from greater choice and competition. This does not mean small customers will have to do more in the market. Customers will continue to interface with retailers and aggregators, but retailers and aggregators will have new

opportunities to engage in the market and offer different choices to customers. Where customers wish to engage more than one service provider (e.g., for their standard energy use to be managed separately to supplies for their electric vehicle), arrangements should support this.

3. Long term reform

The DER Implementation Plan sets out an adaptive approach, enabling continued engagement with industry, customer advocates and interested parties to collaborate on design of future reforms. The pace of change underway means that new risks and opportunities will continue to emerge (e.g., the forecast uptake of electric vehicles and smart home technology). The Maturity Plan will support this by bringing together a diverse mix of stakeholder views to focus on priority customer issues.

Transmission and access

Investment in, and access to, an enhanced national transmission system is key to a successful transition. The ESB has developed a range of measures to ensure that much needed transmission investment is delivered in a timely and efficient manner. These measures include a solution that ensures that new generation and storage facilities are located in optimal parts of the network, including Renewable Energy Zones (REZs) delivered through the Integrated System Plan (ISP), to help deliver the energy transition at least cost. It is also important to ensure that these investments, once made, are used in an efficient manner.

The management of congestion in operational timeframes is expected to become increasingly critical in the future as the role of variable renewable energy (VRE) increases and power system flows become more variable in accordance with their fuel sources (the sun and the weather). The ESB has developed reform proposals designed to support an efficient level and management of congestion in future.

1. Immediate reforms

AEMO has prepared and regularly updates the ISP. The ISP describes a least cost pathway for the development of the power system, taking into account demand-side, supply-side and network costs. The Group 1 projects identified in AEMO's 2018 ISP are now committed projects and are underway.

The ESB's actionable ISP changes help to implement the priority network investments identified in the ISP to deliver additional network capacity where needed. Further changes have been recommended to provide an interim framework for REZs. REZ schemes can promote efficient location decisions by making it more attractive for generators to invest in certain parts of the network where resources are plentiful, and the grid has capacity.

2. Initial reforms

Challenges are emerging in getting the new transmission projects built, and the costs of investing too late can be substantial. The current regulatory test may not capture wider economic benefits that could be captured in a broader cost-benefit test for actionable ISP projects and additional funding options such as contestability may also need to be considered to deliver these projects at least-cost. The AEMC is undertaking a transmission investment review to consider these issues. The ESB has provided advice to Energy Ministers on transmission cost allocation and governments are currently conducting further analysis and considering next steps. Given the scale of transmission build necessary for the future, the ESB considers there is a need to resolve an appropriate fair cost allocation methodology for transmission.

The ESB considers the planning and implementation of priority REZs is an important step to the efficient connection of generation to the enhanced grid. To support the integration of REZs a congestion management model is proposed. This model complements the interim REZ framework and addresses the emerging congestion management needs of the system. Together these changes are

intended to encourage new generation and storage to locate in REZs, lessen the likelihood that their access to the grid is degraded by the connection of other generators outside the REZ, and also lessen the impact of other REZs. A detailed design needs to be developed enabling comprehensive consultation with stakeholders and interested parties.

Implementing the reforms

The ESB has completed a high-level indicative evaluation of the likely benefits each reform pathway could be expected to deliver. Understanding that the benefits are an order of magnitude significantly greater than the costs of implementation gives confidence for the case for change even though estimates of both costs and benefits at this stage are illustrative only. The implementation costs should be considered in perspective. There are costs in the electricity sector because of the transition occurring, and whether or not the reforms in this paper occur. What can change is the nature of those costs and how they are managed through the right market design and forward planning for implementation. The preliminary evaluation at this stage shows that the benefits of implementing the reforms - which is in the order of billions of dollars — dwarf the implementation costs that can be expected.

The NEM of 2025 and beyond requires modernisation of critical market systems and business processes and adequately resourced market bodies. There are risks associated with the scale of the energy transition including critical data needs, potential changes to the policy landscape, its governance, the need for an adaptive management approach, interdependencies between the pathways, and costs of implementation. The ESB has sought to address these risks in its recommendations, in the design of both reforms and the pathways themselves and the development of the ESB's Data Strategy.

Outline of this paper

This report about advice on design changes in the National Electricity Market (NEM) is set out in three parts:

- **Part A:** provides an overview of the four reform pathways that comprise the reforms package for the market design changes necessary for the NEM along with ESB's final recommendations to Energy Ministers in relation to them.
- **Part B:** provides a more detailed discussion of each reform pathway, including the ESB's reasoning, analysis and response to stakeholder feedback.
- **Part C:** contains appendices providing technical detail for particular reform options and relevant consultant reports. A summary of the stakeholder feedback to the ESB' April Options paper is available on the ESB's website.¹

¹ This summary can be found here: <https://esb-post2025-market-design.aemc.gov.au/reports-and-documents#submissions>

1. The Task and the Approach

1.1. The Task

The Energy Security Board (ESB) was tasked by the former Council of Australian Governments Energy Council (COAG EC), to advise on design changes required in the National Electricity Market (NEM) as it transitions from a fleet of largely coal fired generation to more variable renewable generation.² A pathway that sets out reforms and a timetable for their implementation, towards the year 2025 and beyond, is the basis of the ESB advice.

The request by Energy Ministers for this work reflects a general concern about NEM reliability, security and affordability as the rapid uptake of renewable generation occurs and the existing ageing generation fleet progressively retires. Similar changes are occurring in many electricity markets across the world, but Australia stands out for the rapid pace of its change and for its adoption of distributed (rooftop) solar photovoltaic (PV) systems – the highest in the world.

There are four key drivers of the current transition.

- First, the dramatic and continuing increase in the supply of renewable energy driven by government policy and renewable energy targets. The government schemes incentivise the entry of both large-scale wind and solar generation and small-scale solar PV systems (by commercial and household investors). Community concerns about the impact of fossil fuel generation on carbon emissions, together with the declining financial viability of thermal coal generation, leaves little interest or commercial appetite for future investment in thermal coal generation.
- Second, much of the current thermal generation fleet is ageing and is becoming commercially unviable. Variable renewable generation, with zero fuel costs, puts downward pressure on wholesale energy prices, reducing revenues for much of the existing thermal fleet. Together with the higher operating and maintenance costs of the ageing thermal fleet, there is significant pressure on this less economic generation to exit the market.
- Third, technology costs for renewable and storage resources, both large and small scale, are falling rapidly. These cost reductions, coupled with zero fuel costs and low operational costs, make this new technology highly competitive when compared with the costs of investing in more traditional forms of generation. Battery costs have fallen substantially and continue to drive consumer uptake of electric vehicles and home storage systems that complement small scale solar PV systems. Digitalisation drives technology advances that will radically change not only how energy is produced, but how it is used by consumers.
- Finally, an increasing number of households and business customers have made investments in DER (such as solar panels, batteries, and smart appliances) and their value is not being fully realised by either their owners or the system as a whole. With the new technology now available, customers can be rewarded for their export of electricity, their ability to manage their load across the day, and for their provision of services to the network. It needs to be easy for customers to switch providers and access choices that meet their needs. Building consumer trust in new energy services through effective co-design and consumer protections will also be a key enabler to increased consumer participation, and the effective integration of DER. If managed well, integration of DER into the system will benefit the owners of the DER resources as well as the system as a whole.

² <https://energyministers.gov.au/publications/post-2025-market-design-national-electricity-market-nem>

These drivers give rise to the challenges that need to be addressed in designing the required changes for the NEM, which are the subject of each of the reform pathways set out in this paper.

1.2. The Approach

To address the large task of redesigning the NEM the ESB divided the work into four interrelated reform pathways, a timeline for implementation and consulted widely. The four pathways are:

1. Resource adequacy and ageing thermal generation retirement

The objective of this pathway is to support the orderly retirement of the ageing thermal fleet and have sufficient replacement generation in place. To enable this outcome, investment is needed that provides an efficient mix of capacity (generation, storage and demand response); and is timely, so the exit of ageing thermal generation does not cause significant price or reliability shocks to consumers.

2. Essential system services and scheduling and ahead mechanisms

The retirement of thermal generation means the essential system services these generators provide (along with energy) also exit the system. These services include frequency control, inertia, operating reserves, and system strength – and all are essential for the security of the electricity system. The objective of this pathway is to ensure that essential system services are properly valued and continue to be provided by the market. Changes are also needed to AEMO’s dispatch mechanisms so that the operator can efficiently procure and schedule the essential services on hand that are required for system stability.

3. Integration of Distributed Energy Resources (DER) and flexible demand

The sheer size of consumer-driven growth in rooftop solar PV, the projected growth of battery storage, and continued advances in digital technology, have the combined potential to revolutionize the way many customers receive and use energy. These changes have already begun for many customers today, and the increase in EV ownership will add momentum towards an even more de-centralised energy system. A significant amount of electricity is already generated at a smaller scale – with close to 3 million households now having solar PV on their rooftops (which is at least twice as large as the single biggest generator in the NEM).

The objective of this pathway is to effectively integrate these distributed resources into the NEM and properly value the flexibility from customer demand in a market that has always been dominated by supply. The DER Implementation Plan has been developed to coordinate and effectively sequence the reforms necessary to address emerging risks, to get ahead of the curve on others and unlock value to all customers (both those with DER and without). Digitalisation will untap the potential of these smaller assets, leading to innovation in services, greater choice, and value to all consumers.

4. Transmission and access

The Integrated System Plan (ISP) describes a least cost pathway for new transmission and Renewable Energy Zones (REZs) to meet the needs of the sizeable investment in variable renewable generation that is occurring. The objective of this workstream is to further facilitate ‘actioning the ISP’. A plan about how best to develop REZs is needed to efficiently connect new renewable generation and make the most of the abundant renewable resources across the NEM. Once the new transmission and REZs are developed, congestion on the grid is expected in some places and at some times. This congestion needs to be managed.

Challenges are emerging in getting the new transmission projects built in a timely manner, and the costs of investing too late can be substantial for consumers. Ministers will be provided advice on how to improve and support the timeliness and efficiency of transmission project delivery through the AEMC’s Transmission Investment and Planning Review.

The ESB has provided advice to Energy Ministers on transmission cost allocation and governments are currently conducting further analysis and considering next steps. For instance, the actionable ISP project to develop Marinus Link is subject to a decision rule whereby the project will only proceed if agreement is reached on how the cost of the project will be recovered. Given the scale of transmission build necessary for the future, the ESB considers there is a need to resolve an appropriate fair cost allocation methodology for transmission.

Package of reforms

The four Post-2025 reform pathways are a package of timely and interrelated reforms and actions to deliver the necessary design changes in the NEM for 2025 and beyond. Each of these four pathways is set out on a timeline to reflect the urgency of the situation. The reforms are divided into immediate – those to be done and implemented now, initial – those to develop now and implement in the medium term done, and long-term reforms – which can be worked on now but depend on due consideration and analysis and developments across the sector before implementing. As a package these four timely and interrelated reform pathways deliver the necessary changes in the NEM in the period to 2025 and beyond.

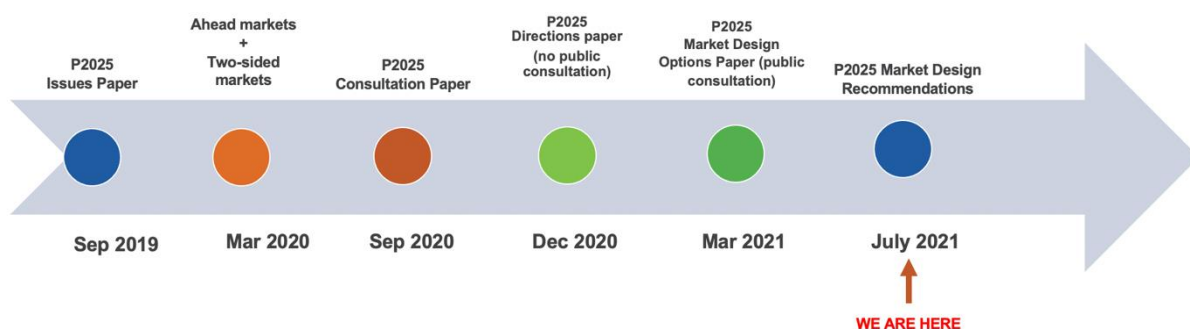
1.2.1. Consultation

This paper, prepared by the ESB, represents the joint and collaborative efforts of the energy market bodies: the Australian Energy Market Commission (AEMC), Australian Energy Market Operator (AEMO) and the Australian Energy Regulator (AER). The ESB has also worked closely with a broad range of industry stakeholders, consumer bodies, academics, government bodies and interested parties over the two-year reform program.

Over this period, the ESB has carried out approximately 150 work group meetings and briefings (as well as those run by / together with AEMC processes). These include the regularly convened Technical Working Group and Advisory Group meetings (comprised of a broad range of stakeholders with relevant expertise from more than 30 organisations), as well as deep dive workshops, Integrating DER design sprints, pilot programs, CEO Roundtables and reference groups.

In late 2019, the ESB ran an International Symposium to bring together academics and speakers from a number of energy markets to engage in discussions on critical issues facing the NEM.

For the Post-2025 program, the ESB has published an Issues Paper (September 2019), Directions Paper (March 2020), Consultation Paper (September 2020), Directions Paper (January 2021), Options Paper (April 2021) and now Final Advice (July 2021). We have received substantial stakeholder feedback to each of these processes, with over 100 submissions received to each of the consultation processes carried out.³



³ Details of Post-2025 reports, submissions and consultant reports can be found here: <https://esb-post2025-market-design.aemc.gov.au/reports-and-documents>

These processes have been complemented by adjacent processes carried out in relation to specific reform elements, and in collaboration with our market body colleagues (AEMO, AEMC, AER). Considerable stakeholder interest and feedback has been received via these processes which has also greatly contributed to thinking in the Post-2025 program.

The ESB also commissioned and published consultancy reports to provide advice and input into the issues being considered across various workstreams.

Stakeholders have committed significant time and resources to provide considered and thoughtful input into the Post-2025 reform process. The ESB values this engagement and sincerely thanks all stakeholders for their participation in this process.

1.3. Enabling implementation

Reforming the NEM is not without risk. Although implementation will not be a ‘big bang’ and will instead be managed in a stepped process over time, some reforms representing a fundamental shift in market design. There are risks involved in the successful implementation of the pathways which the ESB has sought to address in its recommendations, in the design of both reforms and the pathways themselves and the development of the ESB’s Data Strategy.

1. Critical data needs

Existing data management systems, processes and regulations struggle to keep up with changes in how energy related data is generated, used, and accessed. New technologies, such as smart meters, smart home devices and distributed energy resources (DER), are creating opportunities for consumers and the sector, but also challenging the effectiveness of current systems and data flows, highlighting where data can be better managed across the NEM. There are barriers for consumers and market participants in accessing certain types of information and costs involved in sharing it effectively. Regulatory and governance constraints on data sets means simple activities such as linking energy consumption data to behind the meter activities cannot readily occur.

This results in consumer behaviour being poorly understood despite the abundance of rich data sets. Failing to meet emerging data needs of the NEM results in suboptimal forecasting and network planning, poor visibility of resources on the grid, difficulties in monitoring performance of energy companies, reduced innovation, and choices for consumers. Each of these outcomes will have significant impacts for the reliability and security of the NEM.

Consistent with the recommendations made by the Finkel Review on this issue, the ESB has developed a Data Strategy for the NEM.⁴ Meeting the data needs of the NEM not only enables the reform pathways, particularly to support the integration of DER and flexible demand but puts consumers at the centre of digitalisation. Access to clear and simple information allows consumers to make better, more informed choices and have greater agency and control over their energy use and devices.

2. Changes to policy

Policy changes can be expected over the years ahead as the changes are implemented. The effect of such changes on the delivery of the reforms must be monitored and Recommendation Ten (relating to ongoing monitoring) is directly relevant. One policy area that would have a profound impact on the reforms is emissions reductions targets. At present, each jurisdiction has a target for emissions reduction and a trajectory, implied or specified, about how to reach that target. Typically, the target is ‘net zero emissions by 2050’ though some jurisdictions have more challenging targets and

⁴ The ESB Data Strategy is published alongside this report.

trajectories. Should policy move to a more rapid and deeper emissions reduction target the reforms may need to be implemented with more speed and vigour.

3. Governance

Given that the ESB arrangements are due to be reviewed, following both the Edwards Report last year and the delivery of the Post-2025 market design proposals, the ongoing responsibility for delivery of these reforms in coming years must be addressed. To this end the ESB has delivered suggestions to the Energy Ministers. Given that the changes in the industry are not stopping, the momentum of the reform process needs to continue. The features of the ESB work that should be retained include good cooperation between the market bodies, extensive consultation with industry participants and jurisdictions, and quite detailed input from those participants, customer advocates, academics, and others. To ensure that appropriate governance continues Energy Ministers are recommended to decide on the future of the ESB or its replacement as soon as possible.

4. An Adaptive management approach

Progressive implementation of the Post-2025 reforms provides a managed evolution of the market and allows participants the opportunity to adapt to reform. While some early and interim measures will be (and have been) delivered to address the needs already emerging within the system, an adaptive approach for delivering initiatives enables the market to respond to each set of measures before building further on these with additional reforms.

5. Interdependencies between the pathways

While each of the reform pathways have been designed to address the four key challenges for the NEM as it transitions, there are clear interdependencies between them. As the reforms progress to a more detailed level, careful preparation and planning of reforms is necessary to take account of evolving market conditions and the implications of the interrelated nature of the reforms.

6. Implementation costs

Implementing the reforms in this paper have both benefit and cost implications.

It is important that Ministers ensure the market bodies are adequately funded to undertake their functions, including the work programs necessary for the further development of the reforms identified in each pathway.

Planning now for the investment necessary in critical systems will not only minimise the delivery risk that comes with the timing and sequencing of reform implementation but unlock the development of system capability that allows the NEM to function efficiently and keep up with the technology advances that are driving change.

1.4. Benefits of the reform pathways and the need for ongoing monitoring

Benefits for the sector

The ESB has completed a high-level, indicative evaluation of the benefits each reform pathway could be expected to deliver. The objective of doing this evaluation is not to provide an accurate estimate of benefits but rather to understand the general magnitude of benefits that could be expected from the breadth of the market design package. Understanding that the benefits are an order of magnitude greater than the costs of implementation gives confidence for the case for change. It also allows the direct costs of reform, to AEMO and market participants, to be considered in perspective. There are costs to transition regardless of whether the reform occurs – but what can change is the nature of those costs and how they are managed through the right market design and forward planning for implementation.

This preliminary evaluation shows that the benefits of implementing the reforms - which is in the order of billions of dollars - dwarf the implementation costs that can be expected. Moreover, these reforms will 'smooth' the transition to deliver the security, reliability, and price outcomes we need for the forecast levels of large-and small-scale renewable energy penetration for the NEM. They facilitate the transition to a low emissions system and harness the benefits that renewable energy has to offer.

As part of and following the implementation of the ESB's Post-2025 reforms, continued monitoring of reliability and overall benefits and costs to consumers is necessary. It is also important to recognise that operating and regulating a system with so much variable renewables (both small and large scale) is a new experience globally. We are leading the world in our uptake of decentralised resources. The pace at which Australia is leading the world in installing renewable generation is unprecedented. Per capita, we are installing renewable generation at double the rate of the next fastest country, Germany, and about 10 times the world average. This makes review and monitoring essential so adaptation can occur as experience grows and learning occurs. While this is happening now the increasing penetration of renewables makes the approach even more important.

Benefits beyond the sector

Acting now also provides more far-reaching benefits. As the market transitions to net zero emissions, driven by the penetration of renewable energy, this will benefit customers, with future energy prices driven by zero fuel costs. The cheaper electricity becomes, the more the economy will continue to electrify, a trend we are already seeing in the transport sector. Cheaper decarbonised electricity also makes the prospect of a hydrogen economy much more likely.

Getting the energy transition right, provides the path to a decarbonised economy, providing economic stimulus for the domestic economy and benefiting all consumers.

2. Final Recommendations

Resource adequacy mechanisms and ageing thermal retirement pathway

1. To support *immediate* resource adequacy in the NEM, the ESB recommends Energy Ministers agree a number of reforms:
 - a) instruct the ESB to prepare rule changes for submission to the AEMC to implement:
 - i. a NEM wide jurisdictional strategic reserve for the procurement of any required reserves, that individual jurisdictions consider necessary beyond the market reliability standard; and
 - ii. enhancements to existing generator exit mechanisms to provide greater transparency of generator availability.
 - b) adopt a set of principles to guide the development of any future jurisdictional schemes to ensure a common approach that is consistent with current market signals for investment. Jurisdictions are encouraged to use currently available information on market needs and seek additional information from the market bodies as necessary when considering jurisdictional schemes.
 - c) adopt a Ministerial lever to trigger the current Retailer Reliability Obligation as is currently in place in South Australia. This would give Ministers the ability to strengthen the Retailer Reliability Obligation if they wish while further detailed design work is undertaken on a capacity mechanism.
2. To support timely entry and orderly exit of resources in the NEM for 2025 and beyond, the ESB **recommends** Energy Ministers agree to a further *initial reform*:
 - a) provide in-principle support for a capacity mechanism for the NEM to ensure the competitive provision of the right mix of resources as the market transitions towards net zero emissions. This mechanism will ensure investment in an efficient mix of variable and firm/flexible capacity that meets reliability at lowest cost and increase government and community confidence that resource adequacy will be delivered by the market reducing the need for interventions.
 - b) In recognition of significant stakeholder concerns, instruct the ESB to work with stakeholders and jurisdictions over the next 12-18 months to develop the detailed design of the capacity mechanism for the agreement of Ministers in mid-2023. There are a number of policy choices in the design of a capacity mechanism, as set out in this advice, which need to be considered to ensure the recommended design is both effective and efficient.
 - c) a decentralised capacity mechanism (where the volume of required capacity is determined by liable entities, such as the Physical Retailer Reliability Obligation set out in this advice) should be the starting point for the design work. Further consideration should also be given to:
 - i. whether it would be preferable to centrally determine the volume of required capacity;
 - ii. whether using existing contracts between registered market participants would be preferable as the basis of the scheme (rather than creating a new certificate);
 - iii. how to best address the impacts of the proposed capacity mechanism on retail competition (including small retailers), commercial and industrial customers,

market power concerns, transaction costs for market participants, and affordability; and

- iv. integrating a NEM-wide, common approach to jurisdiction investment schemes to work alongside the new capacity mechanism

Essential system services and scheduling and ahead mechanisms pathway

3. The ESB **recommends** Energy Ministers note that AEMC rule change requests are underway to progress the following *immediate and initial reforms* to support the availability, investment in and scheduling of the resources capable of delivering essential system services:
 - a) frequency control, including a new fast frequency response service and enduring primary frequency response arrangements
 - b) operating reserves services, to explicitly value reserve services separately to energy
 - c) unit commitment for security and system security mechanism. These are operational and short-term procurement mechanisms allowing AEMO to value, procure and schedule specific services and resources to help keep the system secure
 - d) enhanced system strength frameworks, to make it simpler, faster, and more predictable for new generation to connect to the grid and keep supply as secure as possible
4. The ESB **recommends** Energy Ministers instruct the ESB to monitor and provide advice about market conditions and the need for, *longer term reforms* for essential system services, including the need for further unbundling of essential system services, an integrated ahead market or development of inertia spot market.

Transmission and access reform pathway

5. To support the integration of renewable energy zones (REZs), the ESB **recommends** Energy Ministers agree a number of *immediate and initial reforms*:
 - a) to adopt the REZ Planning Rules and the Principles for an Interim REZ framework to address the urgent planning implications for REZs.
 - b) instruct the ESB to prepare a rule change for submission to the AEMC to progress the congestion management model, adapted for integration with REZs. This model complements the Interim REZ framework and will address the emerging congestion management needs of the system. Comprehensive consultation, with a wide range of industry, consumer and government stakeholders on the detailed design of the model will be undertaken as part of the rule change process.
6. To support timely and efficient transmission investment, the ESB **recommends** Energy Ministers seek advice from the AEMC on what initial reforms are necessary to current regulatory frameworks to improve the timely and efficient delivery of major transmission projects (including ISP projects). This advice will be prepared as part of the AEMC's current Transmission Investment and Planning Review.

Enabling the integration of Distributed Energy Resources (DER) and flexible demand pathway

7. To enable the effective integration of high volumes of DER and flexible demand into the NEM the ESB **recommends** Energy Ministers support the DER Implementation Plan (see Section 5). The Plan sequences *immediate and initial* regulatory, technical and market reforms that address emerging risks and builds capability to deliver benefits to all consumers from high levels of distributed energy resources and new energy services. The ESB will provide Energy Ministers with

advice on additional reforms that will be developed in customer focussed stakeholder co-design and consultation processes as part of the Plan. The Plan will deliver the following outcomes:

- a) Consumers are rewarded for their flexible demand and generation, have options for how they want to engage (including being able to switch between DER service providers), and are protected by a fit-for-purpose consumer protections framework.
 - b) The wholesale market supports innovation, the integration of new business models and has a more efficient supply and demand balance.
 - c) Networks are able to accommodate the continued uptake of DER and two-way flows and are able to manage the security of the network in a cost-effective way.
 - d) AEMO has the visibility and tools it needs to continue to operate a safe, secure and reliable system, including maintaining system security associated with minimum load conditions.
8. To support system security and improved transparency at times of minimum system load, the ESB **recommends** Energy Ministers adopt a jurisdictional Ministerial lever for emergency backstop measures, as an *immediate reform*. Enduring measures to address system security challenges associated with low minimum system load are being prepared as part of the Plan.
9. To support ongoing fit for purpose consumer protection, the ESB **recommends** Energy Ministers note the ESB has developed a Consumer Risk Assessment tool as an *immediate reform*. The tool will be used by the ESB and market bodies in work identified in the Plan.

Implementation

10. The ESB **recommends** Energy Ministers instruct the ESB to monitor each of the reform pathways in light of changing market conditions and provide reports at least annually or more regularly if required.
11. To enable the Post-2025 reform pathways, the NEM of 2025 and beyond requires modernisation of critical market systems and business processes (see Section 8) and adequately resourced market bodies. These are costs and risks associated with the scale and nature of the energy transition rather than costs of the Post-2025 reforms. The ESB **recommends** Energy Ministers:
- a) instruct AEMO to provide more detail of its required funding on a year-by-year basis (to 2025) by end August for the longer-term upgrade that is necessary for AEMO's existing systems and business processes to enable these reforms.
 - b) instruct the AER and the AEMC to provide proposals on a year-by-year basis (to 2025) by end August about additional resources they need to implement the Post-2025 reform pathways.

3. Resource adequacy mechanisms and ageing thermal retirement

3.1. The objective:

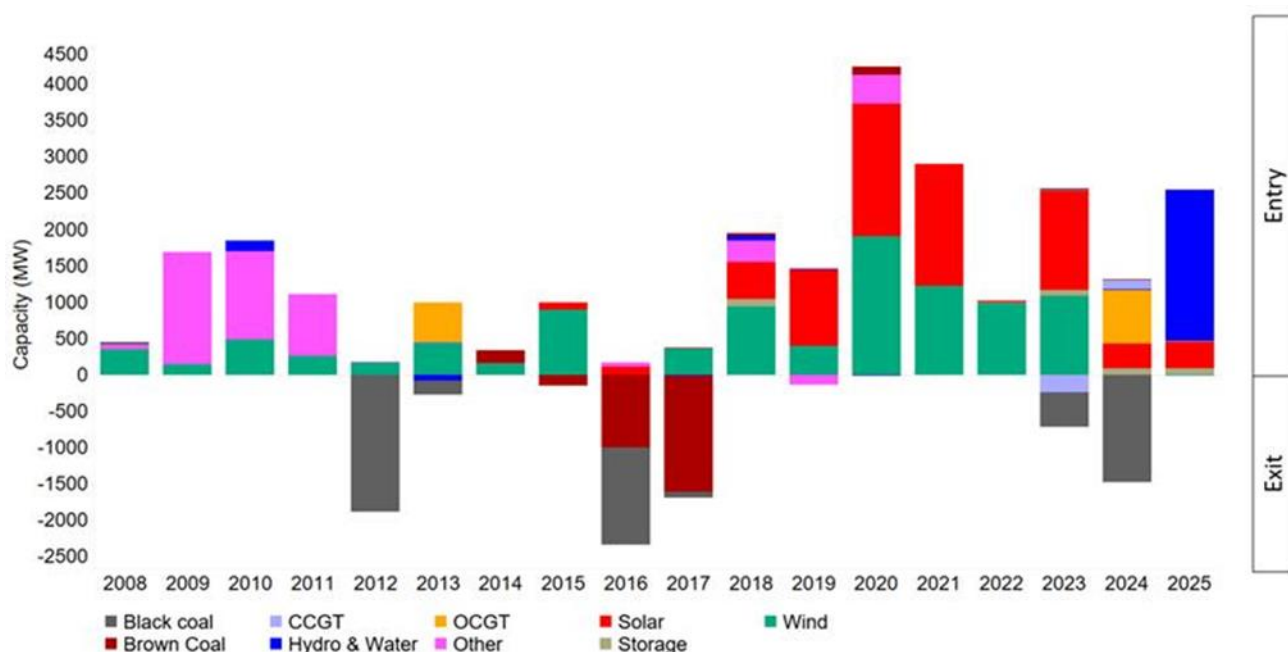
The pathway is designed to deliver:

- new market-based arrangements to explicitly value capacity to provide an ‘investable’ and enduring long-term signal for the competitive provision of the right mix of capacity as the generation mix transitions to higher levels of near zero marginal cost variable renewable generation
- market arrangements that continue to encourage the behaviours that can support efficient allocation of investment risk between participants, jurisdictions, and consumers for the investment needs of the NEM.
- tools that provide jurisdictions sufficient confidence that reliability will be maintained in a way that preserves market signals.

3.2. The issue:

The NEM is rapidly transitioning to a lower-emissions generation profile, characterised by higher levels of near zero marginal cost variable renewable generation. The 2020 Integrated System Plan (ISP) step change scenario projects that 29 GW of large and small-scale variable renewable capacity will be built by 2030. The same modelling also projects that coal capacity will decrease from over 23 GW to around 12 GW by 2030. On current performance the transition is likely to occur at an even faster rate than the modelled step change scenario.

Figure 1 Entry and exit of generation – historical and committed



Source: analysis of AEMO MMS database, AEMO Generator Information Page

As new, more economically competitive variable renewable energy (VRE) comes into the market, more pressure will be exerted on existing thermal generators to retire. As renewable resources and batteries are built, the role for traditional thermal generators declines. They either operate at lower capacity factors (i.e., be producing energy for less of the time), subject to technical constraints or are

replaced by storage and/or other types of flexible and firming resources that operate at times when renewable resources are low.

At the same time, jurisdictional schemes are introducing additional uncertainty. While these schemes can support new investment, their policy priorities are often broader and are often regionally focussed, which has implications for an interconnected market such as the NEM. These schemes can risk dampening spot and wholesale contract market prices which may lead to unexpected closure of existing large-scale generation. This can in turn drive further government interventions to keep ageing thermal plant open for longer. These interventions may not always be transparent and may create further uncertainties in the commercial investment environment.

Given the uncertainty the transition creates, jurisdictions naturally feel compelled to step in to manage longer-term risks, if there is no confidence that the risks are being managed elsewhere in the market. However, jurisdictions' willingness to accept gaps in reliability or the very high scarcity pricing necessary for investment, seems to be significantly lower than that of the private sector, with governments investing sooner to manage risk on behalf of customers. Governments may also have less risk appetite for outages than the commercial generators.

Other changes driven by the transition are also adding to investment uncertainty. Technology costs for renewable and storage resources continue their sharp decline, creating new considerations for what will be the most economically viable technology for generation in the longer term.

Demand is increasingly hard to predict and hedge. Demand is currently falling, as residential customers support the growth in solar PV and battery installation, along with engaging with smart appliances and other DER.

Large energy use is also changing, with many large users also examining ways to modify their production processes to become more flexible as they strive to produce 'green' steel, aluminium and even 'green' cement. At the same time, energy intensive commercial and industrial demand has also been falling, and there is uncertainty over future energy intensive industries, also making it difficult for generation investors to undertake long term investments that would have otherwise underpinned commercial and industrial electricity demand. Many of these large commercial and industrial customers – and an increasing number of retailers for residential customers - do not contract forward (which would drive investment in generation) but instead lower their costs by managing their energy price risk in the real time market because energy prices are low. In the future, demand may increase substantially after years of decline with the entry of EVs, larger demand from energy intensive data centres, from hydrogen electrolysis production and increasing electrification in other sectors as they seek to decarbonise.

Potential changes by generators to the timing of large thermal exits impact the timeliness of replacement capacity and potentially affect reliability and price. Expectations of lower average market prices (but still with periods of extreme volatility) have the same effect. Under our current market design investors rely on prices being high enough to incentivise investment in some resources which may only be called on rarely. As noted above investors also lack confidence that government will tolerate the periods of high prices necessary for investment.

In the face of this uncertainty, participants delay or defer investment decisions and manage short term risk exposure. Investors may not have sufficient incentive to manage long-term investment risk.

The problem to address then is one of risk allocation. Without the ability to lock in longer-term revenue streams, participants need sufficient incentive and confidence to invest in an environment of extreme uncertainty. Jurisdictions need reassurance that participants are going to meet the needs of the system. Without this assurance, jurisdictions will continue to intervene in the market in order to ensure supply meets reliability with capacity-equivalent arrangements, increasing investment risk in the process.

The ESB considers the solution is to align the risk decisions faced by the participants and the risk expectations of the jurisdictions. Governments can therefore be reassured that the market delivers timely entry and orderly exit, in a manner that is consistent with the expectations of consumers.

To encourage investors to take long-term capacity risk, market arrangements that explicitly value capacity, separately from the energy price, are needed to support the quantum of build required over the next decade. Under current arrangements electricity generators are paid for the energy they produce but not the capacity they make available. Valuing capacity explicitly complements existing spot and contract market revenue streams, and in doing so provides an 'investable' and enduring long-term signal.

The NEM does value capacity at present but relies on extreme pricing volatility as a fundamental driver for new investment. A future high-VRE power system with low-to-no fuel costs will diminish the value implicit in current spot and contract prices, which are currently low on average. Power Purchase Agreements – which predominantly underwrite VRE – may not be in such plentiful supply. Adjustments to design settings could address the issues but are inconsistent with both government and community expectation.

The NEM needs a mechanism to more specifically value capacity, to harness the power of commercial investment necessary for capacity requirements, including in new technologies that can deliver firm and flexible resources as the effectiveness and efficiencies of ageing thermal assets fall away. Explicitly valuing the signal for capacity can be achieved through a new capacity mechanism that complements the existing market, and which could be integrated with a NEM-wide common approach to jurisdictional schemes.

A new mechanism to explicitly value capacity is a major change to the NEM. The significance of this change to market design means there is a need to consult on the development of the detailed design for the mechanism over the next 12-18 months.⁵ The market will then need sufficient notice before it can be implemented. However, there are improvements to be made in the short term, prior to the implementation of a capacity mechanism, to support efficient risk allocation and provide jurisdictions greater confidence that reliability will be maintained in a way that preserves market signals.

3.3. The reforms

3.3.1. Immediate reforms

Adopting investment principles for jurisdictional schemes

The ESB is recommending a set of principles be adopted by jurisdictions to guide the development of future government investment schemes. The principles seek to maintain alignment between both the physical needs of the electricity system and the financial interests of generating resources that are party to long duration underwriting agreements. In doing so the principles will 'dovetail' these schemes with current market arrangements and, by increasing transparency around them, coordinate their impact on the market. They will also enable a new capacity mechanism to function more effectively, minimising total costs and risks for participants and jurisdictions.

⁵ The ESB notes that international experience suggests that development of an appropriately designed capacity mechanism can be an involved process. The UK developed a central capacity market over five years and introduced it in 2014 as part of a wider programme of reform to decarbonise the UK's electricity supply while maintaining reliability and affordability. The French capacity mechanism was implemented in 2017, with development beginning in 2010 and detailed rule design from 2014.

Information gathering and provision

Information on the resource needs for the NEM needs is critical for the market to make investment decisions and to inform the development of any future jurisdictional schemes. The current arrangements are fit for purpose and no specific reforms are proposed. The ESB considers if existing arrangements are better leveraged, they can provide the information that jurisdictions and participants require to make informed investment decisions. For example, AEMO currently has flexibility to change the information it makes available to the market and jurisdictions through the ISP and Electricity Statement of Opportunities (ESOO) to increase the visibility of what mix of resources are needed for reliability and security, in light of jurisdictional policies and their 'over the border' impacts in an interconnected NEM. Jurisdictions are encouraged to use currently available information on market needs and seek additional information from the market bodies as necessary when considering jurisdictional schemes.

Managing early exits

Having considered a range of options to bolster current exist arrangements, the ESB is recommending changes to increase information provision around mothballing and seasonal shutdowns to support notice of closure requirements. This will involve changing obligations on generators when submitting their availabilities to generate to AEMO for inclusion in AEMO's Medium-Term Projected Assessment of System Adequacy (MT PASA). These changes provide greater transparency around when generators will be available to supply, and the lead time required for recall from an outage. This information may also be used by the AER as part of its existing monitoring functions and could inform its assessment of compliance under the current notice of closure arrangements.

Any viability, market impact or other assessments completed by jurisdictions when considering the impact of a generator's retirement, should also be shared with the market to the extent practical. Understanding the assessed risk of early exits assists the market in making better decisions about how to address the implications of generator exits.

Jurisdictional Strategic Reserve (JSR)

As we move to a new capacity mechanism in the medium term, a JSR may provide those jurisdictions who are concerned about increasing risk of unforeseen reliability events (for example, the early exit of generators within the notice of closure period) with an additional backstop in the form of an out of market reserve. A JSR would facilitate the procurement of any required reserves additional beyond the market reliability standard that jurisdictions consider necessary, in a manner which is targeted and least distortionary to current market arrangements.

The jurisdiction would be responsible for determining the level of reserve that it considers appropriate and for establishing the reserve. The JSR would then become part of AEMO's RERT portfolio and would be activated as needed. Costs of the reserve, once activated, would be recovered in a manner consistent with the existing cost recovery arrangement for the current RERT. The fixed purchase and establishment costs of the strategic reserves would be met by the jurisdictions seeking the reserves. As an out of market reserve, it also has no impact on wholesale prices. A JSR is proposed for implementation through a rule change process. This will allow the opportunity for consultation with stakeholders on its final design.

A Ministerial trigger for T-3 RRO instruments

Until a new capacity mechanism is in place, the ESB considers a jurisdictional lever to trigger the RRO to be an appropriate tool for jurisdictions to manage reliability gaps, where a jurisdiction considers additional confidence, over and above the other immediate reforms, is needed. At present, only the South Australian Minister has the ability to trigger the RRO at T-3 in the event it does not trigger automatically. The ESB recommends this be implemented nationally to allow Ministers to use a lever

if they so wish. If this reform is not agreed, it is open for jurisdictions to implement a lever in their own jurisdictions.

Operating reserves

Explicitly valuing flexible, responsive resources as separate essential system services is being considered as a reform on the Essential Systems Service, Scheduling and Ahead Mechanism pathway for its operational implications. The ESB has also given further consideration to an operating reserve product in terms of its value in the investment timeframe and in meeting resource adequacy needs of the NEM.

The extent to which an operating reserve product influences resource adequacy depends on a range of factors, including the exact design of the operating reserve product as well as the implementation of any of the other reforms being canvassed under the resource adequacy mechanisms workstream. An operating reserve product has many similar limitations to the energy market in terms of its ability to deliver long-term investment signals. This means that while an operating reserve product may deliver some reliability benefits, it is unlikely that it would support a business case for parties making long-term investment decisions. Further consideration is needed on the form and operation of an operating reserve product, but it is likely it should be considered as a potential complement to the suite of resource adequacy reforms, rather than as a mechanism to deliver the necessary long-term signals. This will be considered further as part of the rule change process underway for this reform (see below).

3.3.2. Initial reform

A new capacity mechanism

A detailed straw proposal for a capacity mechanism, based on a certificate scheme, has been developed by the ESB and is detailed in Part C of this report. This could form the basis of a starting point for further design work. The straw proposal is a decentralized capacity mechanism in that the volume of required capacity is determined by liable entities (market participants) who would be required to hold a certificate position to cover their actual demand.

In the straw proposal for the physical retailer reliability obligation (PRRO):

- certificates would be allocated to resources, based on their expected ability to be available to generate during 'at risk' reliability periods. As a new tradeable product, its complementary revenue stream will provide an investable and enduring signal that more directly targets the needed capacity for timely entry and orderly exit. The forward value of certificates would reflect any perceived risks of scarcity (high prices) for capacity.
- certificates would value both existing fleet and new investment in assets that are best placed and most cost-effective in responding to shortfall period.
- requiring liable entities to hold sufficient physical certificates to meet demand during a predefined period provides a 'line of sight' between demand and physical supply, providing transparency and confidence that demand will be met. Participants would continue to be incentivised to manage their financial risk in the spot market through financial contracts, making the straw proposal an 'adjunct' to the current market.

There are a range of design settings that need to be selected, including but not limited to certification, assessment frequency, certificate duration, locational restrictions, time of compliance assessment, trading arrangements, market liquidity obligations and penalties for any such mechanism. These will be considered in the proposed detailed design process. Integrating a NEM-wide, common approach to jurisdiction investment schemes to work alongside the new capacity mechanism will also be considered further in the development of the capacity mechanism.

In light of the significant stakeholder feedback however, the ESB proposes to first answer a series of structural questions posed by stakeholders as part of developing the detailed design:

- Whether it would be preferable to centrally determine the volume of required capacity will be considered in the detailed design process. This and other more ‘centralised’ design choices within the straw proposal may better minimise the transaction costs for participants;
- whether using existing contracts between registered market participants would be preferable as the basis of the scheme (rather than creating a new certificate of financial contracting to particular types) is a preferable basis for a new capacity mechanism. Limiting the nature of the existing contracts between registered market participants that are used to meet obligations under the RRO could incentivise financial contracting which has a stronger link to achieving a ‘firm’ physical resource outcome.

The ESB is cognisant of the potential impacts associated with this significant shift in market design. Addressing these risks is a key priority in the detailed design phase in order to safeguard competition in the retail and wholesale market (the impact on small customers and innovation) and reduce impacts on commercial and industrial customers in a way that best minimises the transaction costs of market participants of the new mechanism and maintains affordable outcomes for consumers.

3.3.3. Long term reform

It will be necessary to monitor the presence of various types of resources, including long-term storage such as pumped hydro and new innovative fuel types such as hydrogen. Pumped Hydro, in particular, with its planning and infrastructure requirements, may require contracting arrangements that go well beyond a market’s ability to efficiently deliver. A new capacity mechanism could be designed to lengthen the investment signal for such assets, but the current proposed decentralised nature of that mechanism may make it difficult to provide 10 to 15 year contracts outside of those underwritten by jurisdictions for such assets. Settings for a new capacity mechanism will need to be revisited regularly to ensure it is being leveraged to its full capability to drive good outcomes for consumers.

3.4. The benefits of this reform pathway

The ESB has undertaken a high-level indicative evaluation of the benefits of this reform pathway supported by some modelling. The analysis undertaken shows that, to achieve the acceptable reliability in the face of uncertainty as to when generators will exit, there are potential benefits of a new capacity mechanism of \$1.3 billion (NPV), when compared to adjusting the current market signals for capacity by raising the market price cap and increasing price volatility in the energy market.

This modelling suggests that, with reform (an appropriately designed capacity mechanism), it will be cheaper to deliver capacity under new market arrangements that reduce the uncertainty for investment in capacity. Without reform to the way that plants enter and exit the system to smooth the transition, there will be costs to consumers. The timely entry of generation to replace gaps in available capacity is also crucial to maintaining reliability

Further work will be undertaken on the costs and benefits associated with the new capacity mechanism as part of the proposed detailed design process.

4. Essential system services and scheduling and ahead mechanisms

4.1. The objective

This pathway is designed to deliver:

- new market-based arrangements to value the services needed to support the changing mix of resources in the NEM. These capabilities are currently 'bundled' in the provision of energy by the exiting thermal generation fleet. Four essential system services were identified for initial focus: frequency, inertia, system strength, and operating reserves,
- new market mechanisms to support efficient scheduling and dispatch by AEMO. Learnings from the operation of these new markets and mechanisms will be important to understand how new technologies and resources with capabilities can continue to deliver these essential services,
- a range of supply and demand-based technologies and resources with capabilities to deliver these essential services.

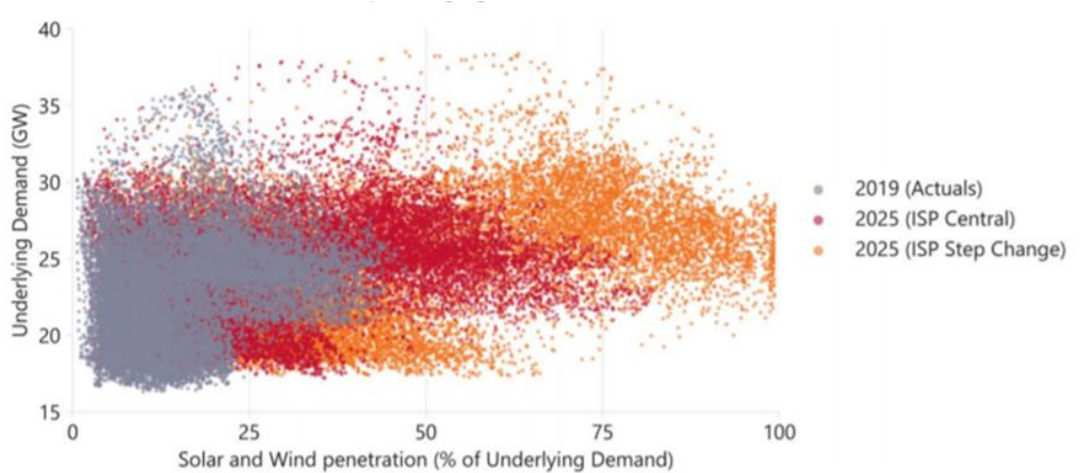
In considering these changes to the NEM, ideally spot market arrangements combined with co-optimisation should be used where possible, and the market should progressively move towards spot market provision for services. However, there are some services that may be better suited to structured procurement where spot market arrangements may not be appropriate (either now or ever).

4.2. The issue

The NEM currently has over 17GW of wind and solar capacity installed. A further 53GW is proposed for the NEM, which is almost all the current NEM capacity. This change in the generation mix contributes to a fall in wholesale energy prices through the low marginal operating costs of wind and solar generation. Falling wholesale prices mean operations are increasingly uneconomic for ageing synchronous plant across the NEM, resulting in lower levels of commitment of synchronous generation and early exits of these plants. The essential system services (frequency, inertia, operating reserves and system strength) that were traditionally provided as a by-product of energy, produced by synchronous spinning generation, are no longer provided in abundance. This move from a synchronous system dominated by big rotating generators to an asynchronous system dominated by variable decentralised renewable energy will press the limits of current system security and operational experience.

As we transition towards a resource mix with a high penetration of variable renewable energy, the power system of the NEM needs to accommodate periods of either very high, or very low instantaneous penetration of renewables – and sudden changes from one to the other that comes with the weather dependence of a low emission fleet. The issue is urgent. Since 2012, 90% of investment in generation in the NEM has been wind and solar. Instantaneous wind and solar penetration in the NEM was 38% in 2018 and 52% last year. In South Australia, 100% of instantaneous local demand is regularly met by local wind and solar output, and we have already seen a world-first milestone of 100% instantaneous renewable solar penetration.

Figure 2 Instantaneous penetration of wind and solar generation, actual in 2019 and forecast for 2025



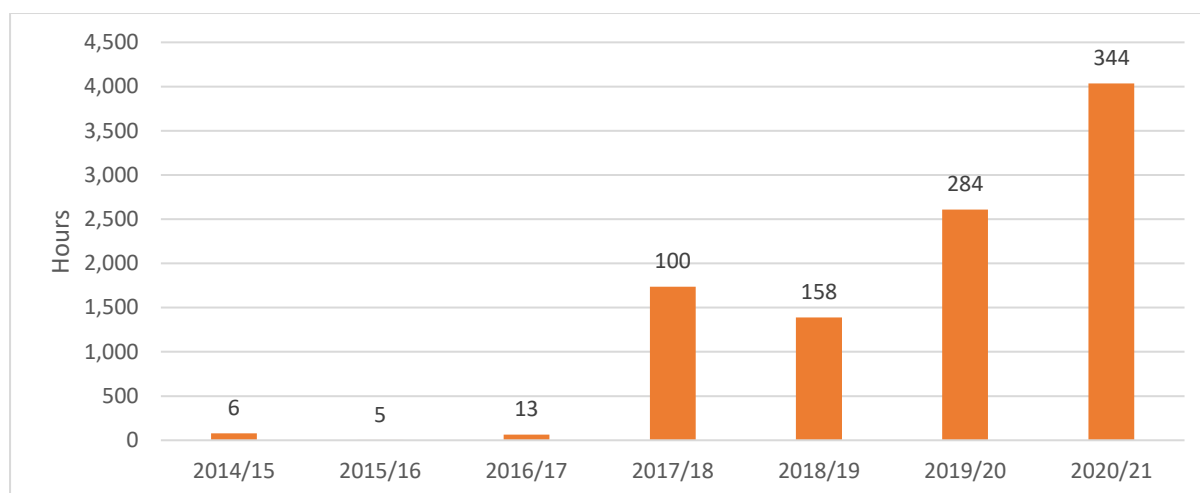
Source: AEMO

Future operation of the power system requires management of significantly different dynamics. The NEM now needs to separately value these essential system services from energy provision to encourage alternative sources of supply via market or other procurement mechanisms. We now have 'missing markets' for these services which must be addressed in advance of the services becoming scarce. The business cases for investing in resources and technologies that can provide these services, including batteries, synchronous condensers, and other advanced technology, such as by grid-forming inverters, is supported by the establishment of these missing markets.

The present system is designed around traditional one-way flows and provision of power to meet customer demand from a small number of large synchronous generators that are centrally located. There are now new modes of operation with more dispersed non-synchronous generation, and rapidly increasing uptake in solar PV, changing the combinations of resources on the grid meeting customer needs.

AEMO will need the right tools to manage these changing dynamics. The absence of effective tools means scheduling the market is increasingly chaotic, with real-time dispatch unable to co-ordinate commitment effectively across all essential system services. Without an efficient means to procure and schedule the resources that are providing the necessary capabilities, AEMO may be required to consistently intervene in the market and direct participants to stay or come online. AEMO's interventions in the market have increased dramatically, from 5 in 2016 to 344 last year.

Figure 3 Historical number of directions and duration, 2015-2021



Source: AEMO, data by financial year

Without new tools to manage the system, AEMO also has a diminished ability to learn through operating new modes of the power system without relying on directions and interventions. AEMO will always have the ability to intervene and direct resources to maintain power system security – consistent with best practice of electricity market operations. However, reliance on interventions to ensure system security is inefficient. Market-based scheduling mechanisms can instead enable a greater range of resources to participate, are more transparent, and provide greater certainty to AEMO and market participants of commitment decisions.

Learning will be an important part of the transition. Ongoing technical analysis and research is required to ensure that the needs of the power system in these new dynamics are provided to support a secure system. We are at the frontier of understanding how to operate a power system with increasing levels of renewable penetration. For example, while Australia is leading the world in experiencing operating conditions of low levels of synchronous generation, to date no gigawatt-scale system has ever operated without some synchronous generation online. This situation can be compared to other power systems, such as in New Zealand or France, where power systems are increasing their proportion of DER and variable renewable energy to meet emissions targets; but both have significant levels of synchronous plant (hydro and nuclear respectively).

4.3. The reforms

4.3.1. Immediate reforms

Frequency

Substantial work on frequency control frameworks in the NEM has been completed to ensure that these frameworks keep up with the needs of the transition. This places the reform at an advanced stage of implementing enhancements to the frameworks; augmenting and leveraging the current arrangements as needed.

The two immediate reforms are:

- implementation of a new fast frequency response (FFR) service to help manage system frequency following contingency events with reducing system inertia; and
- developing enduring primary frequency response (PFR) arrangements to support frequency control during normal operation.

Fast frequency response

On 15 July 2021, the AEMC made a final rule to introduce two new market ancillary services to allow for Fast Frequency Response (FFR) to be procured by AEMO to help control system frequency following sudden and unplanned generation or power system outages. The use of these new services is expected to lower the cost of frequency control ancillary services relative to the expected future costs under a continuation of the current market ancillary service arrangements or other alternative arrangements.

Primary frequency response

AEMO is currently in the process of coordinating changes to generator control systems in accordance with the mandatory primary frequency response rule. The monitoring of plant and power system impacts due to the implementation of this rule will inform the AEMC determination for enduring Primary Frequency Response (PFR) arrangements.

The AEMC intends to invite further stakeholder comment through the publication of a draft determination for the primary frequency response incentive arrangements rule change on 16 September 2021.

4.3.2. Initial reforms

Inertia

There is a close interaction between the immediate reforms for FFR services and the valuation of inertia. However, FFR and inertia are different services. Although FFR has the potential to assist with frequency management at lower levels of system inertia, FFR and inertia are delivered via different physical mechanisms, and play roles that are not directly interchangeable.

Currently, the NER includes an inertia framework that supports the provision of security critical inertia for each of the NEM regions. However, the NER does not support the full valuation of inertia above these minimum levels. The introduction of a FFR market would likely address much of the system needs under low inertia conditions for the immediate future, but further needs may emerge over time.

Together with the consideration of a new operational scheduling tool, a Unit Commitment for Security (UCS) and potential additional structured procurement through a System Security Mechanism (SSM), it is expected that sufficient inertia and frequency control capability is procured and enabled in the short and near term. Both the UCS and SSM are identified as separate reforms on this pathway.

The ESB considers that further development and technical consideration is necessary before developing an inertia spot market, but the ESB has identified an inertia spot market as a longer-term reform for development. Continued analysis of the needs of the power system in managing frequency control using frequency services (the immediate reforms addressing both primary frequency control and contingency frequency services), synchronous inertia and equivalent synthetic inertia services (currently being trialled in the NEM) will be necessary. This also enables further technical learning of the capability and availability of new technology, such as advanced inverter technology, to assist in the provision of these services. Learnings from the West Australian's Wholesale Electricity Market (WEM) novel approach to valuing inertia (due to go live in October 2022) will be relevant.

Further to stakeholder feedback, the market bodies will commence work now to consider the appropriate steps to take in moving to a lower inertia system. The primary vehicle for the consideration of the technical requirements will be through AEMO's Engineering Framework.⁶

⁶ Details on AEMO's Engineering Framework can be found here: <https://aemo.com.au/en/initiatives/major-programs/engineering-framework>

Operating Reserves

Currently, operating reserves have been provided by generators implicitly, by generators who keep some of their 'spare' capacity in reserve to manage their risks in the energy market. That is, they use their reserves to 'ramp up' for unplanned system development or respond to high prices. Demand response can also provide this sort of reserve. This un-dispatched capacity that is made available by market participants in the wholesale market can act as 'in market' reserves (a buffer for the system) and be drawn upon by AEMO as part of various market and regulatory arrangements; however, they are not specifically provided for through a mechanism or market.

The costs of providing these operating reserves are part of the cost of providing energy, that is, they are 'bundled together'. Without a separate and explicit signal for their provision (that is, 'unbundling' them from the value of energy), the level of operating reserves available to the system is dependent on the commercial obligations of market participants. Investment in reserves is a commercial decision by generators to maintain spare capacity within their portfolios to ensure they can meet their commercial obligation. While commercial drivers are a key reason participants invest in spare capacity to begin with, how participants make this capacity available to the market depends on a number of incentives in the current arrangements. Generators offering in more supply, or consumers reducing their demand, can be rewarded if this capacity is called upon.

The increasing variability and forecast uncertainty of supply and demand that comes with a transitioning fleet, the wide range of power system challenges that can come with extreme weather, and the integration of new technologies and combinations of resources into the power system, suggest the potential need for reserves is increasing. Or rather the changing generation mix may mean that the volume of reserves in the NEM could be decreasing.

Unbundling reserves from energy to separately value flexible, responsive resources, through one or more new markets is what lies at the heart of this reform. The AEMC is currently considering two rule change requests that propose two different reserve service options. The AEMC published a Directions paper on these two rule change requests in January 2021 with a draft determination planned for December 2021. Detailed modelling to investigate the operational impacts of increasing variability and forecast uncertainty in the NEM is being completed to better understand the need for an operating reserve in light of stakeholder feedback.

Structured procurement and scheduling mechanisms (and system strength)

With the changing power system and resource mix, there are some supporting system services that are currently provided predominantly as a by-product of synchronous generation. At this stage of the transition, these services may not be easily disaggregated, quantifiable or specifically able to be defined, to allow for the formation of a spot market and may be best addressed through structured procurement.

System strength is one such essential system service. Current system strength frameworks provide minimum security - critical levels of system strength - but they do not value system strength above these minimum levels. There is a need for mechanisms to provide system strength services above these levels to enhance security. Given the nature of this essential service a structured procurement approach for these services is preferable as well considering what is needed in both an investment timeframe and an operational timeframe for their provision.

To support procurement in an investment timeframe, the AEMC made a draft rule which requires Transmission Network Service Provider (TNSP) to lead procurement of system strength. This results in better coordination of the provision of system strength between the TNSP and connecting generators, and new access standards for connecting parties to ensure they use only the efficient volume of system strength. It is expected that implementation of this rule change will lead to efficient levels of system strength being provided through economies of scale of the TNSPs central co-ordination role. Additionally, as TNSPs would be required to provide the full amount of system strength, not just

covering a shortfall, sufficient levels will be provided ahead of connecting parties, which will improve the connection process. A final rule for this reform is expected in October 2021.

There is also a need to coordinate the resources procured in this planning timeframes, with those needed in the operational timeframe, to meet the specific conditions of the day. Operationally, the grid configuration can be different to that used in planning studies years before, and the dynamics of the power system need to be managed at a more granular and comprehensive manner. A Unit Commitment for Security (UCS) tool would allow for optimisation in the unit commitment timeframe to optimise the provision of system strength through the resources that have been procured under contract by TNSPs.

A further complementary operational mechanism, a System Security Mechanism (SSM), is a reform that would allow for procurement of other resources in an operational timeframe. The SSM could be used to increase the pool of possible providers to all resources capable of maintaining the system configuration needed for a secure and stable power system. The SSM is proposed to manage emerging needs for the provision of services not otherwise provided through the spot markets, as well as the need for essential system services such as system strength and inertia, which may differ to that which was contracted for in the planning timeframe. Both the UCS and SSM are being progressed in AEMC rule changes underway. A directions paper is due in early September 2021, ahead of draft determinations in December 2021.

4.3.3. Long term reform

Further unbundling of services

As experience is built in operating the system in new conditions, with increased variable renewable penetration and reduced synchronous generation, there may be an opportunity to further unbundle services to specifically value the individual requirements of a secure power system. For example, as knowledge of operating with increased inverter-based resources improves, there may be further opportunity to disaggregate the ancillary support currently provided by the synchronous fleet. This will allow assessment for how the unique performance characteristics of nascent technology meet the necessary capabilities, in turn allowing the evolution to more sophisticated designs with greater market efficiency where and when possible.

The ESB and market bodies will continue to monitor market conditions to provide advice to Ministers on further opportunities for additional reforms.

Integrated ahead market

An integrated ahead market would incorporate ahead trading and co-optimisation of energy and system services. It could be used by the market to coordinate the complex and varying needs of different resources and align these with the operational conditions of the day.

Stakeholders supported the ESB's intent to de-prioritise the development of the integrated ahead market. Some stakeholders, particularly incumbent generators, considered the ESB should remove the integrated ahead market completely from the potential reform pathway, while others agreed with the ESB that there may be value in further consideration of a co-optimised ahead market for energy and services in the future and to allow intertemporal trading.

Lessons learnt from the implementation of the ESS reforms, together with better understanding the power systems dynamics from upcoming reforms including five-minute settlement (commencing October 2021), the wholesale demand response mechanism (commencing October 2021), and increased active demand-side participation and penetration of storage resources, will be necessary to inform further advice to Energy Ministers on this reform.

4.4. The benefits of this reform pathway

The reform pathway provides mechanisms to address the emerging challenge of operating the power system in an environment of high VRE penetration. Implementing reforms to procure and directly value the system services essential to system security would improve the operation of the power system and drive innovation and investment in the supply of these services.

The ESB has undertaken a high-level indicative evaluation of the benefits of this reform pathway supported by some modelling. The analysis undertaken shows that, the benefits of the structured procurement, scheduling mechanisms and TNSP led procurement of system strength alone would yield benefits of up to \$1.2 billion (NPV). The magnitude of benefits substantially outweigh the implementation costs considered.

Further work will be undertaken on the costs and benefits associated with the reforms on this pathway as part of the AEMC rule changes underway to progress them.

5. Effective integration of Distributed Energy Resources (DER) and flexible demand

5.1. The objective

This pathway is designed to deliver:

- Frameworks that enable **consumers** to be rewarded for their flexible demand and generation, facilitate options for how they want to engage (including being able to switch between DER service providers), and remain protected by a fit-for-purpose consumer protections framework.
- **Wholesale market arrangements** that support innovation, the integration of new business models and a more efficient supply and demand balance.
- **Networks** with the ability to accommodate the continued update of DER, two-way energy flows, and manage the security of the network in a cost-effective way.
- **AEMO** with the visibility and tools it needs to continue to operate a safe, secure, and reliable system, including maintaining system security associated with low minimum system load conditions.

5.2. The issue

The largest generator in the NEM is now owned collectively by customers – and sits on their rooftops. The rapid uptake of domestic DER, with solar now on close to 3 million homes across the NEM, continues to outstrip all forecasts. The emergence of digital and battery technologies is likely to drive further growth in batteries and electric vehicles (EVs) over the coming years, supporting new choices and potential value streams for customers as they offer new forms of flexibility in their load to the grid. Excess power can be stored in batteries and sold back to the grid from the household or vehicle batteries. Figures 4 and 5 below from CSIRO illustrate the projected growth in solar PV and EVs over a range of scenarios, highlighting the potential for EVs to contribute to a significant growth in energy consumption over time.

Although the CSIRO net zero or step change scenarios in particular assume much greater potential for EV uptake towards 2050, we note this is starting from a low base currently here in Australia. Accurate projections at this stage will be challenging but it is clear that significant potential for further uptake exists, and the implications this could have for increased electricity consumption are considerable. A considered and coordinated approach is necessary to support effective integration.

Figure 4 CSIRO, Solar PV capacity: capacity projections⁷

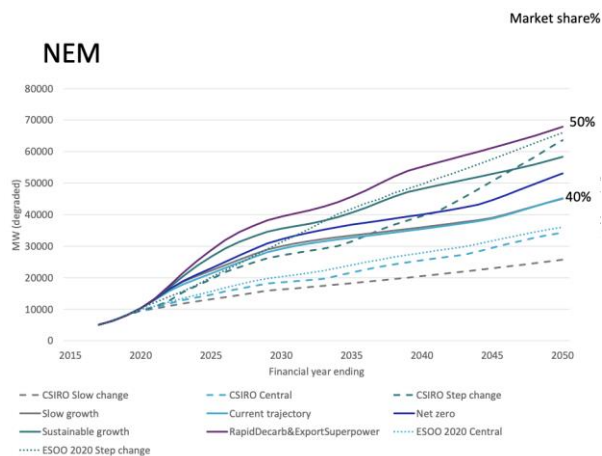
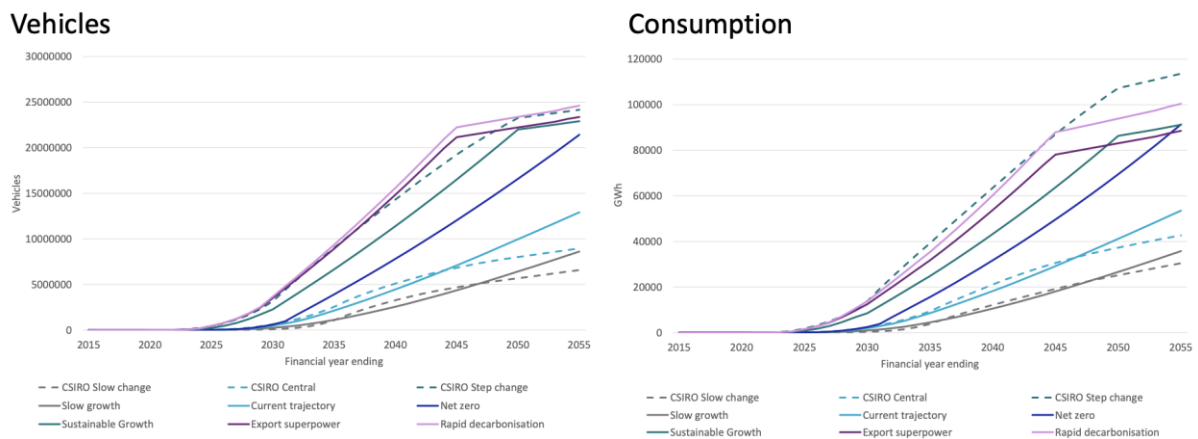


Figure 5 CSIRO, Number of Vehicles and Consumption NEM (BEV)⁸



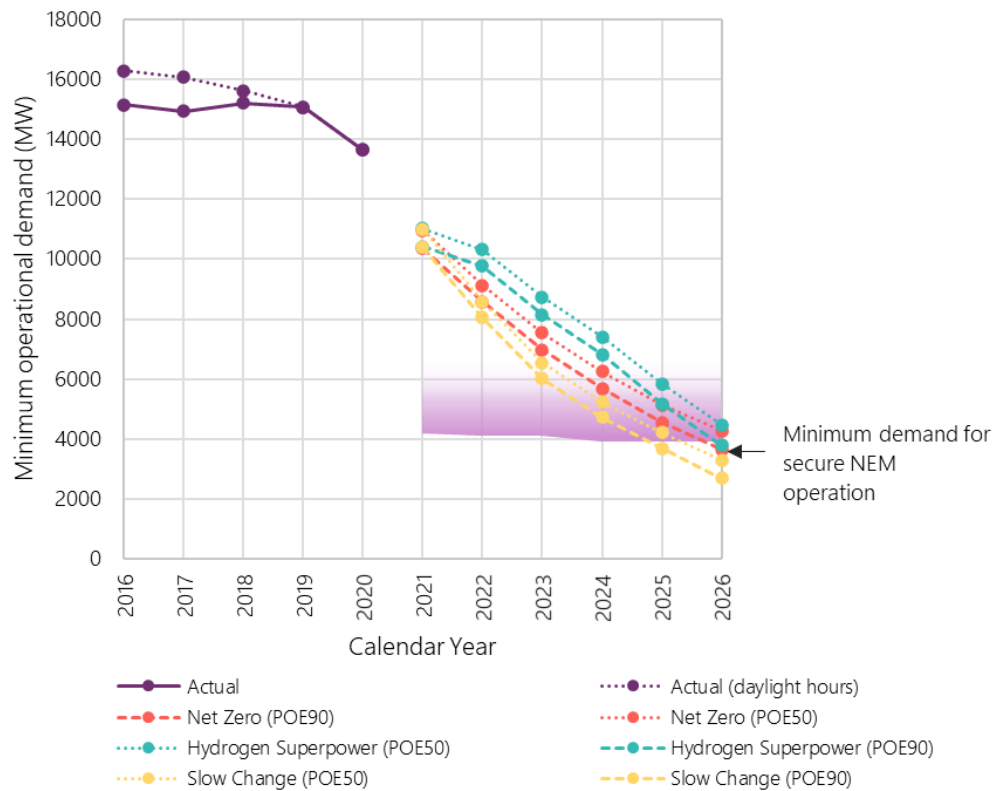
System security challenges

With Australia leading the world in its uptake of DER, emerging system security issues associated with minimum system load are a new challenge for maintaining stable grid operation. These conditions are already being observed in South Australia, and AEMO has forecast the occurrence across the mainland NEM (i.e., Victoria, Queensland and NSW) in its ESOO modelling, as shown in Figure 6 below. Analysis for AEMO’s 2021 ESOO, sets out a number of scenarios (with the central scenario being the Net Zero scenario). AEMO forecasts indicate that NEM mainland minimum demand could be in the range of 4-6 GW by 2024 in the Net Zero scenario. This is a snapshot of the scenarios developed by AEMO in July which were yet to be finalised.

⁷ CSIRO, 2021

⁸ CSIRO, 2021

Figure 6 Minimum demand on the NEM mainland (excluding Tasmania) (90% POE as generated)



Source: AEMO

The system security issues we are currently observing with low minimum system load in South Australia are a symptom of a high penetration of DER devices (notably solar PV installations) not being well integrated into the system. As we transition into the future where the penetration levels of EV's, home storage, and solar PV are predicted to rise to significant levels, the interaction between the system and consumer devices will need to be coordinated to maximise benefits to all customers.

More work is needed by AEMO on characterising how the significant operational challenges associated with times of low system load emerge in each region to better inform when and what solutions are implemented and how they are used. These insights need to be communicated with stakeholders to build greater understanding of the contributing factors. Enhanced transparency of this information will help the market respond with cost-effective solutions.

Enhanced information from AEMO regarding the conditions that lead to low minimum system load events would assist the market in developing a clearer understanding of factors contributing to when and why these system security events may occur, improving community awareness and understanding of the changing system needs and conditions (and how the market can assist).

Emergency backstop solutions that are used to curtail exports from solar PV are in place in South Australia, and it is likely that similar tools are required (given the forecast for system security challenges) in all mainland NEM jurisdictions in the coming years. More immediate action may be required for Queensland, followed by Victoria. The most appropriate backstops may differ by region, depending on the existing infrastructure and technology, and the size and likelihood of the risks.

However, emergency backstops (on their own) are a blunt instrument and need to be complemented with measures to support market response to the system needs, such as development and

implementation of enduring solutions such as dynamic operating envelopes and two-sided market reforms.

Fit for purpose frameworks and customer protections

Technology is changing at such a fast pace; we need to make sure we set up arrangements and remove barriers so new business models and innovative offerings can emerge to offer greater choices to customers (while ensuring they remain protected). Much like how mobile plans have evolved – driven by customer needs and technology – customers will be offered a different range of products to what is in place today and with these products come new risks. Not all customers have access to DER assets, but the efficient market integration of these assets can deliver value to all customers. It is important that customers without DER assets are not disadvantaged through arrangements, and that all customers are adequately protected. Building trust with customers in relation to the delivery of new energy services, including through robust consumer protection arrangements, is a key enabler to the successful integration of DER.

Making the market arrangements more technology neutral means that customers can benefit from a broader range of service providers, with innovative service offerings to meet our needs in ways we cannot even imagine today.

These changes in the way consumers use energy and adopt DER mean that different actors in the system will need to take on more sophisticated roles so the value of resources at the distribution level can be unlocked. For example, networks will need to cope with increasing two-way flows on their system, taking on a more dynamic role in optimizing the needs at distribution level. Where they can use flexibility from their processes, businesses and aggregated customers may also be able to benefit in the form of more efficient processes, new revenue streams that reward their flexibility and reduced energy bills. Businesses that can adapt their processes and demand for power should also benefit from positioning themselves for a global market, leveraging Australia's abundant renewable power for their benefit of their production and supply chain. Ensuring all actors across the energy system have access to data to make informed decisions will be a key enabler for driving greater value to customers.

This means a different mix of resources on the system can meet our future energy needs, as well as supporting a low emissions future and economy. With energy as a significant contributor to emissions, making changes to how we produce and use energy, can deliver decarbonisation benefits and position Australian businesses competitively in markets shifting to tighter controls and decarbonisation policies.

5.3. The reforms

The ESB has developed a **DER Implementation Plan** to integrate the necessary evolution of roles and responsibilities of actors across the system into a suite of technical, market and regulatory reforms from now until 2025. Reforms are intended to leverage technology and data, improve access and efficiency, enhance market participation, and strengthen customer protections and engagement.

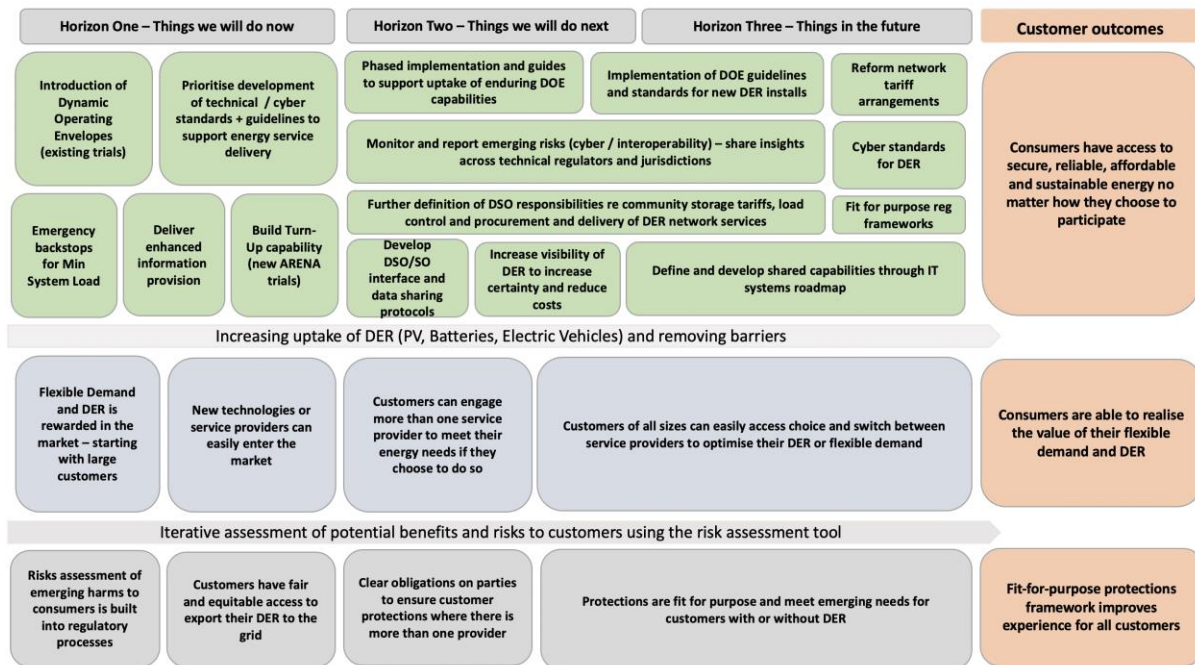
Recognising the different stages in the elements of reform, the Plan sets out activities across new and existing workstreams, including contributions from market and industry bodies. The Plan sequences key dependencies to ensure these reforms are introduced quickly, and timed to address urgent needs associated with the rapid take-up of DER. It highlights where interim measures may be introduced to support the industry through the reform process.

Many of the reforms in the DER Implementation Plan such as development of communications standards and technical regulation, cyber-security, and evolved roles and responsibilities inform both the implementation and operation of some backstop measures, as well as support the move towards more enduring responses. The delivery of the DER Implementation Plan will be supported by a Maturity Plan framework to drive engagement on key issues with stakeholders, including customer

groups. In addition, a customer risk identification and assessment tool will be deployed to assist in ensuring consumer protection frameworks remain fit for purpose.

These activities have been sequenced as *immediate*, *initial*, and *longer-term* reforms (with detail for each reform set out in Part B). A summary page view of the Plan is set out in Figure 7 below.

Figure 7 DER Implementation Plan – summary view



5.4. The benefits of this reform pathway

The ESB has undertaken a high-level, indicative evaluation of the benefits of this reform pathway, supported by some modelling. The analysis shows that the potential benefits of harnessing flexible demand and the successful integration of DER are around \$6.3 billion over the next 20 years. In contrast, in the absence of reform, these new technologies will be misaligned with, and potentially operating against the needs of the system.

The benefits of reform substantially outweigh the implementation costs considered, and indeed these costs may be lower than the costs of no reform. Moreover, these reforms deliver a more diverse, flexible power system that is well-placed to capture all the potential benefits that may emerge from the advent of new technologies, noting that these benefits depend on consumer choice to become more active in the energy market. This highlights the importance of building trust through robust consumer co-design and consumer protections for new energy services.

Further work will be undertaken on the costs and benefits associated with relevant reforms in the DER Implementation Plan (where relevant) as part of the development and implementation of these reforms.

6. Transmission and access reform pathway

6.1. The objective

This pathway is designed to deliver:

- Better signals for generators to locate in areas where there is available generation capacity - namely in the REZs that are being delivered through the ISP and state government policies,
- Reduced uncertainty for investors, through measures that give rise to more predictable future patterns of congestion, and a more orderly and predictable connections process,
- Better use of the network, resulting in more efficient dispatch outcomes and lower costs for consumers, and
- Batteries locating where they are needed most and being paid to operate in ways that benefit the broader system.

Under the current access regime, even an investment that causes heavy congestion may still be profitable for an investor, because the costs of congestion are borne in part by pre-existing generators or consumers rather than fully by the party that caused the congestion. This is because the NEM's current access regime permits any generator that meets the relevant technical standards to connect – irrespective of whether the investment provides value to the broader power system – and then the new generator competes with existing generators for access to available network capacity.

There is also a need to better utilise the network in real time so that the current wave of investments, particularly storage investments, can deliver maximum value for money for consumers.

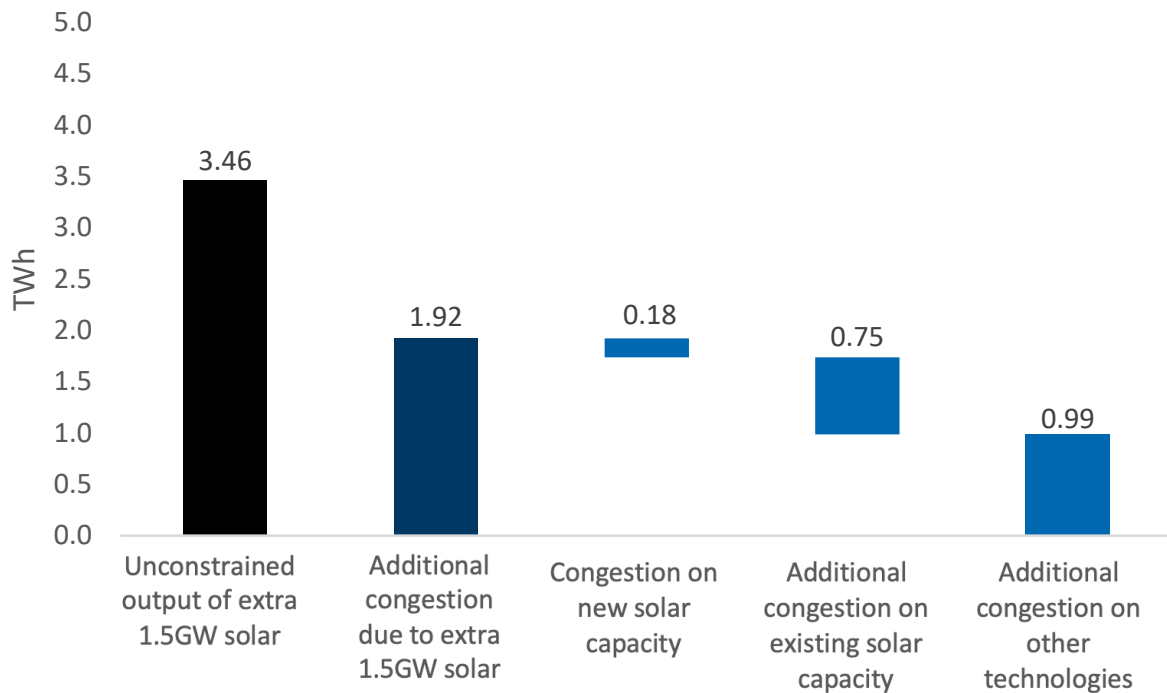
6.2. The issue

6.2.1. Why do we need to change the way we manage congestion in the NEM

At present the Integrated System Plan (ISP) drives the transmission investment, and market signals drive generation investment. The ISP, which is an engineering assessment designed to minimise total system costs, identifies the best possible places for new generation or storage developments from a whole of system perspective and assumes that those resources decide to locate there. However, under the NEM's regional pricing model, investors may be incentivised to make decisions that are individually profitable, but inefficient from a whole of system perspective.

Figure 8 shows how, when generation and transmission investment get out of sync, much of the additional output of the extra generation is offset by additional congestion. Further, only a small fraction of the additional congestion is borne by the party that caused it, with the remainder being borne by pre-existing generators. This inefficient congestion affects the profitability of existing generators, including variable renewable energy (VRE), and has the potential to result in disorderly market exit.

Figure 8 Impact of additional solar generation capacity on congestion volumes



Source: FTI Consulting

To stress test the impact of generation investment in excess of the levels forecast in the ISP, FTI Consulting modelled the impact of adding additional solar capacity to assess how much that would increase congestion rather than provide net additional capacity to the system. For the test, FTI added 300 MW of additional solar generation to the most productive regime in each region (1.5 GW additional capacity in total) for the year 2030. All other inputs and assumptions were derived from the ISP step change scenario assuming no additional major transmission capacity. The additional solar generation provided 3.46 TWh of energy to the system but increased congestion by 1.92 TWh, i.e., only one third of the additional energy was a net gain to the system. While the parties investing in that additional generation suffered a small reduction in output from congestion, the majority of the impact of congestion was on third parties.

The management of congestion in operational timeframes is expected to become increasingly critical in the future as the role of VRE increases and the supply of energy varies in accordance with their fuel sources, the sun and wind. However, investors in VRE have told us that they regard congestion-related operational challenges to be a lower priority than other difficulties they currently face.

On the basis of this feedback, the ESB has done further work to explore whether there is a case for reform of the congestion management arrangements. The ESB engaged FTI Consulting to examine the prevalence of congestion in the NEM in 2030 assuming that transmission, generation, and storage are built in accordance with the ISP step change scenario.

FTI’s modelling suggests that congestion will become significantly more frequent in all regions except Tasmania (see Figure 9 below). FTI estimates transmission constraints will bind almost three times more frequently in 2030 than in 2020. While congestion management may not be a critical issue from the perspective of investors, it is expected to have a substantial impact on the efficiency of the power system and on the level of costs borne by customers.

Figure 9 Percentage of hours per month with at least one constraint binding by State



Source: FTI Consulting⁹

Congestion is a normal, everyday feature of a high VRE power system. It can be profitable for solar developers to build solar farms that produce surplus output during the middle of the day, so that they can produce more during the lucrative shoulder periods. But we are already seeing examples of the impact of congestion now.

Figure 10 shows the forecast impact of congestion on the generation mix in 2030. Over the course of the year, FTI’s modelling suggests that approximately 2.5 TWh of low emission solar will be constrained off, as well as 1 TWh of hydro. Three TWh of higher emission thermal generation will be dispatched instead. Wind output may either increase or decrease as a result of congestion, depending on the circumstances

Constraints generally lead to higher prices in each state for each month, as illustrated below in Figure 11.

⁹ FTI Consulting, Forecast congestion in the NEM, prepared for ESB, August 2021.

Figure 10 Impact of constraints on generation in 2030 (step change scenario), GWh

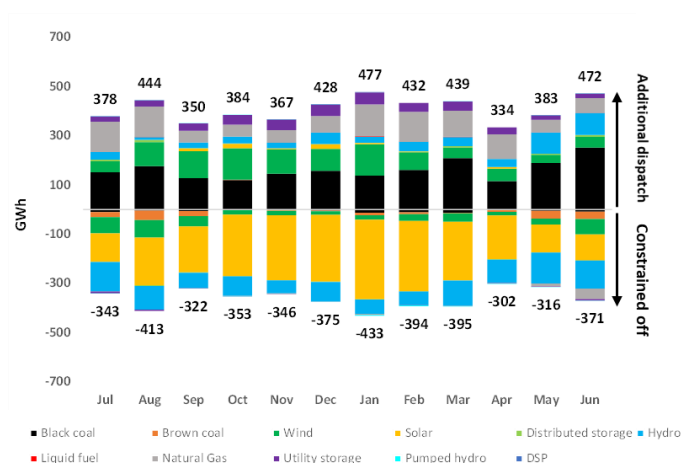
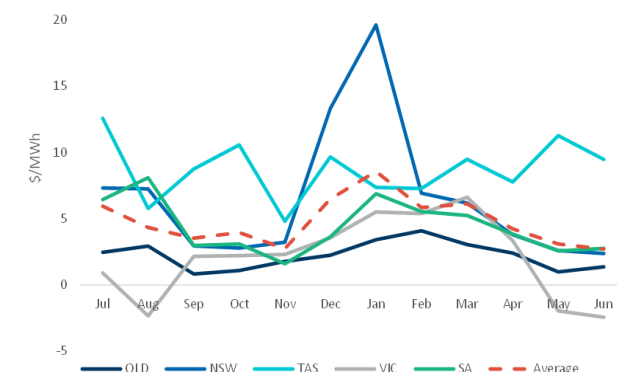


Figure 11 Impact of constraints on time weighted spot market prices, \$/MWh



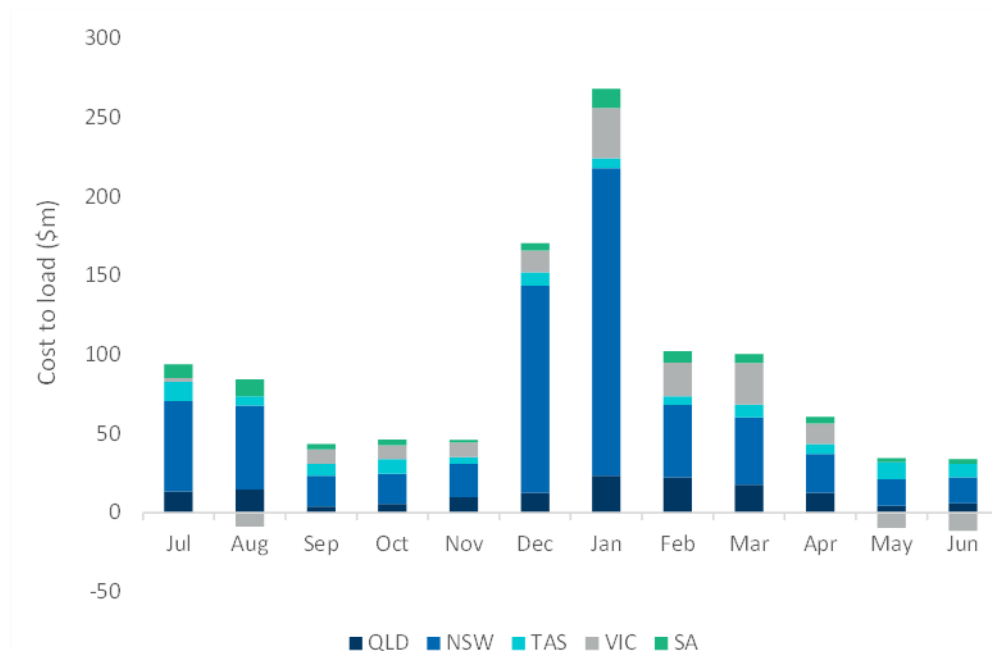
Source: FTI Consulting

The average increase in price across each state is \$5/MWh. In periods when the system is already under stress (for example, during summer), constraints lead to a significant increase in prices. The average price difference in December and January is \$8/MWh.¹⁰ FTI Consulting’s report showed that constraints lead to higher consumer costs, particularly during periods of increased system stress. The total increase in cost to load due to constraints in 2030 is forecast to be around \$1 billion.¹¹

10 FTI calculated these prices using short run marginal cost bidding methodology. They also imposed a price cap of \$1,000/MWh to prevent infrequent price spikes at the Market Price Cap (“MPC”) from overwhelming the results. Prices are time-weighted monthly averages. These results therefore are likely to be conservative.

11 For the purposes of this modelling, FTI reduced the market price cap to \$1000/MWh to prevent outlier events from distorting the results.

Figure 12 Increase in cost to load due to network constraints, 2030



These results can be considered a best-case scenario because FTI’s modelling assumes that the NEM makes the best possible use of the mix of resources available to it. To assess the cost impacts of congestion, it assumes that generators bid in accordance with their short run marginal costs. However, this is not necessarily the case. In practice, when there is congestion on the grid, NEM generators have an incentive to change their bidding behaviour in a way that is profit maximising, that is, tries to avoid being constrained off. This is often referred to as ‘race to the floor’ bidding behaviour: where generators bid at the market floor price to maximise their share of limited transmission capacity. Not racing to the floor when one’s competitors are doing so reduces the generator’s share of dispatch, and hence revenue. If generators adopt these alternative bidding strategies in the presence of congestion, then the costs of congestion (and spot prices) are likely to be higher. As the frequency and cost of congestion increases, it becomes increasingly important to manage congestion in a way that ensures that the associated costs are minimised.

We need to better utilise the network in real time so that the current wave of investments can deliver maximum value for money for consumers. Current market structures are a poor reflection of conditions on the physical power system. They are expected to come under increasing strain as VRE increases and power system flows become more complex. For instance, if the current market design is retained, there is a risk that interconnectors will not be able to be fully utilised due to more frequent clamping (where AEMO is required to intervene to prevent flows across the interconnector).¹² In the absence of reform, these types of market intervention – which are needed because of the current market design – can be expected to have the effect that consumers will not receive the full anticipated benefits of these investments.

6.2.2. Why we need to change the way we invest in transmission

Substantial transmission investment is needed to accommodate the forecast 26-50 GW of new low-cost large-scale variable renewable energy expected by 2040. These relatively smaller and geographically dispersed renewable generators need to connect in windy or sunny parts of the grid. Historically the transmission network was built to transport energy from coal fuelled and hydro

¹² This issue is explained in more detail in Part C.

generation to load centres. The current networks have not required large amounts of transmission capacity in the areas where this new generation now needs it.

Work is underway to develop committed and actionable ISP projects. However, challenges are emerging in getting the new network built. These include planning issues, community concerns, biodiversity, indigenous heritage, difficulties getting access to land and reluctance by networks to take risk and cope with financing very large projects. There are also questions over whether the network planning framework, including the role of the ISP and Regulatory Investment Test for Transmission (RIT-T), could be streamlined and whether large transmission projects could be delivered more efficiently through competition rather than by incumbent transmission network service providers. These emerging challenges create risk that the new network is not built in a timely manner and at least cost.

The methodology used to allocate transmission costs between jurisdictions and between loads is also coming under greater scrutiny. For instance, the actionable ISP project to develop Marinus Link is subject to a decision rule whereby the project will only proceed if agreement is reached on how the cost of the project will be recovered. The ESB has provided advice to Energy Ministers on transmission cost allocation and governments are currently conducting further analysis and considering next steps.¹³ Given the scale of transmission build necessary for the future, the ESB considers there is a need to resolve an appropriate fair cost allocation methodology for transmission.

6.3. The reforms

The ESB's package of transmission and access reform include a range of measures to get transmission and generation built when and where it is needed. In parallel to the ESB's package of reforms, major programs are being undertaken by State governments. The reforms described below are intended to complement and support the work of State governments.

6.3.1. Immediate reforms

AEMC's dedicated connections assets and system strength rule changes

On 8 July the AEMC made a final rule on its Dedicated Connection Assets rule change, which establishes new opportunities for a generator, a group of generators, merchant investors or governments to develop a radial REZ on a commercial basis. The AEMC has also recently published its draft determination on the system strength rule change, with a final determination expected by October 2021.¹⁴ The reformed system strength regime has the potential to complement and build on the coordinated process used to deliver REZs. Both of these reforms complement the ESB's reform pathway.

An interim REZ framework - including access within a REZ

The ESB has separately made recommendations for an interim REZ framework - including access within a REZ. The principles relate to four key issues: planning, connections, funding and economic regulation, and access. These principles provide flexibility to enable jurisdictions to pursue REZ schemes in accordance with required timeframes, while also maintaining consistency across the NEM with respect to core aspects of the market design. The interim REZ framework is designed to align with key areas of market reform that should ultimately form part of the Rules, including the transmission access regime and system security frameworks.

13 <https://energyministers.gov.au/sites/prod.energycouncil/files/publications/documents/EC%20-%20communique%20-%2020200320.pdf>

14 <https://www.aemc.gov.au/rule-changes/efficient-management-system-strength-power-system>

In an interconnected power system, developments in one location can have significant flow on consequences elsewhere, including in other jurisdictions. The interim REZ principles seek to ensure that REZ developments avoid costly ramifications from a whole of system perspective.

6.3.2. Initial reforms

Transmission Access Reform

The interim REZ framework, and jurisdictional schemes developed in line with that, should allow the implementation of a number of early REZs to proceed. However, these arrangements will not be sufficient to ensure efficient development of the grid and connection to it in the medium to longer term. Broader, network wide, access reform is required for this.

Having considered stakeholder feedback, the ESB recommends the congestion management model adapted for integration with REZs, or CMM(REZ), be further developed and progressed. The CMM(REZ) uses REZs to co-ordinate generation and transmission investment and deliver an orderly transition. It is designed to resolve the problems associated with the current open access regime, while seeking to avoid the concerns identified by stakeholders in relation to the Locational Marginal Pricing/Financial Transmission Rights (LMP/FTR) model. It supports and strengthens the REZ framework by:

- strengthening incentives for new entrants to locate and participate in REZ investments
- improving connection as pro-active and scale efficient actions can be taken to manage system security issues including system strength; and
- giving REZ participants confidence that their investment case will not be undermined by subsequent inefficient investment decisions outside the REZ.

The CMM(REZ) also improves the way that the NEM deals with congestion in operational timeframes. It creates a market design that incentivises generators to bid more closely to their true costs of generation based on their location (that is they bid in line with their short run marginal cost). Better incentives to drive operational behaviour means congestion across the grid is managed efficiently and maximises the value derived from new transmission investments. These better operational incentives also create new business opportunities for batteries and other types of storage to be paid to alleviate transmission congestion.

To deliver these benefits, the CMM(REZ) introduces a dual mechanism of congestion charges and congestion rebates:

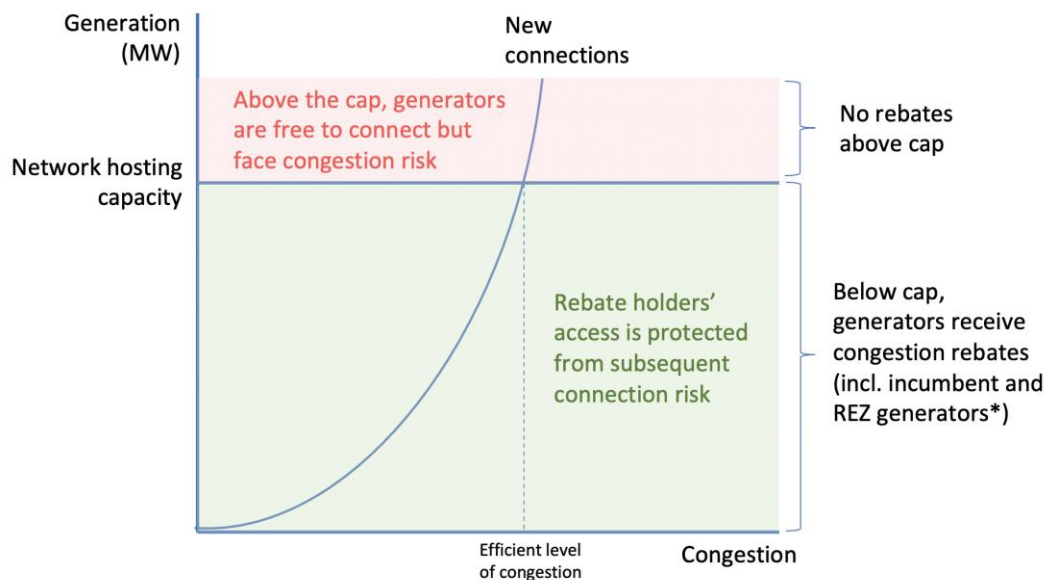
1. All scheduled and semi-scheduled generators would face a **congestion charge**, calculated each dispatch interval on a \$/MWh basis reflecting the generator's impact on congestion in the dispatch interval.
2. Eligible scheduled and semi-scheduled generators would receive a **congestion rebate**, calculated each dispatch interval, funded from the collective revenue received from the congestion management charges. The size of the rebate would be determined in accordance with a pre-determined allocation metric, such as availability.

The ESB proposes that only incumbent generators and new generators that locate in accordance with the planning framework (i.e., in REZs) receive the congestion rebate.

The rebate, in combination with the congestion management charge, is designed to result in financial outcomes for eligible market participants that replicate the status quo arrangements, recognising in

practice that changes in bidding behaviour could have some effect on outcomes.¹⁵ The model supports and strengthens the REZ framework by rewarding generators who locate in the 'right' place, who receive greater certainty on matters such as marginal loss factors, congestion and constraints.

Figure 13 Availability of congestion rebates under CMM(REZ)



* Note: A key issue for further consultation is whether to confer "REZ" status on areas with spare network capacity outside regions currently classified as REZs.

Generators would still be entitled to connect where they wish (subject to meeting agreed technical standards). However, if they wish to connect in a location that is inconsistent with the planned development of the system, then they would face the associated congestion risk.

A key issue for further consideration is how to determine which new developments should be eligible to receive rebates. There is scope to make the rebates more widely available (for instance, by conferring 'REZ' status on areas with spare network capacity outside regions currently classified as REZs). However, there is a trade-off between giving investors more flexibility in terms of their location decisions and the level of certainty that they obtain from the congestion rebates.

Transmission Planning and Investment Review

A wave of new transmission investment is underway. However, challenges are emerging in getting the new network built. In this context, the AEMC is conducting a review to determine whether changes are required to the regulatory framework in order to maximise benefits to consumers through the timely and efficient delivery of major transmission projects (including ISP projects). The scope of the review may include, but is not limited to:

- Implications of TNSPs having the monopoly right but no obligation to build critical major transmission infrastructure.
- Consideration of whether existing frameworks support and provide sufficiently strong incentives for TNSPs to deliver major transmission projects in a timely and efficient way,

¹⁵ In practice, differences will arise because generators are expected to change their bidding behaviour. However, the difference would be second order. For instance, generators that engage in race to the floor bidding currently have a disproportionate advantage over those who do not, but this advantage would cease under CMM. The precise impact on market participants will depend on detailed specification of the metric used to allocate congestion rebates between eligible generators.

including examination of potential improvements and alternatives such as the introduction of contestability in transmission planning and delivery.

- Opportunities to improve the RIT-T and the ISP processes.
- Related rule changes that could be run concurrently with the Review.

Stage 1 of the review will focus on identifying and testing issues associated with the frameworks for planning, funding, financing, and delivering major transmission projects. Stage 2 will focus on identifying and developing solutions to address the issues identified in Stage 1. A consultation paper is anticipated in Q3 2021.

Enhanced congestion information

AEMO is consulting on options to enhance the information made available in operational timeframes in its Congestion Information Resource. This resource provides information to the market about existing and forecast congestion. In addition, AEMO and the Clean Energy Council are considering whether there are opportunities to make more forward-looking information available in the context of the Connections Reform Initiative. No action is needed by Ministers on this reform.

6.3.3. Long term reform

Throughout the Post-2025 project, the ESB has supported locational marginal pricing and financial transmission rights as a preferred model in the long term and proposed a stepping-stone approach to reach that goal. However, a strong theme of submissions to the options paper made clear that it would be disruptive to introduce successive access models to move to an LMP/FTR regime. To provide stability and clarity to the market, the ESB's view is that implementing the congestion management model should be the priority reform at the current time to address congestion.

6.4. The benefits of this reform pathway

The ESB has undertaken a high-level, indicative evaluation of the benefits of this reform pathway, supported by some modelling. Historic analysis of the Californian and Texan electricity markets suggest that the savings associated with efficient congestion management are between 2-4% of the variable costs of generation. Applying the average of these results in the context of the NEM managing congestion in operational timeframes would suggest potential benefits of around \$1 billion over the period 2024-2040. This finding is broadly consistent with the bottom-up analysis of the potential dispatch efficiencies associated with a move to locational marginal pricing in the NEM and other modelling previously completed in relation to the benefits of locational marginal pricing. The magnitude of these benefits substantially outweigh the implementation costs considered.

Further work will be undertaken on the costs and benefits associated with choices for the detailed design of the congestion management model.

7. ESB Data Strategy

7.1. The objective

Digitalisation and data are critical foundations for the transformation. Coordinating a secure and affordable energy system of diverse renewable and distributed technologies, with consumer services at the centre, is achievable but depends on the opportunities that digital technologies and data bring.

The ESB Data Strategy addresses these challenges, providing direction for the data management needed to:

- *Manage changing data needs in the energy transition, and*
- *Optimise the long-term interests of energy consumers in a digitalised economy.*

The ESB Data Strategy and recommendations are provided to Energy Ministers alongside this report.

7.2. The issue

It is important that customers, market participants, operators and policy makers have the data they need to respond to changes in the sector and make efficient and effective decisions. Inefficiencies associated with data gaps or access have contributed to customer affordability and security challenges in recent years. Current and emerging challenges include:

- **Customers:** Are exposed to more choice and innovative products and services and need easy access to clear information to make those choices. Improved data services are critical to facilitate this.
- **Service providers:** Service providers and new entrants will benefit by improved access to customers data. Currently only incumbent retailers have access to historic data for a large number of consumers, allowing them to analyse and target services in a way new entrants cannot. Current data gaps create barriers to innovation that can deliver benefits to customers.
- **Network operators:** Network operators are already managing significant volumes of DER on their networks and making decisions with limited knowledge about the DER on their network. Export constraints are occurring, and local network needs are difficult to understand. As the penetration of solar PV, EVs, batteries and flexible demand services increases, visibility of DER is essential to support network operators in managing the system security needs effectively.
- **Market bodies:**
 - **Regulation:** More products and greater diversity of retail models means there is a need for additional data to identify and assess emerging risks to customers. Additional data will allow regulators to monitor customer outcomes, ensuring protections remain fit for purpose as products and services evolve.
 - **Market development:** Markets need to evolve and adapt, particularly over this period of rapid transition. Information is needed to monitor market participants, assess emerging trends and how customers are responding.
 - **Planning and operations:** The Integrated System Plan (ISP) and planning activities are critical to transmission development. Access to timely and accurate data can inform the development of Renewable Energy Zones (REZs), and broader investment decisions by participants. Data such as that published by AEMO in the Electricity Statement of Opportunities (ESOO) is fundamental to development of future market mechanisms, including the proposed capacity mechanism. From an operational perspective, access to timely data and enhanced visibility of resources is critical to AEMO and network businesses in a highly distributed environment.

- **Policy Makers:** Improved access to data can lead to better policy outcomes for consumers and improved monitoring of consumer protections. Directions for reforms have been proposed by ESB for all Post-2025 market design pathways. It is important that progression of these reforms is informed by timely and accurate information.

Digitalisation of the energy market is well underway, but despite this, decision makers across the energy sector, from customers to planners, frequently cannot access the data they need, leading to less certainty, discouraging investment, and placing unnecessary costs on consumers. Access to relevant data can better target research outcomes, guide effective policy and enable informed decision making. Key issues remain, including that:

- The current regulatory frameworks often prohibit effective sharing
- Processes and systems needed to share, coordinate, and use data safely are often missing, leading to costly attempts to negotiate *ad hoc* solutions and delays in addressing sector-wide needs.
- Current systems are not able to keep pace with new technologies, which are creating new data needs, particularly in the areas of distributed energy technologies and consumer decision-making and billing.

These challenges require a coordinated approach.

7.3. The Strategy

Addressing new data needs and current gaps cannot be resolved in time to support the rapidly transforming market without a more active and coordinated approach. The Data Strategy addresses these concerns through its four key pillars:

- **New Framework:** Introducing new guiding principles and regulatory reforms to remove existing barriers to better consumer outcomes, support safer data management, and ensure frameworks are fit-for-purpose in a future energy market.
- **Capability building:** Building leadership, coordination and capability across agencies and stakeholders, to better manage data growth, grow value from analytics and support the data services the market needs.
- **Priority data gaps:** Filling gaps in current data sets, critical to support the *needs today* of better planning, evolving services, and robust consumer protections.
- **Forward planning and adaptability:** Introduce regular proactive review and planning to meet *needs tomorrow*, timely standards, flexibility in data arrangements, and facilitating early needs for research and innovation.

Implementation of the Data Strategy is proposed to begin immediately in 2021-22 in order to deliver the immediate, initial and longer-term measures identified within it.

7.4. Benefits of the strategy

Early action on data better equips the sector to manage these risks and challenges that come with a more complex, diverse, and variable energy system through:

- informed consumer choice and personalised advice across more competitive, innovative, complex, and tailored services, reducing consumer bills and costs. (e.g., bundling services like EV and batteries across multiple providers).
- safe integration of new technologies and optimisation of their benefits, both through research and operational processes.
- enhanced monitoring and visibility of the energy contracting behaviour of wholesale market participants, which can have impacts on price, energy dispatch and reliability.
- enhanced visibility of resources to networks and the system operator, helping to balance diverse two-way markets while maintaining reliable supply and efficient prices.
- better forecasting and planning activities in an environment with increasing two-way flows, variable output resources, and new technologies and configurations of supply and demand flows on the grid.
- better management of dynamic local networks and extreme events (e.g., to support understanding of hosting capacities and constraints, development of minimum demand measures, and dynamic operating envelopes).
- efficient planning of significant upgrades to network and distribution infrastructure, resource adequacy and essential services, around rapid change, minimising risks to affordability.
- fit for purpose consumer protections and equity, in the face of increasingly sophisticated services. Transparency can allow for light-handed but responsive regulation of emerging new services, while not limiting innovation through prescriptive requirements.
- data to support greater visibility of real-time behaviours at different levels of the network, and compliance of DER systems with market commitments (noting transparency of DER and the low voltage network remain as the largest data gaps in the system).
- up-to-date technical and communications standards which consider interoperability, to support competition and innovation.
- cyber security requirements, to protect against attempts by sophisticated but ill-intentioned actors to exploit NEM systems.

It also supports an informed, staged, and responsive approach to wider reforms on data, outside of the energy sector, as market-driven change and technologies continue to emerge.

8. Enabling Implementation

The Post-2025 reform pathways set out ‘what’ needs to be done to meet the needs of the transition. The ‘how’ of the reform implementation is critical for delivery and involves *inter alia* the management and mitigation of the delivery risks. The more important risks include governance, the management of the reforms, recognising the interdependencies between the reforms, implementation costs, and possible changes in policy.

Management of the reforms

An adaptive management approach to delivery is needed so the market can respond as reforms progress. This approach is supported by the pathway across time outlined for each of the four workstreams. The ongoing process of reform over time also enables a continued focus on the changes needed to support the transition at least cost to consumers.

Each reform should undergo thorough preparation and careful planning before implementation and be reviewed and monitored as it progresses. This needs to occur at a detailed level as well as more generally. At a more general level, the type of industry change happening here has not been experienced anywhere before. As we learn more there is a need to adapt and modify to ensure that the changes are benefiting consumers. The delivery program for each reform needs to accommodate this approach.

Interdependencies

While the work has concentrated on four pathways the reality is that all four pathways are interconnected. The workstream separation has made the task of developing a redesign of the NEM manageable but separation runs the risk of interdependencies across the pathways being overlooked. The four key interdependencies that were relevant in developing the reform pathways were:

- *Resource adequacy mechanisms and ageing thermal retirement and Effective integration of Distributed Energy Resources (DER) and flexible demand (DER Implementation Plan)*
- *Transmission and access reform and Resource adequacy mechanisms and ageing thermal retirement*
- *Resource adequacy mechanisms and Essential system services and scheduling and ahead mechanisms*
- *DER Implementation Plan and Essential system services and scheduling and ahead mechanisms.*

As implementation of the reforms progress it is important that checks are made to ensure that these interdependencies are being accounted for appropriately. Doing so needs more detailed designs developed in many areas.

Implementation Costs

Measures that enable implementation also require adequate funding. An assessment of the likely costs to market participants (to be borne by them) and for the market bodies has not been undertaken in detail, and generally cannot be, until more detail on the reforms is developed and the precise timing and manner of their introduction is decided. While the estimated costs of some reforms (like transmission construction) have received some attention, the costs of most other reform measures are awaiting more detail before costings and the timing of those costs are developed.

Nevertheless, the broad parameters of annual budgets for the market bodies over several years into the future can be formulated within a range. The market bodies are able to provide their initial views on their budget requirements for the reform process by the end of August 2021. Noting that as implementation of reforms will occur over time, these cost estimates will be set out on a year-by-year basis. The important point is that without these budgets being funded, the reforms cannot be implemented, and this is a major risk.

IT systems and processes are a critical enabler in this reform process and the reforms bring changes to systems that are felt right through the NEM. An impact assessment of the AEMO run IT system shows how the multiple reforms in the Post-2025 design are accompanied by necessary IT changes and business processes in many different areas and systems. All the NEM is impacted to some degree.

AEMO will consider how to deliver the IT system and business process changes together with industry stakeholders as part of an integrated roadmap for NEM regulatory and IT systems implementation. This will enable careful sequencing of reforms, avoid unnecessary or duplicative costs, test key assumptions for system design and identify where strategic investments can be made to enable more efficient outcomes for AEMO, market participants and customers.

AEMO has developed an indicative cost estimate to implement its system changes to support the reforms and this estimate is between \$250 to \$330 million. AEMO's current funding mechanism may be insufficient for the longer-term upgrade that is necessary for AEMO's existing systems and business processes. AEMO, the AER and the AEMC will provide indicative annual funding proposals out to 2025 for consideration by 31 August 2021.

Contact details:

Energy Security Board

Level 15, 60 Castlereagh St

Sydney NSW 2000

E: info@esb.org.au

W: <http://www.coagenergycouncil.gov.au/market-bodies/energy-security-board>